

# Opportunities and Challenges: Construction and Demolition Debris Recycling in the Northeast



NERC's 30<sup>th</sup> ANNIVERSARY

DSM ENVIRONMENTAL  
SERVICES, INC.

Resource Economists  
Environmental Scientists

# A lot has happened in 30 years!

- ▶ DSM is also celebrating 30 years!
- ▶ Worked in most of the NERC states:
  - Waste characterizations for DE, VT, MA, RI, CT
  - Recycling economic analysis in PA, NY, MA, RI and ME
  - Recent C&D Studies – Delaware and Massachusetts
- ▶ National studies on increasing plastics recycling, product stewardship, container recycling, and electronics recycling economic benefits.
- ▶ International depth – 17 countries around the world on solid waste and recycling, municipal finance, and marine debris

# Overview of C&D Data

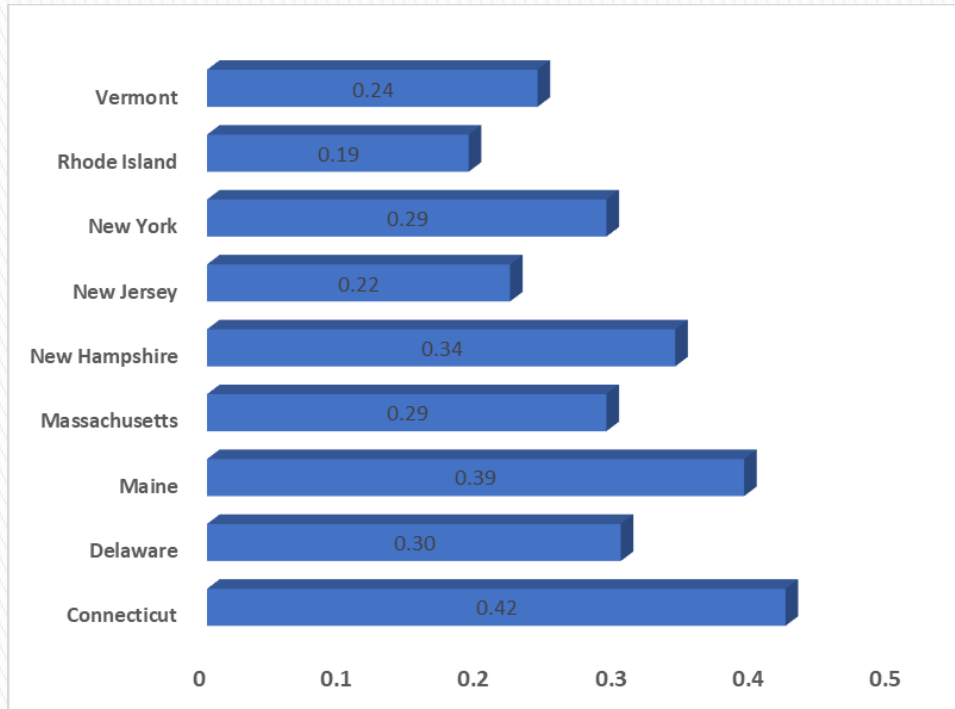
- ▶ Wide fluctuations compared to MSW
- ▶ Impacted by natural disasters and the economy
- ▶ Disposal more disbursed than for MSW, and less regulated



# How Much Is Generated Annually?

- ▶ US EPA estimates 166 million tons of building debris (2014 Report)
  - Plus 234 million tons of asphalt and concrete waste from roads and bridges, and another 135 from communication, power, transportation, sewer and waste disposal, water supply, and development and manufacturing infrastructure
- ▶ This compares against 258 million tons of MSW generated
  - But 89 million tons recycled or composted leaving 169 million tons left to manage
- ▶ Many states have no idea how much C&D generated

# State Per Capita Estimates



- ▶ MassDEP tracked 1,129,861 tons or .17 tons (2015) for processing
- ▶ CT tracked 1,041,643 tons or .29 tons (2013) to VRFs
- ▶ DE tracked 220,000 tons disposed or .24 tons (2014)

