Diving Into the Organics Cart

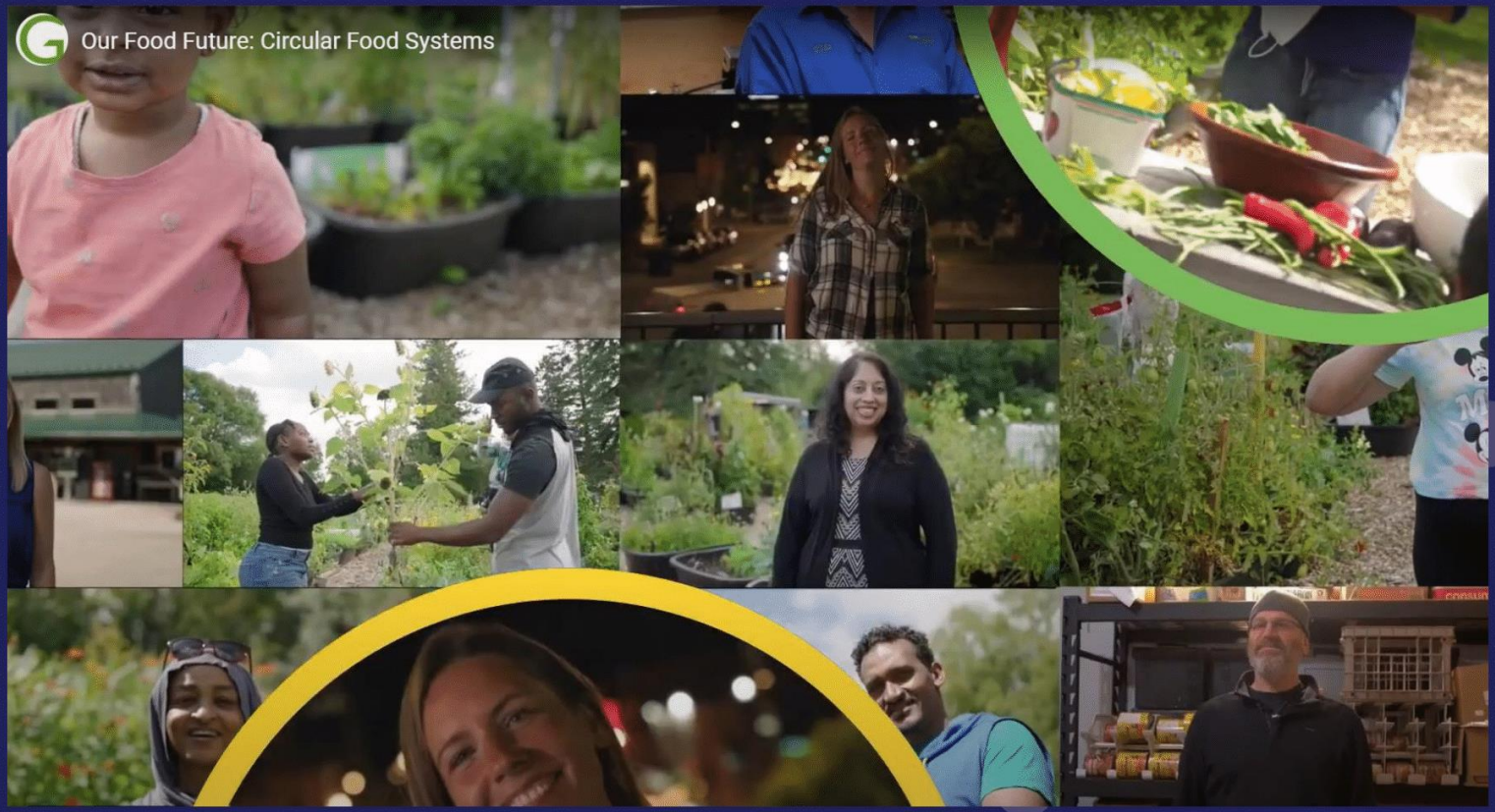
A Residential Waste AI Technology Challenge

