Greenbelt Greenhouse Gas Emissions Inventory

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The Friends of the Greenbelt Foundation's Working Paper series provides an avenue to disseminate research findings and information on particular topics. It is intended to encourage discussion and the exchange of ideas among Greenbelt stakeholders and the public.

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1. Introduction

This report provides estimates of greenhouse gas emissions from the Greenbelt. Information mirrors the provincial Greenhouse Gases (GHG) reporting format. The Province does not report on land use changes (LUC) as part of its GHG emissions inventory. LUC emissions can be a significant source or sink of GHG emissions so this report contains an analysis of this information for the Greenbelt.

It was not always possible to align provincial and Greenbelt reporting years so the results represent a best approximation at the time of writing.

2. Summary of Accounts

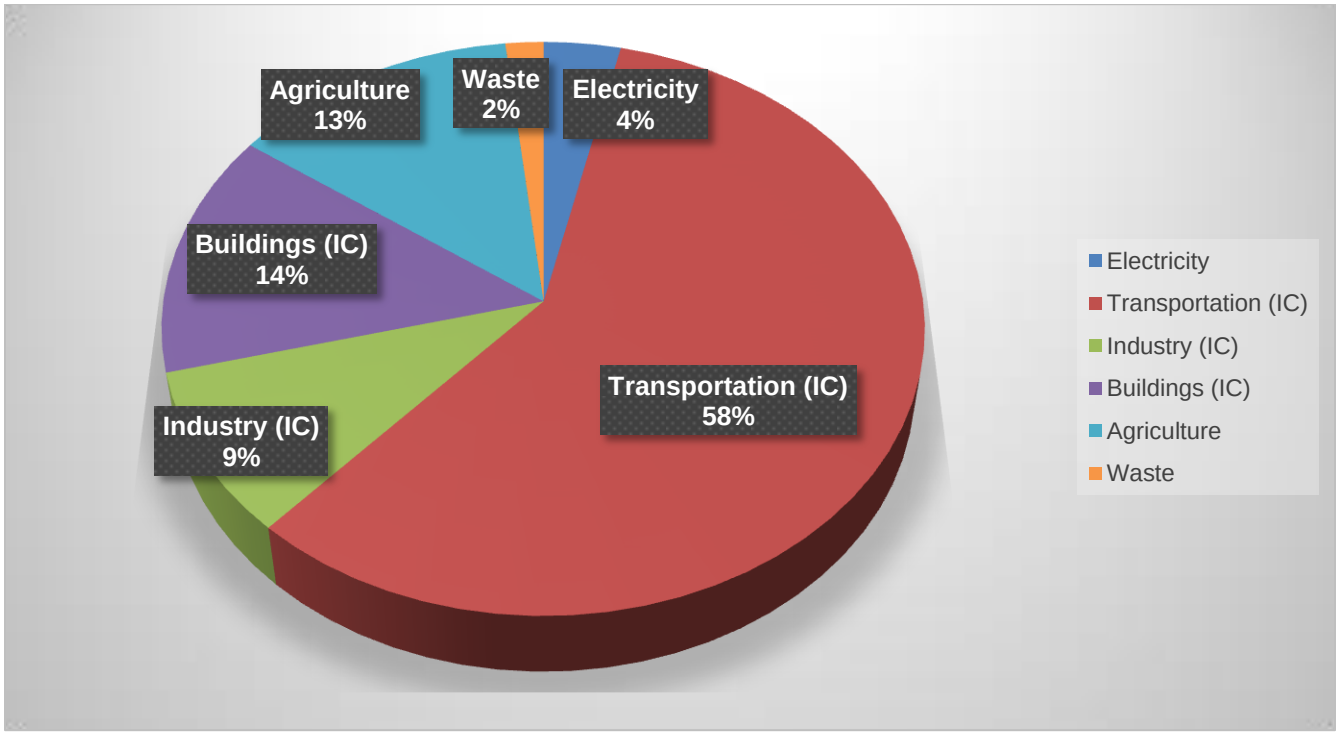
The provincial GHG inventory is described under six categories and 23 sub-categories. Greenbelt estimates are provided for each category and seven sub-categories. Some activities, for example fossil fuel refining, do not take place in the Greenbelt. For other categories such as freight transportation, we are not able to provide estimates without significant additional research. Finally, for some categories such as domestic aviation, it is not possible to disaggregate the data to provide a sensible allocation for the Greenbelt area.

