Recyclable Organic Feedstock Supply Assessment in Ontario

Prepared for: **The Atmospheric Fund**

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Date: **January 2022**

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TAF **This report is funded by The Atmospheric Fund**

REPORT AT A GLANCE

This study is intended for potential developers of and investors in anaerobic digesters in Ontario. Its primary objectives are to estimate the total amount of solid and liquid recyclable organic feedstock ("ROF") and source-separated organics ("SSO") generated at the census division level in the province and assess the current capacity for recycling and disposing of the feedstock and related tipping fee costs.

Generation

- There is an estimated combined total of 1,943,858 tonnes per year (tpy) of ROF generated by the industrial, commercial, institutional (ICI) and municipal sources in Ontario.
- It is estimated that a total of 662,498 tpy of *Liquid* ROF is generated in Ontario by ICI sources.
- It is estimated that a total of 704,012 tpy of *Solid* ROF is generated in Ontario by ICI sources.
- It is estimated that a total of 577,348 tpy of Source Separated Organics (SSO) is generated in Ontario.

ROF Processing and Disposal Facilities

- There are 24 ROF-consuming anaerobic digesters in Ontario, with an estimated total ROF intake *capacity* of 359,500 tpy. The tipping fees range between $15 and $80/mt for Liquid and Solid ROF; with an average being $45/mt.
- There are four ROF-consuming anaerobic digesters that are under construction or proposed in Ontario.
- There are 21 ROF-consuming compost facilities in Ontario with an estimated total intake *capacity* of 881,908 tpy. Tipping fees charged by compost facilities range between $20 and $159/mt, with an average tipping fee of $102/mt.
- There are 27 MSW landfills that intake ROF (mixed in with MSW) in Ontario. The tipping fees at these landfills range between $61 and $204/mt.

ROF Surplus Analysis

- Our modelling indicates that, in total, there is a surplus of at least 1,371,478 tpy of ROF in Ontario.
- The City of Toronto and three surrounding municipalities -- Mississauga, Brampton, and Vaughan -- together account for 1,047,205 tpy (76%) of the surplus.
- The GTA would be the most optimal location for a new AD from feedstock supply perspective.

REPORT AT A GLANCE

Key Barriers to Investment from Feedstock Perspective

There are four main barriers from the feedstock perspective which impact investment:

1. *Availability of long-term supply contracts;*
2. *Availability of proximal feedstock;*
3. *Data access / understanding of feedstock availability;*
4. *Lack of market transparency.*

Key Drivers in Tipping Fee and Hauling Costs

- Key drivers in tipping fee costs include presence of an organic waste diversion policy, presence of competing ROF processors, landfill tipping fees and feedstock quality.
- Key drivers in hauling costs include external factors (diesel and labor costs), as well as internal factors (distance travelled and vertical integration).

Effect of ROF Landfill Ban on Tipping Fees

- It is expected that an Ontario landfill ban would result in an initial increase in tipping fees amongst ROF generators due to the shortage of disposal options.
- Tipping fees would be expected to decrease over time after the initial increase due to new competing facilities entering the market at reduced tipping fee costs; thus, lowering the overall market costs.
- Tipping fee reactions will also depend heavily on how the province aims to divert food waste; options such as donation, animal feed and other alternatives may be prioritized over AD and composts.

Conclusions

- We believe that there is ample room for new ADs to enter the market due to the ROF surplus availability in the province.
- The most optimal location for a new AD would be in the west suburbs of the Toronto region.
- Due to the current lack of de-packaging infrastructure in the market, a new facility may benefit well from targeting packaged ROF.

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1.0 OVERVIEW

This study is intended for potential developers of and investors in anaerobic digesters in Ontario. Its primary objectives are to estimate the total amount of solid and liquid recyclable organic feedstock ("ROF") and source-separated organics ("SSO") generated at the census division level in the province and assess the current capacity for recycling and disposing of the feedstock and related tipping fee costs.

In the following pages we survey the landscape of recyclable organic feedstock generation in the province, provide insight into the current supply and demand dynamics surrounding liquid and solid recyclable organic feedstock, a detailed analysis of current processing facilities and disposal markets, and calculate the amount of surplus feedstock province wide. We also include a map highlighting which areas of the province currently offer the highest potential for anaerobic digester development, outline key barriers to investment in anaerobic digesters from a feedstock perspective, and provide our view on the impact of a potential landfilling ban on organics. In addition to the data provided in this report, we based our conclusions on more than a decade of experience conducting supply risk assessments for investors and developers in the anaerobic digestion industry.

Units and Definitions

The following are main units used throughout this report:

- **mt** -- ROF quantity information is provided in metric tons ("mt").
- **$/mt** – dollars per metric ton*
- **tpy** -- metric tons per year

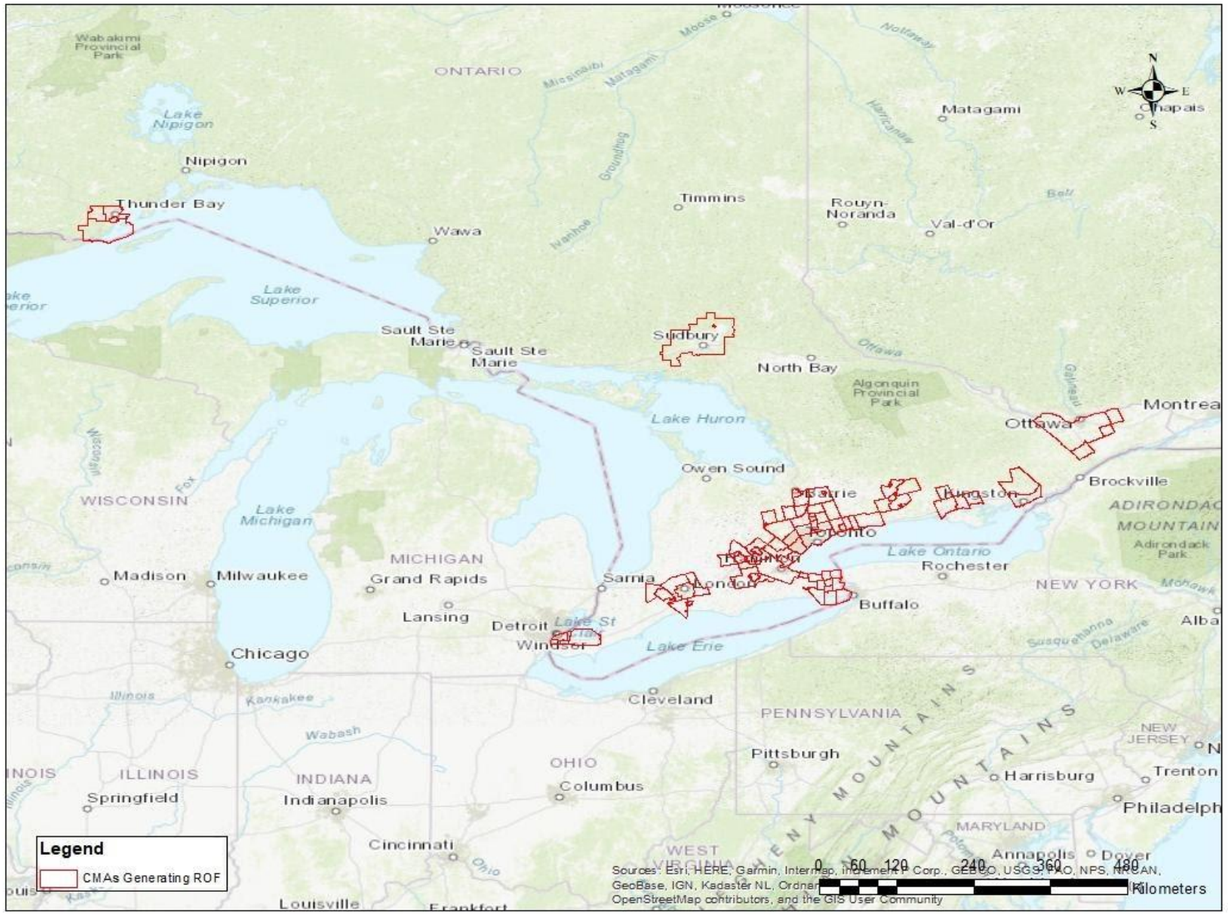
Type of Feedstock

- **Liquid** - includes sludges, dissolved air flotation (DAF), fats, oils and greases, and other liquid waste streams resulting from industrial food manufacturing and is typically delivered in tanker trucks capable of transporting between 1,500-9,000 gallons.
- **Solid** - includes clean solid organic waste such as that derived from fruits, vegetables, meat and other types of food processing, and is typically delivered in dump trucks, roll-off bins or flatbed trucks.
- **Packaged -** includes expired, damaged or off-spec food waste originating at food processors, distribution centers and grocery stores, etc. Since the waste arrives in packages that have to be removed by a de-packager, which is a relatively expensive piece of equipment, most anaerobic digesters and compost facilities are unable to process this type of feed.
- **Source-Separated Organics (SSO)** – includes food waste generated by residential and commercial sources sorted from other waste streams and collected as part of municipal food waste recycling programs such as the City of Toronto's "green bin" program.

1.1 STUDY SITE

All analyses of ROF generation are conducted at the Census Metropolitan Area (CMA) level. There are 563 CMAs in Ontario. However, data on economic activities generating ROF were available only for 82 CMAs. Map 1-1 shows CMAs under consideration in this study.

Map 1-1: Study Region



2.0 FEEDSTOCK GENERATION

ROF GENERATION

This section provides high-level estimates of ROF Generation for the 82 Census Metropolitan Areas (CMAs) indicated in Map 1-1. All estimates are based on industrial, commercial, institutional and municipal sources, transfer functions that we have either published or developed internally (see Appendix A), and CMA-level employment data. These estimates do not distinguish between ROF that can be easily processed by an anaerobic digester, and that which cannot. Nor did we address factors such as ROF's higher value as animal feed, or the fact that it is included with other waste streams. Due to the resolution of the estimates , the factor of error is estimated to be plus or minus 15%.

2.1 TOTAL ROF GENERATION

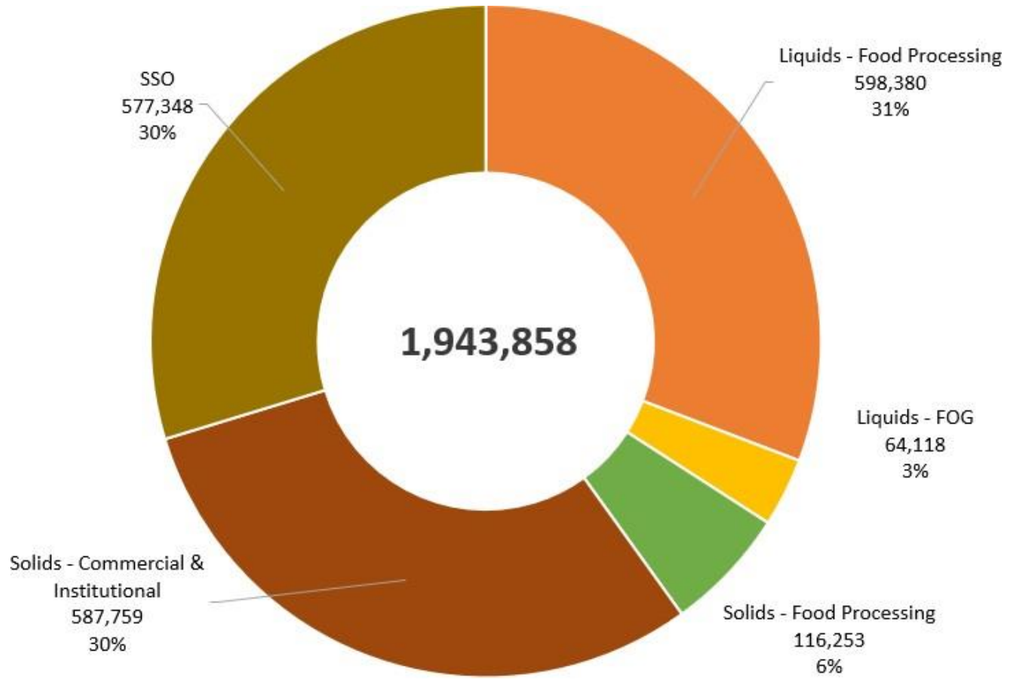
There is an estimated combined total of 1,943,858 tonnes per year (tpy) of ROF generated by the industrial, commercial, institutional (ICI) and municipal sources in Ontario.

In the industrial sector, liquid ROF accounts for 598,380 tpy or 31% of the total amount generated. Of that amount, fats, oils and greases account for 64,118 tpy or 3% of the total, while solid ROF accounts for 6%. Commercial and institutional sources produce an estimated 587,759 tpy or 30% of the total generated, while source-separated organics account for an estimated 577,348 tpy or 30%. (Figure 2-1, Table 2-1, Maps 2-1, 2-2).

Table 2-1: Estimated total ROF generation from ICI sources (tpy)

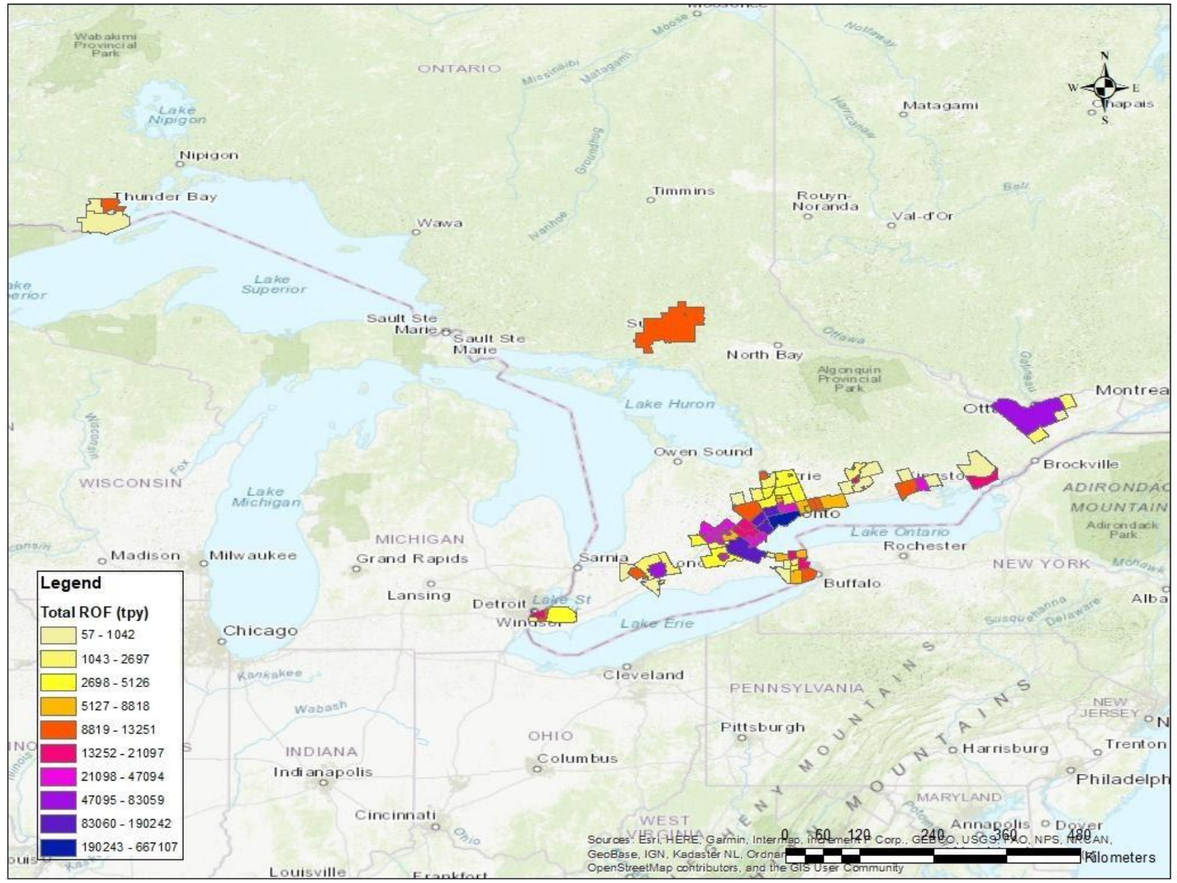
Source Category	Generation (tpy)	% of total
Liquids – Food Processing	598,380	31%
Solids – Commercial & Institutional	587,759	30%
Source Separated Organics (SSO)	577,348	30%
Solids – Food Processing	116,253	6%
Liquids – FOG	64,118	3%
Total	**1,943,858**	

Figure 2-1: Estimated total ROF generation in Ontario (tpy)

