APPENDIX A. GREENHOUSE GAS EMISSIONS INVENTORY

REVISED NOVEMBER 2022

The City of Shoreline periodically assesses the levels at which we – as both City government and our greater community – emit greenhouse gases (GHG), the primary cause of recent climate change. The King County Growth Management Planning Council – a formal body of elected officials from across King County – voted in 2014 to adopt a shared target to reduce countywide sources of greenhouse gas (GHG) emissions, compared to a 2007 baseline, by 25% by 2020, 50% by 2030, and 80% by 2050.

The City has also adopted those targets but uses 2009 as a baseline year because that was the year the City Hall – a certified LEED Gold building and primary building for housing City employees and services – was completed. The City also has a goal of zero net emissions by 2030 for local government operations. This goal refers to the need to both reduce future GHG emissions and take steps to remove GHGs from the atmosphere in a process referred to as carbon removal. Carbon removal can happen through natural processes – such as by restoring forests and wetlands – and with technological strategies.

The City measures progress in meeting those goals with GHG emissions inventories. These inventories identify the major sources of GHGs and levels of pollution. Major sources include transportation, energy used by homes and buildings, and solid waste. The City has completed four GHG emissions inventories for 2009, 2012, 2016, and 2019.

Emissions are calculated based on the types and quantities of activities that release GHGs, and associated emissions factors. An emissions factor is a representative value that attempts to relate the quantity of a pollutant released to the atmosphere with an activity associated with the release of that pollutant.[5] Burning different fuels releases different types and quantities of pollutants, such as carbon dioxide. Typically, GHG emissions are reported in units of carbon dioxide equivalent (CO_2e). Gases – such as methane and nitrous oxide – are converted to CO_2e based on their global warming potential. In this report, GHGs are reported in metric tons of carbon dioxide equivalent ($mtCO_2$e).

This report summarizes the results of a 2019 GHG Emissions Inventory for both the Shoreline community and local government operations. The City used the ClearPath online software platform to complete and document inventory calculations and data sources in accordance with the following protocols, developed by ICLEI – Local Governments for Sustainability:

- U.S. Community Protocol (USCP) for Accounting and Reporting of Greenhouse Gas Emissions
- Local Government Operations Protocol (LGOP)

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5 US EPA, "**Basic Information of Air Emissions Factors and Quantification**," accessed on 6/16/21

Community-wide Inventory

The City of Shoreline has completed four "geographic-plus" inventories for community-wide activities. The geographic-plus inventory quantifies the estimated release of GHG emissions from activities within the City of Shoreline's geographic boundary, including from transportation and building energy use. The "plus" portion expands this scope to include emissions produced by electricity generation outside of the community but consumed by in-city activities, emissions associated with waste generated in the city but processed outside of city boundaries, and fugitive emissions (i.e., unintentional leaks) from natural gas distribution.

Not included are the GHG emissions associated with the goods and services consumed within the community. A "consumption-based" inventory typically measures those emissions, including embodied emissions associated with production, transportation, use and disposal of goods, food, and services consumed in the city. The consumption of goods and services can result in a significant amount of GHG emissions. While a consumption-based inventory is not available for the City of Shoreline, King County's 2015 consumption-based GHG emissions totaled 2.7 times the emissions calculated in their 2015 geographic-plus inventory.[6]

Key Results from the 2019 Community-wide Inventory

- The City of Shoreline's geographic-plus GHG emissions (Figure 1) totaled 246,001 metric tons of carbon dioxide equivalent ($mtCO_2e$) in 2019.

- The largest sources of GHG emissions were transportation (55%), and the built environment (42%), primarily from natural gas usage in the residential and commercial sectors.

- 2019 GHG emissions decreased by an estimated 6% compared to 2009. This trend is not on track to meet the City's near-term goal to reduce GHG emissions by 25% by 2020 compared to 2009.

- Per-person GHG emissions declined to 4.4 $mtCO_2e$ per person in 2019, an estimated 10% decrease compared to 2009 (Figure 2), despite an increase in population.

