

Residential Waste Characterization Study

City of Cambridge

FINAL REPORT

PREPARED FOR



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Summary of Findings

The City of Cambridge’s Department of Public Works (DPW) sought to complete a representative waste characterization study of the City’s residential trash. The City contracted with CDM Smith, who in turn subcontracted with VHB to conduct a comprehensive waste characterization study using representative samples collected on two separate weekdays by the City’s DPW. VHB conducted the two waste audits on October 24, 2022, and October 27, 2022, at Casella Waste Systems’ Charlestown facility (24 Bunker Hill Industrial Park, Boston, MA 02129). **Appendix A** of this report provides the Waste Stream Characterization Protocol prepared and implemented by the City’s DPW and VHB.

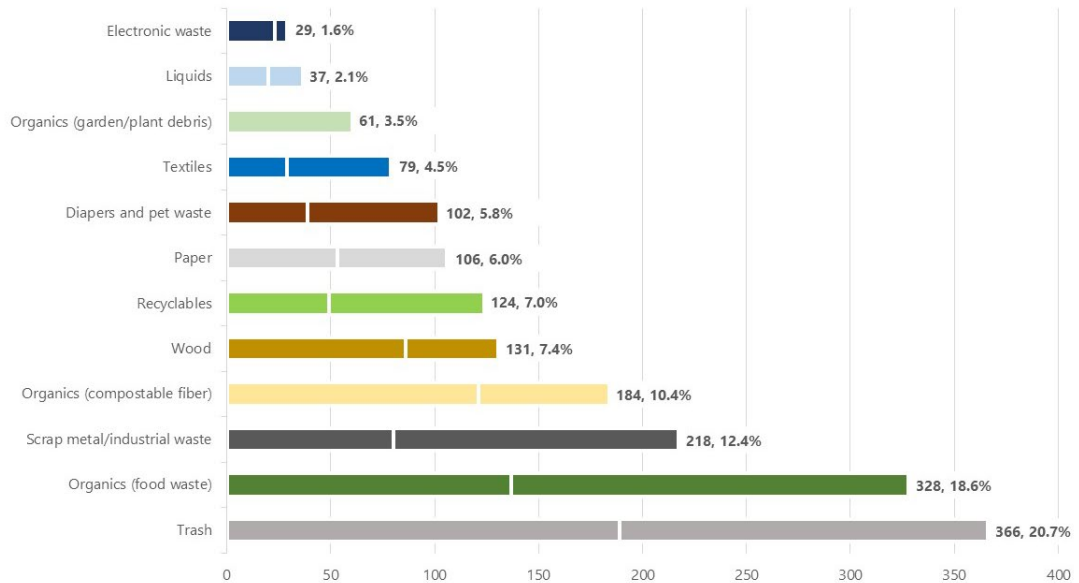
The City conducted this Waste Study concurrent with an update to its community-wide greenhouse gas (GHG) inventory. The results of this study will inform GHG emissions calculations to be reported in the inventory under the waste sector.

Hand Sort Results

The waste characterization study included two sorts, with 1,765 pounds of total waste sorted (887 pounds on Day 1 and 878 pounds on Day 2). VHB sorted curbside trash. Source separated recycling and compost was not studied. As shown in **Figure 1**, among total actual waste sorted, trash was the most abundant material at 20.7%, followed by organics (food waste) at 18.6%, and then scrap metal/industrial waste at 10.4%. **Figure 2** and **Figure 3** provide the actual weights and percentage of material sorted on Day 1 and Day 2, respectively. **Table 1** provides an overview of the raw data from the summary, and **Table 2** reflects a summary of the percentage of materials and weighted percentage.

Figure 4 reveals the weighted average of waste streams sorted with the confidence interval noted in the red bars. The confidence interval indicates that there is a 90 percent confidence level that the actual weighted mean (average) for that material is somewhere within the error bars. In other words, nine out of 10 times this waste sort is conducted, the average for that material will be within the range of the error bars.

Figure 1 Summary of City of Cambridge Residential Waste Audit Results, in Actual Pounds



Source: VHB, 2022

Table 1 Total Actual Weight Collected, by Stream

Stream	Day 1 Pounds Collected	Day 2 Pounds Collected	Total Pounds Collected
Trash	189	177	366
Organics (food waste)	137	191	328
Scrap metal / industrial waste	80	138	218
Organics (compostable fiber)	121	63	184
Wood	86	45	131
Recyclables	49	75	124
Paper	53	53	106
Diapers and pet waste	39	63	102
Textiles	29	50	79
Organics (garden and plant debris)	61	0	61
Liquids	20	17	37
Electronic waste	23	6	29
Total	887	878	1,765

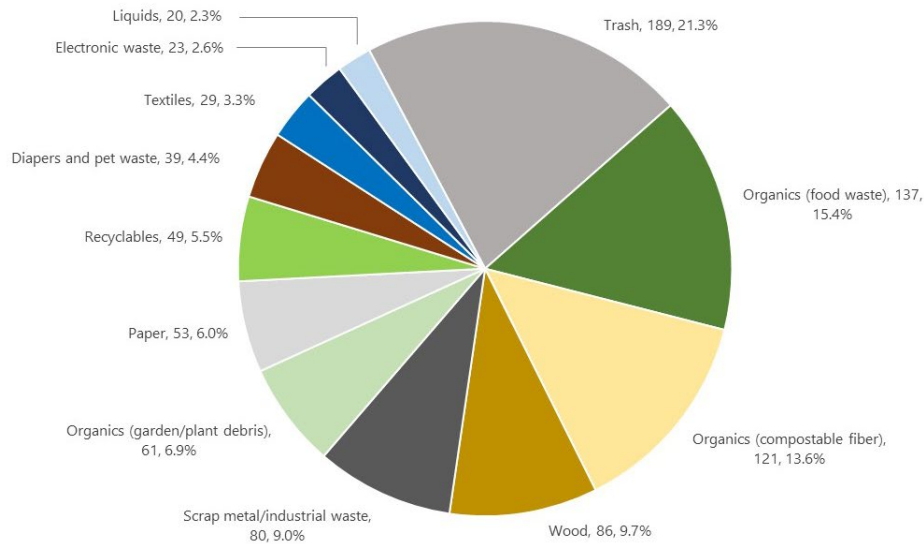
Source: VHB, 2022

Table 2 Percentage of Composition, by Stream

Stream	Day 1, Actual Percentage	Day 2, Actual Percentage	Summary of Actual Percentage	Weighted Average¹
Trash	21.3%	20.2%	20.7%	20.5%
Organics (food waste)	15.4%	21.8%	18.6%	21.5%
Scrap metal / industrial waste	9.0%	15.7%	12.4%	8.8%
Organics (compostable fiber)	13.6%	7.2%	10.4%	8.7%
Wood	9.7%	5.1%	7.4%	8.4%
Recyclables	5.5%	8.5%	7.0%	7.9%
Paper	6.0%	6.0%	6.0%	12.4%
Diapers and pet waste	4.4%	7.2%	5.8%	-
Textiles	3.3%	5.7%	4.5%	4.3%
Organics (garden / plant debris)	6.9%	0.0%	3.5%	6.6%
Liquids	2.3%	1.9%	2.1%	-
Electronic waste	2.6%	0.7%	1.6%	0.8%
Total	100%	100%	100%	100%

Source: VHB, 2022

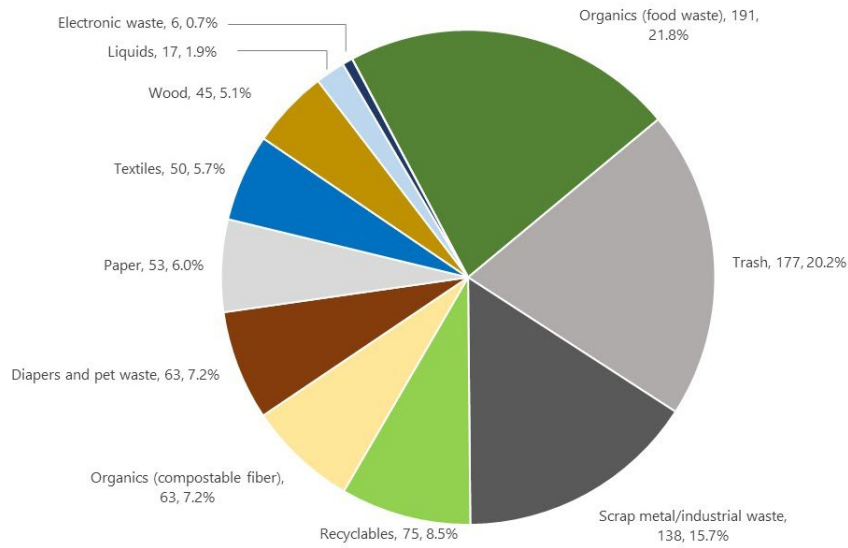
Figure 2 Day 1 City of Cambridge Waste Audit Results, in Actual Pounds



