Mead & Hunt

Friedman Memorial Airport
GHG Emissions Inventory

SUN

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SUN

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Executive Summary

In 2021 the Regional Sustainability & Climate Advisory Committee (comprising stakeholders from Blaine County, the City of Ketchum, and the City of Hailey) initiated a regional Sustainability Program to reduce the community's contribution to climate pollution, strengthen resilience against climate-related hazards, transition to clean energy, and enhance livability and quality of life for all residents. As part of this effort, the Hailey City Council pledged to dramatically cut its carbon footprint over the next two decades, starting with participation in a community wide greenhouse gas (GHG) emissions inventory effort.

To align with the community GHG emissions inventory and the City of Hailey's commitment to carbon reduction, the Friedman Memorial Airport Authority (FMAA) and staff at Friedman Memorial Airport (SUN or the Airport) have voluntarily commissioned the preparation of this GHG emissions inventory associated with activity at the Airport. The inventory uses an airport-specific GHG methodology from the National Academy of Sciences (Airport Cooperative Research Program (ACRP) Report 11) to assess airport-related emissions. The year 2020 was identified as a baseline because it is the most current year for which the Airport has complete data. It is important to note that due to the pandemic enplanements in 2020 were nearly half of what they are in normal conditions, however operations remained consistent. Emissions are organized by the party that has ownership or control over the various sources of emissions. In the Airport's case, this is based on three categories:

1. **Airport-owned/controlled**
2. **Airlines, aircraft operators, tenant-owned/controlled**
3. **Public-owned/controlled.**

This inventory reflects two themes for identifying the boundaries associated with greenhouse gas inventories: organization boundaries and operational boundaries. In the case of the Airport, the organization boundaries were limited for this review to the Airport's activities and associated emissions. Operational boundaries reflect the emissions associated with airport activity. Direct and indirect emissions within these boundaries reflect sources that are owned and controlled by the Airport (terminal buildings, mobile sources, and the power required to operate these resources). Other indirect emissions are a consequence of the activities of the Airport but occur by sources owned and controlled by another party. At an airport, these indirect emissions are associated with the airlines, tenants, and general public that use that airport.

Based on these boundaries, approximately 22,100 metric tons of greenhouse gas emissions were emitted in 2020 as a result of the operation of and air travel associated with the Friedman Memorial Airport. The distribution of emissions organized by ownership and control is shown below and are illustrated in **Figure ES-1**.

Ownership/Control	Percent of Total	Key Sources
Airlines/Tenants	94.2%	Aircraft
Public	2.3%	Rental Car/Passenger Travel
Airport	3.5%	Facility power, airport support/fleet vehicles, on-airport roadway travel

Friedman Memorial Airport's owned and controlled emissions represent about 768 metric tons of CO2 in 2020, reflecting about 3.5% of total airport-wide emissions. The largest portion of these greenhouse gas emissions was associated with purchased electricity for stationary or facility usage, reflecting 50% of airport owned or controlled emissions. The next largest airport-owned sources were associated with natural gas from facility stationary sources at 29.7%. Airport ground support equipment/fleet vehicles accounted at 14.4% of airport-controlled emissions. The two smallest sources of airport-controlled emissions are from passenger travel on on-airport roads in rental cars (0.4%) and passenger-owned vehicles (1.3%) (see **Figure ES-2**).

Airline/tenant/aircraft operator-owned and controlled emissions represent 20,813 metric tons of CO2 in 2020, or 94.2% of total airport-related emissions. Of this category of ownership and control, aircraft represent the single largest source of CO2 emissions. About 93.17% of the airport-related emissions are from aircraft alone (99% of tenant emissions).

The final category of sources represents public-owned emissions associated with the airport. This category comprises ground vehicle movements associated with air travel at SUN, including all ground travel on off-airport roadways. Public-owned emissions accounted for 519 metric tons of CO2 in 2020, or 2.3% of total airport-wide emissions.

Regional Context

In 2019 Blaine County published the *2018 Inventory of Community Greenhouse Gas Emissions* (Blaine County Inventory) to estimate greenhouse gas emissions resulting from sources and activities. Sources included in the analysis were Residential Energy, Commercial Energy, Industrial Energy, Solid Waste, Process and Fugitive Emissions, and Transportation and Mobile Sources. However, Transportation sources did not include the Friedman Memorial Airport.

To calculate emissions, the Blaine County Inventory used the ICLEI Community Greenhouse Gas Emissions Protocol, which was released in effort to assist local governments in developing effective community GHG emissions inventories. According to the Blaine County Inventory, community emissions totaled 332,004 metric tons, of which 40% (133,982 metric tons) were a result of Transportation sources (excluding the airport). To provide an *approximate*[1] understanding of how Friedman Memorial Airport contributes to county-wide emissions, airport emissions can be considered with community emissions. Airport-related activities - *not including any vehicle miles traveled on roads* – result in approximately 21,344 metric tons of emissions. If these 21,344 metric tons are incorporated into the Blaine County analysis, the airport would be responsible for 6% of community emissions,[2] while other Transportation sources would be responsible for 38% of community emissions.

Next Steps

The Airport is committed to supporting local and regional efforts to improve climate resilience. As a stakeholder of the Regional Sustainability & Climate Advisory Committee, the Airport will work with local and regional partners to facilitate alignment on climate goals and collaborate on key strategies to improve resilience. Further, the Airport

[1] Note that the base year for the Blaine County Inventory was 2018, while the base year for this SUN Inventory is 2020. Therefore, this calculation is only an approximation.

[2] Airport-related emissions (excluding vehicle miles traveled on roads) is approximately 21,344 metric tons. Adding these emissions to the total community emissions in Blaine County would result in 353,330 metric tons. Of this total, the airport would be responsible for 6.0% of community emissions.

will use this GHG emissions inventory as a baseline to consider and implement appropriate initiatives to reduce SUN's carbon footprint and increase the overall sustainability of the Airport and community.

Figure ES-1 Sources of Emissions – Airport-Wide Greenhouse Gas Emissions

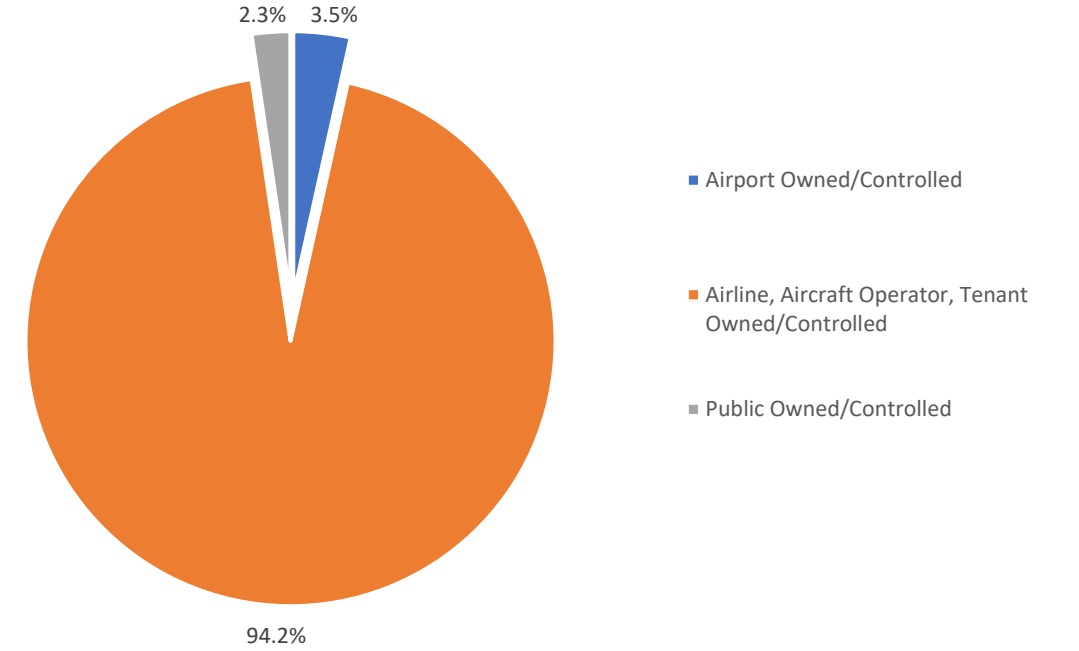
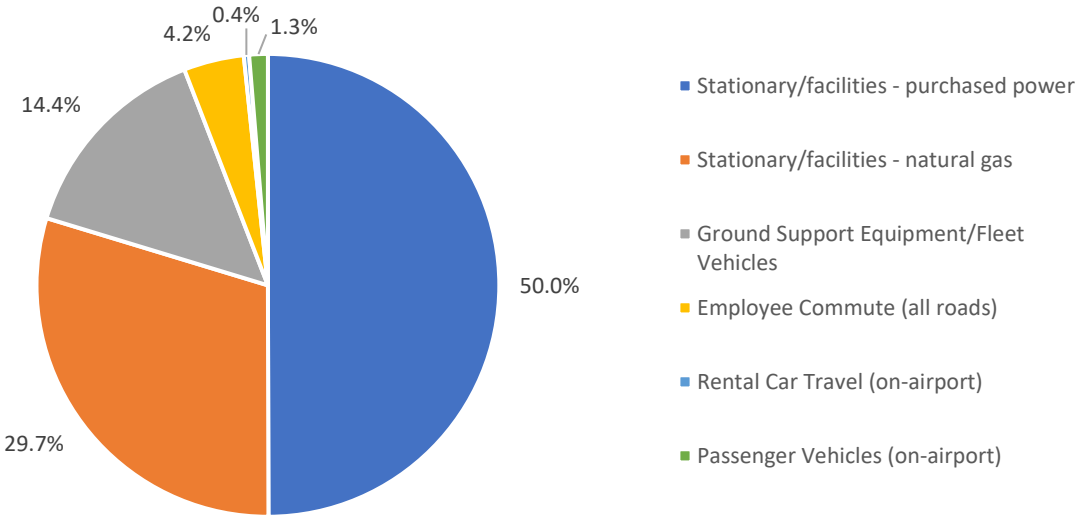


Figure ES-2 Airport Owned/Controlled Greenhouse Gas Emissions



Chapter I

Background

I.1 What are Greenhouse Gases (GHG)?

