Zero Waste Plan
Materials Characterization Study
January 2020

UNIVERSITY OF CALIFORNIA
SANTA CRUZ

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Introduction

The University of California, Santa Cruz has many state of the art programs for waste prevention, recycling and composting, including:

- Source-separated recycling
- Food scrap composting
- Zero Waste events

The University is developing a Solid Waste Operational Action Plan and Campus Zero Waste Plan to increase efficiency and performance and to identify actions to undertake to achieve the University's zero waste goals, including 90% diversion and waste reduction.

The University undertook this materials characterization study to identify the opportunities for reducing contamination and increasing recycling and composting.

Materials characterization studies (also known as waste composition studies) are conducted to find out how much recyclable (e.g., paper, glass) or compostable (e.g., food, yard trimmings) materials are discarded into the landfill containers and to identify any contamination in the recycling or compost containers. The data is collected by taking samples of materials and sorting them into material types such as mixed paper, mixed plastics, metal containers and glass containers and estimating the proportion of each type.

The data is then summarized to determine the estimated amount of:
1) recyclable and compostable materials found in the landfill containers
2) compostable and landfill materials found in the recycling containers
3) recyclable and landfill materials found in the compost containers

Methodology

The field research for the materials characterization study was performed over five days from January 13 to 17, 2020. The data collected during the field research provided a snapshot of the composition of material streams generated during a typical week of operations at the University.

Sampling Locations and Sample Counts

The field crew characterized samples from 25 service point locations adjacent to buildings within the following operational areas: Operations, Academics, Housing, and Dining. Table 1 lists the sampling locations and sample counts. "Bins" are 6-cubic yard front load containers and "carts" are 64-gallon or 96-gallon wheeled containers.

TABLE 1 SAMPLING LOCATIONS AND SAMPLE COUNTS

Operational Area	Location	Sample Counts		
		Recycling	Landfill	Compost
Operations	Field House East	1 cart	1 bin	1 cart
	McHenry Library	2 carts	1 bin	4 carts
Academics	Baskin Engineering	2 cars	1 bin	
	Baskin Engineering 2		1 bins	
	College 9	1 cart		
	College 9/10	1 bin	3 bins	
	Earth Marine Sciences	2 carts	1 bin	
	Hahn Student Services	2 carts		
	Kerr Hall	1 cart		1 cart
	Physical Sciences	4 carts	1 bin	
	Thiman Laboratories	2 carts	1 bin	
Housing	Cowell College	1 bin	1 bin	
	Cowell College Parrington House	6 carts		
	College 9 Housing	5 carts, 1 bin	1 bin	
	Crown/Merrill Apartments	5 carts, 1 bin	1 bin	
	Merrill College	1 cart, 1 bin	2 bins	
	Stevenson College	1 bin	2 bins	
	Oakes College	3 carts	1 bin	
	Porter College (Chutes)	2 bins	2 bins	
	Porter College Apartments	1 cart	2 bins	
	Rachel Carson College Housing	1 bin	2 bins	
	Family Student Housing	6 carts	1 bin	
	The Village	3 carts		
Dining	College 9/10 Dining	2 bin	1 bins	
	Rachel Carson College Dining		2 bin	

Over the five days of the field research, a total of 92 samples were characterized including: 58 recycling samples, 28 landfill samples, and 6 compost samples.

The majority of recycling samples and all of the compost samples were taken from 64-gallon or 96-gallon wheeled carts. Some of the recycling samples and all of the landfill samples were taken from 6-cubic yard bins. The containers were approximately 70% full on average. Thus, a total of 142 cubic yards or 12 tons were characterized over the five day sampling period.

