Technical Memorandum

To: Department of Commerce
(GMSClimate@commerce.wa.gov)

Date: May 16, 2025

From: Anna Poliski, PE

Project No.: M2373.01.004

Re: Contract No. 24-63610-300 -- Memorandum of Completion, Deliverable #3: Emissions Worksheet and Emissions-Reduction Targets

Maul Foster & Alongi, Inc. (MFA) has prepared this memorandum on behalf of the City of Ferndale (the City) to summarize the completion of the work contained within Deliverable #3. This deliverable includes the following components:

- Emission Worksheet from the Climate Element Workbook (Attachment A)
- 2023 Greenhouse Gas (GHG) Emission Inventory Report (Attachment B)
- Emission Inventory Management Plan (Attachment C)

The Emission Worksheet (Attachment A) provides a high-level summary of the 2023 GHG Emission Inventory Report (Attachment B), which identifies key emission sources and potential reduction strategies for the City. The worksheet also ranks emission sectors from highest to lowest, helping to identify priority areas for action.

The analysis found that electricity use was the largest source of emissions, accounting for 37% of the City's total emissions. This was followed by natural gas heating at 34%, and transportation at 17%. For a complete summary of findings and methodology, please refer to Attachments A and B.

The Inventory Management Plan (Attachment C) was also developed to guide future updates and ensure consistency in tracking progress over time in accordance with Task 1.5 – 1.8 of the GHG Emissions Reduction Sub-element section of the Washington State Department of Commerce's Climate Element Intermediate Planning Guidance (Section 4, Pathway 3).

The City is choosing not to establish specific GHG emission reduction targets at this time. The City, in consultation with its Climate Policy Advisory Team, is working to develop a draft list of goals and policies for inclusion in its Comprehensive Plan update. This process is informed by a public values survey the City conducted in April 2025.

The City expects to have a draft list of goals and policies complete in June 2025, after which it will conduct a second round of community engagement to obtain feedback on the draft. This feedback will inform the draft sub-element that will be presented to the Ferndale Planning Commission and City Council in late 2025.

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Attachment A

Emission Worksheet

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City of Ferndale
2023 Greenhouse Gas Emissions

Emissions Worksheet (*For Pathways 1 or 3*)				
Emission Source	**Identify specific emission source, plus value and percentage from inventory or estimate[1]**	**Percentage of source, statewide[2]**	**Rank sectors (highest to lowest) as sources of emissions**	**GHG Emission Reduction Targets**
Electricity	Residential, Commercial, and Industrial Electricity; 50,984 MT CO_2e; 37%	20%	1	See 2023 GHG Emission Inventory Report Section 3: Emissions Reduction Opportunities, Subsection 3.1 Built Environment
Transportation	On-road vehicles and transit; 23,727 MT CO_2e; 17%	40%	3	See 2023 GHG Emission Inventory Report Section 3: Emissions Reduction Opportunities, Subsection 3.4 Transportation
Heating	Natural Gas (34%), Propane (<1%), and Fuel Oil (%2); Total: 50,883 MT CO_2e; 37%	25%	2	See 2023 GHG Emission Inventory Report Section 3: Emissions Reduction Opportunities, Subsection 3.1 Built Environment
Solid Waste Management	Solid waste emissions; 1,962 MT CO_2e; 1%	3%	5	See 2023 GHG Emission Inventory Report Section 3: Emissions Reduction Opportunities, Subsection 3.6 Solid Waste
Landfill/Waste Treatment	N/A.	N/A. Not included in state inventory	N/A	N/A
Natural Gas/propane transport and non-heating uses[3]	N/A. Amount by end use not available.	N/A. Amount by end use not available.	N/A	N/A
Industrial Processes	N/A. Data not available.	5%	N/A	N/A
Agriculture	N/A. Not included in inventory.	7%	N/A	N/A
Other	Wastewater; 261 MT CO_2e, <1%	<1%	7	See 2023 GHG Emission Inventory Report Section 3: Emissions Reduction Opportunities, Subsection 3.5 Wastewater
Other	Tree Canopy Loss; 1,377 MT CO_2e; 1%	N/A. Not included in state inventory	6	See 2023 GHG Emission Inventory Report Section 3: Emissions Reduction Opportunities, Subsection 3.3 Land Use
Other	Refrigerants; 8,086 MT CO_2e, 6%	2%	4	See 2023 GHG Emission Inventory Report Section 3: Emissions Reduction Opportunities, Subsection 3.2 Refrigerants

Notes

N/A - Not applicable.

References

[1] Data source: Ferndale 2023 GHG Emission Inventory prepared by Maul, Foster & Alongi, April 4, 2025

[2] Data source: Washington State Greenhouse Gas Emissions Inventory 1990-2021

[3] Natural Gas and propane data are not available by end use. All usage is assumed to be used for heating purposes.

Attachment B

2023 Greenhouse Gas Emission Inventory Report

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City of Ferndale 2023 Greenhouse Gas Emissions Inventory

Prepared for:

City of Ferndale

May 8, 2025
Project No. M2373.01.004

Prepared by:

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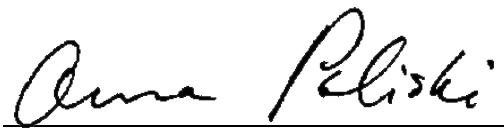
City of Ferndale 2023 Greenhouse Gas Emissions Inventory

The material and data in this report were prepared under the supervision and direction of the undersigned.

Maul F oster & Alongi, Inc.



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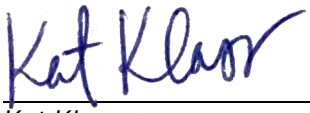

Kat Klass
Staff Environmental Scientist

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Contents

Limitations

Figures

In the Text

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Tables

In the Text

Appendixes

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Abbreviations

City	City of Ferndale
CH_4	methane
CNG	Cascade Natural Gas
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
EPA	U.S. Environmental Protection Agency
GHG	greenhouse gas
ICLEI	International Council for Local Environmental Initiatives
MFA	Maul Foster & Alongi, Inc.
MT	metric ton
N_2O	nitrous oxide
PSE	Puget Sound Energy
VMT	vehicle miles traveled
WCOG	Whatcom Council of Governments
WTA	Whatcom Transportation Authority

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1 Background

Maul Foster & Alongi, Inc. (MFA), was engaged by the City of Ferndale (the City) to assist with climate planning to inform the development of a new Climate Element for the 2025 Comprehensive Plan periodic update cycle. House Bill 1181, signed into law in 2023, requires Washington cities and counties to add a Climate Element to their comprehensive plans to increase resilience and reduce greenhouse gas (GHG) emissions. For eleven counties (including Whatcom County) and the cities within, creating a GHG emissions sub-element is a mandatory part of their next comprehensive plan update. This GHG emissions inventory supports the City's planning efforts by identifying emission sources and estimating the magnitude of current emissions. This is essential for understanding the primary sources of emissions and determining potential reduction opportunities. This report summarizes 2023 community-wide emissions and includes potential strategies for consideration in the Climate Element to reduce GHG emissions.

1.1 Methods

To determine the methods for Ferndale's GHG emissions inventory, the project team used the following guiding principles:

Replicability and transparency, which ensure that inventories can be conducted for Ferndale in future years and compared to this baseline inventory.

Consistency, which allows for comparison with the Whatcom County 2022 Greenhouse Gas Emissions Analysis.

Accuracy, which ensures inclusion of relevant emission sources and use of locally specific data.

GHG Emissions Inventory Protocols

This GHG emissions inventory was conducted according to the following protocols:

The U.S. Community Protocol for Accounting and Reporting of GHG Emissions, developed by the International Council for Local Environmental Initiatives (ICLEI 2019). This protocol provides a standardized method for quantifying GHG emissions at the community level.

- The Local Government Operations Protocol for the Quantification and Reporting of GHG Emissions Inventories (ICLEI 2010). This protocol provides a standardized method for quantifying GHG emissions from local government operations.
- The Recycling and Composting Emissions Protocol (ICLEI 2013). This protocol provides a standardized method for quantifying the climate benefits of recycling and composting. These benefits are reported as line items separate from the inventory emissions total to comply with the U.S. Community Protocol.

These protocols address the six internationally recognized GHGs:

- Carbon dioxide (CO_2)

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- Methane (CH_4)
- Nitrous oxide (N_2O)
- Hydrofluorocarbons
- Perfluorocarbons
- Sulfur hexafluoride

In this inventory, GHGs are reported collectively as carbon dioxide equivalents (CO_2e). CO_2e is a measure that standardizes each GHG according to its global warming potential. Global warming potential values quantify the relative impact of different climate-related pollutants, expressed as the amount of potential climate warming a pollutant may cause over a 100-year period relative to CO_2.

Ferndale's emissions were calculated for the 2023 calendar year, the most recent year with available data at the time of this inventory. All data is from 2023 unless specifically noted in Appendix A. Emissions calculations and analysis were performed in Microsoft Excel. The spreadsheet documenting emissions calculations and analysis was provided to City staff as a project deliverable.

Emissions Sources

The GHG emissions inventory includes sources listed in Table 1-1. Sources were selected and categorized to align with the Whatcom County 2022 Greenhouse Gas Emissions Analysis conducted by the Washington State Department of Commerce.

Table 1-1: Emissions Sources for the 2023 GHG Emissions Inventory

Category	Sources
Built Environment	Electricity Natural gas Propane Fuel oil
Refrigerants	Refrigerants
Land Use	Tree cover loss Carbon sequestration*
Transportation	Community on-road vehicles Transit
Wastewater	Treatment processes
Solid Waste	Landfilled waste Compost* Recycling*

Note:
Asterisk (*) indicates avoided emissions or emissions removals that are reported as separate line items and not included in total inventory emissions.

Methods and data considerations for each emissions source are provided in Attachment A.

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2 GHG Emissions Inventory Findings

In 2023, the Ferndale community produced an estimated 137,280 metric tons (MT) CO_2e. This is approximately 9.12 MT CO_2e per capita. The community's largest sources of emissions were electricity (37 percent of total emissions), natural gas (34 percent of total emissions) and transportation (17 percent of total emissions). Figure 2-1 and Table 2-1 below summarize 2023 community-wide emissions by category and source.

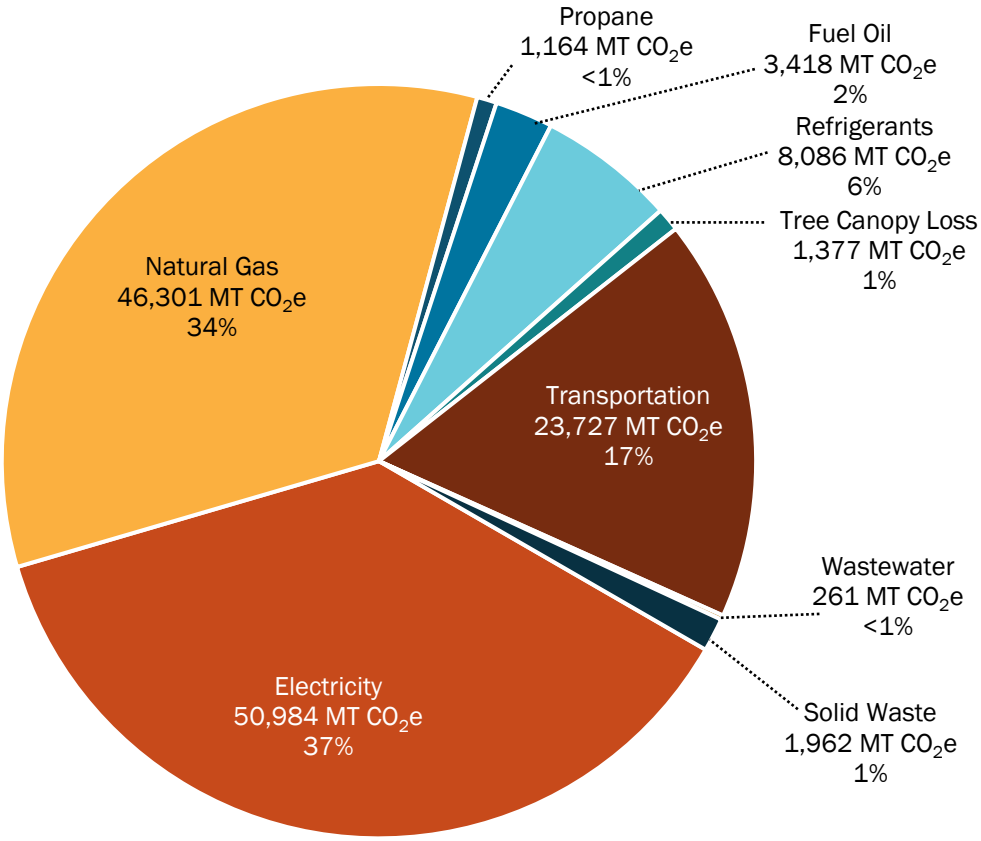

Figure 2-1: Total Emissions, by Category

Table 2-1: Total and Per-capita GHG Emissions, by Category

Category	Total Emissions (MT CO_2e)	Per-capita Emissions (MT CO_2e)	Percent of Total Emissions
Built Environment	**101,868**	**6.77**	**74**
Electricity	**50,984**	**3.39**	**37**
Residential	21,496	1.43	16
Commercial	23,726	1.58	17
Industrial	5,762	0.38	4