Source: VHB, 2022

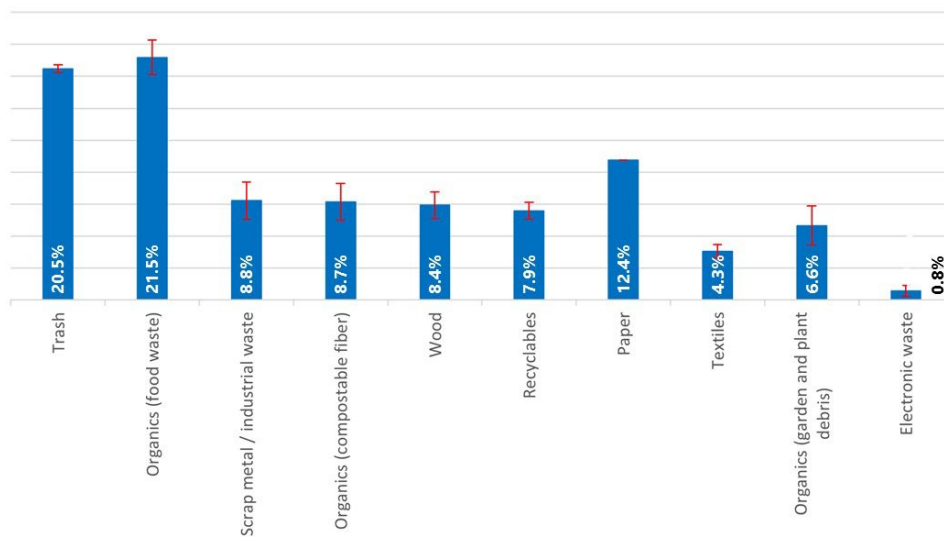
¹ Weighted average was calculated using Massachusetts Department of Environmental Protection (MassDEP) data prepared for the Solid Waste Master Plan (the 2020-2030 Plan). VHB sourced this data via <https://www.mass.gov/doc/summary-of-waste-combustor-class-ii-recycling-program-waste-characterization-studies-includes/download>. Diapers and pet waste and liquids are two material types assessed in the City of Cambridge waste characterization study but are not included as separate streams assessed in the MassDEP waste characterization study; therefore, are not reflected in this assessment of weighted average.

Figure 3 Day 2 City of Cambridge Waste Audit Results, in Actual Pounds



Source: VHB, 2022

Figure 4 Weighted Percentage of Waste Streams and Confidence Intervals



Source: VHB, 2022

Observed Issues and Opportunities

Whether looking at actual percentage or weighted percentage, the two largest waste streams collected during the audit were trash and organic food waste. Just over one fifth of the residential material collected (at 20.7%) was comprised of landfilled waste or “trash,” the largest stream collected overall. However, organic food waste was the top stream collected on Day 2, at 21.8% of the actual weight.

The results reveal that there are three important diversion opportunities:

- › Approximately 34.6% of the residential material collected was compostable, consisting of organic food waste (18.6%), organic fibers (10.4%), or plant material/yard debris (3.5%). The City of Cambridge offers a community-wide curbside composting program through which these materials could be diverted from the landfill. More education and awareness can help to bring more awareness of the compostable items that are included in this program.
- › Approximately 13% of the residential material collected were easily recyclable, consisting of mixed recyclables (7.0% of the actual weight) and mixed paper (6.0% of the actual weight). The City of Cambridge offers free weekly recycling collection to residential buildings, through which these materials may be diverted from the landfill.
- › A third category comprised of materials that the City can recycle using current programs. This category made up approximately 12% of the actual weight of residential material collected. We estimated that half of the material in the “Scrap metal / industrial waste” category was scrap metal that we could have diverted. The three streams that could be diverted today consisted of scrap metal (6.2%), textiles (4.5%), and electronic waste (1.6%). While large bulk-items may be collected curbside, some of these materials require a permit. In lieu of curbside collection, the City has a Recycling Center, located at 147 Hampshire Street, at which residents can safely and efficiently dispose of electronic waste and scrap metal. And, the City offers free curbside collection and drop-off options for textiles. Once again, continued education and awareness of these services may help to better divert these materials from the landfill.

Comparison of 2022 Waste Characterization Study Results to 2016 Audit Results

In October 2019, the City of Cambridge adopted its Zero Waste Master Plan. As a part of the baseline assessment completed in development of the Zero Waste Master Plan, the City referenced two residential waste audits completed in 2016.² These waste audits were completed to assess the diversion potential for a municipal curbside recycling program. The first included a sample of households included in an organics collection pilot, while the second included households that were not in the pilot, offering a comparative analysis between the two audits. Another set of audits using the same parameters was completed in 2019. As the City now runs the composting program for all residents, this comparative analysis only includes the results for the waste audit completed for those participating in the organics collection pilot. **Table 3** presents the percent composition for the 2016, 2019 and 2022 audits.

Comparative to the 2016 audit results, there was a notable drop in the percentage of food waste in the 2022 waste summary results, which used to comprise nearly one-third (29%) of the total waste stream and is now below one-fifth of the total waste stream (18.6%). This trend was also evident in the 2019 results, in which approximately 23.8% of the total waste stream was food waste. Other streams that were reduced include paper (4% total reduction), diapers and pet waste (3.2% total reduction), liquids (1.9% total reduction), organics (compostable fiber (1.6% total reduction), and electronic waste (1.4% total reduction). There was a notable increase in scrap metal or industrial

² Results of the 2016 audit are found in Appendix A of the City of Cambridge Zero Waste Master Plan at [Zero Waste Master Plan - City of Cambridge, MA \(cambridgema.gov\)](https://www.cambridgema.gov/zero-waste-master-plan)

waste, which in 2016 made up just 2%, in 2019 made up just 0.2% of the total sample and in 2022 made up 12.4% of the total sample.

Table 3 Comparison between 2016, 2019 and 2022 Audit Results, by Stream

Stream	2016	2019	2022	Percent Change (2016 to 2022)
Trash ³	21.0%	57.6%	20.7%	-0.3%
Organics (food waste)	29.0%	23.8%	18.6%	-10.4%
Scrap metal / industrial waste	2.0%	0.2%	12.4%	+10.4%
Organics (compostable fiber)	12.0%	3.9%	10.4%	-1.6%
Wood*	-	-	7.4%	-
Recyclables	6.0%	8.6%	7.0%	+1.0%
Paper	10.0%	0.7%*	6.0%	-4.0%
Diapers and pet waste	9.0%	-	5.8%	-3.2%
Textiles	4.0%	3.1%	4.5%	+0.5%
Organics (garden and plant debris)*	-	-	3.5%	-
Liquids	4.0%	0.1%	2.1%	-1.9%
Electronic waste	3.0%	2.0%	1.6%	-1.4%
Total	100%	100%	100%	

* There were two streams not sorted separately in the 2016 waste audit, comparative to the 2022 Study: organics (garden and plant debris) and wood. As such no comparative analysis was made for these two streams; this analysis assumes that *if* these materials were represented in the sample collected in 2016, that they would have been categorized in the “other materials” category. This may have reduced the results of “other materials”, but other results would not be affected.

Comparative to the 2019 audit, there were additional notable differences in streams sorted, so no comparative analysis has been provided. In addition to organics (garden and plant debris) and wood not having been sorted separately, diapers and pet waste were not sorted separately in 2019. Each of these categories are assumed to have been categorized in the “other materials” or “trash” category. Additionally, the “paper” category was only identified as including cartons and paper cups; comparative to the 2022 audit, the “paper” category included other paper items such as mail and magazines.

³ In the 2016 waste audit, “trash” was sorted as “other materials”, which may have included some wood and organics (garden and plant debris). In the 2019 waste audit, materials sorted in the “trash” category would have included diapers and pet waste in addition to the wood and organics (garden and plant debris) categories.



