Mississippi River Plastic Pollution Initiative

QUAD CITIES SCIENCE REPORT

DAVENPORT, IA; ROCK ISLAND, IL; BETTENDORF, IA; MOLINE, IL; EAST MOLINE, IL

University of Georgia

Kathryn Youngblood, Sheridan Finder, Jenna Jambeck

Foreword

The Mississippi River is America's most essential inland waterway, providing hundreds of billions of gallons of water each day to key industries, as well as drinking water to 20 million people in 50 cities in 10 states. The river is rich in biodiversity, supporting the livelihoods of people living along the river as well as a wide range of plant and animal species.

But the river also hosts a threatening foreign substance — plastic pollution. Plastic litter that continuously enters the Mississippi River poses a large threat to environmental quality and ecosystem health, and these impacts extend far beyond the river valley. Up to 80% of marine plastic originates from land-based sources, and as the drainage system for 40% of the continental United States, this pollution travels through storm drains and smaller waterways into the river and its tributaries, ultimately making its way to the Gulf of Mexico and into the ocean.

Approximately 11 million metric tons of plastic enters the oceans each year, so understanding the extent of the plastic pollution problem is key to devising effective solutions. The United Nations Environment Programme's North America Office, the Mississippi River Cities and Towns Initiative and University of Georgia's Debris Tracker have come together through the Mississippi River Plastic Pollution Initiative to generate a first ever snapshot of plastic pollution along the River.

Using a citizen science approach, this initiative facilitated and supported data collection at key sites along the river in the Spring of 2021. The aim was to understand the movement and accumulation of plastic pollution while painting as rich a picture as possible within a small amount of time of the extent, type, and brand of plastic litter along the river. Following a successful phase of initial data collection in three pilot cities, the initiative expanded to the Quad Cities.

The intention of this Mississippi River Plastic Pollution Initiative Quad Cities Science Report is to generate information about plastic waste concentrations in specific areas, which all stakeholders — from policy makers, to businesses and citizens — can use to take action within their communities. We hope that this research will not only help cities and towns in Iowa and Illinois, but also provide an example of what can be done collectively to address the plastic pollution crisis around the world.

Dr. Barbara Hendrie
Director, North America Office
United Nations Environment Programme

Colin Wellenkamp
Executive Director
Mississippi River Cities and Towns Initiative

Dr. Jenna Jambeck
Distinguished Professor, Environmental Engineering
University of Georgia

Published by:
Jambeck Research Group

Location:
The University of Georgia
Athens, GA
USA 30602
https://jambeck.engr.uga.edu/

Contact:
Dr. Jenna Jambeck
jjambeck@uga.edu

Authors:
Kathryn Youngblood, Sheridan Finder, Jenna Jambeck

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On behalf of:
The Mississippi River Plastic Pollution Initiative

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UN environment programme
MRCTI
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UNIVERSITY OF GEORGIA
Marine Debris Tracker

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Executive Summary

The United Nations Environment Programme (UNEP) North America Office, the Mississippi River Cities and Towns Initiative (MRCTI), the University of Georgia's Debris Tracker, and other local and national partners are working together as part of the Mississippi River Plastic Pollution Initiative to generate a first-ever snapshot of the state of plastic pollution along the Mississippi River.

Hundreds of community volunteers surveyed targeted areas in the Quad Cities to understand the movement and accumulation of plastic pollution, generating key data through a citizen science approach. Community members collected data with Debris Tracker, an open data citizen science movement and free mobile phone app.

The cities that participated in this phase of data collection included: Davenport, Iowa; Bettendorf, Iowa; Rock Island, Illinois; Moline, Illinois; and East Moline, Illinois. The data gathered in the Quad Cities was examined to understand the state of plastic litter, generating as rich a picture as possible, within a dedicated timeframe, of the extent and type of litter that can make its way to the river.

This project consisted of scientific strategy development and refinement, volunteer training and outreach, field data collection, and data analysis and reporting. The community training and data collection occurred from September–October, 2021. The initiative was successful in engaging citizen scientists with 24,943 total litter items logged in the Quad Cities from October 1–31, 2021. Plastic was the top material found, comprising 76% of the items logged in the Quad Cities.

While there was some variation of litter across the cities as described in more detail in the report, the top ten items remained relatively consistent: cigarette butts, food wrappers, paper and cardboard, film/foam/hard plastic fragments, aluminum cans, beverage bottles, and plastic bags were some of the most common items found. Personal Protective Equipment (PPE), an emerging contaminant in the environment and waterways, was a consistent 1-2% of the items found (by count).

Each of the Quad Cities was successful in collecting adequate data to provide a baseline snapshot of the litter in each city. The average litter density (calculated by the number of litter items over the area surveyed in count/m^2) across all sites in the Quad Cities is 0.53 items/m^2. To visualize this density, imagine that when observing a 1-m (3-ft) wide path while walking along a 100 m city block, one would see 53 litter items. The litter densities are similar for Rock Island, Moline, and East Moline, but are relatively lower in Davenport and Bettendorf (Table ES-1). Litter densities of 0.6–0.7 items/m^2 are consistent with findings in Baton Rouge (0.61 items/m^2) and St. Louis (0.69 items/m^2) during the initial pilot phase of the initiative conducted in April 2021. The litter density in Bettendorf is similar to that found in St. Paul (0.28 items/m^2) during the pilot phase as well. Further analysis of data and influencing factors could help to better evaluate both the similarities and the differences in the litter density data, and repeated surveying could help establish trends and further verify initial findings.

Table ES 1: Quad Cities Litter Summary Data

City	Items (Count)	# of Sites Surveyed (square kilometers)	Average Litter Density (items/m²)
Davenport	17,460	41	0.50
Bettendorf	1,168	12	0.20
Rock Island	1,935	10	0.73
Moline	3,263	13	0.71
East Moline	1,107	5	0.61

Community volunteers reported brand information for 470 items, about 2% of the total items logged. Of these, 192 unique brand names were identified. These brand names were then associated with their parent companies. In total, 113 parent companies were identified in the litter in the Quad Cities, representing an opportunity to engage a myriad of stakeholders to address plastic pollution in the region.

Essential to the success of this project is the participation of communities, especially the leadership and engagement of the Mayors and Mayors' offices. Results from the Quad Cities initiative were presented to the Mayors and city officials, as well as city partners, in November 2021. Based upon the project core partners and discussions with the cities and local partners, the following opportunities for reducing plastic pollution in the Mississippi River have been identified:

- Items like PET bottles and aluminum cans are highly recyclable. Access to recycling in public spaces could be further examined.
- Improved automation and access to return centers might enhance the existing deposit return program in Iowa.
- Straws found in commercial and mixed-use areas might present an opportunity for changes to business practices, such as straw by request policies.
- Litter found in parking lots might suggest the need to expand availability of waste management services at these locations.
- The wide variety of brands identified means there is potential to engage numerous brand stakeholders in solutions.
- Municipal contracts could be used to enforce cleanup prior to mowing, require litter cleanup at construction sites, and require waste collectors to reduce leakage from automated garbage collection.
- Local policy could help support installation of cigarette receptacles.
- Exploring new materials could reduce plastic consumption, although waste management capacity for new materials needs to be taken into account.
- Expanded communication and messaging around plastic pollution in the Quad Cities could bring together new partners to address this issue.

The next steps for this initiative are to continue dialogues in the pilot cities, as well as between stakeholders, to take action in order to address plastic pollution in their communities, protect their local environments, the Mississippi River, the global ocean and beyond.

Introduction

Background

The Mississippi River flows over 2,000 miles from its headwaters in Minnesota to the Gulf of Mexico. The basin drains 40% of the United States and encompasses 32 states. It is one of America's most essential inland waterways, supporting the livelihoods of people along the river, and it is home to diverse plant and animal species. The Mississippi River generates over $400 billion in revenue and supports over 1.5 million jobs.[1] But plastic pollution is a significant problem throughout the Mississippi River Basin, and the river is often impacted by our actions on land. Items that we use every day – like disposable coffee cups, water bottles, masks and plastic bags – can end up in the environment and ultimately be blown by wind or washed by rainfall into the river.

Recognizing the urgency of the plastic pollution problem, state legislators and mayors of cities and towns along the Mississippi River made a commitment to reduce plastic waste in the Mississippi River Valley in September 2018. Under the leadership of the Mississippi River Cities and Towns Initiative (MRCTI), mayors invited public and private entities to reduce their plastic use or waste stream by 20% by 2020.

To support this commitment, The United Nations Environment Programme (UNEP) North America Office, the Mississippi River Cities and Towns Initiative (MRCTI), the University of Georgia's Debris Tracker, and other partners are working together on the Mississippi River Plastic Pollution Initiative to generate a first-ever snapshot of the state of plastic pollution along the Mississippi River. Following an initial pilot phase in April 2021, data collection was expanded to the Quad Cities region in October 2021. Hundreds of community volunteers surveyed targeted areas in the Quad Cities to understand the movement and accumulation of plastic pollution, generating key data through a citizen science approach. Community members collected data with Debris Tracker, an open data citizen science movement and free mobile phone app. Cities participating in this phase of data collection included: Davenport, Iowa; Bettendorf, Iowa; Rock Island, Illinois; Moline, Illinois; and East Moline, Illinois. The data gathered in the Quad Cities was examined to understand the state of plastic litter in these river cities. The goal was to generate as rich a picture as possible, within a dedicated timeframe, of the extent and type of litter that can make its way to the river.

1. Data compiled by MRCTI

The Core Partners

MRCTI is a coalition of 101 mayors from across the Mississippi River Basin, which spans nearly a third of the country. The Mississippi River is of significant importance in the region, providing drinking water to more than 20 million people and 50 cities. More than 60 billion gallons of fresh water is withdrawn from the river daily. The River's resources support 1.5 million jobs and create $496.7billion in annual revenue.

UNEP is the leading global authority that sets the environmental agenda, promotes the coherent implementation of the environmental dimension of sustainable development within the United Nations system, and serves as an authoritative advocate for the global environment. UNEP provides leadership and encourages partnership in caring for the environment by inspiring, informing, and enabling nations and peoples to improve their quality of life without compromising that of future generations.

The University of Georgia's Debris Tracker is a free mobile app designed to help community members make a difference by contributing data on plastic pollution. Developed in 2010 in partnership with the National Oceanographic and Atmospheric Administration (NOAA) and currently supported by Morgan Stanley, the Debris Tracker community is creating a bigger picture of marine debris and plastic pollution through collecting open data, generating scientific findings, informing policy, and inspiring upstream design. Every day, dedicated educational, non-profit, and scientific organizations and passionate citizen scientists from all around the world record data on inland and marine debris with the easy-to-use app, with over 5 million items logged to date.

Other Partners

Local partners joined the Quad Cities initiative to participate in data collection, identify areas of concern for litter, organize cleanups that happened during the project period, and to receive and facilitate training on effective data collection for this project. A list of city partners is included in Appendix A.

Report Organization

This report is organized into sections, with the results first, including results for the Quad Cities region as a whole, followed by results for each city, along with an overall results discussion. The results are followed by a summary of the strengths, weaknesses and opportunities, informed by the cities and local partners, for addressing plastic pollution in the Quad Cities Region. Detailed methods, including data collection and training, are presented in Appendix B.

Results

Overview of Litter in the Quad Cities

In total, 24,943 total litter items were logged in the Quad Cities. Plastic was the most common material found at 76%, followed by 11% paper and lumber, and 7% metal. Cigarette butts, food wrappers, paper and cardboard, film/foam/hard plastic fragments, aluminum cans, beverage bottles, and plastic bags were some of the most common items found. PPE, an emerging contaminant in the environment and waterways, was a consistent 1-2% of the items found (by count). Material types and top items are provided in Figures 1 and 2.

Interesting items reported by participants in the Quad Cities included: a beer bottle with a living greenhouse in it, a bike, chipped up fragments in mowed grass, confetti, food sample cups, headphones, a huge plastic tarp, hundreds of thank you mint wrappers from a restaurant, construction styrofoam, multiple Fireball shooters, a saw, more than 20 energy gummy packages littered on a bike and running path, many candy wrappers from a nearby bank, a truck bed, and a TV.

Figure 1: Material Categories (by percent of abundance) logged in the Quad Cities