Greenhouse gases are those gases that trap heat in the earth's atmosphere. Both naturally occurring and anthropogenic (man-made) greenhouse gases include water vapor (H_2O), carbon dioxide (CO_2),[3] methane (CH_4), nitrous oxide (N_2O), and ozone (O_3).[4] Because different greenhouse gases absorb and re-radiate different wavelengths of infrared light, and because they remain in the atmosphere at different levels and lengths of time, each type of greenhouse gas traps a different amount of heat. In an inventory, emissions of greenhouse gases often focus on CO_2, because this gas constitutes most greenhouse gases. If the inventory includes other greenhouse gases, they are reported as "carbon dioxide equivalent" or $CO_{2\text{-eq}}$.

There are also gases that do not have a direct global warming effect, but indirectly affect land and/or solar radiation absorption by influencing the formation or destruction of other greenhouse gases. These gases include carbon monoxide (CO), oxides of nitrogen (NOx), and non-methane volatile organic compounds (NMVOCs). Aerosols, which are extremely small particles or liquid droplets, such as those produced by sulfur dioxide (SO_2) or elemental carbon emissions, can also affect the ability of the atmosphere to absorb or shed heat.

Although the direct greenhouse gases CO_2, CH_4, and N_2O occur naturally in the atmosphere, human activities have changed their atmospheric concentrations. Since the pre-industrial era, concentrations of these greenhouse gases have increased substantially (according to Intergovernmental Panel on Climate Change (IPCC) – see Section 1.2 for a summary of policymakers). For example, beginning in the 1950s the use of chlorofluorocarbons (CFCs) and other stratospheric ozone depleting substances (ODSs) increased by nearly 10% per year until the mid-1980s. CFCs deplete the ozone layer when they are broken down by ultraviolet radiation, release chlorine atoms, and then react with ozone molecules In the 1980s international concern about ozone depletion led to phased reductions in ODSs.[5] In recent years, use of ODS substitutes such as hydrofluorocarbons (HFCs)[6] and perfluorocarbons (PFCs)[7] has grown as they begin to be phased-in as replacements for CFCs and hydrochlorofluorocarbons (HCFCs).

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3 All greenhouse gas inventories measure carbon dioxide emissions, but beyond carbon dioxide different inventories include different greenhouse gasses (GHGs).

4 Several classes of halogenated substances that contain fluorine, chlorine, or bromine are also greenhouse gases, but they are, for the most part, solely a product of industrial activities. For example, chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs) are halocarbons that contain chlorine, while halocarbons that contain bromine are referred to as bromofluorocarbons (i.e., halons) or sulfur (sulfur hexafluoride: SF_6).

5 The Montreal Protocol, finalized in 1987, is a global agreement to protect the stratospheric ozone layer by phasing out the production and consumption of ODSs.

6 HFCs are used in many applications, such as solvents, domestic and commercial refrigerants, firefighting agents, propellants for pharmaceutical and industrial aerosols, foam-blowing agents, and in blends for air conditioning refrigerants

7 PFCs are emitted as by-products of industrial processes and are also used in manufacturing.

Gases in the atmosphere can contribute to the greenhouse effect both directly and indirectly. Direct effects occur when the gas itself absorbs radiation. Indirect radiative forcing (also known as climate forcing, which is defined as heating caused by GHGs in the atmosphere) occurs when: 1) chemical transformations produce other greenhouse gases; 2) when a gas influences the atmospheric lifetimes of other gases; and/or 3) when a gas affects atmospheric processes that alter the radiative balance of the earth (e.g., affect cloud formation, etc.). The IPCC developed the Global Warming Potential (GWP) concept to compare the ability of each greenhouse gas to trap heat in the atmosphere relative to another gas. As noted in later sections of this report, the greenhouse gas inventory for SUN focuses mostly on CO_2 as 1) it is the greatest greenhouse gas emitted by airport sources; and 2) emission rates of some sources are not available for many of the other greenhouse gases.

I.2 Who Addresses Greenhouse Gases?

Historically, the United States has demonstrated varying approaches and intent with regard to addressing climate change. The US participated in the 1992 United Nations Framework Convention on Climate Change (UNFCCC) and adopted the Paris Agreement (PA) in 2015[8].

U.S. climate change policy has involved voluntary programs to address climate change, as well as regulatory programs that indirectly limited GHG emission increases from vehicles, appliances and equipment, and buildings Concentrations of a few greenhouse gases, such as nitrogen oxides (NO_x), ozone (O_3), and carbon monoxide (CO), are regulated by the US Environmental Protection Agency's (US EPA) Clean Air Act. Primary players currently addressing greenhouse gases and climate change are described below.

- While not a group that has established greenhouse gas reduction goals, the **Intergovernmental Panel on Climate Change (IPCC)**, the United Nations body for assessing the science related to climate change, plays a major role in guiding international and national emission quantification and reduction work. Recognizing the problem of potential global climate change, the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) established the IPCC in 1988. It is open to all members of the United Nations and WMO. The role of the IPCC is to understand the risk of human-induced climate change, its potential impacts, and options for adaptation and mitigation. The IPCC does not carry out research or establish regulation. It bases its assessments mainly on peer reviewed and published scientific/technical literature. The IPCC has completed six assessment reports, developed methodology guidelines for national greenhouse gas inventories, special reports, and technical papers.

- The **Kyoto Protocol**, an extension of the **UNFCCC's** international treaty on climate change, assigns mandatory targets for the reduction of greenhouse gas emissions to signatory nations. Countries that ratify the Kyoto Protocol commit to reduce their emissions of carbon dioxide and five other greenhouse gases or engage in emissions trading if they maintain or increase emissions of these gases.

- Governments are separated into two general categories: developed countries that have accepted greenhouse gas emission reduction obligations; and developing countries that have no greenhouse gas emission reduction obligations. A total of 192 countries had ratified the agreement. Developing countries, such as India and China, which have ratified the protocol are not required to reduce carbon emissions under the present agreement despite their relatively large populations.

[8] President Trump announced U.S. withdrawal from the PA in June 2017, which became effective in November 2020. President Biden again accepted the PA, and the United States became a Party on February 19, 2021.

Emissions from international aviation were specifically excluded from the targets agreed upon under the Kyoto Protocol. Instead, countries were encouraged to control international aviation-related emissions through the activities of the International Civil Aviation Organization (ICAO). ICAO's Committee on Aviation Environmental Protection continues to consider the potential for using market-based mechanisms. ICAO is currently developing guidance for states who wish to include aviation in an emissions trading scheme (ETS) to meet their Kyoto commitments, and for airlines who wish to participate voluntarily in a trading scheme. Emissions from domestic aviation are included within the Kyoto targets agreed upon by countries.

- Even though the US has not ratified the Kyoto Protocol, various regional, state, and local agencies continue to act to quantify, and control and/or reduce GHG emissions. Currently, there are 192 parties (191 states, and 1 regional economic integration organization) to the Kyoto Protocol.[9] Policies include carbon pricing, emission limits, energy efficiency mandates and incentives and steps to promote cleaner transportation. Examples include:
    - **Carbon pricing** is one of the most direct policies that states use to address emissions. Essentially, carbon pricing is a market-based mechanism that creates financial incentives to reduce GHG emissions. Twelve states have active carbon-pricing programs, including California and the eleven northeastern U.S states that comprise the Regional Greenhouse Gas Initiative (RGGI). RGGI is the first mandatory cap-and-trade program in the United States to limit carbon dioxide emissions from the power sector, and has helped RGGI states reduce annual power-sector CO2 emissions by 50% since its inception.
    - **Energy efficiency policies** allow states to promote energy efficiency projects and practices through mandates or incentives. Many states take both approaches. Such mandatory policies include building codes that require low-energy features or appliance standards. Eighteen (18) states plus the District of Columbia currently have some appliance efficiency standards that exceed federal requirements.[10]
    - **Transportation policies** include several techniques that are used to control transportation emissions, one of the largest sources of emissions in the U.S. Rebates and incentives are used to encourage consumers to purchase electric vehicles. A low-carbon fuel standard, aimed at reducing greenhouse gas emissions by requiring a shift to lower-carbon fuel (biofuels, etc.) are currently used in California and Oregon and are being considered in Washington, Colorado, South Dakota, Minnesota, Iowa, and New York. Land use decisions and public transportation investments are also used to reduce vehicle miles travelled and associated emissions.
- In 2021, the FAA published the US Aviation Climate Action Plan which sets a goal of net-zero GHG emissions from the US aviation sector by 2050. The efforts of the plan include:
    - Increasing sustainable aviation fuel (derived from organic materials and serve as a drop-in fuel for conventional fossil fuels) production.
    - Investment in new aircraft technology development.
    - Researching methods of increasing operational efficiency.
    - Enhancing airport resilience and cutting emissions.