SWANA 2022 Canadian Symposium

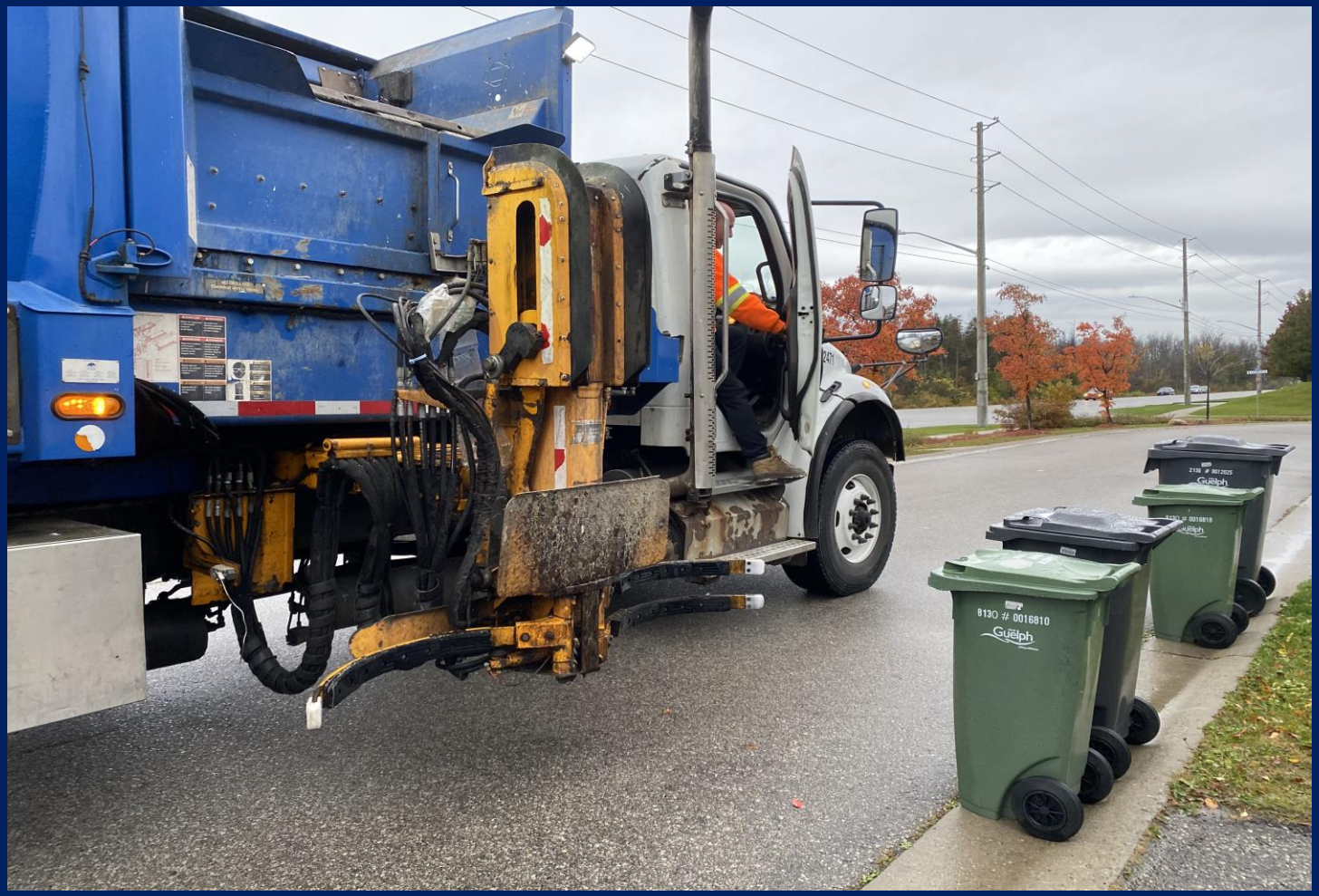
April 6, 2022

Vivian De Giovanni - Circular Economy Specialist
Solid Waste Resources, City of Guelph ON

Our Circular Food Economy



Guelph's Cart System



Municipalities as an Innovation Partner

Challenge Specifics

- **Challenge Statement**
    - How might the City of Guelph consistently collect detailed household-level data on avoidable food loss/waste or incorrect sorting in the organics collection stream (green cart), that can be used to help households understand their own food waste and inform city-wise food waste reduction projects?
- Solution
- Applicability