Photo 1: Day 1, Personal Protective Equipment Check



Photo 2: Day 2, Image of Waste Sample



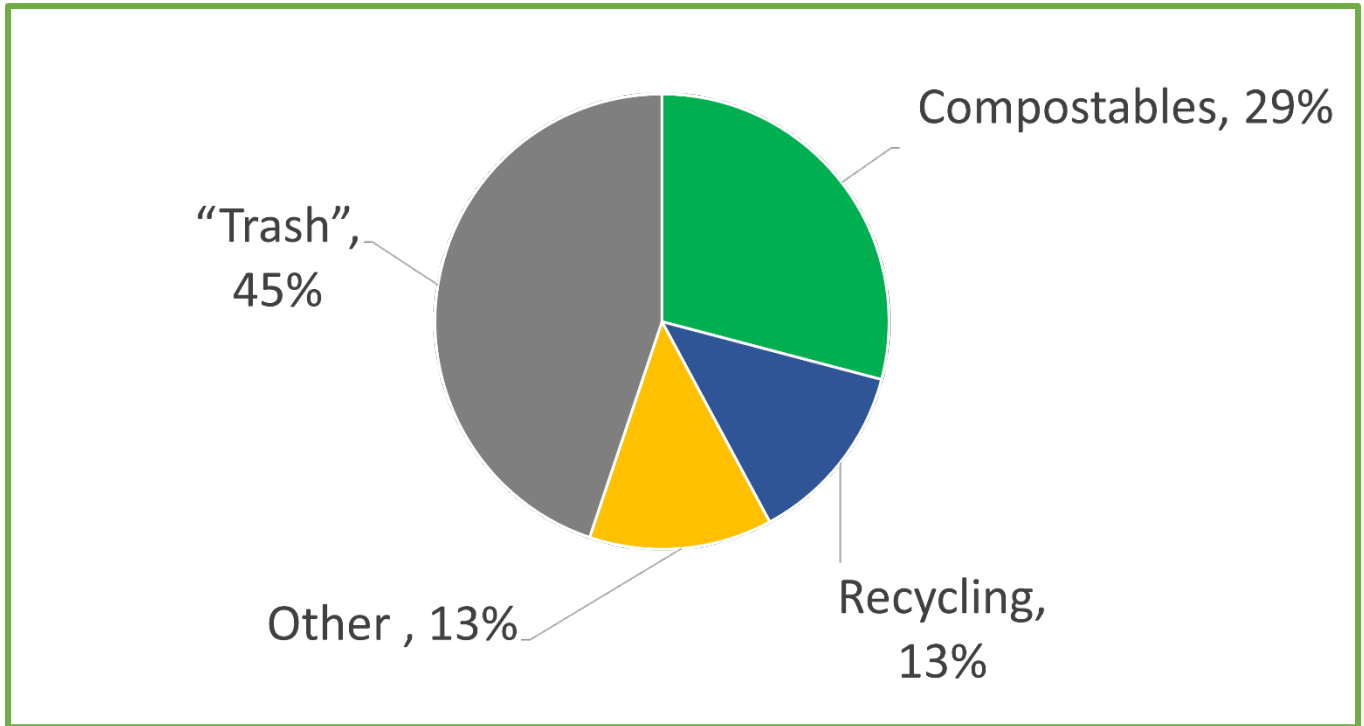
Photo 3: Day 2, Tipped Material in Sorting Location



Photo 2: Day 2, Waste Sorting Activity

Conclusion:

Approximately, 55% of the City's trash could be diverted using existing programs in Cambridge, today.



Appendix A: Waste Stream Characterization Protocol

City of Cambridge

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Waste Stream Characterization Protocol

Introduction

The following Waste Characterization Protocol (herein, Protocol) provides the relevant information and detail to plan and execute a Waste Characterization Study (herein, Waste Study).

As described in this Protocol, the Waste Study will provide a summary of the waste sorting, safety protocol, and analysis on the waste streams that are generated by City of Cambridge residents.

City of Cambridge Waste Management Overview

Project Scope

As a signatory to the Compact of Mayors, the City of Cambridge committed to complete an inventory of community wide greenhouse gas emissions and update the inventory every 5 years using the Global Protocol for Community Wide Emissions. The first community wide greenhouse gas emissions inventory was completed in 2017 using baseline data from 2012. In March 2022, the City released a bid for a Contractor to assess and update the 2017 Community-wide Greenhouse Gas (GHG) Inventory for emissions driven by solid waste and wastewater using 2019 data. As part of the waste sector update, the Contractor would complete a waste audit in partnership with the City of Cambridge Department of Public Works (DPW). The updated waste-sector inventory will then be compiled with the results of previously completed sectors to provide a final 2019 Community-wide Greenhouse Gas Emissions Inventory Report.

Citywide Waste Characterization

In 2008, the City committed to reducing trash collected by the City by 50% by 2030 and 80% by 2050. As of 2021, solid waste generation had already decreased 26%. The Envision Cambridge plan reported that more than half of the solid waste generated in Cambridge can be recycled or otherwise diverted away from landfills, or incineration. Across Massachusetts nearly 65% of the municipal solid waste generated will be directed to an incineration facility where it will be burned for electricity generation. The remaining 35% is directed toward landfills. As of 2021, there was no data available at

the city-level. However, the City will attempt to find the share of trash collected by the City going to landfill and incineration.

The inventory and subsequent updates provide the necessary information and insights that advances and enables Cambridge’s work towards setting and achieving greenhouse gas emissions reduction targets, engaging specific sectors in actions to reduce emissions, updating the plan to reduce emissions, and tracking the community’s progress towards the emission reduction targets.

Residential Waste Flows

The City of Cambridge currently provides an extensive range of waste management services to all residents. An overview of the waste management services was provided in the Cambridge Zero Waste Master Plan, herein included as **Table 1**. Currently, the City has a public/private split in the provision of waste collection services: the City collects trash and curbside organics from residential sources, and contracts for collection of recyclables and other materials with the private sector. Waste processing and/or disposal is also contracted to the private sector.

Table 1 City of Cambridge Waste Management Services

Material Stream	Collection Frequency	Service Provider	Collection Details
Trash	Weekly	City staff	City-provided carts, semi-automated collection (32,500 households)
Recycling	Weekly	City contracts with private service provider	Single Stream, City-provided carts, semi-automated collection (44,800 households & 200 small businesses)
Yard Waste	Weekly, April 1- Dec. 31	City contracts with private service provider	Paper lawn bags or resident-provided bin with sticker; Manual Collection (44,800 households)
Compost (food waste)	Weekly	City Staff	City-provided carts, Manual & semi-automated collection. (>32,500 households & 75 small businesses as of Nov. 2022)
Household Hazardous Waste (HHW)	4 events per year	City contracts with private service provider	Residents bring items to event held at one of two locations in the City
Mattress Collection	Weekly	City contracts with private service provider	Residents schedule curbside collection through the City website
Textiles Collection	Weekly	City contracts with private service provider	Residents schedule curbside collection through the City website or they drop-off at one of 12 drop-off bins (as of Nov. 2022)
Appliances / Large Item / Metal Collection	Weekly	City Staff	Residents schedule or pay for permit to have item collected.
Recycle Center	Open 3 days per week	City Staff	Residents may drop-off metal, e-waste, universal waste, recyclables, books, and plastic film.

Schedule

The overall schedule for the key activities associated with the Waste Study is provided in **Table 2**. As noted, the waste sorting calls for two (2) days of sorting at Casella Waste Systems (herein, Casella) in Boston, MA. The location of Casella Waste Systems is provided in **Figure 1**. DPW will be responsible for scheduling the waste pick-up and drop-off by Casella on the day of the two waste sorts. The Consultant Team will arrive at the waste sort location no later than 7 a.m. on the days of the sort to organize materials and start the sorting activity at approximately 8:00 a.m. once the waste sample is dropped-off. The sorting activity is anticipated to end around noon, or when all samples taken are sorted. The City will support the waste sorting activity by providing at least one City staff person as the designated Field Supervisor to assist and supervise.

As currently anticipated, the week preceding the sorting week will be used for equipment check, and review of the Waste Characterization Protocol and Health & Safety Plan.