9 https://unfccc.int/process/the-kyoto-protocol/status-of-ratification

10 States | ASAP Appliance Standard Awareness Project (appliance-standards.org)

I.3 Sources of Greenhouse Gases at an Airport

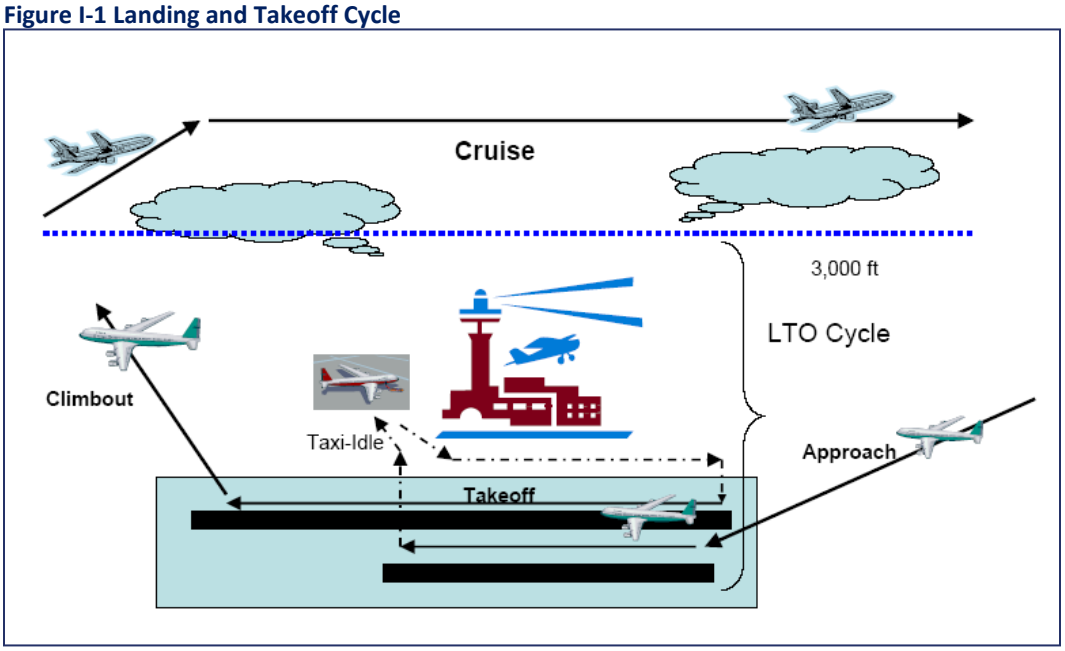
Research has shown that there is a direct link between fuel consumption and greenhouse gas emissions. Therefore, sources that require power/fuel at an airport typically are reflected in a pollutant emissions inventory and are the principal focus of a greenhouse gas inventory. Airport sources of greenhouse gas emissions include:

1. **Aircraft including auxiliary power units (APU):** The category of aircraft includes jet and propeller driven aircraft, as well as APUs. An APU generates electricity and compressed air to operate the aircraft's instruments, lights, ventilation, and other equipment and to start the aircraft main engines. If ground-based power or air is not available, the APU may be operated for extended periods when the aircraft is on the ground with its engines shut down.

   For aircraft emissions, an inventory often presents emissions in two or three ways: Landing and takeoff-cycle (LTO), total fuel dispensed to aircraft at the airport, or a combination of these first two. The LTO cycle, shown in **Figure I-1** below, only captures emissions associated with an aircraft at an individual airport up to an altitude of 3,000 feet. Fuel dispensed, the method used in this emissions inventory, reflects the fuel needed by individual aircraft leaving the airport, necessary to fly to their destination. ACRP Report 11 provides an option for using both in such a way to report cruise-related emissions, by subtracting LTO emissions from fuel dispensed.

2. **Ground support equipment (GSE):** A variety of ground equipment service commercial aircraft while they unload and load passengers and freight at an airport. GSE primarily consists of vehicles that do not leave the airfield, such as aircraft tugs, air start units, loaders, tractors, ground power units, cargo-moving equipment, service vehicles, etc. In general, GSE are off-road vehicles and include vehicles of the airport operator that maintain airport facilities (such as snow removal, firefighting, etc.).

Figure I-1 Landing and Takeoff Cycle



Note: Four LTO Modes – approach, taxi-in/taxi-out, takeoff, and climbout.

3. **Ground access vehicles (GAV)** encompass all on-road or highway vehicle trips generated by the users of an airport. GAV include all vehicles traveling to and from, as well as within the airport public roadway system (excluding GSE). On-road and highway vehicles include privately-owned vehicles, government-owned vehicles, rental cars, hotel shuttles, buses, taxicabs/Uber/Lyft, private passenger vehicles, and trucks.

4. **Airport infrastructure and stationary sources** include sources such as energy for lighting, cooling, heating, etc. Included in airport infrastructure is purchased electricity, natural gas, propane, and stationary sources such as generators.

5. **Airport and airline maintenance industrial activities.**

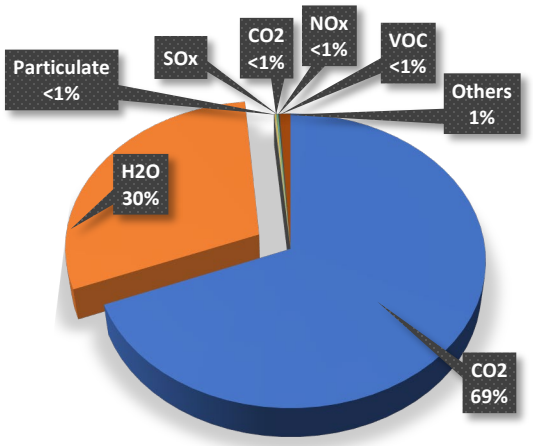
6. **Airport construction activities.**

Depending on the airport, other sources of emissions may arise directly and/or indirectly. For example, some airports account for emissions produced by waste by going through the steps to improve waste management and recycling programs.

Because the inventory documented in this report is the first in-depth greenhouse gas inventory for Friedman Memorial Airport related sources, it is scoped to consider only emissions from the first four sources (aircraft/APU, GSE, GAV, and airport infrastructure) as they are expected to be the dominant (key) sources of greenhouse gases. It is possible that in the future, construction and maintenance activities associated with SUN may be itemized.

Aircraft are probably the most often cited air pollutant source, but as is noted in FAA materials, they produce the same types of emissions as cars. According to the 2018 Blaine County GHG Emissions Inventory, approximately 40% of emissions are attributable to transportation sources (not including the airport). Aircraft jet engines, like many other vehicle engines, produce carbon dioxide (CO_2), water vapor (H_2O), nitrogen oxides (NO_x), carbon monoxide (CO), oxides of sulfur (SO_x), unburned or partially combusted hydrocarbons (also known as volatile organic compounds [VOCs]), particulates, and other trace compounds. **Figure I-2** shows the approximate composition of aircraft engine emissions.

Figure I-2 General Engine Emissions Composition



Source: FAA Emissions Primer.

The FAA's Emissions Primer further notes that:

> *About 10 percent of aircraft emissions of all types, except hydrocarbons (i.e., VOC) and CO, are produced during airport ground level operations and during landing and takeoff. The bulk of aircraft emissions (90 percent) occur at higher altitudes. For hydrocarbons and CO, the split is closer to 30 percent ground level emissions and 70 percent at higher altitudes.*

The IPCC estimated that global aircraft emissions account for about 3.5% of the total radiative forcing by all man-made activities. However, the scientific community has identified areas that need further study to enable them to more precisely estimate aviation's effects on the global atmosphere. As for the contributions of US aviation relative to other US industrial sources, data from the USEPA show that commercial aircraft accounted for about 5.1% of US greenhouse gas emissions.[11] As the US General Accounting Office (GAO) noted[12] "global aviation emissions of carbon dioxide (measured in million metric tons of carbon) are a small percentage of carbon emissions worldwide; however, they are roughly equivalent to the carbon emissions of certain industrialized countries."

The GAO report noted the importance of aircraft emissions in greenhouse gases for the following reasons:

- Jet aircraft are the primary source of human emissions deposited directly into the upper atmosphere. The IPCC noted that some of these emissions have a greater warming effect than they would have if they were released in equal amounts at the surface.
- CO_2 is relatively well understood and is the main focus of international concern, as it survives in the atmosphere for about 100 years and contributes to warming the earth.

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11 USEPA, *DRAFT Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 – 2020*, **available at:** https://www.epa.gov/ghgemissions/draft-inventory-us-greenhouse-gas-emissions-and-sinks-1990-2020

12 US General Accounting Office (GAO) *Environment: Aviation's Effects on the Global Atmosphere Are Potentially Significant and Expected to Grow*; GAO/RCED-00-57, February 2000.

- CO_2 emissions combined with other gases and particles emitted by jet aircraft - including water vapor, nitrogen oxide and nitrogen dioxide (collectively termed NOx), and soot and sulfate — could have two to four times as great an effect on the atmosphere as carbon dioxide alone.
- The IPCC concluded that the increase in aviation emissions attributable to a growing demand for air travel would not be fully offset by reductions in emissions achieved through technological improvements alone. Experts agree that the aviation industry will continue to grow globally and contribute increasingly to human-generated emissions. The experts differ, however, in the rates of growth they project and the effects they anticipate.

Chapter II

Inventory Protocol

This chapter documents the methodologies used to prepare the 2020 greenhouse gas emissions inventory for the Friedman Memorial Airport. This chapter discusses:

- **Friedman Memorial Airport organization and operational boundaries**
- **Methods to quantify airport-related sources**
- **Uncertainties and data cautions**

The principles by which this inventory was prepared reflect general factors considered in most greenhouse gas inventories:

- **Relevance** means that the inventory includes the appropriate facilities and types of emissions sources to meet the entity's goals.
- **Completeness** means that an adequate percentage of the entity's (i.e., Friedman Memorial Airport Authority) total facilities and emissions sources have been included in the inventory.
- **Accuracy** means using accepted quantification methods and emissions factors as well as managing data quality.
- **Transparency** means that the important boundary decisions, data sources, and quantification methods are well documented.
- **Consistency** means that the same facilities, emissions sources, and emissions quantification methods are used from year to year. Therefore, this inventory was prepared in a transparent way to enable emissions presented herein to be re-tabulated as needed. As noted earlier, however, it is anticipated that the approach to considering airport-related emissions will evolve over time.

