

Materials Management 101: Waste Characterization Studies

February 24, 2026

NEWMOA

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Acronyms

- **ASTM:** American Society for Testing and Materials
- **C&D:** Construction and Demolition
- **EPA:** US Environmental Protection Agency
- **EPR:** Extended Producer Responsibility
- **HHW:** Household Hazardous Waste
- **ICI:** Industrial/Commercial/Institutional
- **MSW:** Municipal Solid Waste
- **MTCO₂E:** Metric tons of Carbon Dioxide Equivalent
- **OMG:** 1 of 2 common exclamations heard around the sort table when an especially icky item is found in the trash
- **WARM:** Waste Reduction Model
- **WCS:** Waste Composition Study or Waste Characterization Study
- **WTE:** Waste-to-Energy



Syllabus

- Waste Characterization Studies
 - Overview
 - History
 - Study Design Considerations
 - Field Data Collection
 - Statistics/Analysis
 - Recent Studies in NEWMOA States
- Other Related Studies
 - Waste Audits
 - Visible Litter Studies
 - Recycling Contamination Monitoring

What makes it a Waste Characterization Study?



A Waste Characterization Study follows technical guidelines to apply statistical sampling and analytical principles to the measurement of mixed material composition

This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.



Designation: D5231 – 92 (Reapproved 2024)

Standard Test Method for Determination of the Composition of Unprocessed Municipal Solid Waste¹

This standard is issued under the fixed designation D5231; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method describes procedures for measuring the composition of unprocessed municipal solid waste (MSW) by employing manual sorting. This test method applies to determination of the mean composition of MSW based on the collection and manual sorting of a number of samples of waste over a selected time period covering a minimum of one week.

1.2 This test method includes procedures for the collection of a representative sorting sample of unprocessed waste, manual sorting of the waste into individual waste components, data reduction, and reporting of the results.

1.3 This test method may be applied at landfill sites, waste processing and conversion facilities, and transfer stations.

1.4 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

1.5 This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use. For specific hazard statements, see Section 6.

1.6 This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

2. Terminology

2.1 Definitions:

2.1.1 **composite item**—an object in the waste composed of multiple waste components or dissimilar materials, such as

disposable diapers, bi-metal beverage containers, electrical conductors composed of metallic wire encased in plastic insulation, etc.

2.1.2 **solid waste composition or waste composition**—the characterization of solid waste as represented by a breakdown of the mixture into specified waste components on the basis of mass fraction or of weight percent.

2.1.3 **sorting sample**—a 200 to 300 lb (91 to 136 kg) portion deemed to represent the characteristics of a vehicle load of MSW.

2.1.4 **unprocessed municipal solid waste**—solid waste in its discarded form, that is, waste that has not been size reduced or otherwise processed.

2.1.5 **waste component**—a category of solid waste, composed of materials of similar physical properties and chemical composition, which is used to define the composition of solid waste, for example, ferrous, glass, newsprint, yard waste, aluminum, etc.

3. Summary of Test Method

3.1 The number of samples to be sorted is calculated based on statistical criteria selected by the investigators.

3.2 Vehicle loads of waste are designated for sampling, and a sorting sample is collected from the discharged vehicle load.

3.3 The sample is sorted manually into waste components. The weight fraction of each component in the sorting sample is calculated from the weights of the components.

3.4 The mean waste composition is calculated using the results of the composition of each of the sorting samples.

4. Significance and Use

4.1 Waste composition information has widespread applications and can be used for activities such as solid waste planning, designing waste management facilities, and establishing a reference waste composition for use as a baseline standard in both facility contracts and acceptance test plans.

4.2 The method can be used to define and report the composition of MSW through the selection and manual sorting of waste samples. Where applicable, care should be taken to consider the source and seasonal variation of waste.

¹ This test method is under the jurisdiction of ASTM Committee D34 on Waste Management and is the direct responsibility of Subcommittee D34.03 on Treatment, Recovery and Reuse.

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ASTM D-D5231 – 92 (2024) Standard Test Method for Determination of the Composition of Unprocessed Municipal Solid Waste



What Are the Polls Saying?

“How many voters in Moldova intend to vote for the Rational Centrist Party (RCP) in the upcoming election?”

Poll Findings: 78%

*Based on 1,392 responses
Margin of error +/- 3%*



What is the WCS Saying?

“What is the composition of this mixed material stream?”

Key Material Category	Margin			Key Material Category	Margin		
	Mean	of Error	Tons		Mean	of Error	Tons
Material Group 1 - Paper	26.7%	1.1%	206,165	Material Group 6 - Glass	1.5%	0.2%	11,727
CR OCC (Old Corrugated Cardboard)	8.4%	0.9%	64,665	CR Glass Bev. Bottles & Cont.	1.2%	0.2%	9,077
CR Boxboard (Chipboard)	1.5%	0.1%	11,537	NR Other Glass (Non-Container)	0.3%	0.2%	2,650
CR Aseptic and Gable Top Cartons	0.4%	0.1%	3,194	Material Group 7 - Electronics	1.0%	0.2%	7,997
CR High Grade Office Paper	0.3%	0.1%	2,037	RS Non-CED Electronics	0.2%	0.0%	1,301
CR Magazines/Catalogs	0.5%	0.1%	3,523	RS CED Electronics	0.1%	0.0%	628
CR Mixed Recyclable Paper	2.3%	0.2%	18,037	RS Other Electronics	0.1%	0.1%	609
CR Newsprint	0.3%	0.0%	2,049	RS Small Appliances	0.5%	0.1%	3,915
PD Books	0.4%	0.1%	3,268	RS White Goods	0.2%	0.2%	1,544
CO Compostable Paper	7.9%	0.4%	61,388	RS Solar/PV Panels/Compon.	0.0%	0.0%	0
NR Non-Recyclable R/C Paper	4.7%	0.7%	36,468	Material Group 8 - Hazardous Waste	0.9%	0.3%	6,745
Material Group 2 - Plastic	18.1%	0.9%	139,685	RS Mercury-Containing Prod.	0.0%	0.0%	12
CR #1 PET Beverage Bottles	0.9%	0.2%	6,725	RS Paint	0.1%	0.0%	528
CR #1 PET Thermoforms	0.6%	0.1%	4,408	RS HHW	0.1%	0.1%	1,107
CR #2 HDPE Beverage Bottles	0.0%	0.1%	149	RS Medical Waste	0.7%	0.0%	5,098
CR #2 HDPE Containers	1.1%	0.2%	8,716	Material Group 9 - Ceramics	0.1%	0.0%	964
CR #3, 4, 5, 7 Bottles & Cont.	0.0%	0.0%	233	PD Ceramic Bottles - BB	0.0%	0.0%	5
CR #5 PP Containers	1.1%	0.1%	8,495	NR Other Ceramics Containers	0.1%	0.0%	959
CR #6 PS Rigid Containers	0.3%	0.1%	2,049	Material Group 10 - CDD	4.5%	0.7%	34,620
NR #6 EPS Foam Food and Bev. Cont.	0.1%	0.0%	1,089	CD Asphalt Brick and Concrete	0.0%	0.0%	164
NR #6 EPS Foam Non-Food Pkg./Prod.	0.2%	0.1%	1,621	CD Asphalt Shingles	0.1%	0.1%	1,122
PD Bulky Rigid >1 Gallons	2.3%	0.3%	17,593	CD CDD Metal	0.2%	0.1%	1,629
PD Plastic Film	8.6%	0.1%	66,106	CD Ceramic Fixtures	0.0%	0.0%	306
NR Remainder/Other Plastic	2.9%	0.4%	22,500	CD Drywall/Gypsum Board	0.4%	0.2%	2,757
Material Group 3 - Metal	4.2%	0.5%	32,675	CD OSB/Plywood	0.1%	0.1%	837
CR Aluminum Cans	0.5%	0.0%	4,116	CD Other/Residual CDD	2.1%	0.4%	16,205
CR Aluminum Foil & Pans - NBB	0.3%	0.0%	2,665	CD Painted/Treated Wood	1.5%	0.4%	11,601
CR Ferrous Containers	0.8%	0.1%	6,171	Material Group 11 - All Other Waste	16.2%	1.1%	125,458
PD Other Ferrous	1.6%	0.4%	12,517	CD Carpet/Padding	0.8%	0.3%	6,275
PD Other Non-Ferrous	0.9%	0.2%	7,206	NR Diapers/Sanitary Products	3.6%	0.5%	27,500
Material Group 4 - Organics	26.7%	1.3%	206,406	PD Furniture/Bulky Items	3.5%	0.9%	26,935
PD Food Waste - Packaged	7.4%	0.6%	57,276	RS Supplem./Pharma./Medic.	0.0%	0.0%	229
CO Food Waste, Unpackaged	11.8%	0.8%	91,064	RS Textiles/Leather	3.5%	0.3%	27,144
CO Branches and Stumps >1"	0.0%	0.1%	250	RS Rubber/Tires	0.8%	0.2%	6,140
CO Mixed Yard Waste	1.4%	0.4%	10,795	RS Mattresses	0.3%	0.2%	2,001
CO Clean Wood	1.4%	0.4%	10,598	NR All Other Materials	1.5%	0.2%	11,280
NR Other Organics	1.2%	0.2%	9,642	NR Fines	2.3%	0.1%	17,955
NR Pet Waste	3.5%	0.5%	26,781				
Material Group 5 - Batteries	0.1%	0.0%	488	Total	100.0%		772,930
RS Batteries	0.1%	0.0%	488	<i>Samples</i>	<i>268</i>		



Overview of WCS Process



Sample



Sort by Category



Weigh



Document



Analyze

Why were Waste Characterization Studies invented?