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Category	Total Emissions (MT CO_2e)	Per-capita Emissions (MT CO_2e)	Percent of Total Emissions
Natural Gas	**46,301**	**3.08**	**34**
Residential	17,637	1.17	13
Commercial	10,415	0.69	8
Industrial	18,249	1.21	13
Propane	**1,164**	**0.077**	**<1**
Residential	43.7	2.91E-03	<1
Commercial	519	0.034	<1
Industrial	602	0.040	<1
Fuel Oil	**3,418**	**0.23**	**2**
Commercial	841	0.056	<1
Industrial	2,577	0.17	2
Refrigerants	**8,086**	**0.54**	**6**
Land Use (Tree Canopy Loss)	**1,377**	**0.092**	**1**
Transportation	**23,727**	**1.58**	**17**
Community On-Road Vehicles	**23,277**	**1.55**	**17**
Transit	**450**	**0.030**	**<1**
Wastewater	**261**	**0.017**	**<1**
Solid Waste	**1,962**	**0.13**	**1**
Total Emissions	**137,280**	**9.12**	**100**
Avoided Emissions	**-1,933**	**-0.13**	**–**
Recycling	**-1,860**	**-0.12**	**–**
Compost	**-73.0**	**-4.85E-03**	**–**
Carbon Sequestration	**-3,171**	**-0.21**	**–**

2.1 Built Environment

The built environment category accounted for 74 percent of Ferndale's 2023 emissions, contributing 101,868 MT CO_2e. This category includes emissions from the use of electricity, natural gas, propane, and fuel oil to heat, cool, and power buildings and processes.

Figure 2-2 summarizes Ferndale's 2023 emissions from the built environment by category and source. Approximately 37 percent and 34 percent of Ferndale's total emissions came from electricity and natural gas consumption, respectively. Propane and fuel oil consumption contributed <1 percent and 2 percent, respectively.

Residential energy use (electricity, natural gas, and propane) accounted for 29 percent of total emissions. Commercial and industrial energy use (electricity, natural gas, propane, and fuel oil) accounted for 26 percent and 20 percent, respectively, of total emissions.

Emissions from electricity were calculated using utility-specific emission factors obtained from Puget Sound Energy (PSE) and are reported in Table 2-1 based on this utility-specific approach. For informational purposes, emissions from electricity were also calculated using EPA Emissions & Generation Resource Integrated Database emission factors, which represent regional electric power mixes. When calculated using this location-based method, Ferndale's electricity emissions were approximately 34,568 MT CO_2e, compared to 50,984 MT CO_2e when estimated using a utility-

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specific approach. This indicates that PSE's fuel mix for electricity generation is more emissions-intensive than the regional electric power mix.

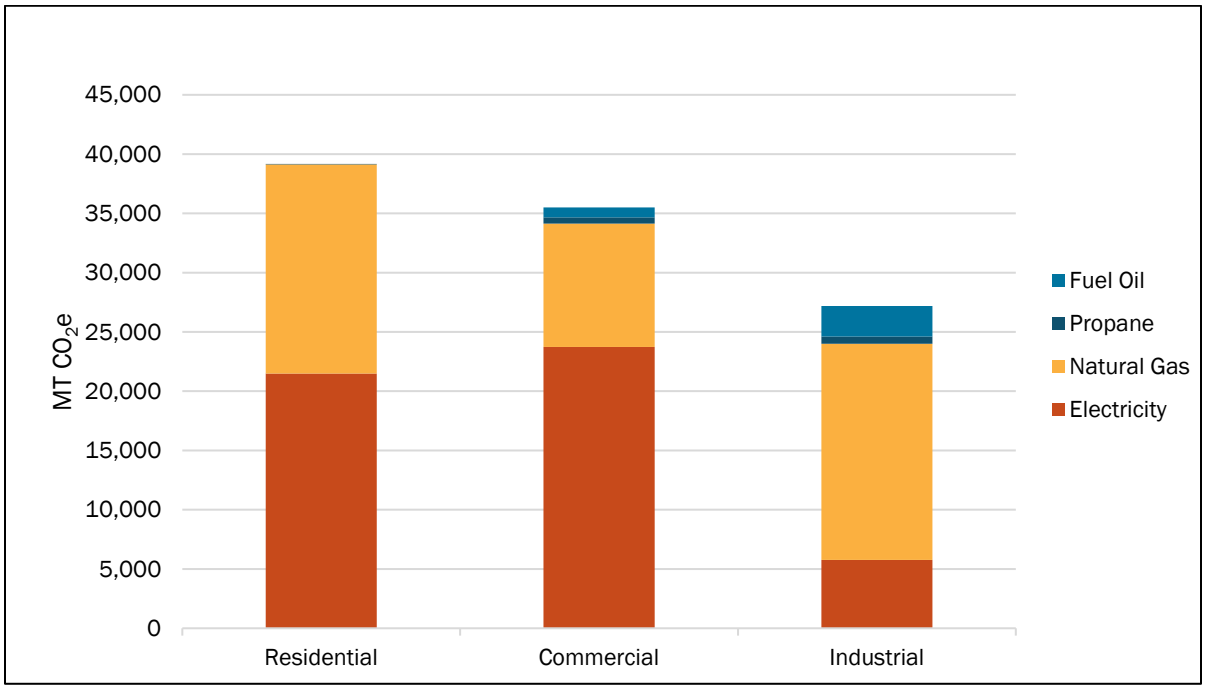

Figure 2-2: Built Environment GHG Emissions by Category and Source

2.2 Refrigerants

The refrigerants category made up 6 percent of Ferndale's 2023 community-wide emissions, emitting an estimated 8,086 MT CO_2e. Refrigerant category emissions come from hydrofluorocarbons, perfluorocarbons, and CO_2 due to ozone-depleting substances. Due to limited local data, city-level refrigerant emissions were estimated using national data downscaled based on population.

2.3 Land Use

The land use category includes two subcategories: tree cover loss and carbon sequestration. Tree cover loss and carbon sequestration estimates are based on remote sensing data and account for tree characteristics such as types, age, and health.

Tree cover loss accounted for 1 percent of Ferndale's 2023 emissions, contributing 1,377 MT CO_2e. Tree loss can be attributed to several factors, including conversion of forest land for other uses, decrease in urban tree canopy, deforestation and harvesting, and damage from insects, fire, and diseases.

Trees and forests in Ferndale sequestered approximately 3,171 MT CO_2e from the atmosphere in 2023. Carbon sequestration refers to the removal of carbon dioxide from the atmosphere.

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Emissions removals from carbon sequestration should not be netted with tree cover loss; therefore, carbon sequestration is reported as a separate line item from the emissions inventory total (see Table 2-1).

2.4 Transportation

The transportation category made up 17 percent of Ferndale's 2023 community-wide emissions, emitting an estimated 23,727 MT CO_2e (see Figure 2-1 and Table 2-1). This sector includes emissions from community on-road vehicles within the Ferndale subarea[1] and Whatcom Transportation Authority (WTA) transit service provided on roads in Ferndale.

According to Whatcom Council of Government's (WCOG) travel demand model,[2] on-road vehicles traveled approximately 51,830,000 miles on city-owned roadways in the Ferndale subarea in 2023. Community on-road vehicles accounted for 23,277 MT CO_2e. WTA transit service in Ferndale accounted for approximately 61,098 vehicle miles traveled (VMT) and 450 MT CO_2e.

2.5 Wastewater

The wastewater category made up <1 percent of Ferndale's 2023 emissions, contributing an estimated 261 MT CO_2e (see Figure 2-1 and Table 2-1). This category includes fugitive emissions from septic systems and emissions from the treatment of wastewater produced within the Ferndale wastewater treatment plant service area, which serves approximately 16,330 people, according to wastewater treatment plant staff.

Wastewater treatment plant emissions were attributed to fugitive methane emissions from septic systems, process N_2O emissions from wastewater treatment with nitrification, and process N_2O emissions from effluent discharge.

The wastewater treatment plant in Ferndale also produces emissions from energy used to power wastewater treatment processes; these emissions are accounted for in the commercial energy category to avoid double-counting between categories.

2.6 Solid Waste

The solid waste category made up 1 percent of Ferndale's 2023 emissions, contributing an estimated 1,962 MT CO_2e (see Figure 2-1 and Table 2-1). This category includes methane emissions from the decomposition of organic material in landfilled waste, emissions from the collection and transportation of solid waste to landfill, and process emissions associated with landfill operations.

According to the Whatcom County Comprehensive Solid and Hazardous Waste Management Plan, most of the waste generated in Ferndale is trucked to the Columbia Ridge Landfill in Arlington,

[1] The Ferndale subarea approximates city limits but does not match them exactly, as some of the transportation network links represented in the travel demand model overlap with city boundaries. The Ferndale subarea was defined by WCOG in response to the data request for an estimate of vehicle miles traveled in Ferndale for this GHG inventory.
[2] WCOG's travel demand model is used for regional transportation planning and follows a conventional travel demand model process that includes trip generation, trip distribution, mode choice, and route assignment. For more information, see https://wcog.org/regional-transportation-model.

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Oregon. The Columbia Ridge Landfill has a system that recovers landfill gas for energy generation, which decreases the magnitude of Ferndale's solid waste emissions.

The solid waste category also includes avoided emissions resulting from recycling and composting programs. Recycling offers GHG reduction benefits in three distinct ways:

- it offsets a portion of upstream GHG emissions during raw material acquisition, manufacturing, and transport of virgin inputs and materials;
- it enhances carbon sequestration in forests when wood and paper products are recycled; and
- it decreases emissions associated with landfilling waste.

Recycling collected in Ferndale led to an estimated 1,860 MT CO_2e of avoided emissions.

Composting provides GHG reduction benefits in two ways quantified in this inventory:

- it prevents emissions by displacing the need for chemical fertilizer production, and
- it decreases emissions associated with landfilling waste.

Organic material collected in Ferndale for composting led to an estimated 73 MT CO_2e of avoided emissions.

Avoided emissions due to use of recycling and composting programs should not be netted with solid waste emissions; therefore, these subcategories are reported as separate line items from the emissions inventory total.

3 Emissions Reduction Opportunities

This section highlights emission reduction opportunities for each category that could be included in the Climate Element, based on the results of this inventory. Many of the example goals and policies were selected from the Department of Commerce's Climate Policy Explorer, which offers model climate goals and policies as a starting point for communities developing a Climate Element. A comprehensive list of potential strategies can be reviewed by consulting the Climate Policy Explorer (Washington State Department of Commerce 2025b).

3.1 Built Environment

Electricity use was Ferndale's largest source of emissions within the scope of the inventory. Residential and commercial electricity present the largest opportunities for emissions reduction from electricity, accounting for 29 percent and 26 percent of total emissions, respectively. In 2023, PSE's electricity fuel mix consisted of approximately 30 percent natural gas, 18 percent coal, 30 percent hydroelectric, and 22 percent wind, with the remaining <1 percent from nuclear, solar, and unspecified sources (PSE 2024). Washington State's Clean Energy Transformation Act, enacted in 2019, aims to transition the State to 100 percent clean electricity by 2045 and requires utilities to develop plans for achieving clean energy targets (Washington State Department of Commerce 2025a). PSE and other utilities are required to reduce the carbon intensity of electricity supplied to

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customers; therefore, it is anticipated that electricity in Washington State will become less emissions-intensive over time.