II.1 Friedman Memorial Airport Organization and Operational Boundaries

While a standard greenhouse gas inventory protocol has not been developed for the airport setting, protocols have evolved from a number of sources that can be used in whole or part including:

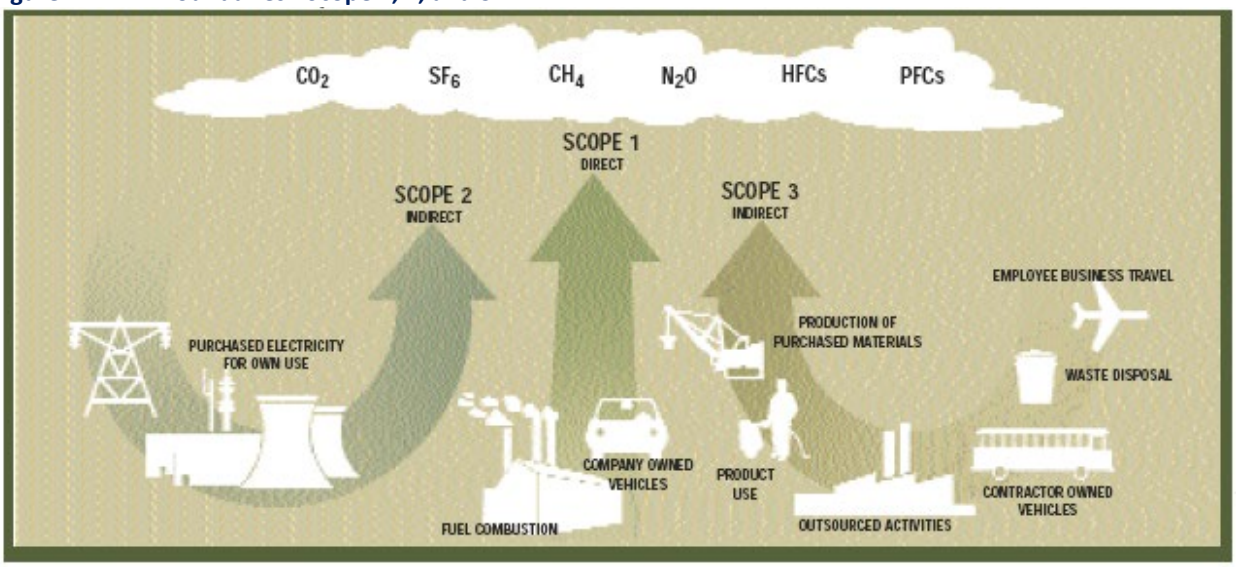
- **Intergovernmental Panel on Climate Change (IPCC)** is focused on inventories for nations, but provides guidance for other parties on various sources, including aviation.
- **US EPA** has prepared guidance for states to prepare inventories, but has also prepared a protocol through the Climate Leaders effort to assist other entities with consistent greenhouse gas inventories.
- **World Resource Institute (WRI)**, an environmental think tank, in collaboration with the World Business Council for Sustainable Development, has developed comprehensive guidance to assist corporations with preparing emission inventories, both representing the corporate entity as well as corporate projects.
- **International Council for Local Environmental Initiatives (ICLEI)** is an international association of local governments and national and regional local government organizations that have made a commitment to sustainable development. ICLEI has implemented a program titled, the Cities for Climate Protection (CCP), to assists cities with adopting policies and programs to reduce local greenhouse gas emissions, improve air quality, and enhance urban livability and sustainability. According to their web site, more than 650 local governments participate in the CCP.

As noted by these protocols, for a greenhouse gas inventory to be of use, it must convey information in a way that allows the data to be useful and must document the conditions associated with the reporting entity. In most cases, the preparation of an inventory enables the identification of notable or key sources of greenhouse gases associated with the reporting entity and the identification of measures to reduce those emissions. To be useful, an inventory uses an appropriate inventory boundary that reflects "the substance and economic reality of the entities activities" and responsibilities, and presents emissions at a source level that enables the capture of changes in emissions over time and with mitigation/offset. For corporate entities, this often relates to the legal form of the business. For governmental parties, this can become less clear, but typically focuses on emissions directly from the governmental activities (sources owned by the entity), as well as those within its control. Thus, the choice of the inventory boundary is typically dependent on the characteristics of the entity, the intended purpose of the information, and the needs of the information users.

EPA and WRI guidance suggest that the following be considered when establishing the boundaries, and is shown in **Figure II-1**:

- **Organizational structure:** The structure, as reflected by control through ownership, legal agreements, joint ventures, etc. In the case of the Friedman Memorial Airport, the organization boundaries were limited for this review to SUN's activities and associated emissions.
- **Operational boundaries:** Once an entity has determined its organizational boundaries in terms of the operations that it owns or controls, it then sets its operational boundaries. This involves identifying the emissions associated with its operations and categorizing them as direct, indirect, and optional emissions.
    - **Direct/Scope 1** emissions are from sources that are owned or controlled by the party. For example, emissions from combustion in owned or controlled boilers, furnaces, vehicles, etc. The WRI methods refer to direct emissions as Scope 1 emissions. In the case of Friedman Memorial Airport, direct emissions reflect energy consumed by Airport facilities, and fuel powering Airport owned vehicles.
    - **Scope 2** emissions are associated with the purchase of electricity necessary to power airport facilities. All electrical power billed to SUN is reflected in Scope 2 emissions.
    - **Scope 3/Optional** is a reporting category that allows for the identification of all other emissions that are a consequence of the activities of the entity but occur from sources not owned or controlled by the entity.

Figure II-1 WRI Boundaries - Scope 1, 2, and 3



Given the organization boundaries, the operational boundary for the Airport was defined as the land at Friedman Memorial Airport which comprises approximately 272 acres. Because of the visibility of aircraft and their emissions within the physical boundaries of the Airport, as well as other activities by tenants, attempts were made to capture the emissions associated with those activities and note that they are owned and controlled by airlines/tenants and private parties using the Airport. In addition, because of the amount of on-road vehicular travel associated with passengers using the Airport, emissions from these sources were also quantified based on the information available but noted as associated with public (private) activities. The inclusion of these emissions provides further information about Airport-related activities and their associated emissions.

An important element of the inventory protocol is the use of proper boundaries that avoid the double counting of emissions. As noted in the IPCC guidance[13] "National inventories include greenhouse gas emissions and removals taking place within national territory and offshore areas over which the country has jurisdiction… For example, emissions from fuel used in road transport are included in the emissions of the country where the fuel is sold and not where the vehicle is driven, as fuel sale statistics are widely available and usually much more accurate."

In an airport setting, the issue of ownership is clear, as ownership is related to the party that has title to the asset (i.e., the aircraft is owned or leased by an airline or private entity, most buildings and facilities are owned by the Airport, but may be the subject of a long-term lease by a tenant). However, control can be more difficult to identify, as many parties contribute to the control of various sources. Therefore, the Friedman Memorial Airport inventory identifies sources of emissions and attempts to focus first on ownership and then control.

[13] 2019 Refinement to the 2006 IPCC Guidelines for Preparing National Greenhouse Gas Inventories, Volume I - General Guidance and Reporting, IPCC

II.2 Methods Used to Quantify Greenhouse Gases at Friedman Memorial Airport

Emissions were quantified from the following sources at Friedman Memorial Airport.

II.2.1 Aircraft Emissions (Tenant or Public Sources)

Aircraft greenhouse gas emissions would be expected to be the largest sources of greenhouse gases at most commercial service airports due to the fuel requirements of air travel. To quantify aircraft-related greenhouse gases, the following steps were used:

- Information concerning the quantity of fuel dispensed at SUN to aircraft (jet fuel and aviation gas) was obtained by airport staff. In 2020, a total of 2,045,175 gallons of Jet-A and 54,437 gallons of Avgas were dispensed (sometimes referred to as fuel sales). Fuel dispensed represents the amount of fuel that airlines acquired at Friedman Memorial Airport for departures to reach their desired destination. It does not reflect the fuel acquired in origin cities that is necessary to enable travel to the City of Hailey (arrival-based fuel). While the arrival-based fuel consumption is not reflected in fuel dispensed, it would be attributed to that flight origination city.

  As noted earlier, fuel sales or fuel dispensed data does not account for fuel obtained in other locations that enables the aircraft to fly to the City of Hailey and, in some cases, achieve the desired destination (travel from the City of Hailey to a destination). This is often called "tankering." With the methodology used herein, fuel dispensed at another airport would result in the emissions then being associated with that other airport.

- ACRP Report 11's Method 1 for aircraft emissions was used to calculate emissions. This is due to the data available, which did not include fleet mix with operations per aircraft type. This method relies of aircraft fuel sales data and uses emission factors to calculate emissions.

- Fuel dispensed can be translated into CO2 emissions based on the US Energy Information Administration's estimate that about 21.5 pounds of CO2 is generated by burning one gallon of Jet A fuel or 18.32 pounds of CO2 per gallon of Avgas. Additional greenhouse gases are also emitted while burning fuel. The emission factors for CH4 and N2O were also calculated and then converted to the CO2 equivalent. Thus, aircraft fuel dispensed at Friedman Memorial Airport generated about 20,591 metric tons of CO2.

