

# Appendix A



## Memorandum

**To:** John Orr, Pia Gerstle, Martin Postma, Emily Hunt (City of Thornton)  
**From:** Melody Redburn, Judy Dorsey, Amy Volckens (Brendle Group)  
**Date:** March 16, 2020  
**Re:** City of Thornton Greenhouse Gas and Energy Efficiency and Resource Management Inventory, 2018

### Purpose

As part of the City of Thornton Sustainability Action Agenda, which considers sustainability at both the organizational and community levels, a Greenhouse Gas (GHG) and Energy Efficiency and Resource Management inventory was completed. This memorandum is intended to provide an overview of the inventory methodology, data sources, and findings.

### Methodology and Data Sources

#### OVERVIEW

Two GHG inventories were developed – one to represent emissions from City operations and one to represent emissions from the Thornton community (inclusive of City operations). The year 2018 was chosen as the baseline year as it was the most recent year with complete data at the time of analysis.

A community-scale inventory that was previously completed in 2008 ([2008 Greenhouse Gas Emissions Inventory](#)) was used for purposes of comparison and understanding of available data sources, though the results are not directly comparable to the current analysis due to changes in reporting requirements over time. However, the results were compared where emissions sectors are directly comparable to infer changes and trends that have occurred from 2008 to 2018.

The inventories were developed using an Excel-based Information Management System (IMS) developed by Brendle Group and transmitted to the City of Thornton (Thornton\_Community IMS\_FINAL.xlsx). This tool is protocol-compliant and offers the benefit of annual data tracking such that the inventories can be updated by Thornton going forward if desired.

## COMMUNITY-SCALE PROTOCOL

The community-scale inventory was developed using the [Global Protocol for Community-Scale GHG Inventories \(GPC\)](#) city-induced framework protocol at the BASIC level and a boundary defined as the incorporated limits of the City of Thornton. The BASIC reporting level requires:

- All Scope 1 emissions, defined as emissions from sources located within the defined boundary.
- All Scope 2 emissions, defined as emissions from grid-supplied electricity and heat that are used within the defined boundary.
- Some types of Scope 3 emissions, defined as emissions occurring outside the defined boundary but that are a result of activities or residents within the boundary.
  - Scope 3 emissions that pertain to the City of Thornton and are required at the BASIC reporting level include solid waste and wastewater-related emissions.
  - Scope 3 emissions that pertain to the City of Thornton but are not included at the BASIC reporting level include:
    - Transmission and distribution losses of all stationary energy used within city boundaries.
    - Transportation associated with airline or rail travel.
    - Consumption-based activities, such as emissions associated with food purchases and fuel production. These emission sources are not required at any reporting level and generally lack good, up-to-date data sources.

Table 1 presents a summary of all potential emission sources, whether they are required at the BASIC reporting level, and whether they are included in the community-scale inventory. In short, every emissions source that is required at the BASIC reporting level in the GPC protocol and that is relevant to the City of Thornton is included in the inventory.

Table 1: GPC BASIC Reporting Requirements (Community-Scale Inventory)

*Green – required, included*

*Grey – required, not included because does not apply or is considered de minimis*

*White – not required, not included*

Emissions Source	Scope 1	Scope 2	Scope 3
<b>Stationary Energy</b>			
Residential	Green	Green	White
Commercial	Green	Green	White
Industrial	Green	Green	White
Institutional	Green	Green	White
Energy generation supplied to grid	White	White	White
Agriculture, forestry, and fishing activities	Grey	Grey	White
Non-specified sources	Grey	Grey	White
Fugitive emissions from mining, processing, and transportation of coal	Grey	White	White
Fugitive emissions from oil and natural gas systems	Green	White	White
<b>Transportation</b>			
On-Road	Green	Green	White
Railways	Grey	Grey	White
Waterborne Navigation	Grey	White	White
Aviation	Grey	Grey	White
Off-Road	Grey	Grey	White
<b>Waste</b>			