Figure 1. Sources of geographic-plus based GHG emissions for Shoreline in 2019 (246,001 mtCO₂e)
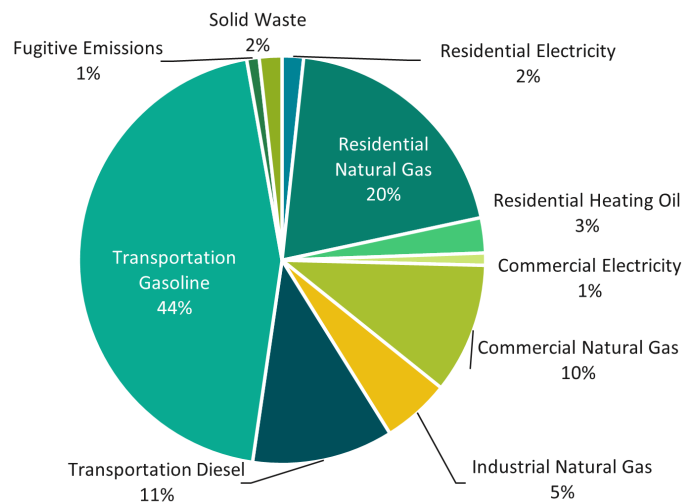
6 "**King County Greenhouse Gas Emissions Inventory, A 2015 Update: Executive Summary**," accessed on 6/16/21

Figure 2. Per capita emissions for Shoreline in 2009 compared to 2019. The line represents Shoreline's population
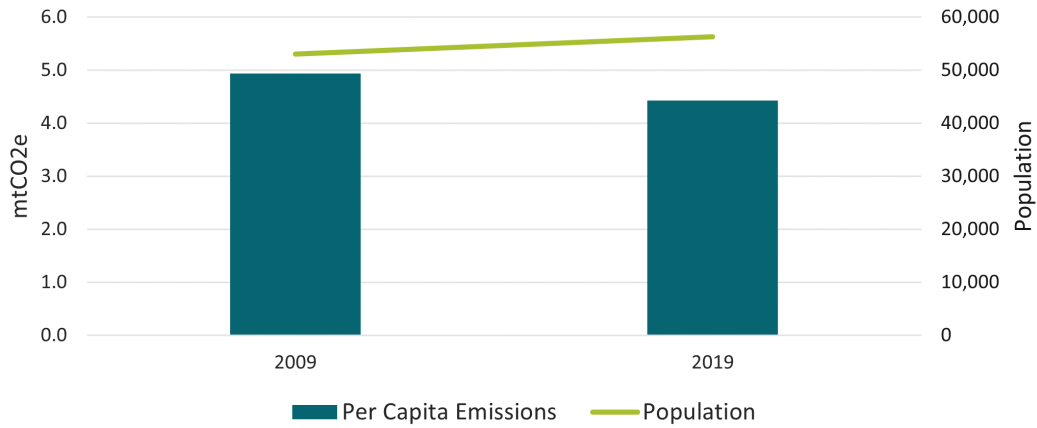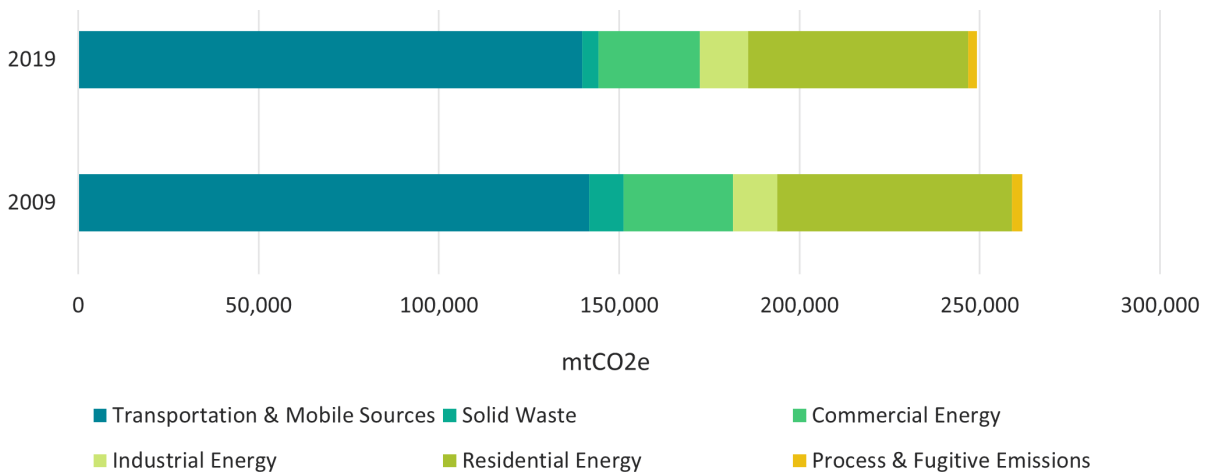

Figure 3. Yearly comparison of emissions for Shoreline from 2009-2019.

