Circularity Assessment Protocol
Pittsburgh, PA, USA

University of Georgia

Circularity Informatics Lab

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New Materials Institute
UNIVERSITY OF GEORGIA

The Circularity Informatics Lab at the University of Georgia is committed to information sharing, data analytics, empowering communities, and systems change related to circular materials management.

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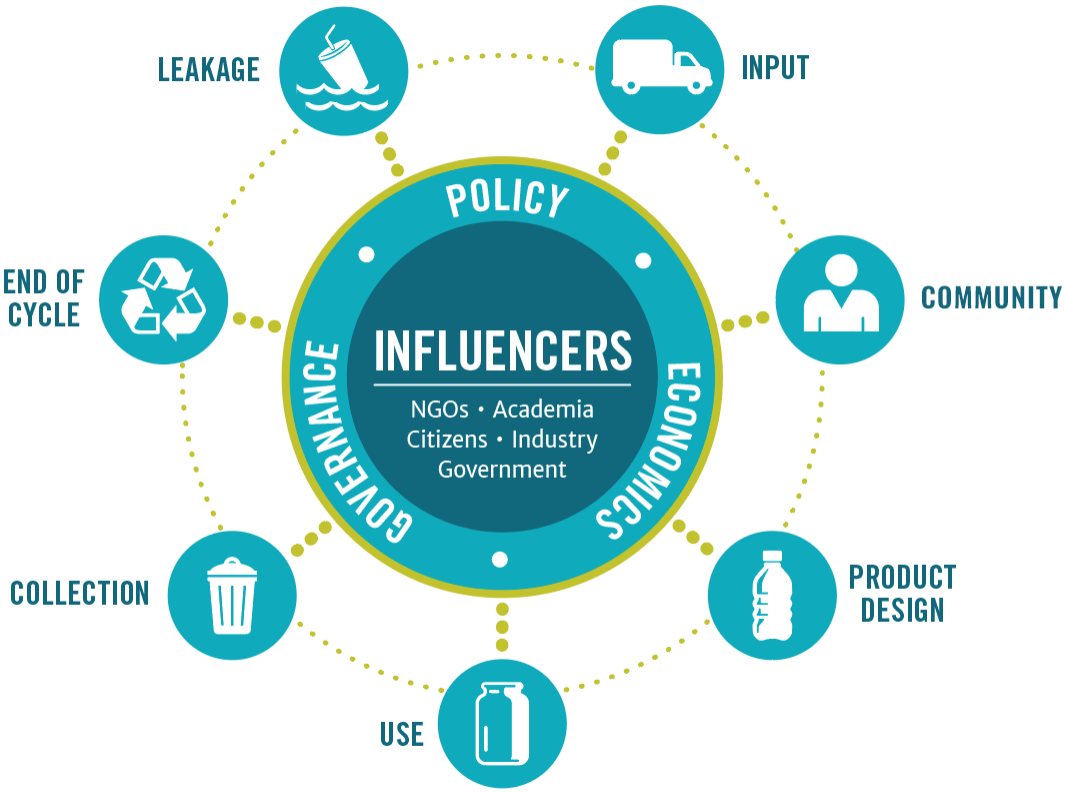
Executive Summary

Developed by the Circularity Informatics Lab at the University of Georgia, the Circularity Assessment Protocol (CAP) is a standardized assessment protocol to inform decision-makers through collecting community-level data on plastic usage. Grounded in materials flow and systems thinking concepts, the CAP uses a hub-and-spoke model to holistically characterize how consumer plastic flows into a community, is consumed, and flows out, either through waste management systems or leakage into the environment. The model, shown below, is comprised of seven spokes: input, community, material and product design, use, collection, end of cycle, and leakage. At the center, the system is driven by policy, economics and governance with key influencers including non-governmental organizations, industry, and government.



Field work was conducted from June 26th, 2023 until September 4th, 2023. This report was made possible through funding from the National Science Foundation under Grant No. 2236080. Fieldwork included product and packaging assessments in stores across the city; key stakeholder interviews with government, industry, and non-profit organizations; material type characterizations for consumer plastic items; cost analysis of reusable products and alternatives to plastic available in the city; visual audits of recycling contamination; identification of public waste and recycling collection bins; and litter transects in three categories of population. Key findings from each spoke are summarized in the table below.

Key Findings

INPUT

Findings: Domestic brands, such as PepsiCo, Coca-Cola, Mars, and Herr Foods Inc. were found frequently in stores across Pittsburgh.

Opportunities:

- Extended Producer Responsibility (EPR) could be discussed with domestic companies with products for sale in the stores. EPR policies currently exist in five USA states so companies are getting more used to complying with EPR regulations and are also sometimes open to voluntary efforts.
- The Hershey Company is a local (state of PA) company that might be interested in increasing circularity.

COMMUNITY

Findings: Based on preliminary data from our social media analysis, there seems to be some interest in compostable/biodegradable plastics and EPR in the Northeastern U.S., where Pittsburgh is located.

Opportunities:

- There is interest around EPR based upon frequencies of mentions in social media; there is an opportunity to further this discussion through community engagement.
- There also appears to be more frequent conversations around biodegradable and compostable plastics in the Pittsburgh region, so this interest could further expand the conversation about these alternatives.

PRODUCT DESIGN

Findings: Over half of the sampled to-go cold cups consisted of unlabeled hard plastic, followed by paper, PP, and PET. A little over half of the sampled food containers were made out of paper/paperboard, although hard plastic, EPS, and other plastic food containers were present. Straws had fewer variety in material type: they were either multilayered or biodegradable. Utensils overwhelmingly tended to be largely made of unlabeled hard plastic, although some were made of natural fibers/plant materials.

Opportunities:

- There is an opportunity to expand the use of plastic material alternatives as most of the material used in packaging are traditional plastic and films that are not collected locally for recycling.
- There is a wide variety of materials offered from restaurants and some are unlabeled, so there could be some standard offerings for businesses to offer more consistent materials that the public can become familiar with.

- The majority of beverage containers are recyclable backing in PET or aluminum.

Findings: All of the plastic alternatives were on average most expensive than their plastic counterparts, ranging from 1.2x more expensive to 9.5x expensive. Reusable items tended to be more widely available at larger/big-box stores, as were reusable bags. There is currently a plastic bag ban in place in the city, yet it is not well enforced.

USE

Opportunities:

- Due to the high cost of alternatives, there is an opportunity to expand the offerings or incentivize or subsidies the purchase of durable versus single-use products.
- There is an opportunity to expand the availability of reusable items to smaller stores, allowing alternatives to reach a new customer base.
- There is an opportunity to expand the offering of reusable bags which are currently available at 43% of the stores sampled.
- Enforcement of the plastic bag ban could be strengthened through outreach to local businesses and/or by using financial incentives (such as tax breaks) for the businesses that comply.

COLLECTION

Findings: Curbside waste collection and recycling services are widely available to residents of Pittsburgh, as recycling is mandatory. Private businesses must contract with private recycling haulers. The city provides composting drop-off at the farmers market.

Opportunities:

- Since curbside collection is single-stream, there have been some issues with contamination; there is an opportunity to continue to keep the public educated and aware of what is and is not accepted for recycling.
- There is a private hauler available for composting, and this could be expanded and further supported by the city.

END OF CYCLE

Findings: Landfills, recycling drop-off, and composting drop-off is available to residents in Pittsburgh.

Opportunities:

- As of right now, city-sponsored composting is either a city pilot (collection or drop-off) or private collection. Pittsburgh can continue with these end-of-cycle offerings to reduce material that is landfilled and optimize circularity.

LEAKAGE

Findings: Across all surveyed transects, cigarettes were the item most frequently found in the environment, with 605 logged. Film fragments (236) and plastic food wrappers (187) were also prevalent, as were hard plastic fragments (168) and paper fragments (81). The highest amount of C&D material litter was found in the high-population areas, which suggests that this litter is being left in areas with higher rates of construction.

Opportunities:

- The largest leakage item was cigarette butts. There is an opportunity to address this litter item through innovative receptacles or public education and outreach (e.g., some people do not realize the filters are made of plastic).
- Food packaging, especially food wrappers (third on the top list of items), makes up 17% of the items leaked into the environment. However, recyclable items like cans and bottles are not in the top 10 items leaked, so if food packaging was recyclable or considered more valuable, it might be less likely to leak out.
- Further investigation should be done into prevention methods specifically for C&D waste in high-population/high-development areas

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Introduction

As of 2024, the United States (US) is home to a population of 340 million people (US Census Bureau 2024) and has an average waste generation rate of 2.24 kilograms per person per day, more than twice that of the global rate of 0.74 kilograms per person per day (Kaza et al. 2018). As a high-income nation, waste management in the US is considered advanced due to its well-designed and regulated waste management infrastructure, which provides high coverage of the country's growing population waste needs. These advanced waste management capabilities are met with some of the highest rates of consumption in the world, with the US generating the largest mass of plastic waste (42 million metric tons in 2016) in the world (Law 2020). The waste in the US is 12% plastic, although the largest percentage of the waste stream is paper/paperboard (23%), and organic materials, like food waste, make up 21.6%. And while nearly 100% of waste is collected in the USA, plastic waste is generally disposed of via landfill (76% by mass), combustion (12%), or recycling (8.7%) (US EPA 2020). However, the US has gained attention in recent years for exporting some of the highest quantities of plastic scrap out of the country for management elsewhere, often to developing countries (Brooks et al. 2018, Law 2020). Further, an estimated 0.28 million metric tons of plastic waste are mismanaged in the USA, with an estimated 0.51–1.45 million metric tons lost to the coastal environments from US waste around the world (Law 2020). The focus of the CAP for this project was to look at both plastics and organic materials in the waste stream that could be managed through composting, compostable products, biodegradable products, and plastic packaging.