Natural gas use was Ferndale's second-largest source of emissions within the scope of the inventory. Residential and industrial natural gas use present the largest opportunities for emissions reduction from natural gas, each accounting for 13 percent of total emissions.

Propane and fuel oil use accounted for <1 percent and 2 percent of total emissions, respectively. While propane and fuel oil use represent a smaller percentage of total emissions, there may still be feasible opportunities for action that could help reduce emissions from these sources.

With this context in mind, the goals and policies outlined in Table 3-1 aim to reduce emissions from natural gas, electricity, propane, and fuel oil.

Table 3-1: Goals and Policies to Consider for Built Environment GHG Emissions Reduction

Goal/Policy	Notes
Goal: Ensure that buildings use renewable energy, conservation, and efficiency technologies and practices to reduce greenhouse gas emissions.	Residential and commercial buildings use large amounts of electricity. Jurisdictions can amend land use regulations to require new residential and commercial buildings to utilize renewable energy sources, reducing GHG emissions and mitigating climate change.
Goal: Maximize solar access of site design, where practicable, for new solar-ready residential and commercial buildings.	Solar access, a fundamental aspect of sustainable building design, refers to a building's ability to efficiently utilize sunlight for lighting, heating, and renewable energy generation. Solar access is determined by sunlight availability and potential shading from nearby structures, among other factors.
Policy: Retrofit buildings for energy efficiency.	Develop requirements for updated insulation and replacement of back-up generators that rely on fossil fuels. Replace with onsite solar and storage systems, where feasible.
Policy: Prioritize the preservation and weatherization of housing in overburdened communities, particularly at higher densities, to reduce emissions and increase resilience.	Financial assistance should be prioritized for existing tenants at risk of displacement from "green gentrification."
Policy: Prioritize the use of lower-carbon building materials in new construction and building retrofits to reduce embodied carbon.	While embodied carbon for building materials was not included in Ferndale's GHG emissions inventory, these emissions represent most of buildings' lifetime carbon emissions and a significant opportunity for emissions reduction.
Policy: Develop local microgrid solar and battery storage facilities in low-impact sites.	Integrating small-scale renewable energy production throughout a jurisdiction can reduce transmission losses and provide an alternative to fossil fuel energy sources. Jurisdictions can do this by amending land use regulations to require new structures to have solar orientation. Jurisdictions can also waive or reduce fees for uses that include local renewable energy generation to incentivize developers to include these features in land use proposals. Low impacts could include roofs, parking lots, brownfield sites, and former fossil fuel facilities that have access to the electrical grid. Distributed power can also increase resilience to power grid disruption during storms if it can be used directly by sources.

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3.2 Refrigerants

Due to a lack of refrigerant-specific policies in the Climate Policy Explorer, emission reduction opportunities for refrigerants were not included.

3.3 Land Use

Tree cover loss accounted for 1,377 MT CO_2e in 2023. Though tree cover loss is not a significant source of GHG emissions in Ferndale, maintaining and increasing tree cover is associated with key climate adaptation benefits, such as reducing heat islands and improving air quality.

Goals and policies aimed at maintaining and increasing tree cover could include the examples in Table 3-2.

Table 3-2: Goals and Policies to Consider for Land Use GHG Emissions Reduction

Goal/Policy	Notes
Goal: Increase tree canopy cover to boost carbon sequestration, reduce heat islands, and improve air quality, prioritizing overburdened communities.	Frontline communities identified using land and plants to absorb carbon pollution and prioritizing this work in frontline communities as an environmental justice priority. Parks departments should be able to initiate increases in tree canopy. Subsequent sequestration and air quality improvements depend on a number of variables, especially tree types and soil types.
Policy: Maximize tree canopy coverage in surface parking lots.	Tree canopies in surface parking lots can contribute to carbon sequestration inside an urbanized area in the long term (5 - 10yrs). Biological factors (tree types, soils) should be researched and considered for maximum sequestration benefits in the long term.
Policy: Improve and expand urban forest management to maximize or conserve carbon storage.	Urban forests provide carbon sequestration and climate resilience benefits. Implementing this policy will require developing an urban forest management plan that includes an assessment of carbon sequestration. Trees in urban areas or urban forests can influence air temperatures, building energy use, and consequently alter carbon emissions from numerous urban sources. Local governments can implement strategies such as changing zoning codes for tree retention, minimizing development disturbance areas, and acquiring and restoring forested open space and parks.

3.4 Transportation

Transportation was Ferndale's third-largest source of emissions within the scope of this inventory, accounting for 17 percent of total emissions. Goals and policies aimed at reducing emissions from transportation could include the examples in Table 3-3.

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Table 3-3: Goals and Policies to Consider for Transportation GHG Emissions Reduction

Goal/Policy	Notes
Goal: Convert public fleets to zero-emission vehicles by [target year] and develop supporting infrastructure and programs (e.g., charging stations and dedicated lanes for electric cars and buses).	Frontline communities identified reducing fossil fuel vehicle miles by switching to electric as an environmental justice priority. Provide benefits of adoption by certain date, such as 2040.
Goal: Expand electric vehicle infrastructure.	Jurisdictions can reduce GHG emissions by making ownership and use of electric vehicles convenient and affordable. Jurisdictions should examine their neighborhoods, commercial centers, and transportation systems to determine the optimal locations for charging infrastructure. Update comprehensive plan land use elements to allow and support EV charging infrastructure.
Policy: Integrate "Complete Streets" principles into the roadway designs of residential developments.	Complete Streets are roadways that are designed and operated to provide safe, accessible, and healthy travel for all users of our roadway system, including pedestrians, bicyclists, transit riders, and motorists. A complete street may include sidewalks, bike lanes (or wide paved shoulders), special bus lanes, comfortable and accessible public transportation stops, frequent and safe crosswalks, median islands, accessible pedestrian signals, curb extensions, narrower travel lanes, roundabouts, or related structures.
Policy: Increase multimodal capacity in coordination with the location of higher-density housing and commercial centers.	Transportation and multimodal improvement considerations should be part of the permitting process beyond housing and road impact fee assessments. Transit-supportive residential densities are impactful to provide shorter trips and increase transit and nonmotorized usage. In some locations, such as freeway transit stations, the location of land uses may be best when tangential to the station and not concentrated within 600 feet.
Policy: Implement multimodal transportation planning to reduce single-occupancy vehicle dependence and greenhouse gas emissions.	Develop mode-specific plans, such as bicycle and pedestrian plans, adopt complete streets policies and ordinances, and a multimodal transportation concurrency program.
Goal: Reduce VMT to achieve GHG reduction goals.	Frontline communities identified making it easier to not need a car by designing walkable and accessible neighborhoods and providing affordable public transportation as a top environmental justice priority.
Policy: Create a safe, well-connected, and attractive bicycle and pedestrian transportation network to encourage active transportation.	Implementation of this policy could include a strategy to reduce pedestrian or bicycle and car collisions, beginning with overburdened communities with the highest rate of injury or death. Key to the success of this policy is to establish a safe and welcoming environment that includes lighting, visibility, landscaping, and active uses.
Policy: Ensure public transit stops and stations are located at or near dense commercial and employment areas.	Goals and policies in transportation and land use elements should be consistent and complimentary. Successful implementation of this measure should be coordinated with subarea or corridor planning to ensure that housing is near these transit facilities.

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Goal/Policy	Notes
Policy: Implement complimentary, mixed land uses versus traditional zoning, such as locating business districts, parks and schools in neighborhoods to promote cycling and walking and reduce driving.	Creating walkable, accessible communities with mixed-use developments can reduce VMTs and subsequent GHG emissions from vehicles. The majority of Washington cities are zoned single-family and do not allow for commercial uses adjacent or integrated within the residential area. Amending comprehensive plans and land use regulations to require mixed-use developments can facilitate GHG reductions.

3.5 Wastewater

Wastewater treatment processes accounted for <1 percent of GHG emissions in Ferndale within the scope of this inventory. Mitigating these emissions is challenging due to the essential nature and long lifespan of the wastewater treatment plant.

However, opportunities to reduce emissions could include the examples in Table 3-4.

Table 3-4: Policies to Consider for Wastewater GHG Emissions Reduction

Goal/Policy	Notes
Policy: Develop a local pollution surcharge for large producers of air pollutants, wastewater, and solid waste.	The surcharge budget could help subsidize low-income homes converting to solar and heat pumps.
Policy: Implement measures to reduce the total volume of wastewater needing treatment.	This policy could potentially align with water conservation initiatives.

3.6 Solid Waste

Solid waste accounted for 1 percent of total emissions within the scope of this inventory. These emissions are low compared to the rest of the inventory categories due to the recovery of landfill gas for energy at the Columbia Ridge Landfill.

Goals and policies to enhance emissions reduction from solid waste generation and disposal could include the examples in Table 3-5.

Table 3-5: Goals and Policies to Consider for Solid Waste GHG Emissions Reduction

Goal/Policy	Notes
Goal: Develop targeted campaigns for recycling material with highest GHG reduction impact (e.g., paper, metal, food waste).	Frontline communities identified reducing material consumption and reuse as a top environmental justice priority.
Policy: Incentivize recycling of construction and demolition debris.	Reusing and recycling existing construction and demolition debris avoids carbon emissions associated with depositing construction waste in landfills. Jurisdictions can incentivize recycling of demolition debris by waiving or reducing fees associated with recycling.

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Goal/Policy	Notes
Policy: Create and sustain a business technical assistance program to increase recycling and reduce waste.	Policies in a comprehensive plan can initiate an outreach and education program that could facilitate recycling of solid waste from commercial businesses. One model to consider could include creating an exchange or encouraging industrial and commercial companies to reach out to each other to share residuals or discarded materials that may have other uses.
Policy: Develop a local pollution surcharge for large producers of air pollutants, wastewater, and solid waste.	The surcharge budget could help subsidize low-income homes converting to solar and heat pumps.

4 Conclusion

Ferndale's 2023 GHG emissions inventory identifies significant areas where focused efforts can effectively reduce emissions, informing the selection of future goals and policies to reduce GHG emissions. The built environment and transportation categories stand out as key areas for improvement. Considering emissions reduction initiatives that improve building energy efficiency, expand renewable energy use, reduce energy consumption, and decrease VMT can drive significant progress towards emission reduction.

In spring 2025, the public will be invited to provide input on the prioritization of GHG sub-element policies and desired co-benefits of these policies. Ferndale's Climate Policy Advisory Team will then prioritize GHG sub-element policies based on public input and the results of the GHG emissions inventory. By combining GHG emissions data, public input, and policy advisory team expertise, Ferndale aims to develop a robust GHG reduction sub-element and contribute to regional and statewide climate action.

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Appendix A

Greenhouse Gas Emissions Inventory Methods

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Greenhouse Gas Emissions Inventory Methods

Methods and Data Sources

Estimating Ferndale's greenhouse gas (GHG) emissions involved collecting activity data from various sources, identifying relevant emission factors, and applying these emission factors to the activity data.

Table A-1 summarizes the following:

- Activity data, which quantify levels of GHG-generating activities, such as kilowatt-hours (kWh) of electricity consumed, vehicle miles traveled (VMT), or the amount of waste landfilled.
- Emission factors (e.g., metric tons of carbon dioxide equivalent (MT CO_2e per kWh)) convert activity levels into emissions.

Activity data sources and emission factor sources are fully documented in the Ferndale 2023 GHG Emissions Inventory spreadsheet.