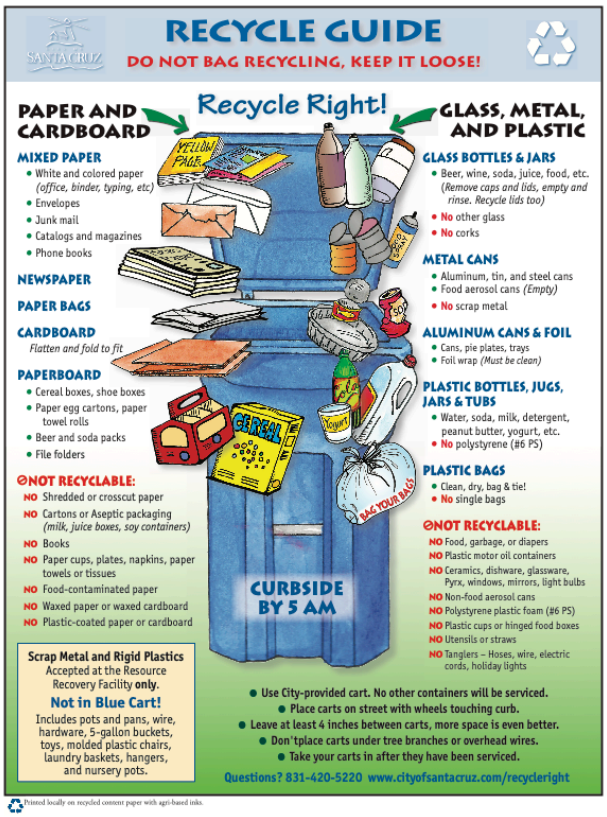
Visual Characterization

For each sample, the field crew conducted a visual characterization. Cart samples were spread out onto a tarp and the estimator then visually estimated the percentage of recycling, compost and landfill materials in the sample by major material types and by volume. For bin samples, bags were opened and materials were spread out into the bin and visually estimated. The totals were calculated to ensure that they added to 100 percent. The data gathered in the field was recorded onto field data sheets and entered into a spreadsheet. Volume-to-weight conversion factors were used to determine the approximate weight in pounds. The appendix includes the conversion factors, a sample field data sheet, sample photos and material category descriptions.

Recycling Sample with 75% recycling, 5% compost and 20% landfill materials

Material Categories

The University brings the majority of its recyclable materials to the City of Santa Cruz Resource Recovery Facility where the materials are processed and sold for recycling. The City processes "single stream" materials (paper and containers are collected together and separated at the facility. The City's processing system and marketing options limit the types of materials that can be recycled. For example, the City cannot accept plastic cups or hinged food boxes, bagged recyclables, scrap metal or pizza boxes. These are considered contaminants in the recycling stream.



City of Santa Cruz Recycling Guide

This study compared materials accepted through City of Santa Cruz program and other nearby regional processors, including the Monterey Regional Waste Management District recycling facility (where more materials are accepted for recycling). The University's compost processor, the Monterey Regional Waste Management District currently accepts a limited number of compostable materials. However, the other regional compost processors accept additional materials (including compostable foodware) and the District will also be modifying the types of materials that will be accepted for composting in the future.

Table 2 lists the material categories used in the study, including those for the University's Current Processors and Alternative Regional Processors.

TABLE 2 MATERIAL CATEGORIES

	CURRENT PROCESSORS	ALTERNATIVE PROCESSORS
RECYCLING	MIXED PAPER MIXED PLASTICS GLASS CONTAINERS METAL BUNDLED PLASTIC BAGS	MIXED PAPER MIXED PLASTICS OTHER MIXED PLASTICS GLASS CONTAINERS METAL BUNDLED PLASTIC BAGS BAGGED RECYCLABLES
COMPOST	FOOD COMPOSTABLE FIBER	FOOD COMPOSTABLE FIBER OTHER COMPOSTABLE FIBER PAPER CUPS COMPOSTABLE PLASTIC FOODWARE
	YARD WASTE	YARD WASTE
LANDFILL	LOOSE PLASTIC BAGS MIXED RESIDUE BAGGED RECYCLABLES OTHER MIXED PLASTICS OTHER COMPOSTABLE FIBER PAPER CUPS COMPOSTABLE PLASTIC FOODWARE	LOOSE PLASTIC BAGS MIXED RESIDUE

"MIXED PLASTICS" includes plastic bottles, jugs and tubs
"OTHER MIXED PLASTICS" includes plastic cups, hinged plastic and rigid plastics
"COMPOSTABLE FIBER" includes UCSC to-go containers
"OTHER COMPOSTABLE FIBER" includes unlined paper foodware, paper plates, napkins, paper towels
"PAPER CUPS" includes polylined paper cold cups and hot cups
"COMPOSTABLE PLASTIC FOODWARE" includes BPI certified plastic
"MIXED RESIDUE" includes non-recyclable, non-compostable materials