| Community-wide Inventory	2009 mtCO₂e	2019 mtCO₂e	% Change 2019 v. 2009
Population	53,007	56,267	+6%
Total Emissions	261,785	246,001	-6%
Emissions Per Capita	4.9	4.4	-10%
Transportation	141,740	136,602	-4%
Residential Energy	65,004	60,886	-6%
Commercial Energy	30,381	28,158	-7%
Industrial Energy	12,278	13,402	+9%

Community-wide Inventory	2009 mtCO$_2$e	2019 mtCO$_2$e	% Change 2019 v. 2009
Fugitive Emissions	2,925	2,462	-16%
Solid Waste	9,457	4,491	-53%

Transportation

Transportation was the largest source of community-wide GHG emissions in 2019, accounting for 55% of total emissions. The majority of those emissions were attributed to gasoline use by passenger vehicles. Total transportation emissions have decreased 4% since 2009.

Transportation data in 2019 was obtained from **Google Environmental Insights Explorer** (EIE) database for the City of Shoreline and analyzed using the **Global Protocol for Community-Scale Greenhouse Gas Emission Inventories** methodology. This data includes vehicle miles traveled (VMT) for both passenger vehicles and public transit buses.

Figure 4. 2019 transportation-related GHG emissions (136,602 mtCO$_2$e).

Diesel 27,927 – 20%

Gasoline 108,675 – 80%
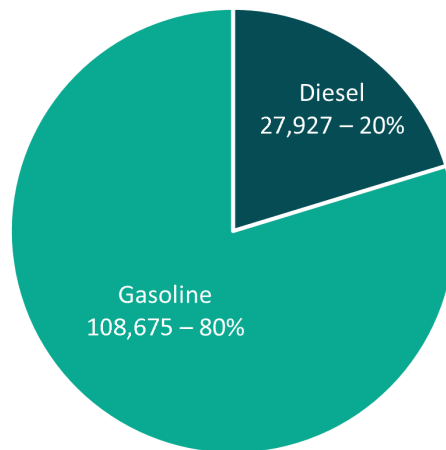
2019 Transportation Emissions Factor Set

Gasoline	Passenger Vehicle	Light Truck	Heavy Truck	Transit Bus	Paratransit Bus	Motorcycle
MPG	24.377	17.868	5.372	17.868	17.868	24.377
g CH$_4$/mile	0.0183	0.0193	0.0785	0.0193	0.0193	0.0183
g N$_2$O/mile	0.0083	0.0148	0.0633	0.0148	0.0148	0.0083

Diesel	Passenger Vehicle	Light Truck	Heavy Truck	Transit Bus	Paratransit Bus	Motorcycle
MPG	24.377	17.868	6.392	17.868	17.868	24.377
g CH_4/mile	0.0005	0.001	0.0051	0.001	0.001	0.0005
g N_2O/mile	0.001	0.0015	0.0048	0.0015	0.0015	0.001

MPG: Miles Per Gallon. CH_4: Methane. N_2O: Nitrous Oxide.

Data Sources: Google Environmental Insights Explorer (EIE); 2019 US National Defaults (updated 2020)

The Built Environment

In the context of this inventory, the built environment refers to emissions from:

- grid electricity consumption,
- natural gas consumption and fugitive emissions associated with natural gas distribution, and
- other stationary fuel consumption (e.g., propane, kerosene, fuel oil).

Together, the built environment produced GHG emissions in the amount of 104,910 $mtCO_2e$ in 2019, or 42% of community-wide emissions. As shown in Figure 5, natural gas consumption was responsible for 87% of emissions from the built environment. The Residential sector was the largest consumer of energy—for both electricity and natural gas— followed by the Commercial sector and the Industrial sector.

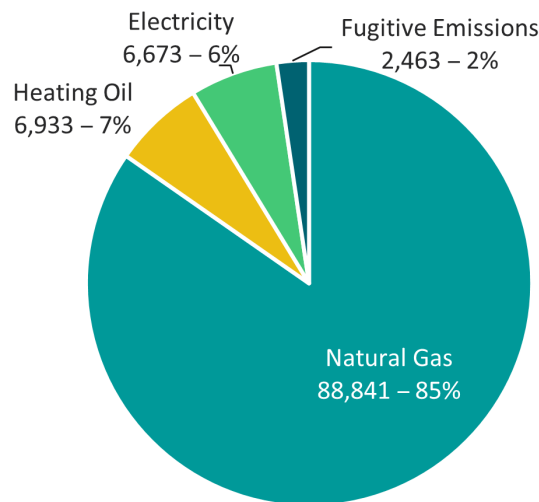**Figure 5. 2019 emissions from the built environment (104,910 $mtCO_2e$)**