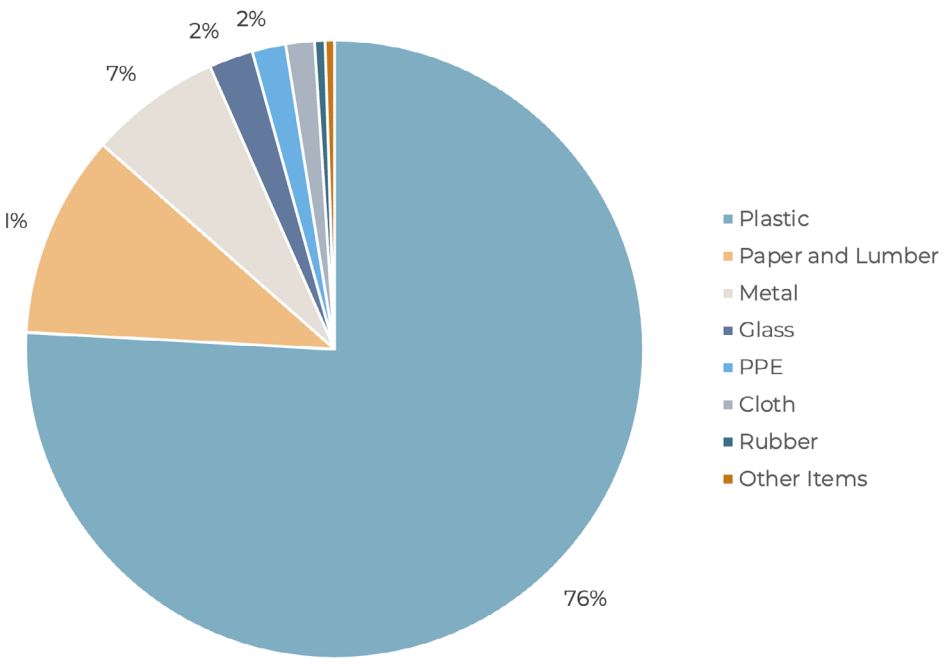
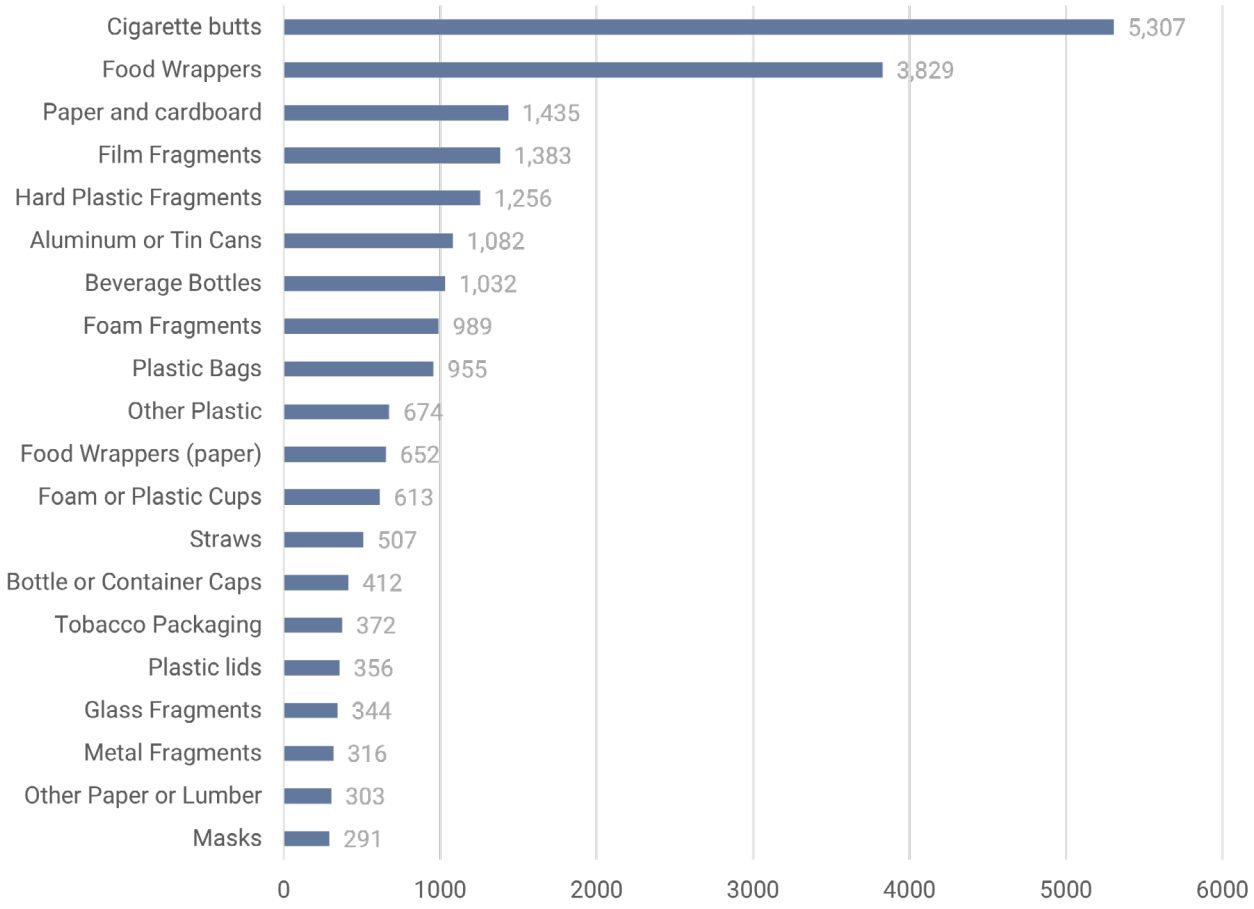
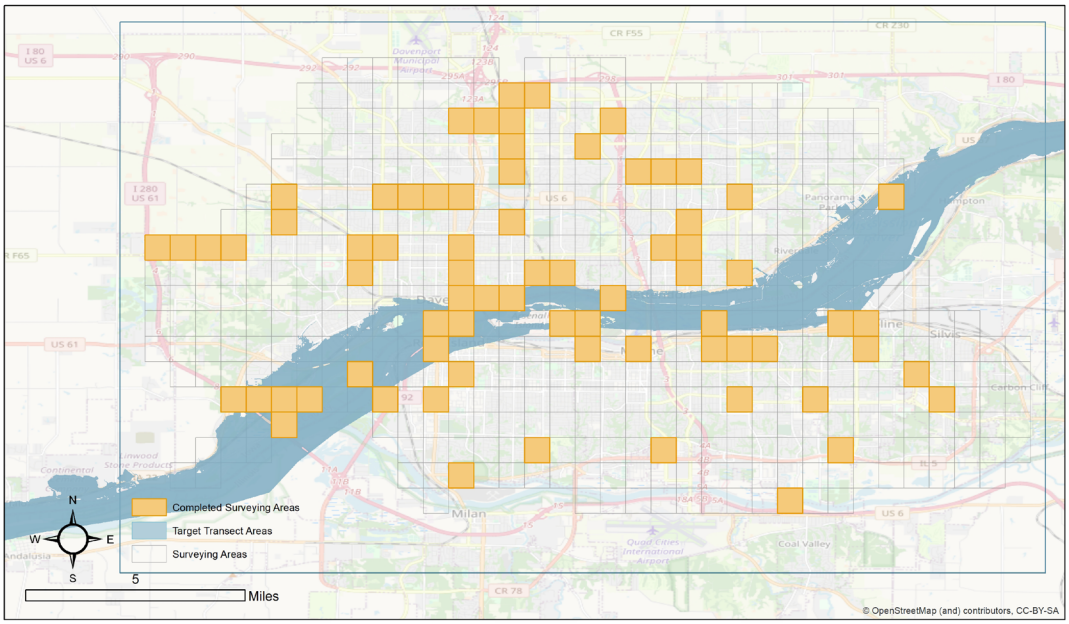


Figure 2: Top Ten Items (by count) logged in the Quad Cities



In total, 73 km^2 had adequate data collection for analysis of litter density, corresponding to more than 45,300 m^2 of transect surveys. A map of surveyed square kilometers in relationship to the Mississippi River is provided in Figure 3.

Figure 3: Surveyed square kilometer Areas (73) Completed in the Quad Cities



Each of the Quad Cities was successful in collecting adequate data to provide a baseline snapshot of the litter in each city. The average litter density (calculated by the number of litter items over the area surveyed in count/m^2) across all sites in the Quad Cities is 0.53 items/m^2. To visualize this density, imagine that when observing a 1-m (3-ft) wide path while walking along a 100 m city block, one would see 53 litter items. The litter densities are similar for Rock Island, Moline, and East Moline, but are relatively lower in Davenport and Bettendorf (Table 1). Litter densities of 0.6–0.7 items/m^2 are consistent with findings in Baton Rouge (0.61 items/m^2) and St. Louis (0.69 items/m^2) during the initial pilot phase of the initiative conducted in April 2021. The litter density in Bettendorf is similar to that found in St. Paul (0.28 items/m^2) during the pilot phase as well. Further analysis of data and influencing factors could help to better evaluate both the similarities and the differences in the litter density data, and repeated surveying could help establish trends and further verify initial findings. An overview map of litter densities is provided in Figure 4; an interactive online version is available here (note that sites were counted in a given municipality if they were contained within or intersected the municipal boundary; some square kilometer sites spanned two municipalities and were therefore included in the density calculations for each city).

Table 1: Quad Cities Litter Summary Data

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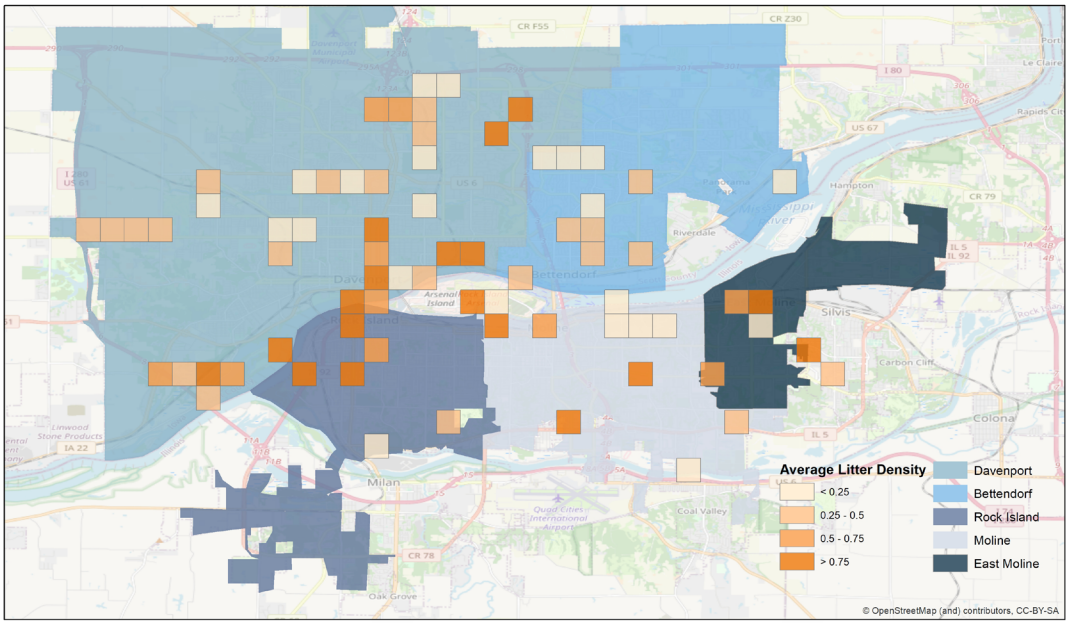
Figure 4: Litter Densities Across Quad Cities October 2021



In total, 265 unique tracking sessions were completed by volunteers. At the end of each tracking session, participants self-reported information in a survey form. Not all participants answered every question in the surveys. 174 of the surveys, or 65%, reported that they were following the transect method (out of 200 surveys who answered this question). Only 2 surveys, less than 1%, reported that they were conducting floating debris surveys.

79 unique user IDs submitted data, including 3 researchers from the University of Georgia that collected data in the Quad Cities. On average, each user tracked 1.84 times and logged 252 items (averages exclude researchers). In addition, users reported an additional 187 volunteers who helped collect data, for a total of 266 participants. On average, each user reported that 3 additional volunteers helped them collect data, meaning many users were tracking with partners or groups (62 users provided data on participants).

Out of the 215 survey respondents that reported time spent tracking, the total time spent tracking was 6,476 minutes (108 hours). The average time spent tracking for each participant was 55 minutes, nearly double the amount of time suggested in the Citizen Science Field Guide (this average excludes surveys conducted by University of Georgia researchers). 70.8% of participants who answered the survey about picking up litter reported that they picked up the litter, which resulted in 11,679 items being cleaned up. Cleanup information was not reported on 7,011 items.

Land Use

Community based data collection occurred across various land use types (self-identified in the field), with 28% of data collected in green space, 20% in mixed use areas, 23% in commercial areas, and 23% collected in residential areas (note that where multiple land use options were selected by volunteers, land use types were combined into mixed and mixed green space). Mixed implies residential and commercial or industrial buildings; mixed green space implies green space and residential, commercial, or industrial buildings. 198 surveys, or 75% of the sessions, reported land use type, which corresponded to 18,384 items, or 74% of the total items. The percentage of surveys conducted in each land use type and the percentage of litter items logged in each land use type are shown in Figures 5 and 6. Note that while 23% of surveys were conducted in residential areas, only 10% of the litter was logged in residential areas, implying that residential areas have relatively less litter compared to other land uses in the Quad Cities.

Figure 5: Percent of surveys conducted in each land use type

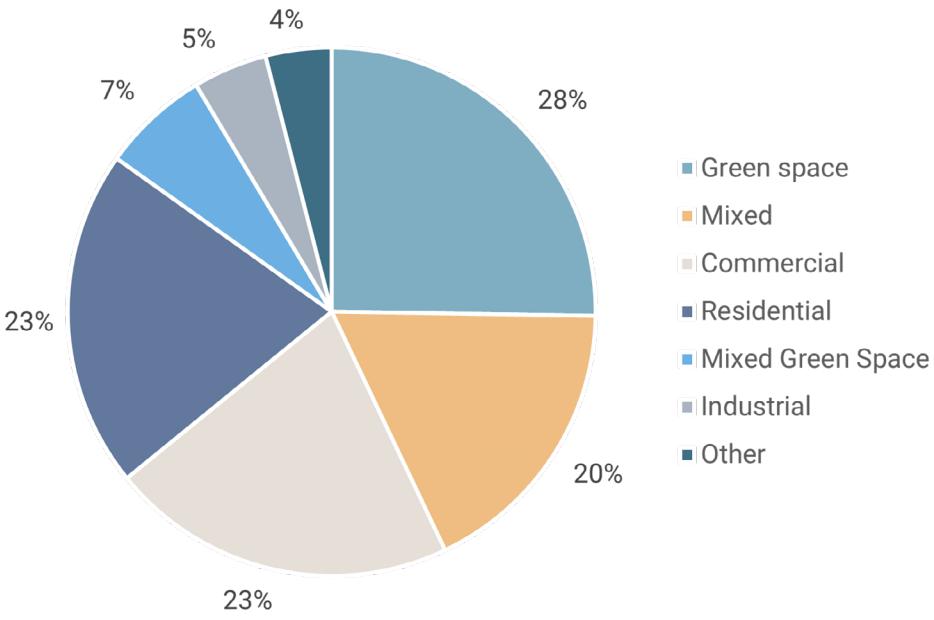
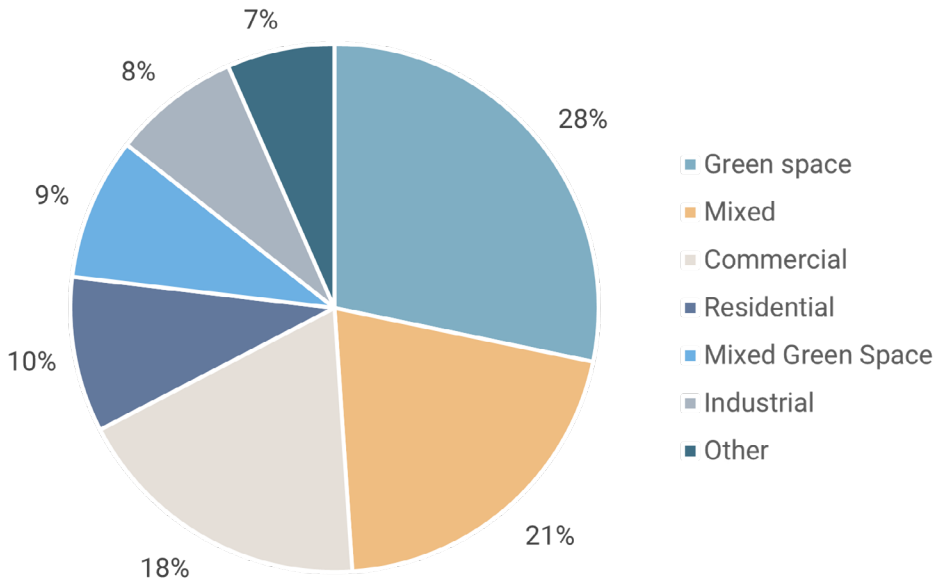


Figure 6: Percent of Items logged in each land use type



Top items by land use type are in Table 2. Bottles and cans were not in top 10 items found in commercial sites, which could potentially be influenced by the availability of bottle deposit return areas in commercial areas in Iowa. Interestingly, aluminum cans and plastic beverage bottles are primarily found in green space and mixed green space areas. Also of note, plastic bags are not in the top ten items in commercial areas, but are in all other land use types, showing a possible discrepancy between the source of some litter items (e.g., stores) and where those items are eventually entering the environment.