WTE engineers needed to forecast the energy (Btu) value of municipal solid waste as a feedstock



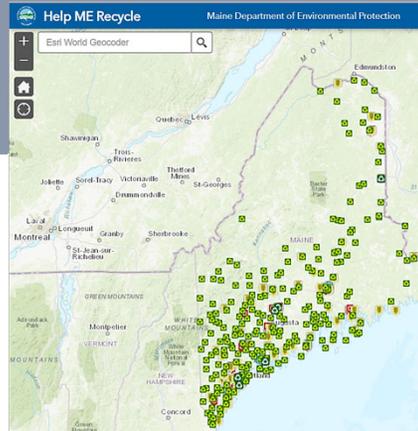


Waste Characterization Studies

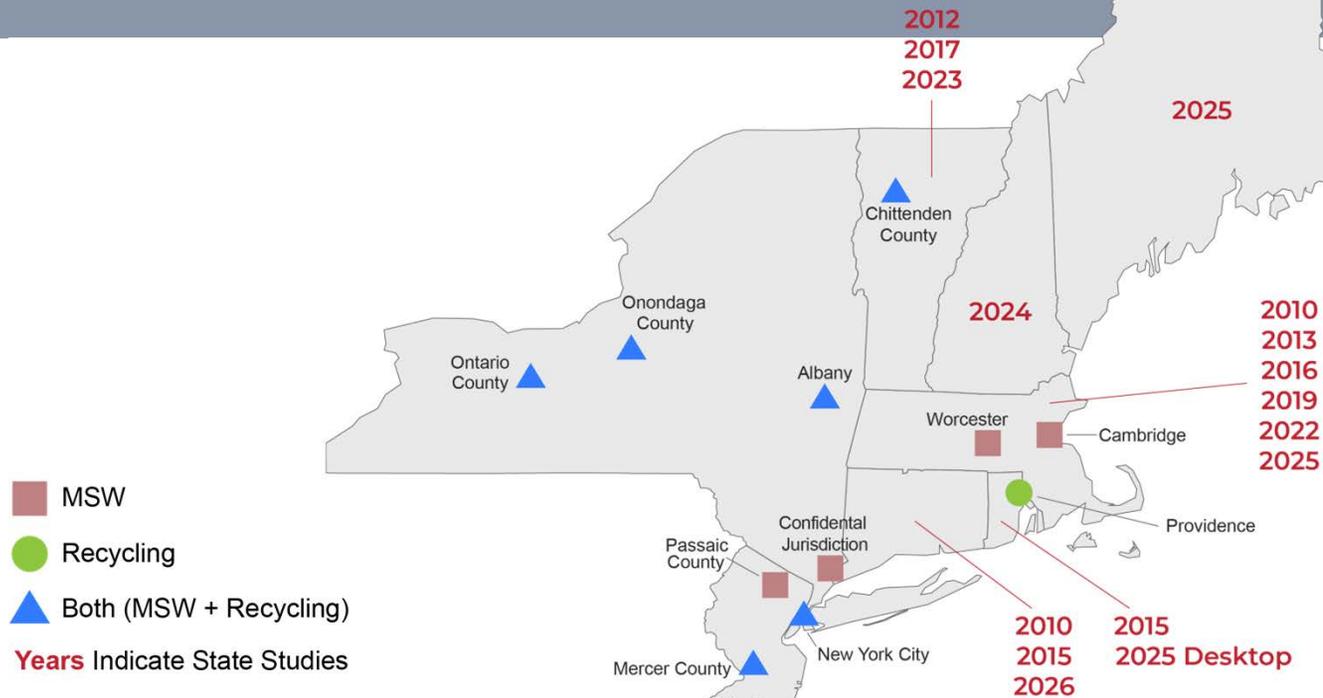


Methodology

- Sampling Plan
- Host Facilities
- Material Categorization
 - Like Groupings
 - Like Management Pathways
- Data Management
- Safety and Health



WCS in NEWMOA States



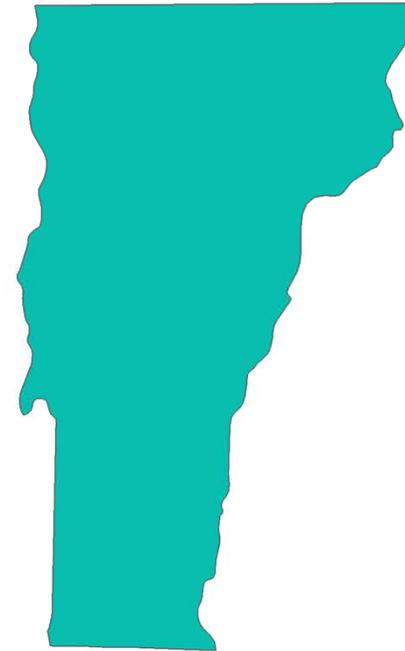
What is the Universe of Materials Being Characterized?

Reported Vermont Waste Disposal (2022)

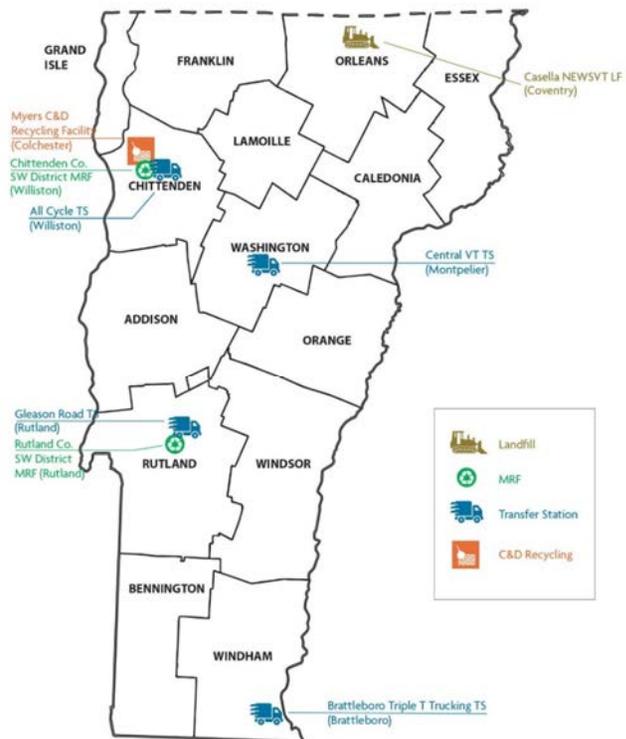
Type of Waste	Tons	Percent
Municipal Solid Waste (MSW)	465,054 ^[1]	95.8%
Construction and Demolition (C&D) Debris	20,469 ^[2]	4.2%
Total	485,523	100.0%

^[1] Includes 63,858 tons MSW disposed out of state.

^[2] Includes 12,128 tons C&D disposed out of state.



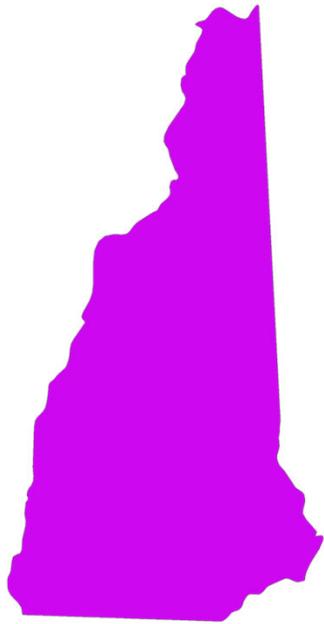
Where Can You Get Representative Samples?



Keys to Host Facility Selection

- Willingness of facility owner
 - Available workspace and support
- Geographic distribution
- Mix of waste by generator sectors
- Direct-haul wastes preferred

Sampling Targets



Facility	Proposed Sample Targets	Actual Samples
TLR-III Refuse Disposal Facility	50	55
Wheelabrator Concord Facility	40	34
Municipal Solid Waste & Citizen Drop-Off Facility	40	53
Mt. Carberry Secure Landfill	40	40
North Country Environmental Services	40	9
Nashua Four Hills Secure Landfill Expansion	10	0
Allenstown Transfer Station	10	42
Bow Recycling Center	8	8
Keene Solid Waste Recycling & Transfer Facility	7	8
Casella/Belmont Transfer Station	8	10
Laconia Transfer Station	8	0
Total	260	259

Not shown: Seasonal Distribution



Scale Data Analysis and Gate Surveys

- Validating peak arrival times
- Identifying primary haulers
- Screening inbound transfer trailers
- Fine-tuning daily sample targets
- Determining the split between residential and ICI generators
- Identifying self-haul volumes and traffic



Categorization

Material Group

- Paper
- Plastic
- Metal
- Glass
- Organics
- Electronics
- Universal/Hazardous Waste
- CDD
- Special and Other Waste

Best Management Pathway

- Commonly Recycled
- Compostable
- Recyclable via Special Collection
- Not Currently Recoverable



Data Management

- Paper Forms
- Laptop w/ Excel
- Tablet/Smart Phone App

Slate of Maine Refuse
Enter Sample Weights
Use this form to enter header information and sample weights by material categories for new samples. You may also update existing header and weight information for previously submitted samples.