Eagle Vision Systems

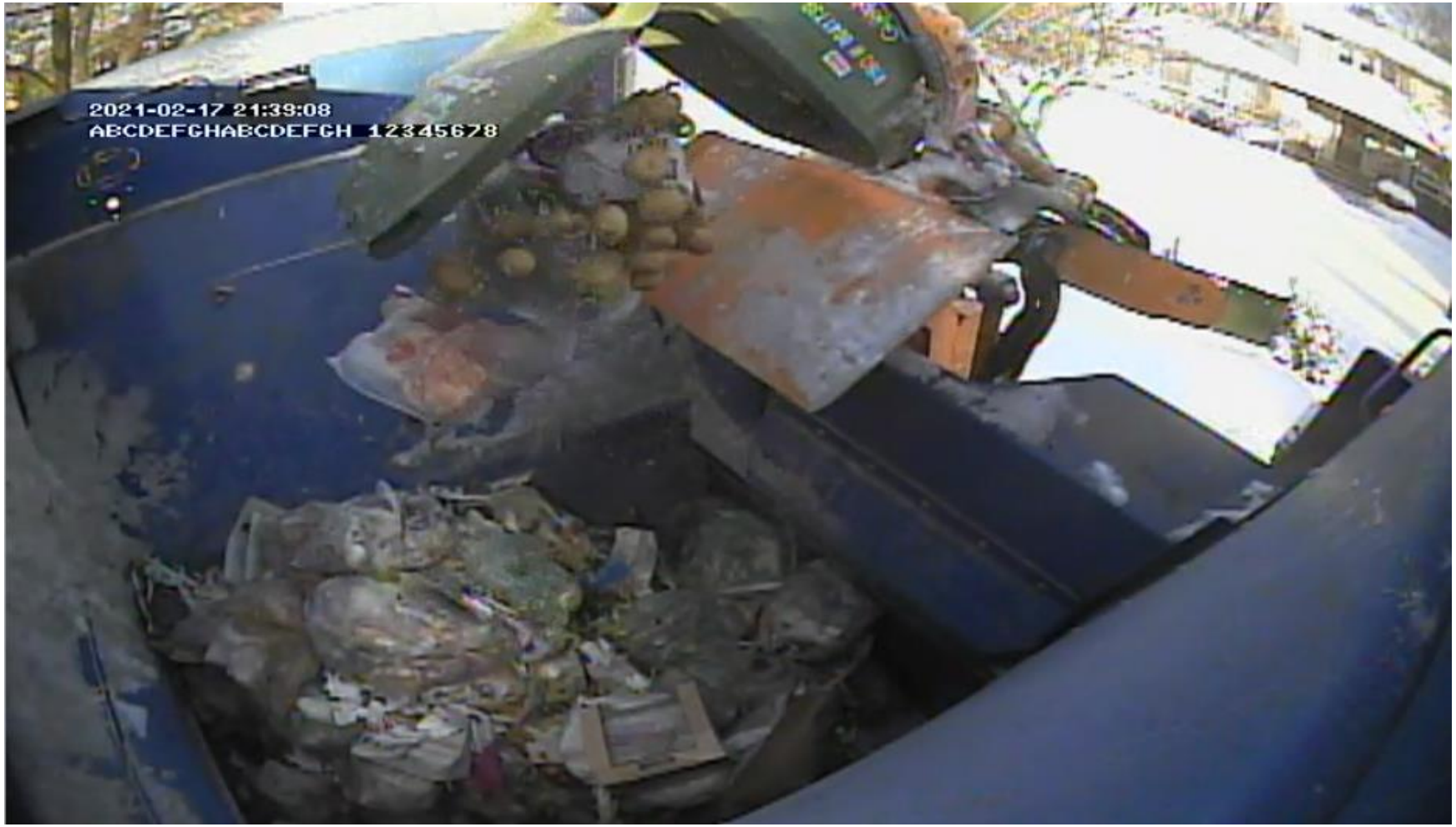
Initial Contaminant List

Contaminant Selection worksheet Please put in your ranking of the items.	Draft Priority		
Acceptable Items - Transparent Bags	Acceptable		
- Pulp Cartons (Egg Cartons)	Acceptable		
- Cut Flowers	Acceptable		
- Small Brown Paper Bags	Acceptable		
- Peat Containers	Acceptable		
Higher Priority Contaminants - Yard Waste/Soil	1		16
- Solid (Non-Transparent) Bags	2		6
- Food Waste (Meats, Fruits, Vegetables, Bread)	3		21
- Plastic Bags (Black, blue, any non-compostable bags, Large Transparent Bags)	4		5
- Large Brown Bags	5		20
- Recyclables (Plastics/Metals)(Containers, Cans, Bottles, etc.)	6		1
Lower Priority Contaminants - Animal Waste Bags	7		12
- Plates (Plastic and paper plates) ALL PLASTIC ITEMS Higher Priority	8		9
- Wood	9		19
- Paper (Loose Papers)	10		18
- Cardboard (Pizza boxes, etc.)	11		17
- Plastic Trays ALL PLASTIC ITEMS Higher Priority	12		8
- Food Containers (Take out containers) ALL PLASTIC ITEMS Higher Priority If paper lower priority	13		7
- Plastic Items (Lamp) ALL PLASTIC ITEMS Higher Priority	14		4
- Aerosol Cans Higher Priority	15		14
Contaminants Not Found In Clips - Loose Diapers Higher Priority	16		10
- Glass Higher Priority	17		3
- Fabrics	18		13
- Coffee Pot Coffee Pods	19		11
- Lids (Can, bottles, etc.) Higher Priority	20		2
- Butane Cylinders Uncommon	21		15