Table 2: Top Litter Items logged in each land use type

	Commercial (3,393 items)		Green Space (5,197 items)		Industrial (1,435 items)	
	Item	***Count***	***Item***	***Count***	***Item***	***Count***
1	Cigarette butts	1198	Food Wrappers	721	Cigarette butts	364
2	Film Fragments	608	Cigarette butts	718	Food Wrappers	183

	Commercial (3,393 items)		Green Space (5,197 items)		Industrial (1,435 items)	
	Item	*Count*	*Item*	*Count*	*Item*	*Count*
3	Food Wrappers	358	Aluminum or Tin Cans	399	Hard Plastic Fragments	158
4	Paper and cardboard	346	Foam Fragments	310	Paper and cardboard	108
5	Hard Plastic Fragments	172	Beverage Bottles	278	Food Wrappers (paper)	89
6	Foam Fragments	134	Plastic Bags	273	Plastic Bags	73
7	Other Plastic	92	Hard Plastic Fragments	214	Film Fragments	59
8	Metal Fragments	57	Paper and cardboard	197	Foam or Plastic Cups	43
9	Food Wrappers (paper)	52	Other Plastic	183	Foam Fragments	39
10	Straws	43	Food Wrappers (paper)	159	Metal Fragments	37

	Mixed (3,799 items)		Mixed Green Space (1,603 items)		Residential (1,749 items)	
	Item	*Count*	*Item*	*Count*	*Item*	*Count*
1	Cigarette butts	1098	Cigarette butts	362	Cigarette butts	303
2	Food Wrappers	542	Food Wrappers	287	Food Wrappers	222

	Mixed (3,799 items)		Mixed Green Space (1,603 items)		Residential (1,749 items)	
	Item	*Count*	*Item*	*Count*	*Item*	*Count*
3	Film Fragments	256	Beverage Bottles	105	Film Fragments	197
4	Hard Plastic Fragments	245	Aluminum or Tin Cans	102	Hard Plastic Fragments	132
5	Paper and cardboard	242	Hard Plastic Fragments	59	Paper and cardboard	124
6	Plastic Bags	129	Plastic Bags	56	Food Wrappers (paper)	84
7	Foam Fragments	113	Paper and cardboard	51	Plastic Bags	81
8	Beverage Bottles	96	Glass Fragments	46	Beverage Bottles	62
9	Straws	96	Foam Fragments	44	Foam or Plastic Cups	60
10	Other Plastic	95	Foam or Plastic Cups	42	Aluminum or Tin Cans	40

Transect Locations

195 surveys, or 74% of the sessions, reported the transect location (e.g., sidewalk, roadside, etc.), which corresponded to 18,039 items, or 72% of total items logged. The percentage of surveys conducted in each transect location and the percentage of litter items logged in each transect location are shown in Figures 7 and 8. Roadsides had a high percentage of litter compared to the number of surveys conducted there. While only 29% of surveys were conducted along a roadside, 38% of litter items were logged in these areas. Roadside/sidewalk areas had the opposite pattern, with more surveys conducted (22%) and fewer items logged (14%). This finding may suggest that more litter comes from vehicles than pedestrians, that areas with sidewalks generally have more waste management infrastructure or services, or that litter cleanup may be occurring more frequently where sidewalks are located. Only 14% of areas were labeled as "other", but 21% of litter items were logged there. According to additional observations recorded by

participants, many of these surveys occurred near or along the edge of a parking lot, which might indicate the need for more waste management services in these locations.

Figure 7: Percent of surveys conducted in by transect location

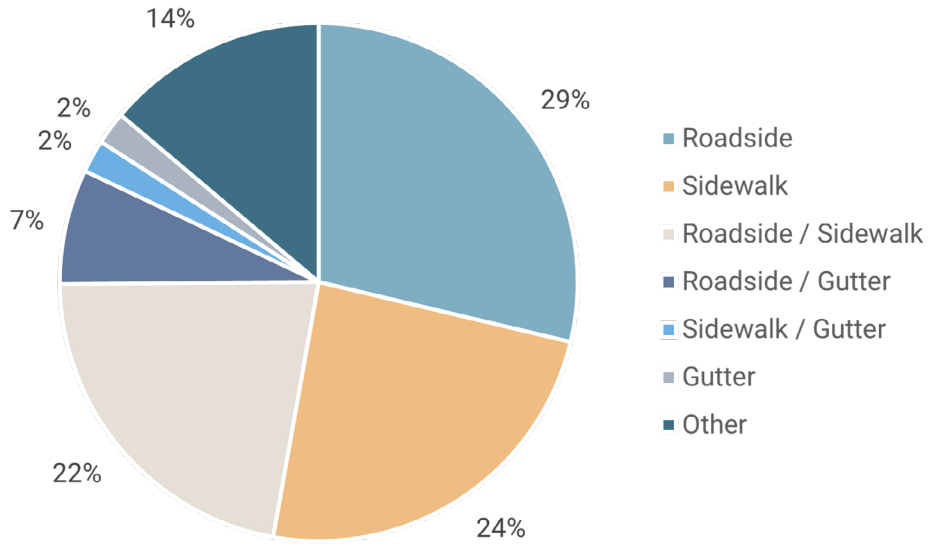
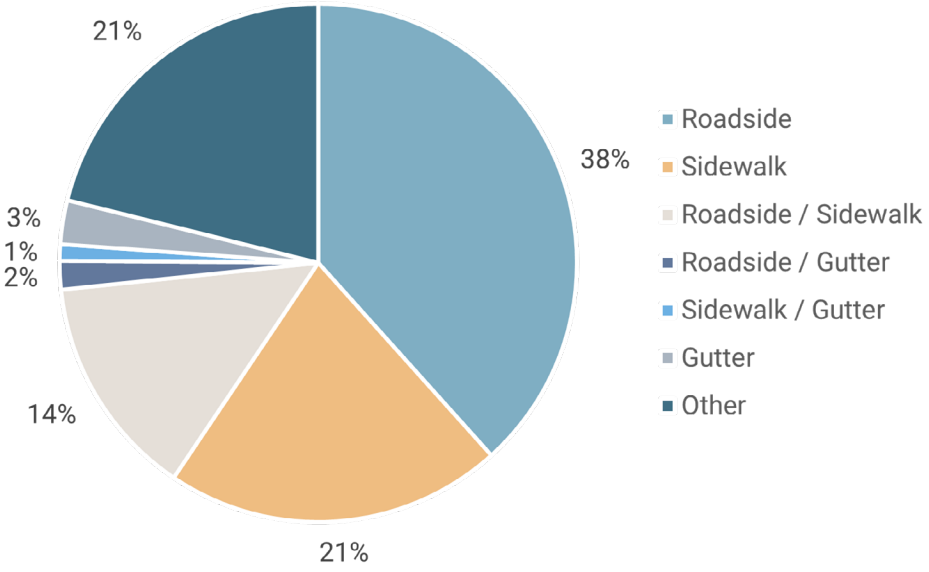


Figure 8: Percent of Items logged by transect location



Brand Information

Community volunteers reported brand information for 470 items, 2% of the total items logged. Of these, 192 unique brand names were identified under a total of 113 parent companies. While a wide variety of brands were noted, the most commonly noted parent companies may not be representative of the top littered items overall due to lack of brand being available and reporting during data collection (2%) or the challenges with recognizing brands on degraded litter items. However, brand identification of litter in the Quad Cities provides an opportunity to engage many different stakeholders to address the issue in the region.

Individual brand names were recorded by volunteers when brands of litter items were recognizable, like the examples in Figure 9. A full list of items recorded and all associated brand names are provided in Table 3. Individual brand names may connect to hyper-local litter issues observed in the field; these included: Gu energy gels found along on a bike path, Dum Dum wrappers found along a sidewalk near a bank, and single-use liquor bottles of Fireball in a park. The most common parent companies of the brands identified were PepsiCo (which makes both Frito Lay food products and Pepsi beverages), Anheuser-Busch InBev (which makes several brands of beer), and Altria (which owns John Middleton Co. and Philip Morris USA, which respectively manufacture the brand names Black & Mild and Marlboro cigarettes) (Figure 10).

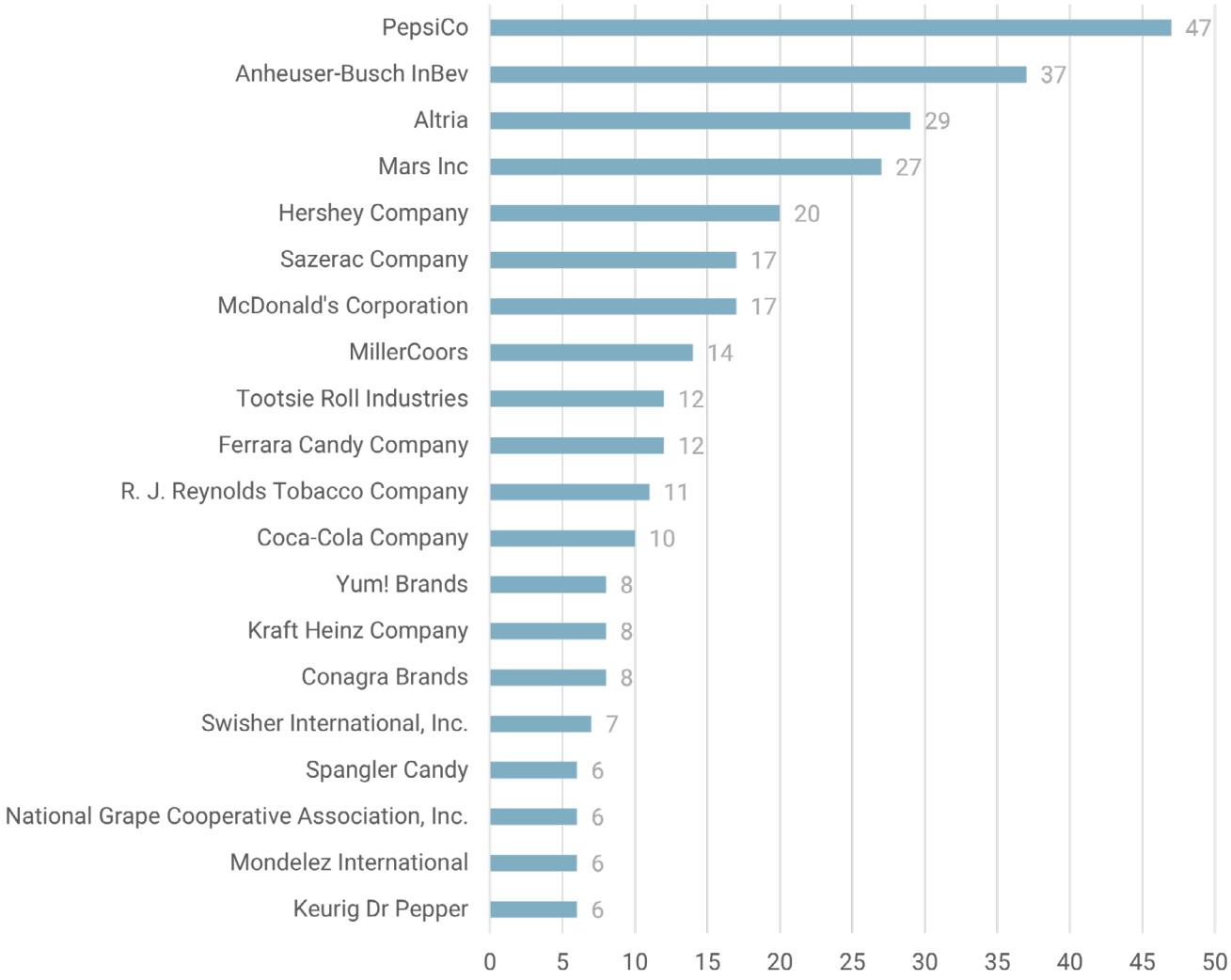
Figure 9: Examples of branded litter items

Table 3: Items and brands noted by community members

Item	All Brands Logged (in alphabetical order)
Aluminum Cans	7-Up, Arizona, Brisk Iced Tea, Bud Ice, Bud Light, Budweiser, Busch, Coca Cola, Dr. Pepper, Fanta, Full Throttle Energy, Keystone, Miller, Milwaukee's Best Ice, Monster, Mountain Dew, Natural Ice, Pepsi, Reign Total Body Fuel, Rockstar Xdurance, Snapple, White Claw
Beverage Bottles (plastic)	Aquafina, Arizona, Brisk, Dasani, Dr. Pepper, Fanta, Fireball, Gatorade, HyVee, Ice Mountain, Little Hug Fruit Barrels, Minute Maid, Mogu Mogu, Mountain Dew, Natures Touch, Nestle, Pepsi, Pibb Xtra, Pur Aqua, Sonora Corp, Silver Falls, Snapple, Sprite, Twister, Welch's
Bottle Caps (plastic)	Wis-pak
Clothing and Shoes	Aleader
Foam or Plastic Cups	7Eleven, Culvers, Farmer Brothers, Freddy's, Hardees, HyVee, KFC, McCafe, McDonalds, Pepsi, Polar Pop, Sonic, Starbucks, Steak and Shake, Subway, Taco Bell, Thortons
Food Wrappers (plastic)	3 Musketeers, 7Eleven, Airheads, Almond Joy, Arcor, Blow Pop, Bubbaloo, Butterfinger, Capri Sun, Carl's Jr (grape jelly packet), Charms Lollipop, Cheetos, Chick Fil A (sauce packet), Crunch, Daisy Sour Cream, Doritos, Double Bubble, Dum Dums, Extra Gum, Frito Lay, Fruit Roll Up, Funyuns, General Mills, Goetze, Great Value, Gu Berry Gel, Halls, Heinz, Hellmans, Hi Chew, Honey Bun, Hostess, International Delight, Jack Links, Jolly Rancher, Kemps, KFC (cookie wrapper), Kit Kat, Kool Aid, Kopiku, Laffy Taffy, Lance, Lemonhead, Little Debbie, Lunchable, M&Ms, Mamba, McDonalds, Mentos, Milky Way, Mounds, Nutri Grain, Oreo, Planters, Popeyes, Quaker, Reeses, Rice Krispy Treats, Ricola, Ring Pop, Ruffles, Skittles, Slim Jim, Smarties, Smithfield Foods Turkey Cracker Crunchers, Snickers, Snyders, Sour Punch Straws, Starburst, Super Bubble, Sweet Baby Ray's, Sweet Tarts, Taco Bell, Taco Johns, Takis, Thays Smart Bread, Tootsie Roll, Twix, Welchs, Werthers Original
Food Wrappers (paper)	Burger King, Casey's, Chester's Chicken, Chick Fil A, Dum Dums, McDonalds, PixyStix, Pringles, Rallys, Wendy's, Wrigleys
Glass Bottle	Angry Orchard, Bud Light, Busch, Coors, Everfresh, Hennessey, Jose Cuervo, Remy Martin Champagne, Seagrams, Starbucks