Emission Factors			
CO_2 Emission Factors	Jet A Fuel Avgas	21.50 18.32	lbs CO2/gallon lbs CO2/gallon
CH_4 Emission Factors	Jet A Fuel Avgas	0 7.06	g CH_4/gal g CH_4/gal
N_20 Emission Factors	Jet A Fuel Avgas	0.30 0.11	g N_20/gal g N_20/gal

Sources: EPA GHG Emission Hub (April 2021)

II.2.2 Airport Fleet Vehicles/Ground Support Equipment (GSE)

This category refers to all airline/tenant-owned and airport-owned vehicles that support aircraft and airport activity or vehicles used to maintain an airport. In general, these vehicles are considered off-road as they do not typically travel off the Airport.

ACRP Report 11 Method 1 for Ground Support Equipment was utilized in calculating emissions by fuel consumption data. This method uses gallons of fuel dispensed to vehicles to determine GSE GHG emissions.

Separate from airline/tenant GSE, the Friedman Memorial Airport operates GSE (sometimes called fleet vehicles) that include firefighting equipment, snow removal, airport administrative ground travel, and airport maintenance vehicles. In 2020, the Airport purchased nearly 1,437 gallons of gasoline and 9,639 gallons of diesel fuel that serviced airport owned vehicles and stationary sources. CO2 emissions associated with the consumption of these fuels were computed based on standard CO2 factors provided in the EPA's GHG Emission Factors Hub (i.e., 19.37 lbs. of CO2 per gallon of gasoline, 22.46 lbs. of CO2 per gallon of diesel). Liquid fuel data was provided by the airport for both gasoline and diesel fuel use and tenant fuel use was provided by the airlines with the assumption that only diesel fuel was used for airline GSE.

II.2.3 Ground Access Vehicles (GAV)

Ground access vehicles (GAV) generally are all of the street-licensed vehicles that operate to and from the Airport. GAV vehicles at the Airport are primarily associated with passengers, employees, and airport deliveries. Limited data exists for ground access vehicle use associated with Friedman Memorial Airport. Therefore, substantial estimates were made to identify GAV travel and associated emissions.

Calculations for GAV emissions were based on ACRP Report 11's Method 1 for Ground Access Vehicles. This method uses average vehicle miles traveled (VMT), vehicle fuel economy information, and emission factors (based on fuel type) to determine emissions.

In 2020, the Airport accommodated 47,590 enplaned passengers.[14] A total of 24,067 annual aircraft operations occurred. Due to lack of data, estimates were needed to determine the modes of transportation taken by passengers and vehicle miles traveled, among other data. Passenger vehicle travel emissions are separated into on-airport road travel and off-airport road travel. Airport and tenant employee commutes are not divided into on- and off-airport road travel as the commutes would be necessitated by airport and tenant-controlled situations (e.g. holiday meaning employees do not need to commute to work).

The following assumptions were made to arrive at an estimate of GAV travel and the emissions from GAV sources:

- On-airport road travel distance is estimated to be 0.7 mile. This is the distance from the airport terminal to the intersection of Airport Way and 801 State Hwy 75. Off-airport travel distance was approximated using the distance from provided zip code data to the terminal minus the 0.7 mile.

[14] Due to the pandemic, enplanements were roughly half of what SUN experiences in a normal year. In subsequent updates of the SUN GHG Emissions Inventory it is likely that changes will occur with regard to public-controlled emissions (i.e, passenger commute and rental cars) due to 2020 being an anomalous year. However, because public controlled emissions account for only 0.8% of airport total emissions in 2020, a significant increase is not anticipated.

- Travel party size was estimated based on information from peer airports at similar ski resort markets and familiarity with the area. A party size of 2 passengers per vehicle was assumed for calculation.

- Information was collected from three rental car company tenants at the Airport with a total of 70,084 rental days across the three companies. The rental companies also included vehicle fleet mix data with total vehicles and percentage of car, SUV, and pickup truck. The average rental contract duration was estimated as 6 days, based on information from rental car companies at peer ski resort airports.

- Travel distance is set as an average of 85 miles per rental period and is based on information from rental car companies at peer ski resort airports. This distance accounts for the distance to and from the airport to nearby attractions and cities.

- Travel for passengers driving personal vehicles, the vehicle types and distance traveled are based on data for employees working at the airport. Vehicle fleet mix data and zip code data for employees was provided by the airport and tenants, and the travel distance and vehicle ownership characteristics for passengers were assumed to match that of the employees. A weighted average of the employee commute resulted in an average distance of 12.77 miles for airport passenger vehicles. The vehicle fleet mix resulted in 24.5% SUVs, 21.8% trucks, and 53.8% cars (sedan/wagon).

- The average fuel economy of different vehicle types was sourced from the U.S. Environmental Protection Agency (EPA)'s 2021 Automotive Trends Report. The main vehicle types considered in the inventory include sedan/wagon (31.7 MPG), truck SUV (23.8 MPG), and pickup (19.2 MPG).

- Employee commute emissions calculations assumed 52 weeks worked. Number of days worked per week was based on employer provided information.

Airport employees reporting to duty at Friedman Memorial Airport were also separately itemized. The Airport supplied information on the number of employees and the zip codes of their homes. The FMAA employs 17 individuals at SUN, with a work commute of up to 40 miles one way. About 30% of the employees work a 2-day week, and 70% a 5-day week. The part-time 2-day work week accounts for seasonal workers with the workdays per week averaged over a year.

Tenant employee (105 non-FMAA employees) commute information was also based on zip code information. Around 50% of tenant employees work part-time. However, each tenant has their own number of days that account for part-time, ranging from four days a week for Avis/Budget rental car employees to one day a week for the car park. The majority of part-time employees are from SkyWest (85% of the 39 SkyWest employees work two days a week). The weighted average work commute for all employees, based on zip codes, was estimated as 12.77 miles.

II.2.4 Facility/Stationary Source Emissions

Stationary fossil fuel burning equipment primarily includes heating and cooling, power supplies for building (i.e., electrical consumption), and cooking activities. The following data was collected in order to quantify emissions from these sources.

- Electricity is consumed to power lighting in the terminal, parking, support facilities, and airfield. Friedman Memorial Airport records indicate that about 1,182,867 kilowatt hours (kWh) of electricity was purchased from Idaho Power in 2020 by FMAA.

- The US EPA eGrid data for Idaho was used to calculate greenhouse gas emissions from purchased electricity. The eGrid Emission Factors Table 6 includes emission factors from 2020 which indicates 715.2 lbs of CO_2 are emitted per MWh. Emission factors for CH_4 and N_2O emission factors are 0.068 lb/MWh and 0.01 lb/MWh, respectively. Including CO_2 equivalence, power consumption at SUN resulted in 383.7 metric tons of CO_2 emitted.

- Natural gas is provided by Intermountain Gas. A total of 34,425 therms was consumed by SUN in 2020. eGrid data for steam and heat indicates 66.33 kg CO_2/mmBtu 1.250 g CH_4/mmBtu, and 0.125 g N_2O /mmBtu. The factors were used to calculate total emissions from natural gas use at SUN to be 228.6 metric tons of CO_2 emitted.

- Both SUN natural gas and electricity emissions calculations included converting CH_4 and N_2O emissions into CO_2 equivalence using the 100-year GWPs from the IPCC Fourth Assessment Report, as referenced in the ACRP Report 11.

Chapter III

Emissions Inventory

Table III-1 summarizes CO_2 emissions in 2020 at SUN by source. The sources are divided into three categories based on ownership and control of the source. In total, the Friedman Memorial Airport emitted 22,100 metric tons of CO_2 in 2020.[15] Relative to the annual total, 3.5% of emissions are associated with Airport-owned or controlled activities, 94.2% of emissions are associated with airline, tenant, or aircraft operator activities, and 2.3% are associated with public access to and from the Airport.

Table III-1: Summary of 2020 Greenhouse Gas Emissions Associated with Friedman Memorial Airport Activity

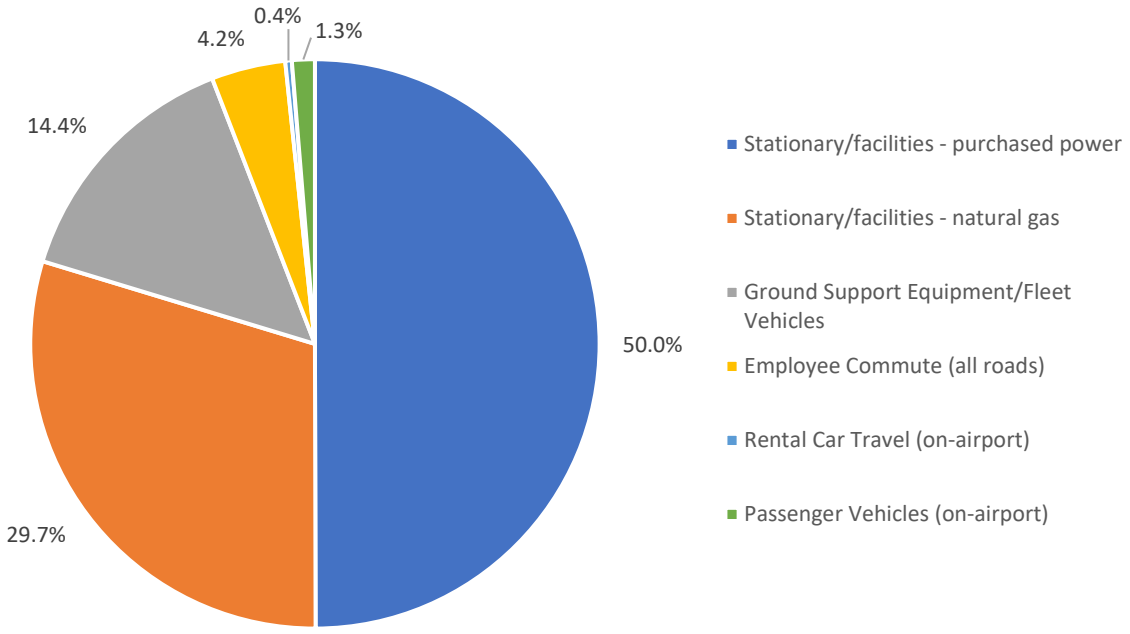
2020			
User/Source Category	**CO2 (metric tons/year)**	**Percent of User**	**Percent of Total**
Airport Operator Owned/Controlled			
Stationary/facilities - purchased power	384	50.0%	1.74%
Stationary/facilities - natural gas	228	29.7%	1.03%
Ground Support Equipment/Fleet Vehicles	111	14.4%	0.50%
Ground Access Vehicles			
Employee Commute (all roads)	32	4.2%	0.15%
Rental Car Travel (on-airport)	3	0.4%	0.01%
Passenger Vehicles (on-airport)	10	1.3%	0.05%
Subtotal	**768**	**100.0%**	**3.5%**
Airline, Aircraft Operator, Tenant Owned/Controlled			
Aircraft	20,591	99%	93.17%
Ground Support Equipment/Fleet Vehicles	31	0.1%	0.14%
Ground Access Vehicles (Tenant Commute)	192	0.9%	0.87%
Stationary sources/facility power	0	0.0%	0.00%
Subtotal	**20,813**	**100.0%**	**94.2%**
Public-owned/Controlled			
Rental Car Travel	343	66.0%	1.55%
Passenger Vehicles	176	34.0%	0.80%
Subtotal	**343**	**66.0%**	**2.3%**
Total	**22,100**		**100.0%**