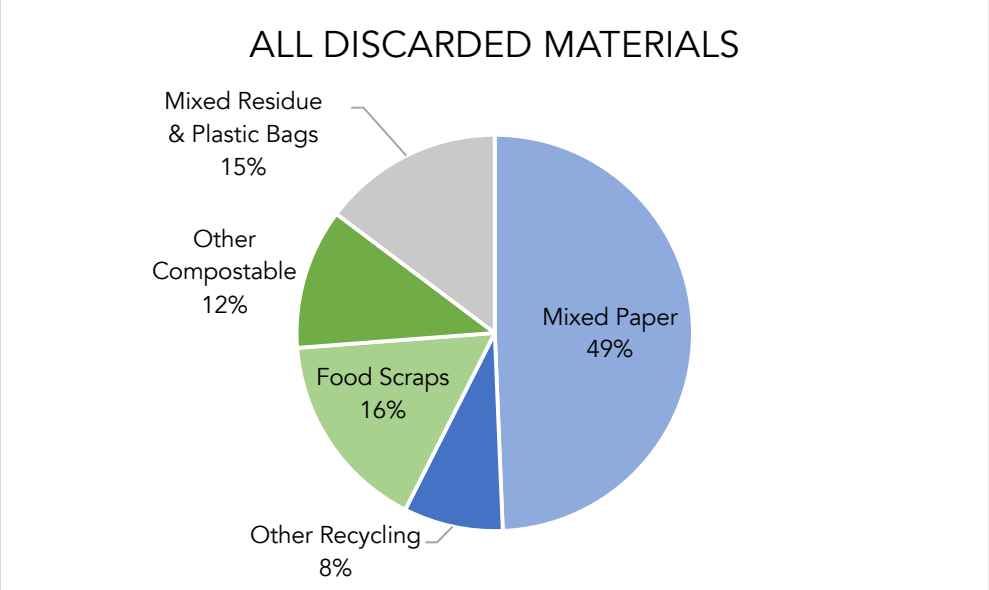
Findings

Composition By Material Stream

The overall discarded materials composition, including all recycling, compost and landfill materials, is shown in Table 3 below. Approximately half of the material by weight observed was clean mixed paper followed by 16% food scraps and 14% mixed residue and 1% plastic bags. If the University contracted with a regional processor that accepted all recyclable and compostable materials, as much as 85% of the discarded materials could be diverted from disposal.

TABLE 3 OVERALL DISCARDED MATERIALS COMPOSITION

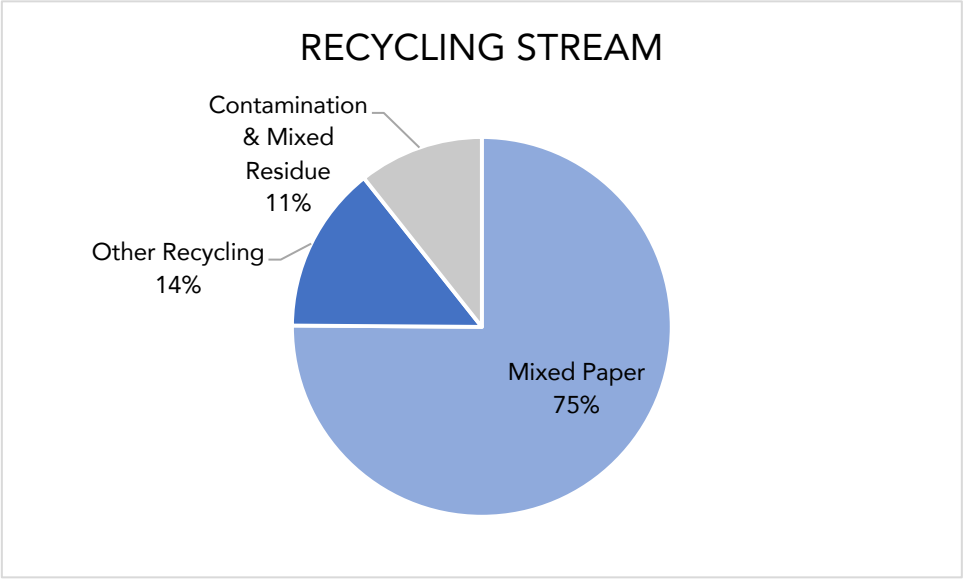
Material Types	Estimated Pounds	Percentage
Mixed Paper	11,824	49%
Mixed Plastics	402	2%
Other Mixed Plastics	183	1%
Glass	155	1%
Metal	1,203	5%
Food Scraps	3,913	16%
Compostable Fiber	1,743	7%
Other Compostable Fiber	747	3%
Paper Cups	138	1%
Compostable Foodware	50	<1%
Yard Waste	67	<1%
Plastic Bags	142	1%
Mixed Residue	3,389	14%
Total	**23,956**	**100%**



The overall recycling stream is comprised mostly of clean mixed paper (75%) and the remaining 25% includes 15% of other recyclable materials, including mixed plastics, metal, and glass and 10% contamination, including compostable materials and residue. If all the material was collected loose and not bagged, the campus could conceivably recover 90% of the recycling stream.