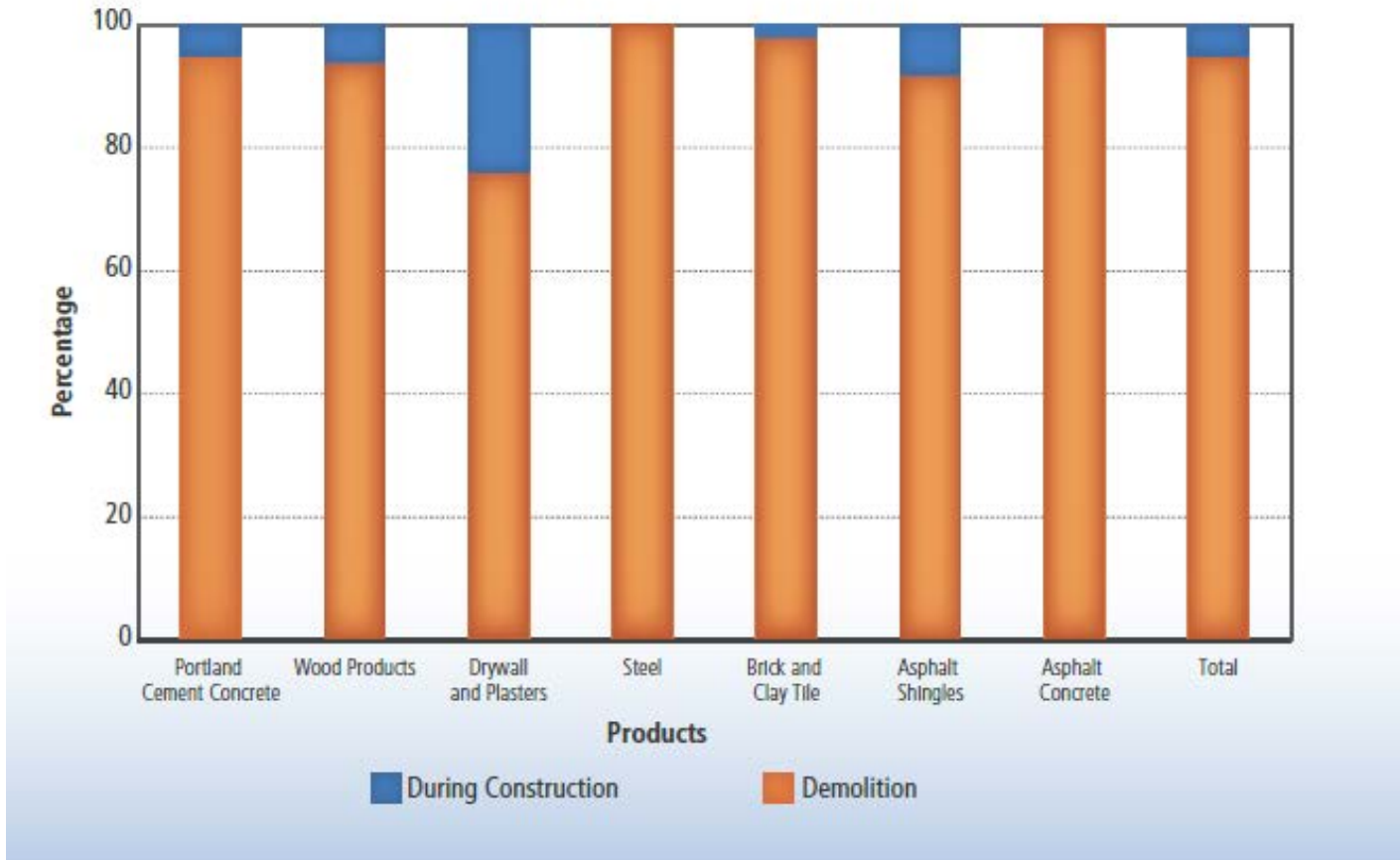
NEWMOA 2009 (2006 Generation)

More Recent (Generation and Disposal)

# When is Most C&D Generated?

*(Source: US EPA)*

Figure 11. Contribution of Construction and Demolition Phases to Total 2013 C&D Debris Generation



# What Has Been Done to Reduce C&D Waste Disposal

- ▶ Material bans
- ▶ Economic Incentives – RECs for Biomass facilities to create demand for B wood
- ▶ Subsidies for mixed (C&D) waste processing facilities
- ▶ Market Development Grants
  - Aggregate

# State Activities

- »» Massachusetts is the most aggressive and our focus  
But several other NERC states have programs in place to increase diversion



# Massachusetts

- ▶ 50% diversion goal for C&D materials, but the rate has plateaued at around 30%
- ▶ Banned asphalt pavement, brick, concrete, metal and wood from disposal as of July 1, 2006 with hopes of:
  - Supporting the development of in-state processing
  - Preserving disposal capacity in the state
  - Achieving non-municipal solid waste reduction goal
- ▶ C&D Subcommittee meets quarterly
  - Developers, C&D industry representatives, consultants, solid waste facility operators and waste haulers, state officials

# Vermont

- ▶ Universal Recycling law bans clean wood disposal (July 1, 2016)
  - This ban encourages separation and collection of clean wood waste at facilities.
- ▶ Act 175 requires recycling of Architectural Materials(1) from certain projects if they:
  - Produce 40 cubic yards or more of architectural waste.
  - Are within 20 miles of a solid waste facility that recycles architectural waste.
  - Are for a commercial building or residential building with 2 or more units.