Solid Waste Disposal			
Wastewater			
<b>Industrial Processes &amp; Products (IPPU)</b>			
Industrial Processes			
Industrial Product Use			
<b>Agriculture, forestry, and fishing activities (AFOLU)</b>			
Livestock			
Land			
Other agriculture			

#### MUNICIPAL-SCALE PROTOCOL

The municipal-scale inventory was developed using the [Greenhouse Gas Protocol for the U.S. Public Sector](#), which is based on the [Corporate Accounting and Reporting Standard](#). According to the U.S. Public Sector standard, the boundary can be defined based on operational control or financial control. For Thornton’s municipal inventory, the boundary is defined based on operational control, which is defined as the authority to introduce and implement operating policies. The U.S. Public Sector protocol includes:

- All Scope 1 emissions are required.
- All Scope 2 electricity indirect emissions are required.
- All Scope 3 emissions are optional.
  - Emissions from solid waste and wastewater were included in the inventory as significant contributors over which Thornton has operational control.
  - Emissions from active oil and gas wells on the Northern properties were excluded from the inventory as being outside of Thornton’s municipal operational control. However, these emissions were estimated to inform City staff about their environmental impact (see Findings section). It should also be noted that the City in some cases benefits financially from oil and gas operations – these emissions might be included in a municipal-scale inventory that was developed based on a financial control boundary rather than an operational control boundary.

Table 2 presents a summary of all potential emission sources, whether they are required for inclusion based on the U.S. Public Sector protocol, and whether they were included in Thornton’s municipal inventory based on operational control. In short, every emissions source that is required and that is relevant to the City of Thornton is included in the inventory, with the exception of refrigerants (data were not available) and chemical production (does not apply).

Table 2: GHG Reporting Requirements for U.S. Public Sector Protocol (Municipal-Scale Inventory)

**Green** – required, included

**Navy** – optional, included

**Grey** – required, not included because does not apply, is considered de minimis, or data are not available

**White** – not required, not included

Emissions Source	Scope 1	Scope 2	Scope 3
<b>Stationary Energy</b>			
Buildings			
Fugitive emissions (leaks, refrigerants)			
<b>Transportation</b>			
Fleet			

Commuter			
<b>Waste</b>			
Solid Waste Disposal			
Wastewater			
<b>Industrial Processes</b>			
Chemical production			

The following sections describe each sector, emission source, data sources, and assumptions.

**STATIONARY ENERGY SOURCES**

*Residential, Commercial, Industrial, Institutional (Electricity and Natural Gas worksheets in the IMS tool)*

Electricity and natural gas consumption data from Xcel Energy and United Power were used to determine emissions associated with Scope 1 (use) and Scope 2 (generation) for both the community and municipal inventories. The data were provided through personal communications with each utility. In the future, Xcel Energy consumption data can be accessed through the annual Community Energy Reports that are posted on-line and through Partners in Energy implementation data pulls. United Power consumption data can be accessed by contacting the City’s account manager (currently Tom Green).

Electricity emissions factors for Xcel Energy are provided in the annual [Corporate Responsibility Report](#). United Power electricity emissions factors are based on [EPA eGRID RMPA region](#) factors, updated every two years (with the next update slated for 2022). Natural gas emissions factors are provided by the EPA in [Emissions Factors for Greenhouse Gas Inventories](#).

Electricity use for municipal operations occurring outside the City boundary and served by United Power (e.g., raw water pumping) is considered Scope 1 and under Thornton’s operational control by the U.S. Public Sector protocol. These emissions are therefore included in the municipal inventory. Scope 2 emissions related to the generation of this electricity is also required and included in the municipal inventory.

*Energy Generation Supplied to Grid*

Per GPC BASIC requirements, electricity generation that occurs within the City boundary and is supplied to the grid is not required for inclusion in a community inventory. This source is not relevant at the municipal scale.