Table A-1: Activity Data and Emission Factors for Ferndale GHG Emissions Inventory

Category	Activity Data	Emission Factors
Built Environment		
Electricity	Consumption within city limits provided by Puget Sound Energy (PSE)	1) PSE-specific emission factor from PSE 2023 GHG reporting 2) Emissions & Generation Resource Integrated Database emission factors (for informational purposes only)
Natural gas	Consumption within city limits provided by Cascade Natural Gas (CNG)	1) Climate Registry emission factors 2) Environmental Protection Agency (EPA) Emission Factors Hub
Propane	WA propane consumption by sector from U.S. Energy Information Administration (EIA)	1) Climate Registry emission factors 2) EPA Emission Factors Hub
Fuel oil	WA fuel oil consumption by sector from U.S. EIA	1) Climate Registry emission factors 2) EPA Emission Factors Hub
Refrigerants		
Refrigerants	EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks, 1990-2022	N/A (data reported in CO_2e emissions)
Land Use		
Tree cover loss	ICLEI Land Emissions and Removals Calculator (LEARN)	N/A (data reported in CO_2e emissions)

Category	Activity Data	Emission Factors
Carbon sequestration*	ICLEI LEARN	N/A (data reported in CO_2e emissions)
Transportation		
Community on-road vehicles	VMT data from Whatcom Council of Governments (WCOG) travel demand model for Ferndale subarea	EPA Emission Factors Hub
Transit	VMT data from Whatcom Transportation Authority (WTA)	EPA Emission Factors Hub
Wastewater		
Treatment processes	Wastewater treatment data from City staff	U.S. Local Government Operations Protocol default emission factors, customized based on data available from wastewater treatment plant
Solid Waste		
Landfilled waste	Tonnage collected within city limits for municipal solid waste and roll-off services from Sanitary Service Company (SSC)	U.S. Community Protocol solid waste emission factors, customized for landfill characteristics (e.g., landfill gas recovery)
Compost*	Compost tonnage collected within city limits from SSC	Recycling and Composting Emissions Protocol composting avoided emission factors
Recycling*	Mixed recycling tonnage collected within city limits from SSC	Recycling and Composting Emissions Protocol recycling avoided emission factors

Note:
Asterisk (*) indicates avoided emissions or emissions removals that are reported as separate line items and not included in total inventory emissions.

Built Environment

Electricity

Emissions from electricity consumption were calculated using the amount of electricity consumed within Ferndale city limits in 2023, multiplied by PSE's 2023 emission factor. PSE supplied residential, commercial, and industrial electricity consumption data. For informational purposes, emissions from electricity were also calculated using EPA Emissions & Generation Resource Integrated Database emission factors which represent regional electric power mixes.

Natural Gas

Emissions from natural gas consumption were calculated using the amount of natural gas consumed within Ferndale city limits in 2023, multiplied by EPA emission factors. CNG provided residential, commercial, and industrial natural gas consumption data.

Propane and Fuel Oil

Residential propane emissions were calculated using 2020 (most recent available data) U.S. EIA average residential propane consumption data for Washington state. Average residential propane consumption was multiplied by U.S. Census American Community Survey (ACS) home heating fuel data for Ferndale and then multiplied by EPA emission factors.

For commercial and industrial propane and fuel oil, U.S. EIA statewide consumption data for 2023 were not available at the time of this analysis, so data from 2022 were used. Commercial and industrial propane and fuel oil emissions were calculated using statewide fuel consumption estimates downscaled by the number of commercial and industrial employees within Whatcom County as compared to total state employment. County-level estimates were further downscaled using the ratio of Ferndale population to Whatcom County population. Employment data were collected from the Washington Employment Security Department, which provides data on the number of employees across industries. Propane and fuel oil emissions were calculated using EPA emission factors.

Refrigerants

Refrigerant emissions were calculated from the EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2022. National-level refrigerant emissions from 2022 were downscaled and attributed to Ferndale based on the ratio of Ferndale population to U.S. population.

Land Use

Tree Cover Loss and Carbon Sequestration

ICLEI's Land Emissions and Removals Navigator (LEARN) tool was used to estimate GHG emissions from tree cover loss and carbon sequestration from tree cover gain and maintenance within Ferndale's boundaries. The LEARN tool uses the National Land Cover Database produced by the United States Geological Survey as the land cover database for this analysis. The LEARN tool requires a minimum of a three-year analysis timeframe; totals from the 2019-2021 period were divided by three to determine an average annual value. At the time of this inventory, the tool was available through 2021, and a 2019-2021 timeframe was analyzed. Default factors used to calculate emissions for the "Trees Outside Forests" category are based on data for Seattle, Washington. The tool allows for customization to major metropolitan areas, but the only available Washington option is for Seattle.

Emissions removals due to carbon sequestration should not be netted with tree cover loss emissions; therefore, carbon sequestration is reported as a separate line item from the emissions inventory total.

The LEARN tool is limited in scope to assessing land-use changes involving forests and trees outside forests. It does not currently address other major land uses that can have significant GHG emissions impacts, such as cropland and pasture.

Transportation

Community On-Road Vehicles

Community on-road emissions estimates were developed using 2023 VMT activity data from WCOG's travel demand model. The data used for calculations only includes estimated VMT on city-owned roads in Ferndale and does not include VMT within Ferndale city limits on roads that are not city-owned (e.g., Interstate 5 and ramps, State Route 548). VMT was split into freight/service vehicles and passenger vehicles VMT based on Washington State Department of Transportation Highway Performance Monitoring System statewide freight percentages. For freight/service vehicle emissions, VMT was multiplied by EPA vehicle-specific emission factors. For passenger vehicles, 2023 vehicle

registration data from Whatcom County was used to estimate VMT by vehicle type, which was then multiplied by EPA vehicle-specific emission factors.

Transit

Transit emissions estimates were developed using 2023 VMT and fuel economy data provided by WTA for routes passing through Ferndale (Route 27 and Route 75). Total revenue miles for each route were multiplied by the percentage of round-trip miles traveled in Ferndale for each route. VMT were attributed to bus types (diesel, hybrid diesel, and electric) based on WTA's 2023 fixed-route fleet composition. Estimated mileage by bus type was divided by average fuel economy by bus type to estimate gallons of fuel or kWh consumed. Fuel consumption data was then multiplied by EPA vehicle-specific emission factors.

Wastewater

Wastewater treatment process emissions produced in the Ferndale service area were estimated based on 2023 data provided by city staff. Emissions were estimated based on the type of processes occurring at the plant and in the city (e.g., wastewater treatment in aerated basins, use of septic systems) as well as the population served. Based on the data provided by city staff, emissions were calculated using U.S. Local Government Operations Protocol default equations.

Solid Waste

Landfilled Waste

SSC provided collection data for municipal solid waste and roll-off tonnage for customers within Ferndale city limits. The 2020-2021 Washington Statewide Waste Characterization Study was used to characterize community-generated waste sent to landfills (i.e., estimate the mass fraction of each material type and multiply those mass fractions by the total tonnage sent to landfill).

Emissions were calculated by multiplying the estimated tons of waste generated in 2023 by material type-specific emission factors from the U.S. Community Protocol's Appendix E: Solid Waste Emissions Activities and Sources. The U.S. Community Protocol includes a default assumption of 75% collection efficiency for landfill gas recovery systems.

Emissions from waste collection, transportation of waste to landfills, and landfill operational processes were estimated using the total mass of waste sent to landfill and emission factors from Appendix E of the U.S. Community Protocol.

Recycling and Composting

SSC provided data for recycling and organics tonnage collected within Ferndale city limits. The 2022-2023 Washington Statewide Recycling and Organics Characterization Study was used to characterize recycling and organics streams from Ferndale (i.e., estimate the mass fraction of each material type and multiply those mass fractions by the total tonnage).

Avoided emissions were calculated by multiplying the estimated tons of waste generated in 2023 by material type-specific avoided emission factors from ICLEI's Recycling and Composting Emissions Protocol.

Avoided emissions due to use of recycling and composting programs should not be netted with solid waste emissions; therefore, these subcategories are reported as separate line items from the emissions inventory total.

Data Limitations

For some categories, data availability was limited and/or it was necessary to scale regional, state, or national data to estimate emissions. Data limitations and the local relevance of data sources for each category are summarized below.

Built Environment

Electricity

- No notable limitations of data sources or approach.
- Electricity data reflect local conditions.

Natural Gas

- No notable limitations of data sources or approach.
- Natural gas data reflect local conditions.

Propane and Fuel Oil

- At the time of analysis, 2023 EIA data for statewide average household residential propane consumption were not available, so 2020 data (most recent available data) were used in calculations.
- At the time of analysis, 2023 EIA data for statewide commercial and industrial propane and fuel oil use were not available, so 2022 data were used in calculations.
- Data for average residential fuel oil use in Washington state were withheld because either the relative standard error was greater than 50% or there were fewer than ten households in the reporting sample.
- Residential, commercial, and industrial propane and fuel oil data are based on scaled regional and state data.

Refrigerants

- At the time of analysis, 2023 refrigerant emissions data were not available, so 2022 data were used in calculations.
- Refrigerant data is based on scaled national data.

Land Use

Tree Cover Loss and Carbon Sequestration

- The most recent data available for the LEARN tool at the time of this inventory was 2021, so the tree cover analysis was conducted for 2019-2021 and divided by three to determine an average annual value.

- Land use data reflect local conditions.

Transportation

Community On-Road Vehicles

- The VMT data used for calculations only include estimated VMT on city-owned roads in Ferndale and does not include VMT within Ferndale city limits on roads that are not city-owned (e.g., Interstate 5 and ramps, State Route 548). WCOG's travel demand model estimated that VMT within the Ferndale subarea (regardless of road ownership, i.e., inclusive of Interstate 5, ramps, and State Route 548) totaled approximately 442,000 miles per day, compared to an estimated 142,000 miles per day on city-owned roads.
- WCOG travel demand model data reflect local conditions.

Transit

- No notable limitations of data sources or approach.
- WTA-provided data reflect local conditions.

Wastewater

- No notable limitations of data sources or approach.
- Wastewater data reflects local conditions.

Solid Waste

Landfilled Waste

- In 2023, SSC served Ferndale with a single garbage truck that picked up both residential and commercial accounts, so disposal tonnage could not be separated by sector.
- Solid waste data reflect local conditions and are characterized using regional data.

Recycling and Composting

- No notable limitations of data sources or approach.
- Recycling and composting data reflect local conditions and are characterized using regional data.

Attachment C

Inventory Management Plan

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Greenhouse Gas Inventory Management Plan

City of Ferndale

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Contents

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Limitations

Figures

Tables

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Abbreviations

CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
CH_4	methane
EIA	U.S. Energy Information Administration
EPA	U.S. Environmental Protection Agency
GHG	greenhouse gas
GWP	global warming potential
HFCs	hydrofluorocarbons
ICLEI	International Council for Local Environmental Initiatives
IMP	Inventory Management Plan
LGOP	U.S. Local Government Operations Protocol
MFA	Maul Foster & Alongi, Inc.
N_2O	nitrous oxide
PFCs	perfluorocarbons
PSE	Puget Sound Energy
SF_6	sulfur hexafluoride
USCP	U.S. Community Protocol for Accounting and Reporting Greenhouse Gas Emissions
VMT	vehicle miles traveled
WTA	Whatcom Transportation Authority

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1 Introduction

This Inventory Management Plan (IMP) was prepared by Maul Foster & Alongi, Inc. (MFA) on behalf of the City of Ferndale (the City) as part of the Greenhouse Gas (GHG) Emission Reduction Sub-element consistent with the Washington State Department of Commerce's (Commerce) Climate Element Intermediate Planning Guidance.[1]

As part of the GHG Emission Reduction Sub-element, a GHG emission inventory was prepared for the City for the 2023 calendar year. The 2023 GHG emission inventory establishes a baseline for monitoring emissions, providing the City with critical data to better understand its emissions profile. The City will continue to monitor GHG emissions over time and will update the GHG emission inventory every five years.

This IMP outlines standardized protocols for future inventory updates, including detailed procedures for data collection, emissions quantification, and inventory management. It ensures consistency and accuracy in tracking emissions over time and emphasizes the importance of community engagement, data quality, and regular updates to support the City's climate action efforts.

2 Inventory Details

2.1 Protocol

The GHG emission inventory and IMP were developed using the International Council for Local Environmental Initiatives (ICLEI) U.S. Community Protocol for Accounting and Reporting Greenhouse Gas Emissions (USCP).[2]

2.2 Boundary Conditions

The City has chosen to define the boundary for the GHG emission inventory using the Ferndale city limits (see Figure 1 below). This ensures that the GHG emission inventory accurately reflects the emissions occurring within the jurisdictional boundary of the community, aligns with standard practices in community GHG emission inventories, and allows for more precise tracking and reporting of emissions and removals over time. However, some trans-boundary sources such as emissions associated with waste disposal (i.e., waste generated in Ferndale and disposed outside of city limits) were included as part of the GHG emission inventory.