*(1) Clean Wood, Scrap Metal, Drywall, Plywood, Oriented Strand Board (OSB)*

# Connecticut

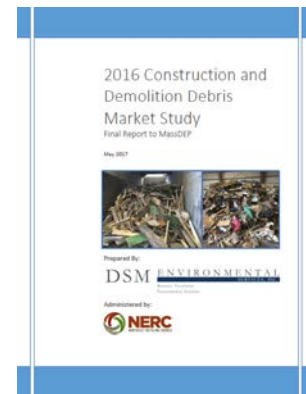
- ▶ C&D Waste Composition Study (2015) analyzed flows to CT volume reduction facilities (VRF) and estimated disposal of 1.04 million tons:
  - 38 % wood / 10 % asphalt shingles / 6 % gypsum/wallboard
  - 30 % "other" (including a variety of oversized MSW)
- ▶ MSW Characterization (2015) estimated 276,000+ tons of C&D materials disposed in MSW disposed (roughly 12 percent) including:
  - 132,000 tons of treated and 39,000 tons of untreated wood
  - 29,000 tons of carpet
  - 13,000 tons of gypsum/wall board
  - 6,000 tons of asphalt roofing
  - 40,000 tons as "remainder/composite C&D" materials.
- ▶ 32 VRF's (capacity of over 130,000 tons per day) handle C&D materials
- ▶ VRF's accept asphalt, brick and concrete, but most of this material is processed by aggregate facilities, which do not require a permit, so data are not available

# Delaware

- ▶ Detailed C&D composition data available statewide – 2007 and for the Jones Crossroads (Southern Landfill) for 2016
- ▶ Mixed C&D processing facility (Revolution Recovery) operating at Delaware Recycling Center processing C&D materials primarily from New Castle County (northern DE)

# Focus on Massachusetts

- ▶ Strictest bans on C&D materials and most infrastructure (some fueled by grants)
- ▶ DSM contracted to assess opportunities and constraints to increasing diversion beyond 30 percent in 2016, and analyzed *initial* progress in 2008: [www.mass.gov/eea/docs/dep/recycle/reduce/06-thru-1/07cdstdy.doc](http://www.mass.gov/eea/docs/dep/recycle/reduce/06-thru-1/07cdstdy.doc)
- ▶ DSM has tracked regional markets through this and other studies