Sample ID: 1101-MWTS-RE-S-119
Facility: Wells Transfer Station
Generator: Residential
Origin: York
Hauler: Casella
Truck Type: Rear Loader
Truck/License Number:
Ticket Number:
Load Weight (lb):

Sample Notes: photo is sample before
Friday, November 01, 2014 05:44 pm

PRE-WEIGHT (lbs): 208
BARRELS (lb): 179
SORTED (lbs): 208.2

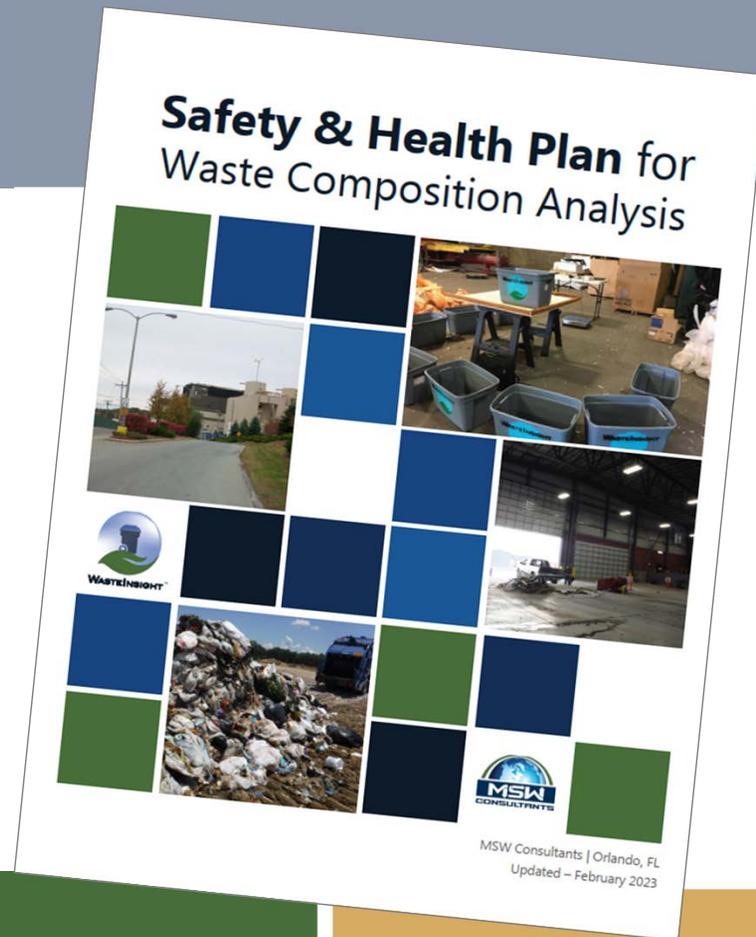
Material Category	Weight (lbs)	Status
1 OCC (Old Corrugated Cardboard)	12.00	0.42
2 Boxboard (Chipboard)	8.45	4.32
3 Aseptic and Gable Top Cartons	4.65	0.59
4 High Grade Office Paper	0.00	0.00
5 Magazines/Catalogs	5.50	1.00
6 Mixed Recyclable Paper	11.31	0.87
7 Newsprint	5.20	7.60
8 Books	11.31	7.90
9 Compostable Paper	17.71	8.10
10 Non-Recyclable B/C Paper	15.40	11.00
11 Glass Beverage Bottles - BB	4.65	0.55
12 Glass Bottles and Jars - NBB	4.95	2.62
13 Other Glass (Non-Container)	0.00	0.00
14 Aluminum Cans - BB	6.40	3.18

Sample Photos

© 2005 WasteRight (a trademark of MidAtlantic Solid Waste Consultants, LLC) MSW Main Site

Safety and Health

- 1st: Meet host facility requirements
- Then: Layer best practices for waste handling





MSW Sampling



Manual Sorting



CDD/Bulky Waste Visual Surveys



CDD/Bulky Waste Visual Surveying

- Apply industry standard density factors for CDD categories
- Volumetric surveys
- Real-time validation is critical for accuracy



State of Maine C&D/Bulky
Enter Visual Estimates
Use this form to enter estimated percentages by material categories for new samples. You may also update existing percentages for previously submitted samples.

Sample ID: #101-MWTS-CDD-129
Sample Notes: bagged debris
Friday, November 01, 2024 01:54 pm

Lead Weight (tons): 5.01

Facility: Wells Transfer Station

Generator: CDD/Bulky Waste

Material Origin: Residential

Origin: select one

Hauler: E Indigo

Truck Type: Roll-off/Open Top

Truck/License Number:

Ticket Number:

Total Truck Volume (CY): 28.0
L (ft) W (ft) H (ft) Area (CY) (CY)

Total Trailer Volume (CY): 0.0
L (ft) W (ft) H (ft) Area (CY) (CY)

Sum of Groups (CY): 100%
Total Volume (CY): 28.0
Actual Weight (tons): 5.01
Actual Sum of Lbs.: 10,020
Sum of Estimated Lbs.: 10,296
Variance (CY): 3%

Item	Volume (CY)	Weight (Lbs.)	Weight (Tons)
15 Ceramic Fixtures	1	150	0.1
16 Gypsum Wall Board	1	150	0.1
17 Pallets & crates	54	457	6.708
18 Oriented Strand Board (OSB)	1	100	0.1
19 Plywood	2	1800	5.75
20 Other Engineered Wood	1	100	0.1
21 Clean Wood	1	100	0.1
22 Painted/Treated Wood	10	150	4.50
23 Other CDD	28	150	1.50
	5	457	5.65

Sample Photos

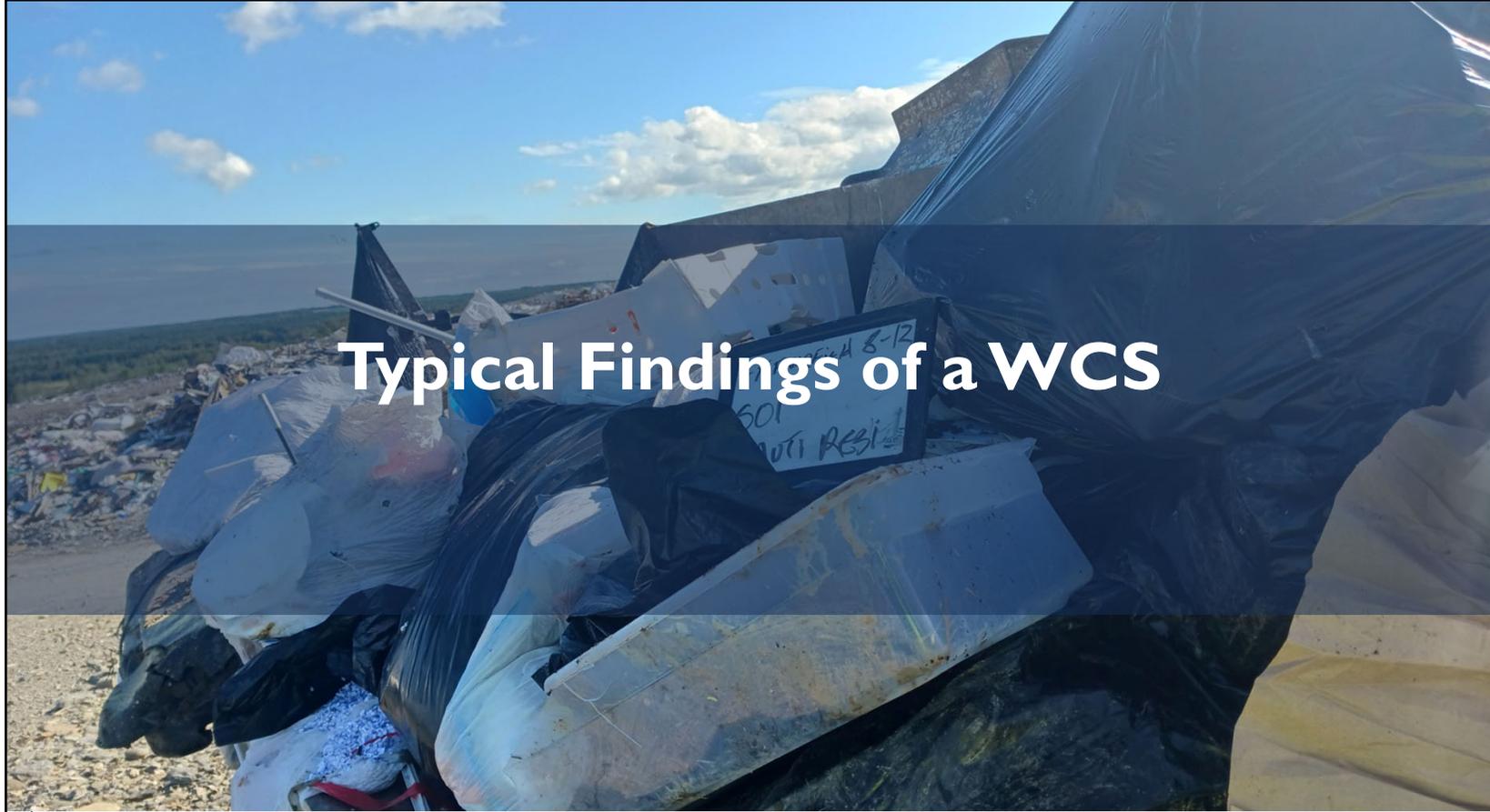
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MSW Main Site