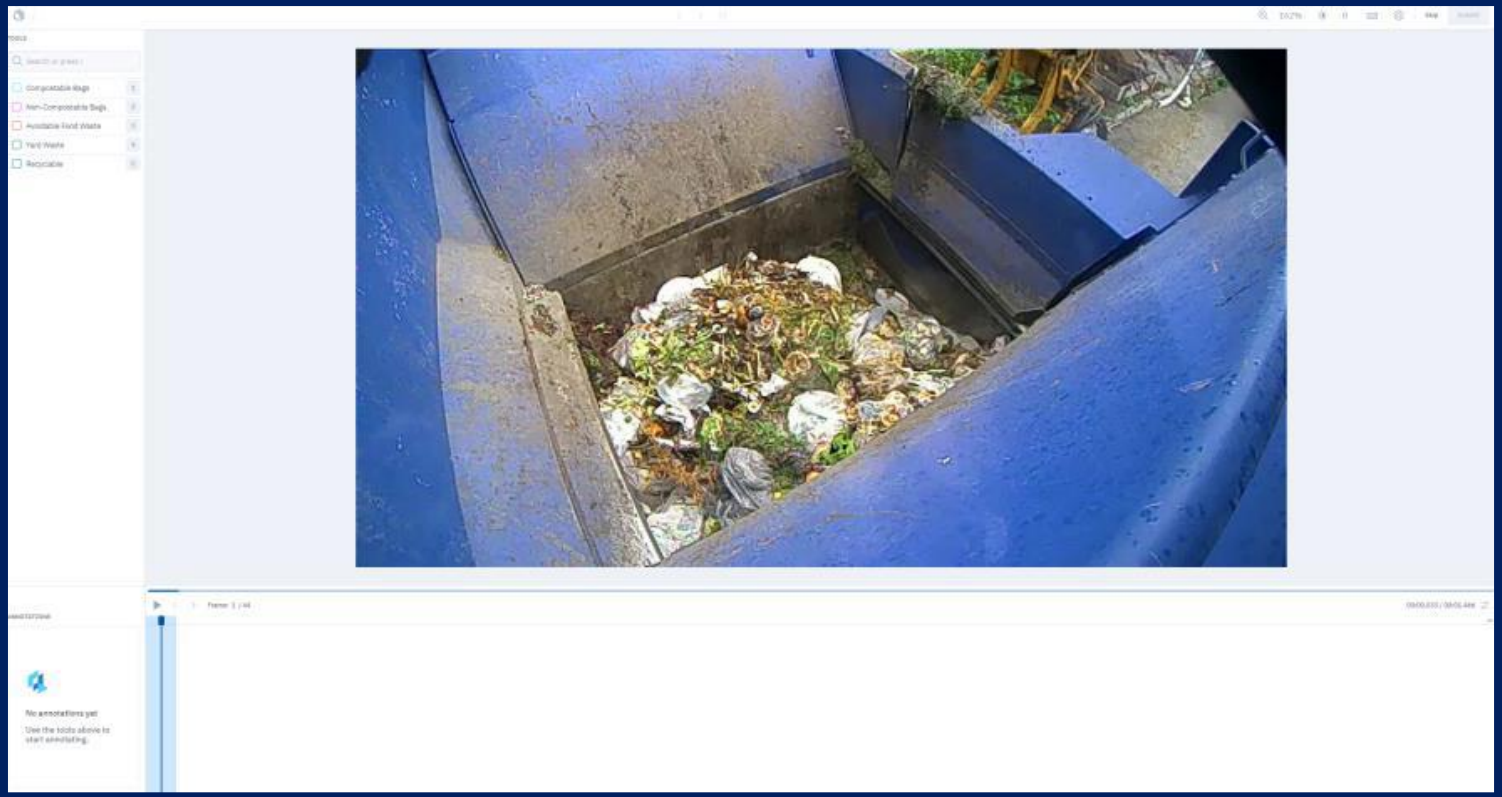
Final contaminant list

- **Compostable bags**
- **Non-compostable bags**
- **Yard waste**
- **Recyclables**
- **Avoidable food waste**