Electricity
6,673 – 6%

Fugitive Emissions
2,463 – 2%

Heating Oil
6,933 – 7%

Natural Gas
88,841 – 85%

Figure 6. Sources of residential (left) and commercial (right) GHG emissions in 2019 (mtCO$_2$e).
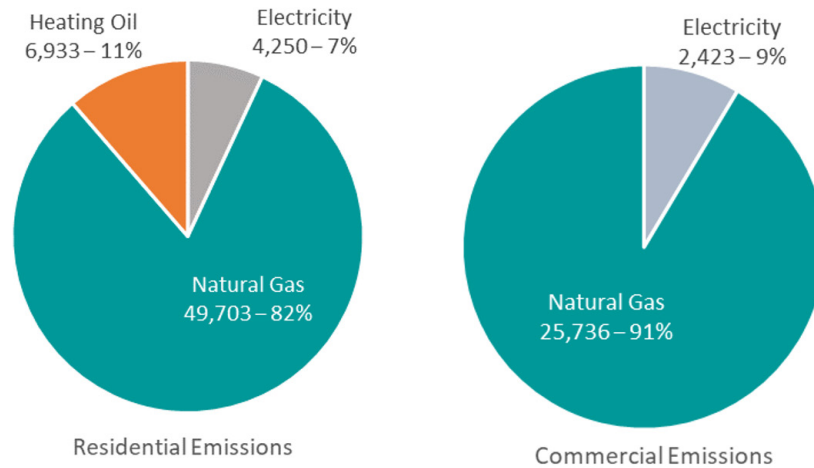

Figure 7. Emissions by fuel type from the built environment from 2009 to 2019 (mtCO$_2$e).
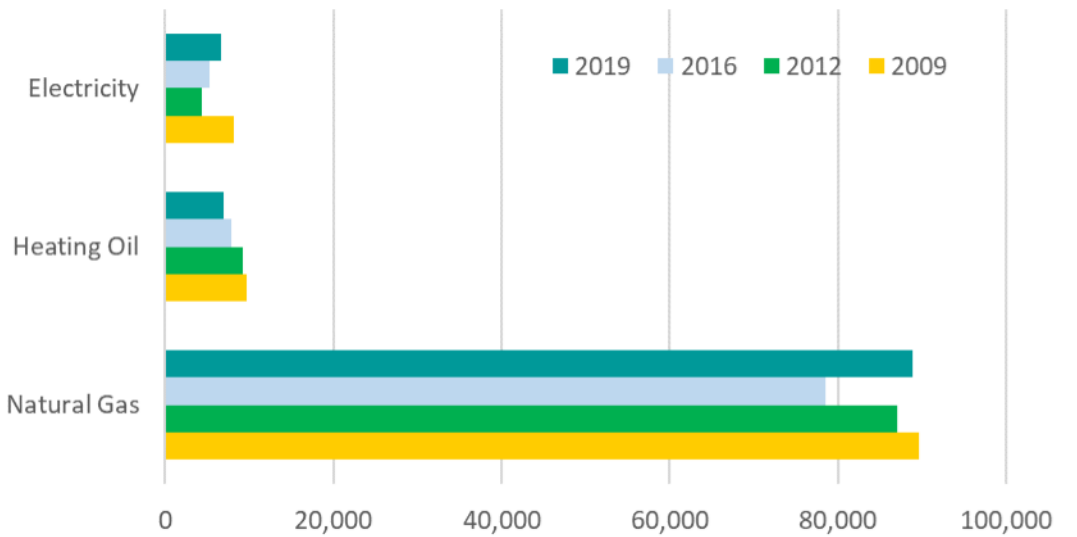
Electricity

Shoreline's electricity is delivered through Seattle City Light (SCL). SCL reports customer classes as residential and commercial (including large, medium and small general service). SCL generates electricity primarily through hydroelectricity. Total electricity use – across all sectors – decreased 16% in 2019 compared to 2009.

2019 Grid Electricity Emissions Factor Set

CO_2 lbs/MWH	41.57	**Data Sources**	Seattle City Light The Climate Registry CRIS Report
CH_4 lbs/MWH	30		
N_2O lbs/GWh	5		

CO_2: carbon dioxide. MWH: Megawatt hour. GWh: Gigawatt hour.

Natural Gas

Natural gas in Shoreline is delivered by Puget Sound Energy (PSE). PSE reports customer classes as residential, commercial, and industrial. Fugitive emissions were calculated related to leakage in the local natural gas distribution system based on the total quantity of natural gas consumed (14,194,696 therms) and assumed leakage rate (default value = 0.3%). Total natural gas use – across all sectors – decreased 1% in 2019 compared to 2009.