In total, we estimate that 4.9 $MtCO_2e$ result from activities taking place within the Greenbelt, which represents approximately 3% of the provincial total. Over half of the Greenbelt emissions result from road passenger trips based on the number of households in the Greenbelt. The next highest categories are household energy use followed by agriculture, which emit 0.68 and 0.61 $MtCO_2e$ respectively. The Greenbelt's natural assets sequester 0.55 $MtCO_2e$ per year, meaning the net emissions from the Greenbelt are 4.35 $MtCO_2e$ / year. Greenbelt natural assets store 261 $MtCO_2e$. Forests and wetlands sequester carbon each year, while agricultural soils are net carbon emitters based on current management practices. However, agricultural soils have the potential to reverse this trend to become carbon sinks. The 5,580 hectares of pits / quarries in the Greenbelt can be restored to naturalized states, which will add to the carbon stocks and annual rate of sequestration.

Some Greenbelt communities are liable to lose some natural assets to designated greenfield[1] area development (DGA) which we estimate will result in emissions of 3.13 $MtCO_2e$ or 1.2% of current carbon stocks and the loss of 0.0074 MtCO2 in annual sequestration. Additional losses could occur from any new infrastructure and aggregate sites.

[1] DGA calculation taken from Neptis Geoweb

Figure1: Estimated Greenbelt Emissions by Sector



IC: Incomplete data collection meaning there are emissions missing from the estimate

Figure 2: Land Cover in the Greenbelt (ha)