TABLE 4 RECYCLING STREAM COMPOSITION

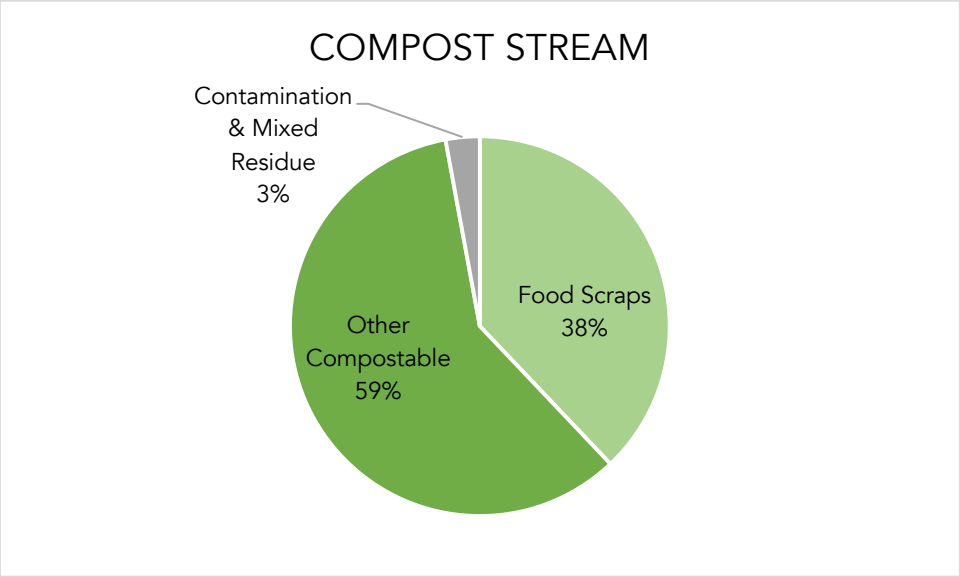
Material Types	Estimated Pounds	Percentage
Mixed Paper	7,464	75%
Mixed Plastics	304	3%
Other Mixed Plastics	72	1%
Glass	121	1%
Metal	916	9%
Food Scraps	213	2%
Compostable Fiber	138	1%
Other Compostable Fiber	71	1%
Paper Cups	24	<1%
Compostable Foodware	5	<1%
Yard Waste	-	0%
Plastic Bags	10	<1%
Mixed Residue	600	6%
Total	**9,937**	**100%**



The compost stream was sampled at the East Field House, Kerr Hall, and McHenry Library Café. Thirty-eight percent of the materials were food scraps and 59% include other compostable materials. Overall, the compost containers were clean with only 3% contaminants and mixed residue.