2019 Natural Gas Consumption

	Residential	Commercial	Industrial
GHG Emissions	49,703 $mtCO_2e$	25,736 $mtCO_2e$	13,402 $mtCO_2e$
Activity/Usage	9,345,098 therms	4,838,754 therms	2,525,221 therms
Emissions factors	ClearPath: 53.02 kg CO_2, 0.005 kg CH_4, 0.0001 kg N_2O per MMBtu		
Data Source	Puget Sound Energy		

MMBtu: one million BTU

Fugitive Emissions

GHG Emissions	2,463 $mtCO_2e$
Activity/Usage	Residential and commercial therms
Emissions factors	ClearPath: 6.6316×10^{-7} MT CO_2/MMBtu, 6.1939×10^{-5} MT CH_4/MMBtu
Data Source	Puget Sound Energy

Residential Heating Oil

Residential heating oil data was estimated based on the number of households using fuel oil, kerosene, etc. as reported in the 2019 5-year American Community Survey (ACS) Data Profiles for Selected Housing Characteristics, House Heating Fuel, and the conversion factor used in the 2016 Emissions Inventory. Residential heating oil use decreased 29% in 2019 compared to 2009.

2019 Residential Heating Oil

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GHG Emissions	6,933 mtCO$_2$e
Activity/Usage	674,722 gallons
Emissions factors	ClearPath: 73.96 kg CO$_2$, 0.010870 kg CH$_4$, 7.2464 ×10^{-4} kg N$_2$O per MMBtu
Data Source	2019 ACS 5-Year Estimates Data Profiles for Selected Housing Characteristics, House Heating Fuel

Solid Waste

Solid waste activities produced GHG emissions in the amount of 4,490 mtCO$_2$e in 2019, or 2% of community-wide emissions. As shown in Figure 8, emissions from waste generation made up 73% of Shoreline's total solid waste-related emissions, followed by emissions from composting (14%) and transporting waste to facilities outside of city boundaries (13%). Emissions from solid waste disposal have declined 38% since 2009 despite increasing population. The amount of solid waste sent to the landfill decreased by 14% in 2019 compared to 2009, while the amount of waste composted increased by 54%.

Solid waste generated in the City of Shoreline is transported to the Cedar Hills Landfill. Food and yard waste from Shoreline is sent to Cedar Grove Maple Valley, Cedar Grove Everett, Lenz Composting, the Shoreline Transfer Station and Pacific Top Soil. Emissions from the transportation of all waste generated in Shoreline in 2019 was estimated based on tonnage and distance to receiving landfills and other waste facilities.

2019 Waste Generation

GHG Emissions	4,490 mtCO$_2$e
Activity/Usage	18,576 tons solid waste generated 9,146 tons composted 9,033 tons recycled
Emissions Factors	2019 King County Waste Characterization Study (Table 43)
Data Source	Recology King County

Figure 8. 2019 solid waste emissions (4,490 mtCO$_2$e)

Composting
637 – 14%

Transportation
of Waste
575 – 13%

Waste Generation
3,278 – 73%
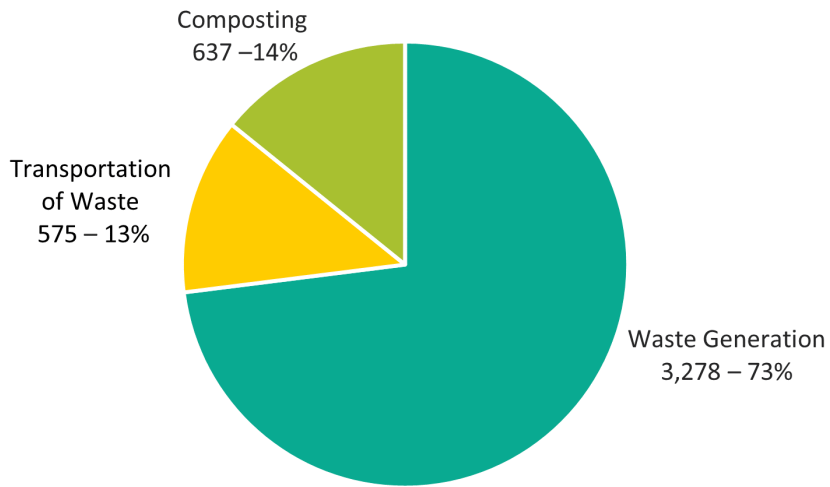
2019 Waste Characterization Emissions Factor Set: Detailed Composition, Overall Disposed Waste, 2019*

Newspaper	0.3%
Office Paper	0.5%
Corrugated Cardboard	3.9%
Magazines/Third Class Mail	5.9%
Food Scraps	15.5%
Grass	1.3%
Leaves	1.3%
Branches	0.6%
Dimensional Lumber	9.6%
Data Source	2019 King County Waste Characterization Study (Table 43)

*Refers to the estimated percentage of each material in the total amount of disposed waste in King County in 2019.