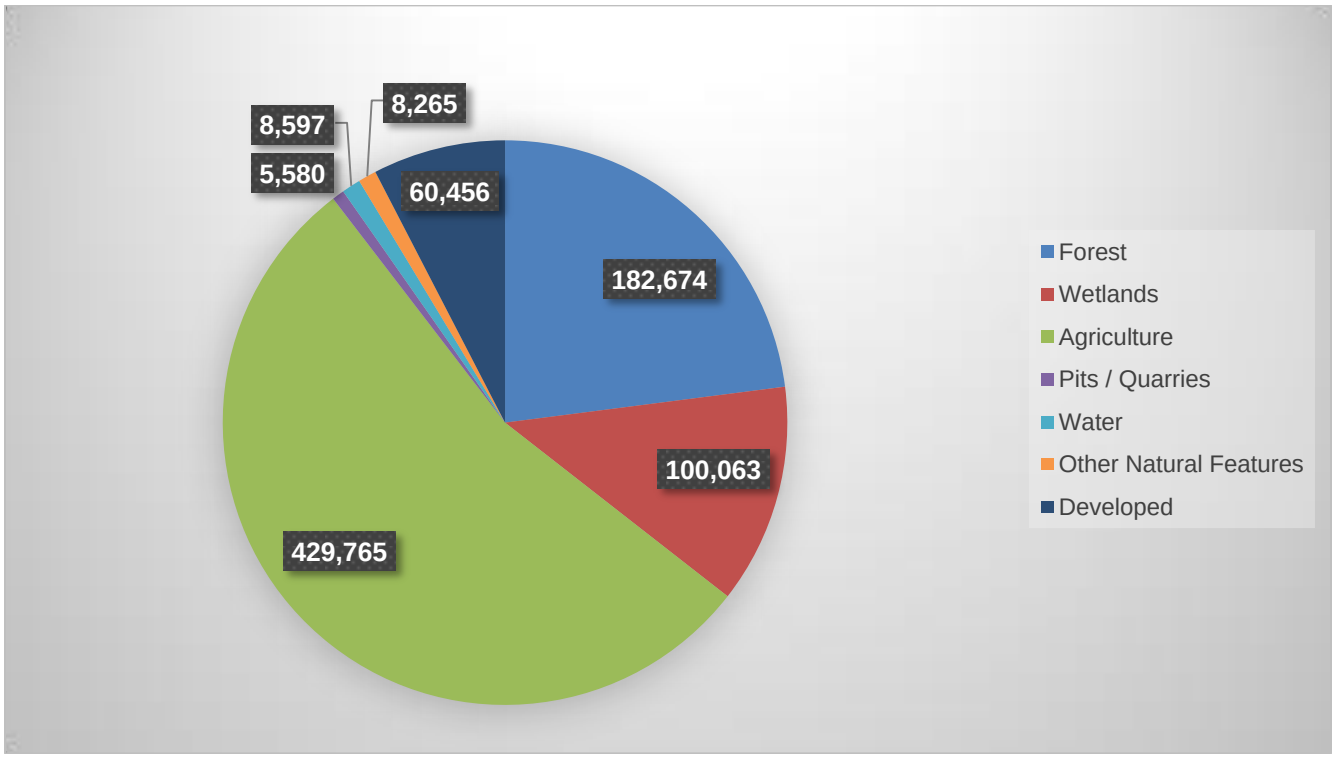


Figure 3: Estimated Carbon Stocks by Land Cover Type

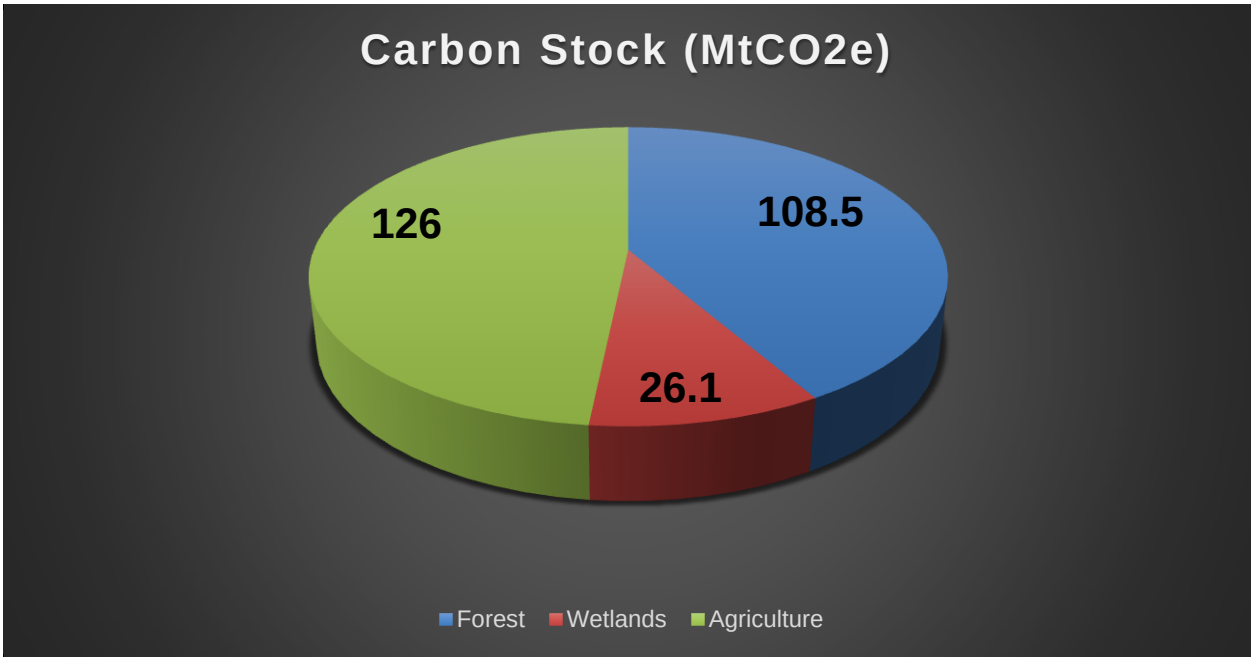
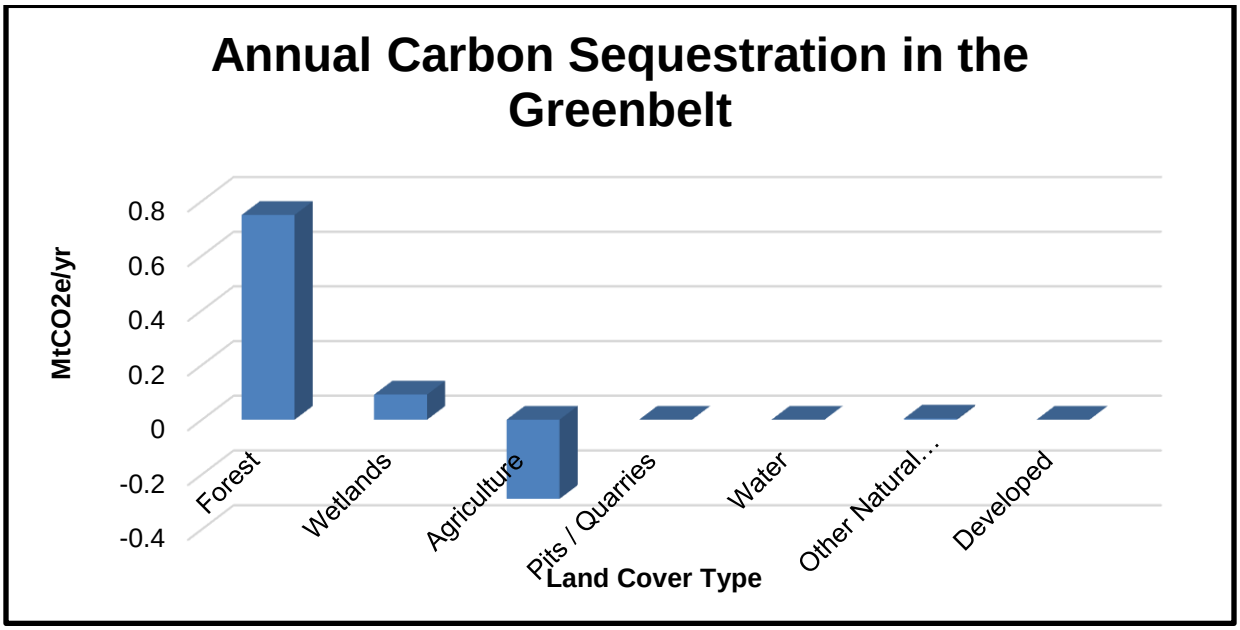


Figure 4: Estimated Carbon Sequestration by Land Cover Types



Summary of Greenbelt Emission Liabilities

Liability	DGA	New Infrastructure	New Pits / Quarries	Total
Quantity (ha)	9,560	unknown	unknown	< 9,560
Carbon Losses ($MtCO_2e$)	3.13*	0.0003/ha	0.0003/ha	< -3.13
Loss of Annual Carbon Sequestration^ ($MtCO_2e$)	7.4E-03	7.8E-07/ha	7.8E-07/ha	na

*Based on the average carbon stored from a hectare of natural cover in the Greenbelt
^ Based on the average rate of carbon sequestration from a hectare of natural cover in the Greenbelt

3. Overview of Emissions by Sector

This report is mainly concerned with emissions arising from within the Greenbelt. This does not mean emissions are necessarily a result of activities within the Greenbelt. For example, there are nine landfill sites in the Greenbelt but we do not track the source of materials that go into them, and indeed, it is likely that some of the waste will originate from outside the Greenbelt boundaries. Similarly, it is unlikely that electricity generated in the Greenbelt is completely consumed within its boundaries. By following the provincial reporting format (2016) this report avoids a risk of double counting.