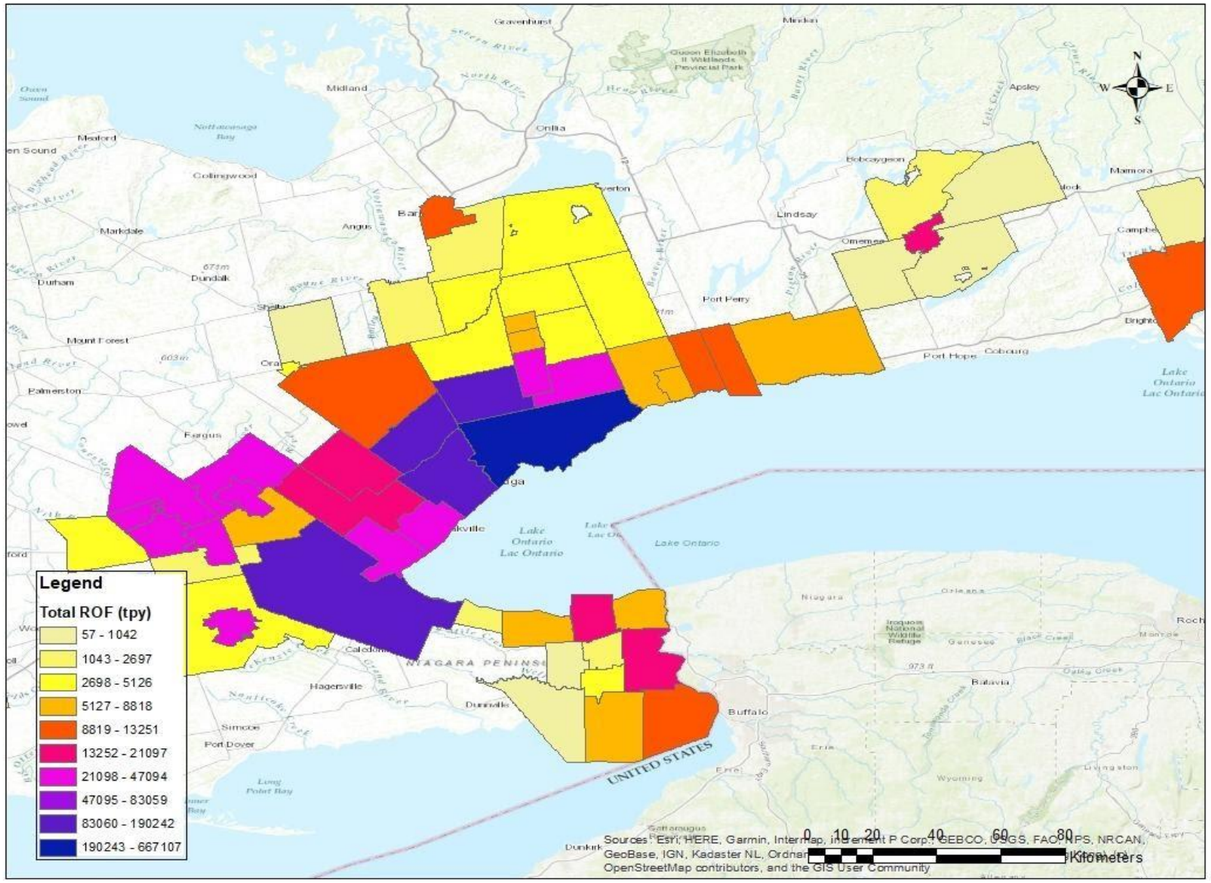


Estimated total ROF generation by ICI sources across Ontario

Map 2-1: Total estimated ROF generation from ICI sources in Ontario (tpy)



Map 2-2: Total estimated ROF generation from ICI sources in around Golden Horseshoe (tpy)



2.2 LIQUID ROF GENERATION

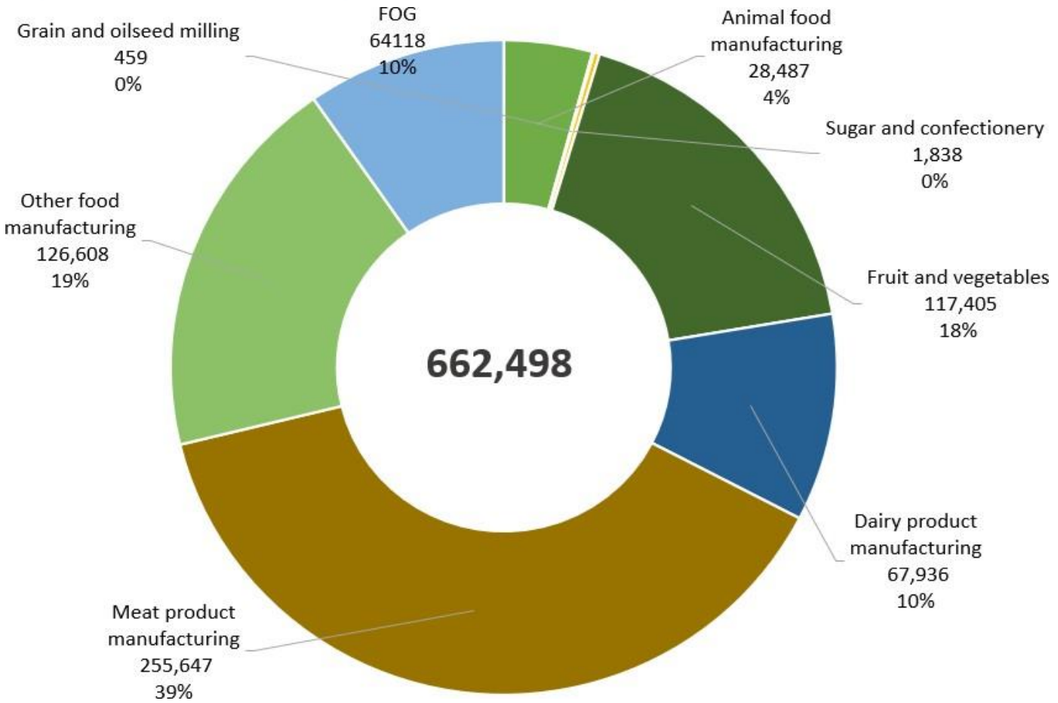
It is estimated that a total of 662,498 tpy of Liquid ROF is generated in Ontario.

Ontario generates an estimated 662,498 tonnes of liquid ROF per year. Of that amount, approximately 598,380 tpy or 90 per cent derives from industrial sources, and 64,118 tpy or 10 per cent from restaurant-generated fats, oils and greases. Meat product manufacturers generate the most liquid ROF in this sector —approximately 255,647 tonnes or 39% per year. In the industrial sector, other types of food manufacturers and fruit and vegetable product manufacturers generate relatively significant quantities of liquid ROF annually — 126,608 and 117,405 tpy respectively. (See Figure 2-2, Table 2-2, Maps 2-3, 2-4).

Table 2-2: Estimated Liquid ROF generation by ICI sources (tpy)

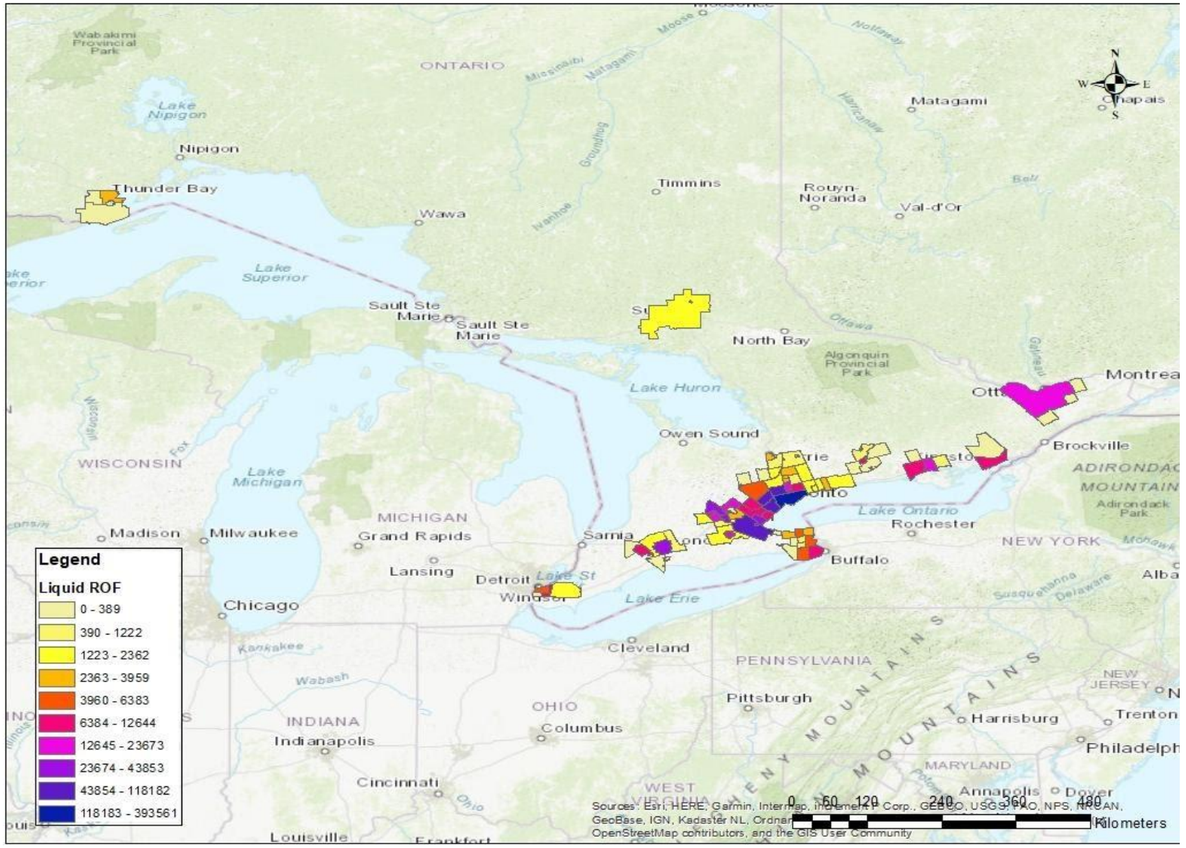
Source Category	Generation (tpy)	% of total
Animal food manufacturing	28,487	4%
Grain and oilseed milling	459	0%
Sugar and confectionery	1,838	0%
Fruit and vegetables	117,405	18%
Dairy product manufacturing	67,936	10%
Meat product manufacturing	255,647	39%
Other food manufacturing	126,608	19%
FOG	64,118	10%
Total	**662,498**	

Figure 2-2: Estimated liquid ROF generation by ICI sources (tpy)

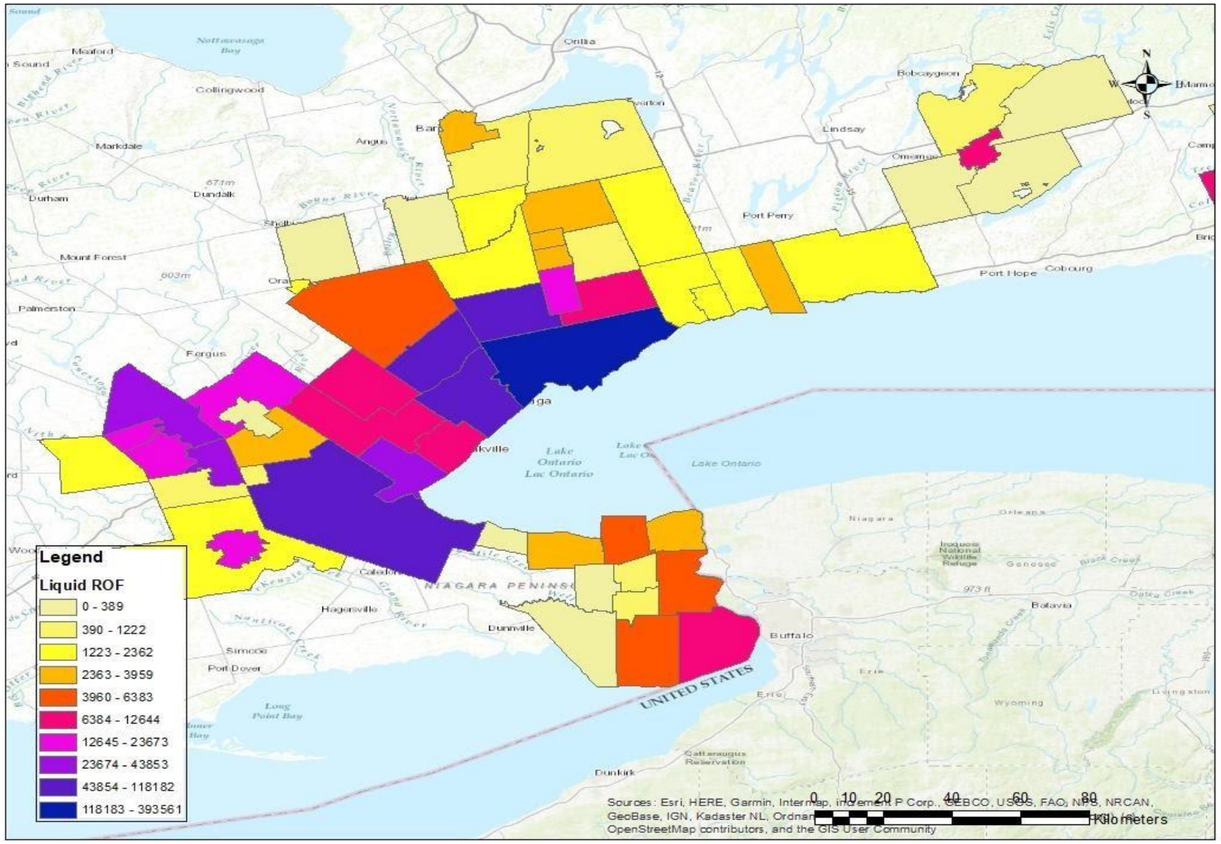


Estimated Liquid ROF generation by ICI sources across Ontario

Map 2-3: Estimated liquid ROF generation by ICI sources in Ontario (tpy)



Map 2-4: Estimated liquid ROF generation by ICI sources around Golden Horseshoe (tpy)



2.3 SOLID ROF GENERATION (Commercial/Institutional)

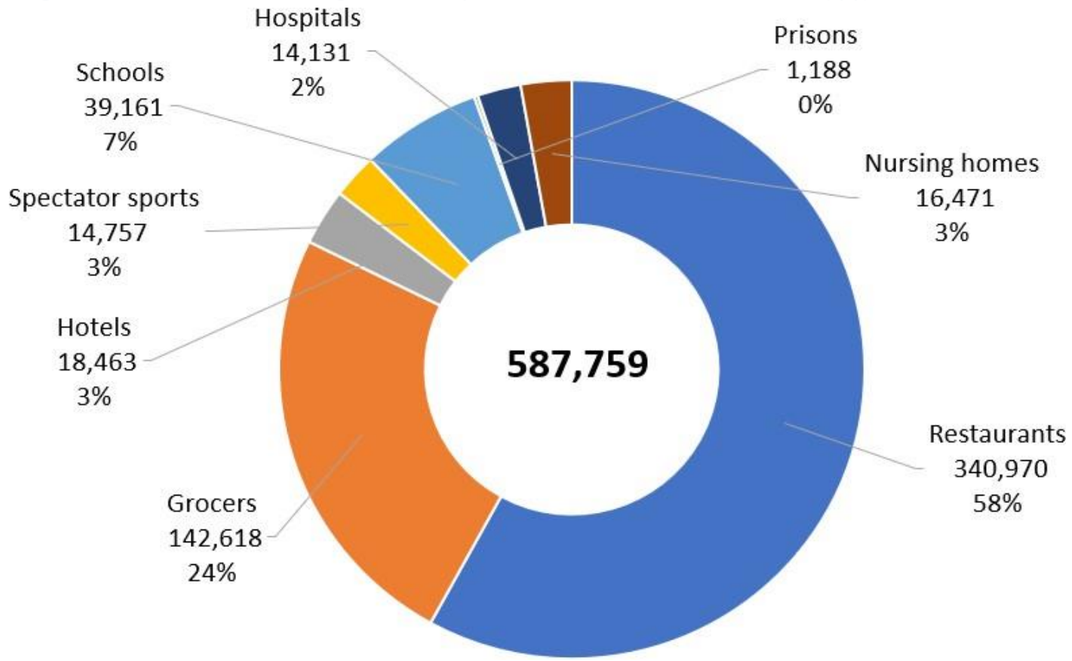
It is estimated that a total of 704,012 tpy of Solid ROF is generated in Ontario by commercial and institutional sources.