Item	All Brands Logged (in alphabetical order)
Metal Bottle Caps	Blue Moon, Bud Light, Corona, Smirnoff, Victoria Cerveza
Other Plastic	3M, Sam's Club, Sharpie
Paper and Cardboard	General Mills, Nerds, Portillos (receipt), Taco Bell (receipt)
Paper Bags	McDonalds
Personal Care Products / Toiletries	Atlas Condoms, Herbal Essences (mousse), Huggies (sticker tag), Walgreens (pill bottle)
Plastic Bags	Aldi, Walmart, Ziploc
Plastic Balls or Toys	Disney, Nerf
Plastic lids	Folgers, Hardees, McDonalds, Solo
Plastic Take Out Containers	D&W Fine Pack, Lunchables, Rubbermaid
Plastic Utensils	Wendys
Single-serve Plastic Liquor Bottles	99 Root Beer, Buzzballz, Crown Royal, E&J Brandy, Fireball, McCormick Vodka, Pink Whitney, Western Son
Straws	Dairy Pure, Hardees, Starbucks
Tobacco Packaging	Black and Mild, Camel, Dutch, Good Time Quickies, Lucky Strike, Marlboro, Newport, Pall Mall, Pyramid, Royal Tulsi, Swisher Sweets, This, Time

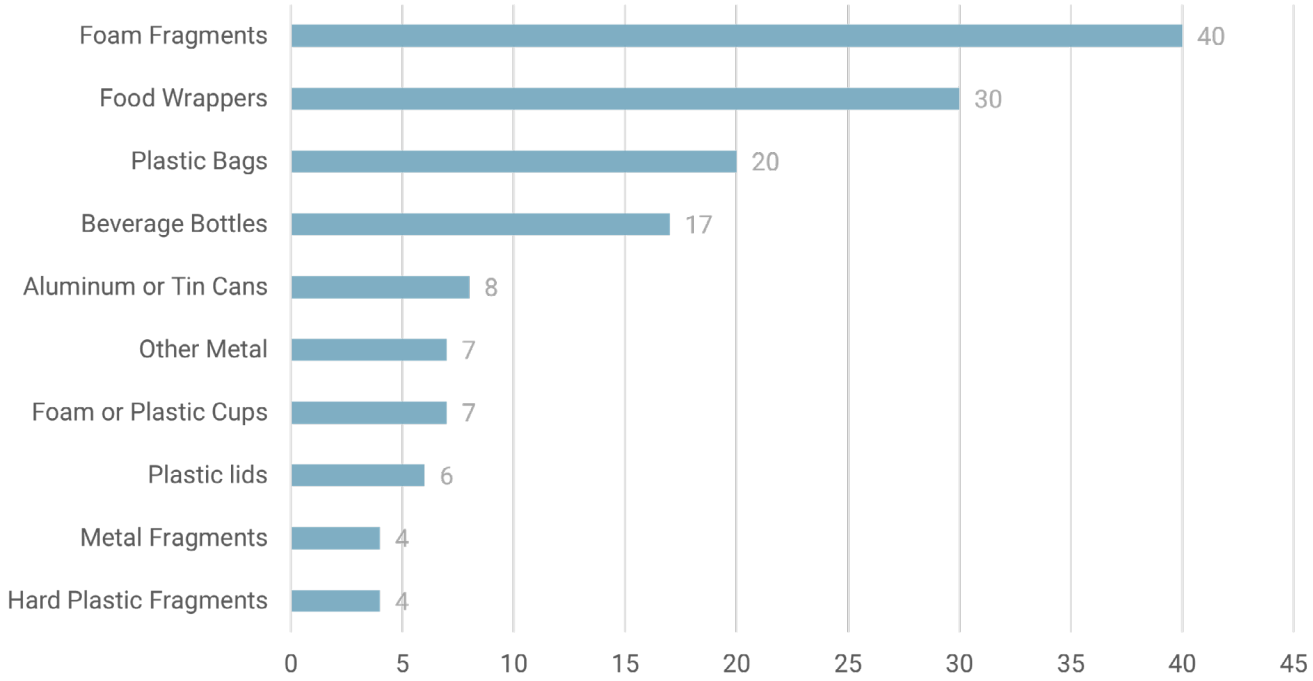
Figure 10: Most common parent companies of branded litter items



Floating Debris

Two tracking sessions recorded floating debris on the river, totaling 180 minutes, and corresponding to 179 litter items. 80% of floating debris items logged were plastic, slightly higher than the litter on land, followed by 11% metal and 3% paper and cardboard. Top items recorded in the floating debris are shown in Figure 11.

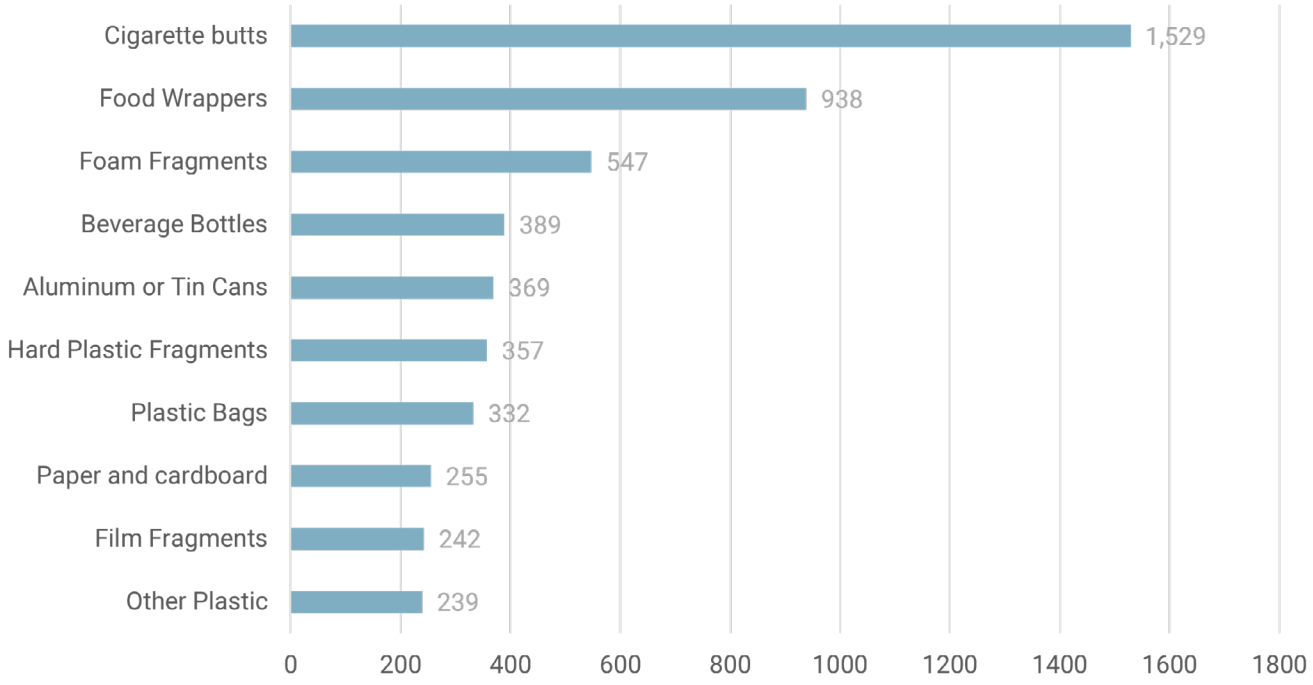
Figure 11: Top items (by count) of floating debris



The top items observed in floating litter were slightly different compared to litter on the land. Only items that are large enough to be seen from a distance and float will be observed through this method. In addition, not all debris items recorded on land actually reach the river, and once they do, some will float and some will sink depending on their buoyancy properties and fragmentation rates. Therefore notably, cigarette butts, which were the top item logged in the Quad Cities overall, are not observed in the floating debris. Floating cigarette butts are likely too small to observe and may sink once they become saturated with water. Foam fragments, which were the eighth most logged item in land overall, were the most common floating debris item. Plastic bags, which were the ninth most logged item overall, were the third most common floating debris item. Bottles and cans moved up slightly as well to 4th and 5th from 6th and 7th.

Several riverside cleanups and data collection events within the floodplain of the Mississippi River in the Quad Cities allowed us to examine litter composition on and near the riverbanks (Figure 12); floodplain areas typically contain litter items that are both dropped locally and washed ashore. The list of top items in the floodplain is not very different from the items in the cities overall; the top two items are still cigarette butts and food wrappers, but foam fragments move up to third and plastic beverage bottles and aluminum cans move up to fourth and fifth, respectively. Hard plastic fragments are sixth, and plastic bags are seventh. While the city data is the most comprehensive for understanding what ends up in the environment and designing interventions, the similar litter compositions in the floodplain and floating data indicate movement of litter to the river. More research is needed for a deeper understanding of the transport mechanisms of litter movement from communities into the river, and its eventual fate.

Figure 12: Top items (by count) logged within the floodplain of the Mississippi River.

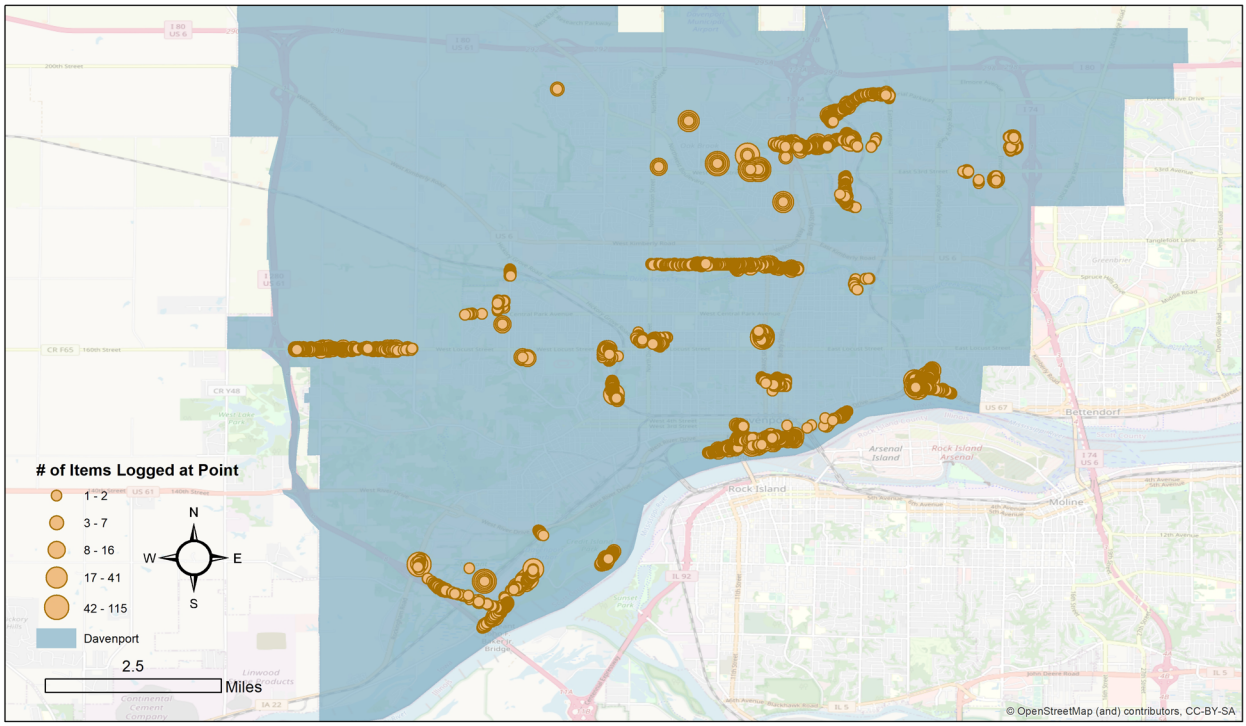


Litter in the Cities

Davenport

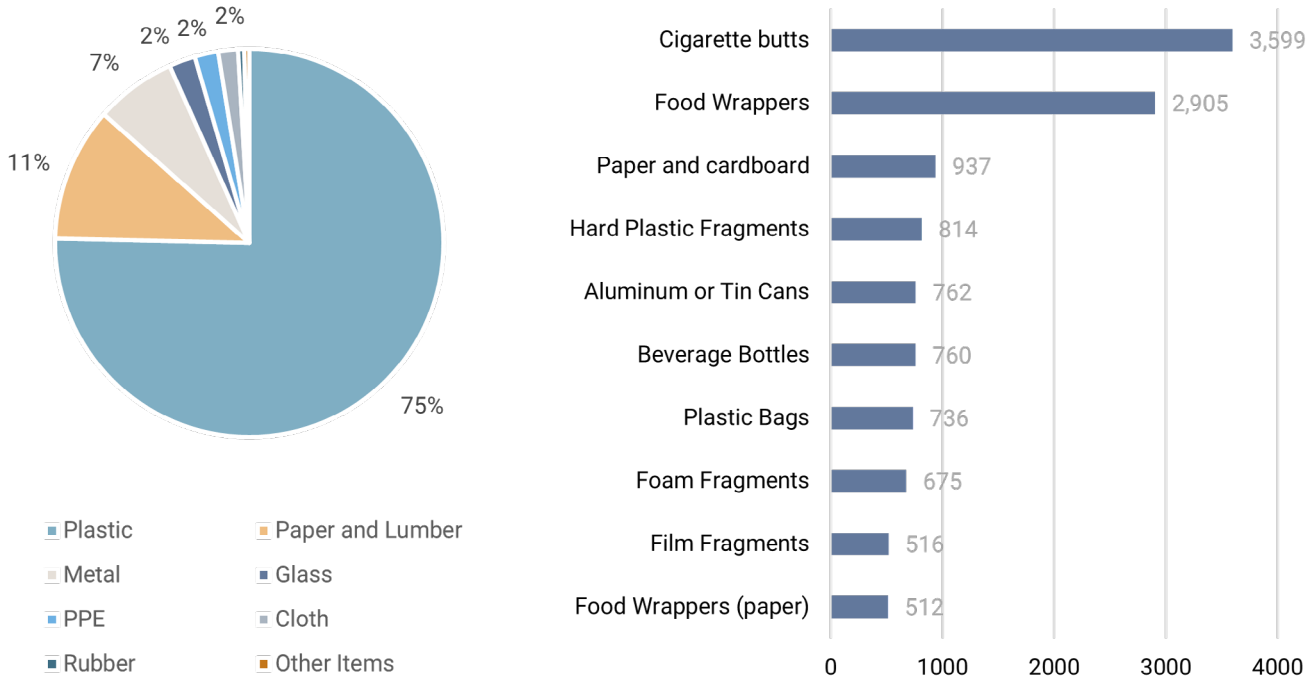
17,460 litter items were logged within the municipal boundary of Davenport (Figure 13). 41 square kilometer sites in Davenport had adequate transect data collection to characterize litter density. Densities in these sites ranged from 0.02 to 1.90 items/m^2, with an average litter density of 0.50 items/m^2.