TABLE 5 COMPOST STREAM COMPOSITION

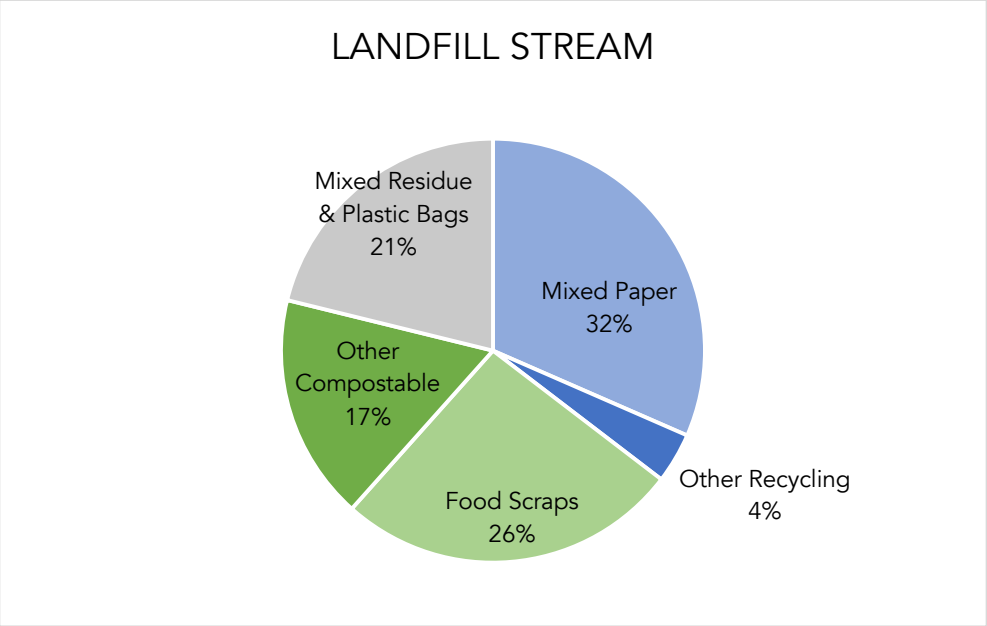
Material Types	Estimated Pounds	Percentage
Mixed Paper	5	2%
Mixed Plastics	-	0%
Other Mixed Plastics	<1	<1%
Glass	-	0%
Metal	-	0%
Food Scraps	83	38%
Compostable Fiber	83	38%
Other Compostable Fiber	39	18%
Paper Cups	5	2%
Compostable Foodware	3	1%
Yard Waste	-	0%
Plastic Bags	-	0%
Mixed Residue	1	>1%
Total	**219**	**100%**



The composition of the landfill stream also shows clean mixed paper as the most prevalent material type at 32%. Followed closely by food scraps (26%) and mixed residue and plastic bags (21%). Overall, 79% of materials in the landfill stream could be diverted from disposal.

TABLE 6 LANDFILL STREAM COMPOSITION

Material Types	Estimated Pounds	Percentage
Mixed Paper	4,354	32%
Mixed Plastics	98	1%
Other Mixed Plastics	111	1%
Glass	34	<1%
Metal	287	2%
Food Scraps	3,618	26%
Compostable Fiber	1,522	11%
Other Compostable Fiber	637	5%
Paper Cups	110	1%
Compostable Foodware	43	<1%
Yard Waste	67	<1%
Plastic Bags	132	1%
Mixed Residue	2,788	20%
Total	**13,800**	**100%**



Contamination by Sectors and Zones

The data was collected at 25 sampling locations and then aggregated by "sectors" (based on the type of the building or facility) and "zones" based on the area of the campus. "Sectors" include Operations, Academic Buildings, Housing, and Dining.

"Operations" included the East Field House and the McHenry Library. "Academic Buildings" comprised the classroom buildings. "Housing" included dormitories, student apartments, and family student housing. "Dining" included the College 9/10 dining hall and the Rachel Carson College dining hall.

Tables 7 and 8 show contamination levels by Sector under two scenarios based on the requirements of the University's "Current Processors" compared to "Alternative Regional Processors." "Current Processors" are the City of Santa Cruz for recyclable materials processing and Monterey Regional Waste Management District for composting. These programs accept a limited number of material types for processing and composting. The City's facility also considers bagged recyclables to be a contaminant. The presence of bagged recyclables was taken into account in calculating the contamination rate. Most of the larger contamination rates in the recycling stream were due to the presence of bagged recyclables.

"Alternative Regional Processors" include processors that are able to accept more recyclable and compostable materials and accept recyclable materials in bags. "Landfill contamination" means recyclable or compostable materials that were present in the landfill stream. The recycling and compost contamination rates are lower under the Alternative Regional Processors scenario because these facilities accept more material types for recycling or composting. Therefore, fewer of the materials placed in the recycling and compost containers would be considered contaminants. The landfill contamination is higher because more of the materials placed in the landfill bins would be considered recyclable or compostable at the Alternative Regional Processors.