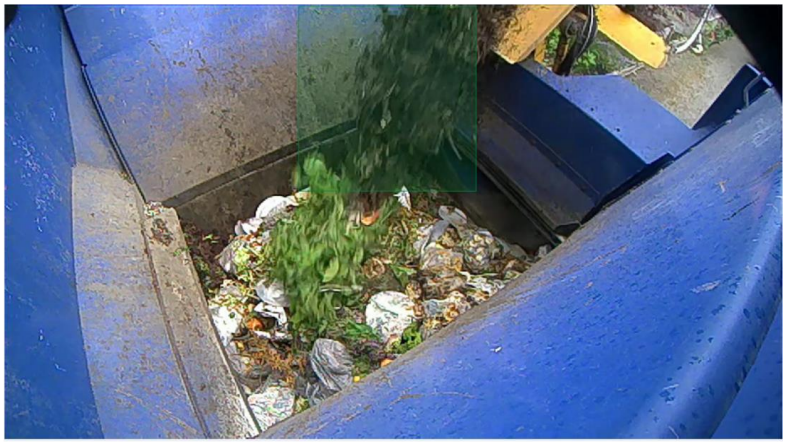
Video Snippets

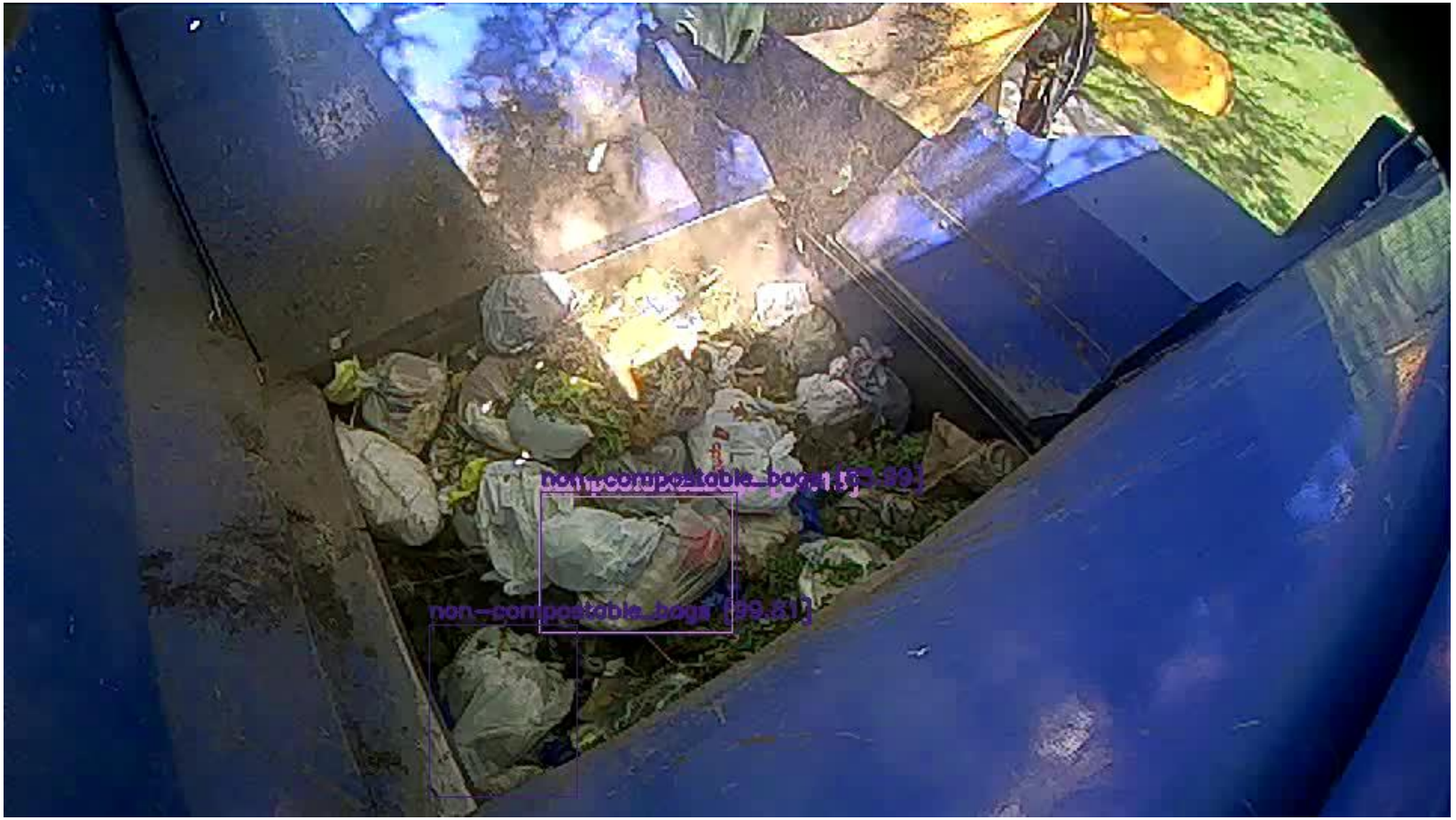


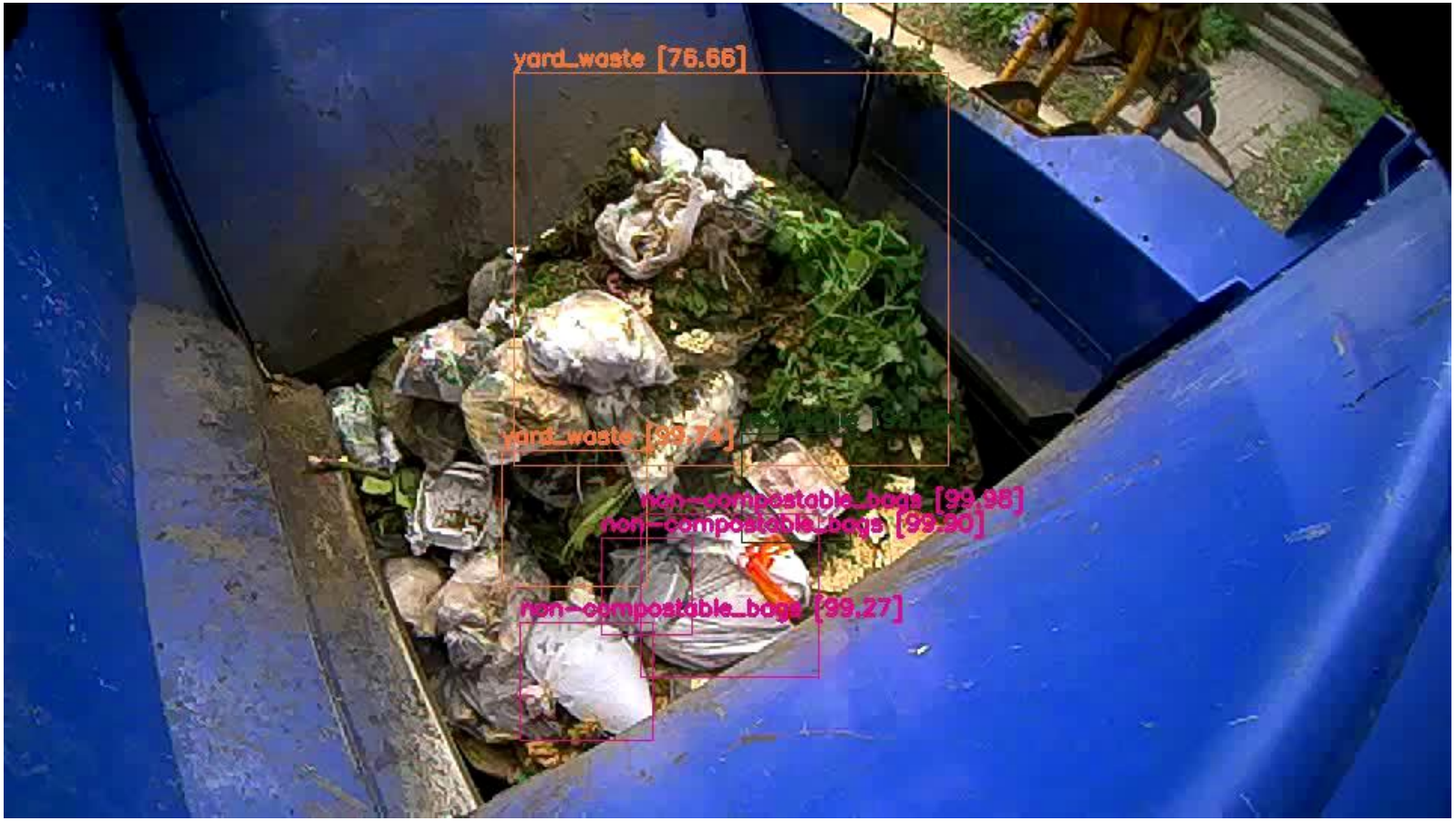
Annotation



Bounding Boxes




non-compostable_bags [99.51]


yard_waste [75.66]
yard_waste [99.74]
non-compostable_bags [99.98]
non-compostable_bags [99.90]
non-compostable_bags [99.27]

Preliminary AI Model

Could recognize 5 items.

Compostable bags: ap = 87.7% (TP = 2131, FP = 1117)

Non- compostable bags: ap = 95.31% (TP = 11367, FP = 2908)

Yard waste: ap = 96.75% (TP = 3370, FP = 707)

Recyclable: ap = 97.33% (TP = 2686, FP = 500)

Avoidable food waste: ap = 85.82% (TP = 674, FP = 268)