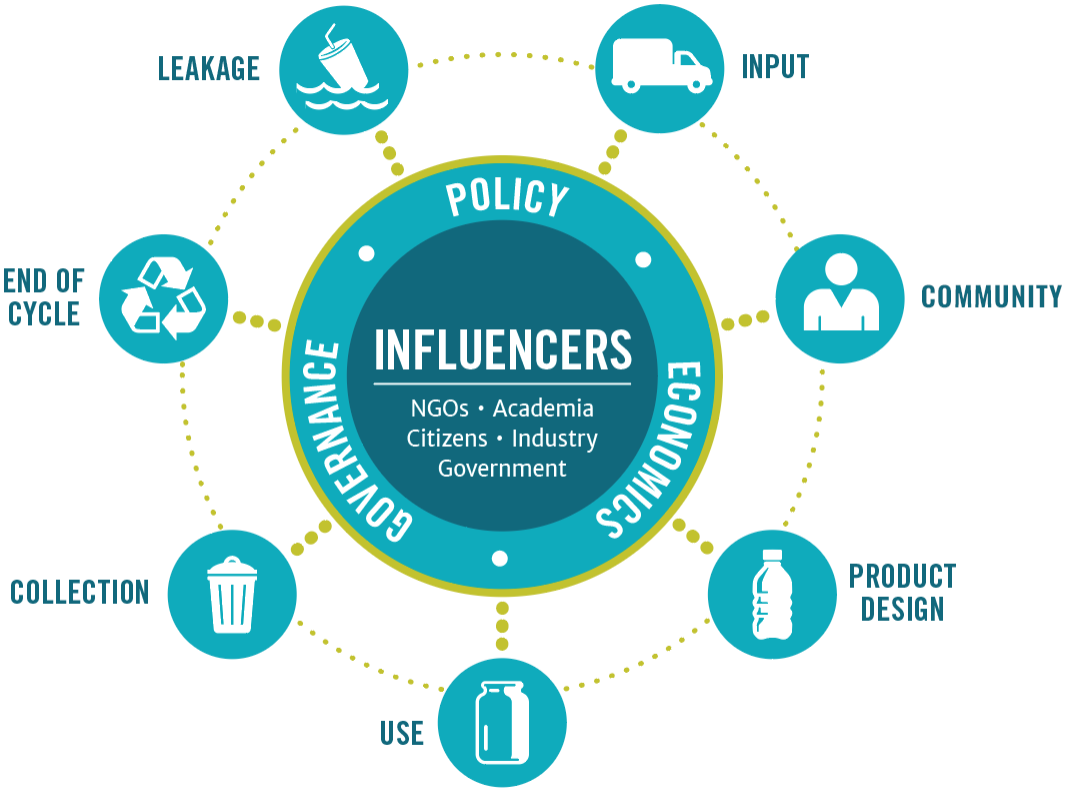
As one of the largest countries in the world, both in terms of population and land coverage, the US is known for substantial variation in infrastructure and development across regions, states, and cities. For example, the city of Seattle generates 0.95 kilograms per capita per day (Kaza et al. 2018) compared to 3.6 kilograms per person per day in Miami (Circularity Informatics Lab 2021). Substantial focus has been given to large cities and states with progressive waste management strategies, however, there is a lack of focus on regions that are in need of assessment in order to develop appropriate, context-sensitive solutions.

Pittsburgh is a major city within Pennsylvania, and has a population of roughly 303,000 people, with a racial makeup of roughly 23% Black people, 64% white people, and 6% for Asian and Latino people, respectively (US Census Bureau 2023). Historically referred to as the "Steel City" because of its steel sector, Pittsburgh is now also a hub for advanced manufacturing, financial services, life sciences and healthcare, and technology (Pittsburgh Region 2025).

The Circularity Informatics Lab (CIL) at the University of Georgia (UGA) developed the Circularity Assessment Protocol (CAP) in 2018, which is a standardized assessment protocol used to collect community-level data to inform decision-makers (Figure 1). The CAP characterizes seven community components:

1. **Inputs** – What products are sold in the community and where do they originate?
2. **Community** - What conversations are happening and what are the stakeholders' attitudes and perceptions?
3. **Product design** - What materials, formats, and innovations are found in products, particularly packaging?
4. **Use** – What are the community trends around use and reuse of product types?
5. **Collection** – How much and what types of waste are generated? How much is collected and what infrastructure exists?
6. **End-of-cycle** – How is waste disposed? What is the fate of waste once it is properly discarded? How is it treated?
7. **Leakage** - What waste ends up in the environment? How and why is it getting there?

Figure 1: Circularity Assessment Protocol (CAP) hub-and-spoke model.

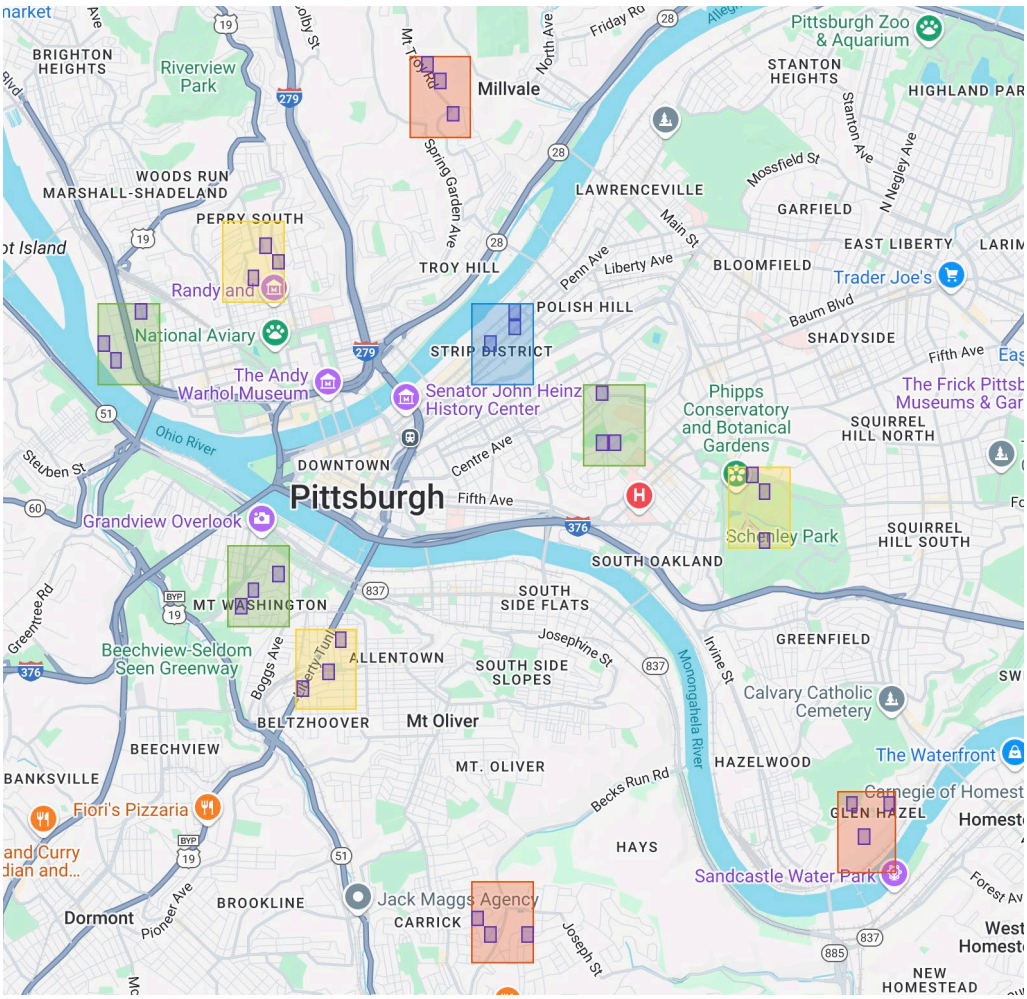


Fieldwork was conducted from June 26th, 2023 until September 4th, 2023. This report was made possible through funding from the National Science Foundation under Grant No. 2236080. The CAP report is split into the following sections, which include results and discussion of each: Input, Community, Product Design, Use, Collection, End of Cycle, and Leakage, followed by Opportunities. The intent is for the data in this report to inform ongoing stakeholder engagement around solutions to strengthen the circular economy and waste management in Pittsburgh.

Sampling Strategy

In order to randomly sample various locations in a city, the CAP typically identifies a 10 x 10km area over the city (with the geographic center of the city as the center of the area). In this area, the ambient population is sectioned into tertiles (three groups) (Figure 2). Ambient population count can be described as "where people go" and "societal activity" — it is not the population density of where people live. These three areas typically form samples of different land uses, etc.

Figure 2: Population tertiles and survey sites in Pittsburgh, Pennsylvania.



Typically, three 1 x 1 km areas for surveying are randomly selected within each population tertile using NOAA's Sampling Design Tool, usually resulting in a total of nine 1km^2 areas for surveying. After discussion with local partners, one more 1km^2 area in the Strip District was added to get representation from the downtown area. In total, 10 sites were surveyed, four in the high population count tertile and three each in both the low and mid population count tertile.

Input

To get a snapshot of the characterization, scope, and source of common plastic packaged items that are entering Pittsburgh, samples of fast-moving consumer goods (FMCG) in four popular categories were taken within the 10 1km^2 transects in Pittsburgh. The team selected three convenience or grocery shops to sample within each 1km^2 transect area, where shops were present and open at the time of surveying. In total, 53 unique brands of convenience products were collected and sampled, including 32 candies, 4 chips, and 17 beverages. Samples of identical brands were not collected multiple times, even when present in multiple stores. Similarly, products already collected in the previous U.S. CAPs were not purchased. Common brands of tobacco products were also visually assessed in stores, although samples were not purchased; 10 different brands of cigarettes are included in the input analysis.