Table 2 Project Schedule

Activity	Start Date	End Date	Location
Waste Sort Logistics Meeting with DPW	August 25, 2022	August 25, 2022	Virtual Meeting
Waste Sort Location Visit with DPW (Cambridge Staff)	September 20, 2022	September 20, 2022	Casella Waste Systems 24 Bunker Hill Boston, MA 02129
Develop Waste Characterization Protocol and Health & Safety Plan	August 25, 2022	September 30, 2022	Consultant Time
Internal Team Kick-off	October 7, 2022	October 7, 2022	Virtual Meeting
Waste Characterization Protocol and Health & Safety Plan Pre-Meeting	October 11, 2022	October 11, 2022	Hybrid Meeting
Equipment Setup and Check	October 24, 2022	October 24, 2022	Casella
Waste Sort 1	October 24, 2022, 7:15 a.m.	October 24, 2022, approximately noon	Casella Waste Systems 24 Bunker Hill Boston, MA 02129
Waste Sort 2	October 27, 2022, 7:15 a.m.	October 27, 2022, approximately noon	Casella Waste Systems 24 Bunker Hill Boston, MA 02129
Draft Waste Study and Data	October 24, 2022	November 18, 2022	Consultant Time
Waste Study and Data Report DPW Review	November 18, 2022	December 9, 2022	DPW Staff Time
Deliver Final Waste Study Report and Data	December 9, 2022	December 16, 2022	Consultant Time

Staffing Roles, Responsibilities, and Training

The Waste Sort is assumed to be conducted at the Casella Waste Systems and will be staffed for two days with the labor complement described in the following paragraphs.

Project Manager

The Project Manager from VHB will have lead responsibility for planning each sampling and sorting event, and maintaining communication between the city staff, contractors and project partners through the project schedule. The Project Manager is ultimately responsible for the successful completion of the project. The Project Manager is responsible for preparing the sorting personnel for the sorting activity, managing the sorting area, including crew management, sorting productivity and accuracy, data recording, following safety protocol, and cleaning up at the end of the day.

City of Cambridge Field Supervisor

The Field Supervisor is responsible for planning, overseeing, and executing each sorting event, and for interacting with the facility personnel in conjunction with the Project Manager. The Field Supervisor is responsible for co-managing the sorting area, including crew management, sorting productivity and accuracy, data recording, following safety protocol, and cleaning up at the end of the day.

Figure 1 Location of Casella Waste Systems, 24 Bunker Hill Industrial Park

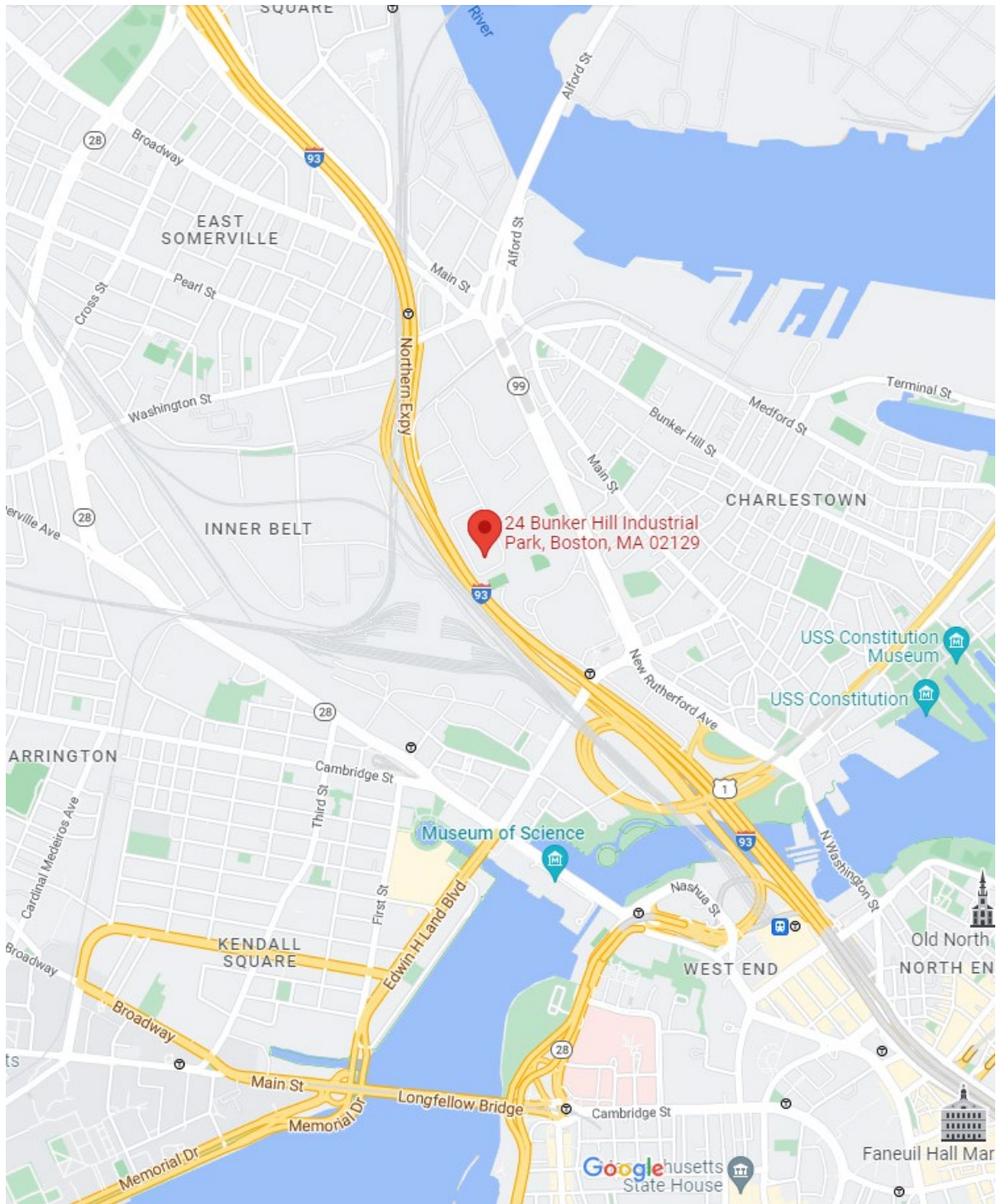


Figure Reference: Google Maps

Sorting Personnel

VHB will staff up to six (6) sorter positions in conjunction with CDM Smith employees for the waste sorting activity. VHB will train these personnel in advance of the sorting activity to conduct the waste composition analysis properly and safely.

Personnel Training

On the Thursday preceding the start of the sort, the Project Manager will lead a discussion with the sorting personnel to review the Waste Characterization Protocol and Health & Safety Plan. This will include an overview of the project schedule, roles and responsibilities. The Project Manager will specifically (1) train the sorters as to their specific roles and responsibilities, (2) discuss the overall objectives of the waste characterization study, and (3) review how to use the equipment and Personal Protective Equipment (PPE) required for the sort. As a follow-up to this discussion, the Project Manager will share the Training Acknowledgement Form for distribution and signature on the day of sorting. A list of equipment is shown in Attachment 1 – Equipment & Supplies List. A copy of the Health and Safety Plan is attached as Attachment 3.

On Monday morning, before the waste sample arrives, the Project Manager and Field Supervisor will review the Health and Safety Plan with the sorting crew and help ensure the sorting personnel have the necessary equipment and PPE required for the sort. Other required PPE, such as Tyvek suits, goggles, gloves, etc. will be distributed to the sorters.

Finally, the morning of the sorting activity, the Project Manager will conduct a demonstration sort with the entire sorting personnel, allowing for any questions on procedures and the classification of material categories. As VHB anticipates retaining the same workers for the duration of the waste sort, this training sort will be the most extensive training, and briefers protocols will be repeated each morning. Using the Training Acknowledgement Form, sorters will be required to sign off each morning acknowledging that they have received a briefing, have received the appropriate PPE, and are aware of hazard exposure protocols at the site. Any new sorters that join the effort throughout the week will be taken through the same training and demonstration procedure.

Material Sorting

Set-up of Sorting Site

On the Friday preceding the start of the sort, the Field Supervisor will coordinate with Casella Waste Systems to provide on-site to set up of the sorting table, buckets, and tarp.

Material Delivery and Arrival

The waste sorts will occur at Casella. To collect representative samples of residential waste generated in the City of Cambridge, specific trucks that normally would dump directly at the transfer station will be routed to Casella. Prior to the waste sort, DPW drivers will be informed of the days, time, and pre-identified route to take to bring the residential sample to the sample location at the appropriate time. DPW will collect approximately 750-1,000 pounds of material to sort each day, for a total of 1,500-2,000 pounds of material.

When the materials arrive at Casella, it will be directed to a dedicated part of the tipping floor and the operator of the site will put a cone in the bay so no other trucks tip there while the sort team is collecting samples. These markers will align with the “no go” zones identified in **Figure 2**, which are areas the sorting team will need to stay out of located approximately 3 feet outside of the sorting area. After the load is tipped, dedicated personnel from the sorting team will quarter materials and start to place them on the table. This process is described in further detail below in the Field Data Collection section of the Protocol.