TABLE 7
CONTAMINATION BY SECTOR BASED ON REQUIREMENTS OF CURRENT PROCESSORS COMPARED TO ALTERNATIVE REGIONAL PROCESSORS

Sector	Recycling Contamination (Current)	Recycling Contamination (Alternative)	Compost Contamination (Current)	Compost Contamination (Alternative)	Landfill Contamination (Current)	Landfill Contamination (Alternative)
Operations	38%	21%	26%	3%	58%	75%
Academics	26%	13%	8%	NA	78%	87%
Housing	40%	11%	NA	NA	74%	79%
Dining	2%	0%	NA	NA	40%	42%

TABLE 8
CONTAMINATION BY ZONE BASED ON REQUIREMENTS OF CURRENT PROCESSORS COMPARED TO ALTERNATIVE REGIONAL PROCESSORS

Zone	Recycling Contamination (Current)	Recycling Contamination (Alternative)	Compost Contamination (Current)	Compost Contamination (Alternative)	Landfill Contamination (Current)	Landfill Contamination (Alternative)
Zone 1 Field House East	7%	6%	0%	0%	52%	70%
Zone 2 Cowell, Stevenson	32%	5%	NA	NA	83%	86%
Zone 3 Merrill, Crown/Merrill Apts, Village	39%	6%	NA	NA	77%	81%
Zone 4 College 9, College 9/10 Housing, Dining	30%	5%	NA	NA	71%	75%
Zone 5 Hahn, McHenry Library	28%	15%	31%	3%	64%	80%
Zone 6 Physical Sciences, Baskin, Baskin 2	34%	24%	NA	NA	74%	85%
Zone 7 Earth Marine Sciences, Thiman Labs, Kerr Hall	61%	25%	8%	3%	72%	74%
Zone 8 Oakes, Rachel Carson, Porter, Family Student Housing	43%	21%	NA	NA	67%	NA

The most prevalent non-recyclable contaminants observed were:

- Bagged recyclables
- Plastic film mailers (from shippers, including Amazon, Fedex, and UPS)
- #6 plastics (such as polystyrene cups)