In total, 21 stores were sampled, representing grocery stores, convenience stores, gas stations, pharmacies, etc. For each of the new items documented, the team noted the type of packaging (including polymer, if possible), as well as the three most common brands (referred to as top brands) across each store for the four product categories. Across Pittsburgh, the most common FMCG brands are:

- **Beverages**: PepsiCo (Aquafina, Gatorade, Mountain Dew, Pepsi), The Coca-Cola Company (Body Armor Coca-Cola, Smart Water, Sprite), Unilever (Pure Leaf)
- **Candy**: The Hershey Company (Hershey, Reese's), Mars Inc. (M&M's, Skittles, Snickers), Nestle (KitKat)
- **Chips**: PepsiCo (Fritos, Lays, Cheetos, Doritos), Utz Brand Inc. (Utz, Zapps, Dirty Potato Chips), Herr Foods Inc. (Herr's)
- **Tobacco Products**: Philip Morris International (Marlboro, L&M, Chesterfield) and R. J. Reynolds Tobacco Company (Newport, Camel, American Spirits)

Among beverages sampled in convenience stores, PepsiCo was the parent company for around 50% of all top brands identified (defined as the top 3 most common based on shelf space and conversations with shopkeepers), followed by The Coca-Cola Company (which owned 29% of top brands identified), and Unilever (which owned 7% of top brands). For candy products, around 40% of top brands identified were owned by The Hershey Company, followed by Mars Wrigley (which, including those owned by Mars Inc., comprised 26% of top brands identified), and Nestle (which owned 5% of top brands identified). For chips, PepsiCo was the parent company for 50% of all top brands identified, followed by Utz Brand Inc. (which owned 15% of top brands identified), and Herr Foods Inc. (which owned 8% of top brands identified). For tobacco products, 52% of the top brands identified were owned by Philip Morris International, followed by R.J. Reynolds Tobacco Company (which owned 36% of top brands identified). All other tobacco brands identified among top brands comprised 4% of the most common.

Community

To better understand consumer attitudes towards circularity in the U.S., the CIL partnered with UGA's Social Media Engagement & Evaluation Suite (SEE Suite) to do a comprehensive social media analysis on three topics related to circularity: biodegradable/compostable plastics, Extended Producer Responsibility (EPR), and reuse. SEE Suite analyzed conversations related to these topics on Instagram, Facebook, and X (formerly Twitter), cataloged the posts with the most interactions, highlighted the notable companies, influencers, and experts in the field, and analyzed sentiments according to emotion. This section provides an overview of the main findings from each of these analyses, with an emphasis on geographic findings from the Northeastern region of the U.S., where Pittsburgh is located. The dates for data collection are shown below:

- Biodegradable/compostable plastics: July 01, 2021 - Aug 31, 2022

- EPR: January 1st, 2024 - December 31st, 2024
- Reuse: January 1st, 2024 - December 31st, 2024

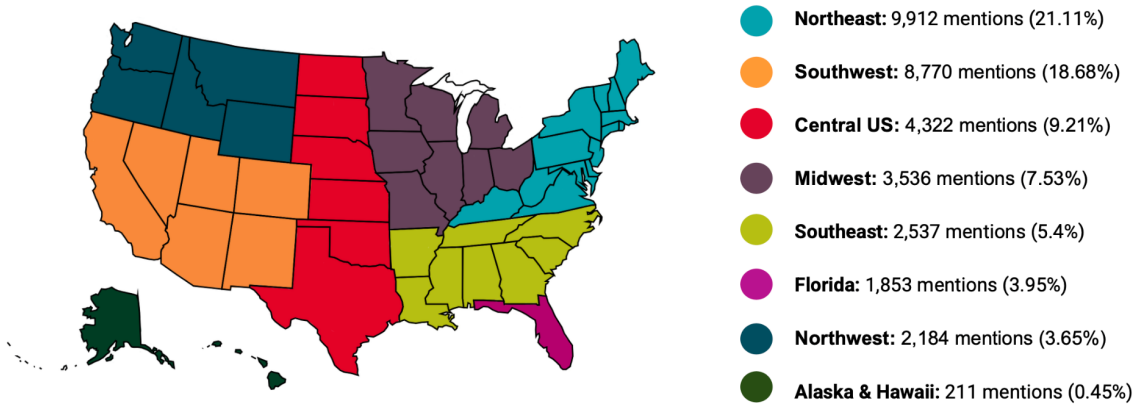
Biodegradable/Compostable Plastics

SEE Suite used Brandwatch to collect data about biodegradable and compostable materials and first addressed three main questions:

1. *Are people aware of and purchasing biodegradable plastic alternatives?*
2. *Do people have access to compostable/biodegradable plastics in their community?*
3. *What types of composting systems would people like to see in their communities?*

The Northeast and the Southwest regions account for 31% of the conversations analyzed on X. In these regions, awareness of plastic alternatives is higher when compared to other regions in the U.S..

Figure 3: Geographic analysis of compostable/biodegradable mentions on X



Compostable and biodegradable plastic products are easily accessible to the general public across the United States. Consumers can purchase these products at grocery stores such as Walmart, Publix, Kroger, Food Lion, Save A Lot, etc. These products are also widely available online, through Amazon and directly through companies and manufacturers. However compostable and biodegradable products are on average more expensive than their plastic counterparts, limiting accessibility to some degree. This is a sentiment the CIL has often heard from interviewees in the U.S. when discussing the availability of plastic alternatives.

When inspecting what types of composting systems people would like to see in their communities, the data found suggests that people are not necessarily focused on specific forms of composting, but rather that it happens at all. When searching for specific methods of composting, ("warm composting," "hot composting," "vermicomposting," etc.), only ~6 mentions were pulled, which is very low compared to the almost 700 mentions from the query in total. However, when looking at the rest of the data pulled with broader terms such as "composting systems" and "composting infrastructure," there is a niche population desiring more industrial composting centers.

Extended Producer Responsibility (EPR)

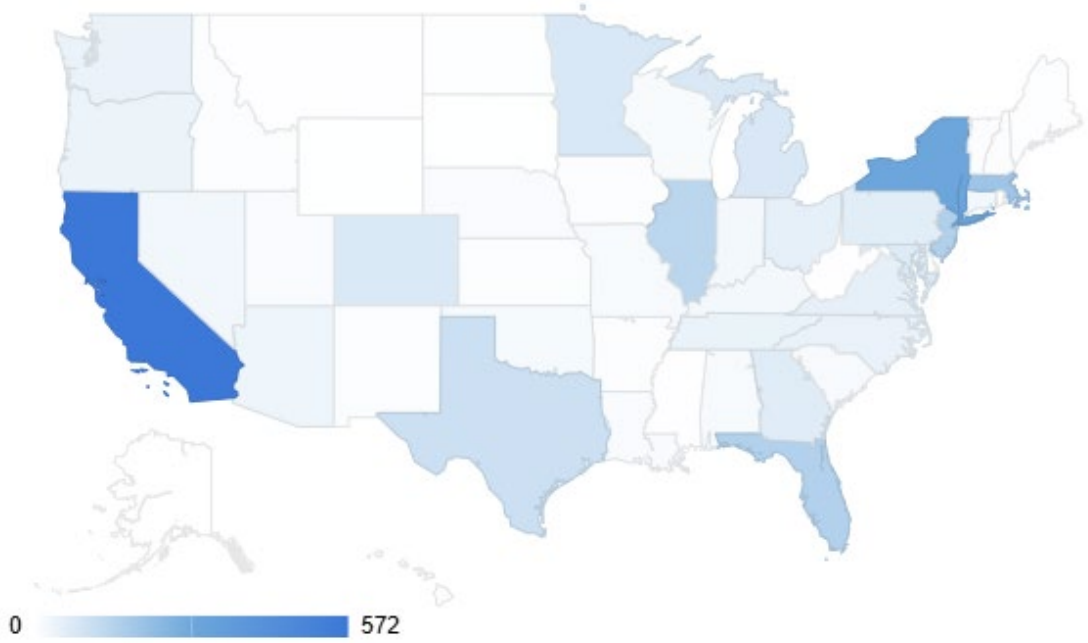
Overall, the conversations about EPR in 2024 showed that this type of legislation is still quite new in the U.S,

but there are people in favor of shifting the financial responsibility of pollution onto the producer rather than the consumer. Popular topics of conversation included polluter pays, plastic waste, plastic pollution prevention law, and waste management. The majority of the conversations have neutral sentiment (87%), followed by 7% positive, and 6% negative sentiment. The conversations show that many people are in support of EPR legislation and are calling upon big corporate polluters in various industries in the U.S. to pay for the environmental harm caused by their products. Since the US is arriving at EPR legislation later than other areas like Europe, references are made to the legislation that has been passed in other countries. California is at the forefront of the conversation, with certain environmental organizations having influence.

Table 1: State-level analysis of EPR mentions on X

State	# of mentions				
California	572	North Carolina	42	Kansas	8
New York	307	Tennessee	41	New Mexico	7
District of Columbia	217	Washington	40	Arkansas	6
Massachusetts	190	Oregon	37	Idaho	6
New Jersey	153	Arizona	33	Vermont	6
Florida	150	Nevada	25	Iowa	5
Illinois	136	Connecticut	23	New Hampshire	5
Texas	102	Indiana	22	Maine	4
Minnesota	76	Kentucky	22	Rhode Island	4
Michigan	74	Oklahoma	18	Hawaii	3
Colorado	73	Alabama	16	North Dakota	3
Maryland	65	Missouri	15	Mississippi	2
Georgia	62	South Carolina	15	Montana	2
Pennsylvania	57	Wisconsin	14	West Virginia	2
Ohio	49	Louisiana	12	South Dakota	1
Virginia	49	Nebraska	12	Wyoming	1
		Utah	12	Alaska	0
				Delaware	0

Figure 4: State-level analysis of EPR mentions on X



New York and California are the most shaded with 300 and 572 mentions, respectively. The other states are much less shaded, which may be due to their lower population counts and/or less awareness or interest in discussing EPR. After New York and California, the next highest mentioned value is 217 in the District of Columbia, with Massachusetts close behind at 190 mentions. Coastal states seem to generally have more mentions. This could be due to higher populations, but could also be due to higher interest in the outdoors and preservation of the environment which goes hand-in-hand with EPR in many ways.