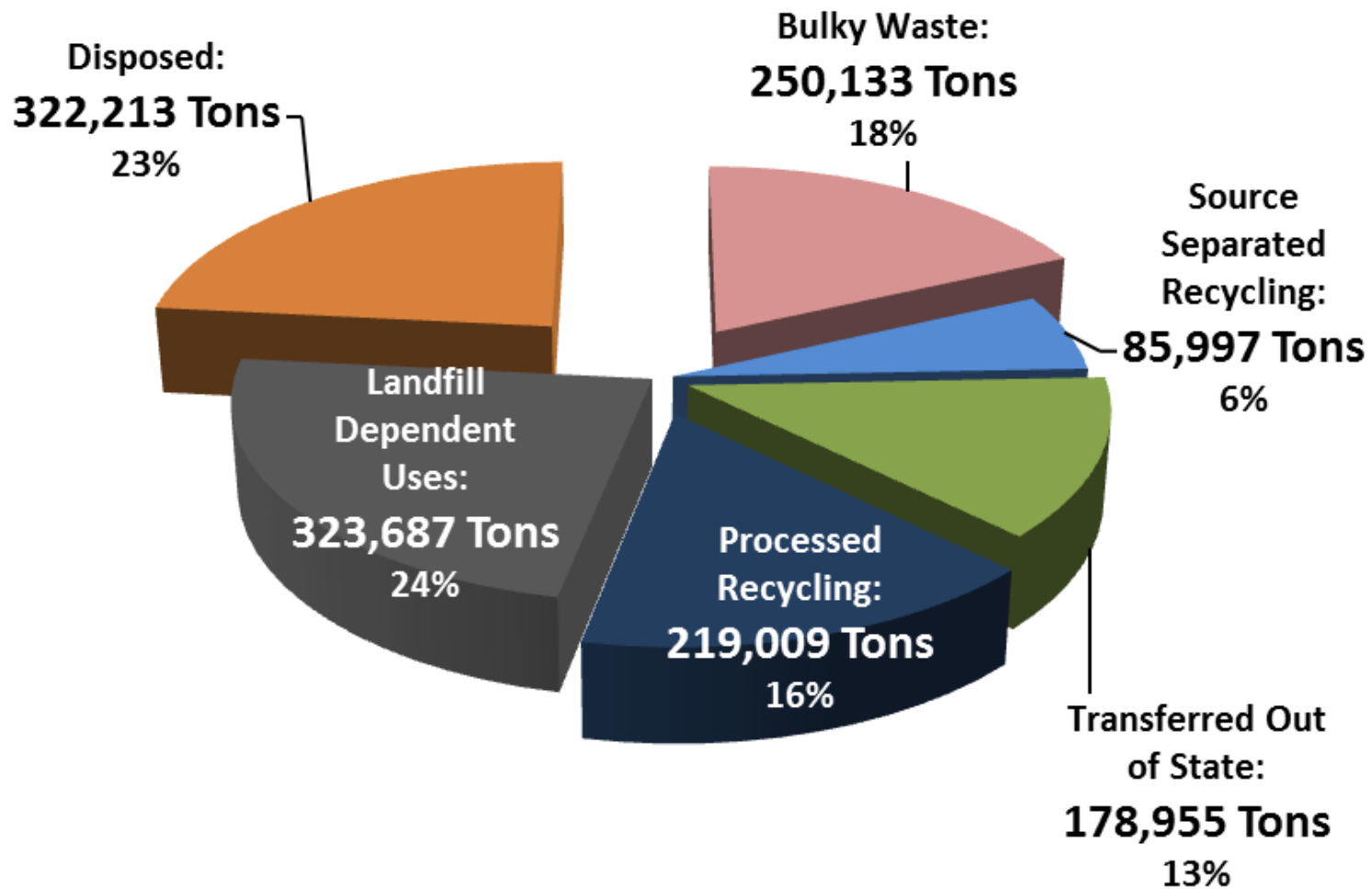
# Massachusetts 2016



- ▶ Analyzed incoming and outgoing C&D loads at seven facilities (5 processors and 2 transfer facilities) to determine where opportunities lie to increase materials recovery
- ▶ Analyzed material flow from annual reports (2015), field work and research
- ▶ Reviewed new technologies that might increase recovery from C&D processing facilities
- ▶ Reviewed market specifications and demand
- ▶ Identified barriers to increased diversion

# Recycling Rate, c. 2015/16

- ▶ Roughly 25 percent of *mixed C&D processed in-state* (219,000 of 865,000 tons) was recovered for recycling in Massachusetts.
  - By adding source separated materials delivered to processors (86,000 tons), 27% recycling rate for all C&D (in-state and out-of-state)
  - 32 percent rate if only counting C&D managed in-state
- ▶ Diversion rate greater if landfill dependent uses included
  - Another 324,000 tons, or 31% of C&D waste processed in-state, or 23 percent of all C&D waste.
- ▶ Both exclude any out of state processors generating recyclables



# 2015 Data on Material Destinations



# What Can Be Done to Increase Recovery?

- ▶ DSM tasked with data collection and analysis of Massachusetts processors to determine possibility of increasing recovery

# Visual Analysis of C&D Waste Processed

- ▶ Incoming C&D loads at seven facilities, and outgoing residue (from processors only) were visually analyzed
  - Goal to characterize incoming materials and outgoing residue
- ▶ Visual sample data converted to weight based estimates to estimate composition of incoming C&D and out-going residue by facility

# Methodology

- ▶ Data entered into spreadsheet with volume converted to weight based on material density
- ▶ Total weight compared with weigh slip for load and adjusted (sum from visual estimate roughly equivalent to net weight of the load)
- ▶ Residual approach similar but samples were randomly taken from residue piles within the facility