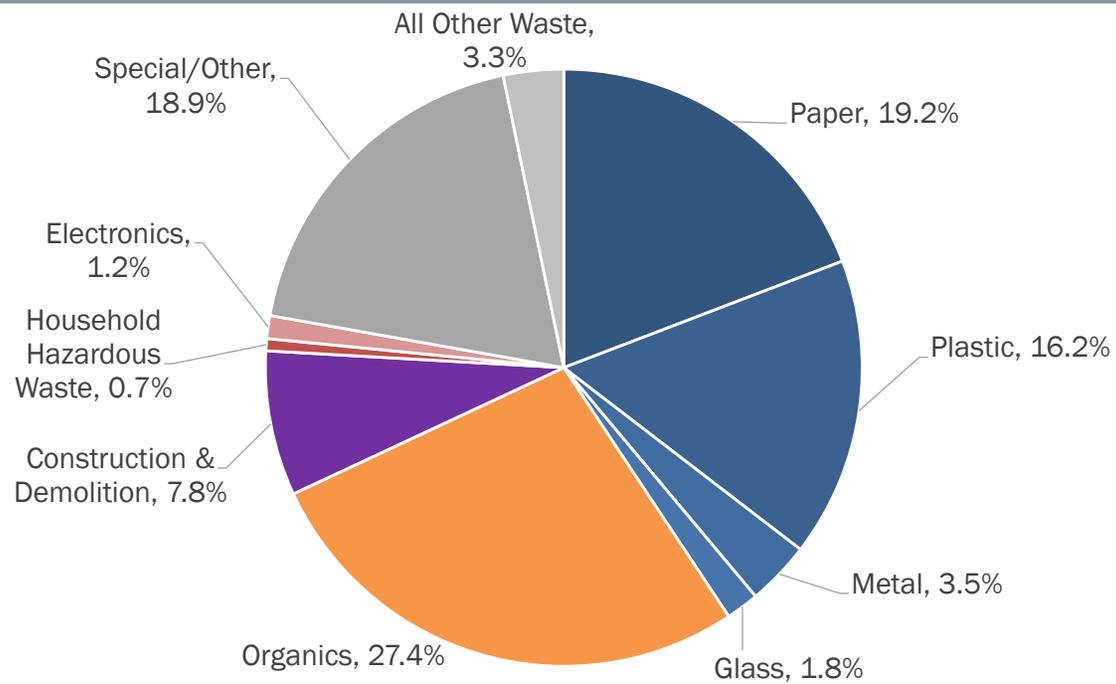
Data Management



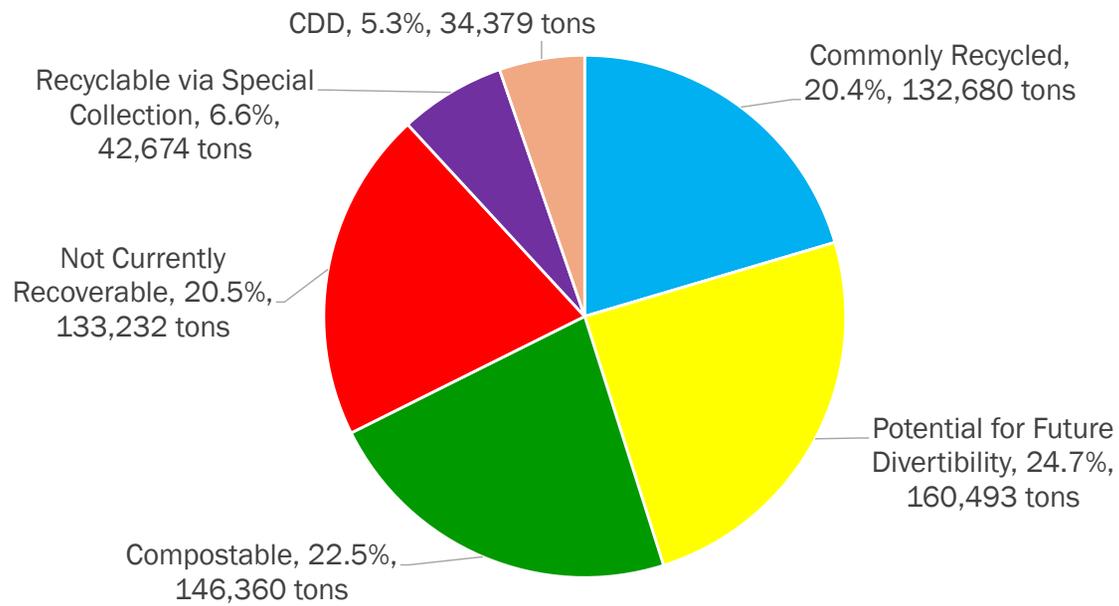
Typical Findings of a WCS



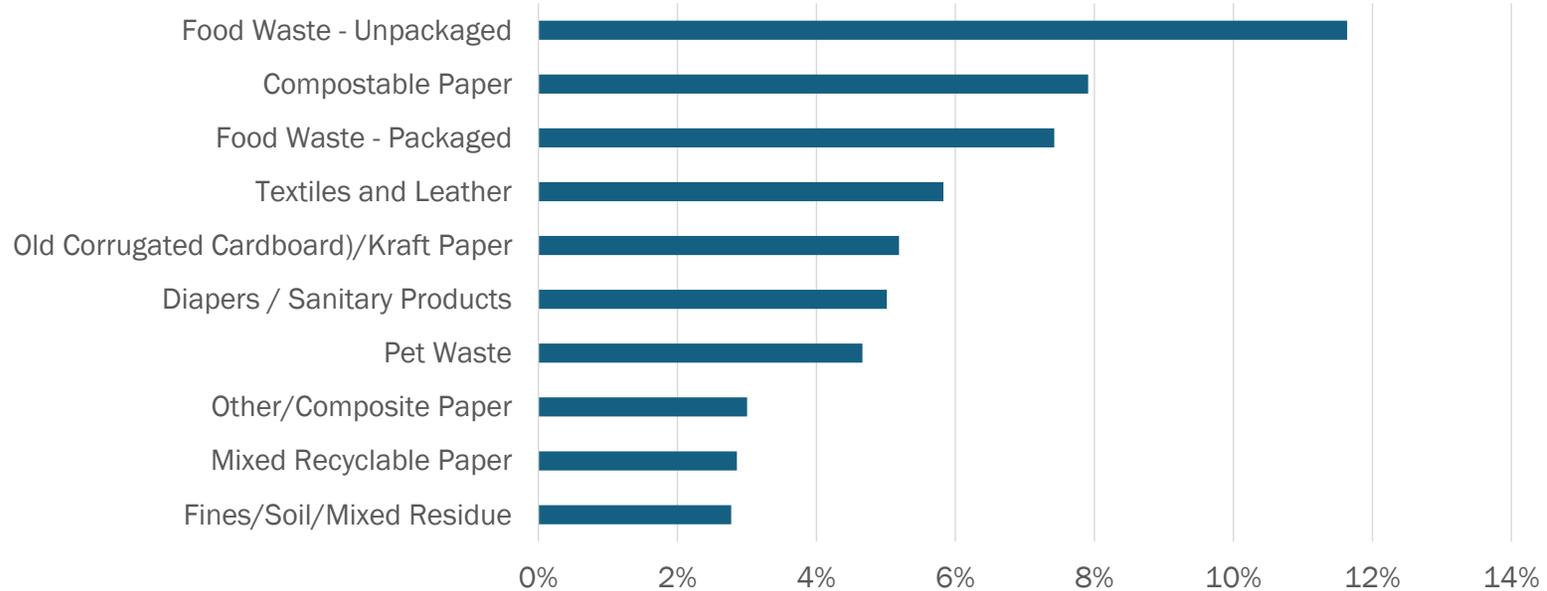
Vermont MSW Composition by Group



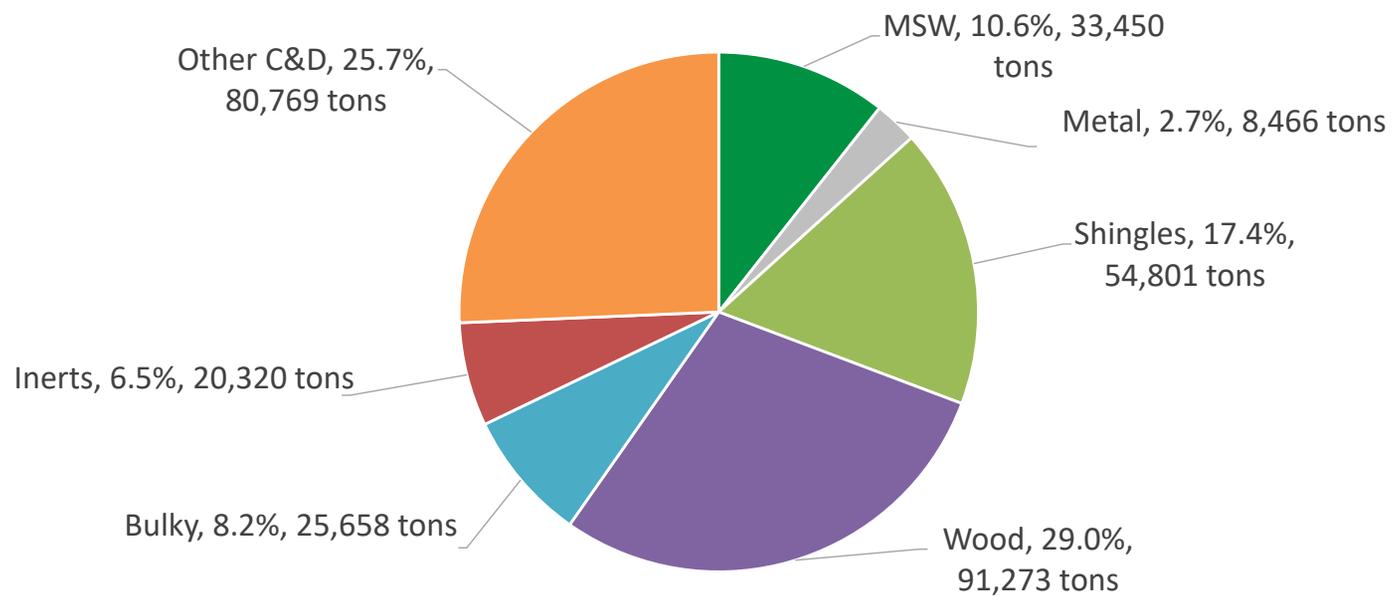
Management Pathways in Maine



Top 10 Constituents in New Hampshire MSW



C&D Composition in New Hampshire



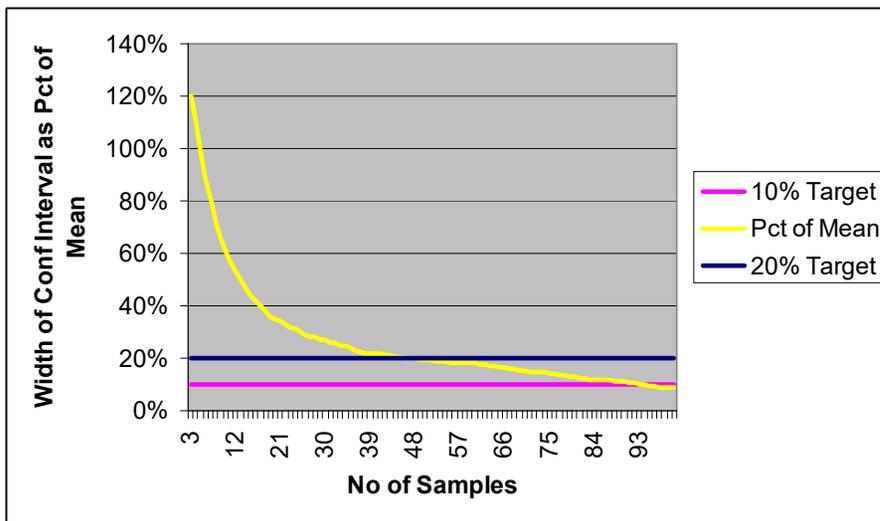
Detailed Results

- Statistical Mean and MOE
- Composition applied to reported tonnage
- Color-coded Management Pathways
- Number of Samples

Material Category	Est.				Est.		
	Percent	MOE	Tons		Percent	MOE	Tons
Paper	19.2%	1.1%	72,563	Electronics	1.2%	0.4%	4,719
1 OCC & Kraft Paper	3.3%	0.5%	12,658	39 Banned - Non-CED Electronics	0.2%	0.1%	575
2 Boxboard (Chipboard)	1.1%	0.1%	4,311	40 CEDs - CRTs	0.0%	0.0%	0
3 Newsprint	0.3%	0.1%	1,182	41 CEDs - Computer Peripherals	0.0%	0.0%	26
4 Mixed Recyclable Paper	2.3%	0.3%	8,755	42 CEDs - Desktop Computers	0.0%	0.0%	0
5 Magazines/Catalogs	0.2%	0.1%	728	43 CEDs - Laptops/Tablets	0.0%	0.0%	80
6 High Grade Office Paper	0.2%	0.1%	590	44 CEDs - Printers	0.0%	0.0%	0
7 Polycoated/Aseptic Containers	0.3%	0.0%	1,081	45 CEDs - Television/Monitors (Non-CRT)	0.0%	0.0%	105
8 Books	0.4%	0.2%	1,523	46 Products with Embedded Batteries	0.0%	0.0%	100
9 Compostable Paper	7.2%	0.5%	27,385	47 Small Appliances	0.8%	0.3%	2,926
10 Remainder/Composite Paper	3.8%	0.6%	14,349	48 White Goods	0.2%	0.2%	907
Plastic	16.2%	1.1%	61,338	Household Hazardous Waste	0.7%	0.3%	2,469
11 #1 PET Bottles	0.9%	0.0%	3,556	49 Batteries - Lead Acid	0.0%	0.0%	0
12 #2 HDPE Bottles	0.6%	0.1%	2,139	50 Batteries - Primary	0.1%	0.0%	251
13 #3 - #7 Bottles	0.3%	0.0%	329	51 Batteries (Rechargeable)	0.0%	0.0%	1
14 #5 PP Food Containers	0.8%	0.3%	3,130	52 Mercury Cont. Products - Lamps	0.0%	0.0%	7
15 #6 PS Rigid Food/Beverage Containers	0.1%	0.0%	219	53 Mercury Cont. Products - Thermostats	0.0%	0.0%	0
16 #6 EPS Food/Beverage Containers	0.2%	0.1%	839	54 Mercury Cont. Products- Other	0.0%	0.0%	2
17 Bulky Rigid Plastics > 1 Gallon	1.6%	0.4%	6,030	55 Paint	0.2%	0.1%	644