Reuse

X had the largest number of unique authors across the 3 social media platforms at 80k, and had a total of 138k posts related to reuse. The overall conversation related to reuse on X pertained to the effects of single-use plastics on the environment, why people should switch to alternatives, and what types of reusable products people recommended. There was also buzz about lawsuits pertaining to companies like PepsiCo because of their contribution to climate change, as well as users criticizing people who were flaunting their Stanley Cups as a sign of wealth and not for their intended purpose. X also had the highest amount of negative posts of the three platforms, which also happened to be the most seen posts.

Facebook had the smallest amount of posts between the three platforms with 72.96k posts on reuse but also had the second highest unique authors count at 19.6k. One of the main takeaways from the Facebook conversation is that people were finding ways to reuse/repurpose old items instead of throwing them away. People were sharing innovative ways they made use of old bottles and boxes, and were encouraging others to think more creatively in order to reduce their plastic waste. There was also an emphasis on circular economy.

Instagram was the largest data set out of the 3 social media platforms with 1.08 million posts and 36 unique authors. The main topics of conversation were zero waste and sustainability more broadly. Posts highlighted different ways to repurpose waste materials for the benefit of the environment. Many of these conversations were about zero waste in the kitchen when cooking and how to live a sustainable lifestyle with specific eco-friendly household products. Another prominent conversation was about minimizing plastic pollution. People all around the world take part in reusing and recycling, however, many feel that the U.S. government and corporations need to play a bigger role.

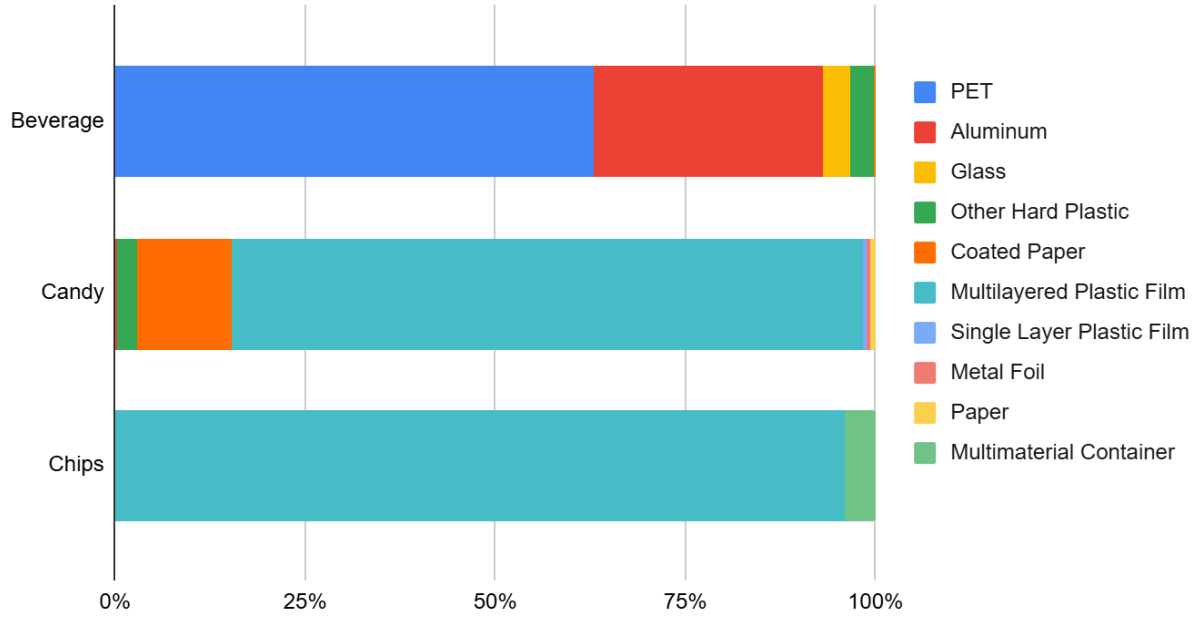
In addition to the social media analysis, preliminary interviews with stakeholders in Pittsburgh was conducted specific to construction and demolition and building material circularity. Although specific to the built environment, interviewees mentioned themes that related to plastics as well. Generally, interviewees revealed frustration with low tipping fees, as it incentivizes landfilling over recycling and/or reuse. Interviewees also expressed an interest in EPR.

Product Design

To characterize material types used in common consumer products, samples of common convenience were obtained as described in the Input section. The CIL team sampled stores in each of the 10 1km^2 transects areas. For each convenience item surveyed, the CIL team documented the material type (Figure 5).

PET was the most common material for beverages, followed by aluminum. Candy and chips both overwhelmingly tended to be made of multilayer plastic film. This aligns with findings in Pittsburgh's sister city, Atlanta, where the CIL team also found that a majority of product materials in stores were made of PET and multilayer film (CIL 2023).

Figure 5: Material Breakdown for Convenience Items in Pittsburgh



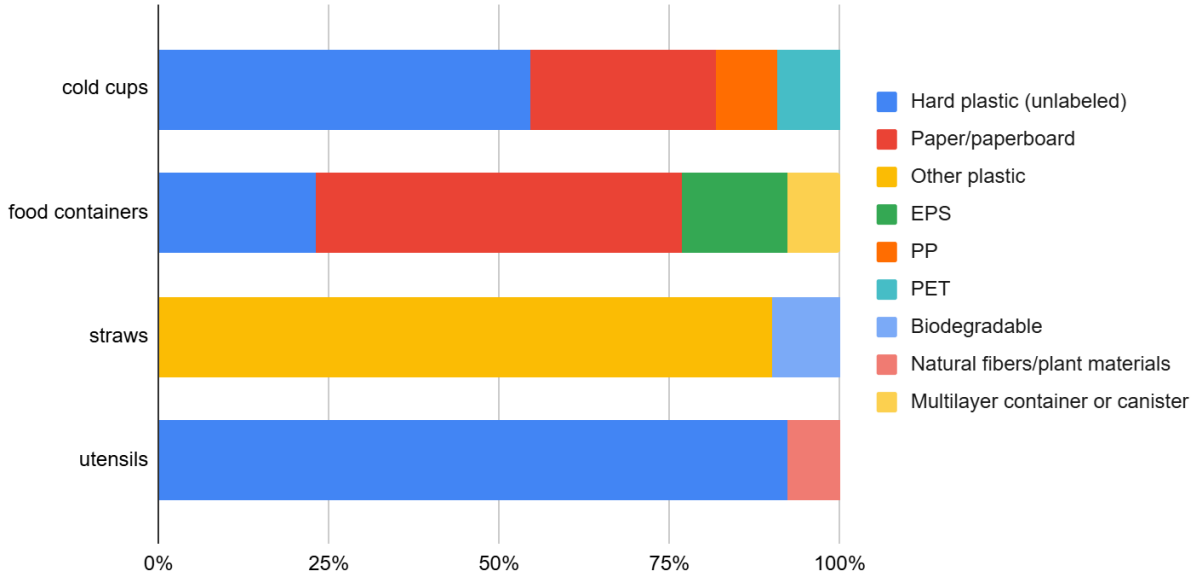
In addition to surveying convenience and grocery stores, the CIL team surveyed restaurants in each of the 10 1km^2 transects areas. Through visual assessments and discussions with restaurant owners, we assessed the material type for to-go food items like containers (including their lids), cups, utensils, and straws. In total, we characterized 52 items from 13 restaurants and food vendors (Table 2).

Over half of the sampled to-go cold cups consisted of unlabeled hard plastic, followed by paper, PP, and PET. A little over half of the sampled food containers were made out of paper/paperboard, although hard plastic, EPS, and other plastic food containers were present. Straws had less variety in material type: they were either multilayered or biodegradable. Utensils overwhelmingly tended to be largely made of unlabeled hard plastic, although some were made of natural fibers/plant materials. (See Table 2 and Figure 6)

Table 2: Products and material types surveyed in restaurants and food vendors.

Product	Material Type	Number of Observations
To-Go Containers (including lids if applicable)	Paper/Paperboard	7
	Hard Plastic (unlabeled)	3
	EPS	2
	Multilayer canister or material	1
Cold Cups	Hard Plastic (unlabeled)	6
	Paper/Paperboard	3
	PP	1
	PET	1
Straws	Other Plastic	9
	Biodegradable	1
Utensils	Hard Plastic (unlabeled)	12
	Natural fibers/plant materials	1

Figure 6: Material Breakdown for To-Go Items in Pittsburgh



Use

To understand the availability of plastic alternatives, the CIL documented the cost per unit of both standard plastic items and their alternatives (Table 3). All of the plastic alternatives were on average more expensive than their plastic counterparts, ranging from 1.2x more expensive to 9.5x expensive. The top 5 items that had the most significant difference between plastic and alternative costs were compostable bowls (9.5x), alternative material bowls (3.25x), compostable cups (4.75x), compostable plates (4.43x), and compostable straws (2.33x). Compostable and reusable utensils did not vary much in price when compared to their plastic counterparts, as they were only on average 1.18x more expensive.