Figure 13: Geographic distribution of litter data collected in Davenport



As shown in Figure 14, 75% of items logged were plastic. Cigarette butts, food wrappers, and paper and cardboard were the most common logged items.

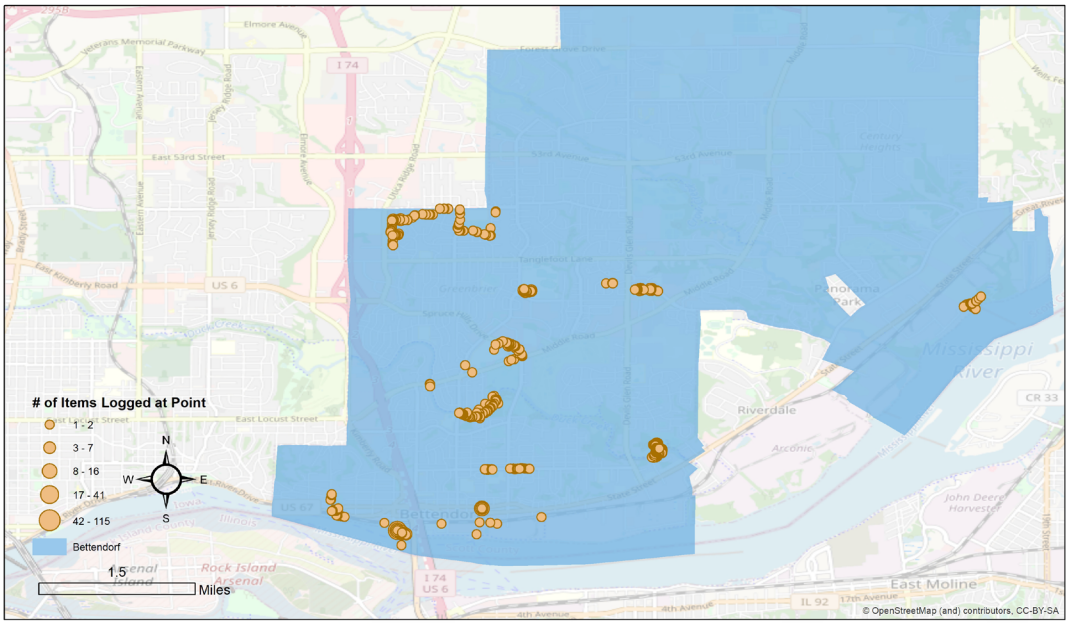
Figure 14: Material Categories (by percent of abundance) and Top 10 Items logged within Davenport



Bettendorf

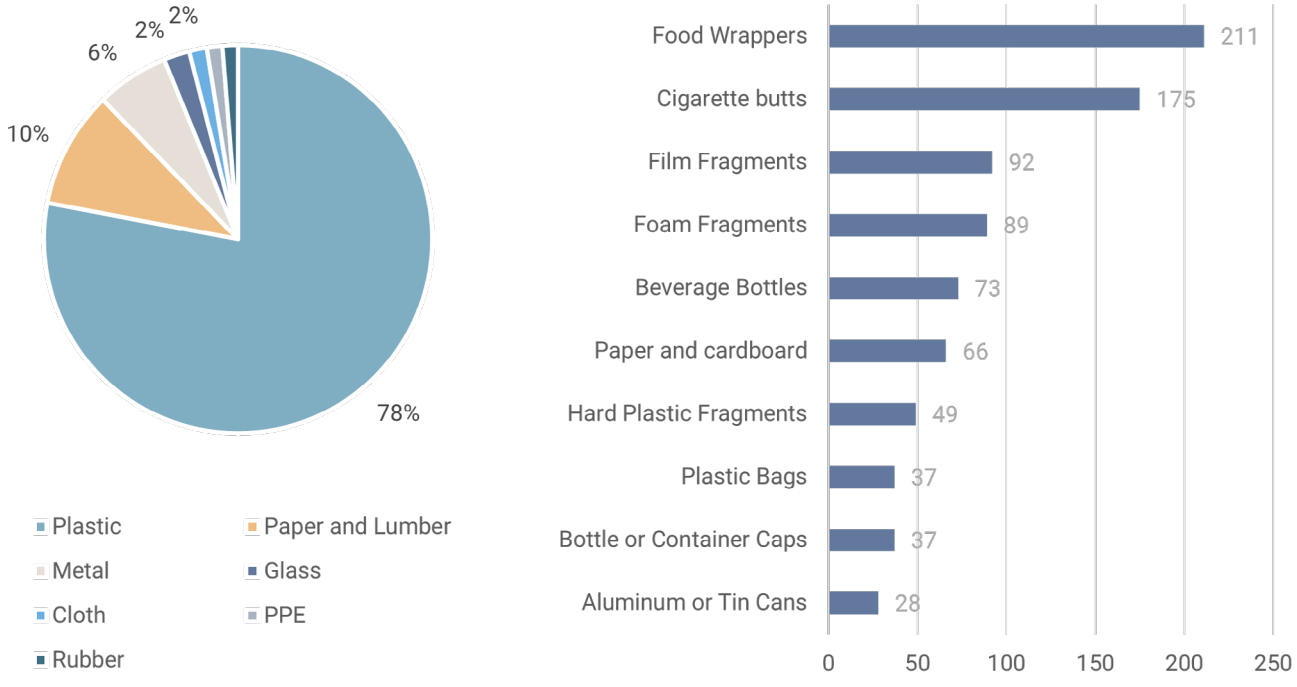
1,168 items were logged within the municipal boundary of Bettendorf (Figure 15). 12 square kilometer sites in Bettendorf had adequate transect data collection to characterize litter density; these sites were concentrated in areas of Bettendorf closer to the river. Densities in these sites ranged from 0.02 to 0.43 items/m^2, with an average litter density of 0.20 items/m^2.

Figure 15: Geographic distribution of litter data collected in Bettendorf



As shown in Figure 16, 78% of items logged in Bettendorf were plastic. Food wrappers, cigarette butts, and film fragments were the most common logged items. Film fragments often derive from plastic food wrappers, plastic bags, and other thin plastic products that might fragment quickly.

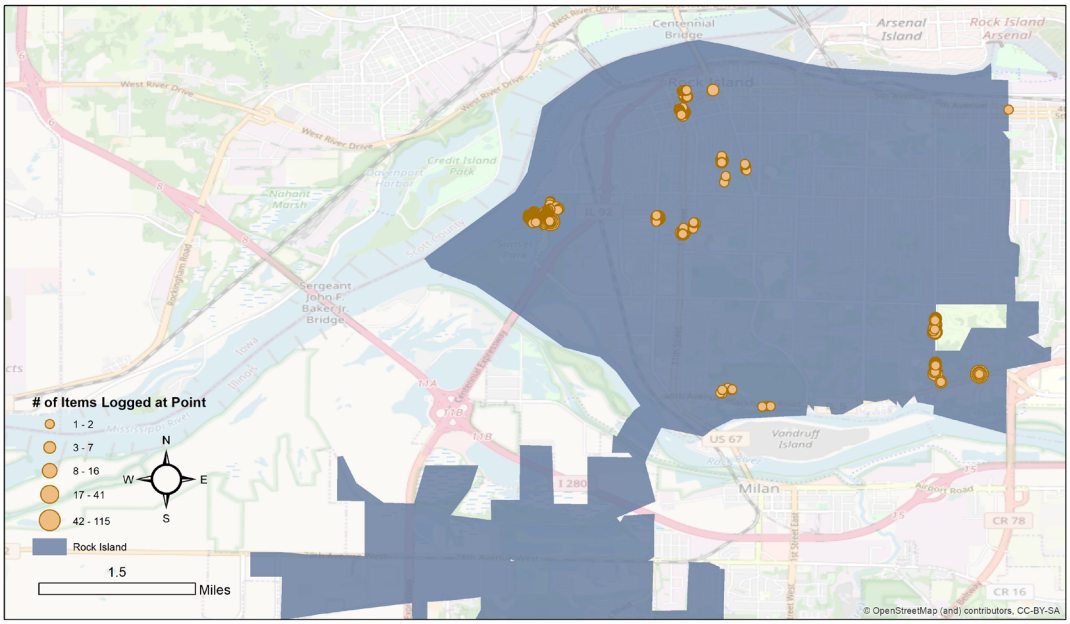
Figure 16: Material Categories (by percent of abundance) and Top 10 Items logged within Bettendorf



Rock Island

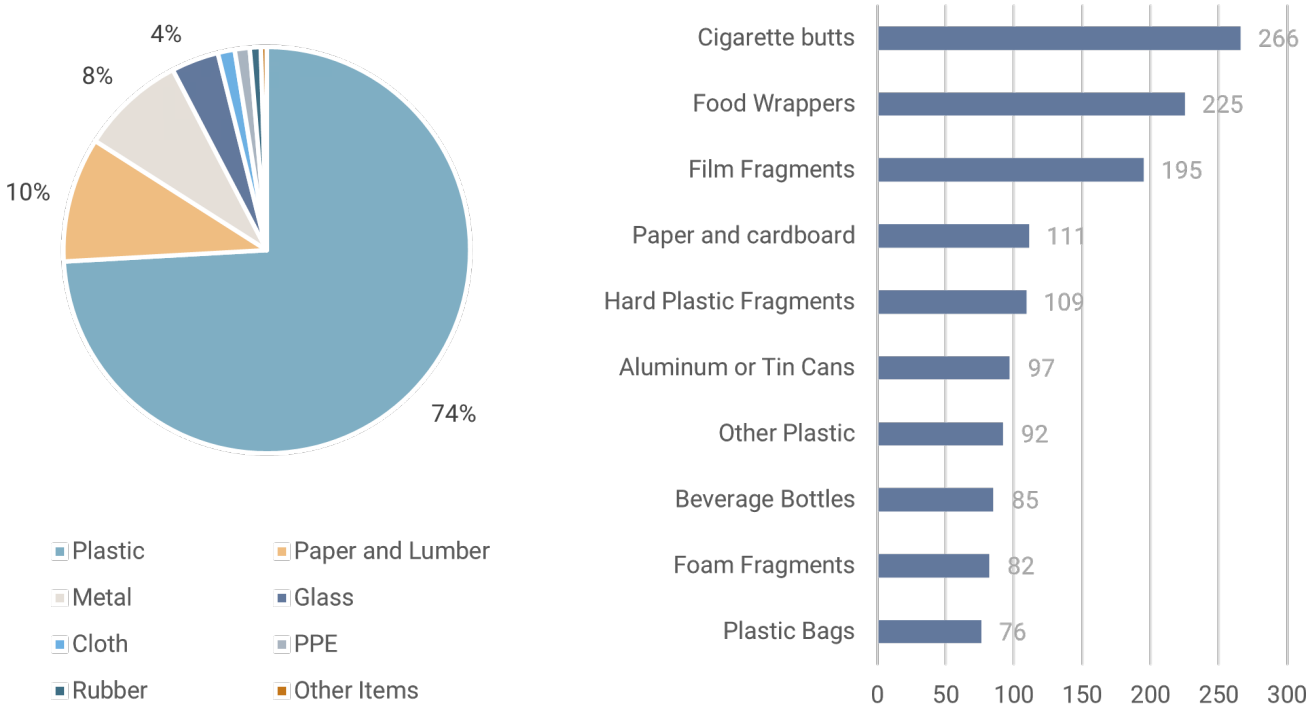
1,935 items were logged within the municipal boundary of Rock Island (Figure 17). 10 square kilometer sites in Rock Island had adequate transect data collection to characterize litter density. These sites were primarily in areas closer to the river, rather than in the southern portion of the city. Densities in these sites ranged from 0.07 to 1.16 items/m^2, with an average litter density of 0.73 items/m^2.

Figure 17: Geographic distribution of litter data collected in Rock Island



As shown in Figure 18, 74% of items logged were plastic. Cigarette butts, food wrappers, and film fragments were the most common logged items.