**Bulky Waste Loads**  
Excluded from Totals



**Roll-offs easier than 100 yard trailers  
to separate materials from,  
and to characterize**

# Results, by Weight

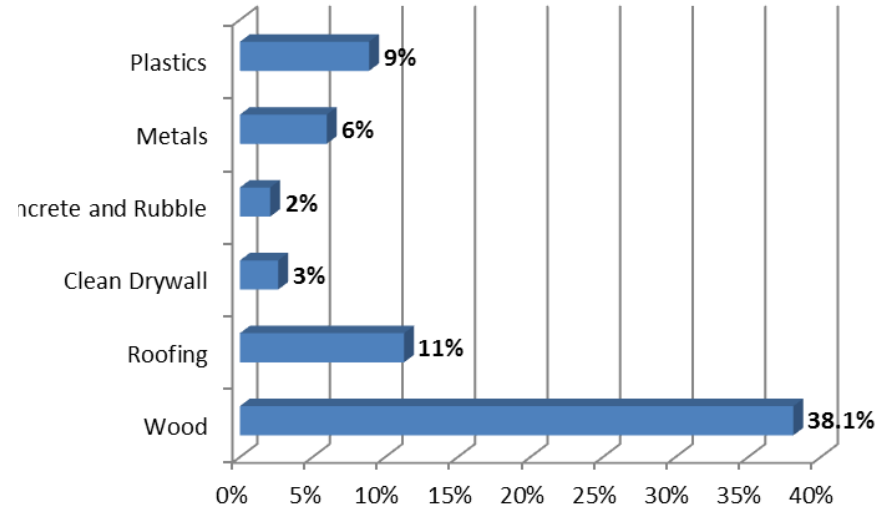
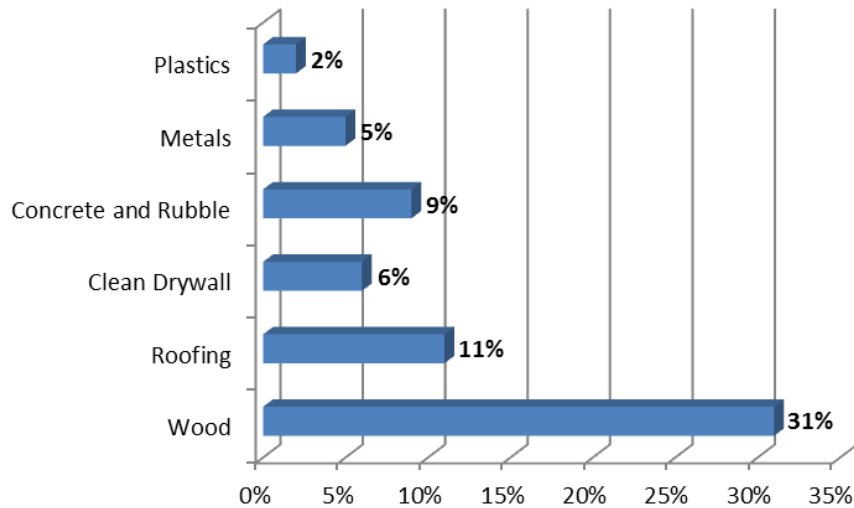
<b>INCOMING MATERIAL COMPOSITION</b>	
	<b>Average</b>
<b>Material Category</b>	<b>(%)</b>
PAPER	2%
PLASTIC	2%
GLASS	2%
ORGANICS	2%
<b>C&amp;D</b>	<b>79%</b>
METAL	5%
SPECIAL WASTE	5%
MSW (Bagged)	2%

# Results, By Weight: C&D

<b>C&amp;D</b>	<b>79%</b>
Concrete/Brick/Rock	2%
Asphalt Paving	0%
Asphalt Roofing	11%
Wood Roofing	1%
Ceiling Tiles	2%
Vinyl Siding	0%
Pallets and Crates	4%
Clean Lumber	12%
Plywood	6%
Other Engineered Wood	6%
Wood Furniture	1%
Painted/Stained Wood	10%
Treated Wood	1%
Clean Gypsum Board	3%
Printed/Papered Gypsum Board	5%
Dirt, Sand and Gravel	5%
Fiberglass Insulation	0%
R/C and Other C&D	11%

*Wood materials are an estimated 39% of Incoming C&D*

# Change in Composition?



2008 Literature, Data

2016 Field



# Estimated Recovery Rates for Mixed C&D Waste

Sorted Material	Processors (%)	Transfer Stations (%)	Overall (%)
OCC	31%	9%	22%
Plastic	6%	0%	3%
Metal	100%	49%	90%
Asphalt/Brick/Concrete	100%	100%	100%
Asphalt Roofing	12%	2%	7%
Clean Gypsum Board	9%	0%	4%
Wood	32%	4%	22%
<b><i>Overall Materials Recovery Rate (1):</i></b>	<b>48%</b>	<b>6%</b>	<b>33%</b>

- 1) Excludes recycled materials reported separately as incoming materials
- 3) Excludes electronics, glass, mattresses, tires and other misc. materials recovered in small quantities