Table 3: Cost comparison of picnic items and alternatives

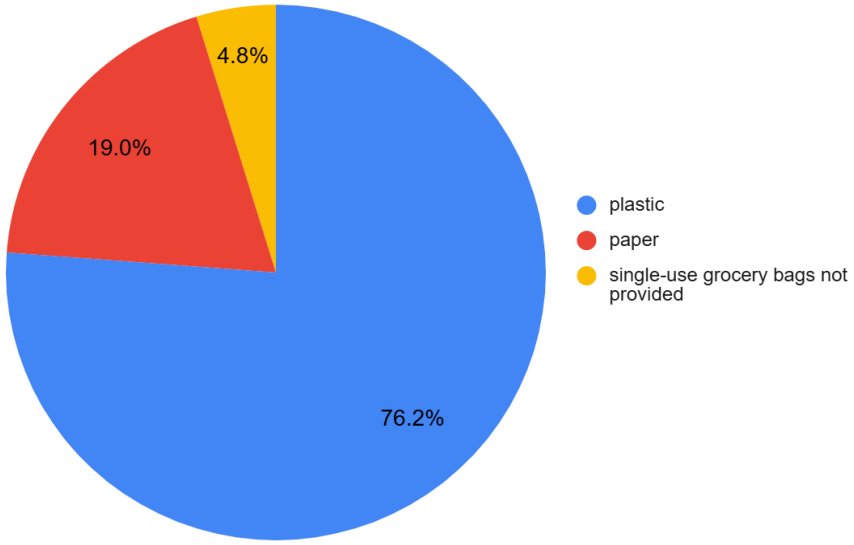
Product	Alternative Type	Average Cost/Unit of Alternative	Average Cost/Unit of Single-Use Plastic Packaging	Cost Difference for Alternative
Bowls	Compostable	$0.38	$0.04	9.5X
	Alternative Material	$0.13	$0.04	3.25X

Cups	Compostable	$0.38	$0.08	4.75X
Plates	Compostable	$0.31	$0.07	4.43X
	Alternative Material	$0.10	$0.07	1.43X
Straws	Compostable	$0.07	$0.03	2.33X
Utensils	Compostable	$0.20	$0.17	1.18X
	Reusable	$0.19	$0.17	1.18X

In total, 21 stores were sampled, representing grocery stores, convenience stores, gas stations, pharmacies, etc. At each of these stores, the CIL documented the availability of bags, as well as their polymer type. In 2022, the Pittsburgh City Council unanimously passed a plastic bag ban for all businesses that sell food or other products to the public and/or all businesses within the Pittsburgh city limits. Businesses are supposed to charge 10¢ for each paper bag while not supplying plastic bags at all, including compostable and biodegradable single-use bags (COP, "Plastic Bag Ban & Paper Bag Fee").

Based on the CIL's findings, it appears that enforcement of this ordinance still has room for improvement. Among the SUP grocery bags with identifiable resin codes denoting material types, the most common polymer was HDPE. Roughly 19% of stores (4 out of 21) did not offer any type of SUP grocery bag. Among the 17 stores that did offer SUP grocery bags, the majority (88%) offered them at no cost to the customer. Only two stores had a fee for SUP grocery bags, ranging from $1-$5 at one store, and $0.98-$0.99 at another. Paper bags were available at a third of the stores. Of these seven stores offering paper bags, six had paper bags available at no extra cost, while one did not offer SUP bags at all had paper bags available for $0.12 apiece. Reusable fabric bags were available at 9 of the stores, (43%) for an average cost of $3.65.

Figure 7: Most Common Material Type Offered for To-Go Grocery Bags (n = 21 grocery stores)



In addition to analyzing how materials are used in Pittsburgh, the CIL identified several local centers for reuse within Pittsburgh:

- Center for Creative Reuse
  Nonprofit art supply shop that sells donated used art and craft supplies and hosts programming about the benefits of reuse.
- Construction Junction
  Nonprofit that sells donated building materials and furniture and coordinates deconstruction efforts to salvage usable items for unoccupied properties. Pick-up and drop-off services available.
- Reuse Fest
  Yearly festival hosted by Pennsylvania Resources Council to donate gently used materials – from clothing to building materials to dog beds – to local nonprofits. A full list of accepted items can be found on the website.

Collection

The Pennsylvania Act 101 of 1988 mandates the collection of food and beverage materials, including PET and HDPE bottles. These values are then counted toward Act 101, Section 904 Recycling Performance Grant awards which are given to local governments (PA DEP 2022, p. E-9).

Waste Generation

In 2021, Pittsburgh generated 94,322 tons of residential waste in 2021 (PA DEP 2022, p. 2-4. Household-reported waste generation rates are 1.06 tons per year for urban areas, 0.92 tons per year for suburban areas, and 0.89 tons per year for rural areas – (please note: these statistics did not report a time frame).

Pennsylvania's statewide waste generation rates for 2021 were 9,392,702 tons with a population of 2,483,314 people, which equates to 20.72 lb of waste per person per day/9.40 kg per person per day. Plastics account for nearly 19% of that waste, at about 3.9 lb per person per day/1.77 kg per person per day.

Waste Characterization

The most recent publication detailing the state of Pittsburgh's waste composition is the 2022 PA DEP Statewide Waste Characterization Report (PA DEP 2022). The main findings from this report are shown below:

- Statewide, plastics comprise 19% of the waste stream (equivalent to 1.74 million tons in 2021), an increase from just over 1 million tons in 2001. (p. E-7).
    - This proportion remains consistent in the southwest region county (p. G-3), which is heavily weighted by Allegheny (p. 2-1).
- Film plastic makes up the second largest item type in the state's waste stream (~9%). It is the third largest component of residential waste 306,935 tons, or 10%) and second largest component (of commercial waste (514,447 tons or 16%) (p. E-14).
- Durable/bulky rigid plastics are the third largest component of waste that is eligible for recycling (p. E-11).
- Paper and plastics are more common among commercial waste streams, while residential waste sees more organics (p. E-11).
- Most plastic waste originates from suburban areas, followed by urban, and rural (p. E-15), however, the proportion of plastic is highest in rural areas (16%) compared to suburban (14%) and urban (13%) (p. E-17).
- An estimated 573,656 tons of recyclable plastic containers were disposed of in 2021, equivalent to $216 million USD in estimated total market value (p. E-18). Recycling of these materials equates to an estimated 534,032 MTCO2E reduction potential (p. E-19).
- Pennsylvania recycling has changed considerably in recent decades. What began as a broad category of recyclable constituents within commingled recyclables in 2001 has now evolved into targeted material diversion, with individual commodities measured and reported including twelve categories of plastic.
- Plastic waste is shifting from heavier, expensive packaging materials to lighter materials, particularly film plastics.

Figure 8: MSW composition in Pennsylvania in 2021 (Adapted from PA DEP 2022)