These sources are the largest generators of solid ROF in Ontario, producing an estimated 587,759 tpy. Restaurants account for 340,970 tonnes or 58 per cent of the total amount generated by these sectors each year. Grocery stores are the only other major generators, contributing an estimated 142,618 tonnes per year or 24% of the total. Schools are the second largest generators of solid ROF, at 39,161 tonnes or 7% annually. (See Figure 2-3, Table 2-3, Maps 2-4 and 2-5).

Table 2-3: Estimated solid ROF generation by commercial & institutional sources (tpy)

Source Category	Generation (tpy)	% of total
Restaurants	340,970	58%
Grocers	142,618	24%
Schools	39,161	7%
Hotels	18,463	3%
Nursing homes	16,471	3%
Spectator sports	14,757	3%
Hospitals	14,131	2%
Prisons	1,188	0%
Total	**587,759**	

Figure 2-3: Estimated solid ROF generation by commercial & institutional sources (tpy)



2.3 SOLID ROF GENERATION (Industrial)

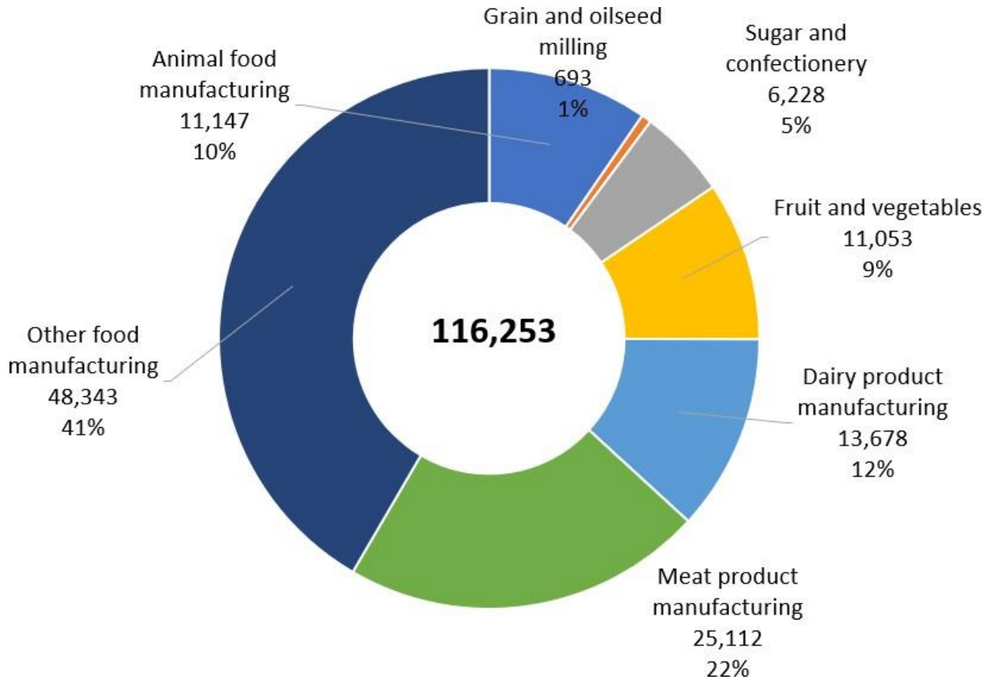
It is estimated that a total of 704,012 tpy of Solid ROF is generated in Ontario by commercial and institutional sources.

These sources generate an estimated 116,253 tonnes of solid ROF annually, of which alternate types of food manufacturing generate 48,343 tonnes or 42% annually. Meat product manufacturers generate an estimated 25,112 of solid ROF or 22% annually, followed by animal food manufacturers, which create an estimated 11,147 tpy or 10 % of the annual total. (Figure 2-4, Table 2-4, Maps 2-5 and 2-6).

Table 2-4: Estimated solid ROF generation by industrial sources (tpy)

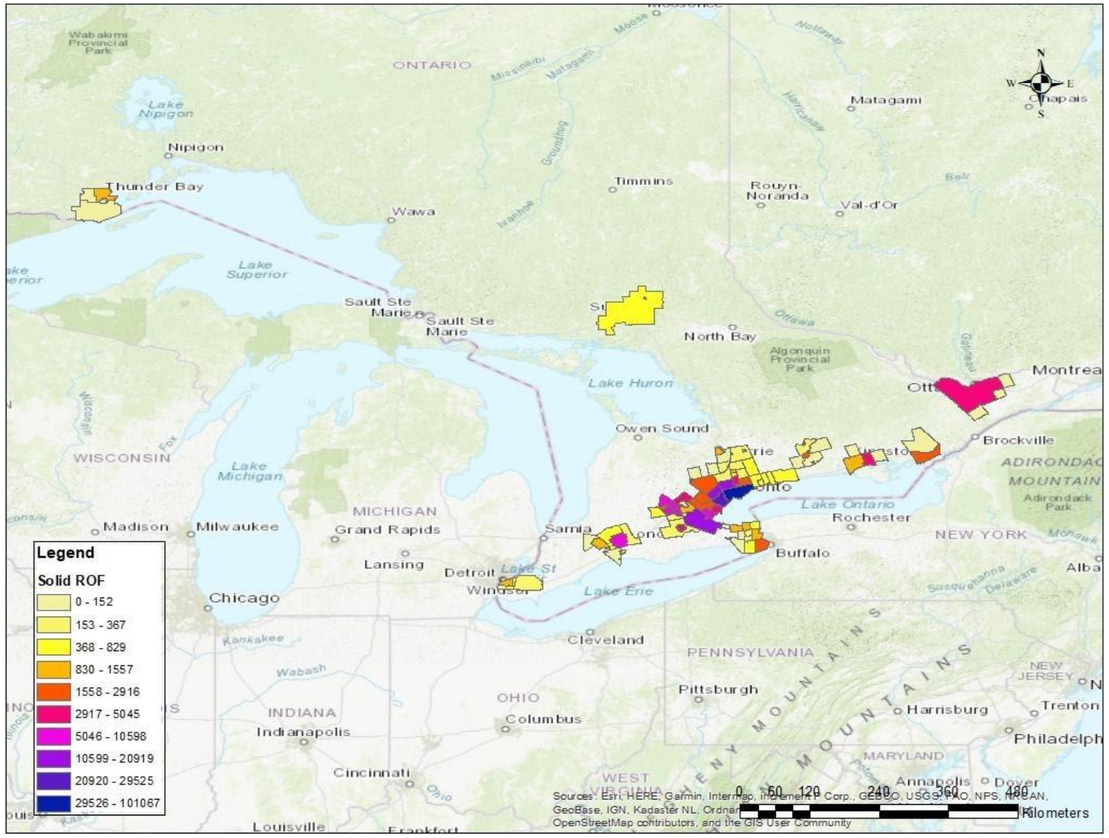
Source Category	Generation (tpy)	% of total
Animal food manufacturing	11,147	10%
Grain and oilseed milling	693	1%
Sugar and confectionery	6,228	5%
Fruit and vegetables	11,053	10%
Dairy product manufacturing	13,678	12%
Meat product manufacturing	25,112	22%
Other food manufacturing	48,343	42%
Total	**116,253**	

Figure 2-4: Estimated Solid ROF generation by industrial sources (tpy)

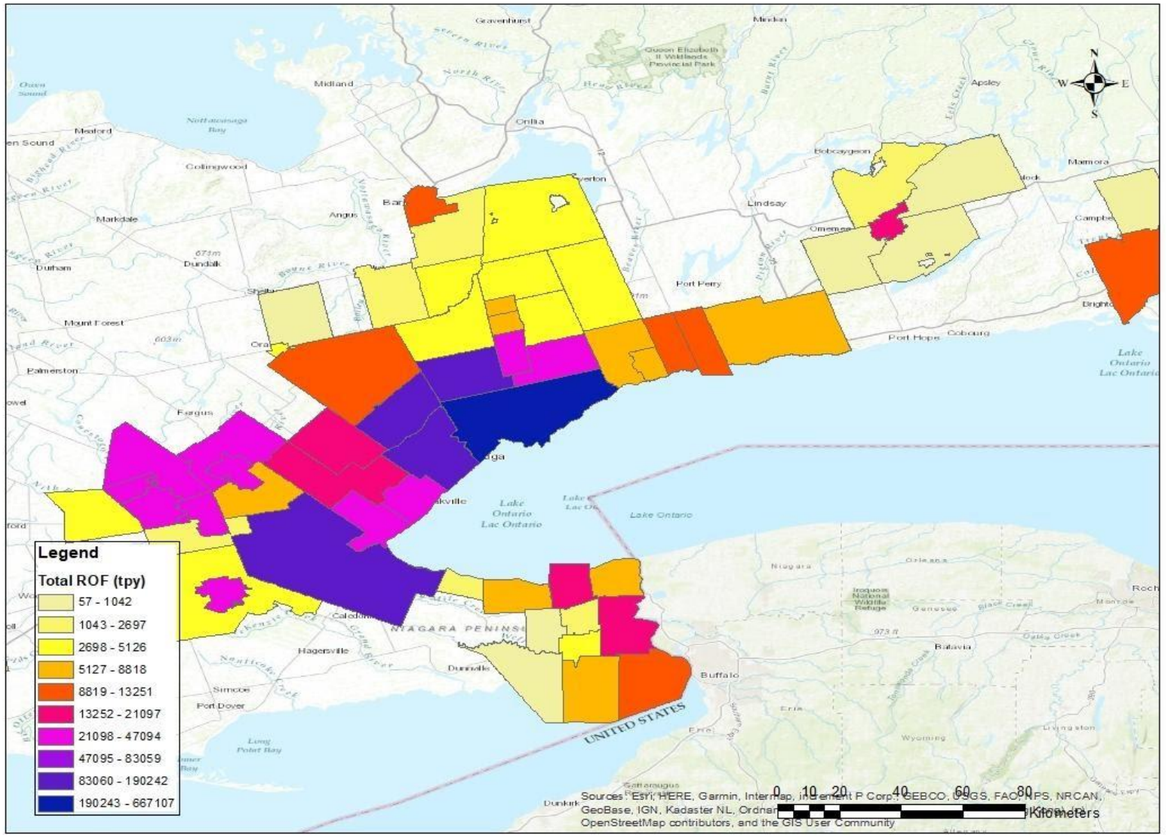


Estimated Solid ROF generation by ICI sources across Ontario

Map 2-5: Estimated Solid ROF generation by ICI sources in Ontario (tpy)



Map 2-6: Estimated Solid ROF generation by ICI sources around Golden Horseshoe (tpy)

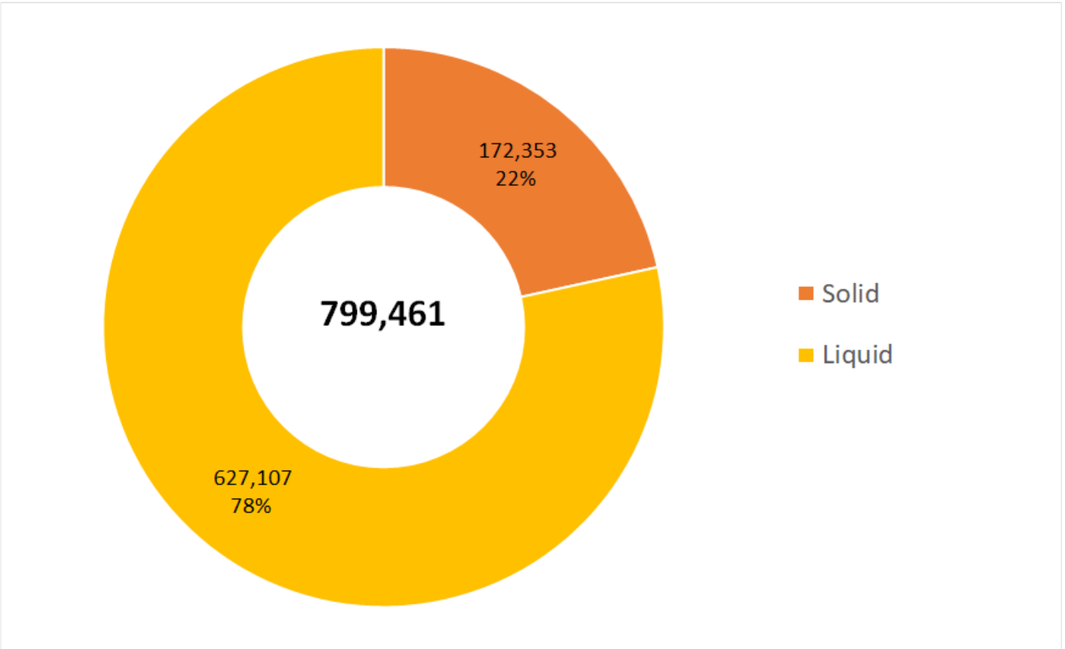


2.4 BAKERY-GENERATED ROF

It is estimated that a total of 799,461 tpy of ROF is generated by bakeries.

Bakeries produce approximately 799,461 tonnes of ROF annually. Of that amount, liquid ROF accounts for 627,107 tpy or 78% of the total, and solid ROF accounts for 172,353 tpy or 22% of the total (Figure 2-5). Although bakeries generate significant quantities of ROF cumulatively, they produce relatively small quantities individually, and therefore it is uneconomical for anaerobic digesters to acquire ROF from multiple sources. Furthermore, ROF that has been generated by bakeries is often high quality and would likely go to the animal feed market whenever possible.

Figure 2-5: Estimated ROF generation by bakeries(tpy)



2.5 SOURCE SEPERATED ORGANICS (SSO)

There is an estimated 577,348 tpy of Source Separated Organics (SSO) generated in Ontario.

An estimated 577,348 tonnes of source separated organics (SSO) are generated in Ontario each year, more than a quarter of which come from Toronto, which produces approximately 163,934 tpy, and accounts for 28% of the total amount generated provincially. Three other regions of note that produce SSO waste are York, Ottawa, and Peel, each of which generates an estimated 100,874, 80,316, and 65,334 tonnes respectively or 17, 14 and 11 % annually. All other regions produce 5% or less of the province's total SSO. (Figure 2-6, Table 2-5). We also studied SSO generation in Ontario between 2015-2019, during which time it increased from 483,757 to 577,348 tpy or by 19%. (The most significant increase occurred between 2016 and 2017, when generation jumped by 40,791 tons. The following year it increased from 555,305 to 577,348 tons, or by 4 %.)