[1] Department of Commerce. 2023. *Climate Element Planning Guidance – Intermediate Version*. Washington State Department of Commerce Growth Management Services: Olympia, WA. December. https://deptofcommerce.app.box.com/s/fpg3h0lbwln2ctqjg7jg802h54ie19jx

[2] ICLEI. 2019. *U.S. Community Protocol for Accounting and Reporting of GHG Emissions, Version 1.2.* International Council for Local Environmental Initiatives: Denver, CO. July. https://icleiusa.org/us-community-protocol/

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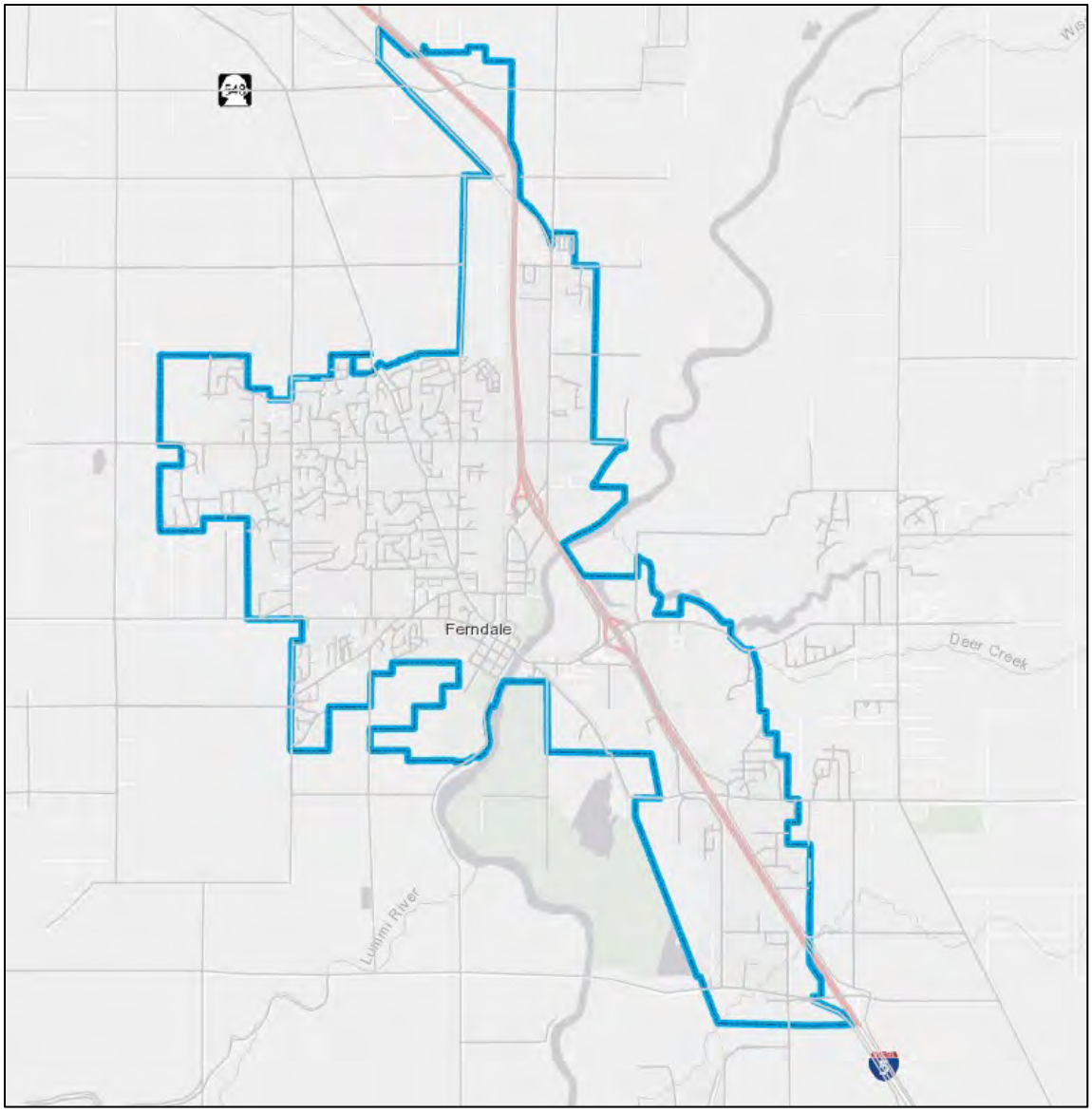

Figure 1: Ferndale City Limits[3]

2.3 Greenhouse Gas Selection

The City's GHG emission inventory follows the ICLEI USCP, which identifies six internationally recognized GHGs that directly impact the climate. These gases and their global warming potential (GWP) values are listed below:[4]

[3] City of Ferndale. 2025. "Ferndale Online Map Viewer 2.3-Public." https://gisportal.cityofferndale.org/mapviewer/. Accessed April 15, 2025.

[4] GWP values quantify the relative impact of different climate-related pollutants, expressed as the amount of potential climate warming a pollutant may cause over a 100-year period relative to CO_2.

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- Carbon dioxide (CO_2) – The most prevalent GHG, used as the baseline for measuring the GWP of other gases (GWP of 1).
- Methane (CH_4) – A GHG with a GWP of 29.8 for fossil fuel sources and a GWP of 27.2 for non-fossil fuel sources.[5] Methane is primarily emitted from landfills, livestock digestion, fossil fuel extraction, and incomplete combustion.
- Nitrous oxide (N_2O) – A GHG with a GWP of 273,[5] commonly released through agricultural activities, fossil fuel combustion, and biomass burning.
- Hydrofluorocarbons (HFCs) – Synthetic chemicals used mainly in refrigeration and air conditioning, with high GWPs (ranging from 140 – 11,700 GWP).
- Perfluorocarbons (PFCs) – By-products of industrial processes, characterized by extremely high GWPs (ranging from 6,500 – 9,200 GWP) and long atmospheric lifespans.
- Sulfur hexafluoride (SF_6) – Primarily used in electrical transmission and distribution systems, with a GWP of 24,300.

For the GHG emission inventory, CO_2, CH_4, N_2O, HFCs, and SF_6 were included, as these gases are most relevant to the City's emissions sources. PFCs were excluded due to the absence of industrial activities that would produce significant emissions of these gases.

2.4 Emission Source Identification Procedure

There are five basic emission sources that must be included in the GHG emission inventory to comply with the ICLEI USCP:

- Use of electricity by the community
- Use of fuel in residential and commercial stationary combustion equipment
- On-road passenger and freight motor vehicle travel
- Use of energy in potable water and wastewater treatment and distribution
- Generation of solid waste by the community

Beyond these required sources, the Whatcom County 2022 Greenhouse Gas Emissions Analysis was used to inform the City's selection of additional emission sources for the inventory, and these additional sources were incorporated based on the City's overarching goals, community priorities, available resources, and data quality and accessibility.

A summary of the emission sources and corresponding data sources included in the City's GHG emission inventory is provided in Table 1 below.

[5] Greenhouse Gas Protocol. 2024. "IPCC Global Warming Potential Values." August 7. https://ghgprotocol.org/sites/default/files/2024-08/Global-Warming-Potential-Values%20%28August%202024%29.pdf. Accessed April 4, 2025.

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Table 1: GHG Inventory Emission Sources and Data Sources

Category	Emission Source	Data Source(s)
Building Energy	Electricity[6]	Puget Sound Energy
	Natural Gas	Cascade Natural Gas
	Propane	U.S. Energy Information Administration U.S. Census Bureau Washington State Employment Security Department
	Fuel Oil	
Transportation	On-Road Emissions (VMT)	Whatcom Council of Governments Washington Department of Transportation
	Transit (Routes 27 and 75)	Whatcom Transportation Authority
Waste	Solid Waste	Sanitary Service Company Washington Department of Ecology
	Compost	
Wastewater	Wastewater Treatment	City of Ferndale
Miscellaneous	Refrigerants	U.S. Environmental Protection Agency
	Land use/cover	ICLEI Land Emissions and Removals Navigator tool

Note
VMT = vehicle miles traveled

3 Base Year

The City chose the 2023 calendar year (January 1, 2023, to December 31, 2023) as the base year for the initial GHG emission inventory. This was the most recent year with available data, ensuring an accurate representation of current community emissions.

The City should recalculate base year emissions if the following occur:

- Changes in calculation methodology or improved accuracy of emission factors or activity data.
- Discovery of significant errors or cumulative minor errors affecting base year emissions.

In cases where specific data for 2023 was unavailable, the most recent year's data was used and documented accordingly in the GHG emissions inventory and this IMP.

[6] Electricity includes the use of energy in potable water and distribution; therefore, it is not listed in Table 1.

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4 Update Interval

The City will update its GHG emission inventory every five years to track and evaluate progress toward reduction goals. Emission factors should be updated during each evaluation based on the latest available data.

5 Emissions Quantification

The GHG emission inventory data quantification methodology for each emission source category is described below. This chapter of the IMP is meant to be used alongside the GHG emission inventory spreadsheet, which contains full documentation of equations, data sources, and emission factors. GHGs are reported collectively as metric tons (MT) of carbon dioxide equivalents (CO_2e). CO_2e is a measure that standardizes each GHG according to its GWP. GWP values quantify the relative impact of different climate-related pollutants, expressed as the amount of potential climate warming a pollutant may cause over a 100-year period relative to CO_2.

5.1 Building Energy

5.1.1 Stationary Combustion Sources

5.1.1.1 Natural Gas

The City's natural gas service provider, Cascade Natural Gas, can provide residential, commercial, and industrial natural gas consumption data. Emissions from natural gas consumption are calculated using the amount of natural gas consumed within Ferndale city limits, multiplied by CO_2, CH_4, and N_2O emission factors, as well as the appropriate unit conversions and GWPs necessary to convert to CO_2e (see Equation 1-Equation 3). CO_2, CH_4, and N_2O emissions (in terms of metric tons of CO_2e) are summed to get total emissions from natural gas.

Equation 1: CO_2 Emissions for Natural Gas, Propane, and Fuel Oil

$$\begin{aligned} CO_2 \text{ emissions (MT } CO_2e) = \; & (\text{amount of fuel used [MCF or gal]}) \\ & \times (CO_2 \text{ emission factor [kg } CO_2 \text{ / unit of fuel]}) \\ & \times (1 \text{ MT / 1,000 kg}) \end{aligned}$$

Equation 2: CH_4 Emissions for Natural Gas, Propane, and Fuel Oil

$$\begin{aligned} CH_4 \text{ emissions (MT } CO_2e) = \; & (\text{amount of fuel used [MCF or gal]}) \\ & \times (CH_4 \text{ emission factor [kg } CH_4 \text{ / unit of fuel]}) \end{aligned}$$

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× *(1 MT / 1,000 kg)*

× *(CH_4 GWP)*

Equation 3: N_2O Emissions for Natural Gas, Propane, and Fuel Oil

N_2O emissions (MT CO_2e) = *(amount of fuel used [MCF or gal])*

× *(N_2O emission factor [kg N_2O / unit of fuel])*

× *(1 MT / 1,000 kg)*

× *(N_2O GWP)*

Notes
CO_2e = carbon dioxide equivalent
gal = gallons
GWP = global warming potential
kg = kilograms
MCF = thousand cubic feet
MT = metric tons

5.1.1.2 Propane and Fuel Oil

Residential propane emissions are calculated using U.S. Energy Information Administration (EIA) average residential propane consumption data for Washington state.[7] Average residential propane consumption is multiplied by the number of households in Ferndale using bottled, tank, or liquified petroleum gas for home heating (from the U.S. Census American Community Survey) to estimate gallons of propane consumed (see Equation 4) and then multiplied by CO_2, CH_4, and N_2O emission factors (see Equation 1-Equation 3). CO_2, CH_4, and N_2O emissions (in terms of metric tons of CO_2e) are summed to get total emissions from residential propane.

Equation 4: Residential Propane Use

Total residential propane use (gallons) = *(average household propane consumption, Washington [gal])*

× *(number of Ferndale households using bottled, tank, or liquified petroleum gas for home heating)*

Commercial and industrial propane and fuel oil consumption estimates are calculated using statewide fuel consumption data downscaled by the number of commercial and industrial employees within Whatcom County compared to total state employment.[8] County-level estimates are further downscaled to the city level using the ratio of Ferndale population to Whatcom County population (see Equation 5-Equation 8).