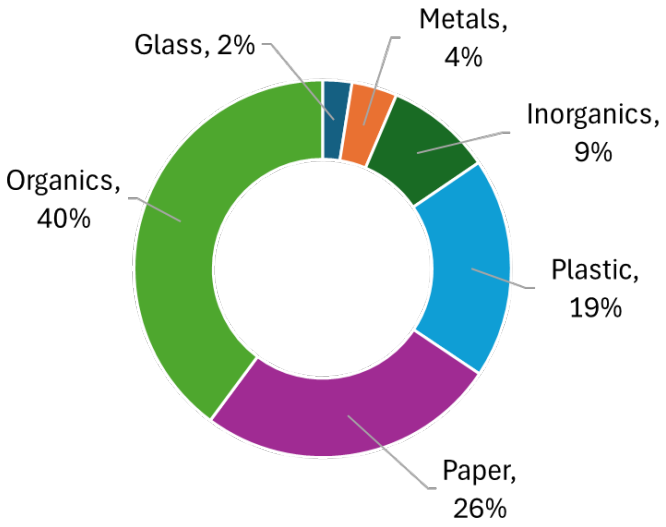
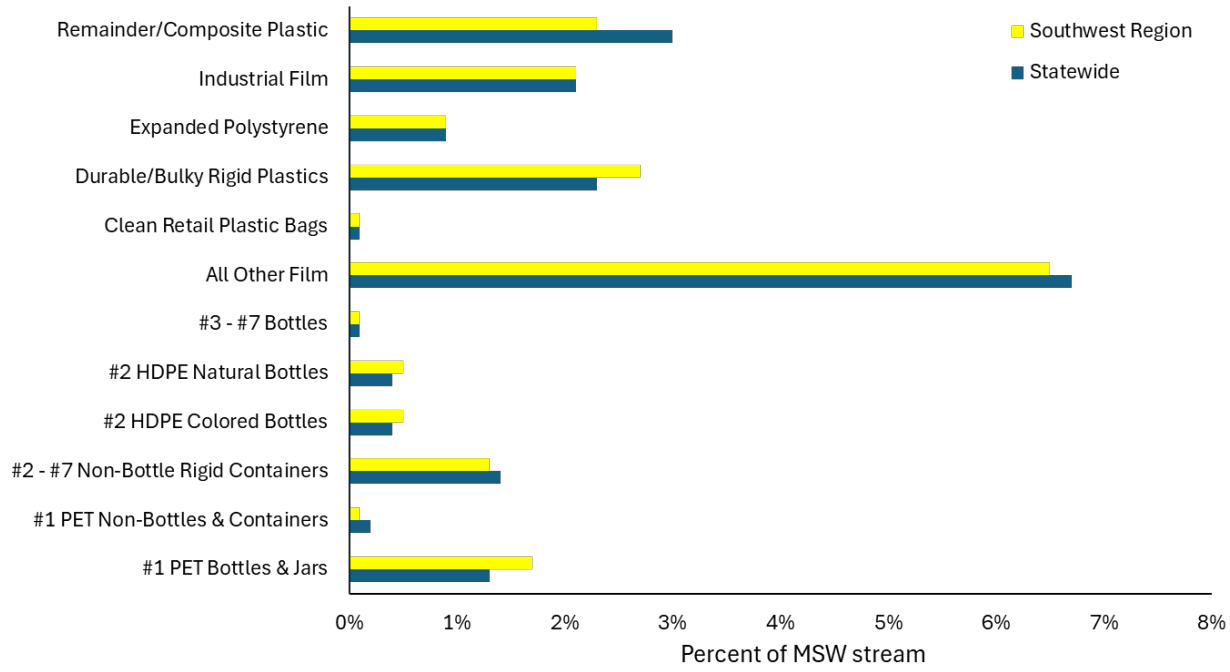
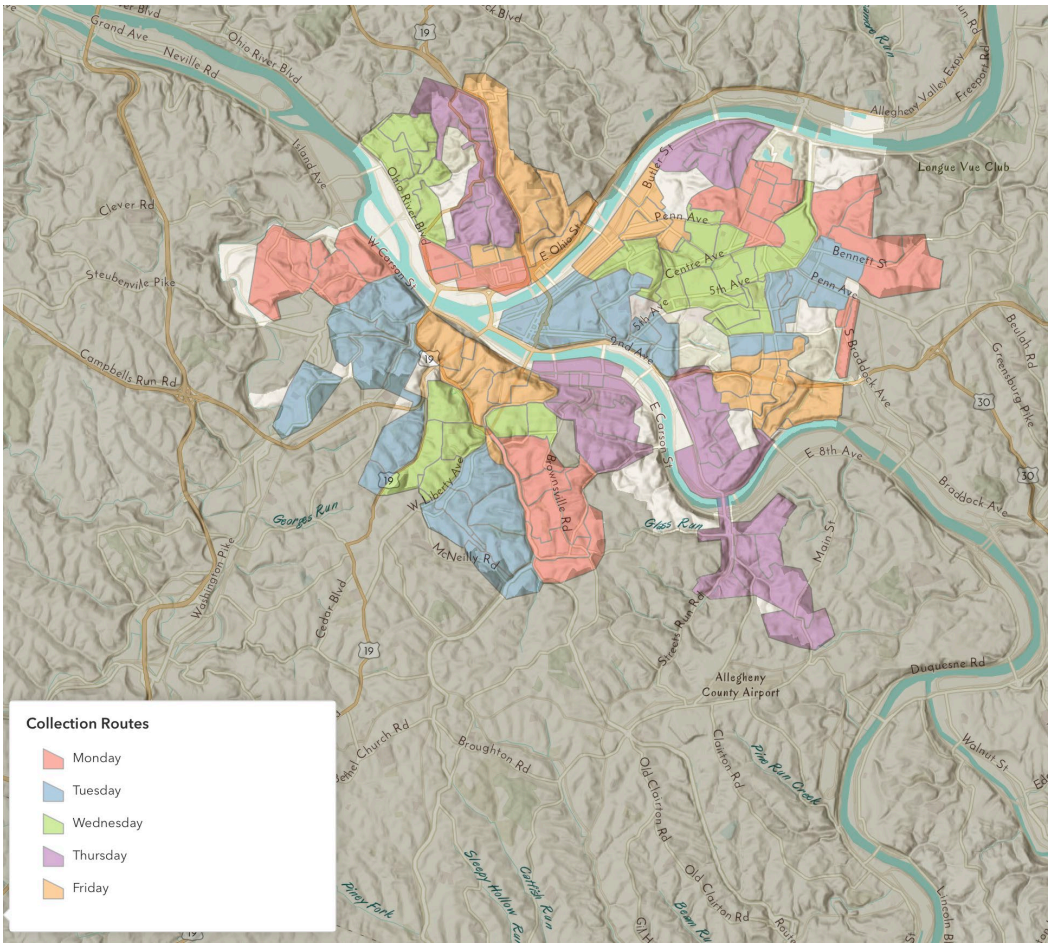


Figure 9: Proportion of plastic MSW generated in Pennsylvania and the Southwest region in 2021 by plastic type (Adapted from PA DEP 2022).



Recycling is mandatory in the City of Pittsburgh, and single-stream recycling is practiced, with all recyclables going into one single bin prior to collection. All residents of single-family homes and small apartments must separate recyclable items from household trash. The city provides bi-weekly recycling curbside collection via their Environmental Services bureau. All recyclables are combined and placed into one truck and taken to a Materials Recovery Facility for further processing (COP, "Curbside Recycling").

Figure 10: Pittsburgh curbside collection schedule, found here.



The City of Pittsburgh's Environmental Services bureau has a curbside refuse program that functions on a weekly basis. Aside from collecting household waste, the refuse program accepts furniture (chairs, end tables, shelving), bicycles, larger household items (such as garden tools, ironing boards), roasters and grills, small appliances (excluding "e-waste" or Freon-based equipment), and bulky waste (COP, "Curbside Refuse").

The following local resources are available for hard-to-recycle materials:

- City of Pittsburgh Department of Public Works
  Tire collection program at East End Drop-Off Center, Hazelwood Drop-off Center, and West End Drop-Off Center.
- Pennsylvania Resources Council + City of Pittsburgh Electronic Waste Recycling
  Tuesday and Thursday drop-off hosted at Environmental Services in Strip District and heavily subsidized by the City of Pittsburgh. Drop-offs are hosted twice per week and must be scheduled in advance
- Liberty Tire Tire recycling with pickup and drop-off services.

End of Cycle

To better understand how materials at the end of their cycle move through Pittsburgh, the CIL identified key local resources related to landfilling, recycling, and composting.

Landfills

Municipal Waste Landfills and Resource Recovery Facilities are available statewide, with four sites available in Allegheny County. A comprehensive list of these facilities can be found here.

Recycling

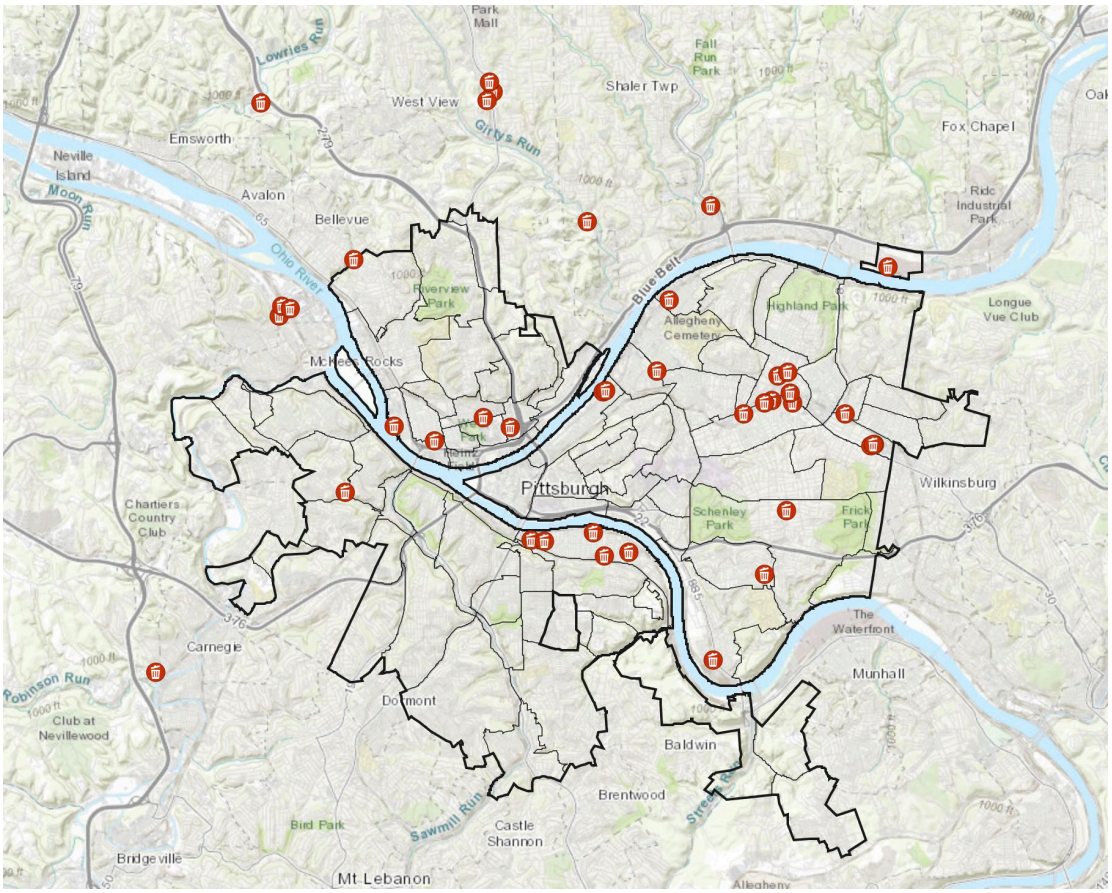
In addition to curbside recycling services provided by the city, five drop-off locations are available for residents in the areas of East End, Hazelwood, West End, Strip District, and North Point Breeze. In 2024, the city instituted the Blue Bin Program to thwart the use of plastic recycling bags, as they complicate material sorting at the MRF (located in Hazelwood). Through this program, 100,000 32-gallon blue bins were distributed across Pittsburgh, and residents now use the bins instead of bagging all recyclables (COP, "Blue Bin Program").

If organizing an event where 200 or more participants are expected, the event organizers must separate waste and recycling. Organizers may choose between, self-hauling, hiring a private hauler, or coordinating with the city. The city may also help with logistics and provide a cost-recovery model to incentivize recycling at these events (COP, "Special Event Recycling").

On the commercial side, All businesses in Pittsburgh must establish a program to recycle at least three of the following types of materials: mixed paper, aluminum and steel, plastics, glass, and organic waste (COP, "Commercial Recycling"). Because the city is unable to service commercial entities, businesses must find private recycling services. A list of commercial haulers can be found here.

Additionally, a variety of waste recovery sites can be found around Pittsburgh and the surrounding area.

Figure 11: Pittsburgh area waste recovery sites, found here.