# Additional Recovery Potential

- ▶ Depends on Incoming Composition
  - Massachusetts stream was mixed C&D
  - Much of the metals already removed
  - High tip fees drive removal of value materials
- ▶ Depends on Markets
  - Changing markets for wood
- ▶ Depends on regulatory and other factors
  - Breadth and enforcement of bans
  - LEED Incentive
  - Competing options for C&D waste

# Comparison, By Weight, of Incoming and Residue Composition

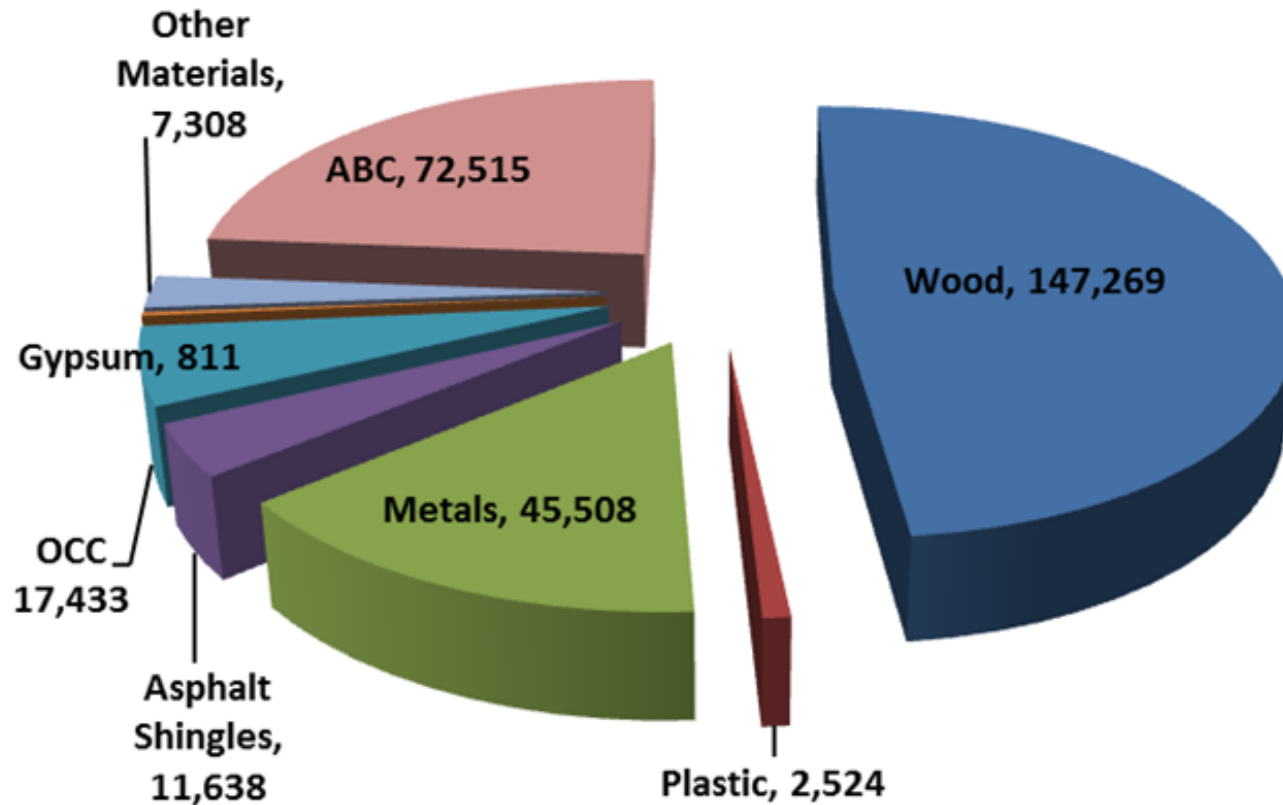
*(Potentially Marketable Materials Only)*

Material Category	INCOMING (%, By Weight)	Marketability	RESIDUALS (%, By Weight)
<b>PAPER</b>	2.3%		6.3%
OCC/Kraft	1.4%	H	3.3%
<b>PLASTIC</b>	2.5%		8.6%
Rigids	0.9%	M	4.5%
Film	0.1%	L	1.2%
<b>ORGANICS</b>	3.1%		3.9%
Yard Waste	1.3%	H	0.2%
Carpet/Padding	1.5%	L	3.7%
<b>C&amp;D</b>	78.6%		74.5%
Concrete/Brick/Rock	2.1%	H	0.4%
Asphalt Roofing	11.3%	M	8.5%
"A Wood"	27.5%	H	22.3%
"B Wood"	10.6%	M	6.3%
Clean Gypsum Board	2.6%	L	3.0%
<b>METAL</b>	4.6%		2.5%
Ferrous	3.7%	H	1.2%
Non-Ferrous	1.2%	M	1.3%