Plastic film mailers, Plastic cups and Bagged recyclables

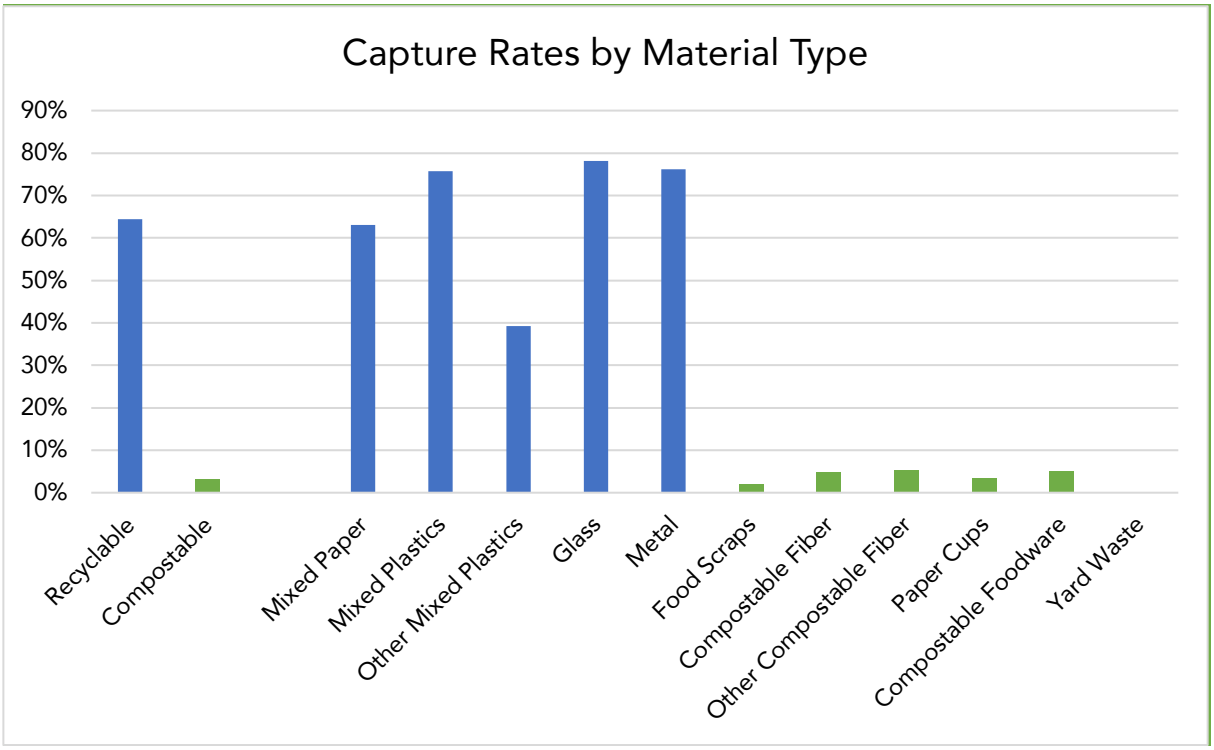
Contamination by Zone

This map depicts the relative level of contamination in the recycling stream (shown in blue) and the landfill stream by Zone (shown in gray) based on what is accepted by the University's current processor. The larger the blue oval, the more recycling contamination (mixed residue or other contaminants in the recycling cart or bin). The larger the gray oval, the more landfill contamination (recyclable and compostable materials in the landfill bin). Much of the contamination from the Academic buildings was due to large amounts of bagged recyclables. The day that each area was sampled is also shown in this map.

Capture Rates

By characterizing all three streams (Recycling, Compost, Landfill) a "capture rate" can be established. A capture rate indicates what proportion of a material type is being placed in the correct container. Capture rates were able to be evaluated in the materials characterization study because each of the landfill, recycling and compost streams was sorted.

Overall, the University staff and students are doing a fairly good job of sorting recyclables correctly. The University is "capturing" 64% of recyclable materials. However, compostable materials, such as food and compostable paper have much lower capture rates and represent an opportunity for program enhancements. Over 79% percent of the materials destined for the landfill were recyclable (35%) or compostable (44%) and could have been included in the recycling or compost collection program.



Appendix

Conversion Factors

Material Group	Density (Pounds/Cubic Yards)	Density (Tons/Cubic Yards)	Source
Mixed Paper - Remainder/Composite Paper	364	0.18	U.S. EPA 1996, 1997
#1 PET Water bottles, #2 HDPE Bottles & Jugs	31	0.02	RW Beck 2011
#3-#7 Other	50	0.03	RW Beck 2011
Recyclable Glass Bottles & Jars	693	0.35	RW Beck 2011
Aluminum Beverage Containers and ferrous metal	108	0.05	RW Beck 2011
Food Scraps & Compostable Paper	300	0.15	SEE&I 2011
Other Compostable Paper	53	0.03	RW Beck 2011
Compostable Plastic Foodware	32	0.02	CIWMB 2006
Prunings, Trimmings, Branches, & Stumps	127	0.06	CIWMB 2006
Plastic bags (loose)	35	0.02	U.S. EPA 2016
Campus Trash (loose)	90	0.05	U.S. EPA 1997

Sample Field Data Sheet

VISUAL ASSESSMENT FORM

Date Sampled:		**Evaluator 1:**		**Evaluator 2:**	
Container Description					
Container Type		**Service Point:**		**Load Name:**	
Container Size (CY, GAL)					
Container Ref. No.		**Trash/Recycling/Compost:**		**Sample #:**	
% Full (volume)		**Quadrant:**			

Recycle:	%	Bagged:	%	Notes:
MIXED PAPER				
MIXED PLASTICS				
OTHER MIXED PLASTICS (CRV#1, HDPE#2, PET#1-5, Bndld Bags)				
GLASS				
METAL				
Subtotal (must equal 100%)				

Compost:	%	Bagged:	%	Notes:
FOOD				
COMPST. FIBER				
OTHER COMPST. FIBER				
PAPER CUPS				
COMPST FOODWARE				
YARDWASTE				
Subtotal (must equal 100%)				

Trash:	%	Notes:
Plastic Bags		
Mixed Materials		
Subtotal (must equal 100%)		

Grand Total:	
(Must Equal 100%)	

Sample Photos

Recycling Cart - Family Student Housing - Recycling 58%, Compost 3%, Landfill 39%