*Agriculture, Forestry, and Fishing Activities*

These activities are considered *de minimis* in Thornton and are not included in the inventories. A summary of the *de minimis* emissions is included on a separate “De Minimis Sources” worksheet tab in the IMS, along with the sources used to determine that the activities are *de minimis*.

*Non-Specified Sources*

This category is not applicable to Thornton at the community or the municipal scale.

*Fugitive Emissions from Coal*

No coal related activities occur within city boundary; this category is not applicable to Thornton at the community or the municipal scale.

*Fugitive Emissions from Oil and Natural Gas Systems (Natural Gas worksheet in the IMS tool)*

The City of Thornton has approximately 27 active oil and natural gas wells within the City limits (per [COGCC](#)), and 11 miles of natural gas pipelines (per the [Natural Pipeline Mapping System](#)). The fugitive emissions associated with these operations are included in the community inventory, but not the municipal inventory, because the City does not control their operations.

Emissions per mile of pipeline were taken from a research paper published by the [National Energy Technology Laboratory](#) and emissions per well were obtained from the US EPA [Greenhouse Gas Reporting System for Onshore Production](#).

## **TRANSPORTATION SOURCES**

### *Community-Scale Inventory*

Scope 1 emissions are included for the community inventories (On-road Transportation worksheet in the IMS). Scope 2 emissions, which are associated with electricity supplied to electric vehicles, are embedded in the community's electricity consumption and are included in stationary energy (Electricity worksheet in the IMS). On-road emissions at the community level are based on vehicle miles traveled within the city boundary (provided by DRCOG via personal communication) and broken out by heavy and light duty vehicles. Emissions factors are sourced from EPA for light-duty and heavy-duty vehicles. See the IMS workbook for specific data sources.

Other transportation types are required by the GPC BASIC reporting level, but are not relevant to Thornton (i.e., waterborne navigation), or are determined to be *de minimis* (i.e., railway, off-road). While the Thornton community does contribute aviation emissions through travel at Denver International Airport, these are considered Scope 3 emissions and are not required at the GPC BASIC reporting level.

### *Municipal-Scale Inventory*

The municipal inventory includes Scope 1 emissions from fleet vehicles. Emissions are calculated based on the consumption of gasoline and diesel fuel (provided by the city's fleet manager via personal communication; see the On-road Transportation tab in the IMS). Emissions factors are sourced from EPA for gasoline and diesel fuels. See the IMS workbook for specific data sources.

Employees who commute to work in most cases also contribute transportation emissions, but this activity is considered Scope 3 and is not required in the municipal inventory. However, commuting activities in general are captured in the community inventory through the vehicle miles traveled data.

## **WASTE SOURCES**

The waste category includes both solid waste disposal and wastewater. Although Thornton does not have a landfill or wastewater treatment plant within city boundaries, the emissions associated with the solid waste and wastewater that Thornton generates and sends to outside landfills and wastewater treatment plants are included in the community inventory, per GPC BASIC reporting requirements. The generation of waste within the city boundary is considered under Scope 1 emissions, while the treatment of waste is considered under Scope 3 emissions for both the community and municipal inventories.

### *Solid Waste (Solid Waste worksheet in the IMS tool)*

The solid waste generated at the community scale is estimated from a per capita waste factor provided by the [State of Colorado](#). For future inventories, data from private haulers and the City of Thornton are preferred, but these data are not currently available. While data from the City of Thornton residential service territory is available, private hauler data could not be obtained.

The solid waste generated by City operations is estimated from Republic Services invoices, which provide the size of waste container (e.g. 3 cubic yards) and the number of pickups per week, multiplied together and converted from cubic yards to tons. For future inventories, data from Republic Services on the exact volume of waste collected are preferred, but these data are not currently available.