# Market Status

»» Based on 2016 MassDEP Study

# Composition of Material Sales (Massachusetts Tons Reported, 2015)



# Waste Wood

- ▶ In 2007, the market for waste wood was robust, but since then markets have tightened:
  - Sappi/Westbrook, Maine buys very little waste wood from MA
  - Boralex (ReEnergy) bio-fuels combustion facilities in Maine all stopped accepting waste wood (due to CT ruling concerning Renewable Energy Credits)
    - Although we have heard that some facilities may be accepting waste wood again
  - Quebec has tightened combustion specifications resulting in tighter specifications for burning waste wood :
    - Tafisa no longer has arrangement with Kruger so tightened its specification for fines (which they were sending to Kruger)
    - Allowable trace metals has been reduced at Tafisa, reducing the amount of fines Tafisa can accept in the “A” wood.



# Waste Wood



- ▶ Tafisa is the largest single market for waste wood from MA C&D processors
  - Consumed 216,000 tons in 2016, of which 60 percent were sourced from MA and NH (e-mail correspondence from Sylvain Martel)
  - They would like to increase consumption of waste wood, but fines remain a problem
- ▶ Plainfield Renewable Energy (PRE) gasification facility also purchases waste wood but no data on quantities purchased
  - Processors shared that PRE has some operational and storage constraints and tighter specifications, especially for fines

# Fines Markets, “Not Fine”

- ▶ As in 2007 fines continue to be a significant issue for processors
  - Can't use in ADC due to hydrogen sulfide emissions at landfills
  - Can't be mixed in with wood delivered to bio-mass combustion facilities due to higher concentrations of trace metals and other contaminants
- ▶ Bio-mass combustion facilities accepting wood waste have reduced level of allowable fines
  - Tafisa has reduced the amount, in part because fines contain higher concentrations of lead which Tafisa needs to limit in its' products
- ▶ This leaves fines with no markets although they are an inevitable by-product of processing mixed C&D waste:
  - Dumped on a tipping floor
  - Size reduction of incoming material by excavators (prior to conveying to sort line)
  - Grinding of resultant recovered wood, with screening to reduce fines, to meet end users specifications



# OCC and Metals

- ▶ OCC in mixed C&D loads often contaminated by other materials, and open top containers create wet OCC
  - Most facilities do not have balers limiting markets
  - So while OCC is positively sorted, recovery rate is much lower than in single stream MRFs, and the resultant value lower.
- ▶ Robust markets remain for both ferrous and non-ferrous metals, although with large swings
  - Metal in the residue is often attached to wood (such as roofing) or is wire and wire sheathing which can be difficult to manually remove, and may not be captured by magnets.

*Wishful Typical  
C&D Load*



# Plastics



- ▶ Chinese import restrictions have reduced the price of lower value plastics, the primary types available in mixed C&D.
- ▶ While bulky rigid plastics especially, including clean five gallon pails or other containers, have some value, contaminants significantly reduce their value.
- ▶ Plastic film is prevalent in mixed C&D but often highly contaminated reducing its value.
  - And difficult to pull film off picking line as it gets tangled with other materials

# Still Waiting on Gypsum Markets

- ▶ Gypsum recycled from MA facilities typically goes to Pennsylvania where it is made into an agricultural product.
- ▶ Best method for recycling gypsum is to manage it separately at the job site
  - When delivered in mixed C&D, tends to break into small particles during collection, transport and mixing on the tipping floor.
  - Typically pulled off the tip floor manually from mixed loads
- ▶ Most gypsum recycling facilities require new gypsum, not painted or wallpapered gypsum, which is typical of demolition debris.

# Asphalt Shingles

- ▶ Most asphalt roofing recycled is delivered directly to facilities/end markets
  - A fair amount of mixed C&D from roofing jobs or repairs contain asphalt shingles
  - Main market in Massachusetts is Carneys (Raynham).
    - Other markets are Rooftop Recycling in Boxborough, MA and RAS-Tech located in Brentwood, NH.