Photo 1: Casella Sorting Location

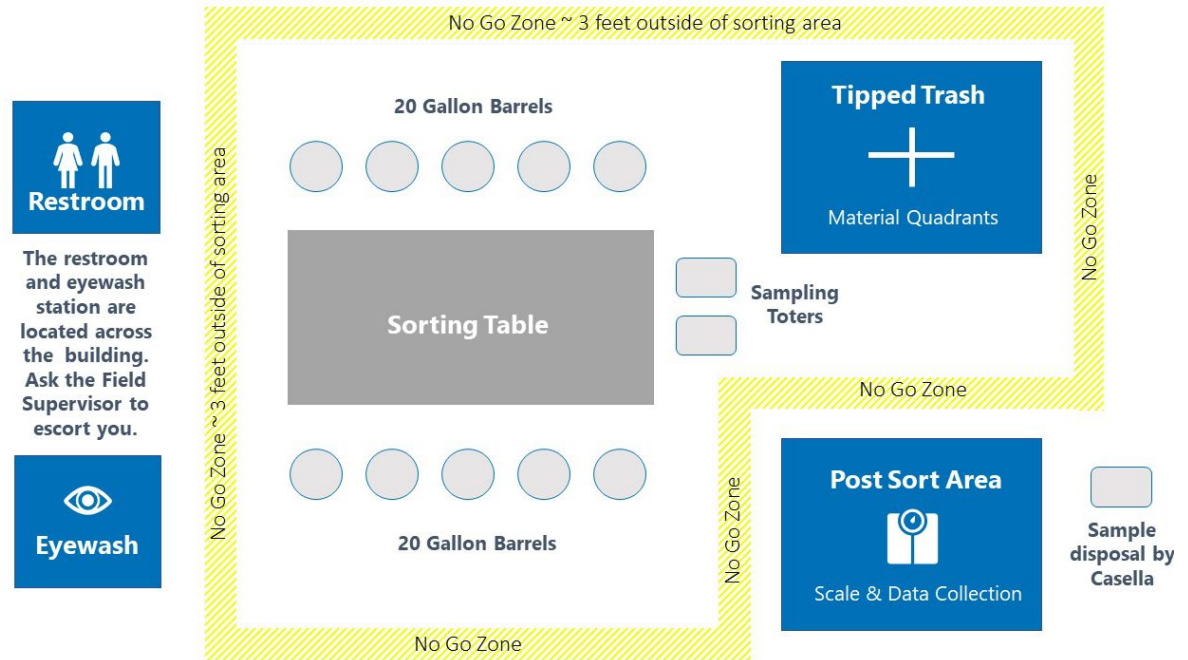


Photo 2: Sorting Table Set-up Example



Photo 3: Tipped Material in Sorting Location

Figure 2 Casella Sorting Area Layout



Material Categories

A list of 12 material categories will be used for the Waste Sort. These categories were selected to be consistent with the methodology included in the GHG emissions inventories. The waste categories include:

- › Recyclables (cans, bottles, foil)
- › Paper (office paper, newsprint) and cardboard
- › Organics (food waste only)
- › Organics (garden waste and plant debris)
- › Organics (compostable fibers)
- › Textiles
- › Electronic waste
- › Diapers and pet waste
- › Industrial waste including scrap metal
- › Wood
- › Liquids
- › "Trash" (includes cartons, paper cups, plastic film, and other items that do not fit into the other categories)

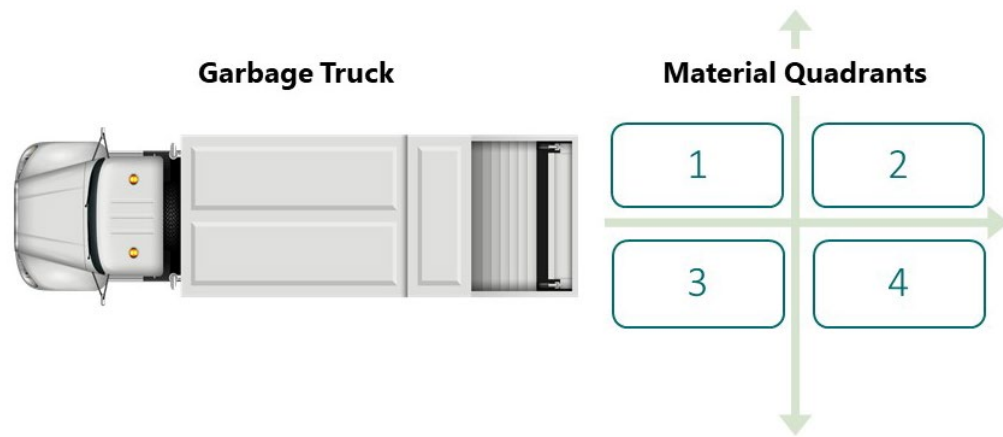
In Attachment 2, each of the material categories identified in the list above are more defined.

Field Data Collection

The purpose of this section is to describe, in detail, the steps that will be performed in the field to successfully acquire, sort, weigh, record and discard manually sorted samples by the sorting team.

Approximately 1 ton, or 2,000 pounds, of material will be brought to the waste sorting location via garbage truck each day. Traditionally, waste sorts are conducted by taking material from inbound trucks at the landfill, choosing a series of 100–200-pound samples, and then sorting the material. Material unloaded from the truck will need to be quartered into four quadrants (see **Figure 3**) for continued sorting.

Figure 3 Division of Material Sample into Quadrants



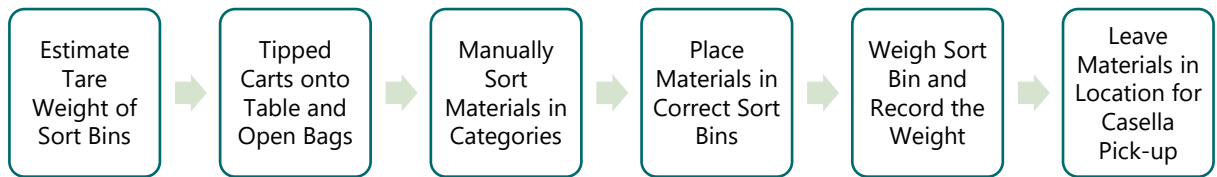
When the truck comes to the Transfer Station, their gross weights and tare weights will be recorded on Collection Data Recording form so the net weight of the materials collected can be determined (note: for the Waste Sort, the posted or historical tare weight on any vehicle must not be used). If the volume of materials coming to the site drops to the point where the sort team is unable to collect sufficient samples, the Field Manager will alert the Project Manager and suggest a change to increase the number of samples collected the following day.

The Project Manager will act as a spotter and direct a group of 2-3 sorters to collect 100-200 pound samples from each truck, using two sampling carts to collect and carry the material to the sort tables. When sorters collect a sample, the Project Manager will select a quadrant, as shown in **Figure 3**, and direct the team to collect material from the top, middle, and bottom of that quadrant of material. Throughout the sort day, the Field Supervisor will rotate quadrants to randomize sampling.

Materials Sorting

Materials will be sorted in a series of steps under the supervision of the Project Manager and Field Supervisor, as reflected in **Figure 4** and described below.

Figure 4 Materials Sorting Steps



After the sort, the Project Manager will weigh four (4) empty 20-gallon barrels to estimate the tare weight.

Sample carts full of material received from the pile quadrants will be lifted and tipped onto the table. All bags and other containers in the sample will be opened and the contents separated and sorted into the individually marked receptacles by material type surrounding the sorting tables.

The materials will be manually sorted by the sorting personnel into the prescribed material categories described and under the supervision of the Project Manager and Field Supervisor. Each material category will have its own individually marked receptacle, provided by VHB.

The Project Manager will monitor the quality of the sorted material containers as each sample is sorted, rejecting (and pointing out to the sorters) materials that may be improperly classified. Open containers allow the Project Manager and Field Supervisor to see the material at all times.

Materials on the sort tables will be manually sorted until a mixed remainder of minus two-inch “Fines” material is left. The Fines will be allocated to the appropriate categories based on the best judgment of the Field Supervisor, generally: Recyclables, Miscellaneous Organics, and/or Food Waste. The goal is to maximize the sorting of samples into component categories and reduce the remainder. The Fines will be dumped from the table into a container and weighed at the appropriate time.