3.1. Electricity

In the energy generation sector, Ontario emits 6.2 $MtCO_2e$. There are three non-renewable energy-generating facilities in the Greenbelt, producing 0.176 $MtCO_2e$ per year. There is some renewable energy generation in the Greenbelt that is considered carbon neutral.

3.2. Transportation

The average household in Ontario owns 1.47 cars and the average car emits 4.7 tCO2/yr. This gives an estimate of 2.87 $MtCO_2e$ /yr from Greenbelt residents. We were not able to estimate commercial transportation emissions.

3.2.1 Additional Considerations

Research indicates that suburban and rural areas are likely to have higher transportation emissions than the Ontario average. This could be assessed with further research.

3.3 Industry

All facilities in Ontario emitting over 20,000 tCO_2 / yr are required to report their emissions annually. We found three industrial facilities in the Greenbelt through Ontario's Greenhouse Gas Emissions Regulation Report, which totaled approximately 0.46 $MtCO_2e$.

3.3.1 Pits and Quarries

Operations that extract more than 500,000 tonnes per year are required to report on their emissions. We were not able to access this data but could undertake further research if required. The first step would be to identify the names of sites in the Greenbelt so we could request the relevant data. If this data is not publically available we could model the emissions based on extraction rates from their operating permits. Mining operations are subject to the provincial GHG mandatory reporting threshold. The threshold will soon be lowered so we can revisit that list to see if any Greenbelt sites are added. We can estimate the remaining sites GHG emissions based on average emissions / tonne extracted from those that do report.

3.4 Buildings

3.4.1 Residential

There are approximately 414,000 households in the Greenbelt, which is just over 3% of the Ontario 13,500,000 total. The estimate for residential emissions was 21.8 Mt in 2014. The Greenbelt proportion is therefore estimated to be 0.68 $MtCO_2e$ / yr.

3.5 Agriculture

In the provincial GHG inventory report, the agriculture sector covers non-energy GHG emissions relating to the production of crops and livestock. This means emissions from fuel use and those from manufacturing inorganic; nitrogen fertilizers (which have a high carbon footprint) are not included.

3.5.1 Enteric Fermentation

Enteric fermentation is the process by which microorganisms in a cow's rumen break down food during digestion, producing a by-product of CH_4. The Greenbelt is home to 95,040 (5.46%) of the 1,739,100 total cattle raised in Ontario. Assuming Greenbelt cattle are in line with the provincial average, enteric fermentation is responsible for 0.197 $MtCO_2e$ in annual GHG emissions.

3.5.2 Manure Management

Anaerobic decomposition of the organic matter from animal wastes (such as agricultural manure) occurs during storage, and produces CH_4. N_2O is also produced, both during storage and soil application. Ontario emits 1.9 MtCO_2e from manure management, and the Greenbelt contains 5.46% of Ontario's cattle, giving an estimate of 0.104 MtCO_2e for the Greenbelt. Manure management for cattle raised in the Greenbelt may not take place in the Greenbelt but we assume it does for the purposes of allocating emissions in this study. Other livestock also contribute to emissions in this category but we have assumed that the proportions will be similar so the cattle ratio is accurate enough for this report.

3.5.3 Soil Emissions

Based on applying the percentage of Ontario farmland found in the Greenbelt, we estimate soil emissions to be 360,000 tCO2e / yr, at a rate of 0.84tCOe / ha. Much of this is in the form of nitrous oxide (a GHG many times more potent that CO_2). Some will also be from a loss of soil carbon (SOC) because of soil management practices.