[15] Note that the total emission measurement includes non-CO_2 greenhouse gases such as CH_4 and N_2O for aircraft and stationary sources. Emissions estimates for these pollutants were converted into CO_2 equivalent amounts via the ACRP 11 CO_2 equivalencies calculation method.

III.1 Airport Owned/Controlled Emissions

768 metric tons of CO2 were emitted in 2020 from sources owned or controlled by SUN. The largest portion of greenhouse gas emissions that SUN controls is associated with the stationary sources. Specifically, the electricity usage of the stationary sources alone emitted 50% of total Airport associated emissions. Combustion activities, represented as natural gas, at the stationary sources made up 29.7%, followed by ground support equipment emissions (i.e., snow removal) (14.4%), Airport employee work commute (4.2%), and on-airport road travel by passengers in rental cars (0.4%) and passenger-owned vehicles (1.3%).

Figure III-1 Airport Owned or Controlled Sources (2020)



III.2 Airline, Aircraft Operator, and Tenant Owned/Controlled Emissions

This category of emissions generated the most CO2 emissions at SUN in 2020, with 20,813 metric tons of CO2, or 94.2% of total emissions. Aircraft related emissions are the largest source of emissions for both this category and the Airport overall, accounting for 99% of emissions (20,591 metric tons of CO2). This category also includes all non-Airport employee commutes which generates 0.9% of emissions in this category. This is followed by the airlines' ground support equipment at 0.1% of emissions. The airlines' equipment was assumed to be diesel-fueled equipment. No stationary source emissions are included in this category due to data not being available.

III.3 Public Owned/Controlled Emissions

The public owned and controlled emissions in this inventory reflect on-road travel associated with airport activity by passengers in both rental and personal vehicles. This group represents 2.3% of total emissions at SUN in 2020 consisting of passenger travel on off-airport roads. This totaled in 519 metric tons CO2 of which 66% emitted by rental cars and 34% from passenger-owned vehicles.

Appendix A

Abbreviations, Glossary, and References

Abbreviations

ACRP – Airport Cooperative Research Program of the Transportation Research Board
APU – Auxiliary Power Unit
CCP – Climate Protection Program of ICLEI
CO2 – Carbon Dioxide
CO2-eq – Carbon Dioxide equivalent (sometimes CO2e)
EIA – Energy Information Administration of the Department of Energy
FAA – Federal Aviation Administration
GAV – Ground Access Vehicle
GHG – Greenhouse Gases
GSE – Ground Support Equipment
ICLEI – International Council for Local Environmental Initiatives
IPCC – Intergovernmental Panel on Climate Change
kWh – Kilowatt hour
LTO – Landing and Takeoff Cycle
SUN – Friedman Memorial Airport
WRI – World Resource Institute
US EPA – US Environmental Protection Agency

Glossary

Absorption of Radiation: The uptake of radiation by a solid body, liquid or gas. The absorbed energy may be transferred or re-emitted.

Aerosol: Particulate matter, solid or liquid, larger than a molecule but small enough to remain suspended in the atmosphere. Natural sources include salt particles from sea spray, dust and clay particles as a result of weathering of rocks, both of which are carried upward by the wind. Aerosols can also originate as a result of human activities and are often considered pollutants. Aerosols are important in the atmosphere as nuclei for the condensation of water droplets and ice crystals, as participants in various chemical cycles, and as absorbers and scatters of solar radiation, thereby influencing the radiation budget of the Earth's climate system.

Air Carrier: An operator (e.g., airline) in the commercial system of air transportation consisting of aircraft that hold certificates of Public Convenience and Necessity issued by the Department of Transportation to conduct scheduled or non-scheduled flights within the country or abroad.

Anthropogenic: Human made. In the context of greenhouse gases, anthropogenic emissions are produced as the result of human activities.

Atmosphere: The mixture of gases surrounding the Earth. The Earth's atmosphere consists of about 79.1 percent nitrogen (by volume), 20.9 percent oxygen, 0.036 percent carbon dioxide and trace amounts of other gases. The atmosphere can be divided into a number of layers according to its mixing or chemical characteristics, generally

determined by its thermal properties (temperature). The layer nearest the Earth is the troposphere, which reaches up to an altitude of about 8 kilometers (about 5 miles) in the polar regions and up to 17 kilometers (nearly 11 miles) above the equator. The stratosphere, which reaches to an altitude of about 50 kilometers (31miles) lies atop the troposphere. The mesosphere, which extends from 80 to 90 kilometers atop the stratosphere, and finally, the thermosphere, or ionosphere, gradually diminishes and forms a fuzzy border with outer space. There is relatively little mixing of gases between layers.

Aviation Gasoline (AvGas): All special grades of gasoline for use in aviation reciprocating engines, as cited in the American Society for Testing and Materials (ASTM) specification D 910. Includes all refinery products within the gasoline range that are to be marketed straight or in blends as aviation gasoline without further processing (any refinery operation except mechanical blending). Also included are finished components in the gasoline range, which will be used for blending or compounding into aviation gasoline.

Biodegradable: Material that can be broken down into simpler substances (elements and compounds) by bacteria or other decomposers. Paper and most organic wastes such as animal manure are biodegradable.

Biofuel: Gas or liquid fuel made from plant material (biomass). Includes wood, wood waste, wood liquors, peat, railroad ties, wood sludge, spent sulfite liquors, agricultural waste, straw, tires, fish oils, tall oil, sludge waste, waste alcohol, municipal solid waste, landfill gases, other waste, and ethanol blended into motor gasoline.

Biomass: Total dry weight of all living organisms that can be supported at each tropic level in a food chain. Also, materials that are biological in origin, including organic material (both living and dead) from above and below ground, for example, trees, crops, grasses, tree litter, roots, and animals and animal waste.

Biomass Energy: Energy produced by combusting biomass materials such as wood. The carbon dioxide emitted from burning biomass will not increase total atmospheric carbon dioxide if this consumption is done on a sustainable basis (i.e., if in a given period of time, re-growth of biomass takes up as much carbon dioxide as is released from biomass combustion). Biomass energy is often suggested as a replacement for fossil fuel combustion.

British Thermal Unit (Btu): The quantity of heat required to raise the temperature of one pound of water one degree of Fahrenheit at or near 39.2 degrees Fahrenheit.

Bunker Fuel: Fuel supplied to ships and aircraft for international transportation, irrespective of the flag of the carrier, consisting primarily of residual and distillate fuel oil for ships and jet fuel for aircraft.

Carbon Dioxide: A colorless, odorless, non-poisonous gas that is a normal part of the ambient air. Carbon dioxide is a product of fossil fuel combustion. Although carbon dioxide does not directly impair human health, it is a greenhouse gas that traps terrestrial (i.e., infrared) radiation and contributes to the potential for global warming.

Carbon Equivalent (CE) or Carbon Dioxide Equivalent: A metric measure used to compare the emissions of the different greenhouse gases based upon their global warming potential (GWP). Greenhouse gas emissions in the United States are most commonly expressed as “million metric tons of carbon equivalents” (MMTCE). Global warming potentials are used to convert greenhouse gases to carbon dioxide equivalents ($CO_{2\text{-eq}}$).

Carbon Sequestration: The uptake and storage of carbon. Trees and plants, for example, absorb carbon dioxide, release the oxygen and store the carbon. Fossil fuels were at one time biomass and continue to store the carbon until burned.

Carbon Sinks: Carbon reservoirs and conditions that take-in and store more carbon (i.e., carbon sequestration) than they release. Carbon sinks can serve to partially offset greenhouse gas emissions. Forests and oceans are large carbon sinks.

Carbon Tetrachloride (CCl4): A compound consisting of one carbon atom and four chlorine atoms. It is an ozone depleting substance. Carbon tetrachloride was widely used as a raw material in many industrial applications, including the production of chlorofluorocarbons, and as a solvent. Solvent use was ended in the United States when it was discovered to be carcinogenic.

Chlorofluorocarbons (CFCs): Organic compounds made up of atoms of carbon, chlorine, and fluorine. An example is CFC-12 (CCl_2F_2), used as a refrigerant in refrigerators and air conditioners and as a foam blowing agent. Gaseous CFCs can deplete the ozone layer when they slowly rise into the stratosphere, are broken down by strong ultraviolet radiation, release chlorine atoms, and then react with ozone molecules.