Figure 2-6: Estimated SSO generation by region in 2019 (mt)

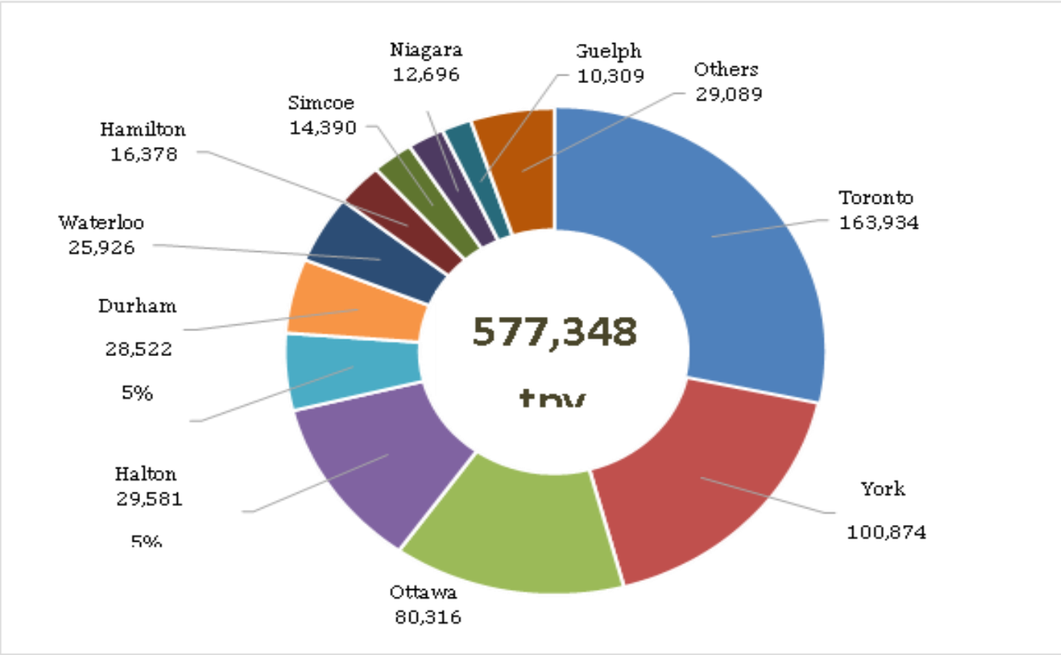
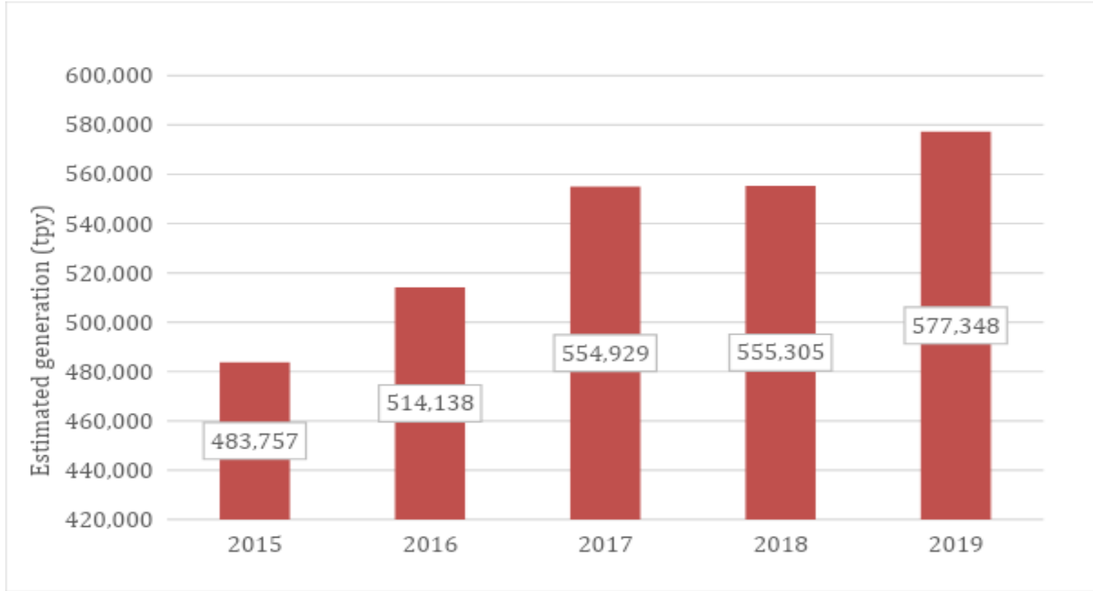


Figure 2-7: Historical SSO generation, 2015-2019 (tpy)



Historical SSO generation was also studied from 2015-2019. Over this timeframe, Ontario saw an overall increase of 19% in SSO generation, from 483,757 to 577,348 tpy. The most significant increases occurred prior to 2017. From 2015 to 2016, estimated SSO generated increased by 30,381 tons. The most significant increase in estimated SSO generation occurred from 2016 to 2017, when generation increased by 40,791 tons, from 514,138 to 554,929 tons. There was no significant difference in estimated SSO generation between 2017 and 2018. From 2018 to 2019, estimated SSO generation increased by 4%, from 555,305 to 577,348 tons.

3.0 SUPPLIER SURVEY

3.1 GENERATORS

Low correlation between the size of a food/beverage manufacturer and the availability of ROF

Excluding bakeries, 3,087 food and beverage manufacturers operate in Ontario. To understand the correlation between facility size and quantity of available ROF, we sampled 57 manufacturers. Only 11 manufacturers expressing an interest in supplying ROF to a new anaerobic digester responded to our survey. Nevertheless, even within the small sample, the annual supply of ROF available ranged from 86 tonnes of chicken meat to 2,500 tonnes of liquid soda.

We also found that facility size was not a good predictor of potential supply. In Toronto, a mixed food products manufacturer with 50 employees generated 1,100 tonnes of ROF a year, while a meat and animal processing plant with 250 employees generated 550 tonnes annually. (Figure 3-1 shows the correlation between the number of employees and the quantity of available ROF. The correlation is low with an R^2 value of 0.45 for a linear model.) Nevertheless, based on our surveys of other North American jurisdictions, we believe that larger facilities are likely to generate larger quantities of ROF.

Figure 3-1: Correlation between food and beverage manufacturers' number of employees and ROF available for anaerobic digesters

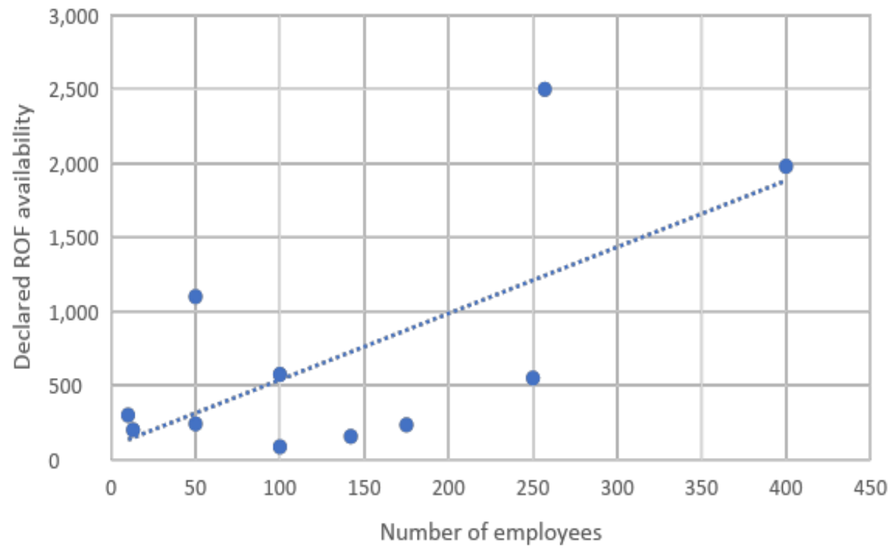


Table 3-2: Sample of generators interested in supplying ROF

Location	Industry Type	Feedstock Type	No of employees	Quantity (mt/yr)
Brampton	Meat & Animal Processing	Breading	400	1,980
Toronto	Food Manufacturer	Mixed Food Products	50	1,100
St.Catherines	Meat & Animal Processing	Raw Materials	100	575
Oakville	Meat & Animal Processing	Chicken meat	100	86
Toronto	Meat & Animal Processing	Paunch	250	550
Cambridge	Meat & Animal Processing	Breading	50	241
Toronto	Fish & Seafood Merchant	Liquid Fat, Solid Fat, Oils	175	234
Newmarket	Meat & Animal Processing	Deadstock	142	156
Mississauga	Soft drink manufacturing	Liquid soda waste	257	2,500
Toronto	Brewery	Spent grains	13	200
Toronto	Brewery	Spent yeast	10	300

3.2 HAULERS

A significant portion of the province's ROF supply is currently controlled by waste haulers, who collect waste from generators and supply it to anaerobic digesters and compost facilities, dispose of it in landfills, or land apply it. Because each hauler can collect ROF from multiple generators, haulers can serve as significant sources of supply. See Table 3-1 for a list of all the major waste haulers operating in Ontario.

Cornerstone Renewables

Cornerstone Renewables, a large ROF aggregator and broker, supplies 11 of the 24 anaerobic digesters that accept ROF in the province, some exclusively. Although the company mostly supplies small ADs, which are located on farms, it also aggregates and supplies ROF to large commercially scaled ADs, such as BioEn and Seacliff Energy. We estimate that Cornerstone Renewables supplies 137,000 tonnes of ROF a year to the 11 facilities. As such, it is the largest ROF aggregator in the province.

3.2 HAULERS

Table 3-1: Major waste haulers in Ontario

Company	Location	Service area	Feedstock
AIM Environmental Group	Stoney Creek, ON	Southwestern Ontario	Residential Green Bin
BFI Canada Inc.	Ottawa, ON	Eastern Ontario	IC&C organic waste
BFI Canada Inc.	Windsor, ON	Southwestern Ontario	IC&C organic waste
Butler Disposal and Recycling Services	Stouffville, ON	Central Ontario	Organic waste from Restaurants, Grocery stores, Food Processing Plants
Detox Environmental Ltd.	Bowmanville, ON	Province of Ontario	ICI organic waste
Everest Environmental Group	Paris, ON	Southwestern Ontario	ICI organic waste
Future Waste Management	Drumbo, ON	Southern Ontario	ICI organic waste
GFL Environmental Corp.	Toronto, Ontario	Province of Ontario	Municipal and IC&I organic waste
Lamoureux Pumping Inc.	Casselman, Ontario	Province of Ontario	NASM, ASM, septage, biosolid, leachate, commercial & organic & food waste
Ontario Greenways Inc.	Mitchell, ON	Within 200 km radius of Mitchell, ON	Agricultural, Industrial, Municipal, Commercial organic waste
Perth Environmental Inc.	Brunner, Ontario	Province of Ontario	Food processing and slaughtering plants, Commercial, Grease traps
Stormfisher Environmental Ltd.	London, Ontario	Province of Ontario	Municipal and IC&I organic waste
The TrapDoc Inc.	Dorchester, ON	Central, Southwestern and Eastern Ontario	Grease
Walker Industries	Niagara Falls, ON	Southern Ontario	Municipal SSO, ICI organic waste, various others
Waste Management		Province of Ontario	Municipal, IC&C organic waste
Wasteco - Toronto Region	Toronto, ON	Central Ontario	Commercial and Industrial organic waste
Wessuc Inc.	Brantford, ON	Province of Ontario	Liquid and Solid IC&C organic waste and agricultural waste

4.0 CONTRACT AVAILABILITY (MUNICIPAL SSO)

To understand the potential availability of SSO available municipally, and how each region in the province and its corresponding municipalities manage its disposal, we reached out to the City of Toronto and five regions: Durham, Halton, Peel, Waterloo and York Wherever possible, we also gathered information related to SSO contracts and bidding processes. Of the six regions contacted, two (City of Toronto and York), confirmed that SSO contracts were available for bidding, and four confirmed that contracts were unavailable. (See Appendix F for regional bidding information.)

Note that this research is valid as of Q32021. The municipal SSO contract situation may have changed since then.

4.1 City of Toronto

The City of Toronto sends the majority of its SSO to its own anaerobic digesters: CCI Disco and CCI Dufferin, and contracts out the balance through a public procurement process which is accessible on the city's website.

4.2 Durham Region

Durham Region has no contracts for SSO available . The region is currently in a procurement process for developing its own AD where it will process all of Durham's SSO. The Durham project is for a 20-year operating contract, which will begin once the proposed facility is commissioned.

4.3 Halton Region

Halton currently has a 5-year contract, including annual renewal options, with Stormfisher to process all the SSO it has acquired through its Green Cart program. When the contract ends, Halton Region will review alternatives and proceed with a new competitive procurement process.

4.4 Peel Region

Peel only awards waste contracts to currently operational facilities and generates 60,000 tonnes of SSO a year through its Green Bin program, half of which is processed at the region's composting facilities. The remaining 30,000 tonnes are awarded via contract to other facilities and Cornerstone Renewables. Peel is currently engaged in the procurement process for an AD with a proposed feedstock intake capacity of 90,000 tonnes per unit, which is targeted to go online in May 2024, at which point Peel Region will process all of its SSO at that facility and its own compost facilities, thus eliminating the need for waste contracts with third party facilities or haulers.

4.5 Waterloo Region

Waterloo generates approximately 28,000 tonnes of SSO a year through its weekly curbside Green Bin Program and currently has a long-term contract (10 years + extensions) with the City of Guelph, which receives and processes 20,000 tonnes of SSO annually. Walker Environmental is under contract until 2024 to collect and process the remaining 8,000 tpy, at which point Waterloo region will engage in a competitive procurement process to dispose of its excess SSO.

5.0 ROF PROCESSING & DISPOSAL FACILITIES

5.1 ANAEROBIC DIGESTERS

There are 24 ROF-consuming ADs in Ontario with an estimated total ROF intake *capacity* of 359,500 tpy.

Twenty-four ROF-consuming anerobic digesters with a total estimated intake capacity of 359,500 tpy operate in Ontario (Maps 5-1 and 5-2, Table 5-1) and there are four more proposed facilities or expansions of existing ones. Most digesters are located on farms, where manure and other agricultural by-products are in close proximity. In addition, three large-scale commercial digesters operating in the province (Seacliff Energy in Leamington, Stormfisher in London, and BioEn in Elmira) also source feedstock from ICI sectors, and two relatively large-scale, Toronto-based digesters source SSO exclusively in the City of Toronto. While our research indicates that tipping fees for liquid and solid ROF waste typically range between $15 - $80/mt or $45/mt on average, we advise caution when considering these prices, since most of the companies we contacted were already well-supplied with ROF and did not provide information on their tipping fees.

Table 5-1: ROF-processing Anaerobic Digesters in Ontario

# On Map	Name	City	Total Estimated Feedstock Capacity (tpy)	Estimated ROF Intake (tpy)
1	Athlone BioPower	Tavistock	36,000	18,000
2	Bayview Flowers	Jordan Station	10,000	5,000
3	Ben Gardiner Farms	Kirkton	10,000	5,000
4	BioEn	Elmira	110,000	55,000
5	Birchlawn Farms	Listowel	10,000	5,000
6	CARES University of Guelph Ridgetown	Ridgetown	3,200	500
7	CCI Disco	Toronto	83,000	83,000
8	CCI Dufferin	Toronto	30,000	30,000
9	Clovermead Farms	Owen Sound	10,000	5,000
10	Delft Blue Veal	Cambridge	10,000	5,000
11	Eilers Farm	Zurich	10,000	5,000
12	Ferme Geranik	St. Albert	10,000	2,500
13	Greenholm Farms	Embro	10,000	5,000
14	Jockvalley Farms	Ottawa	10,000	5,000
15	Kirchmeier Farms	St-Isidore	10,000	5,000
16	Koskamp Family Farms	Stratford	10,000	5,000
17	Marl Creek Renewables	Elmwood	10,000	5,000
18	Maryland Biogas	Reaboro	14,500	7,250
19	Petrocorn Farms (CH FOUR Biogas)	Pendleton	21,900	11,000
20	Schouten Corner View Farms	Richmond	10,000	5,000
21	Seacliff Energy	Leamington	110,000	60,000
22	Stormfisher	London	195,000	65,000
=23	Terryland Farms	St-Eugene	10,000	5,000
24	Zooshare	Toronto	17,000	14,000
	Total		**760,600**	**411,250**

Table 5-2: AD projects under development In Ontario

Company	Location	Feedstock	Estimated Feedstock Capacity (tpy)	Output (MW)	Development Phase
Bio-En Power**	Elmira, Ontario	Organic (unspecified)	Additional 40,000	5.87	Expansion
Chatham-Kent PUC	Chatham, Ontario	Organic (unspecified)	11,419	2.20	Project Operational
Petawawa Biofuel/ CH Four Biogas	Dundalk, Ontario	Agriculture, Food	50,000- 70,000	2.00	Pending Approval
Town of Petawawa / Anaergia	Petawawa, Ontario	Food, Waste Oil, Wastewater	12,363	Not available	Funding Approval

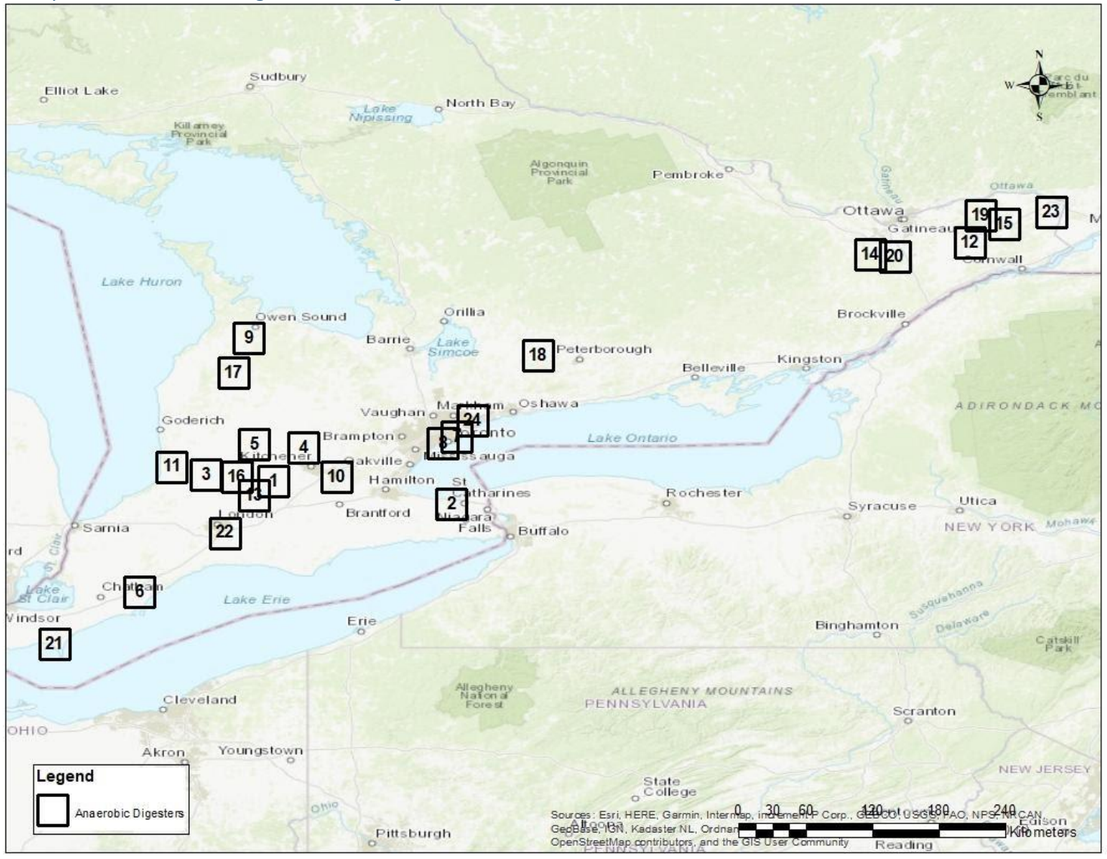
Trends and opportunities

***Lack of Packaged ROF processing infrastructure*.** Our survey of ROF generators and haulers indicated that there could be significant quantities of Packaged ROF available to ADs; however, currently the infrastructure is lacking. Only two ADs in Ontario that source ROF from the ICI sectors have de-packagers onsite, being able to accept Packaged ROF. Both of these facilities are located in Southwestern Ontario. Based on these data, we conclude that there is an opportunity for additional ADs with de-packing capabilities. This is especially true around the GTA, and to the immediate East and West of the GTA, where ROF surpluses are identified (see Section 6.0).