Composting

The city of Pittsburgh has a food waste drop-off system. Community members can drop off their food waste at the city-run farmer's markets at East Liberty on Mondays or Northside on Fridays. After, the food waste is picked up by a local composting company, who uses the food scraps in soil for urban farming (SOP, "Food Waste"). In 2023, the city also had a compost pilot, SoilMill PGH, wherein residents could participate in a 5-month long composting pilot (COP, "SoilMill PGH"). Although there is no city or county-sponsored curbside compost provider, one private composter, AgRecycle, provides composting pickup services ideal for commercial businesses and event hauling. None of these programs currently accept compostable or biodegradable foodware, such as the plastic alternatives sold locally in stores, so it is likely that these compostable products are not currently entering the appropriate waste stream (see "Product Design" for more.)

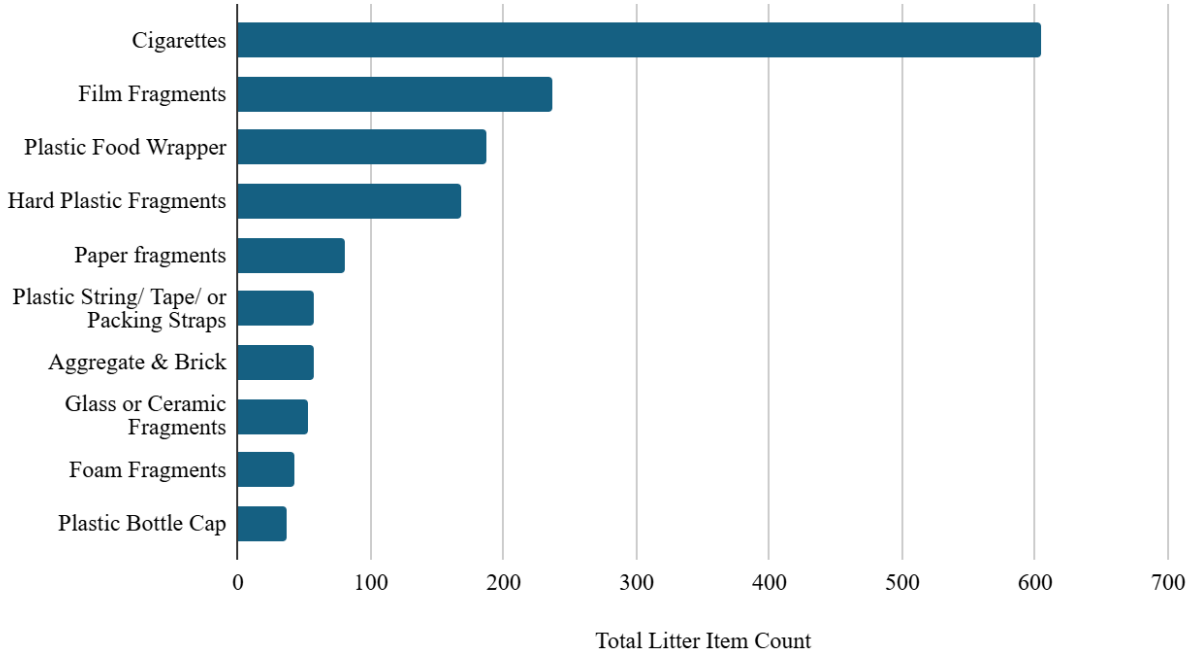
There are also local organizations working within the compost space. The Pennsylvania Resources Council hosts backyard composting workshops seasonally, and each workshop includes a free compost bin. Shadyside Worms is a curbside vermicompost exchange that services the East End, from the Strip District to Wilkinsburg. Worm Return provides hauling and bin services for small-medium businesses and organizations as well as consulting, and live worms for vermicomposting to those interested in composting their waste. Finally, Zero Waste Wrangler provides hauling and bin services for small to medium-sized businesses and organizations interested in composting their waste. One compost is collected locally, it goes to an Agrecycle facility in Washington County, Pennsylvania.

Leakage

In total, 2,001 items were logged in 10 transects (each 100m^2) characterizing 10 different square kilometer areas. Transect locations were selected using a stratified random sampling method, in which transects were randomly selected in 10 square kilometers which were distributed across three groups of population count (upper, middle, lower) based on LandScan ambient population data. Litter items were recorded using the open-source Marine Debris Tracker app. A full list of items available in the app and their associated material categories as well as a map of sample sites and their surveyed litter densities can be found in the Appendix. Litter was examined based on abundance, proportion of material and product types, and product densities across all transects and aggregated across the three population groupings.

Across all surveyed transects, cigarettes were the item most frequently found in the environment, with 605 logged. Film fragments (236) and plastic food wrappers (187) were also prevalent, as were hard plastic fragments (168) and paper fragments (81). Plastic string/tape (57), aggregate and brick (57), glass/ceramic fragments (52), foam fragments (42), and plastic bottle caps (37) comprised the rest of the top 10 litter items.

Figure 12: Top 10 Litter Items for Pittsburgh



Interestingly, material fragments represent 60% of the top 5 litter items, and 50% of the top 10 litter items. There are no cans or bottles, which implies the local materials management system is functioning well. The large proportion of fragments may indicate these materials have been in the environment for some time to have weathered and fragmented. Also notable is the large proportion of film fragments and plastic food wrappers, both of which are not accepted for municipal recycling.

Figure 13: Plastic food wrapper found in the environment

In alignment with the top litter item being cigarettes, the most prevalent material found in Pittsburgh's litter was tobacco products (32%). Plastic fragments accounted for 23% of materials found in the environment, while food-related plastic packaging comprised 17%. Paper, other plastics, and C&D materials accounted for 6%, 5%, and 4%, respectively. The 10 other material types, ranging from PPE to E-waste, accounted for roughly 13% of the materials in total. When compared to recent findings in Atlanta, Pittsburgh had a higher percentage of tobacco products in the litter, yet both Pittsburgh and Atlanta had similar percentages of plastic fragments and food plastic packaging (CIL 2023). This could imply that waste systems in both Pittsburgh and Atlanta are not completely capturing all food-related packaging.

Figure 14: Material Breakdown of Litter in Pittsburgh

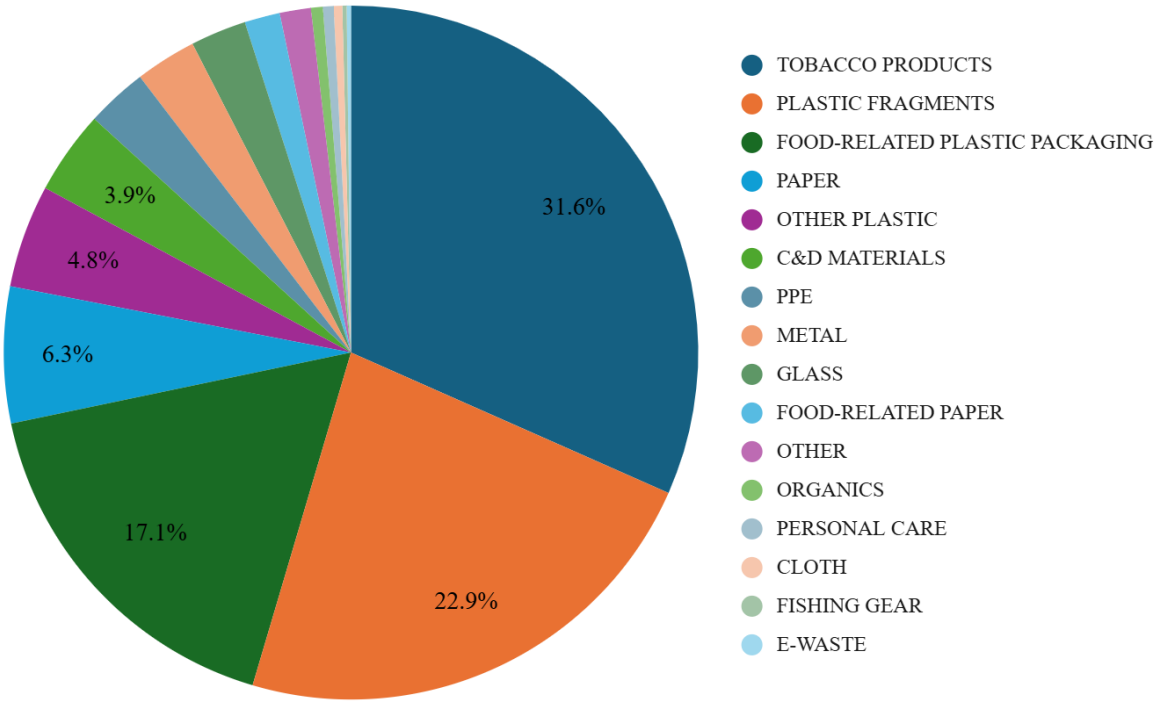


Figure 15: Plastic cups found in the environment

Figure 16: Plastic receipts, PPE, and aluminum found in the environment

Tobacco products, plastic fragments, and food-related plastic packaging were the most common material items found in the low, mid, and high population count areas. The highest amount of C&D material litter was found in the high population area, which suggests that this litter is being left in areas with higher rates of construction.