### *Wastewater (Wastewater worksheet in the IMS tool)*

Wastewater sent to Metro Wastewater's treatment facility was provided by the city water department via personal communication for both the community and municipal scales. Operational information for the treatment facilities was provided by Scott Twombly from the City of Thornton via personal communication. Emissions factors and calculations are based on the [ICLEI Community Protocol, Appendix F](#) (registration and download are required).

## **INDUSTRIAL PROCESSES & PRODUCT USE SOURCES (LARGE EMITTERS WORKSHEET IN THE IMS TOOL)**

According to EPA sources, there are no users in Thornton that fall under this category, so this sector is excluded from the community inventory.

The U.S. Public Sector protocol requires chemical production emissions be included for municipal inventories, but this category is not applicable to the City of Thornton.

## **AGRICULTURE, FORESTRY, & FISHING ACTIVITIES SOURCES**

This category is not required by the GPC BASIC reporting level and therefore is not included in the community inventory. There are no activities within Thornton's boundaries that contribute significant emissions in this sector based on the City of Thornton zoning map and [EPA State Inventory and Projection Tool](#).

This category is not applicable to the municipal-scale inventory.

## **Findings (Communitywide Summary worksheet in the IMS tool)**

### **COMMUNITY-SCALE GHG EMISSIONS**

In 2018, the City of Thornton emitted 1,044,000 metric tons of carbon dioxide equivalent (MT CO<sub>2</sub>e), a 10% reduction from the 2008 inventory for comparable sectors. Figure 1 shows a breakdown by sector. The largest contributing sector is stationary energy (61%), followed by transportation (32%) and waste (7%). Fugitive natural gas emissions are part of the stationary energy sector but are broken out separately because this result was of interest to city staff.