Note: ap = average precision

TP = True Positives

FP = False Positives

FN = False Negatives

Base AI Model

- **Compostable bags: ap = 92.54% (TP = 6662, FP = 2426)**
- **Non- compostable bags: ap = 95.95% (TP = 19980, FP = 4717)**
- **Yard waste: ap = 97.5% (TP = 6481, FP = 1235)**
- **Recyclable: ap = 97.17% (TP = 4584, FP = 864)**
- **Avoidable food waste: ap = 87.42% (TP = 3436, FP = 1160)**

Note: ap = average precision

TP = True Positives

FP = False Positives

FN = False Negatives

Model Comparison

Preliminary	**Final**
TP = 90.25%	TP = 90.6%
FP = 24.45%	FP = 22.9%
FN = 9.7%	FN = 9.37%

Final Model

Real Time Recognition

Conclusions

- It is possible to recognize avoidable food waste and contaminants that are visually different enough and are in view
- Multiple classifications are possible but there needs to be sufficient examples of these classes to get recognition results

Recommendations

- **Increase the database size to increase accuracy and number of classes**
- **Import the model into a mobile hardware platform such as GPS and RFID to link the results to addresses and verify the performance**
- **Increase frame rate of the camera and supporting hardware to improve the recognition during higher velocity dumping**