When all the material from the sample has been segregated into the individually marked receptacles, the sort team will “weigh out” each sample. The individually marked receptacles will be brought to the scale to record its weight. Weights will be both hand-written and recorded in digital tablets to provide an additional layer of quality assurance and control.

After the weigh-out, the field supervisor will give the OK to discard the sorted samples after ensuring that all baskets have been weighed and recorded. The Field Supervisor will also monitor quality control during the weighing process.

When each sample is completely sorted and weighed, the material will be disposed in a specific location, for pickup by Casella.

Data Collection

The weighing and data recording process is the most critical process of the sort. The Field Supervisor will be responsible for overseeing all weighing and data recording of each sample. Just before an individually marked material receptacle becomes too full to add materials, or too heavy to carry, the Waste Jockey will bring the full container to be weighed on a digital scale. The Health and Safety Supervisor will assist with carrying and weighing the containers of sorted material, and the Field Supervisor will record all data.

The Field Supervisor will use the Composition Data Recording Sheet (see Attachment 4) to record the weights of each container filled with each material category. Each data sheet containing the sorted weights of each material will be added and ultimately digitized using ESRI's Survey123 platform to assure accurate tracking of the daily samples. The raw data collected is shared in Attachment 4.

Site Cleanup

Throughout the day, the sorters will be disposing material in the designated location for Casella pick-up at the end of the sorting activity. Once the Project Manager and Field Supervisor re satisfied that all material category containers have been weighed and recorded for the entire day's sample, Casella personnel will dispose of the material.

End of Day Activity

At the end of each sorting day, any sensitive equipment will be secured by the Project Manager and Field Supervisor. All data sheets will be retained by the Project Manager for copying and compiling. Sorting containers will be stacked and secured from weather at the end of day one, and finally collected at the end of day two. The sorting tables and other durable equipment will be left in place at the end of the first sorting day for use on the following day. As needed all re-usable PPE provided by VHB will be collected and redistributed to the sorting crew for the next day.

At the end of the second sorting day, all equipment used in sorting will be broken down. Equipment will be distributed back to its owner and disposable materials will be properly discarded at the direction of the Field Supervisor.



Attachment 1: Equipment & Supplies List

The following suggested list of equipment, tools, and supplies will be required on site. Also noted is the entity responsible for providing each of the items.

Equipment, Tools, & Miscellaneous Supplies	Supplied By	Total Quantity
Sorting Table	Casella	1
Sorting Carts	Casella	2
Plastic barrels/'Rubbermaid' containers of 20-gallon capacity	Casella	20
Heavy Duty scale of 800 lb. capacity	Casella	1
Tablets for Recording	VHB	1
Sanitary wipes/hand sanitizer (in bulk)	VHB	2
Tyvek suits, hooded and chemical resistant (at least 1 suit/day/sorter)	VHB	14
Booties (at least 1 pair/day/sorter)	VHB	14
Cut-Resistant Gloves (mix of (S/M/L) (at least 1 pair/day/sorter)	VHB	14
Nitrile Gloves (mix of (S/M/L/XL) (at least 2 pairs/day/sorter)	VHB	600
Hard hats (at least 1 hat per sorter)	VHB	7
Steel-toed boots (at least one pair per sorter)	VHB	7
Face Shields (at least 1 shield/day/sorter)	VHB	14
First Aid Kit	VHB	2
Safety Vests	VHB	7
Dust Masks (at least 2 masks/day/sorter)	VHB	40
Safety Glasses/goggles (at least 1 pair per sorter)	VHB	7
Ear Plugs (at least 1 set/day/sorter)	VHB	14
Clipboards, data sheets	VHB	2
Fire Extinguisher	Casella	1
Duct tape (minimum of 10mm thick)	VHB	2
Digital Camera / Phone	VHB	1
Permanent markers and pencils	VHB	Mix
Calculator / Phone	VHB	1
Broom	VHB	1
Dust pan	VHB	1
Drinking Water (at least 2 bottles/day/sorter)	VHB	48
Scissors	VHB	1



Attachment 2: Waste Categories

Recyclables (cans, bottles, foil)

- › PET Bottles (#1) – shall mean narrow necked or other containers identified by the recycling symbol with the number 1, contents shall be emptied into the Food category.
- › PET Containers/Packaging (#1) - open containers or packaging identified by the recycling symbol with the number 1
- › HDPE Natural & Color (#2) – shall mean narrow necked or other containers that are opaque due to coloring and can be identified by the recycling symbol with the number 2, contents shall be emptied into the Food category.
- › Mixed Bottles/ Containers (#3-#7, except #6) - all rigid plastic containers. Contents shall be emptied into the Organics (Food Waste) or other appropriate category
- › Recyclable Glass – shall mean all containers made from glass (bottles, jars) of all colors, shapes and sizes. Contents shall be emptied into the Food or other appropriate category.
- › Aluminum Cans (UBC) – shall mean any non-ferrous used beverage can (UBC) containers such as soda cans.
- › Aluminum foil - any aluminum foil. Contents shall be emptied into the Organics (Food Waste) or another appropriate category
- › Metal cans - any can containers including cans used to store soup, beans, other non-perishable items

Paper (office paper, newsprint, and other mixed paper) and Cardboard

- › Paperboard & Kraft Paper – shall mean kraft paper sheets or bags and/or materials made from reclaimed paper and wood stock, including particleboard, that are clean and dry enough to be recycled.
- › Old Newsprint (ONP), Office Paper, Magazines – shall mean old newspapers, office paper or magazines that are clean and dry enough to be recycled as a commodity when separated. This shall include all newspaper and/or magazine inserts. This shall not include newspapers contaminated with food, feces, etc.

- › Other Mixed Recyclable Paper – shall mean paper of composite material or other paper that is clean and dry enough to be recycled as a commodity when separated, such as mailing envelopes with film plastic windows, glossy magazines, books, and phonebooks.
- › Old Corrugated Cardboard (OCC) – shall mean old, corrugated containers that are clean and dry enough to be recycled

Organics (food waste only)

- › Food/Putrescible Waste – shall mean both uncooked foods such as potatoes and apples and cooked left over food from homes and restaurants. This shall include foodstuffs emptied from containers during the sort.

Organics (garden and plant debris)

- › Garden waste and plant debris – landscaping debris including yard clippings and garden waste

Organics (compostable fibers)

- › Compostable Fibers – paper products that are contaminated by food or other putrescible products.

Textiles

- › Re-usable Textiles – shall mean all cloth items that are clean and dry enough to be re-used and/or recycled, including apparel, linens, and carpet.
- › Non-recyclable Textiles – shall mean all items made from fibrous materials that cannot be recycled such as teddy bears and carpet padding.
- › Leather & Rubber – shall mean any leather items such as shoes, or belts and rubber items such as tires or padding, and combination item such as purses or shoes

Electronic Waste

- › All Electronics – shall include non-alkaline batteries, televisions, computers, cell phones/tablets, personal electronics, and other electronic waste.

Diapers and Pet Waste

- › Diapers – shall mean used diapers or any other cloth that contains human feces.
- › Pet waste – shall include any pet waste in or outside of disposable bags.

Scrap Metal / Industrial Waste

- › Ferrous and Non-Ferrous Metals – any other metals than UBC, soup cans, foil, etc. Examples include nuts and bolts, license plates, or automotive parts.

- › Other C&D – shall mean any other construction and demolition materials such as composite building components, roofing, drywall (gypsum), vinyl siding, non-metallic plumbing, etc.

Wood

- › Wood – shall mean any treated, untreated, or bulky dimensional wood material including pallets and dunnage.

Liquids

- › Liquids that may have been left in containers such as PET Bottles.