Updated Inventory Methodologies

The 2019 community-wide inventory was conducted in adherence with the U.S. Community Protocol, to the extent possible. New categories of data gathered for the 2019 Emissions Inventory included:

- Data entries for waste collected in Shoreline for composting outside of city boundaries.

- Data entries for transporting solid waste and compost from Shoreline to processing facilities located outside of city boundaries.

- Data on fugitive emissions from natural gas distribution.

- Data on vehicle miles traveled by vehicles passing though city boundaries (referred to as out-of-boundary, Scope 3 emissions) was collected from Google EIE. Out-of-boundary transportation represents a significant source of emissions, increasing transportation-related emissions from 139,782 $mtCO_2e$ to 276,384 $mtCO_2e$ (a 98% increase). This data was not included in the official 2019 Emissions Inventory as comparable data could not be obtained for previous inventory years to allow for a direct comparison.

- Data on electricity used to treat potable water for consumption within city boundaries. Data was obtained from Seattle Public Utilities and North City Water District, which both provide potable water in Shoreline but do not have treatment plants located within city boundaries. Water treatment data was collected but not included in the formal 2019 Emissions Inventory as comparable data for previous inventory years was not available.

- Data on electricity used to treat wastewater generated within city boundaries. Both King County and the City of Edmonds operate wastewater treatment plants that service Shoreline. Data was obtained from King County regarding the operation of their West Point Wastewater Treatment Plant, which is located outside of city boundaries. No data was provided by the City of Edmonds. Wastewater data was collected but not included in the formal 2019 Emissions Inventory as comparable data for previous inventory years was not available. Emissions calculated for water and wastewater treatment outside city boundaries totaled 578 $mtCO_2e$ in 2019.

Each inventory update may require some level of change from past practices to make improvements on calculations that were data-limited in the past or to work within data limitations of the current inventory. A summary of changes applied to the 2009, 2012, and 2016 inventories to provide a more robust analysis and allow for direct comparison with 2019 Emissions Inventory data is provided in the table below.

Summary of Changes Applied to the 2009, 2012, and 2015 Greenhouse Gas Inventories

Inventory Year	Summary of Changes to Analysis Conducted in 2021
2009	- Added data on composted waste and corrected an error in the waste characterization factor set. - Added data on fugitive emissions from natural gas distribution. - Updated calculations based on IPCC 5th Assessment 100 Year Values for Global warming Potential (previously used IPCC 2nd Assessment). - Edited VMT calculations to exclude pass-thru vehicle travel.[*]

Inventory Year	Summary of Changes to Analysis Conducted in 2021
2012	• Added landfill and compost data, and 2012 King County waste characterization factor set. • Added data on fugitive emissions from natural gas distribution.
2016	• Added data on composted waste and corrected an error in the waste characterization factor set. • Added data on fugitive emissions from natural gas distribution. • Updated calculations based on IPCC 5th Assessment 100 Year Values for Global warming Potential (previously used IPCC 2nd Assessment). • Updated SCL emissions factors from 2015 data to 2016 data.

*Note that this calculation was not edited for 2012 and 2016 VMT data. Thus, inventories for those two years do not provide a direct comparison of transportation-related emissions – or overall community emissions – and would need to have pass-thru travel data removed from the VMT totals in order for that to occur.
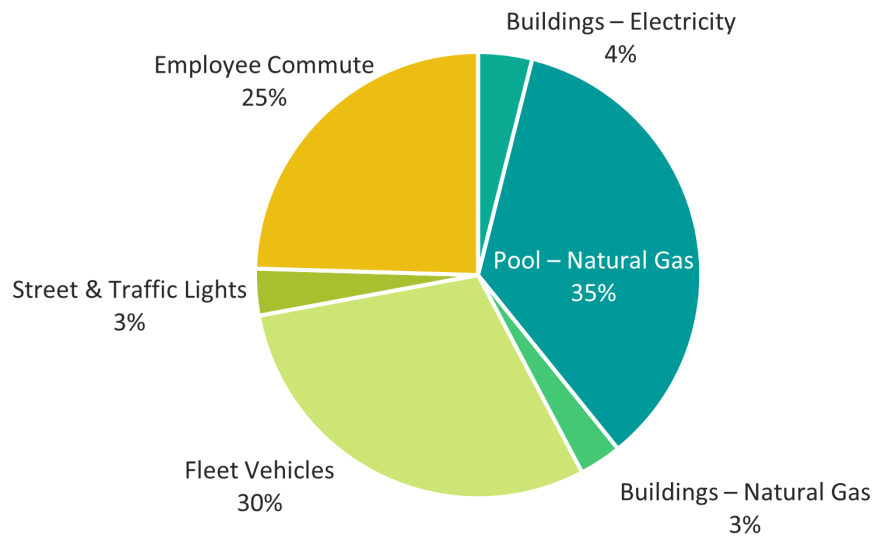
Local Government Operations Inventory