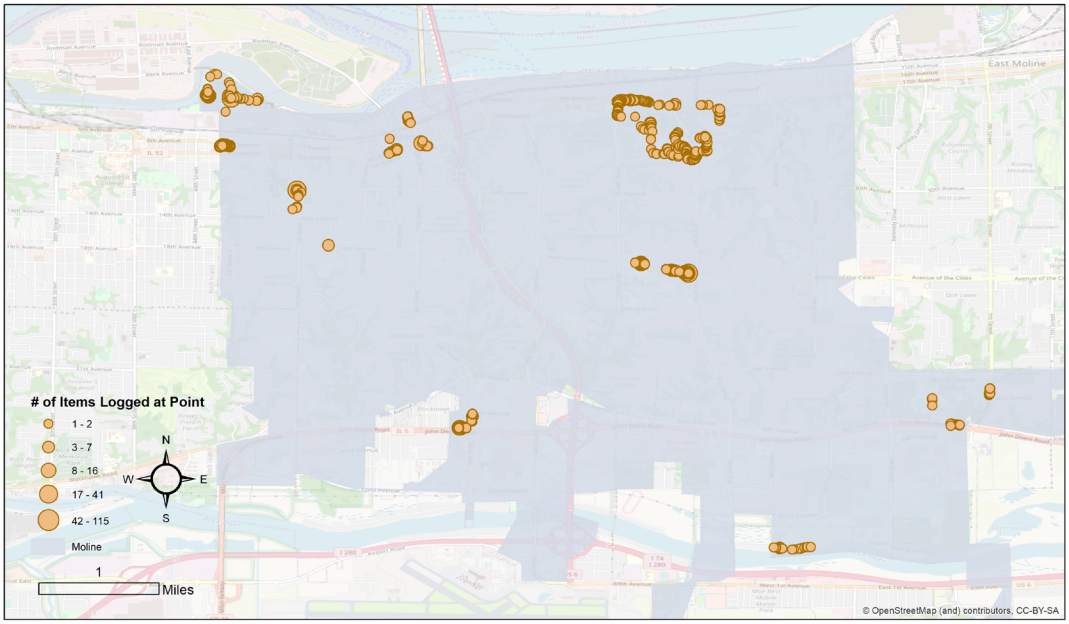
Figure 18: Material Categories (by percent of abundance) and Top 10 Items logged within Rock Island



Moline

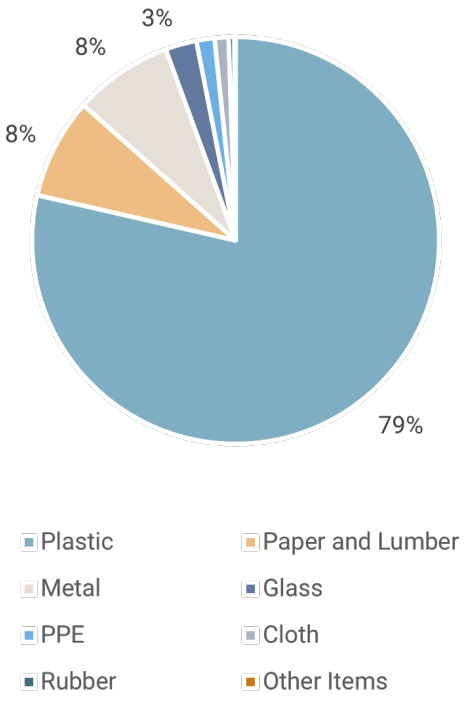
3,263 items were logged within Moline (Figure 19) spread out throughout the municipal boundary. 13 square kilometer sites in Moline had adequate transect data collection to characterize litter density. Densities in these sites ranged from 0.08 to 2.79 items/m^2, with an average litter density of 0.71 items/m^2.

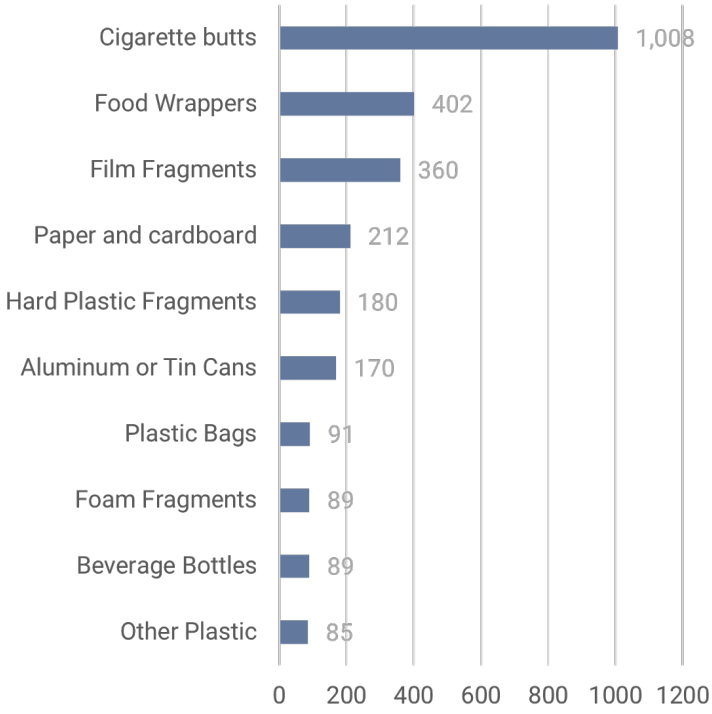
Figure 19: Geographic distribution of litter data collected in Moline



As shown in Figure 20, 79% of items logged were plastic. Cigarette butts, food wrappers, and film fragments were the most common logged items.

Figure 20: Material Categories (by percent of abundance) and Top 10 Items logged within Moline

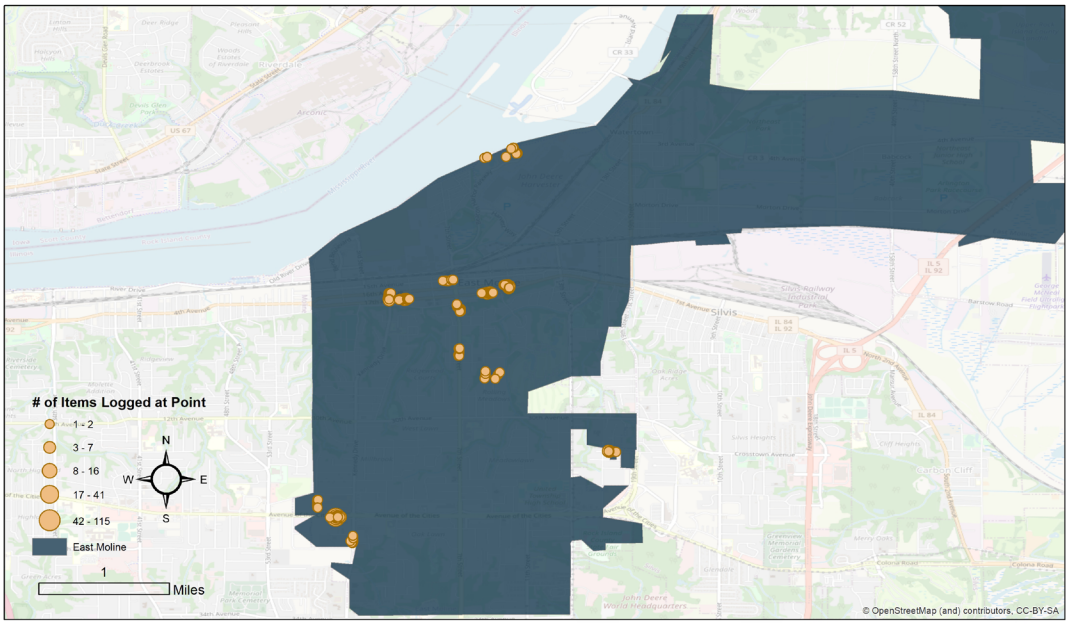




East Moline

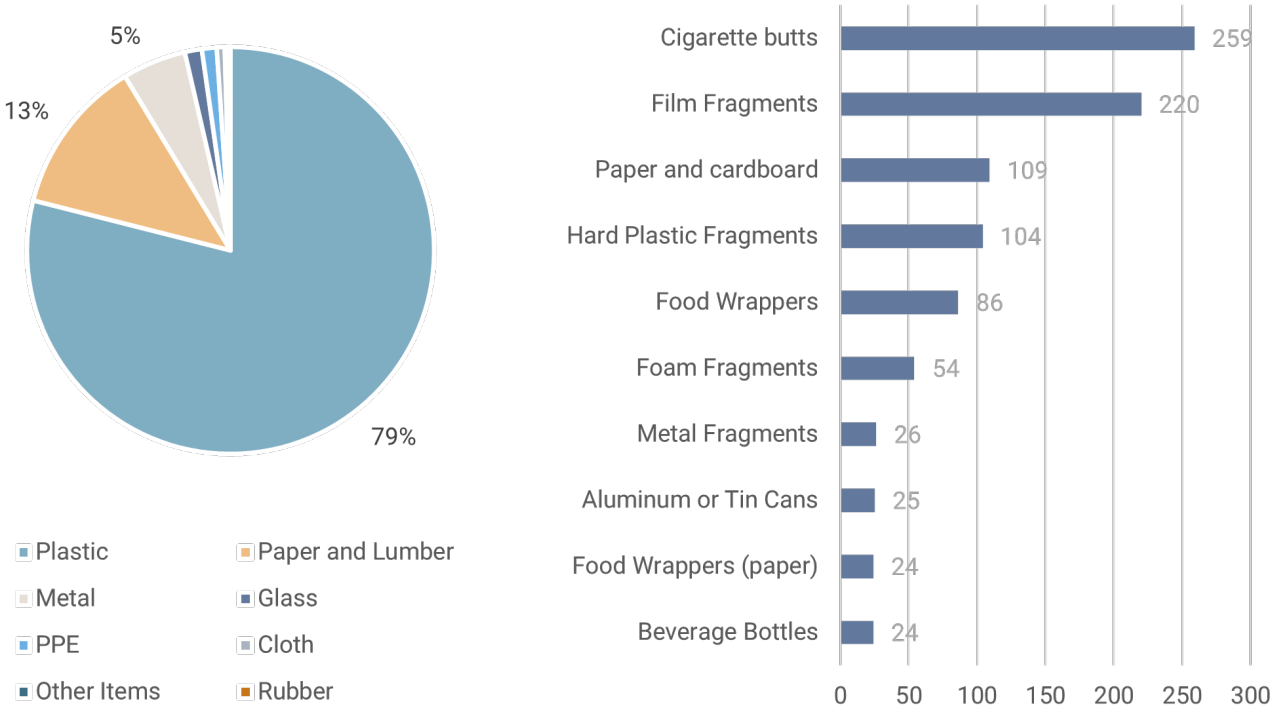
1,107 items were logged within the municipal boundary of East Moline (Figure 21). Data collection was concentrated in the western portion of the city. 5 square kilometer sites in East Moline had adequate transect data collection to characterize litter density. Densities in these sites ranged from 0.17 to 0.88 items/m^2, with an average litter density of 0.61 items/m^2.

Figure 21: Geographic distribution of litter data collected in East Moline



As shown in Figure 22, 79% of items logged were plastic. Cigarette butts, film fragments, and paper and cardboard were the most common logged items.

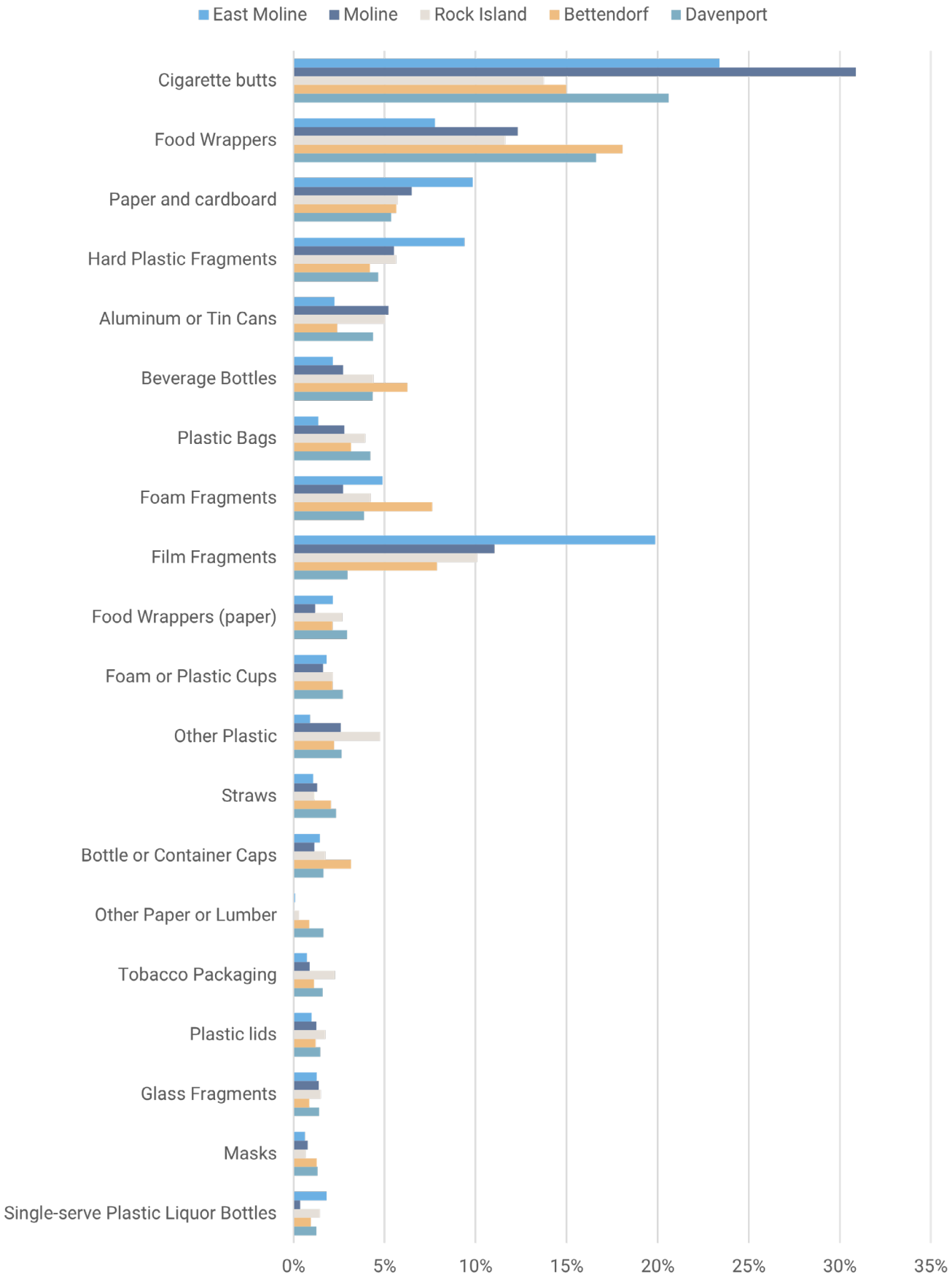
Figure 22: Material Categories (by percent of abundance) and Top 10 Items logged within East Moline