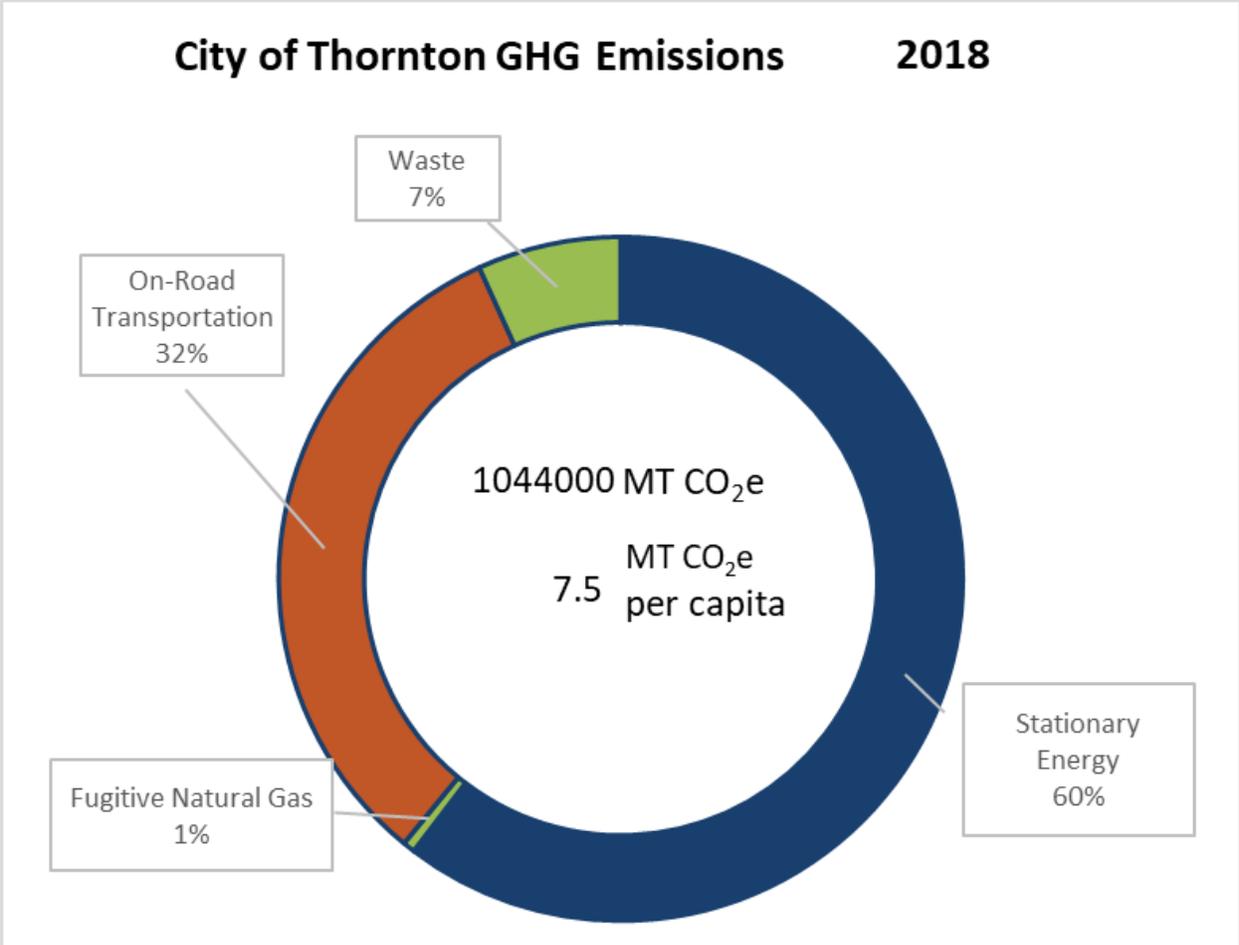


Figure 1: Thornton Community GHG Emissions by Sector, 2018

Using a 2018 population estimate of 139,806, this result translates to 7.5 MT CO<sub>2</sub>e per person per year. This per capita emissions value is similar to other North American cities reporting at the BASIC level, according to [C40 Cities](#). The average per capita emissions in North America is 8.4 MT CO<sub>2</sub>e per person per year. The 2008 inventory similarly found a lower-than-average per capita emissions factor for Thornton, attributed to the fact that Thornton is predominantly a residential community without heavy industrial contributors.

**MUNICIPAL-SCALE GHG EMISSIONS**

City operations emitted 51,700 MT CO<sub>2</sub>e in 2018. The 2008 inventory did not break out municipal emissions, so a comparison cannot be made. Similar to the community inventory, stationary energy is the largest contributing sector in the municipal inventory (86%), followed by transportation (10%) and waste (4%), as shown in Figure 2. Stationary energy makes up a larger portion of the municipal inventory because most municipal operations occur in buildings that require significant energy to heat and cool or are process-intensive such as water pumping and pool heating.