The City's 2019 Emissions Inventory for local government operations measures emissions from City-owned and operated buildings and vehicles, street and traffic lights in city boundaries, and City employee commuting methods. By tracking emissions over time, the City can measure the GHG reduction benefits from policies and programs put in place to reduce emissions within our operations. Although the GHG emissions from the City of Shoreline's operations as a government entity are small when compared with community-wide emissions (approximately 0.4% of the community-wide total), the City is committed to reducing its own footprint to model best practices for climate action.

Key Results from the 2019 Local Government Operations Inventory

- The City of Shoreline's GHG emissions from local government operations (Figure 9) totaled 1,271 metric tons of carbon dioxide equivalent (mtCO$_2$e) in 2019.

- Emissions from natural gas use associated with the community pool accounted for 35% of total municipal emissions, followed by emissions from the City's vehicle fleet (30%) and emissions from employee commuting (25%).

- Total emissions from local government operations (not including employee commute emissions, which were not available for 2009), increased 15% compared to 2009. This increase is primarily due to a 32% increase in the number of fleet vehicles in 2019 vs. 2009, including more trucks and fewer passenger cars.

- While the City does not have a means to accurately measure net emissions (i.e., to estimate the amount of carbon removed from the atmosphere by City facilities and natural spaces), it does not appear that we are on track to meet our goal of zero net emissions by 2030.

Figure 9. 2019 GHG emissions for City of Shoreline local government operations (1,271 mtCO$_2$e).

Local Government Operations Inventory	2009 mtCO$_2$e	2019 mtCO$_2$e	% Change 2019 v. 2009
Total Emissions (no employee commute data)	835	959	+15%
Total Emissions (with employee commute data)	835*	1,271	+52%
Buildings & Facilities	584	537	-8%
Streetlights & Traffic Signals	53	42	-21%
Vehicle Fleet	198	380	+92%
Employee Commute	NA	312	NA

*No employee commute data available for 2009.

Excluded from Government Operations Inventory

The following components were not included in this inventory:

- Electric Power Production: The City of Shoreline does not own or operate any power generation facilities.

- Transit Fleet: Public transit in Shoreline is managed independently by King County Metro Transit and Sound Transit. Estimates of public transit-related emissions are included in the Community-wide inventory using data from Google EIE.

- Water and Wastewater Treatment: The City of Shoreline does not own or operate any water/ wastewater treatment facilities. Electricity use associated with wastewater distribution via the Ronald Wastewater District is included in the Community-wide inventory as the City did not own or control that distribution system in 2019.

- Solid Waste: The City does not track waste generation for municipal facilities. Emissions associated with waste generation, transport of solid waste, and composting resulting from City facilities and operations are included in the Community-wide inventory.

Buildings & Facilities

Electricity

The City owns and operates a number of buildings and facilities that use electricity, including office buildings, community centers, park facilities, public restrooms, trails/lighted pathways, and pump stations used by the Public Works department. Seattle City Light provides electricity for all City facilities.

Electricity use for City buildings and facilities increased 44% in 2019 compared to 2009. City Hall was responsible for 54% of electricity use in 2019, followed by the Shoreline Pool (15%), Hamlin Park Maintenance Facility (6%), Shoreline Park (6%) and all other City buildings, parks, and facilities.

GHG Emissions	49.8 mtCO$_2$e
Activity/Usage	2,507,881 kWh
Emissions Factors	SCL Emissions Factor 2019
Data Sources	Seattle City Light Individual bills for Ronald Wastewater accounts

Natural Gas

A total of five City facilities used natural gas in 2019: the Shoreline Pool, the Richmond Highlands Recreation Center, Kruckeberg Gardens, the old Police Station at 185th, and the Ronald Wastewater office. Natural gas use in City buildings and facilities decreased 11% in 2019 compared to 2009. The pool was responsible for most (92%) of natural gas use at City facilities in 2019 and 35% of total emissions from municipal operations. The pool was permanently decommissioned in early 2021 which should yield significant emissions benefits moving forward.