Equation 5: Commercial Fuel Oil Use

Total commercial fuel oil use (gallons) = *(state commercial fuel oil use [barrels])*

[7] The 2023 GHG emission inventory used U.S. EIA residential propane data from 2020, the most recent year with data available when the inventory was conducted.
[8] The 2023 GHG emission inventory used U.S. EIA commercial and industrial propane and fuel oil data from 2022, the most recent year with data available when the inventory was conducted.

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× *(42 gallons/barrel)*

× *(ratio of Whatcom County to Washington commercial employees)*

× *(ratio of Ferndale to Whatcom County population)*

Equation 6: Commercial Propane Use

Total commercial propane use (gallons) = *(state commercial propane use [barrels])*

× *(42 gallons/barrel)*

× *(ratio of Whatcom County to Washington commercial employees)*

× *(ratio of Ferndale to Whatcom County population)*

Equation 7: Industrial Fuel Oil Use

Total industrial fuel oil use (gallons) = *(state industrial fuel oil use [barrels])*

× *(42 gallons/barrel)*

× *(ratio of Whatcom County to Washington industrial employees)*

× *(ratio of Ferndale to Whatcom County population)*

Equation 8: Industrial Propane Use

Total industrial propane use (gallons) = *(state industrial propane use [barrels])*

× *(42 gallons/barrel)*

× *(ratio of Whatcom County to Washington industrial employees)*

× *(ratio of Ferndale to Whatcom County population)*

Employment data can be collected from the Washington Employment Security Department, which provides data on the number of employees across industries. Commercial and industrial propane and fuel oil consumption estimates are then multiplied by CO_2, CH_4, and N_2O emission factors, unit conversions, and GWPs if necessary (see Equation 1-Equation 3). CO_2, CH_4, and N_2O emissions (in terms of metric tons of CO_2e) are summed to get total emissions from commercial and industrial propane and fuel oil.

5.1.2 Electricity

5.1.2.1 Market-Based Electricity Calculations

Market-based calculations reflect the electricity that a jurisdiction chooses to purchase, often through contracts like power purchase agreements or renewable energy certificates. These contracts let a jurisdiction claim the environmental attributes of specific energy sources, even if those sources are not located in or near the jurisdiction itself. For example, a city might buy wind energy produced

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in another state and claim that it is using clean power, even if the local grid is mostly fossil-fueled. Market-based electricity emissions calculations highlight the energy that consumers (e.g., commercial, industrial, or local government) pay for, not necessarily what is physically used.

The City's electricity service provider, Puget Sound Energy (PSE), can provide residential, commercial, and industrial electricity consumption data, as well as Green Direct sales data.[9] In the market-based calculation approach, Green Direct kilowatt-hours (kWh) are subtracted from total kWh, as Green Direct sales are offsetting a portion of the energy that was produced and consumed locally. Emissions from electricity consumption are then calculated using the amount of electricity consumed (total kWh minus Green Direct kWh) within Ferndale city limits by sector and multiplied by PSE's emission factor, as well as the appropriate unit conversions and GWPs if necessary (see Equation 9).

Equation 9: Total Emissions from Electricity (Market-Based Calculations)

Total emissions (MT CO_2e) = *(electricity consumed [kWh])*
× *(PSE emission factor [lbs CO_2e/MWh])*
× *(1 MWh/1,000 kWh)*
× *(1 MT/2,204 lbs)*

Notes
CO_2e = carbon dioxide equivalent
kWh = kilowatt-hours
lbs = pounds
MT = metric tons
MWh = megawatt-hour
PSE = Puget Sound Energy

5.1.2.2 Location-Based Electricity Calculations (Informational Only)

Location-based calculations reflect the electricity that a jurisdiction physically draws from the local power grid, regardless of any contracts or renewable energy purchases. These calculations are grounded in the actual mix of energy sources that supply the regional grid. For example, a city located in a coal-heavy region would report higher emissions under this method, even if it has purchased renewable energy credits. Location-based electricity emissions calculations highlight the environmental impact of the electricity that is physically consumed based on the regional generation profile. **In this inventory, it is important to note that location-based calculations are provided for informational, comparative purposes only and are *not* added to Ferndale's emissions total.**

Location-based electricity calculations also use the residential, commercial, and industrial electricity consumption data provided by PSE but do not consider Green Direct sales data. Consumption data are multiplied by Emissions & Generation Resource Integrated Database CO_2, CH_4, and N_2O emission factors for the Northwest Power Pool region, as well as the appropriate unit conversions and GWPs if necessary (see Equation 10-Equation 12). CO_2, CH_4, and N_2O emissions (in terms of metric tons of CO_2e) are summed to get total location-based emissions from electricity.

Equation 10: CO_2 Emissions from Electricity (Location-Based Calculations)

CO_2 emissions (MT CO_2e) = *(electricity consumed [kWh])*

[9] Green Direct is a PSE program that allows corporate and governmental customers to purchase renewable energy. For more information, see https://www.pse.com/en/green-options/Renewable-Energy-Programs/green-direct.

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× *(eGRID regional emission factor [lbs CO_2/MWh])*
× *(1 MWh/1,000 kWh)*
× *(1 MT/2,204 lbs)*

Equation 11: CH_4 Emissions from Electricity (Location-Based Calculations)

CH_4 emissions (MT CO_2e) = *(electricity consumed [kWh])*
× *(eGRID regional emission factor [lbs CH_4/MWh])*
× *(1 MWh/1,000 kWh)*
× *(1 MT/2,204 lbs)*
× *(CH_4 GWP)*

Equation 12: N_2O Emissions from Electricity (Location-Based Calculations)

N_2O emissions (MT CO_2e) = *(electricity consumed [kWh])*
× *(eGRID regional emission factor [lbs N_2O/MWh])*
× *(1 MWh/1,000 kWh)*
× *(1 MT/2,204 lbs)*
× *(N_2O GWP)*

Notes
CO_2e = carbon dioxide equivalent
eGRID = Emissions & Generation Resource Integrated Database
GWP = global warming potential
kWh = kilowatt-hours
MT = metric tons
MWh = megawatt-hour

5.2 Refrigerants

Refrigerant emissions are calculated based on data from the Environmental Protection Agency (EPA) Inventory of U.S. Greenhouse Gas Emissions and Sinks.[10] National-level refrigerant emissions can be downscaled and attributed to Ferndale based on the ratio of Ferndale population to U.S. population.

5.3 Land Use

ICLEI's Land Emissions and Removals Navigator (LEARN) tool can be used to estimate GHG emissions from tree cover loss and carbon sequestration from tree cover gain and maintenance within Ferndale's boundaries. The LEARN tool uses the National Land Cover Database produced by the United States Geological Survey as the land cover database for this analysis. The LEARN tool

[10] The 2023 GHG emission inventory used refrigerant data from 2022, the most recent year with data available when the inventory was conducted.

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currently requires a minimum of a three-year analysis timeframe.[11] Default factors used to calculate emissions for the "Trees Outside Forests" category are based on data for Seattle, Washington. The tool allows for customization to major metropolitan areas, but the only available Washington option is for Seattle.

Emissions are included in the inventory total, but emissions removals due to carbon sequestration should *not* be netted with tree cover loss emissions. Carbon sequestration is reported as a separate line item from the emissions inventory total.

5.4 Transportation

5.4.1 Community On-Road Vehicles

Community on-road emissions estimates can be developed using a daily vehicle miles traveled (VMT) estimate from Whatcom Council of Governments' (WCOG) travel demand model, if available, or a daily VMT estimate from WSDOT's Highway Performance Monitoring System. The data used for calculations should only include estimated VMT on city-owned roads in Ferndale and should not include VMT within Ferndale city limits on roads that are not city-owned (e.g., Interstate 5 and ramps, State Route 548). See Note:

TAZ = Traffic Analysis Zone

Figure 2 for a map of the Ferndale sub-area and VMT estimates produced by WCOG's travel demand model for Ferndale's 2023 inventory.

[11] Totals from the 2019-2021 period were divided by three to determine an average annual value. At the time of this inventory, the tool was available through 2021, and a 2019-2021 timeframe was analyzed.

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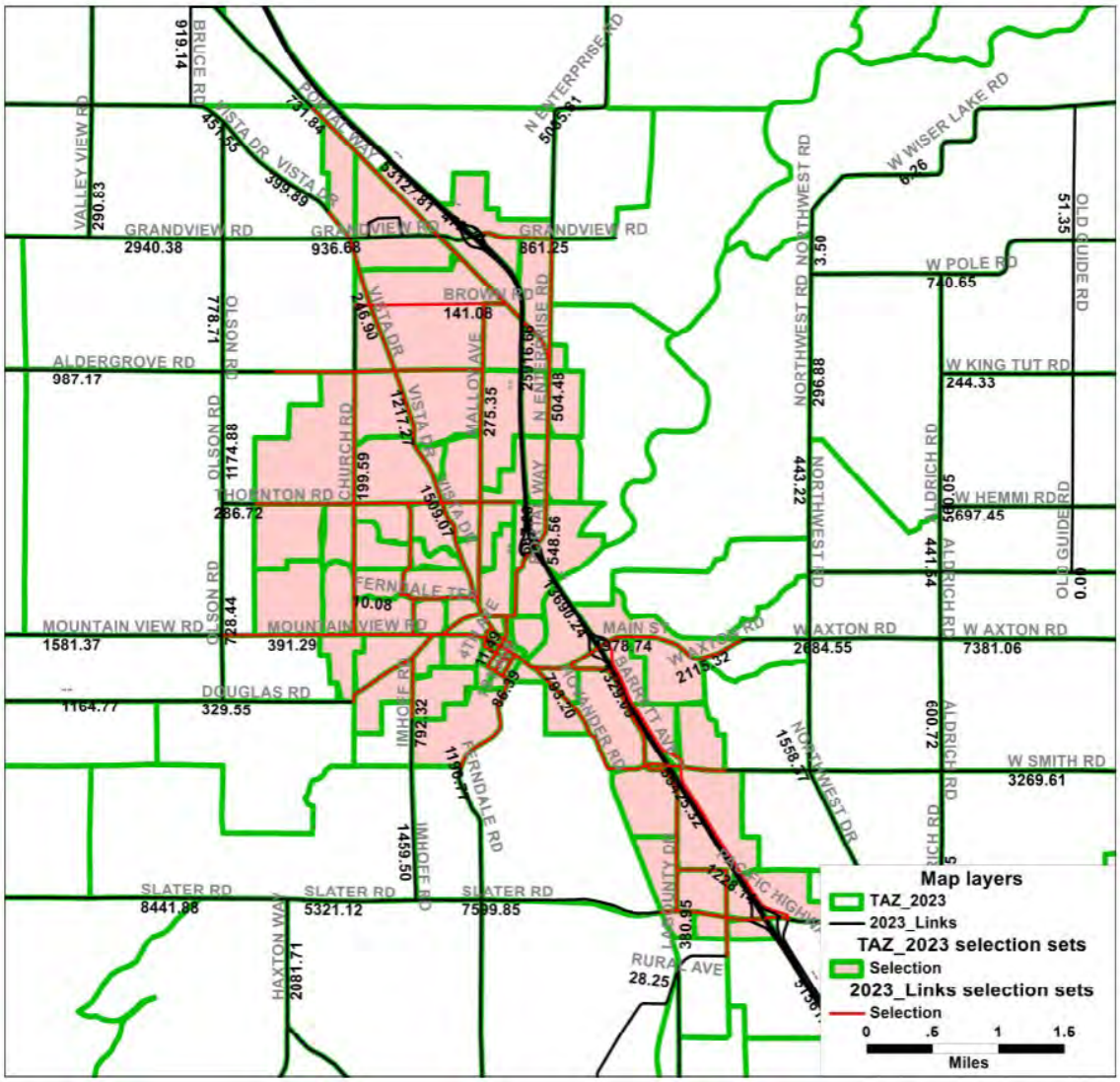

Note:
TAZ = Traffic Analysis Zone

Figure 2: Ferndale 2023 Daily VMT by Link

VMT are attributed to either freight and service vehicles or passenger vehicles using Washington State Department of Transportation Highway Performance Monitoring System statewide travel activity percentages (see Equation 13-Equation 14). For passenger vehicles, VMT is further attributed to passenger vehicle types (see Equation 15) using vehicle registration data for Whatcom County.