18 Plastic Thermoforms	0.9%	0.1%	3,240	56 Other HHW	0.4%	0.2%	1,563
19 Film - Agriculture/Marine Shrink Wrap	0.3%	0.2%	1,285	Construction & Demolition	7.8%	1.4%	29,646
20 Film - Retail Bags	0.1%	0.0%	299	57 Asphalt, Brick and Concrete (ABC)	0.0%	0.0%	115
21 Film - Garbage Bags	2.6%	0.2%	9,826	58 Asphalt Shingles	0.4%	0.3%	1,627
22 Film - Other Bags	0.9%	0.2%	3,557	59 C&D Metal	0.1%	0.1%	286
23 Film - Other - Non-Bag	3.7%	0.3%	14,166	60 Drywall/Gypsum Board	0.3%	0.2%	1,119
24 Remainder/Composite Plastic	3.4%	0.6%	12,724	61 Oriented Strand Board	0.1%	0.1%	275
Metal	3.5%	0.5%	13,125	62 Other/Residual C&D	2.4%	0.7%	8,915
25 Aluminum Cans	0.4%	0.0%	1,545	63 Wood - Painted and Treated	1.6%	0.5%	6,169
26 Aluminum Foil, Pans, and Containers	0.5%	0.0%	1,710	64 Plywood	0.8%	0.3%	2,889
27 Ferrous Containers	0.5%	0.1%	1,771	65 Carpet & Carpet Padding	2.2%	0.7%	8,251
28 Other Ferrous	1.4%	0.3%	5,467	Special/Other	18.9%	1.3%	71,578
29 Other Non-Ferrous	0.7%	0.2%	2,633	66 Diapers/Sanitary Products	4.0%	0.6%	15,233
Glass	1.8%	0.3%	6,734	67 Fines/Dirt/Mixed Residue	2.8%	0.3%	10,517
30 Glass Bottles	1.0%	0.0%	3,777	68 Furniture/Bulky Items	4.8%	1.8%	18,271
31 Other Glass	0.8%	0.2%	2,957	69 Rubber	0.5%	0.2%	1,974
Organics	27.4%	1.5%	103,524	70 Textiles and Leather	6.5%	0.8%	24,413
32 Food Waste - Contained in Packaging	7.8%	0.8%	29,650	71 Tires	0.3%	0.3%	1,171
33 Food Waste - Unpackaged	11.0%	0.9%	41,462	All Other Waste	3.3%	0.3%	12,346
34 Branches & Stumps >1"	0.0%	0.0%	113	72 All Other Waste Not Elsewhere Classified	3.3%	0.3%	12,346
35 Leaves, Grass, & Brush <1"	1.2%	0.5%	4,376				
36 Wood - Clean	1.6%	0.7%	6,235				
37 Pet Waste	4.0%	0.7%	15,226				
38 Other Organics	1.7%	0.4%	6,463				
Total				Total	100.0%		378,042
Mandated Recyclable	11.3%		42,721	Non-Divertible	43.3%		163,588
Mandated Organic	21.6%		81,836	Potentially Divertible	23.8%		89,897
				Samples	180		

Interpreting Statistics

Relationship of Number of Samples to Accuracy



Corrugated Cardboard

Mean: 8.4%, or 64,665 tons

Margin of Error:

+/- 0.9%

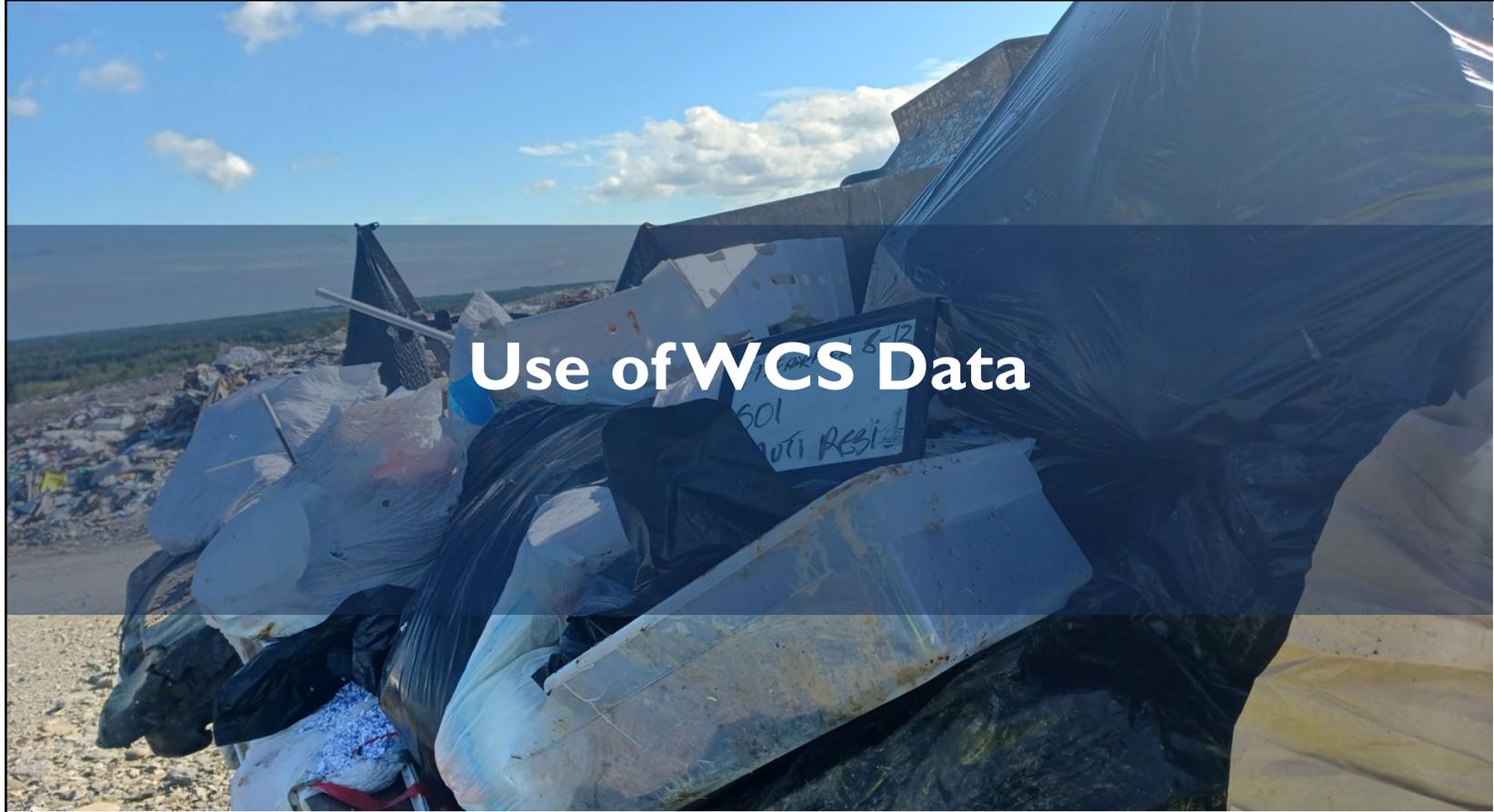
+/- 6,676 tons

Confidence Interval (90%)

7.5% to 9.3%

57,989 to 71,341 tons





Use of WCS Data



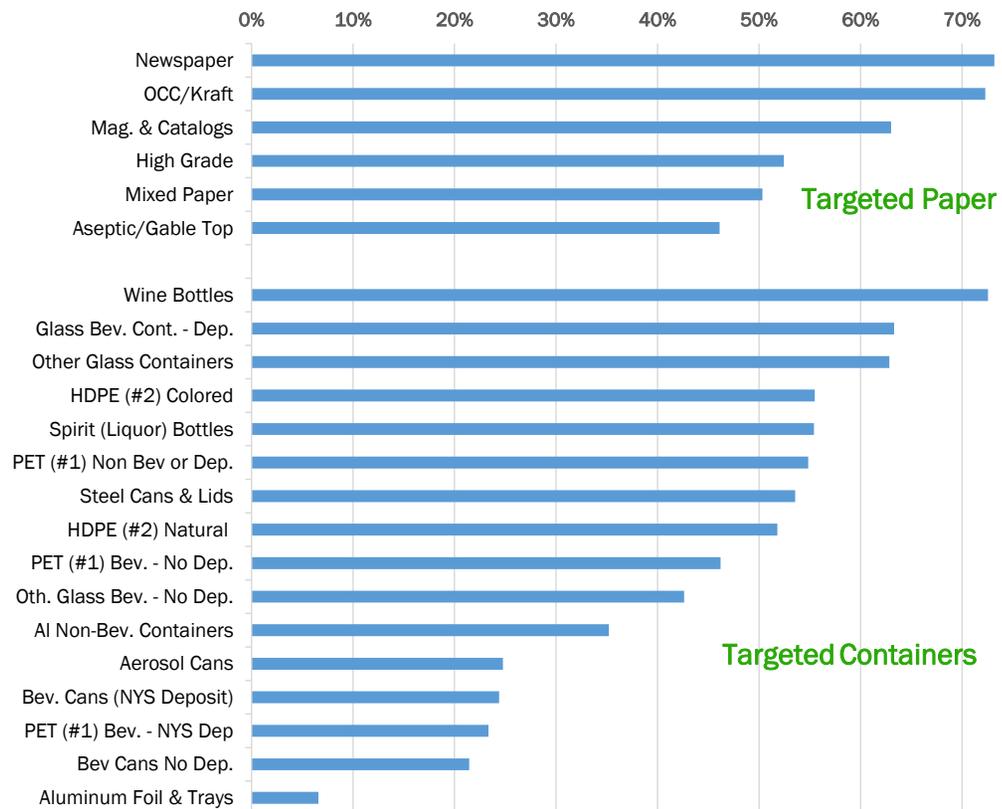
Recycling Capture Rates

- **Measures the percentage of a targeted recyclable that is actually recovered through a program**
- **Waste & recyclables composition must be determined**
- **Samples should be from the same “universe” of waste**



**What is in each cart?
(and how much)**

Onondaga County (NY) Capture Rates (2020)



Value of Disposed Recyclable Fiber & Containers in Maine

Recyclable Paper

Material Components	Estimated Tons Disposed	Average Market Price (\$/ton) ^[1]	Estimated Total Market Value (\$) ^[2]
OCC (Old Corrugated Cardboard)	54,334	\$101	\$5,488,000
High Grade Office Paper	1,711	\$127	\$217,000
Mixed Recyclable Paper	15,166	\$58	\$880,000
Newsprint	1,723	\$80	\$138,000
Magazines/Catalogs	2,962	\$80	\$237,000
Boxboard (Chipboard)	9,700	\$58	\$563,000
Total Paper	85,596	\$88	\$7,523,000

Recyclable Containers

Material Components	Estimated Tons Disposed	Average Market Price (\$/ton) ^[1]	Estimated Total Market Value (\$) ^[2]
#1 PET Beverage Bottles - BB	3,243	\$340	\$1,102,000
#1 PET Bottles and Jars -NBB	2,412	\$340	\$820,000
#1 PET Thermoforms	3,706	\$170	\$630,000
#2 HDPE Natural Beverage Bottles - BB	70	\$871	\$61,000
#2 HDPE Colored Beverage Bottles - BB	56	\$319	\$18,000
#2 HDPE Natural Containers - NBB	3,390	\$871	\$2,953,000
#2 HDPE Colored Containers - NBB	3,936	\$319	\$1,256,000
#3, 4, 5, 7 Beverage Bottles - BB	9	\$35	\$0
#3, 4, 7 Bottles, Jars, Containers - NBB	186	\$35	\$7,000
#5 PP Containers	7,142	\$165	\$1,178,000
#6 PS Rigid Containers	1,722	\$60	\$103,000
Aluminum Cans - BB	2,425	\$1,515	\$3,674,000
Aluminum Cans - NBB	1,036	\$1,515	\$1,569,000
Aluminum Foil & Pans - NBB	2,242	\$0	\$0
Ferrous Containers	5,189	\$188	\$976,000
Glass Beverage Bottles - BB	3,287	-\$15	-\$49,000
Glass Bottles and Jars - NBB	4,347	-\$15	-\$65,000
Total Recyclable Containers	129,995	\$321	\$21,756,000

^[1] Source: Recyclingmarkets.net



Reduction Potential of Recycling Over Landfill & WTE in New Hampshire

Material Components	Tons Recycled/ Composted	Emissions Reduced (MTCO ₂ E)
Recyclable Paper	73,202	226,869
Corrugated Cardboard/Kraft Paper	33,112	100,268
High Grade Office Paper	2,726	9,285
Mixed Recyclable Paper	28,891	97,504
Newsprint	3,411	6,502
Magazines/Catalogs	5,063	13,310
Recyclable Containers	54,169	115,555
Aluminum	7,892	72,203
Steel Cans	5,628	8,317
Glass	17,292	5,127
PET	8,905	12,481
HDPE	8,071	9,605
PP	6,381	7,822
Compostable	129,013	51,640
Food Waste	120,527	52,559
Yard Waste ^[3]	8,486	-919
Total	256,384	394,064