GHG Emissions	487.9 mtCO$_2$e
Activity/Usage	91,733 therms
Emissions Factors	ClearPath
Data Sources	Puget Sound Energy

Streetlights & Traffic Signals

Seattle City Light provides electricity to City facilities, including streetlights and traffic signals. Electricity use for streetlights and traffic signals decreased 18% in 2019 compared to 2009.

GHG Emissions	43 mtCO$_2$e
Activity/Usage	2,126,024 kWh
Emissions Factors	2019 SCL Emissions Factors
Data Sources	Seattle City Light

Vehicle Fleet & Machinery

The City had 71 on-road fleet vehicles in 2019, including passenger vehicles, light/medium/heavy trucks, and light vans, which used gasoline, diesel, and electricity for fuel. Gasoline and diesel fuel is also used to power some off-road machinery, such as lawnmowers.

Fuel consumption (in gallons of gasoline/diesel) and mileage totals were used to calculate emissions from the City's vehicle fleet. Fuel consumption was used to calculate emissions from off-road machinery. The number of vehicles in the City fleet increased by 32% in 2019 vs. 2009, with fewer passenger cars and more light and medium trucks. Estimated miles traveled by City vehicles in 2019 decreased by 8% compared to 2009, while gallons of fuel consumed increased by 69% (primarily diesel fuel use).

On-Road Vehicles

|	
GHG Emissions	351 mtCO$_2$e
Activity/Usage	22,031 gallons – gasoline 15,075 gallons – diesel 436 kWh – electricity (estimated)
Emissions Factors	2019 US National Default 2019 Seattle City Light
Data Sources	City staff in the Administrative Services Department: miles from CityWorks and fuel use from King County Fleet and the Shoreline School District (which both provide fueling sites for City vehicles).

Off-Road Machinery

GHG Emissions	28 mtCO$_2$e
Activity/Usage	504 gallons – gasoline 2,777 gallons – diesel
Emissions Factors	2019 US National Default
Data Sources	City staff in the Administrative Services Department

Employee Commute

Estimated emissions associated with City of Shoreline employee commutes were obtained from the 2019 Commute Trip Reduction (CTR) Employer Survey Report from the Washington State Department of Transportation. In 2019, 76% of City employees completed the survey and reported a 75.9% drive alone rate (Figure 10). Employee commute data was not included in the 2009 baseline inventory.

GHG Emissions	312 mtCO$_2$e
Activity/Usage	439,584 vehicle miles traveled
Emissions Factors	2019 US National Default
Data Sources	2019 CTR Employer Survey Report – Washington State Department of Transportation

Figure 10. Mode split for all City employees in 2019.
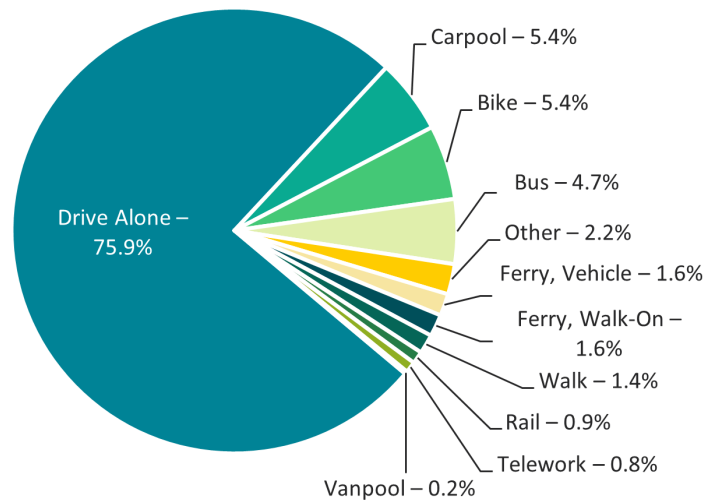
Next Steps

The City plans to conduct a Contribution Analysis in the Summer of 2021 to help understand the factors driving the noted changes in emissions between the 2009 and 2019 Emissions Inventory years, such as weather or population growth. The information from this report and the Contribution Analysis will help inform community discussions about priority strategies to reduce GHG emissions as we update our 2013 Climate Action Plan. To learn more about what the City is doing to fight climate change and reduce emissions, please visit **www.shorelinewa.gov/climate**.

This report was developed in June 2021 by Autumn Salamack and updated in November 2022 by Cameron Reed. For more information on City efforts to reduce GHG emissions and take climate action, visit **www.shorelinewa.gov/climate**.