3.5.4 Additional Considerations

- Although soil emissions are the smallest of the three agricultural categories, they are important because they can be reversed, moving farming from emitting to sequestering carbon.
- A life cycle approach to GHG accounting for the agricultural sector would reveal the impacts of management practices throughout the food value chain. This would likely reveal potential for significant GHG reductions. For example building soil carbon reduces atmospheric concentrations of CO_2, reduces the use of nitrogen fertilizers, which will result in lower on farm emissions and will reduce industrial emissions from manufacturing the fertilizers.
- The Ontario Federation of Agriculture and other agricultural groups are campaigning for the expansion of the natural gas network into more rural communities. Replacing electricity with natural gas as a source of energy will increase GHG emissions from the sector.

3.6 Waste

Waste is the second smallest emissions sector with 90% of emissions coming from solid waste disposal (landfill). Its emissions have risen 19% since 1990. The Greenbelt is home to nine of Ontario's 882 operating landfill sites. This gives an estimated 0.087 Mt for Greenbelt landfill emissions. We have not researched the emissions arising from the other waste disposal categories, as they do not cross the materiality threshold.

Since 2010, Ontario landfills larger than 1.5 million cubic metres have been obliged to operate landfill gas systems to capture and either use or burn the methane, in order to reduce the volume of methane released into the atmosphere. Only 39 landfills have such capture systems in place and we have only been able to determine that one of the nine Greenbelt facilities has this technology installed.

4. Greenbelt Carbon Sinks: Natural Features

4.1 Agricultural Soil

Soils in agricultural lands are an organic carbon sink, storing more biomass than in many ecosystems. Our recent natural capital study estimates that Greenbelt farmland soils currently store 34.4 MtC (126 $MtCO_2e$). However, it is highly likely that this sink is shrinking as a result of farming practices. It is not possible to determine how rapidly this is occurring. The AAFC estimated (2016) that over 80% of Ontario farmland is losing soil carbon each year, with over 50% of land losing SOC at a rate of at least 25kg C / ha / yr. However, a more recent study (Legg, 2017) found that over the past 15 years Ontario soils have lost on average 200kg of soil carbon per year, which is equivalent to emissions of 733kg CO_2e / yr.

A recent analysis of Greenbelt farming practices estimates that a widespread adoption of soil conservation practices could reverse this trend and move the sector from emitting to capturing carbon. The report estimates that Greenbelt soils can store up to 810,000 tCO_2e / yr. Over a 20-year period that would result in an additional 16 $MtCO_2e$ stored, with a market value of $193 million. It is worth noting that management practices associated with building SOC will generally result in lower emissions from nitrogen fertilizer and fuel use, while maintaining yields.

4.2 Forests

Our recent natural capital report modelled carbon uptake for the age and mix of the Greenbelt's forests. Forests make up almost a quarter of protected Greenbelt area and currently store 108.5 $MtCO_2e$. The model estimates an annual rate of carbon sequestration of 0.75 $MtCO_2e$ over the next 40 years. The analysis does not take into account wood harvesting from managed forests. We do not currently know the volume of wood or area of plantations within the Greenbelt.

4.3 Wetlands

Poorly drained organic soils such as those found in wetlands and other anaerobic environments have the ability to store considerable amounts of carbon due to their high productivity and low decomposition rates.

The 2016 natural capital report estimates that Greenbelt wetlands currently store 26.1 $MtCO_2e$, with an annual sequestration rate of 0.09 $MtCO_2e$.

4.4 Additional Considerations

Some areas of the natural system can be enhanced or restored through conservation management. We are not able to estimate the potential impact of such activities at this time.

5. Land-Use Changes

The Provincial GHG Inventory does not include emissions from land use changes. Under the IPCC framework these are typically estimated but not included in the official reports. At time of writing we were not able to find this information for Ontario. The following section provides an overview of how land use changes could impact the Greenbelt.

5.1 Pits and Quarries

It is possible to rehabilitate sites used for aggregate extraction into a naturalized state. Once restored, these areas will sequester and store carbon. There are 5,580 ha of land currently used for aggregate operations. Rehabilitated they have the potential to sequester carbon at the rate of the land cover type they are restored to. For example, tree planting over the entire area could sequester 22,900 tCO_2e / year.