City Discussion

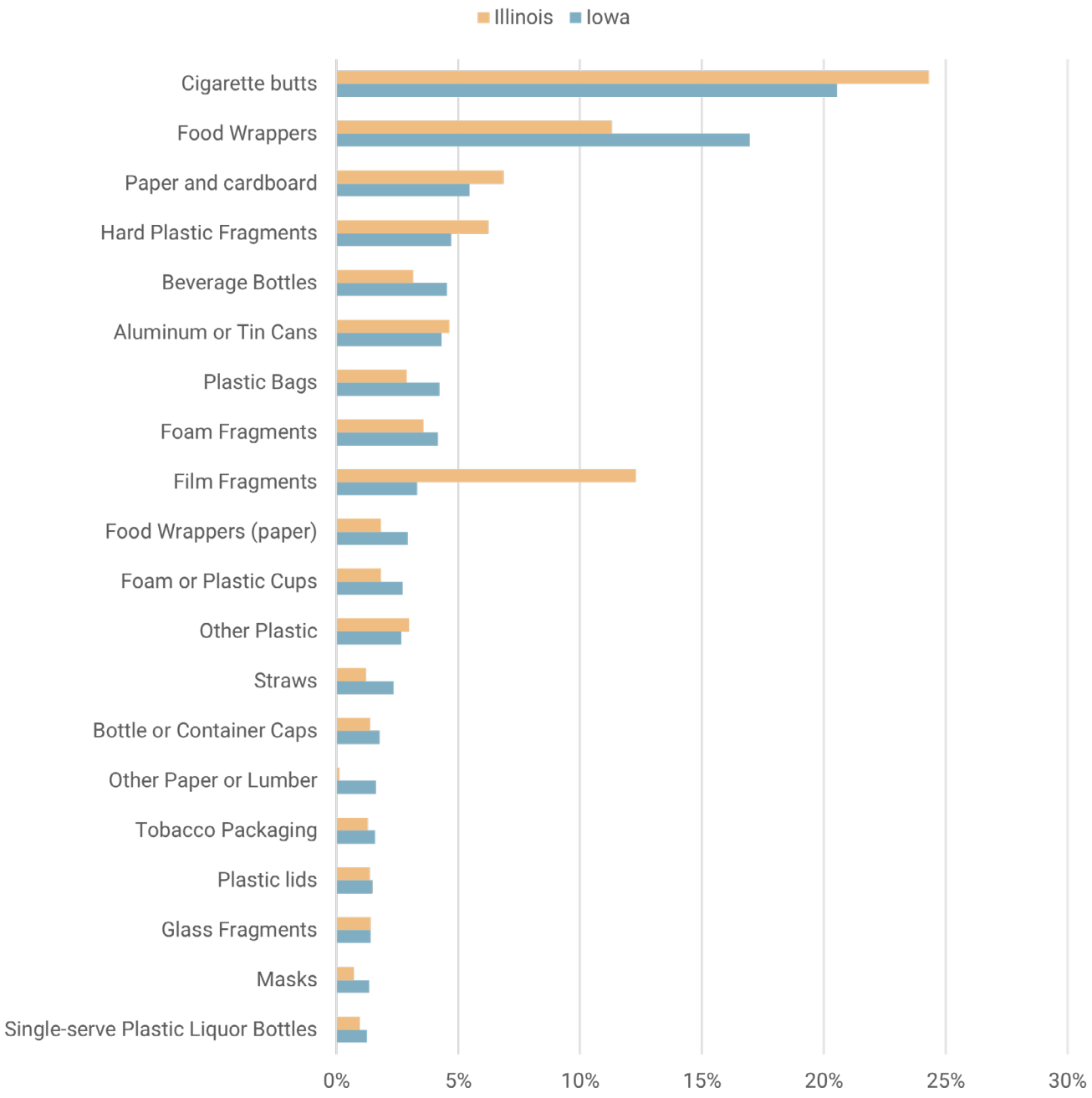
Figure 23 shows the relative proportion of commonly logged items across the Quad Cities. Moline had the highest proportion of cigarettes, followed by East Moline and Davenport. Cities on the Illinois side of the river — East Moline, Moline, and Rock Island — had a slightly lower proportion of food wrappers compared to those on the Iowa side of the river — Bettendorf and Davenport. Of note, East Moline has a particularly high fraction of film fragments. Film fragments were anecdotally observed in high frequencies in areas where mowing equipment had run over litter and caused fragmentation. The proportion of recyclable items, like aluminum cans and plastic beverage bottles, are similar between the different cities.

Figure 23: Relative Percent of items between the Individual Quad Cities



When comparing the composition of litter data collected in Iowa to data collected in Illinois (Figure 24), they appear relatively similar, with a few exceptions. Cigarette butts were a slightly higher proportion of litter in Illinois, and food wrappers were a slightly higher proportion in Iowa. While there was a relatively small proportion of film fragments in Iowa, film fragments made up a high proportion of the litter in Illinois.

Figure 24: Relative Percent of items between Illinois and Iowa



A bottle and can deposit system exists in Iowa, and previous research by others shows that deposit systems influence litter densities and characterization, resulting in the potential for 40% less bottles to end up on the ground where a

deposit return scheme exists.[2] While cans were very slightly lower in Iowa, in this case, the data does not indicate a difference in the proportion of bottles from Iowa to Illinois (the proportion of bottles is higher in Iowa). Local partners suggested several reasons for this anomaly. Not all bottles are eligible for the deposit system; the deposit fee applies only to carbonated beverages and not to hydration products like water and electrolyte drinks. In addition, closures associated with the recent COVID-19 pandemic temporarily impacted the availability of drop-off centers. While most drop-off centers are now back in operation according to local partners, these closures may have had a more lasting impact on public perception or willingness to participate. In future sampling, partners suggested separating deposit containers and non-deposit containers in the data collection to enable more refined analysis of these patterns.

2. Schuyler, Q., Hardesty, B. D., Lawson, T. J., Opie, K., & Wilcox, C. (2018, 2018/10/01/). Economic incentives reduce plastic inputs to the ocean. Marine Policy, 96, 250-255.

Strengths, Challenges, and Opportunities

Preliminary results from data collection in the Quad Cities were presented to the Mayors and city officials and local partners in November 2021. Based upon input from project partners and discussions with the cities and local partners, the following strengths, challenges, and opportunities for reducing plastic pollution input from the Quad Cities to the Mississippi River were identified.

Strengths

- A lower proportion of plastic beverage bottles were found in the litter compared to most other sites surveyed along the Mississippi River.
- A slightly lower proportion of cans were found in Iowa cities compared to Rock Island and Moline, possibly demonstrating the effectiveness of the deposit program in preventing litter. Cans and bottles were not in the top 10 items in commercial areas, possibly due to more accessibility of return areas.
- Residential areas and areas with sidewalks were relatively cleaner compared to other land uses.
- Curbside recycling is widely available in the Quad Cities.
- Some areas have contracts requiring litter pickup along right of ways in their landscaping agreements, which might help prevent litter being mowed over and fragmented.
- A Keep Iowa Beautiful program exists where you can call a phone number if you see someone throwing out cigarette butts.
- Programs like XStream Cleanup, Adopt a River Mile, and Adopt a Stream already are well-established in the Quad Cities.

Challenges

- Many of the commonly littered items are products people tend to consume on-the-go.
- Items like PET bottles and aluminum cans were found mainly in areas where recreation activities occur, like green spaces and parks.
- Straws were primarily found in commercial and mixed-use areas.
- Relatively high levels of litter are found in parking lots.
- Many different brands of items are ending up in the environment.
- Bottles and cans are still found in litter in Iowa, which could be related to challenges with access to redemption

centers or residual effects of pandemic closures. Challenges with the bottle and can deposit scheme also include lack of automation and lack of business support.
- Contract clauses requiring litter cleanup prior to mowing are challenging to enforce.
- Attempts to install cigarette butt receptacles have been met with resistance by businesses that don't want to encourage smoking. The Smoke Free Air Act in Iowa also restricts the ability to place cigarette butt receptacles. Additionally, people might not be aware that the filter in cigarette butts is plastic.
- Automated garbage/recycling truck collection might influence leakage of items (e.g., items falling and blowing out of cans while being emptied into the truck) and a lower tendency to retrieve these items.
- Roadsides and right of ways are areas of high litter accumulation.

Opportunities

- Items like PET bottles and aluminum cans are highly recyclable. Access to recycling in public spaces could be further examined.
- Improved automation and access to return centers might enhance the existing deposit return program in Iowa.
- Straws found in commercial and mixed-use areas might present an opportunity for changes to business practices, such as straw by request policies.
- Litter found in parking lots might suggest the need to expand availability of waste management services at these locations.
- The wide variety of brands identified means there is potential to engage numerous brand stakeholders in solutions.
- Municipal contracts could be used to enforce cleanup prior to mowing, require litter cleanup at construction sites, and require waste collectors to reduce leakage from automated garbage collection.
- Local policy could help support installation of cigarette receptacles.
- Exploring new materials could reduce plastic consumption, although waste management capacity for new materials needs to be taken into account.
- Expanded communication and messaging around plastic pollution in the Quad Cities could bring together new partners to address this issue.

The next steps are to continue the dialogue in the pilot cities, and between stakeholders, to take action in order to address plastic pollution in their communities, protect their local environment, the Mississippi River, the global ocean and beyond.

Appendices

Appendix A — Local Project Partner List

City of Bettendorf, IA
City of Davenport , IA
City of East Moline, IL
City of Moline, IL
City of Rock Island
City of Riverdale, IA
City of Coal Valley, IL
Village of Port Byron, IL
Levee Commission/Riverfront Improvement Commission
Partners of Scott County Watersheds
Progressive Action for the Common Good (PACG)
Bi-State Regional Commission
Scott County Health Department
Boy Scouts of America ILLOWA Council
Visit Quad Cities
Waste Commission of Scott County
Xstream Clean-up
North High School
Rock Island Arsenal Child Development Center
Augustana College
1 Mississippi/Mississippi River Network
Iowa State Office of Sustainability and the Environment
Moline Rotary
Davenport Community School District
QC Interfaith
Rock Island County Soil & Water Conservation District
Living Lands and Waters
River Action
Davenport Metrocom NAACP
Quad Cities Earth Coalition

Appendix B — Methods

Methods

In order to get a "snapshot" of plastic pollution along the Mississippi River, the following methods were employed and are further described in this section.

1. Development of the scientific strategy and surveying plan
2. Training of community-based volunteers
3. Field work and data collection
4. Data Analysis

Development and Refinement of Scientific Strategy and Plan

The initial scientific strategy for data collection was developed from September 2020–February 2021 and was implemented in three pilot cities in April 2021.[3] After completion of the first pilot phase of data collection, feedback on the strategy was obtained both through virtual sessions with partners and an online survey. Field methods were adapted based on this feedback and published in an updated version of the Debris Tracker Citizen Science Field Guide.

The guide is a 13-page document that outlines the steps that community-members can take to join and participate in the initiative. The document contains step-by-step directions on how to contribute data to the project for 1) litter on land, 2) floating litter or debris, and 3) other ways of collecting data. These methods are further described here.

Debris Tracker is the data collection tool that was used in each of the methods outlined below. The full list of litter items available to track is provided in Appendix B. The Debris Tracker interface is shown in Figure B1.

3. Youngblood et al., 2021. Mississippi River Plastic Pollution Initiative 2021 Science Report, Jambeck Research Group, University of Georgia, Athens, GA, USA

Figure B-1: Debris Tracker (free mobile app used for data collection) Interface

A survey was available at the end of each tracking session to obtain additional metadata on the survey, such as which method the user was employing, further information about land use, and if the litter being logged was picked up or not. For multiple choice questions, users could select all that applied. The survey contained the following questions:

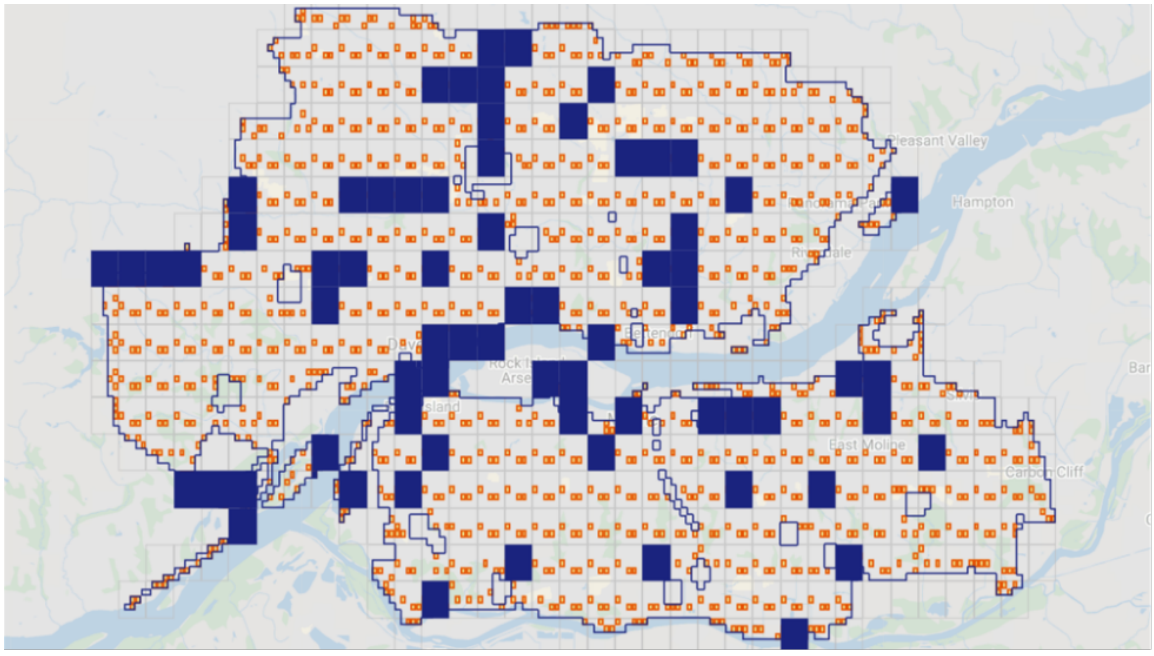
1. Were you sampling litter on land or floating debris in the river?
   - On land
   - In the river
2. Were you following the 1-m width transect sampling method?
   - Yes
   - No
3. Time spent tracking (min)
4. How many people helped collect this data INCLUDING yourself? (Note: do not include members of your group who are submitting data on other devices or did not track data.)
5. Did you pick up the litter you tracked
   - Yes
   - No
6. Which of the following land uses most applies to the general surrounding area?
   - Residential (housing)
   - Commercial (developed buildings)

  - Mixed (housing and buildings)
  - Industrial (such as warehouses)
  - Green spaces (such as parks)
  - Other
7. If recording land-based debris, where was your survey transect located?
  - Along a sidewalk
  - In a gutter
  - Along a roadside
  - Other
8. Any interesting litter items to note?
9. Any other observations to share?