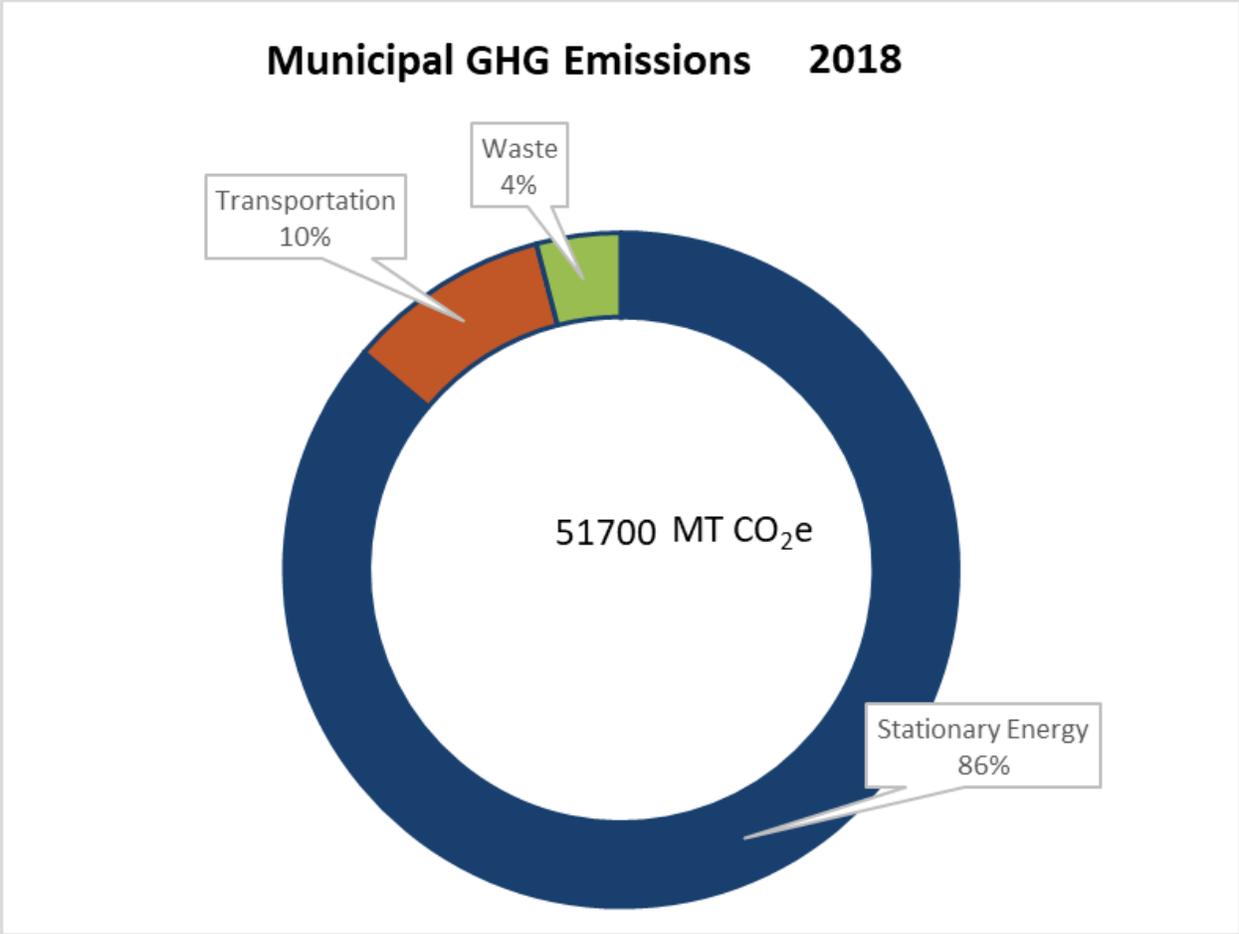


Figure 2: Municipal GHG Emissions by Sector, 2018

Municipal emissions in Thornton account for approximately 5% of the total community emissions. This percentage is slightly higher than found in other communities, again because Thornton is largely residential and has no major industrial operations. It is also possible that factors such as the City of Thornton wholesaling water to the City of Westminster could contribute to this higher municipal percentage.

**EMISSIONS ASSOCIATED WITH THE NORTHERN PROPERTIES**

The northern properties owned by the City of Thornton and their future land uses are being evaluated under the Thornton Northern Properties Stewardship plan.

Under current conditions, there are 55 active oil and gas wells on these properties (provided by the city via personal communication). The fugitive emissions associated with these active oil and gas operations are estimated to be 12,000 MT CO<sub>2</sub>e.

Under future land use scenarios, the City could choose to use some of the northern properties for carbon sequestration. In this case, the City would have to demonstrate a number of factors (land use change, active management that increases carbon sequestration, etc.) in order to take credit for the carbon sequestration and represent this source as a negative emitter in a future inventory. Useful references on this topic include [Land Use, Land-Use Change, and Forestry](#)

[Guidance for GHG Project Accounting](#) and a study completed by the [City of Fort Collins](#), which quantifies emissions and sequestration potential for various land use and land cover scenarios.