Climate: The average weather, usually taken over a 30 year time period, for a particular region and time period. Climate is not the same as weather, but rather, it is the average pattern of weather for a particular region. Weather describes the short-term state of the atmosphere. Climatic elements include precipitation, temperature, humidity, sunshine, wind velocity, phenomena such as fog, frost, and hailstorms, and other measures of the weather.

Climate Change: The term "climate change" is sometimes used to refer to all forms of climatic inconsistency, but because the Earth's climate is never static, the term is more properly used to imply a significant change from one climatic condition to another. In some cases, "climate change" has been used synonymously with the term, "global warming"; scientists however, tend to use the term in the wider sense to also include natural changes in climate.

Climate Feedback: An atmospheric, oceanic, terrestrial, or other process that is activated by direct climate change induced by changes in radiative forcing. Climate feedbacks may increase (positive feedback) or diminish (negative feedback) the magnitude of the direct climate change.

Climate System (or Earth System): The atmosphere, the oceans, the biosphere, the cryosphere, and the geosphere, together make up the climate system.

Combustion: Chemical oxidation accompanied by the generation of light and heat.

Concentration: Amount of a chemical in a particular volume or weight of air, water, soil, or other medium.

Criteria Pollutant: A pollutant determined to be hazardous to human health and regulated under EPA's National Ambient Air Quality Standards. The 1970 amendments to the Clean Air Act require EPA to describe the health and welfare impacts of a pollutant as the "criteria" for inclusion in the regulatory regime. In this report, emissions of the criteria pollutants are carbon monoxide (CO), nitrogen oxides (NOx), volatile organic compounds (VOCs), and sulfur oxides (SOx).

Distillate Fuel Oil: A general classification for the petroleum fractions produced in conventional distillation operations. Included are products known as No. 1, No. 2, and No. 4 fuel oils and No. 1, No. 2, and No. 4 diesel fuels. Used primarily for space heating, on and off-highway diesel engine fuel (including railroad engine fuel and fuel for agricultural machinery), and electric power generation.

Emission Factor: The rate at which pollutants are emitted into the atmosphere by one source or a combination of sources.

Emission Inventory: A list of air pollutants emitted into a community's, state's, nation's, or the Earth's atmosphere in amounts per some unit time (e.g. day or year) by type of source. An emission inventory has both political and scientific applications.

Emissions: Releases of gases to the atmosphere (e.g., the release of carbon dioxide during fuel combustion). Emissions can be either intended or unintended releases.

Energy Quality: Ability of a form of energy to do useful work. High-temperature heat and the chemical energy in fossil fuels and nuclear fuels are concentrated high quality energy. Low quality energy such as low-temperature heat is dispersed or diluted and cannot do much useful work.\

Energy: The capacity for doing work as measured by the capability of doing work (potential energy) or the conversion of this capability to motion (kinetic energy). Energy has several forms, some of which are easily convertible and can be changed to another form useful for work. Most of the world's convertible energy comes from fossil fuels that are burned to produce heat that is then used as a transfer medium to mechanical or other means in order to accomplish tasks. In the United States, electrical energy is often measured in kilowatt-hours (kWh),while heat energy is often measured in British thermal units (Btu).

Energy-Efficiency: The ratio of the useful output of services from an article of industrial equipment to the energy use by such an article; for example, vehicle miles traveled per gallon of fuel (mpg).

Enhanced Greenhouse Effect: The concept that the natural greenhouse effect has been enhanced by anthropogenic emissions of greenhouse gases. Increased concentrations of carbon dioxide, methane, and nitrous oxide, CFCs, HFCs, PFCs, SF6, NF3, and other photochemically important gases caused by human activities such as fossil fuel consumption, trap more infra-red radiation, thereby exerting a warming influence on the climate.

Enplanements: The number of passengers on departing aircraft.

Ethanol (C2H5OH): Otherwise known as ethyl alcohol, alcohol, or grain spirit. A clear, colorless, flammable oxygenated hydrocarbon with a boiling point of 78.5 degrees Celsius in the anhydrous state. In transportation, ethanol is used as a vehicle fuel by itself (E100), blended with gasoline (E85), or as a gasoline octane enhancer and oxygenate (10 percent concentration).

FAA ASDi (Aircraft Situation Display to Industry): This represents data collected by the FAA that tracks the minute-by-minute progress of their aircraft in real-time. The ASDI information includes the location, altitude, airspeed, destination, estimated time of arrival and tail number or designated identifier of air carrier and general aviation aircraft operating on IFR flight plans within U.S. airspace.

Fixed Based Operator (FBO): A private operator that may conduct refueling, aircraft or ground support equipment services for others at the airport.

Fluorocarbons: Carbon-fluorine compounds that often contain other elements such as hydrogen, chlorine, or bromine. Common fluorocarbons include chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), hydrofluorocarbons (HFCs), and perfluorocarbons (PFCs).

Forest: Terrestrial ecosystem (biome) with enough average annual precipitation (at least 76 centimeters or 30 inches) to support growth of various species of trees and smaller forms of vegetation.

Fossil Fuel: A general term for buried combustible geologic deposits of organic materials, formed from decayed plants and animals that have been converted to crude oil, coal, natural gas, or heavy oils by exposure to heat and pressure in the Earth's crust over hundreds of millions of years.

Fossil Fuel Combustion: Burning of coal, oil (including gasoline), or natural gas. The burning needed to generate energy release carbon dioxide by-products that can include unburned hydrocarbons, methane, and carbon monoxide. Carbon monoxide, methane, and many of the unburned hydrocarbons slowly oxidize into carbon dioxide in the atmosphere. Common sources of fossil fuel combustion include cars and electric utilities.

General Aviation: That portion of civil aviation, which encompasses all facets of aviation except air carriers. It includes any air taxis, commuter air carriers, and air travel clubs, which do not hold Certificates of Public Convenience and Necessity.

Geothermal Energy: Heat transferred from the Earth's molten core to underground deposits of dry steam (steam with no water droplets), wet steam (a mixture of steam and water droplets), hot water, or rocks lying fairly close to the Earth's surface.

Global Warming Potential (GWP): The index used to translate the level of emissions of various gases into a common measure in order to compare the relative radiative forcing of different gases without directly calculating the changes in atmospheric concentrations. GWPs are calculated as the ratio of the radiative forcing that would result from the emissions of one kilogram of a greenhouse gas to that from the emission of one kilogram of carbon dioxide over a period of time (usually 100 years). Gases involved in complex atmospheric chemical processes have not been assigned GWPs.

Global Warming: The progressive gradual rise of the Earth's surface temperature thought to be caused by the greenhouse effect and responsible for changes in global climate patterns.

Greenhouse Effect: Trapping and build-up of heat in the atmosphere (troposphere) near the Earth's surface. Some of the heat flowing back toward space from the Earth's surface is absorbed by water vapor, carbon dioxide, ozone, and several other gases in the atmosphere and then reradiated back toward the Earth's surface. If the atmospheric concentrations of these greenhouse gases rise, the average temperature of the lower atmosphere will gradually increase.

Greenhouse Gas (GHG): Any gas that absorbs infrared radiation in the atmosphere. Greenhouse gases include, but are not limited to, water vapor, carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydrochlorofluorocarbons (HCFCs), ozone (O3), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF6).

Heat: Form of kinetic energy that flows from one body to another when there is a temperature difference between the two bodies. Heat always flows spontaneously from a hot sample of matter to a colder sample of matter. This is one way to state the second law of thermodynamics.

Hydrocarbons: Substances containing only hydrogen and carbon. Fossil fuels are made up of hydrocarbons.

Hydrochlorofluorocarbons (HCFCs): Compounds containing hydrogen, fluorine, chlorine, and carbon atoms. Although ozone depleting substances, they are less potent at destroying stratospheric ozone than chlorofluorocarbons (CFCs). They have been introduced as temporary replacements for CFCs and are also greenhouse gases.

Hydrofluorocarbons (HFCS): Compounds containing only hydrogen, fluorine, and carbon atoms. They were introduced as alternatives to ozone depleting substances in serving many industrial, commercial, and personal needs. HFCs are emitted as by-products of industrial processes and are also used in manufacturing. They do not significantly deplete the stratospheric ozone layer, but they are powerful greenhouse gases with global warming potentials ranging from 140 (HFC-152a) to 11,700 (HFC-23).

Hydropower: Electrical energy produced by falling or flowing water.

Infrared Radiation: The heat energy that is emitted from all solids, liquids, and gases. In the context of the greenhouse issue, the term refers to the heat energy emitted by the Earth's surface and its atmosphere. Greenhouse gases strongly absorb this radiation in the Earth's atmosphere, and re-radiate some of it back towards the surface, creating the greenhouse effect.

Inorganic Compound: Combination of two or more elements other than those used to form organic compounds.

Intergovernmental Panel On Climate Change (IPCC): The IPCC was established jointly by the United Nations Environment Programme and the World Meteorological Organization in 1988. The purpose of the IPCC is to assess information in the scientific and technical literature related to all significant components of the issue of climate change. The IPCC draws upon hundreds of the world's expert scientists as authors and thousands as expert reviewers. Leading experts on climate change and environmental, social, and economic sciences from some 60 nations have helped the IPCC to prepare periodic assessments of the scientific underpinnings for understanding global climate change and its consequences. With its capacity for reporting on climate change, its consequences, and the viability of adaptation and mitigation measures, the IPCC is also looked to as the official advisory body to the world's governments on the state of the science of the climate change issue. For example, the IPCC organized the development of internationally accepted methods for conducting national greenhouse gas emission inventories.