Litter in Communities

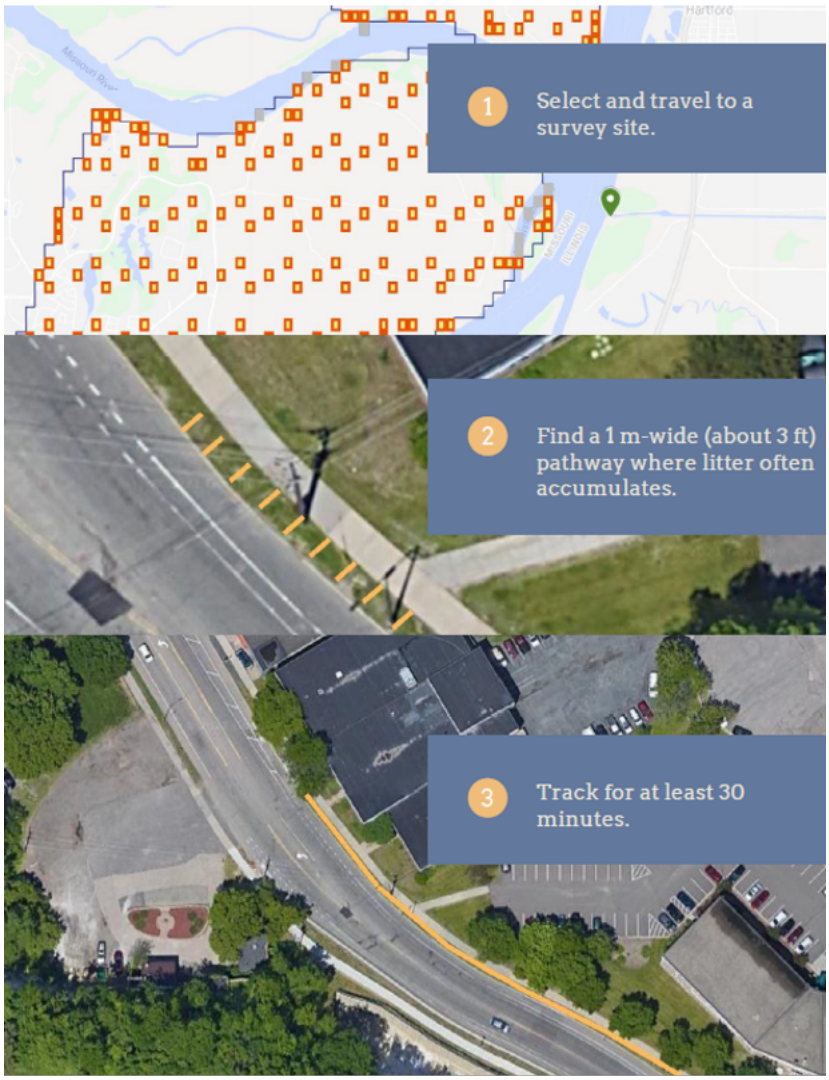
Sampling areas in each of the Quad Cities were determined based on input from local partners and areas of interest in the community. To provide a comprehensive look at what items are ending up on the ground from societal activities close to the source, and in order to capture active, upstream litter input, volunteers were asked to collect data in the identified urban areas (as opposed to just riverbanks). Community members (citizen scientists) were asked to select a 200 x 200 m (or about 650 x 650 ft) priority sampling area square on the map provided (Figure B2). Once a community member arrived at their selected area, they were asked to determine a safe public place to collect data along a roadside, sidewalk or other walkable area where litter often accumulates, e.g., a pathway on the side of a road, between a roadway and sidewalk or along a walkway in the park. If multiple pathways existed, the community members determined which to take. They were asked to follow the pathway generally; a pathway was not necessarily a straight line, i.e., if the path turns the person tracking should follow it (Figure B3).

Figure B-2: Sampling areas in the Quad Cities. Blue squares indicate sites with adequate transect data collection for analysis; smaller orange squares indicate priority sampling areas



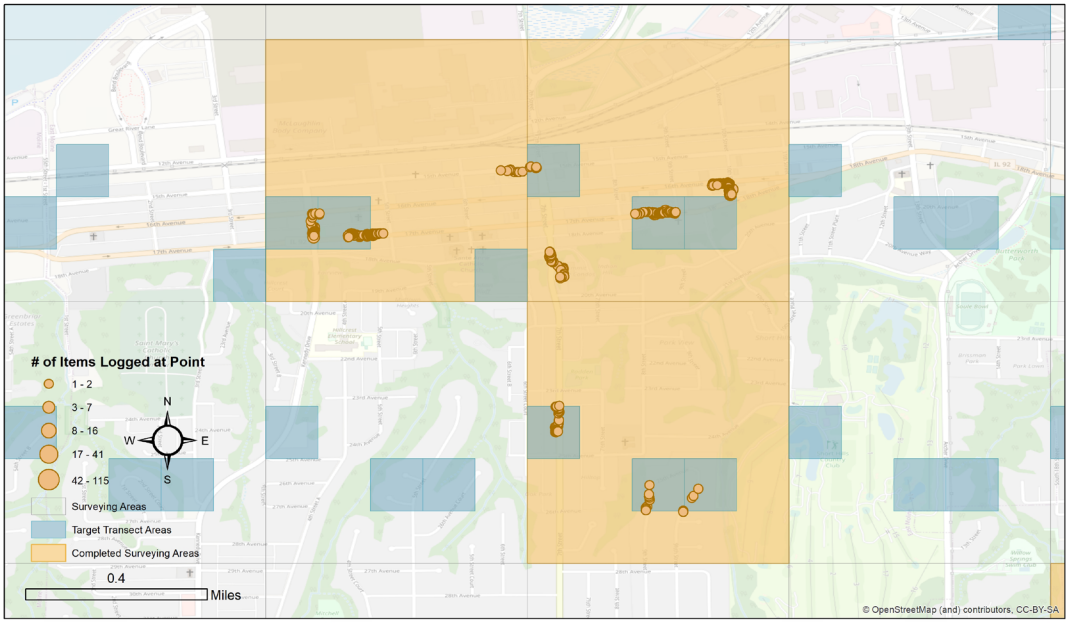
The community member who was tracking was asked to visually estimate a 1m (approx. 3 ft) width (about the length from the center of an adult's chest to the fingertips of an outstretched arm) covering the area where litter accumulates in the pathway. They were then asked to use Debris Tracker to walk for a minimum of 30 minutes and record all litter items in the 1 m wide pathway (transect). When possible, community members were asked to type the brand of each litter item in the description box in Debris Tracker.

Figure B-3: Quick start steps for collecting data in a transect



The goal of the orange square starting points was to spread the community members out to collect data all around the cities in a variety of locations. Based upon previous work, the researchers determined that 300m^2 of transect data in a 1km-square was enough to characterize that area. Once adequate data was collected in the square, the square was marked dark blue on the manually-updated, online sampling map (Figure B2). Community members were told that the blue squares on the map indicated that data collection was complete (which gave them a sense of accomplishment), and to collect data in other location squares that were still orange. An example of transect data resulting in a completed survey area is shown in Figure B4.

Figure B-4: An example of transects (litter data collection in 1m wide path) completed in targeted sampling areas



Floating Litter and Debris

To document floating litter and debris, community members were asked to stand on the bank of the river in a safe location during the day (for optimal light and visibility) and observe the river for a minimum of 15 minutes. They were asked to use Debris Tracker to record all visible debris within about 100 m (or about 325 ft) during that time period. If there were floating items that they could not identify, they were asked to log them as "other". They were also asked not to log natural floating debris, such as sticks or logs. When filling out the submission survey, they were asked to note this effort as debris logged "In the river".

Other Ways to Collect Data

Community members were asked to submit data even if they were not able to follow the transect method. Some organizations taking part in the initiative already had planned clean-up events, which ranged from locations in a park or along the riverbank. Volunteers were given several options to collect data in this situation:

1. Log data as they cleaned: Tracking in pairs with one person logging items in Debris Tracker while the other partner cleans up. This generates the most accurate geospatial litter data.
2. Clean First, Log Later: If it was easier to pick up all the litter and then sort and count it, community members were given this option as well. While this does not generate point-specific data on where litter is found, it can still

be valuable in identifying broad patterns. There are two options for getting the data to the database in this case. If the community member was in the same location where they collected the litter, they could sort the litter and log the data in the Debris Tracker app at the site.

3. If they were sorting in a different location than where they collected the litter (or if they needed to log it on their computer later), they could log in to their account on debristracker.org and select "manually upload data." In doing so, they could enter the quantity and type of items they have found (just like in the app) and then select the location where the data was collected on a map. Like data from the app, manually uploaded data is part of Debris Tracker's open database that is free and publicly accessible.

If a community member opportunistically came across an accumulation area in a transect or during tracking, they were asked to log it as an accumulation zone in Debris Tracker and estimate the area in the description box.

Training of Community-Based Volunteers

Training consisted of developing a video overview of the project and giving one targeted webinar to educators, one webinar to partners, and one public webinar to community groups and individuals. The education webinar was given September 29, 2021. The partner webinar was given on September 22, 2021, and the public webinar was given on September 30, 2021. The educator-focused and public webinars were recorded and placed on the main project webpage at www.unep.org/Mississippi for anyone interested in the project to access.

- Quad Cities Educator Session
- Debris Tracker Training for Quad Cities

Field Work and Data Collection

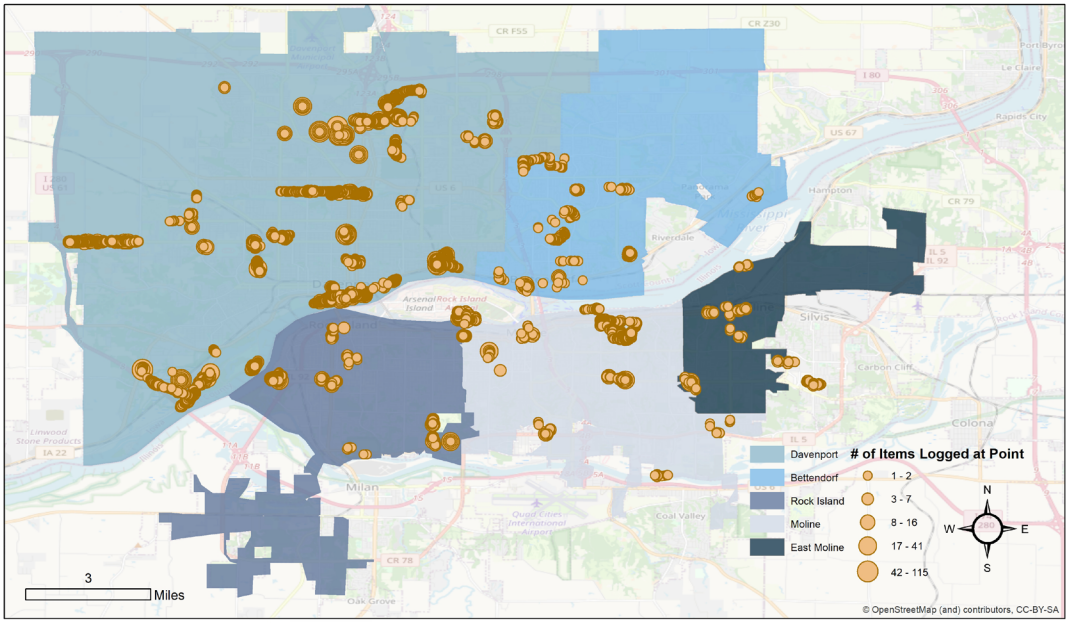
The primary field work of the initiative took place from October 1 – 31, 2021. This was the advertised time window for the project to the public and participating groups and partners. A public launch event to disseminate information about the project and to encourage data collection by the community was held on October 15, 2021. This event was held at 9am CST at Jetty Park in Bettendorf, Iowa. The event was held in collaboration with XStream cleanup organizers and speakers included partners from MRCTI, UGA, Scott County, Iowa and mayors from the region: Mayor Gallagher of Bettendorf, IA; Mayor Matson from Davenport, IA; Mayor Bawden from Riverdale, IA; Mayor Freeman of East Moline, IL; Mayor Rayapati of Moline, IL; Mayor Thoms of Rock Island, IL; Mayor Cray of Port Byron, IL; and Mayor Maddasion of Clinton, IA.

Data Analysis

Data analysis was conducted with Geographic Information Systems (GIS) including using ArcMap to determine the quantity and the characteristics of litter collected in the Quad Cities. Data was queried from the database in the five cities both the Mississippi River Plastic Pollution / MRCTI list on Debris Tracker from October 1–31, 2021. To provide a snapshot of litter and plastic pollution along the Mississippi River, data analysis is being presented for the Quad

Cities as a whole and for each individual city: Davenport, Bettendorf, Rock Island, Moline, and East Moline. An overview of locations where data was collected in the sites is provided in Figure B5. Floating litter was then isolated from total litter and compiled in terms of time spent by community members and items observed and logged into the app.

Figure B-5: Map of Litter data collected in the Quad Cities



Appendix C — Mississippi River Plastic Pollution Initiative / MRCTI Debris Tracker List

Plastic
Food Wrappers
Beverage Bottles
Other Jugs or Containers
Bottle or Container Caps
Cigar Tips
Cigarette butts
Disposable cigarette lighters
Six-pack rings
Plastic Bags
Foam or Plastic Cups
Plastic lids
Plastic Utensils
Plastic take out containers
Foam take out containers
Straws
Balloons
Personal Care Products / Toiletries
Hard Plastic Fragments
Foam Fragments
Film Fragments
Fishing Gear
Tobacco Packaging
Needles or Syringes
Single-serve plastic liquor bottles
Plastic Balls or Toys
Other Plastic

Metal
Aluminum or Tin Cans
Aerosol cans
Metal Bottle Caps
Metal Fragments
Electronics
Household Appliances
Cylinders, Tanks, and Barrels
Other Metal

Glass
Glass Bottle
Glass Jars
Glass Fragments
Lightbulbs and Tubes
Other Glass

Rubber
Latex Balloons
Flip-flops
Rubber Gloves
Tires
Rubber Fragments
Other Rubber

Cloth
Clothing and Shoes
Fabric Pieces
Gloves (non-rubber)
Towels or rags
Rubber flip-flops
Mattresses
Carpet or Rugs
Other Cloth

Paper and Lumber
Paper Bags
Lumber/Building Materials
Food Wrappers (paper)
Paper and cardboard
Pallets
Stir sticks
Other Paper or Lumber

PPE
Masks
Disposable Gloves
Face shields / Goggles
Gowns
Empty bottles of hand sanitizer
Other PPE

Other Items
Other
Test Item

END OF DOCUMENT