Compost Cart - McHenry Library - Recycling 2%, Compost 98%, Landfill 0%

Landfill Bin – Merrill - Recycling 25%, Compost 40%, Landfill 35%

Landfill Bin – Rachel Carson Dining - Recycling 20%, Compost 2%, Landfill 78%

Material Categories and Material Types

MATERIAL CATEGORY	MATERIAL TYPE	EXAMPLES
PAPER	Office Paper/Magazines/Paperboard	High grade white copy paper, letterhead, junk mail, notebook paper, envelopes, folders, cereal boxes, non-corrugated boxes, boxboard, shiny/glossy magazines, catalogs, brochures.
	OCC	Cardboard.
	ONP	Newspaper.
PLASTIC	CRV PET #1 bottles	Soda bottles, water bottles, all CRV bottles.
	Non-CRV PET #1	Other PET containers, thermoform clamshells, berry containers, includes colored PET.
	HDPE #2	Milk jugs, liquid soap, mouthwash and other personal care product containers, laundry and detergent bottles, colored and natural.
	Plastics 3-7	Fruit trays, plastic egg cartons, medication bottles, butter and yogurt tubs, skin care product containers, cosmetic containers, all marked 3-7
	Plastics Rigid	Buckets, milk crates, toys, laundry baskets, plastic chairs, plumbing piping, waste baskets, reusable plastic thermos, reusable plastic water bottles.
	Plastic bags and film plastic	Grocery and other merchandise bags, one-time use shopping bags, bags for newspaper, bread, paper towels, toilet paper, food storage bags, case wrap, plastic garbage bags used to contain trash, all colors and clear, Bubble wrap, shrink wrap, mattress bags, agricultural films, drop cloths, woven polypropylene cloth and reusable bags.
GLASS	Food & Beverage Glass, CRV & Non-CRV	Beer and malt beverages, wine coolers, spirits bottles, sauce and condiment jars, wine bottles.
METAL	CRV Aluminum	Soda and water cans, all CRV aluminum cans.
	Non-CRV Aluminum	Aluminum foil, trays, solid aluminum piping, scrap aluminum.
	Tin Cans	Soup, chili, vegetable, fruit cans, cat food cans, dog food cans, tuna cans.
ORGANICS	Food waste	Food, food residue, otherwise edible and food scraps.
	Food-Soiled Paper	Paper towels, plates and napkins with food residue, pizza boxes, takeout cartons, wooden chopsticks, wax paper, paper bags with food residue, waxed cardboard, paper coffee cups
	Yard Waste	Branches, stumps, flowers, sticks, branches, leaves, green material, landscaping & pruning waste
	Wood Waste	Pallets, non-treated construction wood, lumber and wood
	Manure & Biosolids	Manure, biosolids, digestate and sludges

MATERIAL CATEGORY	MATERIAL TYPE	EXAMPLES
TRASH	Clean Carpet	Synthetic and natural fibers, carpet rolls, carpet squares, rugs, wool, nylon
	Dirty Carpet (too dirty to be recycling)	Synthetic and natural fibers, carpet rolls, carpet squares, rugs, wool, nylon
	Textiles	Fabric trimmings, draperies, clothes, natural fibers, silk, cotton, nylon, pillows, mattress topping, wool, leather, pillows, natural and synthetic fibers, luggage with composite metal, heavily-soiled clothing
	Mixed Residue	Straws, disposable tableware, chip bags, packing peanuts, foam plates/cups, window panes, flat automotive glass, Pyrex, mirrors, light bulbs, pet food bags, mylar, garden hoses, ash, furniture, small corded appliances, auto fluff, pipe insulation, farming/animal wastes and bedding, diapers, shoes, belts, hair, cigarette butts, miscellaneous materials that are undesignated
	Tires	Tires means vehicle tires. Tires may be pneumatic or solid. Examples include tires from trucks, automobiles, motorcycles, heavy equipment, lawn mowers, and bicycles
	Mattresses and Box Springs	All mattresses and box springs
	C&D/Inerts	Building foundation, concrete paving/blocks, black/brown tar-like material used for paving, asphalt shingles, roofing tar, tar paper, treated lumber, treated plywood, gypsum drywall, rocks, soil, stones, sand, bricks, tiles, toilets, sinks
	E-Waste	Microwaves, stereos, VCRs, televisions, DVD players, laptops, keyboards, printers, computers, modems, cell phones, cameras, PDAs, computer monitors
	Large Appliances	Refrigerators, washers and dryers, dishwashers, white goods
	Aseptic & Gable Top Containers	Containers for broth, coconut water, kids sized milk and juice, soups, cocktail drinks, paper milk and juice cartons
	Scrap Metal	Pipe, industrial cuttings, doorknobs, cooking pans, plumbing pipes, C&D metal
	Hazardous Waste, Medical Batteries, Solvents	Latex and oil-based paint, fine art paint, anti-freeze, brake fluid, hydraulic oil, gear oil, transmission oil, car batteries, flashlight batteries, small appliance batteries, watch batteries, medical waste