5.2 Designated Greenfield Areas

There are 9,560 ha of zoned DGA for settlements in the Greenbelt, or 1.3% of the combined area of forest, wetland and farmland. DGA is within urban boundaries so this does not change the amount of protected countryside in the Greenbelt. This analysis is concerned with land cover type, which does not differentiate land in and outside urban boundaries.

As we do not know the current land cover type for these areas, an estimate for the GHG implications for the development of this land was derived by applying the average sequestration and storage rates from combined natural cover types. Assuming a total loss of stored carbon from DGA results in emissions of of 3.13Mt CO2e and the loss of 0.0064 Mt CO2e / yr in sequestration.

6. Conclusion

The inventory for the Greenbelt is incomplete but provides estimates for many of the most significant sectors. During the course of the research for this report, we identified many sources of information that could provide additional estimates and a more detailed understanding. This additional work would require considerable time and effort or funding to complete. The findings highlight the importance of the transportation for meeting GHG reduction targets and raise questions for how Greenbelt communities can contribute to those reductions. As the predominant land use in the Greenbelt, agriculture will play a critical role in efforts to reduce emissions. Our research indicates that the trend in soil emissions can be reversed through adoption of best management practices.

This would result in annual sequestration of 0.4 $MtCO_2e/yr$, reducing total Greenbelt emissions by nearly 10%. These management practices would reduce emissions from other sectors (e.g. industrial emissions from fertilizer production). A life cycle approach to calculating emissions would be required to demonstrate these effects.

The results also show the importance of protecting natural assets from future development. Emissions resulting from the development of existing DGA within the Greenbelt will release 2/3 of annual emissions and prevent further sequestration. This also points to the importance of land restoration and rehabilitating aggregate sites as rapidly as possible in order to start benefiting from long-term carbon sequestration.

Appendix 1

Breakdown of Greenbelt GHG Emissions by Sub-Sector

	Provincial		Greenbelt	
	Amount	**Percentage**	**Amount**	**% of sector**
Electricity	**6.2**	**3.6**	0.176	2.84
Transportation	**58.7**	**34.5**		
Road Passenger	33.1		2.87	8.67
Road Freight	15.2		no data	
Off-road	5.4		no data	
Domestic Aviation	2.2		no data	
Domestic Marine	1.3		no data	
Rail	1.4		no data	
Industry	**51**	**30**	**0.46**	
Fossil fuel refining	5.7		na	
Manufacturing	17.4		part	
Process emissions - Mineral production (cement, lime, mineral products)	3.4		part	
Chemical Industry	0		no data	
Process emissions - metal production	8.8		no data	
Fugitive sources	1.4		no data	
Other	14.3		no data	
Buildings	**34.8**	**20.5**		
Commercial and Institutional	13		no data	
Residential	21.8		0.68	3.12
Agriculture	**9.4**	**5.5**	**0.661**	7.03
Enteric Fermentation	3.6		0.197	5.46
Manure Management	1.9		0.104	5.46
Agricultural Soils	4.3		0.36	8.37
Waste	**9.4**	**5.5**		
Solid Waste Disposal on Land	8.5		0.087	1.02
Wastewater Handling	0.3		no data	
Waste Incineration	0.3		no data	
Incineration and Open Burning of Waste	0.3		no data	
TOTAL	**170**	**100**	**4.93**	**2.90**
Provincial 2020 Target	**152**		**4.4**	
Provincial 2030 Target	**112**		**3.2**	
Provincial 2050 Target	**36**		**1**	

Table 3: Summary of Greenbelt Carbon Sinks

Sinks / Assets	Forest	Wetlands	Agriculture	Pits / Quarries	Total
Quantity (ha)	182,674	100,063	429,765	5,580	721,082
% of ON total	0.26	1.05	8.37	unknown	na
Carbon Stock ($MtCO_2e$)	108.5	26.1	126	0	260.6
Annual Carbon Sequestration ($MtCO_2e$)	0.749	0.092	-0.289	depends on restored state	0.55