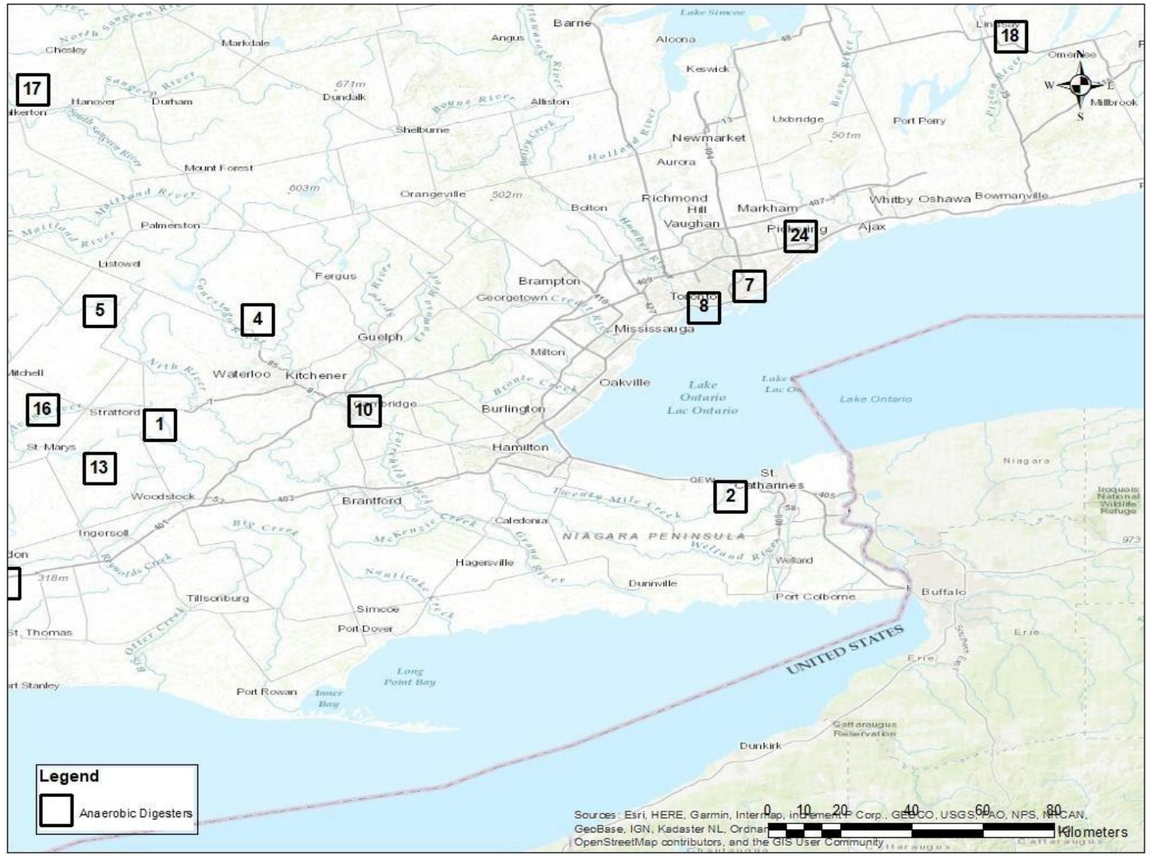
Note on data collection methodology. **All intake capacity and tipping fee data as well as some qualitative information are based on direct outreach to ROF processors and disposal facilities, and verbal feedback provided by the facilities' staff. Information provided verbally was supplemented through online research.**

ROF consuming anaerobic digesters in Ontario

Map 5-1: ROF consuming anaerobic digesters in Ontario



Map 5-2: ROF-consuming anaerobic digesters in Southern Ontario



5.2 COMPOST FACILITIES

There are 21 ROF-consuming compost facilities in Ontario with an estimated total ROF intake *capacity* of 881,908 tpy.

Twenty-one ROF-consuming compost facilities with a total estimated intake capacity of 881,908 tpy currently operate in Ontario, most of which charge tipping fees ranging between $20 -$159/mt ($102/mt on average). We did not identify any proposed facilities. (Maps 5-3 and 5-4, Table 5-3).

Trends of Compost Facilities in Ontario

Limited capacity to accept liquid ROF

Of 21 compost facilities, only four indicated the ability to accept liquid ROF, and their intake capacity was further limited by their composting process. Of the four facilities that did accept liquid ROF, tipping fees ranged between $75- $110/mt.

Higher tipping fees

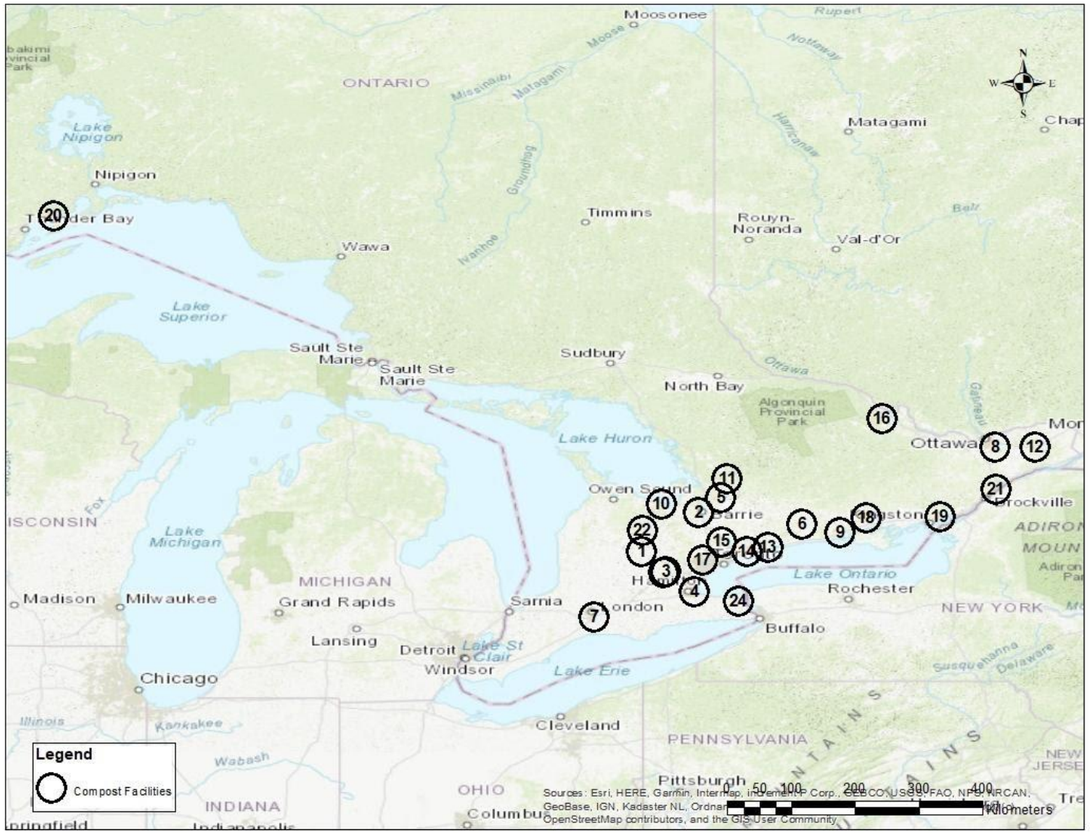
Compost facilities charge average tipping fees of $102/mt, while most ADs only charge $45/mt. This discrepancy is due to compost facilities generally only accept SSO feedstock, which tends to be lower quality, while ADs generally only accept feedstock generated by ICIs. Furthermore, since many compost facilities are either owned by or have supply contracts with municipalities, which are in the public sector, they can often charge significantly higher tipping fees than they would if they only accepted ICI-generated feedstock.

Table 5-3: ROF-consuming Compost Facilities in Ontario

# On Map	Name	City	Total Estimated Feedstock Capacity (tpy)	Estimated ROF Intake Capacity (tpy)
1	All Treat Farms (Walker Environmental)	Arthur	64,000	32,000
2	City of Barrie Compost	Barrie	73,000	36,500
3	City of Guelph Compost	Guelph	30,000	15,000
4	City of Hamilton Central Composting Facility	Hamilton	40,000	20,000
5	City of Orillia Compost	Orillia	73,000	36,500
6	City of Peterborough Compost	Peterborough	45,000	22,500
7	Convertus London	London	150,000	75,000
8	Convertus Ottawa	Edwards	100,000	50,000
9	County of Northumberland Compost Facility	Brighton	1,000	500
10	County of Simcoe Compost	Collingwood	1,000	500
11	District Municipality of Muskoka Compost	Gravenhurst	1,000	500
12	GFL Environmental	Casselman	120,800	12,000
13	Miller Composting	Pickering	25,000	12,500
14	Ottawa Valley Waste Recovery Centre	Pembroke	6,000	3,000
15	Region of Peel Compost	Brampton	60,000	30,000
16	SusGlobal Energy	Roslin	30,000	15,000
17	Tomlinson Organics	Kingston	10,000	5,000
18	Town of Dryden Compost	Oxdrift	1,000	500
19	Town of Prescott Compost	Prescott	1000	500
20	Township of Southgate Compost	Dundalk	1,000	500
21	Walker Environmental	Thorold	90,000	73,000
	Total		1,931,817	881,908

ROF consuming compost facilities in Ontario

Map 5-3: ROF consuming compost facilities in Ontario



Map 5-4: ROF consuming compost facilities in Southern Ontario

5.3 LANDFILLS

Landfills do not actively seek feedstock but rather serve as a last resort for ROF disposal. Landfills are utilized if i) they are a less expensive option than ROF processing facilities; ii) there is no ROF-processing infrastructure in convenient location; iii) ROF is highly contaminated and unacceptable by ROF-processing facilities.

Twenty-seven MSW landfills accept ROF operate in Ontario. (Maps 5-4 and 5-5, Table 5-4). Tipping fees range between $61-$204/mt, or $104/mt on average, depending on the location and owner. Due to these relatively high tipping fees, haulers transport significant quantities of MSW to landfills in Michigan, where the tipping fees are as low as $25 - $35/mt.

Map 5-5: Landfills in Ontario

Map 5-6: Landfills in Southern Ontario

Landfills in Ontario

Table 5-4: Landfills in Ontario

# On Map	Facility	City	Fill Rate (tpy) as of 2010/11*	Total Waste Received (tpy) as of 2011*	Assumed Waste Density **(tonnes/m³)	Estimated Remaining Capacity (years) as based on Fill Rate	Estimated Remaining Capacity (years) as based on Waste Received	Estimated residential food waste in MSW (tpy)
1	Bensfort Road	Peterborough	85,000	72,277	0.7	12.88	15.14	10,376
2	City of Barrie Landfill (Sandy Hollow)	Barrie	81,000	36,609	0.7	5.57	12.32	9,888
3	Cornwall Landfill	Cornwall	103,000	45,972	0.7	7.26	16.27	12,573
4	Deloro	Timmins	43,000	35,497	0.7	62.62	75.85	5,249
5	Eastern Ontario Waste Handling Facility	Moose Creek	755,000	281,461	0.7	4.73	12.69	92,163
6	EWSWA Regional Landfill	Harrow	275,000	224,5725	0.8	24.09	29.50	33,569
	Glanbrook	Hamilton	662,110	134,534	0.8	7.25	35.70	80,824
7	Green Lane	Southwold	1,100,000	741,391	0.9	10.74	15.94	134,277
8	Halton Regional Landfill	Milton	123,000	74,327	0.7	28.80	47.65	15,015
9	Humberstone	Welland	255,500	59,528	0.8	1.38	5.94	31,189
10	Lindsay-Ops	Kawartha Lakes	58,200	29,342	0.7	13.49	26.75	7,104
11	Line 5 Landfill	Sault Ste. Marie	58,000	63,010	0.7	13.22	12.17	7,080
12	Merrick Landfill	North Bay	49,000	44,899	0.7	20.97	22.89	5,981
13	Mohawk Street	Brantford	176,059	79,055	0.7	26.54	59.11	21,492
14	Newalta Stoney Creek Landfill	Stoney Creek	750,000	874,054	0.7	1.77	1.51	91,553
15	Niagara Regional Road 12	Smithville	49,640	16,011	0.7	18.68	57.91	6,060
16	Niagara Waste Systems Limited Walker South Landfill	Niagara Falls	850,000	839,394	0.7	13.44	13.61	103,760
17	Ottawa Valley Waste Recovery Centre	Pembroke	73,000	59,813	0.7	9.25	11.29	8,911
18	Ridge Landfill	Blenheim	1,212,165	726,483	0.9	9.22	15.38	147,969
19	Salford	Salford	116,000	51,036	0.7	18.36	41.73	14,160
20	Stratford	Stratford	No Data	23,901		No Data	32	NA
21	Sudbury Landfill	Sudbury	131,400	68,388	0.7	17.72	34.05	16,040
22	Thunder Bay Solid Waste and Recycling Facility	Thunder Bay	No Data	132,323	0.7	No Data	15.06	NA
23	Trail Road	Richmond	563,300	233,485	0.7	8.20	19.78	68,762
24	Twin Creeks	Alvinston	750,000	429,041	0.7	21.16	36.99	91,553
25	W12A	London	600,000	250,949	0.8	5.74	13.72	73,242
26	Waterloo Landfill	Waterloo	492,750	209,907	0.7	8.15	19.13	60,150
27	WSI Navan Road	Ottawa	344,750	342,202	0.7	7.43	7.49	42,084

6.0 ROF SURPLUS ANALYSIS

Our modelling indicates that, *in total, there is a surplus of at least 1,371,478 tpy of ROF in Ontario. The City of Toronto and three surrounding municipalities -- Mississauga, Brampton, and Vaughan -- together account for 1,047,205 tpy (76%) of the surplus.*

The surplus potential availability of ROF is defined as the difference between generated ROF and ROF processing facilities' (ADs and compost facilities) ROF intake capacities. The objective of this section is to model and map the surplus potential availability of ROF. To achieve the objective, we model the flow of ROF in Ontario based on processing facility ROF intake capacity and distance to the source of ROF.