Tons That Could Have been
Recycled or Composted

256,384

Emission Reduction Potential
(MTCO₂E) from WARM

394,064

Based on US EPA Waste Reduction Model
(WARM) Version 15, New England region



Related Studies



Waste Audits

These steps constitute a Waste Audit

- Review Waste & Recycling Data
- Site Tour and Staff Interviews
- Define Generation Areas & Materials
- Sort and Weigh ← This is what many people think constitutes a Waste Audit
- Analyze Data
- Identify and Prioritize Diversion Opportunities



Waste Audit Objectives

- Designing back-of-house employee workflows
- Improving front-of-house containerization and signage
- Capturing more targeted recyclables
- Recovering edible food waste
- Diverting organics
- Reducing contamination

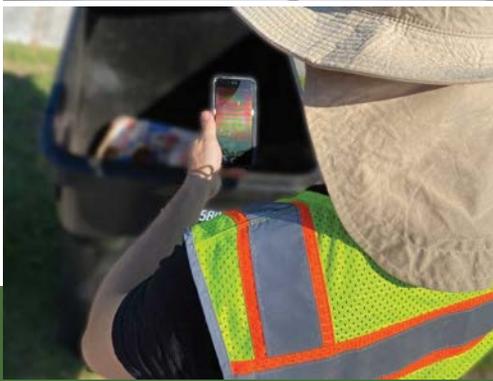


Visible Litter Studies

	2024
Litter Incidence (Pieces/Mile)	6,670
Margin of Error	+/-4,293
Universe of Miles	360,364
Total Litter Count (1,000,000 Pieces)	2,403
Margin of Error	+/-763
Litter per Capita*	62
Margin of Error	+/-20



Recycling Contamination Monitoring



Thank You

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Use of Waste Characterization Studies in Massachusetts



John Fischer
NEWMOA 101 Session
February 24, 2026

Scope of Studies

- Conducted by five municipal waste combustors as part of conditions of renewable energy certificates
- Municipal waste combustors accept about 3 million tons per year, about $\frac{3}{4}$ of MSW disposal
- Municipal Solid Waste (MSW)
 - Excludes C&D, other non-MSW
- Conduct every three years starting in 2010

Study Design

- Protocol based on ASTM Methodology
- 9 primary categories and 62 secondary categories
- Alternate spring/summer & winter/fall sampling periods
- Categorize loads as residential vs. industrial/commercial/institutional (ICI)
- Categorize loads by truck type
 - Rear load/side load packer, front packer, open top roll off, closed roll off/compactor

Uses

- Inform program priorities
 - Define 2030 Solid Waste Master Plan Priorities
 - See Appendix B, page 38
 - Select priority materials for grant programs
- Evaluate program progress over time

Example Material - Textiles

- Learned more textiles in trash than we realized
- Approximately 260,000 tons/year as of 2019
- Basis for:
 - Developing textiles disposal ban
 - Prioritizing Recycling and Reuse Market Development Grants
 - Building out RecycleSmart MA Beyond the Bin Listings
- Based on 2022 data, at 230,000 tons

Contact Information

- [Individual Studies](#)
- [Summary of Study Data](#)
- John Fischer – john.fischer@mass.gov



SOLID WASTE UPDATES FOR Rhode Island

- ▶ **Mark Dennen, Supervising Environmental Scientist, RIDEM/ Office of Land Revitalization and Sustainable Materials Management**
- ▶ **David McLaughlin, Sustainability Coordinator, Office of the Director**



Rhode Island Resource Recovery Corporation

- ▶ **Pseudo-state Corporation in Charge of:**
- ▶ **State's only active landfill (a.k.a. "Central Landfill")**
- ▶ **Materials Recycling Facility**
- ▶ **leaf and yard debris composting program**
- ▶ **Eco-Depot collection events for household hazardous waste.**



Waste Operations in RI



11 Leaf and Yard
Waste Compost
Facilities



2 Putrescible
Waste Compost
Operations



9 Agricultural
Compost
Facilities



1 C&D
Processing
Operation



1 Large C&D
Transfer Station



1 Large
Anaerobic
Digester

Incoming Waste by Facility 2024



- RIRRC Landfill and Transfer Station
- JR Vinagro
- New England Waste Systems Transfer Station
- South Quay
- Oldcastle Lawn & Garden
- Warwick Transfer Station

2024 RIRRC Incoming Waste



- Mixed Solid Waste
- Aggregate (asphalt, brick, concrete)
- Commingled (mixed) recyclables
- Yard Trimmings
- Contaminated Soil
- Mixed C&D (combined)

Outgoing Waste 2024 (largest destinations)



■ Tunnel Hill Landfill

■ New England Waste Systems

■ Retail Stores

■ RIRRC

■ Arrow Head Landfill

■ JR Vinagro Scrap Yard

■ SeMass, West Wareham, MA

■ Residential / Commercial

■ RI Resource Recovery Corp



Waste Characterization Study

- A waste characterization study is used to identify and quantify the materials in a waste stream to optimize waste management, enhance recycling programs, and reduce disposal costs. By analyzing waste composition, organizations can create targeted diversion strategies, improve sustainability, and make data-driven infrastructure decisions.



Landfill Gas Generation and Waste Diversion

- Rhode Island's Central Landfill, the state's only disposal facility, will reach capacity within the next two decades ([RIRRC, 2015](#)). As closure approaches, decisions on waste diversion and methane management will directly influence climate and energy outcomes.
- Methane (CH₄) is the primary component of landfill gas and a powerful greenhouse gas - 28 times stronger than CO₂ over a 100-year period and 80 times stronger over a 20-year period ([IPCC, 2019](#); [IEA, 2023](#)). Therefore, capturing or preventing methane emissions is critical for meeting state and national climate goals.
- The analysis used EPA's Landfill Gas Emissions Model (LandGEM) ([Krause & Thorneloe, 2024](#)), with Rhode Island-specific waste data from the 2015 Waste Characterization Study ([RIRRC, 2015](#)) and decay constants from EPA's 2023 Food Waste Methane Study ([EPA, 2023](#)).



2015 Waste Characterization Study

- Over four seasons a total of 248 samples were captured and hand sorted to analyze composition of solid waste delivered to the RIRRC landfill.
- Data organized by material category and 70 material types.
- Data provided with estimated percentage, standard deviation and estimated tonnage.

Material	Estimated Percent	Standard Deviation	+ / -	Estimated Tons	Material	Estimated Percent	Standard Deviation	+ / -	Estimated Tons
Plastic	11.8%			62,514	Textiles	5.5%			28,860
Plastic #1 PET bottles, under 2 gallons	0.9%	0.1%	0.1%	4,715	Apparel	3.4%	0.4%	0.6%	17,783
Plastic #2 HDPE bottles and jugs, under 2 gallons	0.3%	0.0%	0.0%	1,651	Non-apparel textiles	2.1%	0.3%	0.4%	11,077
Plastic clamshells, under 2 gallons	0.1%	0.0%	0.0%	510					
Plastic blister packaging, under 2 gallons	0.0%	0.0%	0.0%	221	Other Organics	27.5%			145,193
Plastic #1-#7 & unmarked non-bev. containers <2 ga	1.1%	0.0%	0.1%	5,956	Branches and stumps >2 inches	0.2%	0.2%	0.3%	897
Plastic containers, larger than 2 gallons	0.2%	0.1%	0.1%	1,142	Leaf and yard debris	5.2%	0.6%	0.9%	27,679
Bulky plastic >2 gallons	0.9%	0.2%	0.3%	4,724	Clean dimensional lumber	1.3%	0.3%	0.5%	6,992
Retail bags and film	1.1%	0.1%	0.2%	5,982	Vegetative food waste	16.1%	0.7%	1.2%	84,827
Contaminated film/bags	4.0%	0.2%	0.3%	20,883	Protein food waste	2.9%	0.3%	0.4%	15,202
Styrofoam	0.8%	0.1%	0.2%	4,035	Other organics	1.8%	0.4%	0.7%	9,595
Remainder/composite plastic	2.4%	0.5%	0.8%	12,696					
Paper	23.9%			126,391	Construction and Demolition	9.7%			51,087
Brown corrugated cardboard boxes and kraft paper	7.8%	0.6%	1.0%	41,244	Asphalt, brick, and concrete	0.6%	0.2%	0.4%	3,346
Whole pizza boxes	0.1%	0.0%	0.0%	451	Roofing whingles	0.1%	0.1%	0.2%	788
Uncoated paperboard/chipboard	1.6%	0.2%	0.3%	8,633	Drywall/gypsum board	0.8%	0.2%	0.4%	4,199
Coated paperboard, refrigerated and frozen food	0.3%	0.0%	0.0%	1,417	Treated wood	6.6%	0.7%	1.1%	35,111
Hot paper coffee cups and bowls	0.3%	0.1%	0.1%	1,713	Fixtures	0.2%	0.1%	0.1%	949
Shredded paper	0.4%	0.2%	0.3%	2,236	All other C&D	1.3%	0.3%	0.4%	6,695
Newsprint	1.4%	0.2%	0.3%	7,655					
Glossy paper	0.9%	0.2%	0.4%	4,731	Bulky Waste	7.1%			37,395
Tissue paper, gift-wrapping	0.2%	0.1%	0.1%	1,051	Major appliances	0.1%	0.1%	0.1%	280
Compostable Paper	6.4%	0.3%	0.6%	34,048	TVs, computers, computer peripheral devices	0.4%	0.1%	0.2%	2,194
Cartons, gabletop	0.2%	0.0%	0.1%	962	Small consumer electronic and electrical devices	0.4%	0.1%	0.1%	1,969
Aseptic juice boxes	0.2%	0.1%	0.2%	1,098	Furniture	2.6%	0.6%	1.0%	13,847
Paperback books	0.1%	0.0%	0.0%	543	Tires	0.2%	0.1%	0.2%	1,123
Phone books	0.1%	0.0%	0.0%	294	Carpet and carpet padding	2.9%	0.5%	0.8%	15,495
Hardcover books	0.1%	0.0%	0.0%	297	Mattresses and box springs	0.5%	0.3%	0.6%	2,487
Office/mixed paper	2.1%	0.2%	0.3%	11,083					
Remainder/composite paper	1.7%	0.4%	0.7%	8,934	Special Waste	0.5%			2,782
Glass	2.0%			10,596	Sharps	0.0%	0.0%	0.0%	33
Glass bottles and jars	1.8%	0.2%	0.3%	9,331	Medications	0.0%	0.0%	0.0%	254
Remainder composite glass	0.2%	0.0%	0.1%	1,266	Propane tanks	0.0%	0.0%	0.0%	8
Metal	3.0%			15,676	Fluorescent bulbs and ballasts	0.0%	0.0%	0.0%	120
Aluminum beverage cans	0.2%	0.0%	0.0%	1,192	Batteries: single-use, alkaline	0.1%	0.0%	0.0%	308
Aluminum foil and pie plates	0.3%	0.0%	0.1%	1,705	Batteries: lead acid (vehicles)	0.0%	0.0%	0.0%	1
Aluminum non-beverage cans	0.1%	0.0%	0.0%	548	Batteries: all other rechargeable batteries	0.0%	0.0%	0.0%	9
Ferrous cans	0.5%	0.0%	0.1%	2,831	Paints and stains	0.1%	0.1%	0.2%	637
Small scrap metal	1.1%	0.1%	0.2%	5,799	Empty liquid and gel HHW containers	0.1%	0.0%	0.0%	431
Large scrap metal	0.7%	0.2%	0.3%	3,601	Other hazardous or household hazardous waste	0.2%	0.1%	0.1%	981
Hybrids	0.3%			1,645	Other	8.7%			46,028
Foiled wrappers	0.2%	0.0%	0.0%	1,002	Miscellaneous	8.7%	0.7%	1.2%	46,028
Mixed material packaging	0.1%	0.0%	0.0%	643					
					Totals	100.0%			528,168
					Sample Count	211			