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Equation 13: Estimated VMT for Freight/Service Vehicles

Estimated VMT for freight/service vehicles (miles) = *(2023 total Ferndale VMT [miles])* × *(freight/service vehicles percentage of travel activity [%])*

Equation 14: Estimated VMT for Passenger Vehicles

Estimated VMT for passenger vehicles (miles) = *(2023 total Ferndale VMT [miles])* × *(passenger vehicles percentage of travel activity [%])*

Equation 15: Estimated VMT by Passenger Vehicle Type

Estimated VMT by passenger vehicle type (miles) = *(estimated VMT for passenger vehicles [miles])* × *(percentage of vehicle registrations for passenger vehicle type [%])*

Notes
VMT = vehicle miles traveled
Passenger vehicle types include passenger vehicles, trucks, and motorcycles.

VMT is multiplied by EPA vehicle-specific emission factors (see Equation 16) to calculate emissions from freight and service vehicles and passenger vehicle types (see

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Equation 17). Total emissions for freight and service vehicles and passenger vehicle types are summed to get total emissions from community on-road vehicles.

Equation 16: General Formula for Calculating Vehicle-Specific Emission Factors

$$\text{Emission factor (kg } CO_2e \text{ / vehicle-mile)} = (CO_2 \text{ emission factor [kg } CO_2\text{/vehicle-mile]}) + \{(CH_4 \text{ emission factor [g } CH_4\text{/vehicle-mile)} \times (1 \text{ kg/1,000 g)} \times (CH_4 \text{ GWP)}\} + \{(N_2O \text{ emission factor [g } N_2O \text{ /vehicle-mile)} \times (1 \text{ kg/1,000 g)} \times (N_2O \text{ GWP)}\}$$

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Equation 17: Total Emissions from Community On-Road Vehicles, by Vehicle Type

Total emissions (MT CO_2e) = *(estimated VMT [miles])*
× *(emission factor [kg CO_2e/vehicle-mile])*
× *(1 MT/1,000 kg)*

Notes
CO_2e = carbon dioxide equivalent
g = grams
GWP = global warming potential
kg = kilograms
MT = metric tons
VMT = vehicle miles traveled

5.4.2 Transit

Transit emissions estimates are developed using VMT and fuel economy data from Whatcom Transportation Authority (WTA) for routes passing through Ferndale (Route 27 and Route 75). Total revenue miles for each route are multiplied by the percentage of round-trip miles traveled in Ferndale for each route (see Equation 18).

Equation 18: Revenue Miles Traveled in Ferndale

Ferndale revenue miles = *(revenue miles) x (Ferndale fraction of round-trip miles)*

VMT can be attributed to bus types (diesel, hybrid diesel, and electric) according to WTA's fixed-route fleet composition. Estimated mileage by bus type was divided by average fuel economy by bus type (provided by WTA)to estimate gallons of fuel or amount of electricity consumed (see Equation 19-Equation 20).

Equation 19: Diesel Consumed by Diesel or Hybrid Buses

Diesel consumed by diesel or hybrid buses (gal) = *[(Ferndale revenue miles, Route 27)*
+ (Ferndale revenue miles, Route 75)]
× *(diesel or hybrid buses fraction of WTA fleet)*
÷ *(diesel or hybrid bus fuel economy [mpg])*

Equation 20: Electricity Consumed

Electricity consumed (kWh) = *[(Ferndale revenue miles, Route 27)*
+ (Ferndale revenue miles, Route 75)]
× *(electric buses fraction of WTA fleet)*
÷ *(electric bus fuel economy [kWh/mi])*

Notes
gal = gallons
GWP = global warming potential
kWh = kilowatt-hours
mi = miles
mpg = miles per gallon

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WTA = Whatcom Transportation Authority

Fuel consumption estimates for diesel and hybrid buses can then be multiplied by EPA vehicle-specific CO_2, CH_4, and N_2O emission factors, as well as the appropriate unit conversions and GWPs if necessary to convert to CO_2e (see Equation 21-Equation 23).[12] CO_2, CH_4, and N_2O emissions (in terms of metric tons of CO_2e) are summed to get total emissions from diesel and hybrid buses. The electricity consumption estimate for electric buses can be multiplied by the PSE electricity emission factor as well as the appropriate unit conversions to get total emissions from electric buses (see Equation 24).

Equation 21: CO_2 Emissions for Diesel and Hybrid Buses

CO_2 emissions (MT CO_2e) = *(diesel consumed [gal])*
× *(diesel mobile fuel CO_2 emission factor [kg CO_2/gal])*
× *(1 MT/1,000 kg)*

Equation 22: CH_4 Emissions for Diesel and Hybrid Buses

CH_4 emissions (MT CO_2e) = *(estimated VMT [miles])*
× *(diesel heavy-duty vehicle CH_4 emission factor [g CH_4/mi])*
× *(1 MT/1,000,000 g)*
× *(CH_4 GWP)*

Equation 23: N_2O Emissions for Diesel and Hybrid Buses

N_2O emissions (MT CO_2e) = *(estimated VMT [miles])*
× *(diesel heavy-duty vehicle N_2O emission factor [g CH_4/mi])*
× *(1 MT/1,000,000 g)*
× *(N_2O GWP)*

Equation 24: Total Emissions for Electric Buses

Total emissions from electric buses (MT CO_2e) = *(electricity consumed [kWh])*
× *(PSE electricity emission factor [lbs CO_2e/MWh])*
× *(1 MWh/1,000 kWh)*
× *(1 MT/2,204 lbs)*

Notes
CO_2e = carbon dioxide equivalent
g = grams

[12] Each of these equations should be used once for diesel buses and once for hybrid buses, as these groups of vehicles will likely have different assumptions for average vehicle age that will impact the CH_4 and N_2O emission factors used.

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gal = gallons
GWP = global warming potential
kg = kilograms
kWh = kilowatt-hours
lbs = pounds
mi = miles
MT = metric tons
MWh = megawatt-hours
PSE = Puget Sound Energy
VMT = vehicle miles traveled

5.5 Wastewater

CH_4 and N_2O emissions from wastewater treatment processes in the Ferndale service area can be estimated using data provided by City staff and constants from ICLEI's U.S. Local Government Operations Protocol (LGOP) default equations. Emissions are estimated based on the type of processes occurring at the plant and in the city (e.g., wastewater treatment in aerated basins, use of septic systems) as well as the size of the population served. Emissions are calculated using U.S. LGOP default equations for:

- CH_4 emissions from septic systems
- N_2O emissions from wastewater treatment with nitrification/denitrification
- N_2O emissions from effluent discharge

To estimate CH_4 emissions from septic systems, City staff can provide the number of onsite sewage systems within city limits. This is multiplied by the average population per household in Ferndale from the U.S. Census to estimate the population served by septic systems; the rest of the equation values are LGOP default values (see Equation 25).

Equation 25: CH_4 Emissions from Septic Systems

CH_4 emissions from septic systems [MT CO_2e]) =

(population served by septic systems)
× *(default BOD_5 load [kg BOD_5/person/day])*
× *(maximum CH_4 production capacity [kg CH_4/kg BOD_5])*
× *(septic CH_4 correction factor)*
× *(365 days/1 year)*
× *(1 MT/1,000 kg)*
× *(CH_4 GWP)*

Notes
BOD_5 = biochemical oxygen demand (5-day)
CO_2e = carbon dioxide equivalent
GWP = global warming potential
kg = kilograms
lbs = pounds
MT = metric tons

To estimate N_2O emissions from nitrification/denitrification, City staff can provide the population served by the wastewater treatment plant and the relative magnitude of industrial wastewater

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discharge into the system; the rest of the equation values are LGOP default values (see Equation 26).

Equation 26: N_2O Emissions from WWTP with Nitrification/Denitrification

N_2O emissions from WWTP with nitrification/denitrification (MT CO_2e) =

(population served by nitrification/denitrification)

× *(factor for industrial discharge into the system)*

× *(nitrification/denitrification emission factor [g N_2O/person/year])*

× *(1 MT/1,000,000 g)*

× *(N_2O GWP)*

Notes
According to Appendix E of the ICLEI USCP, the default factor for industrial discharge into the system is 1, assuming insignificant industrial discharge into the wastewater treatment system. If industrial discharge into the wastewater treatment system is deemed significant, this factor may be changed to 1.25. It may be beneficial to determine the amount of industrial wastewater discharged into the sewer system to determine which factor to use. This information was not available when the 2023 inventory was conducted.
CO_2e = carbon dioxide equivalent
g = grams
GWP = global warming potential
kg = kilograms
MT = metric tons

To estimate N_2O emissions from effluent discharge, City staff can provide data on the average nitrogen concentration in effluent, which can be used to estimate the average mass of nitrogen discharged in effluent per day; the rest of the equation values are LGOP default values (see Equation 27).

Equation 27: N_2O Emissions from Effluent Discharge

N_2O emissions from effluent discharge (MT CO_2e) =

(measured average total nitrogen discharged [kg N/day])

(effluent emission factor [kg N_2O-N/kg sewage])

× *(365 days/1 year)*

× *(1 MT/1,000 kg)*

× *(N_2O/N_2 molecular weight ratio)*

× *(N_2O GWP)*

Notes
CO_2e = carbon dioxide equivalent
GWP = global warming potential
kg = kilograms
MT = metric tons

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5.6 Solid Waste

5.6.1 Landfilled Waste

Sanitary Service Company (SSC) can provide collection data for municipal solid waste and roll-off tonnage for customers within Ferndale city limits. The Department of Ecology's Washington Statewide Waste Characterization Study can be used to characterize community-generated waste sent to landfills (i.e., estimate the mass fraction of each material type and multiply those mass fractions by the total tonnage sent to landfill).[13]

Methane emissions from community-generated waste sent to landfills can be calculated by multiplying the estimated tons of waste generated by material type-specific emission factors from USCP Appendix E: Solid Waste Emissions Activities and Sources. The USCP equation includes a default assumption of 75% collection efficiency for landfill gas recovery systems and several other default constants (see Equation 28).

Equation 28: CH_4 Emissions from Community-Generated Waste Sent to Landfills

$$\begin{aligned} CH_4 \text{ emissions (MT } CO_2e) = \; & (CH_4 \text{ global warming potential}) \\ & \times (1 - \text{default landfill gas collection efficiency}) \\ & \times (1 - \text{oxidation rate}) \\ & \times (\text{total mass of waste sent to landfill [wet short tons]}) \\ & \times \sum \{(\text{mass fraction of waste component } i) \\ & \times (\text{emission factor for material } i \text{ [metric tons } CH_4/\text{wet short ton]})\} \end{aligned}$$

Notes
The summation notation (∑) indicates that the process of multiplying a mass fraction for a specific material (material *i*) by the corresponding emission factor will occur multiple times and the results will be summed.
CO_2e = carbon dioxide equivalent
MT = metric tons

Emissions from waste collection, transportation of waste to landfills, and landfill operational processes were estimated using the total mass of waste sent to landfill and default emission factors from USCP Appendix E (see Equation 29-Equation 31).

Equation 29: Waste Collection Emissions

$$\begin{aligned} \text{Collection emissions (MT } CO_2e) = \; & (\text{total mass of waste sent to landfill [wet short tons]}) \\ & \times (\text{collection emission factor [MT } CO_2e/\text{wet short ton}]) \end{aligned}$$

Equation 30: Waste Transportation Emissions

$$\begin{aligned} \text{Transportation emissions (MT } CO_2e) = \; & (\text{total mass of waste sent to landfill [wet short tons]}) \end{aligned}$$

[13] This process is represented in equation The 2023 GHG emission inventory used waste characterization data from the Department of Ecology's 2020-2021 Statewide Waste Characterization Study.