Results

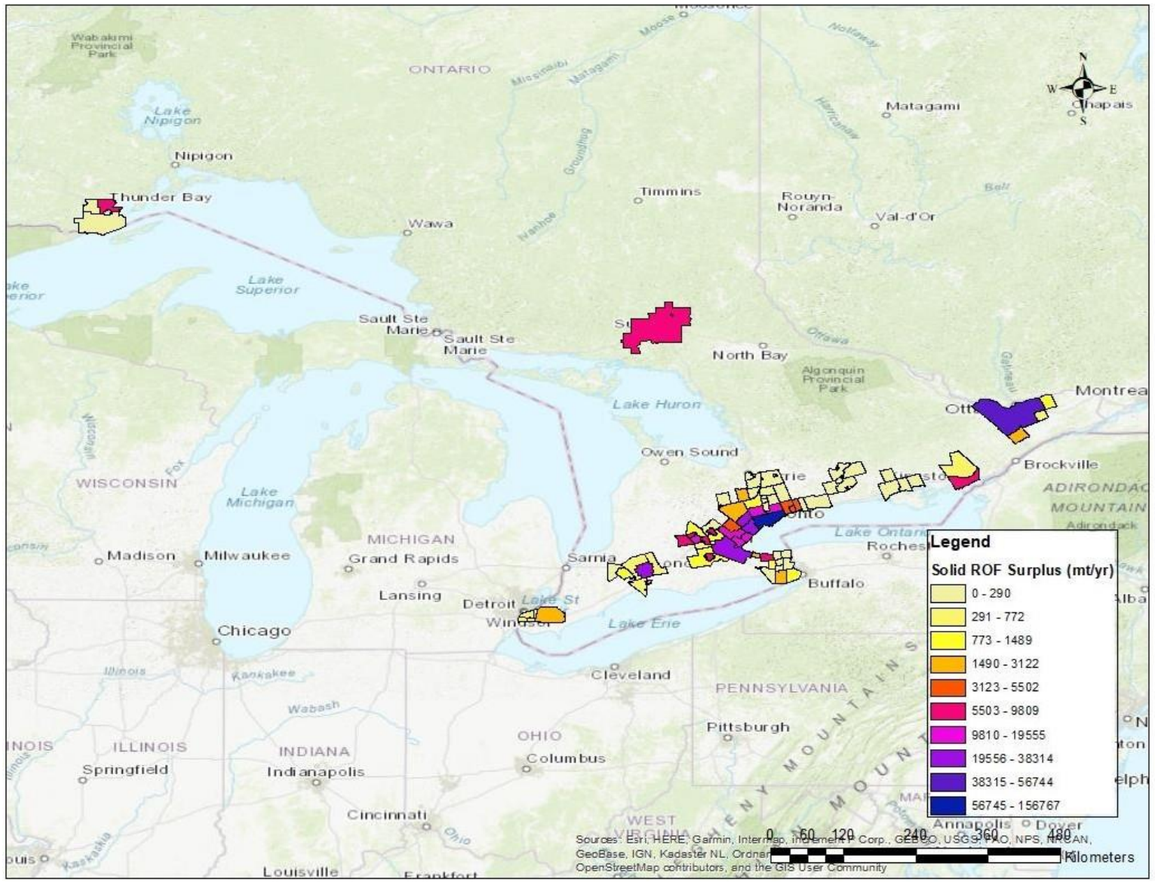
Our modelling indicates that a surplus of at least 957,792 tpy of ROF exists in Ontario. Of that amount, solid ROF accounts for 562,487 tpy and liquid ROF for 546,998 tpy. Currently, the surplus is either landfilled, disposed of at wastewater treatment plants, land applied, or used as animal feed. The City of Toronto and three surrounding municipalities – Mississauga, Brampton, and Vaughan – together account for 550,449 tpy of surplus. Table 6-1 lists CMAs with at least 10,000 tpy of surplus ROF. (See Appendix C for a list of all CMAs.) Maps 6-1 and 6-2 show the distribution of surplus ROF across the province.

Table 6-1: CMAs with >10,000 tpy of surplus ROF in Ontario

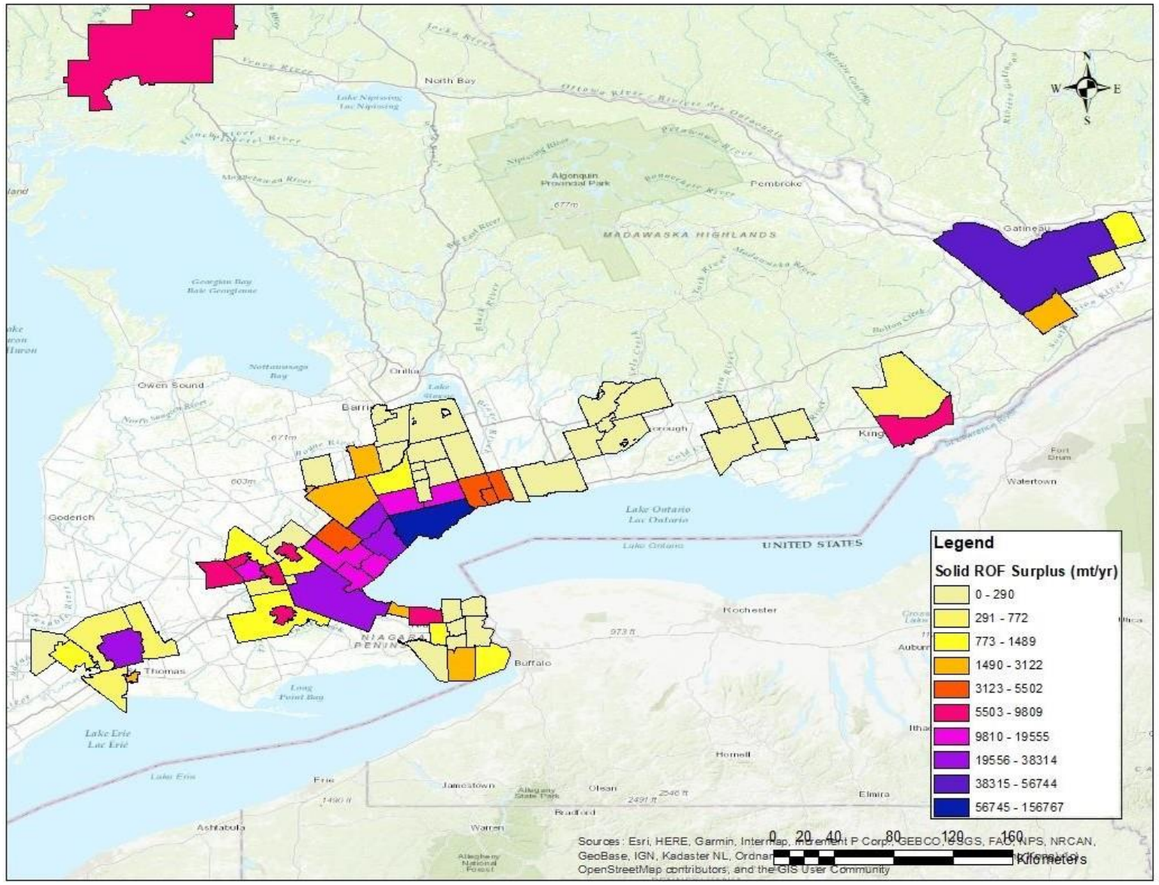
CMA	Solid (tpy)	Liquid (tpy)	Total (tpy)
Toronto	156,767	134,515	291,282
Brampton	31,697	77,975	109,672
Mississauga	38,314	64,550	102,864
Hamilton	34,234	47,100	81,334
Ottawa	56,744	6,168	62,912
Vaughan	19,555	27,077	46,631
Burlington	13,691	18,522	32,212
Woolwich	1,101	27,254	28,355
London	24,075	0	24,075
Markham	15,890	6,670	22,560
Oakville	14,501	7,490	21,990
Belleville	0	20,226	20,226
Milton	18,498	1,710	20,208
Cambridge	8,440	10,910	19,350
Guelph	9,081	8,364	17,445
Kitchener	12,076	3,948	16,025
Brantford	7,486	8,192	15,678
Kingston	9,809	4,283	14,092
Greater Sudbury	8,865	2,016	10,881

Estimated solid ROF surplus in Ontario

Map 6-1: Solid ROF surplus in Ontario

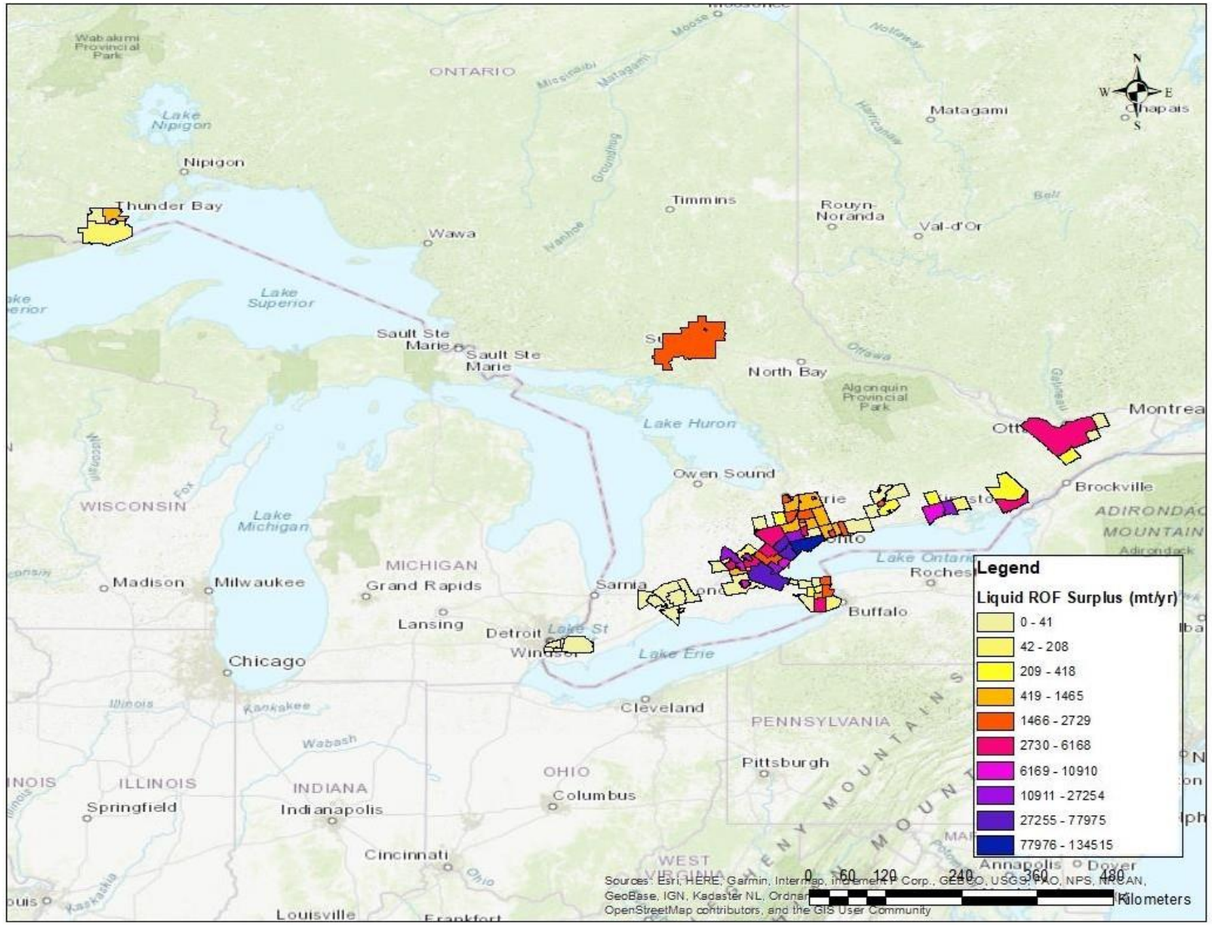


Map 6-2: Solid ROF surplus in Southern Ontario

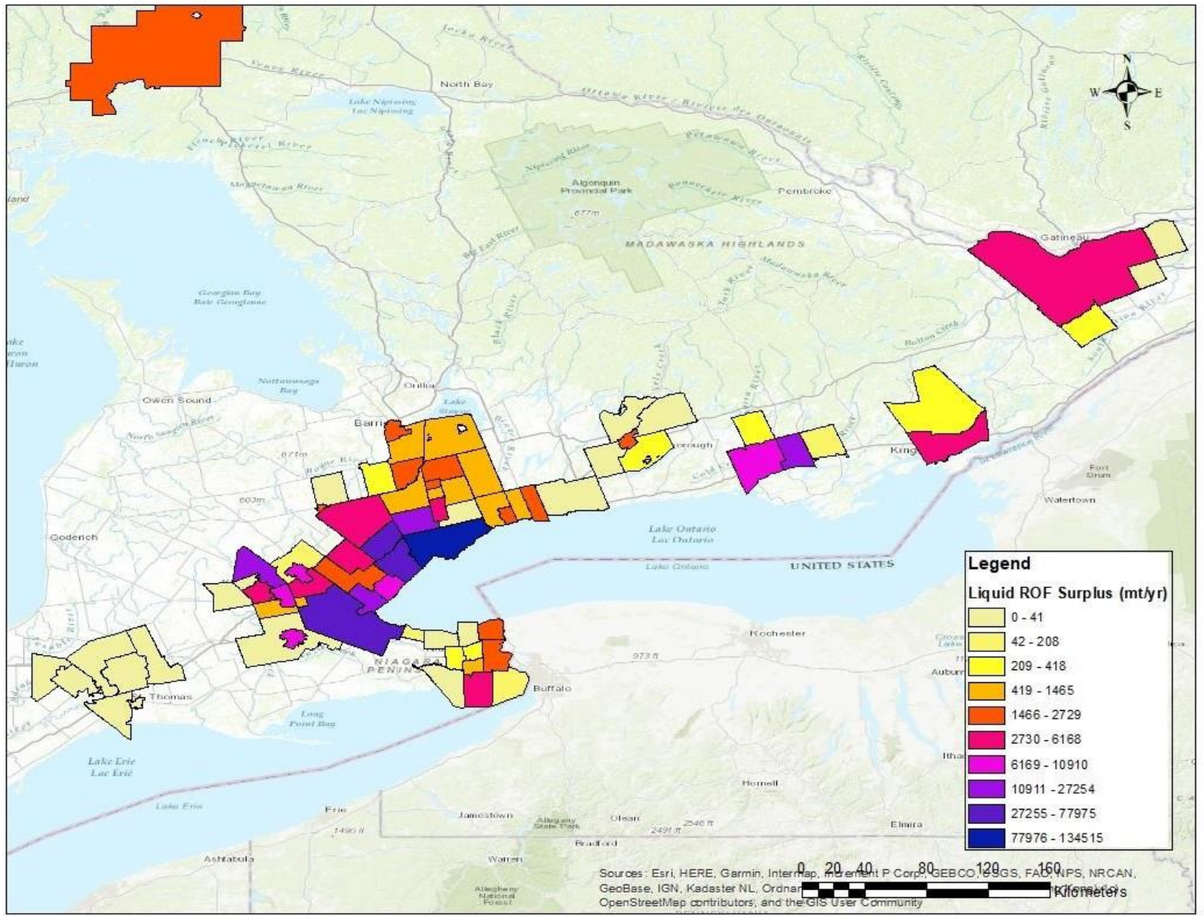


Estimated liquid ROF surplus in Ontario

Map -3: Liquid ROF surplus in Ontario



Map 6-4: Liquid ROF surplus in Southern Ontario



7.0 KEY BARRIERS TO INVESTMENT FROM FEEDSTOCK PERSPECTIVE

This section outlines barriers to investment from a feedstock perspective only, and does not take into account other risk factors such as energy risk, RNG price risk , operational risk, etc.

Investment in new anaerobic digesters from the feedstock perspective are:

1. ***Availability of long-term supply contracts;***
2. ***Availability of proximal feedstock;***
3. ***Data access / understanding of feedstock availability;***
4. ***Lack of market transparency.***

Long–term supply contracts

Most investors prefer, and many require, long-term feedstock supply contracts (5-year minimum, and preferably longer) with credit-worthy suppliers. However, except for municipally controlled contracts for SSO, investors and developers have difficulty acquiring long-term contracts, since feedstock generators are usually unwilling to provide them. They're reluctant to commit to volumes or long-term pricing because of the high costs associated with the disposal of food processing by-products, and because they're aware that alternative disposal applications may be developed. Similarly, traditional waste haulers understand that ROF's value is influenced by demand. Since new processing facilities are being developed, they prefer to keep their options open. The situation is further exacerbated by the fact that a few of the larger haulers are also engaged in developing processing facilities, which makes them reluctant to commit ROF to potential competitors over the long-term.

Proximity to feedstock

Due to the low land costs and wide availability of agricultural feedstocks in rural regions, many developers plan to locate anaerobic digesters in those areas. Since ROF is largely generated in urban regions however, the greater the distance haulers must travel to ADs, the higher the transportation costs. Therefore, to stay competitive, companies with ADs located far from ROF generation sources need to lower their tipping fees. Another factor worthy of note here is that in cases where ROF is disposed of directly at a processing site (as opposed to passing through a transfer station), haulers often choose the closest disposal option even when the tipping fee is unfavorable, because they stand to benefit by minimizing the time they spend on the road.

Availability of feedstock

Since large ROF generators in Ontario are not required to report on the volumes of organic waste they generate, it is difficult to estimate with a high degree of accuracy how much ROF is potentially available in any one area. While we have relied on industry-standard conversion factors to arrive at our high-level estimates, currently the only way to estimate the potential availability of ROF in specific areas with a high degree of accuracy is via direct outreach to generators, which can be a time-consuming and expensive process.