Source:

*AsphaltRoofing.org*



# Processing Advancements and Target Materials

- ▶ Wood (dominant material with market value) can be recovered at relatively high rates depending on incoming loads and equipment available:
  - Recovery depends on ease of separation from contaminants, such as pressure treated wood and difficulty of meeting Tafisa's specification
  - One solution may be to install additional equipment to recover this wood as "A" Wood for sale to Tafisa or to a bio-mass combustion facility.
    - States could assist with the capital cost of up-front conveyors, air separators, disc screens and optical sorters to recover more wood.
    - While optical identification of pressure treated wood is still in the development stage, it appears feasible according to several optical sort manufacturers
  - Alternative approach might be to install more air separators and disc screens to remove contaminants from "B" wood lines

# Alternative Uses of Waste Wood

- ▶ Small scale gasification units to convert the “B” Wood into energy are not feasible for MA C&D facilities
  - Processors need electric power (to run equipment) and not heat
  - Any bio-gas produced would need an internal combustion engine to convert to electricity
  - Bio-gas contains tars and other impurities that are difficult to fuel a combustion engine without (extensive) clean-up, which puts the cost significantly higher than buying conventional gasoline or diesel fuel
    - (Source Ted Pytler, D&B Engineers and Architects)
- ▶ Metals have high value and while ferrous metals are removed by magnets, non-ferrous metals are found in the residue that might be valuable.
  - While additional metal recovery won't have much of an impact on the recycling rate, it could improve processing economics
  - Recovery of non-ferrous metals in most cases would involve the addition of eddy current separators with some additional clean-up of the material before separation

# Barriers to Reaching MA Goal

- ▶ Market specifications for waste wood
- ▶ Relatively low cost landfill and rail transfer and disposal of waste wood
- ▶ Lack of a uniform definition of “processing” for C&D waste leading to low recovery rates at facilities without mechanized processing equipment
- ▶ Distance between where the majority of C&D is generated and availability of processing capacity
  - Processing facilities often not located in high density urban areas
- ▶ Low value for commodities
  - The additional processing and transport costs outweigh the value even when a market can be found

# MA Takeaways

- ▶ Given the markets, processors in Massachusetts are doing a relatively good job of recovering materials from mixed C&D waste
- ▶ Currently recovering roughly 50 percent of marketable materials, resulting in a 32 percent recycling rate for C&D waste managed in Massachusetts
  - Despite the fact that the market for wood waste is more limited now than in 2007
- ▶ Greater recovery requires continued investment in new processing equipment at existing processing facilities and at transfer stations
  - Low tip fees make it difficult for processors to justify running low value C&D through processing lines and constrains investment in new, capital intensive technologies



# Roughly How Much C&D Needs to Be Managed in Our Region?

- ▶ Using .29 tons per capita and a 15% recycling rate = 15.3 million tons annually

State	2016	C&D Waste (tons)	Recycling (%)	Net Disposal (tons)
New York	19,745,289	5,726,134	15%	4,867,214
Pennsylvania	12,784,227	3,707,426	15%	3,151,312
New Jersey	8,944,469	2,593,896	15%	2,204,812
Massachusetts	6,811,779	1,975,416	30%	1,382,791
Maryland	6,016,447	1,744,770	15%	1,483,054
Connecticut	3,576,452	1,037,171	15%	881,595
New Hampshire	1,334,795	387,091	15%	329,027
Maine	1,331,479	386,129	15%	328,210
Rhode Island	1,056,426	306,364	15%	260,409
Delaware	952,065	276,099	15%	234,684
Vermont	624,594	181,132	15%	153,962
<b>Total:</b>	<b>63,178,022</b>	<b>18,321,626</b>	<b>17%</b>	<b>15,277,070</b>

# Where Does C&D Waste Go?

- ▶ In 2015, Connecticut kept 18% instate, 56% to Ohio and rest to NY, MA, PA, RI, VA and ME
  - Eight CT VRFs with Rail
- ▶ Vermont sends C&D to VT, NH, NY and Quebec
- ▶ Massachusetts to RI, NH, ME and OH
  - Several processing facilities and TS with rail
- ▶ Delaware stays instate



# Barriers to Increased Diversion

- ▶ Ohio has plenty of low cost disposal capacity so processing has to stay below rail and tip fee costs to be viable in those states where bans are not in place or enforced
  - Sunny Farms and Tunnel Hill Reclamation has 15,500 TPD permitted capacity (@ 5 millions TPY) Source: THP website
- ▶ Most C&D waste is created during demolition
  - While on-site separation creates highest quality product and recovery rate, limited contribution to diversion
- ▶ Wood markets are limited and are primarily combustion
  - Could be boosted by Renewable Energy Credits
- ▶ MA processing requirement has resulted in higher C&D recovery rates
  - But REC's not available for in-state combustion of waste wood