“Trash” (includes cartons, paper cups, plastic film, and other items that do not fit into the other categories)

- › EPS Foam (#6) – shall mean polystyrene foam, such as disposable coffee cups, coolers, or cushioning material in packaging, which are typically white and are made of expanded polystyrene beads.
- › Film – shall mean all film plastic including trash bags, shrink wrap, plastic sheeting, etc., contents of bags shall be emptied and sorted, and major contaminants of sheeting shall be removed.
- › Non-recyclable Glass – shall mean any non-container glass material including plate glass, window panes, as well as any ceramic or other similar inert material.
- › Gable Top/Aseptic Containers – shall mean containers made of paperboard material but with a “gable top” lid, sometimes including a “screw-on” circular plastic cap. Examples of this material include paper milk cartons, juice boxes, and Dunkin Donuts’ “Box-o-Joe” coffee containers
- › Used cooking oil (not hardened greases)
- › Other Bulky or Composite Items – shall mean other unidentifiable or special waste including illegal substances, composite items, or any other items that don’t fit into the described categories.
- › Batteries - All alkaline batteries
- › Household Hazardous Waste – shall be containers with contents meeting the definition of hazardous, including paint solvents, used oil, sharps, etc. HHW materials include:
 - Automotive fluids (motor oil, antifreeze, transmission fluid, brake fluid, fuel additives, engine de-greasers, kerosene, gasoline, diesel fuel);
 - Batteries (exclusively lead acid auto batteries);
 - Cleaners and Chemicals (lighter fluid, nail polish remover, ammonia, rat poison, furniture polish, formaldehyde, lice shampoo, drain cleaners, arsenic, oven cleaner, drain cleaner, grease and rust removers, mold and mildew removers, detergents, fabric softeners, dyes, hair products, isopropyl alcohol, metal polish, aerosol cleaners, window cleaners, kitchen and bathroom cleaners, moth balls, bleach);

- Lawn/garden/pool chemicals (fertilizer, pesticides, herbicides, weed killers, fungicides, chlorine, bug sprays);
- Light bulbs (fluorescent tubes, CFL, LED, Halogen);
- Paint & painting supplies (latex, oil-based, acrylic, artist paints, hobby chemicals, stains, enamels, paint thinner and stripper, turpentine, varnish, lacquer, epoxy, photography chemicals); and
- Mercury thermometers and thermostats
- Needles, sharps, or any other medical wastes
- Full aerosol cans
- Printer Ink Cartridges



Attachment 3: Health and Safety Plan

Introduction

The health and safety of site workers is a primary concern and goal. Thus, a comprehensive, carefully managed, and thoroughly documented Health and Safety Plan is crucial for successful project completion.

Important Safety Information

EMERGENCY PHONE NUMBERS:

Fire, First Aid, Ambulance, Police – Dial **911**

Massachusetts General Hospital
55 Fruit Street, Boston, MA 02114
(617) 724-4100

VHB Incident Reporting Hotline
844-407-0011

FIELD RESPONSIBILITY:

Donny Goris-Kolb– Project Manager
(716) 830-0487

Michael Orr – Field Supervisor
(617) 349-4800

**A Copy of this Health and Safety Plan and Its Attachments
Must Be Kept at the Site during All Field Activities**

Purpose

The purpose of this document is to inform persons of potential safety and health hazards associated with performing project field work at areas where municipal solid waste is to be handled. This general guidance is intended for the protection of worker safety and health on sites containing biodegradable and solid waste materials, not sites containing hazardous or toxic wastes regulated under federal or State of Massachusetts laws. This document has been prepared for use during the City of Cambridge Waste Characterization Study, scheduled for October 2022.

Discussion

Waste characterization for this project will include the sampling and manual sorting of solid waste into predetermined categories.

Injuries during the performance of waste characterization studies are rare. However, injuries may occur due to the potential hazards associated with the presence of heavy equipment at the site, the components of the waste itself (sharp objects, broken glass), climatic conditions, or carelessness.

The presence of heavy equipment in operation at the site (front-end loaders, graders, trash trucks, etc.) presents potential hazards which can be avoided with the use of general common sense. Equipment operators generally are involved in performing their tasks and may be unaware of the presence of other individuals within the immediate area. Waste sorting crews should be aware of the movement and location of equipment at all times. Highly visible clothing should be worn, including safety vests.

The components of solid waste present numerous potential physical hazards. These include, but are not limited to, cuts from broken glass and sharp metal objects; splinters from pieces of wood; punctures from nails and other potential objects and scrapes and abrasions from the general handling of the solid waste. There also exists the possibility of exposure to household products, such as bleach, cleansers, and other toxic chemicals which have been discarded with the trash, as well as fecal matter such as human waste in diapers and pet wastes.

To minimize the risk of injury, caution should be employed when physically handling the solid waste. Protective clothing, including gloves, dust masks and eye protection should be worn at all times. If there is any question about the handling of a component of solid waste, the Project Manager and Field Supervisor should be notified.

The Cambridge Waste Characterization Study will be performed indoors at Casella, where normal operations will be occurring during the time that the audit will be conducted. Upon arrival, materials for the audit will be directed to a dedicated part of the tipping floor and the operator of the site will put a cone in the bay so no other trucks tip there while the sort team is collecting samples. These markers will align with the "no go" zones identified in **Figure 2, Casella Sorting Area Layout**, of the Waste Stream Characterization Protocol, which are areas the sorting team will need to stay out of to ensure the safety of all personnel.

Sufficient drinking water for personal use will be brought on site daily. Caution should be taken to avoid the possibility of heat stress due to protective clothing or weather.

Responsible Individuals

Safety during the field work will be the responsibility of the Project Manager and Field Supervisor. The Project Manager or Field Supervisor may temporarily suspend or stop work if there appears to be a threat to health or safety. The Project Manager or Field Supervisor may also temporarily suspend or stop work to identify and/or inspect safety concerns. Other safety-related responsibilities are described below.

The Project Manager, or appointed representative, will have responsibility for overall safety policy, planning, and execution. He or she will be responsible for making project level decisions regarding safety rules and operations, in coordination with the VHB Health and Safety Program Manager and safety team.

The Project Manager will have primary responsibility for:

- › Assuring that appropriate personal protective equipment is available and properly utilized by all study personnel.
- › Assuring that personnel are aware of the provisions of this plan, are instructed in the work practices necessary to ensure safety, and in planned procedures for dealing with emergencies.
- › Assuring that personnel are aware of the potential hazards associated with site operations.
- › Supervising the monitoring of safety performance by all personnel to ensure that required work practices are employed.
- › Correcting any work practices or conditions that may result in injury to personnel or exposure to hazardous substances.

Scope and Applicability

A copy of this Health and Safety Plan must be kept at the site during all field activities.

The provisions of this plan are mandatory for all project personnel (including workers under contract) while field work is being conducted at the site. A training session will be held at which this plan will be discussed prior to the beginning of sort activities.

Emergency Information and Procedures

The health and safety of its employees is VHB's number one priority. Personnel shall work together to identifying potential risks at a job site and report incidents should they occur. Any near miss, close call, bump, bite, or bruise qualifies for reporting. During the field activity, the team shall immediately report to emergency personnel by dialing 911 or other identified numbers in Table C.1 for incidents that sustain injury. However, accidents and incidents do not need to result in damage or injury to be reportable.

Emergency Information

Emergency telephone numbers for reporting an emergency are provided in the introduction of this Health and Safety Plan. The Project Manager and Field Supervisor will have cell phones accessible to assist with emergency assistance needs.

Injuries

Should there be an injury to any personnel, depending on the severity of the injury, treatment may be given at the site by personnel trained in First Aid, additional assistance may be required at the site (emergency medical technicians), or the victim may have to be transported to a medical facility (hospital or clinic). The nearest location is Mass General Hospital.

If the injury is severe enough to necessitate immediate transportation to the medical facility, the Project Manager or Field Supervisor shall immediately dial 911 or reach the Mass General Hospital Emergency Room number at (617) 724-4100. If the personnel injured is not able to be safely moved, or the hazard exposure is affecting multiple site personnel, 911 will be called. 911 and the Boston Fire Department will also be called at (781) 526-6128 in the case of uncontrolled fire or explosion. The nearest fire station is Boston Fire Department Engine 32 Ladder 9 located at 525 Main Street, Boston, MA 02129.

Massachusetts General Hospital

Massachusetts General Hospital located at 55 Fruit Street, Boston, MA 02114 is the closest medical center to Casella Waste Systems and offers Emergency Room care. The nearest Hospital to the site is located approximately 2.4 miles away.

Fire

The sorting crew will be alerted to the location of the fire extinguishers and alarms, if any, at the sort locations.

Hazardous Waste and Medical Waste

In the improbable event that hazardous waste or medical waste such as needles or sharps are encountered, the Project Manager or Field Supervisor will immediately instruct all sort laborers to cease work. The Field Supervisor will then contact the appropriate representatives to remediate the situation before operations continue.

Evacuation

Stages of Evacuation:

The Project Manager is responsible for judging if circumstances exist which require evacuation. Specific evacuation procedures will be covered in the health and safety training sessions prior to beginning work.

Three stages of evacuation have been determined.

1. Withdrawal from immediate work area.

2. Withdrawal from site.

3. Withdrawal from area, which would be under direction of the City's Emergency Service Coordinator.

These three stages are discussed as follows.