Market transparency

Since ROF processing facilities in Ontario are not required to report on the volumes of ROF they process either, it is likewise difficult to provide an accurate sense of the competitive landscape — another factor that introduces uncertainty into a market analysis. It is worth noting, however, that this lack of market transparency is generally widely supported by present market players, because any strategy that prevents new entrants to the marketplace reduces competition. More competition will be necessary to reduce tipping fees for processors.

8.0 KEY DRIVERS IN TIPPING FEE & HAULING COSTS

Tipping Fees

There are four key drivers in tipping fee increases/decreases: presence of an organic waste diversion policy, presence of competing ROF processors, landfill tipping fees and feedstock quality.

Presence of an organic waste diversion policy

Jurisdictions that have policies on organic waste diversion in place tend to experience higher tipping fees. In Connecticut, for example, an entity that generates more than 52 tons of ROF annually must divert the organic waste to a processing facility if that facility is located within 20 miles of the generator. Since generators are mandated to divert ROF, processing facilities often exploit the situation by increasing their tipping fees.

ROF processing capacity

Tipping fees increase when the market loses capacity, such as when a processing facility reaches capacity and decreases its intake or ceases operations altogether. In that scenario, processors with capacity can increase their tipping fees. Conversely, when additional capacity enters the market, such as when a new AD or composter becomes operational and attempts to source ROF at a lower rate than that of its competitors, tipping fees decrease and prompt a market shift, since other facilities lower their tipping fees to stay competitive.

Landfill tipping fees

In jurisdictions that lack policies on organic waste diversion, ROF processors tend to lower their tipping fees to compete with those of landfills to incentivize generators to separate and divert ROF to processing facilities.

Feedstock quality

Processing facilities charge lower tipping fees for higher quality ROF and raise them when the feedstock is highly contaminated or packaged.

Hauling Costs

There are three key drivers which impact hauling costs: distance travelled, vertical integration of haulers and external factors (diesel and labor costs).

Distance

The greater the distance ROF must travel, the higher its hauling costs. Processing facilities with access to generators nearby thus enjoy a competitive advantage over those located far from ROF sources.

Vertical Integration

ROF facilities with vertically integrated supply chains, such as those that own their own trucks and trailers, will experience lower hauling costs than those that outsource the task to third-party waste haulers, which aim to increase their profits by driving up prices. In regions with sparse service, such facilities have additional leverage. Note, however, that vertical integration of ROF hauling also introduces additional CAPEX and operational risks.

External Factors

External factors that affect hauling costs such as diesel and labor costs have historically trended upwards. While we don’t address the drivers of such costs, historical trends suggest they’ll continue to rise in the short-term.

9.0 EFFECT OF ROF LANDFILL BAN ON TIPPING FEES

Currently, 60% of Ontario's total food waste is sent to landfill.

Cautionary note: Our conclusions in this section remain largely speculative since we lack data on the effect of landfill bans on organic waste disposal.

Sixty per cent of Ontario's food waste is currently sent to landfill. In 2022, Ontario plans to introduce a landfilling ban on organics as part of its Food and Organic Waste Framework. The Ontario government hopes that introducing the ban will result in the diversion of the vast majority of currently landfilled ROF to processing facilities. However, in our view, this is unlikely to happen. Presently, a significant proportion of Ontario-generated MSW, especially that generated in the GTA, goes to landfills in Michigan, in part because, due to limited capacities, Ontario's landfills limit the volumes of MSW they accept, and in part because tipping fees at Michigan landfills are significantly lower than those at Ontario's.

Since major volumes of ROF go to Michigan landfills, a simple ban on organics is unlikely to have much of an impact on ROF flows. In our view, introducing an organics diversion policy at the generator stage, like the one implemented in Connecticut, would be a far more effective way to address the problem.

Assuming an effective policy is implemented, a larger volume of ROF will likely become available to new disposal markets. However, enough facilities capable of handling the ROF surplus entering the market still would not exist. It is therefore reasonable to assume that with minimal disposal options available, existing compost facilities and ADs would likely increase prices to compensate for the shortage and tipping fees at those facilities would initially increase in response to a landfill ban.

If higher volumes of ROF enter Ontario's organics disposal market, new processing facilities will likely enter the market, and the increased competition would result in tipping fees decreasing. However, over time, as new facilities enter the market, or existing ones increase their capacity, the market would likely become more saturated, and tipping fees would adjust in response to a more stable market scenario.

The availability of ROF for disposal facilities such as composts and ADs will also depend heavily on how Ontario prioritizes where it diverts organics. For example, some municipalities and states have introduced organic waste diversion policies that prioritize food rescue, which means disposing food waste by donating it to shelters and other facilities. New York and Vermont have both prioritized food rescue as their first diversion option. In Vermont, the decision has resulted in a 50% increase in food rescue across the state. That being said, food waste that could be 'rescued' makes up a small portion of all ROF, and therefore a food rescue policy would have a minimal impact on the availability of ROF to anaerobic digesters.

10.0 CONCLUSIONS

Opportunities for AD development

As ROF has increasingly become recognized as a valuable resource, the market has begun to consolidate. Several large haulers and aggregators are now attempting to control its flow. As a result, it has become harder for new players to enter the market. Nevertheless, given the significant quantities of unprocessed ROF available, we believe that plenty of room still exists for new market players to develop ADs.

Our analysis suggests that more than 1.1 million tpy of ROF remain unprocessed by anaerobic digesters or compost facilities in the province. Although some ROF resides in rural regions such as Greater Sudbury, most is clustered around southern Ontario's Golden Horseshoe area, which is large enough to support a significant number of new ADs, depending on their capacities.

The largest opportunity to introduce new anaerobic digesters in Ontario exists in the Toronto/Peel region, where the total ROF surplus is 503,817 tpy.

Optimal locations

Our ROF surplus model clearly indicates that the best location for a new digester is in the GTA, especially its western end. More than 0.5 million tpy of surplus ROF exist in Toronto, Brampton and Mississauga, and significant amounts can also be found in Vaughan, Burlington, and Oakville. In addition to the two Toronto-based CCI digesters, much of the ROF collected in Toronto currently goes to major anaerobic digesters located elsewhere in the province, namely Stormfisher in London, Seacliff in Leamington and BioEn in Elmira. In our view, a large AD facility located in Toronto's west end could intercept the ROF that is currently travelling to distant digesters.

It is important to note however, that our conclusion above does not account for the fact that land in the Toronto and Peel regions can be prohibitively expensive for AD development. As well, due to potential traffic and odour issues, installing an AD in those areas could result in a local resident backlash. However, the fact that two CCI digesters successfully operate in the City of Toronto indicates that such challenges can be overcome.

Assuming a commercial-scale digester could reasonably procure at least 50,000 tpy of ROF, our modelling indicates that Hamilton and Ottawa can also support AD development. In our model, the former has an ROF surplus greater than 81,000 tpy, and the latter of 63,000 tpy. Furthermore, since our estimates do not include surrounding areas, the actual amount of potentially available ROF is likely higher.

De-packaging infrastructure opportunities

Our survey of ROF generators and haulers in Ontario revealed that while a significant amount of packaged ROF is potentially available to anerobic digesters, they do not currently have the infrastructure to de-package it. Only two ADs that source ROF from ICI sectors, both located in southwestern Ontario, have de-packagers onsite. Both of these facilities are likely at capacity and cannot intake large volumes of additional feedstock. Based on these data, we believe an opportunity exists to introduce more ADs with de-packagers into the marketplace, especially in the Toronto and Peel regions, where we have identified ROF surpluses.

APPENDIX A: METHODOLOGY FOR FEEDSTOCK GENERATION ESTIMATES

This appendix describes the methodologies and data sources used to assess Recyclable Organic Feedstock ("ROF") generation and competition in the supply basin.

High-Level Recyclable Organic Feedstock Generation Methodology

Industrial sources

In this study, we provide estimates of high-level generation for industrial Solid and Liquid ROF separately. Estimates of ROF generation are based on census subdivision employment data for the following North American Industry Classification System (NAICS) sectors:

- NAICS 3111: Animal food manufacturing
- NAICS 3112: Grain and oilseed milling
- NAICS 3113: Sugar and confectionery product manufacturing
- NAICS 3114: Fruit and vegetable preserving and specialty food manufacturing
- NAICS 3115: Dairy product manufacturing
- NAICS 3116: Meat product manufacturing
- NAICS 3118: Bakeries
- NAICS 3119: Other food manufacturing

Census subdivision employment data were obtained from the Statistical Registers and Geography Division of *Statistics Canada*. Because this survey provides ranges of employment size classes, we applied the median value in each range to estimate the quantity of waste generated.

Our estimates also rely on sector-specific food-processing transfer functions to estimate the quantities of ROF generated by each sector. These transfer functions are based on historical ROF generation data from approximately 500 food-processing facilities across North America.

Note on ROF generation estimates

ROF generation estimates serve as high-level indications of potential feedstock generation only. These estimates are based on proxy data and are derived from algorithms that are subject to a degree of error (+/- 15%). Feedstock generation estimates are intended to be used as tools for high-level decision making and to draw attention to any early red flags. They are not meant to provide accurate quantities of generated ROF.

Estimates of Solid and Liquid ROF generation are based on Census Metropolitan Area level employment data for each of these sectors and the transfer functions outlined in Table A-1 below. Employment data were obtained from the Census Data's 2016 *Geographic Area Series: County Business Patterns* survey. Sector-specific food processing transfer functions are based on historical waste generation data from approximately five hundred food processing facilities.

This survey provides ranges of employment size classes at the county level. Ecostrat applied the median value in each range to estimate the quantity of waste generated.

APPENDIX A: METHODOLOGY FOR FEEDSTOCK GENERATION ESTIMATES

Institutional and commercial sources

Estimates of commercial and institutional ROF generation are based on the following sectors, with the transfer functions listed in Appendix A:

- NAICS 4451: Grocery stores
- NAICS 7225: Full-service Restaurants
- NACIS 7211: Hotels
- NACIS 7112: Spectator Sports
- NACIS 611: Schools
- NACIS 9221: Prisons
- NACIS 6221: Hospitals
- NACIS 6231: Nursing Homes

Municipal Source Separated Organics (SSO) generation estimates

Estimates of Source Separated Organics (SSO) generation are based on the following published report:

- Resource Productivity and Recovery Authority's Datacall (2019)

Fats, Oils and Greases (FOG) sources

Fats, oils and greases (FOG) refer to grease trap waste generated by commercial restaurants and cafeterias/kitchens. A transfer function of 13 pounds of FOG per person per year is applied to census population data based on municipal census subdivisions in the supply basin to estimate total FOG generation.

APPENDIX A-1: FEEDSTOCK GENERATION TRANSFER FUNCTIONS

Sector	Transfer function	Source
NAICS 4244 (Grocery)		Massachusetts Department of Environmental Protection, "Identification, Characterization, and Mapping of Food Waste and Food Waste Generators in Massachusetts," September 2002. (Average of 25 employees per food store based on NCRLA data.)
NAICS 7225 (Restaurants)		Ibid.
NAICS 3111 – 3119 (Various food manufacturing)	Proprietary	Data obtained from the Wisconsin Department of Natural Resources, Pennsylvania Department of Environmental Protection Residual Waste Management and sector specific data points related to actual waste generation at the facility level.
FOG		Wiltsee, G., Urban Waste Grease Resource Assessment", NREL/SR-570-26131, November, 1998.
Schools		Block D. "School districts supplies organics to commercial composters," BioCycle, 57-58, August 2000.
Prisons		Connecticut Department of Environmental Protection, "Identifying, quantifying, and mapping food residuals from Connecticut businesses and institutions." Prepared by Draper/Lennon and Atlantic Geoscience Corp., September 2001.
Hospitals		Massachusetts Department of Environmental Protection, "Identification, characterization, and mapping food waste and food waste generators in Massachusetts," prepared by Draper/Lennon, Inc. September 19, 2002.
Nursing homes		Massachusetts Department of Environmental Protection, "Identification, characterization, and mapping food waste and food waste generators in Massachusetts," prepared by Draper/Lennon, Inc. September 19, 2002.
Hotels		Massachusetts Department of Environmental Protection & Center for EcoTechnology, "RecyclingWorks in Massachusetts", https://recyclingworksma.com/food-waste-estimation-guide/
Spectator sports		Ibid.

APPENDIX B: COMPETING MARKETS ANALYSIS METHODOLOGY

Analyses of competing markets are based on direct outreach to competing facilities, secondary research, discussions with local industry experts, and data contained in Ecostrat's "Biomass Supply Network" ®. Facility lists are generated using legal and industry databases and verified using satellite imagery. Information related to intake capacities, types of feedstocks accepted, and associated tipping fees are verified through direct outreach to facilities and supplemented with secondary research when necessary. Government contacts and local industry experts have been consulted to verify relevant markets and competing facilities that have been identified.

Landfill intake levels

All relevant landfill sites within the province of Ontario were identified and their remaining capacity in years was estimated. The information on fill rates, estimated remaining capacity in cubic meters and total waste received in the last reporting year (2010, 2011) for each facility was obtained from the Government of Ontario open data catalogue.

It is common practice to assess waste data in tonnages (weight) instead of volumes since the latter is subject to significant variation. However, the estimated remaining capacity of the landfill sites available from Ontario's open data catalogue is presented as volume. Therefore, to forecast residual capacity (years) based on tonnage of total waste received per year or fill-rate tonnage per year, we depend on methods that rely entirely on the assumption of the bulk density of each landfill site. It is important to highlight that the density of the waste can vary due to different feedstock composition and relative proportions of the different waste types.

Where public data were available, the bulk density from each specific site was used, assuming naturally that the future compaction of the sites did not change significantly throughout the years. For the remaining facilities where density was not recorded, a conservative waste compaction of 0.7 tonnes per m3 was used, based on the average waste density found in the literature.

With bulk densities for each facility defined, the estimated remaining volume presented by the open data catalogue in cubic meters was converted to weight by multiplying the volume (in m3) by the density (in t/mm) of each one of the facilities. The estimated remaining time to fill (in years) for each site could then be calculated by dividing the mass of future waste found (in tonnes), by the landfill fill rate (in tonnes per year) and separately, by the total waste received (in tonnes per year).

Waste weight=(volume of waste) x (assumed density)

Time to fill= (Mass of future waste)/(fill rate)

Time to fill= (Mass of future waste)/(total waste received)

It is noted, however, that the present report estimates the remaining lifespan of the facilities based on Ontario's last dataset dated 2010 and 2011. Since the reported year, some facilities have been approved for expansions of waste volume, which has permitted them to continue their operation for additional years, as stated in the report. Also, the estimated remaining site life is directly affected by the Province's existing and future waste management strategy and diversion initiatives.

APPENDIX C: ROF SURPLUS MODELLING ASSUMPTIONS AND DETAILED RESULTS

Approach

The ROF surplus model simulates the flow of ROF in Ontario by *filling in* ROF processing facilities. That is, ROF moves from its source to a processing facility until that facility is filled, i.e. its ROF intake capacity is reached.

The main modelling approach is based on the assumption that ROF is disposed of at the closest ROF processing facility. This assumption is applied unless information on ROF disposal contracts states otherwise. For example, we know that a certain quantity of SSO generated in Toronto goes to Stormfisher anaerobic digester in London, in which case we model this flow. Otherwise, all remaining flows of ROF are modelled based on distance.

The second main assumption is that SSO and Solid ROF is disposed at compost facilities, and Liquid ROF is disposed at anaerobic digesters. Again, if our data suggests otherwise (for example, CCI anaerobic digesters accept mainly SSO from Toronto), we model these flows accordingly. Otherwise, all remaining flows of ROF are modelled based on this assumption. The assumption is based on the following:

i) Most of compost facilities do not accept Liquid ROF, and those that do, tend to limit its volumes.
ii) Anaerobic digesters in general prefer Liquid ROF over Solid ROF; additionally, many digesters do not have equipment to process Solid ROF or SSO, which is often contaminated with packaging and other materials. The fact that some large digesters, like Stormfisher, accept SSO and Solid ROF is already accounted for when data on actual contracts exist.

Thirdly, we prioritize modelling by ROF type:

i) First, we model the flow of SSO. SSO is the highest value feedstock for processing facilities, that is, it garners the largest tipping fee. It is also a priority for municipalities to ensure that SSO is disposed at processing facilities, and not landfills. Therefore, SSO is the first ROF type we model the flow of, filling in processing facilities; this prioritization ensures that the model results in no surplus of SSO.
ii) Second, we model the flow of Solid and Liquid ROF generated by Census Metropolitan Areas (CMAs), based on high-level ROF generation estimates in Section 2.0. Here we assume that each AD pulls Liquid ROF from the closest CMA until either i) it gets *filled*; ii) or the CMA gets *emptied*. If the CMA gets emptied, the AD pulls Liquid ROF from the next closest CMA. Similarly, we use the same method to model compost facilities' pull of Solid ROF.