The Northern Properties Stewardship Plan should consider social and environmental costs and benefits, as well as financial costs and benefits, in evaluating potential future land uses.

### **CONNECTIONS TO THE SUSTAINABILITY ACTION AGENDA**

Both the community and municipal GHG inventories are dominated by emissions related to stationary energy use, indicating significant opportunities to enact climate action through energy reduction in homes, businesses, and municipal facilities, and by incorporating more renewable energy sources. Strategies to increase energy efficiency and renewable energy at the community and the municipal scales are identified in Thornton's Energy Action Plan developed through Xcel Energy's Partners in Energy offering.

Community scale transportation is largely influenced by residents commuting out of Thornton for work. Strategies for reducing transportation related emissions, such as increasing public transit and multi-modal options, should be considered a high priority for the Sustainability Action Agenda.

The waste sector, while the smallest contributor at both scales, represents opportunities for waste reduction and waste diversion. Waste-related emissions are largely associated with sending solid waste to landfills, and therefore strategies to reduce the amount of waste sent to landfills should be considered as part of the Sustainability Action Agenda.

While the City has no control over fugitive emissions from active oil and gas operations within city boundaries, the City may be able to influence emissions reductions from active oil and gas operations on the City-owned Northern Properties. The emissions from these wells are significant compared to the total emissions from City operations (12,000 compared to 51,700 MT CO<sub>2</sub>e) and therefore could represent a meaningful climate action strategy.

## **Recommendations for Future Inventories**

Recommendations for improved data tracking include:

- **Solid waste generation, diversion, and composting:** While most data used to calculate the 2018 inventories are Thornton specific, the solid waste sector uses proxy data from the State of Colorado (community scale) and estimated waste volumes (municipal scale). The City should consider tracking more detailed solid waste data for City operations as well as waste generated in the residential and commercial sectors and managed by private haulers. The City's composting program is currently in a piloting phase, so data were not available for the 2018 inventory.
- **Oil and gas well tracking and emissions factors:** Well size can influence emissions, but this information was not available for the 2018 inventory. As more emissions data from oil and gas wells get published, a localized emissions factor should be used.

Recommendations for future inventory updates include:

- **Updating the inventories on a regular schedule to show the benefits of energy and sustainability actions:** Data collection and analysis can be time intensive, so the frequency of updates should be considered. We recommend biennial updates at a minimum. With future updates, Thornton can also consider the appropriateness of including land use

changes and carbon sequestration accounting to reduce greenhouse gas emissions as appropriate.

- **Evaluating the reporting level:** The GPC BASIC reporting level provides a solid foundation for greenhouse gas inventory reporting. Future inventory updates may consider using the BASIC+ reporting level, which requires Scope 3 emissions for stationary energy and transportation sectors, including:
  - Transmission and distribution losses for electricity and natural gas systems to residences, businesses, municipal facilities, and construction and manufacturing.
  - All transportation that either originates or terminates in Thornton. This may include transportation such as airline travel out of DIA that is attributable to Thornton residents and businesses.
- **Evaluating the defined boundary:** Future inventory updates may consider expanding the community boundary to include Thornton's growth management area and/or the Northern properties. For the municipal inventory, financial control could be considered, but Thornton should consider the data that will need to be gathered prior to expanding either inventory.

Recommendations for reporting and using the inventory results include:

- **Sharing the results publicly with the Thornton community:** By sharing the inventory results in the Sustainability Action Agenda, the City will be showing its commitment to reducing greenhouse gas emissions.
- **Submitting the results for verification and benchmarking:** Reporting to [C40 Cities](#) through the Carbon Disclosure Project allows cities to verify results, disclose their inventory results, track performance, and benchmark against comparable cities around the world. Further definition of data sources and data quality may be required to achieve this step.