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× *(distance to disposal site [miles])*

× *(transportation emission factor [MT CO_2e/wet short ton-mile])*

Equation 31: Landfill Process Emissions

Landfill process emissions (MT CO_2e) = *(total mass of waste sent to landfill [wet short tons])*

× *(landfill processes emission factor [MT CO_2e/wet short ton])*

Notes
CO_2e = carbon dioxide equivalent
MT = metric tons

5.6.2 Recycling and Composting

SSC can provide data for recycling and organics tonnage collected within Ferndale city limits. The Department of Ecology's 2022-2023 Washington Statewide Recycling and Organics Characterization Study should be used to characterize recycling and organics streams from Ferndale (i.e., estimate the mass fraction of each material type and multiply those mass fractions by the total tonnage).[14]

Avoided emissions can be calculated by multiplying the estimated tons of waste generated by material type-specific avoided emission factors from ICLEI's Recycling and Composting Emissions Protocol. The recycling category includes emissions avoided by using recycled inputs in supply chains (see Equation 32) and emissions avoided by diverting materials from landfill (see Equation 33). The compost category includes emissions avoided by displacing fertilizer with compost (see Equation 34) and emissions avoided by diverting materials from landfill (see Equation 35).

Avoided emissions due to use of recycling and composting programs should *not* be netted with solid waste emissions. These subcategories are reported as separate line items from the emissions inventory total.

Equation 32: Emissions Avoided from Using Recycled Inputs

Avoided emissions from using recycled inputs (MT CO_2e) = *(total mass of recycling collected [short tons])*

× $\sum$ *{(material i fraction of recycling stream)*

× *(material i emission factor for using recycled inputs instead of virgin inputs [MT CO_2e/short ton])}*

Equation 33: Emissions Avoided by Recycling Instead of Landfilling

Avoided emissions from no landfill disposal (MT CO_2e) = *(total mass of recycling collected [short tons])*

× $\sum$ *{(material i fraction of recycling stream)*

[14] The 2023 GHG emission inventory used recycling and organics characterization data from the Department of Ecology's 2022-2023 Statewide Recycling and Organics Characterization Study.

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× *(material i emission factor for avoiding landfill disposal [MT CO_2e/short ton])}*

Equation 34: Emissions Avoided with Compost Displacement of Fertilizer

Avoided emissions from fertilizer displacement (MT CO_2e) = *(total mass of compost collected [short tons])*

× ∑ *{(material i fraction of compost stream)*

× *(material i emission factor for fertilizer displacement [MT CO_2e/short ton])}*

Equation 35: Emissions Avoided by Composting Instead of Landfilling

Avoided emissions from no landfill disposal (MT CO_2e) = *(total mass of compost collected [short tons])*

× ∑ *{(material i fraction of compost stream)*

× *(material i emission factor for avoiding landfill disposal [MT CO_2e/short ton])}*

Notes
CO_2e = carbon dioxide equivalent
MT = metric tons

6 Data Management

6.1 Activity Data

Activity data sources and emission factor sources are fully documented in the City of Ferndale 2023 GHG Emission Inventory spreadsheet. Table 2 provides a summary below.

Table 2: Activity Data and Emission Factors for Ferndale GHG Emission Inventory

Category	Activity Data	Emission Factors
Built Environment		
Electricity	Consumption within city limits provided by PSE	PSE-specific emission factor from PSE 2023 GHG reporting Emissions & Generation Resource Integrated Database emission factors (for informational purposes only)
Natural gas	Consumption within city limits provided by CNG	Climate Registry emission factors EPA Emission Factors Hub
Propane	WA propane consumption by sector from U.S. EIA	Climate Registry emission factors EPA Emission Factors Hub

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Category	Activity Data	Emission Factors
Fuel oil	WA fuel oil consumption by sector from U.S. EIA	Climate Registry emission factors EPA Emission Factors Hub
Refrigerants		
Refrigerants	EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks, 1990-2022	N/A (data reported in CO_2e emissions)
Land Use		
Tree cover loss	ICLEI LEARN Calculator	N/A (data reported in CO_2e emissions)
Carbon sequestration*	ICLEI LEARN Calculator	N/A (data reported in CO_2e emissions)
Transportation		
Community on-road vehicles	VMT data from WCOG travel demand model for Ferndale subarea	EPA Emission Factors Hub
Transit	VMT data from WTA	EPA Emission Factors Hub
Wastewater		
Treatment processes	Wastewater treatment data from City staff	U.S. LGOP Protocol default emission factors, customized based on data available from wastewater treatment plant
Solid Waste		
Landfilled waste	Tonnage collected within city limits for municipal solid waste and roll-off services from SSC	USCP solid waste emission factors, customized for landfill characteristics (e.g., landfill gas recovery)
Compost*	Compost tonnage collected within city limits from SSC	Recycling and Composting Emissions Protocol composting avoided emission factors
Recycling*	Mixed recycling tonnage collected within city limits from SSC	Recycling and Composting Emissions Protocol recycling avoided emission factors

Note
Asterisk (*) indicates avoided emissions or emissions removals that are reported as separate line items and not included in total inventory emissions.
CNG = Cascade Natural Gas
EIA = Energy Information Administration
EPA = Environmental Protection Agency
LEARN = Land Emissions and Removals Navigator
LGOP = Local Government Operations Protocol
SSC = Sanitary Service Company
USCP = U.S. Community Protocol
WCOG = Whatcom Council of Governments
WTA = Whatcom Transportation Authority

6.2 Data Management

The responsibility for developing and maintaining the City's GHG emission inventory is distributed among various representatives. City staff are tasked with data collection from wastewater treatment processes, connecting environmental consultants with data stewards, and assisting with data requests where necessary. Environmental consultants (MFA) are responsible for collecting data from

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all other categories as well as data customization and ensuring accurate representation of emission factors.

6.3 Data Collection Process

In the City's GHG emission inventory process, uncertainties arise primarily from variabilities in activity data and emission factor accuracy. These uncertainties can stem from data analysis errors, measurement errors, data reporting inconsistencies, and assumptions made during the data scaling process.

To ensure the accuracy and reliability of the GHG emission inventory, the City and consultants should implement the following measures:

- **Data Verification:** Collected data is cross-referenced with independent sources (e.g., regional GHG inventories, such as the 2022 Whatcom County Emissions Analysis) and historical records (e.g., 2023 baseline inventory for Ferndale) to verify its accuracy. Any discrepancies are investigated and resolved promptly.
- **Training:** City staff are trained by environmental consultants on updates to the GHG emission inventory workbook at least once per update or more often if needed. Environmental consultants are trained to stay updated on best practices in data collection, processing, and emission factor application, ensuring consistency and accuracy.
- **Documentation and Transparency:** Detailed documentation of data sources, methodologies, and assumptions is maintained to provide transparency. This documentation includes records of any adjustments made to the data.

7 Management Tools

7.1 Roles and Responsibilities

Table 3 below describes the typical roles and responsibilities when conducting a GHG emission inventory update. Specific City staff or consultant team members should be assigned to each role prior to starting a GHG emission inventory.

Table 3: Roles and Responsibilities during GHG emission inventory updates

Role	Description
GHG Inventory Manager	Leads the development and implementation of the GHG emission inventory, ensuring compliance with protocols and standards. Responsible for tracking progress related to data collection, analysis, and reporting. Reviews assumptions and limitations with the environmental specialist (and city staff if necessary) to ensure they are reasonable.
Environmental Specialist	Analyzes and processes data related to emissions sources and activities. Ensures accuracy and

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	consistency in data handling and collaborates with other team members for validation. Provides expertise on emission factors, calculation methodologies, and regulatory requirements. Helps identify improvements in data accuracy and inventory methods.
Community Engagement Coordinator	Liaises with community stakeholders to gather relevant activity data and ensure transparency in inventory development. Facilitates communication and awareness about the GHG emission inventory process.
Management Review Team	Reviews and approves the final GHG emission inventory report. Oversees the implementation of corrective actions and ensures organizational commitment to emission reduction goals.

7.2 Document Retention and Control Policy

Maintaining version control for GHG emission inventory management guidelines is crucial to ensure consistency and reliability in the processes. All GHG emission inventory workbooks and reports are assigned a date to track revisions and updates. Changes to inventory workbooks are documented in an edit log, detailing the nature of modifications, reasons for the changes, and the individuals responsible for the updates.

This systematic approach allows for easy reference to previous versions and ensures that all team members are working with the most current and accurate information.

8 Assumptions and Limitations

GHG emission inventories often rely on a combination of local, regional, state, and national data. In some cases, data availability is limited or not current, and it may be necessary to use proxies or scale data to estimate emissions. The following section summarizes typical data considerations and limitations by category that may apply to future inventory updates.

8.1 Built Environment

8.1.1 Electricity

Electricity consumption data generally reflect local conditions. No significant data limitations are typically encountered.

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8.1.2 Natural Gas

Natural gas consumption data generally reflect local conditions. No significant data limitations are typically encountered.

8.1.3 Propane and Fuel Oil

Recent data may not always be available at the time of analysis, requiring the use of the most recent prior-year data.

Data for residential, commercial, and industrial use may need to be scaled from regional or state averages when local figures are unavailable. In some cases, data may be suppressed due to small sample sizes or high uncertainty.

8.1.4 Refrigerants

Refrigerant emissions data are often available only at the national level; therefore, there may be a lag in the availability of the most recent data. Refrigerant data may need to be scaled for local application.

8.2 Land Use

8.2.1 Tree Cover Loss and Carbon Sequestration

Data availability is dependent on the latest release from external tools and datasets (e.g., LEARN tool). Analysis periods may need to be adjusted based on available data windows. Land use data typically reflects local conditions, though assumptions may be necessary.

8.3 Transportation

8.3.1 Community On-Road Vehicles

Vehicle miles traveled (VMT) data may not include all roadway types (e.g., state highways or interstates within city boundaries).

Regional travel demand models are often used to estimate total VMT, and these typically reflect local conditions but may include model-based assumptions.

8.3.2 Transit

Transit data is typically provided by local agencies and generally reflects actual operations. No significant data limitations are typically expected.

8.4 Wastewater

Wastewater treatment data is usually provided by City staff and reflects operational conditions. Data limitations are not generally anticipated.

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8.5 Solid Waste

8.5.1 Landfilled Waste

In cases where collection systems combine residential and commercial waste, it may not be possible to separate disposal tonnage by sector.

Total disposal tonnage data often reflects local conditions but may be characterized using regional data when needed.

8.5.2 Recycling and Composting

These data are usually available from local service providers but may be characterized using regional data when needed.

Sector-specific breakdowns may not always be available.

9 Community Engagement

To effectively share the results of a GHG emission inventory, the City will develop a comprehensive public engagement strategy, with consultant help, if necessary, that prioritizes transparency, accessibility, and inclusivity. The plan will ensure early and continuous public engagement, aligning with Commerce's guidelines, and will place special emphasis on reaching historically underrepresented and climate-impacted communities.

Key tactics will include:

- Accessible communication tools like fact sheets, infographics, newsletter content, website copy, PowerPoint presentations, and email updates.
- Online open houses with plain-language content and graphics to reduce participation barriers and support flexible engagement.
- Surveys to gather input on community values and climate goals, available in multiple languages based on Title VI and community needs.

The strategy will be reviewed and approved by the City before implementation.

In parallel, the City will design a tribal engagement strategy in collaboration with the Climate Planning Advisory Team, ensuring early notification and respectful engagement of the Lummi Tribe and Nooksack Nation. This includes consultation meetings and invitations to participate in the planning process.

Both public and tribal engagement strategies will support informed, inclusive, and transparent communication of GHG data, reduction goals, and implementation strategies to the broader community.

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10 Conclusion

GHG emission inventories allow the City to understand emission sources and identify opportunities for meaningful climate action. This IMP provides key guidance for managing data collection, monitoring data quality, and reviewing and testing assumptions and limitations for the City's GHG emission inventories. . By systematically tracking emissions and engaging both the public and tribal partners throughout the process, the City demonstrates its commitment to accountability, equity, and sustainability.

The data and strategies outlined in this plan will not only guide informed decision-making but also support the development of targeted policies and projects that reduce emissions and build community resilience. As this work continues, the City remains dedicated to updating the GHG emission inventory regularly, sharing progress transparently, and collaborating with all stakeholders to achieve a more sustainable, climate-resilient future.

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Limitations

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Opinions and recommendations contained in this report apply to conditions existing when services were performed and are intended only for the client, purposes, locations, time frames, and project parameters indicated. We are not responsible for the impacts of any changes in environmental standards, practices, or regulations subsequent to performance of services. We do not warrant the accuracy of information supplied by others, or the use of segregated portions of this report.

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