Tables C-1 to C-4 show the modelled flow of ROF by source, ROF type, and facility.

Table C-1: Modelled SSO flow

Municipality	SSO generated (tpy)	Modelled end-markets
Toronto	163,934	CCI Disco; CCI Dufferin; BioEn; Stormfisher
York	100,874	Convertus London; BioEn
Ottawa	80,316	Convertus Ottawa; Ottawa Valley Waste Recovery; Town of Prescott Compost; GFL Environmental; Tomlison Organics; SusGlobal
Peel	65,334	Region of Peel Compost; All Treat Farms
Halton	29,581	Stormfisher
Durham	28,522	Miller Composting; City of Barrie Compost
Waterloo	25,926	City of Hamilton Central Composting Facility
Hamilton	16,378	City of Hamilton Central Composting Facility
Simcoe County	14,390	Region of Peel Compost
Niagara	12,696	Walker Environmental
Guelph	10,309	All Treat Farms
Barrie	5,252	City of Barrie Compost
St. Thomas	4,439	Convertus London
Kingston	3,804	Tomlison Organics
Dufferin	3,019	Township of Southgate Compost; All Treat Farms
Greater Sudbury	2,740	All Treat Farms
Orillia	1,163	City of Orillia Compost

APPENDIX C: ROF SURPLUS MODELLING ASSUMPTIONS AND RESULTS

Table C-2: Modelled flow of Solid ROF

CMA	Solid ROF generated (tpy)	Modelled end-markets
Adelaide-Metcalfe, Ontario	240	
Ajax, Ontario	4,658	
Aurora, Ontario	4,300	City of Orillia Compost
Barrie, Ontario	8,363	City of Barrie Compost; City of Orillia Compost
Belleville, Ontario	6,042	SusGlobal
Bradford West Gwillimbury, Ontario	1,637	City of Orillia Compost
Brampton, Ontario	31,697	
Brant, Ontario	1,489	
Brantford, Ontario	7,486	
Burlington, Ontario	13,691	
Caledon, Ontario	4,197	County of Simcoe Compost; Township of Southgate Compost; District Municipality of Muskoka
Cambridge, Ontario	8,440	
Cavan Monaghan, Ontario	308	City of Peterbourough Compost
Clarence-Rockland, Ontario	995	
Clarington, Ontario	3,385	City of Peterborough Compost
Douro-Dummer, Ontario	17	City of Peterborough Compost
East Gwillimbury, Ontario	1,907	City of Orillia Compost
Fort Erie, Ontario	1,400	
Georgina, Ontario	1,947	City of Orillia Compost
Greater Sudbury, Ontario	8,865	
Grimsby, Ontario	2,078	
Guelph, Ontario	9,081	
Guelph/Eramosa, Ontario	268	
Halton Hills, Ontario	3,700	
Hamilton, Ontario	35,332	City of Hamilton Central Composting Facility
Innisfil, Ontario	1,049	City of Orillia Compost
King, Ontario	1,595	City of Orillia Compost
Kingston, Ontario	9,809	
Kitchener, Ontario	12,076	
Lakeshore, Ontario	1,884	
LaSalle, Ontario	1,229	
Lincoln, Ontario	7,384	
London, Ontario	24,075	
Markham, Ontario	15,890	
Middlesex Centre, Ontario	772	
Milton, Ontario	18,498	
Mississauga, Ontario	38,314	
Mono, Ontario	376	County of Simcoe Compost
Neebing, Ontario	50	
New Tecumseth, Ontario	2,317	
Newmarket, Ontario	4,619	City of Orillia Compost
Niagara Falls, Ontario	12,033	Walker Environmental
Niagara-on-the-Lake, Ontario	2,483	Walker Environmental
North Dumfries, Ontario	510	
North Grenville, Ontario	2,464	
Oakville, Ontario	14,501	
Oliver Paipoonge, Ontario	290	
Orangeville, Ontario	2,105	
Oshawa, Ontario	9,324	City of Peterborough Compost
Otonabee-South Monaghan, Ontario	128	City of Peterborough Compost
Ottawa, Ontario	56,744	
Pelham, Ontario	973	
Peterborough, Ontario	6,031	City of Peterborough Compost
Pickering, Ontario	4,592	
Port Colborne, Ontario	2,027	
Puslinch, Ontario	1,407	
Quinte West, Ontario	1,598	SusGlobal; City of Peterborough Compost
Richmond Hill, Ontario	8,495	City of Orillia Compost
Russell, Ontario	671	
Selwyn, Ontario	362	City of Peterborough Compost
South Frontenac, Ontario	745	
Southwold, Ontario	398	
St. Catharines, Ontario	7,781	Walker Environmental
St. Thomas, Ontario	3,122	
Stirling-Rawdon, Ontario	850	City of Peterborough Compost
Strathroy-Caradoc, Ontario	1,069	
Tecumseh, Ontario	1,370	
Thames Centre, Ontario	675	
Thorold, Ontario	29,958	Walker Environmental
Thunder Bay, Ontario	7,468	Town of Dryden Compost
Toronto, Ontario	156,767	Seacliff
Tyendinaga, Ontario	5,237	SusGlobal
Uxbridge, Ontario	986	City of Orillia Compost
Vaughan, Ontario	19,555	
Wainfleet, Ontario	123	
Waterloo, Ontario	6,613	
Welland, Ontario	2,371	Walker Environmental
Whitby, Ontario	7,600	City of Peterborough Compost; County of Northumberland Compost
Whitchurch-Stouffville, Ontario	2,427	City of Orillia Compost
Wilmot, Ontario	6,584	
Windsor, Ontario	520	
Woolwich, Ontario	1,101	

APPENDIX C: ROF SURPLUS MODELLING ASSUMPTIONS AND RESULTS

Table C-3: Modelled flow of Liquid ROF

CMA	Liquid ROF generated (tpy)	Modelled end-markets
Adelaide-Metcalfe, Ontario	296	Eilers Farm; Seacliff
Ajax, Ontario	2,374	
Aurora, Ontario	788	
Barrie, Ontario	1,695	
Belleville, Ontario	20,226	
Bradford West Gwillimbury, Ontario	2,153	
Brampton, Ontario	77,975	
Brant, Ontario	1,987	Seacliff
Brantford, Ontario	15,159	Seacliff
Burlington, Ontario	18,522	
Caledon, Ontario	5,671	Clovermead Farms
Cambridge, Ontario	11,410	Delft Blue Veal
Cavan Monaghan, Ontario	400	Maryland Biogas
Clarence-Rockland, Ontario	172	Terryland Farms
Clarington, Ontario	735	Maryland Biogas
Douro-Dummer, Ontario	40	
East Gwillimbury, Ontario	2,729	
Fort Erie, Ontario	195	
Georgina, Ontario	1,023	
Greater Sudbury, Ontario	2,016	
Grimsby, Ontario	168	Bayview Flowers
Guelph, Ontario	8,364	
Guelph/Eramosa, Ontario	163	
Halton Hills, Ontario	4,078	
Hamilton, Ontario	47,100	
Innisfil, Ontario	799	
King, Ontario	1,299	
Kingston, Ontario	4,283	
Kitchener, Ontario	3,948	
Lakeshore, Ontario	2,102	Seacliff
LaSalle, Ontario	178	Seacliff
Lincoln, Ontario	1,529	Bayview Flowers
London, Ontario	29,509	Greenholm Farms; Koskamp Farm; Marl Creek Renewables; Seacliff
Markham, Ontario	6,670	
Middlesex Centre, Ontario	1,355	Ben Gardiner Farms; Birchlawn Farms; Eilers Farm
Milton, Ontario	1,710	
Mississauga, Ontario	64,550	
Mono, Ontario	138	Clovermead Farms
Neebing, Ontario	208	
New Tecumseth, Ontario	398	
Newmarket, Ontario	2,639	
Niagara Falls, Ontario	2,330	
Niagara-on-the-Lake, Ontario	2,189	
North Dumfries, Ontario	930	
North Grenville, Ontario	324	
Oakville, Ontario	7,490	
Oliver Paipoonge, Ontario	35	
Orangeville, Ontario	2,127	
Oshawa, Ontario	2,623	
Otonabee-South Monaghan, Ontario	357	
Ottawa, Ontario	12,631	Ferme Geranik; Jockvalley Farms; Kirchmeier Farms; Schouten Farms; Terryland Farms
Pelham, Ontario	279	
Peterborough, Ontario	7,670	Maryland Biogas
Pickering, Ontario	1,298	
Port Colborne, Ontario	5,710	
Puslinch, Ontario	3,710	
Quinte West, Ontario	8,117	
Richmond Hill, Ontario	4,761	
Russell, Ontario	115	Ferme Geranik
Selwyn, Ontario	1,007	Maryland Biogas
South Frontenac, Ontario	388	
Southwold, Ontario	43	CARES
St. Catharines, Ontario	3,418	Bayview Flowers
St. Thomas, Ontario	1,046	CARES, Seacliff
Stirling-Rawdon, Ontario	418	
Strathroy-Caradoc, Ontario	8,849	Seacliff
Tecumseh, Ontario	7,816	Seacliff
Thames Centre, Ontario	252	Greenholm Farms
Thorold, Ontario	285	
Thunder Bay, Ontario	1,465	
Toronto, Ontario	148,515	Zooshare
Tyendinaga, Ontario	204	
Uxbridge, Ontario	1,148	
Vaughan, Ontario	27,077	
Wainfleet, Ontario	41	
Waterloo, Ontario	15,599	Athlone Biopower
Welland, Ontario	732	
Whitby, Ontario	908	
Whitchurch-Stouffville, Ontario	1,090	
Wilmot, Ontario	2,393	Athlone Biopower
Windsor, Ontario	3,101	Seacliff
Woolwich, Ontario	27,254	

APPENDIX C: ROF SURPLUS MODELLING ASSUMPTIONS AND RESULTS

Table C-4: Modelled flow of ROF by facility and source

Facility	Type	Modelled sources of ROF
CCI Disco	AD	SSO Toronto
CCI Duffering	AD	SSO Toronto
Stormfisher	AD	SSO Halton; SSO Toronto; London (Liquid); St. Thomas (Liquid)
City of Guelph	Compost	SSO Waterloo
Walker Environmental	Compost	SSO Niagara; SSO Waterloo; Thorold (Solid); Niagara (Solid); Niagara-on-the-Lake (Solid); St. Catherines (Solid); Welland (Solid)
Convertus Ottawa	Compost	SSO Ottawa
Ottawa Valley Waste Recovery Centre	Compost	SSO Ottawa
Region of Peel Compost	Compost	SSO Region of Peel
Miller Composting	Compost	SSO Durham Region
City of Hamilton Central Composting Facility	Compost	SSO Hamilton; SSO Waterloo
City of Barrie Compost	Compost	SSO Barrie; SSO Simcoe County; SSO Barrie; SSO Durham; Barrie (Solid)
All Treat Farms (Walker Environmental)	Compost	SSO Guelph; SSO County of Dufferin; SSO Greater Sudbury; SSO Peel
Convertus London	Compost	SSO St. Thomas; SSO York Region
Tomlinson Organics	Compost	SSO Kingston; SSO Ottawa
Township of Southgate Compost	Compost	SSO County of Dufferin
City of Orillia Compost	Compost	SSO Orillia; Georgina (Solid); Barrie (Solid); Innisfil (Solid); Uxbridge (Solid); East Gwillimbury (Solid); Bradford (Solid); Whitchurch (Solid); Newmarket (Solid); Aurora (Solid); Richmond Hill (Solid)
BioEn	AD	SSO York Region; SSO Toronto
Town of Prescott Compost	Compost	SSO Ottawa
GFL Environmental	Compost	SSO Ottawa
Petrocorn Farms (CH FOUR Biogas)	AD	SSO Ottawa
SusGlobal Energy	Compost	SSO Ottawa; Belleville (Solid); Tyendinaga (Solid); Quinte West (Solid)
City of Hamilton Central Composting Facility	Compost	SSO Peel; Hamilton (Solid)
City of Peterborough Compost	Compost	Otonabee (Solid); Peterborough (Solid); Douro-Dummer (Solid); Selwyn (Solid); Cavan-Monaghan (Solid); Clarington (Solid); Oshawa (Solid); Stirling (Solid); Quinte West (Solid)
County of Northumberland Compost Facility	Compost	Whitby (Solids)
County of Simcoe Compost	Compost	Mono (Solid); Caledon (Solid)
District Municipality of Muskoka Compost	Compost	Caledon (Solid)
Town of Dryden Compost	Compost	Thunder Bay (Solid)
Township of Southgate Compost	Compost	Caledon (Solid)
Athlone BioPower	AD	Wilmot (Liquid); Waterloo (Liquid)
Bayview Flowers	AD	Lincoln (Liquid); St. Catherines (Liquid); Grimsby (Liquid)
Ben Gardiner Farms	AD	Middlesex Center (Liquid)
Birchlawn Farms	AD	Middlesex Center (Liquid)
CARES University of Guelph Ridgetown	AD	Southwold (Liquid); St. Thomas (Liquid)
Clovermead Farms	AD	Mono (Liquid); Caledon (Liquid)
Delft Blue Veal	AD	Cambridge (Liquid)
Eilers Farm	AD	Middlesex Center (Liquid); Adelaide-Metcalfe (Liquid)
Ferme Geranik	AD	Russel (Liquid); Ottawa (Liquid)
Greenholm Farms	AD	Thames Center (Liquid); London (Liquid)
Jockvalley Farms	AD	Ottawa (Liquid)
Kirchmeier Farms	AD	Ottawa (Liquid)
Koskamp Family Farms	AD	London (Liquid)
Marl Creek Renewables	AD	London (Liquid)
Maryland Biogas	AD	Cavan Monaghan (Liquid); Clarington (Liquid); Selwyn (Liquid); Peterborough (Liquid)
Schouten Corner View Farms	AD	Ottawa (Liquid)
Terryland Farms	AD	Clarence-Rockland (Liquid); Ottawa (Liquid)
Zooshare	AD	Toronto (Liquid)
Seacliff Energy	AD	Lakeshore (Liquid); Tecumseh (Liquid); Windsor (Liquid); LaSalle (Liquid); Strathroy-Caradoc (Liquid); Adelaide-Metcalfe (Liquid); St. Thomas (Liquid); London (Liquid); Brant (Liquid); Brantford (Liquid)

APPENDIX D: ABOUT ECOSTRAT

Ecostrat is a North American leader in developing, optimizing and managing biomass supply chains, with a strong history of developing new markets for bioproducts.

Our trusted approach to market review and analysis has been developed and refined by working closely with leading investment banks, lenders and investors in the biomass industry over the past decade. This experience ensures our reports provide clear, actionable insight, along with the necessary data and analysis required to price risk.

Biomass Advisory Group

Founded in 2008, our Biomass Advisory Group has provided supply assessments, market studies and advisory services to biomass stakeholders in the United States and Canada, including Project developers, power utilities, financial institutions, investment funds, engineering companies, First Nation communities, the U.S. Department of Energy and Sustainable Development Technology Canada. Some of our previous clients include JP Morgan, Shell, Enviva, DTE Energy, Macquarie Bank, Tennessee Valley Authority, Southern Company, Rentech, Noresco, EDF, Sweetwater, Solvay, McKinstry, LaFarge, PGE, Eastman, Coca-Cola, Johnson Controls and Siemens.

Information Capital and Data Collection

Our proprietary Biomass Supply Network® (BSN) is the largest, most comprehensive database on organic and woody biomass availability, pricing and markets in North America. Built on more than 10 years of aggregating and curating transactional market data from biomass suppliers and users, the BSN enables best-of-kind analyses on biomass availability and price; market locations, trends, and players; logistics planning and viability; and risks and sensitivities.

Biomass Supply Group

Founded in 1997, our Biomass Supply Group has been a North American leader in sourcing, aggregating and supplying various types of biomass for more than 20 years. That experience has given us a keen understanding of the biomass supply value chain, from point of generation to delivery of final product. We develop markets, logistics and supply chains for wood waste, food waste, industrial wastewater treatment plant sludge, fats, oils, greases, agricultural residues and more. We also have deep links to and service a wide range of North American and international biomarkets, including heat and power, chemical solidification, anaerobic digestion, animal bedding, land application, soil amendment, compost, mulch and wood pellets. We currently move approximately 500,000 tons of biomass on an annual basis within North America.