1. Withdrawal from Work Area:

Withdrawal to a safe location will be required if any of the following occur:

- › Minor accident - field operations will resume after first aid and/or decontamination procedures have been administered.
- › Equipment, protective clothing, or respirator malfunctions.
- › Hazardous waste or infectious hospital waste is encountered.
- › Unsafe weather conditions, such as high winds or lightening.

2. Withdrawal from Site:

The site will be evacuated in the following cases:

- › Explosive or toxic levels of gases or volatile organics are suspected.
- › A major accident or injury occurs.
- › Fire and/or explosion occur.

3. Withdrawal from Area:

If there is a significant incident the Boston Fire Department, Police Department or other City first responders will take over as the Incident Commander. The Field Supervisor will defer to the judgement of the Incident Commander for area-wide evacuation. The Incident Commander will provide information to the City's Emergency Service Coordinator for action.

Incident Reporting

VHB's Health & Safety Team has a streamlined Incident Reporting Procedure that includes a dedicated hotline and three easy steps. VHB teamed up with Alert Media to provide employees with 24/7 incident reporting assistance. Day or night, weekends or holidays, an Alert Media team member is ready to take a call. Incident reporting procedures are listed below and should be performed in the order indicated. Additional project points of contact are provided in Table C.1.

1. Call the appropriate emergency number (911) (e.g., ambulance, fire, etc.) if it is required to call upon such services.
2. Call 844-407-0011 as soon as possible, after necessary medical attention, to report any near miss, injury, vehicle accident, or emergency incident.
3. Discuss the incident with the Alert Media team member and provide the necessary information.
4. Keep your cell phone readily available and anticipate a follow-up call from a member of VHB's Incident Management Team.

VHB Incident Report

Following the first call made to VHB’s Incident Reporting Hotline, the Project Manager will receive a follow-up call from the VHB Incident Reporting Team. The following information may be collected by the Incident Reporting Team:

- › Name, location, and title of the person(s) reporting.
- › Location of accident/incident, (i.e., building number or specific location on the site, facility name, street address)
- › Site contact information
- › Casualties (fatalities, disabling injuries).
- › Suspected/known chemical substances involved, if any.
- › Details of any existing chemical hazard or contamination
- › Summary of accident incident, giving pertinent details including type of operation at time of accident, etc.
- › Suspected/known cause of accident incident.
- › Response actions taken

Distribution of Written Accident/Incident Report

The accident/incident report form will be distributed by the Project Manager to the individuals reflected in Table C.1 as appropriate and in the following order of priority:

Table 1. Incident Report Contact Information

Name	Organization	Phone	Email
Bill Taber	VHB	617-607-2171	wtaber@vhb.com
Kelly Pina	VHB	P 617.607.0042 M 508.431.3459	kpina@vhb.com
Incident Reporting Hotline	VHB	844-407-0011	

General Field Safety Procedures

Safety is the responsibility of every individual involved in field efforts. Properly followed procedures are essential to assure personal safety and minimize lost time due to injuries or accidents. Anticipated hazards while working at the sites include, but are not limited to:

- › Exposure to toxic or hazardous chemicals.
- › Physical hazards from use of heavy equipment such as front-end loaders, graders, fork trucks, transfer station compactors, etc.
- › Fire or explosion caused by ignition of methane gas or other chemicals.
- › Site physical hazards including debris, uneven terrain, poor footing, and water hazards.
- › Heat stress from personal protective equipment and weather.

This section presents procedures and requirements designed to reduce these hazards and minimize their impact on personnel safety and completion of the task.

Safety Equipment

The level of protection required will depend on the specific activity and the location. The Field Supervisor will define appropriate protection.

All field personnel will be trained in the use of safety equipment and will be required to wear protective clothing appropriate for the tasks in which they will be involved.

The following equipment and/or consumable items will be located on site for distribution as necessary.

- › Dust Masks
- › Hearing Protection
- › Eye Protection
- › Gloves
- › Hard hats
- › Booties
- › Face shields
- › Tyvek or equal protective suit
- › Safety Vests
- › First Aid Kit
- › Hand Sanitizer

Sufficient drinking water for personal use will be brought on site daily by VHB.

Site Standard and Operating Procedures

Sorting crews will conduct themselves in a professional manner at all times. The following restrictions will also be observed by all project personnel and subcontractors:

- › Working while under the influence of intoxicants, narcotics, or controlled substances is prohibited.
- › Hard soled boots or shoes are required to be worn by all site personnel.
- › Loose clothing will not be worn on site.
- › No unapproved work clothes or equipment will be allowed on site.
- › Long hair will be worn "up."
- › Eating, drinking, chewing gum or tobacco, smoking, or any practice that increases the probability of hand-to-mouth transfer and ingestion of material is prohibited on site.
- › No personnel will be admitted to the site without the proper safety equipment, clearance or other approval. Safety equipment will be supplied to all study personnel by the Field Supervisor.

- › All personnel must comply with established safety procedures. Any sort crew member who does not comply with safety policy, as established by the Field Supervisor, will be immediately dismissed from the site.
- › The buddy system will be used during site operations. Each worker should consider himself or herself a safety backup to others on the sort crew. *All* personnel should be alert to help detect any dangerous situations that may develop.
- › Prescription drugs should not be taken by personnel where the potential for contact with toxic substances exist. Use must be specifically approved by a qualified physician.
- › Work areas for various operational activities will be established.
- › Work areas will be established based on prevailing site conditions and are subject to change. Personnel should check with the Field Supervisor for current and appropriate procedures regularly.
- › Contact with contaminated or potentially contaminated material should be avoided. Whenever possible, do not walk through puddles, mud, or any discolored ground surface. Do not kneel on the ground. Do not lean, sit or place equipment on drums, containers, vehicles, or on the ground.
- › No exchange of personal protective equipment will be allowed except in emergency situations involving a threat to health or safety.
- › Lunch eaten at the site will be eaten only at the designated areas located away from the immediate area of the site. Hand washing is required before consuming any food at lunch.
- › Due caution will be observed when proceeding on-foot through open areas.
- › Any medical emergency supersedes routine safety requirements.

A safety meeting will be conducted by the Project Manager with support from the Field Supervisor prior to entering the site. The meeting will cover, but is not limited to, a review of site information and a question-and-answer period. The site information review will include:

- › Expected hazards.
- › Special conditions.
- › Sampling procedures.
- › Location of telephones.
- › Emergency medical information.
- › Level of personal protection required.

Before entering the site, the following checklist should be reviewed:

- › Check location of bathrooms or porta potty, water supply and telephones.
- › Site layout and check safety gear.
- › Put on required safety gear.
- › Check gear for rips and malfunctions.
- › Identify and be familiar with the responsibilities for each of the crew members prior to proceeding, including who is trained in First Aid.

- › Use caution.

The following requirements will be observed during sampling:

- › No eating/drinking/smoking while sampling.
- › Use standard sampling techniques.
- › Use maximum care in handling samples. If the sampling site is not accessible using your gear (i.e., water too high, slippery ground, steeply sloped terrain, holes, etc.), do not sample. Confer with the Field Supervisor about alternate sampling site.
- › Wipe off spills, dirt, and residue immediately.
- › If any gear or equipment damage develops, immediately repair or replace.
- › If any personal protective equipment fails, proceed immediately to a designated area.
- › If you experience any physical discomfort, abnormalities, fatigue, or lightheadedness, stop work immediately, tell the Project Manager, and leave the area with escort.

Inspections

The Project Manager and Field Supervisor will inspect all safety equipment daily for the following:

- › Proper working order.
- › Nicks, cuts, tears, etc., in gloves and Tyvek Suits.
- › Persistent stains.

Any piece of safety equipment that is not in order will be repaired or disposed of properly.

Weather

Decreased body ventilation caused by protective clothing and equipment can result in increased potential for heat stress. Workers should carefully observe each other for signs of heat stress, particularly on hot days. If appropriate, extra equipment will be assembled during periods of inclement weather, such as rain, wind, or excessive heat. Examples might include tents, coveralls, etc.

Housekeeping

Work areas will be kept clean and orderly at all times.

Decontamination

The risks of illness due to ingestion of diseased or decomposing materials from the work site are significant. To minimize these risks, all personnel should remove and store the outer layer of their protective clothing (i.e., Tyvek suits, gloves, hat, etc.) on site. Hands, face and nails should be thoroughly washed, or scrubbed, with antibacterial soap and water prior to engaging in any activity likely to transmit materials encountered on site into the mouth.



Attachment 4: Composition Data Recording Sheets