Figure 17: Proportion of most common material items in low (inner), mid (middle), and high (outer) population count areas in Pittsburgh

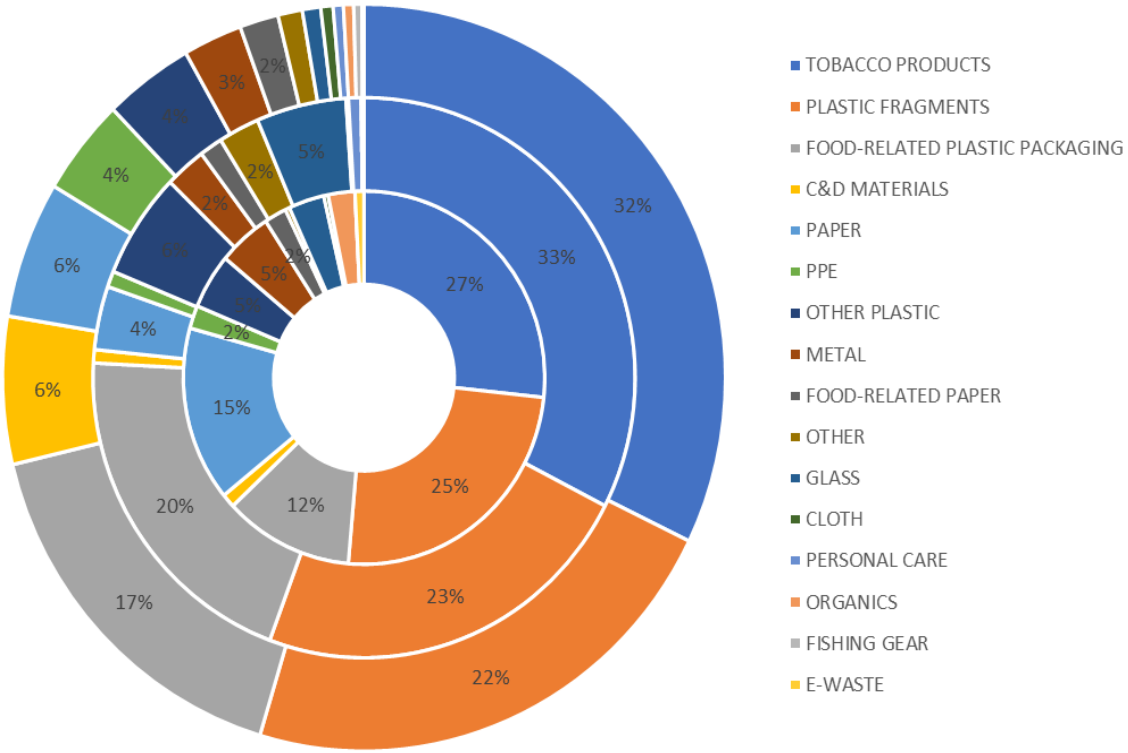


Table 4: Litter Density and Top Litter Items for Each Area of Population Count

Population Tertile	Top 5 Litter Items	Litter Density (item count/m2)
Upper (1,633–22,734 persons/km^2)	1) Cigarettes, 2) Film Fragments, 3) Plastic Food Wrapper, 4) Hard Plastic Fragments, 5) Aggregate & Brick	0.91
Middle (772–1,633 persons/km^2)	1) Cigarettes, 2) Film Fragments, 3) Plastic Food Wrapper, 4) Hard Plastic Fragments, 5) Glass or Ceramic Fragments	0.73
Lower (0–772 persons/km^2)	1) Cigarettes, 2) Paper fragments, 3) Film Fragments, 4) Hard Plastic Fragments, 5) Plastic Food Wrapper	0.28

Opportunities

CIL found the following opportunities to expand and enhance circularity in [city name] based on the findings of this report. These opportunities are categorized based on the seven spokes of the CAP model. Stakeholder engagement with the partners of this project should take place to further expand, refine and prioritize these opportunities based on local context, impact, feasibility, and cost. It is important to note that the opportunities listed below are individualized based on the findings, but solutions cannot happen in a vacuum and are most impactful when strategically combined within a holistic system framework.

Input

- Extended Producer Responsibility (EPR) could be discussed with domestic companies with products for sale in the stores. EPR policies currently exist in five USA states so companies are getting more used to complying with EPR regulations and are also sometimes open to voluntary efforts.
- The Hershey Company is a local (state of PA) company that might be interested in increasing circularity.

Community

- There is interest in EPR based on the frequency of mentions in social media; there is an opportunity to further this discussion through community engagement.
- There also appears to be more frequent conversations around biodegradable and compostable plastics in the Pittsburgh region, so this interest could further expand the conversation about these alternatives.

Product Design

- There is an opportunity to expand the use of plastic material alternatives as most of the material used in packaging are traditional plastic and films that are not collected locally for recycling.
- There is a wide variety of materials offered from restaurants and some are unlabelled, so there could be some standard offerings for businesses to offer more consistent materials that the public can become familiar with.
- The majority of beverage containers are recyclable backing in PET or aluminum.

Use

- Due to the high cost of alternatives, there is an opportunity to expand the offerings or incentivise or subsidies the purchase of durable versus single-use products.
- There is an opportunity to expand the availability of reusable items to smaller stores, allowing alternatives to reach a new customer base.
- There is an opportunity to expand the offering of reusable bags which are currently available at 43% of the stores sampled.
- Enforcement of the plastic bag ban could be strengthened through outreach to local businesses and/or by using financial incentives (such as tax breaks) for the businesses that comply.

Collection

- Since curbside collection is single-stream, there have been some issues with contamination; there is an opportunity to continue to keep the public educated and aware of what is and is not accepted for recycling.
- There is a private hauler available for composting, and this could be expanded and further supported by the city.

End of Cycle

- As of right now, city-sponsored composting is either a city pilot (collection or drop-off) or private collection. Pittsburgh can continue with these end-of-cycle offerings to reduce material that is landfilled and optimize circularity.

Leakage

- The largest leakage item was cigarette butts. There is an opportunity to address this litter item through innovative receptacles or public education and outreach (e.g., some people do not realize the filters are made of plastic).
- Food-packaging, especially food wrappers (third on the top list of items), makes up 17% of the items leaked into the environment. However, recyclable items like cans and bottles are not in the top 10 items leaked, so if food packaging was recyclable or considered more valuable, it might be less likely to leak out.
- Further investigation should be done into prevention methods specifically for C&D waste in high population/high development areas

Glossary

CAP: Circularity Assessment Protocol

CIL: Circularity Informatics Lab

EPR: Extended Producer Responsibility

EPS: Expanded polystyrene

FMCG: Fast moving consumer goods

HDPE: high density polyethylene

MSW: municipal solid waste

PET: polyethylene terephthalate

PP: polypropylene

SUP: single-use plastic

UGA: University of Georgia

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Appendix

Table A1: Full List of Debris Tracker Litter Items and Associated Material Categories

Material	Items
C&D Materials	Aggregate & Brick Bolts, Nails, and Screws Building Materials Lumber Other C&D
Cloth	Clothing Towels or rags Fabric Pieces Other Cloth
E-Waste	Batteries E-Waste Fragments Wire Other E-Waste
Fishing Gear	Buoys and Floats Fishing Line Other Fishing Gear Plastic Net or Net Pieces Plastic Rope
Glass	Glass Bottle Glass or Ceramic Fragments Other Glass
Metal	Aluminum Foil Aluminum or Tin Cans Foil to-go container Metal Bottle Caps or Tabs Metal Fragments Other Metal

Organic Waste	Food Waste Other Organic Waste
Other	Other Popsicle or lollipop Stick
Other Plastic Products	Bulk Bags Flip Flops or shoes Plastic String, Tape, or Packing Straps Rubber Bands Trash bag Tires Balloons Plastic toys or balls Car Parts Hard plastic jugs or containers Other Plastic
Food-Related Paper	Paper cups Paper food box or container Paper plates or bowls Compostable paper cups Paper food wrapper Compostable food box or container Napkins Other Food-Related paper
Paper	Office paper and newspaper Tags, tickets, and receipts Corrugated Cardboard Paper fragments Other Paper

Personal Care Products	Blister Pack or other pill packaging Cotton Buds Ear plugs Personal Care Product Sachet or packet Toothbrushes Toothpaste or Other Product Tube Flossers Feminine products Needles and syringes Other Personal Care Product
Food-related plastic	Foam cups Plastic cups Compostable plastic cups Cup Lids Plastic Bottle Aseptic cartons Mini alcohol bottles Plastic Bottle Cap Plastic Food Wrapper Condiment packet or container Plastic Grocery Bag Sandwich or snack bags Plastic Utensils Straws Foam to-go container or clamshell Plastic to-go container or clamshell Compostable plastic container or clamshell Other Food-Related Plastic
Plastic Fragments	Film Fragments Foam Fragments Hard Plastic Fragments Rubber/ tire fragments

	Other Fragments
PPE	Disinfectant Wipes Disposable Gloves Face Masks Other PPE
Tobacco Products	Cigarette Packaging Cigarettes Tobacco Sachets or packets E-cigarettes and vaping Plastic cigar/cigarillo tips Lighters Cannabis-related waste Other Tobacco Product

Table A2: Parent Companies of Top Brands Identified for Beverages in Convenience Stores in Pittsburgh (for those that were identified among the top three most common brands in at least two stores sampled)

Parent Company of Product	Number of convenience stores in which product was among top 3 most common
PepsiCo	26
The Coca-Cola Company	16
Unilever	4

Table A3: Parent Companies of Top Brands Identified for Candy in Convenience Stores in Pittsburgh (for those that were identified among the top three most common brands in at least two stores sampled)

Parent Company of Product	Number of convenience stores in which product was among top 3 most common
The Hershey Company	21
Mars Wrigley	12
Nestle	3
Mars Inc.	3
Sarris Candies Inc.	2

PepsiCo	2
August Storck KG	2

Table A4: Parent Companies of Top Brands Identified for Chips in Convenience Stores in Pittsburgh (for those that were identified among the top three most common brands in at least two stores sampled)

Parent Company of Product	Number of convenience stores in which product was among top 3 most common
PepsiCo	24
Utz Brands Inc.	7
Herr Foods Inc.	4
Kellogg	2
Jays Foods Inc.	2
Giant Eagle Inc.	2

Table A5: Parent Companies of Top Brands Identified for Tobacco Products in Convenience Stores in Pittsburgh (for those that were identified among the top three most common brands in at least two stores sampled)

Parent Company of Product	Number of convenience stores in which product was among top 3 most common
Philip Morris International Inc.	13
R. J. Reynolds Tobacco Company	9