Mapping of RI Data to EPA Categories

- 17 RI Material Types
- 7 EPA Categories
- Total Tonnage
- Leaves versus Grass

EPA Material Type	RIRRC Material Type	Tonnage in 2015	Percentage of Total in 2015
Branches (Yard)	Branches and Stumps	897	0.2%
Cardboard	Brown corrugated cardboard boxes and kraft paper	41,244	7.8%
Cardboard	Whole Pizza Boxes	451	0.1%
Copy paper	Shredded Paper	2,236	0.4%
Copy paper	Newsprint	7,655	1.4%
Copy paper	Glossy Paper	4,731	0.9%
Copy paper	Compostable Paper	34,048	6.4%
Copy paper	Cartons, Gabletop	962	0.2%
Copy paper	Paperback Books	543	0.1%
Copy paper	Phone Books	294	0.1%
Copy paper	Hardcover Books	297	0.1%
Copy paper	Office/Mixed Paper	11,083	2.1%
Copy paper	Remainder/Composite Paper	8,934	1.7%
Dimensional lumber	Clean Dimensional Lumber	6,992	1.3%
Food waste	Vegetative Food Waste	84,827	16.1%
Food waste	Protein Food Waste	15,202	2.9%
Food waste	Other Organics	9,595	1.8%
Leaves (Yard)		27,679	5.2%
Grass (Yard)			
	<u>Total</u>	<u>257,670</u>	<u>48.8%</u>



EPA Decay Constants & Methane Generation

- Decay Rate
- Half Life

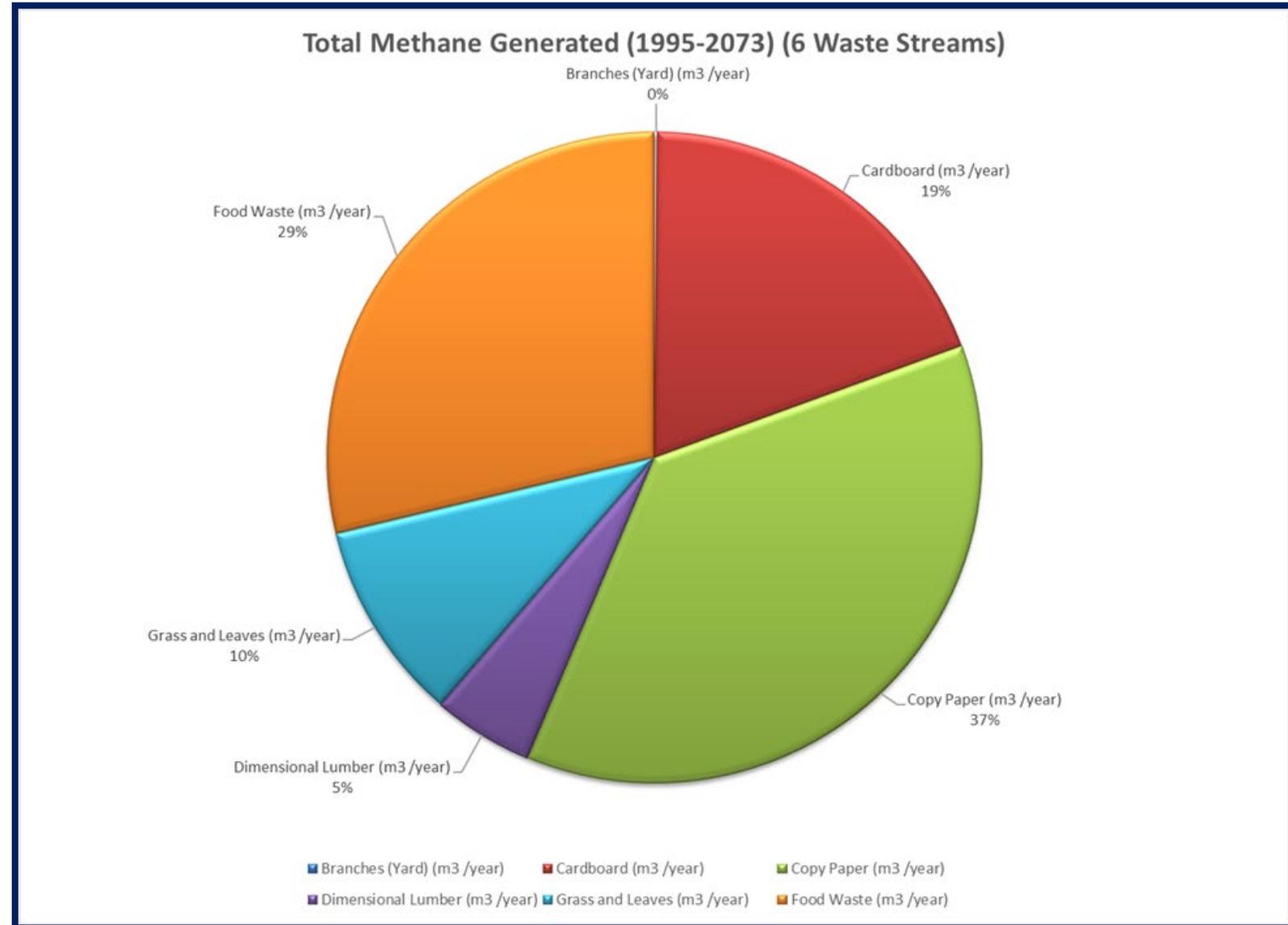
Material	Decay rate (yr ⁻¹)	Number of years over which ½ of the carbon has been degraded to methane
Branches (Yard)	0.02	34.6
Cardboard	0.03	23.1
Copy paper	0.04	17.3
Dimensional lumber	0.11	6.3
Food waste	0.19	3.6
Leaves (Yard)	0.22	3.2
Grass (Yard)	0.39	1.8

Source: EPA WARM v15



Baseline Methane Generation

- Make Assumptions
- Establish baseline
- Organics = 29%
- Other Materials = 71%





Waste Diversion Strategies

- Material
- Strategy
- Start in 2025
- Rate
- Timespan

Strategy	Description	Rate	Years
1	Divert Grass, Leaves and Branches from Landfill to Alternative Collection Program	20%	1-10
2	Divert Paper Products to Mixed Recycling Program (EPR)	20%	5-15
3	Divert Dimensional Lumber to Construction and Demolition	20%	1-10
4	Divert Organics to Composting and Anaerobic Digestion	10%	1-20



Methane Generation with Diversion Strategies

- Results
- WCS provided essential baseline data to understand how waste diversion strategies will impact landfill gas generation.