International Council for Local Environmental Initiatives (ICLEI): http:/www.iclei.org/ is an international association of local governments and national and regional local government organizations that have made a commitment to sustainable development. More than 630 cities, towns, counties, and their associations worldwide comprise ICLEI's growing membership. ICLEI works with these and hundreds of other local governments through international performance-based, results-oriented campaigns and programs. The ICLEI Cities for Climate Protection (CCP) Campaign assists cities to adopt policies and implement quantifiable measures to reduce local greenhouse gas emissions, improve air quality, and enhance urban livability and sustainability. More than 800 local governments participate in the CCP, integrating climate change mitigation into their decision-making processes. http://www.iclei.org/index.php?id=800

Jet Fuel: Includes both naphtha-type and kerosene-type fuels meeting standards for use in aircraft turbine engines. Although most jet fuel is used in aircraft, some is used for other purposes such as generating electricity.

Kerosene: A petroleum distillate that has a maximum distillation temperature of 401 degrees Fahrenheit at the 10 percent recovery point, a final boiling point of 572 degrees Fahrenheit, and a minimum flash point of 100 degrees Fahrenheit. Used in space heaters, cookstoves, and water heaters, and suitable for use as an illuminant when burned in wick lamps.

Kyoto Protocol: An international agreement struck by nations attending the Third Conference of Parties (COP) to the United Nations Framework Convention on Climate Change (held in December of 1997 in Kyoto, Japan) to reduce worldwide emissions of greenhouse gases. If ratified and put into force, individual countries have committed to reduce their greenhouse gas emissions by a specified amount.

Landing and Takeoff Cycle (LTO): LTO refers to an aircraft's landing and takeoff (LTO) cycle. One aircraft LTO is equivalent to two aircraft operations (one landing and one takeoff). The standard LTO cycle begins when the aircraft crosses into the mixing zone as it approaches the airport on its descent from cruising altitude, lands and taxis to the gate. The cycle continues as the aircraft taxis back out to the runway for takeoff and climbout as its heads out of the mixing zone and back up to cruising altitude. The five specific operating modes in a standard LTO are: approach, taxi/idle-in, taxi/idle-out, takeoff, and climbout. Most aircraft go through this sequence during a complete standard operating cycle.

Lifetime (Atmospheric): The lifetime of a greenhouse gas refers to the approximate amount of time it would take for the anthropogenic increment to an atmospheric pollutant concentration to return to its natural level (assuming emissions cease) as a result of either being converted to another chemical compound or being taken out of the atmosphere via a sink. This time depends on the pollutant's sources and sinks as well as its reactivity. The lifetime of a pollutant is often considered in conjunction with the mixing of pollutants in the atmosphere; a long lifetime will allow the pollutant to mix throughout the atmosphere. Average lifetimes can vary from about a week (e.g., sulfate aerosols) to more than a century (e.g., CFCs, carbon dioxide).

Liquefied Natural Gas (LNG): Natural gas converted to liquid form by cooling to a very low temperature.

Liquefied Petroleum Gas (LPG): Ethane, ethylene, propane, propylene, normal butane, butylene, and isobutane produced at refineries or natural gas processing plants, including plants that fractionate new natural gas plant liquids.

Methane (CH4): A hydrocarbon that is a greenhouse gas with a global warming potential most recently estimated at 21. Methane is produced through anaerobic (without oxygen) decomposition of waste in landfills, animal digestion, decomposition of animal wastes, production and distribution of natural gas and petroleum, coal production, and incomplete fossil fuel combustion. The atmospheric concentration of methane has been shown to be increasing at a rate of about 0.6 percent per year and the concentration of about 1.7 per million by volume (ppmv) is more than twice its pre-industrial value. However, the rate of increase of methane in the atmosphere may be stabilizing.

Metric Ton: Common international measurement for the quantity of greenhouse gas emissions. A metric ton is equal to 1,000 kilograms, 2,204.6 pounds, or 1.1023 short tons.

Mobile Source: A moving vehicle that emits pollutants. Such sources include airplanes, cars, trucks and ground support equipment.

Montreal Protocol on Substances that Deplete the Ozone Layer: The Montreal Protocol and its amendments control the phase-out of ozone depleting substances production and use. Under the Protocol, several international organizations report on the science of ozone depletion, implement projects to help move away from ozone depleting substances, and provide a forum for policy discussions. In the United States, the Protocol is implemented under the rubric of the Clean Air Act Amendments of 1990.

Motor Gasoline: A complex mixture of relatively volatile hydrocarbons, with or without small quantities of additives, obtained by blending appropriate refinery streams to form a fuel suitable for use in spark-ignition engines. Motor gasoline includes both leaded and unleaded grades of finished gasoline, blending components, and gasohol.

Natural Gas: Underground deposits of gases consisting of 50 to 90 percent methane (CH_4) and small amounts of heavier gaseous hydrocarbon compounds such as propane (C_3H_4) and butane (C_4H_{10}).

Nitrogen Oxides (NO_x): Gases consisting of one molecule of nitrogen and varying numbers of oxygen molecules. Nitrogen oxides are produced, for example, by the combustion of fossil fuels in vehicles and electric power plants. In the atmosphere, nitrogen oxides can contribute to formation of photochemical ozone (smog), impair visibility, and have health consequences; they are considered pollutants.

Nitrous Oxide (N_2O): A powerful greenhouse gas with a global warming potential most recently evaluated at 310. Major sources of nitrous oxide include soil cultivation practices, especially the use of commercial and organic fertilizers, fossil fuel combustion, nitric acid production, and biomass burning.

Non-Methane Volatile Organic Compounds (NMVOCs): Organic compounds, other than methane, that participate in atmospheric photochemical reactions.

Organic Compound: Molecule that contains atoms of the element carbon, usually combined with itself and with atoms of one or more other element such as hydrogen, oxygen, nitrogen, sulfur, phosphorus, chlorine, or fluorine.

Oxidize: To chemically transform a substance by combining it with oxygen.

Ozone: A colorless gas with a pungent odor, having the molecular form of O3, found in two layers of the atmosphere, the stratosphere and the troposphere. Ozone is a form of oxygen found naturally in the stratosphere that provides a protective layer shielding the Earth from ultraviolet radiation's harmful health effects on humans and the environment. In the troposphere, ozone is a chemical oxidant and major component of photochemical smog. Ozone can seriously affect the human respiratory system.

Ozone Depleting Substance (ODS): A family of man-made compounds that includes, but is not limited to, chlorofluorocarbons (CFCs), bromofluorocarbons (halons), methyl chloroform, carbon tetrachloride, methyl bromide, and hydrochlorofluorocarbons (HCFCs). These compounds have been shown to deplete stratospheric ozone, and therefore are typically referred to as ODSs.

Ozone Layer: Layer of gaseous ozone (O_3) in the stratosphere that protects life on Earth by filtering out harmful ultraviolet radiation from the sun.

Particulate Matter (PM): Solid particles or liquid droplets suspended or carried in the air.

Parts Per Million (ppm): Number of parts of a chemical found in one million parts of a particular gas, liquid, or solid.

Perfluorocarbons (PFCs): A group of human-made chemicals composed of carbon and fluorine only. These chemicals (predominantly CF_4 and C_2F_6) were introduced as alternatives, along with hydrofluorocarbons, to the ozone-depleting substances. In addition, PFCs are emitted as by-products of industrial processes and are also used in manufacturing. PFCs do not harm the stratospheric ozone layer, but they are powerful greenhouse gases: CF_4 has a global warming potential (GWP) of 6,500 and C_2F_6 has a GWP of 9,200.

Pollution: A change in the physical, chemical, or biological characteristics of the air, water, or soil that can affect the health, survival, or activities of humans in an unwanted way. Some expand the term to include harmful effects on all forms of life.

Radiation: Energy emitted in the form of electromagnetic waves. Radiation has differing characteristics depending upon the wavelength. Because the radiation from the Sun is relatively energetic, it has a short wavelength (e.g., ultraviolet, visible, and near infrared) while energy re-radiated from the Earth's surface and the atmosphere has a longer wavelength (e.g., infrared radiation) because the Earth is cooler than the Sun.

Radiative Forcing: A change in the balance between incoming solar radiation and outgoing infrared (i.e., thermal) radiation. Without any radiative forcing, solar radiation coming to the Earth would continue to be approximately equal to the infrared radiation emitted from the Earth. The addition of greenhouse gases to the atmosphere traps an increased fraction of the infrared radiation, reradiating it back toward the surface of the Earth and thereby creates a warming influence.

Recycling: Collecting and reprocessing a resource so it can be used again. An example is collecting aluminum cans, melting them down, and using the aluminum to make new cans or other aluminum products.

Renewable Energy: Energy obtained from sources that are essentially inexhaustible, unlike, for example, fossil fuels, of which there is a finite supply. Renewable sources of energy include wood, waste, geothermal, wind, photovoltaic, and solar thermal energy.

Sector: Division, most commonly used to denote type of energy consumer (e.g., residential) or according to the Intergovernmental Panel on Climate Change, the type of greenhouse gas emitter (e.g., industrial process).

Short Ton: Common measurement for a ton in the United States. A short ton is equal to 2,000 lbs. or 0.907 metric tons.

Sink: A reservoir that uptakes a pollutant from another part of its cycle. Soil and trees tend to act as natural sinks for carbon.

Solar Radiation: Energy from the Sun. Also referred to as short-wave radiation. Of importance to the climate system, solar radiation includes ultra-violet radiation, visible radiation, and infrared radiation.

Source: Any process or activity that releases a greenhouse gas, an aerosol, or a precursor of a greenhouse gas into the atmosphere.

Stratosphere: Second layer of the atmosphere, extending from about 19 to 48 kilometers (12 to 30 miles) above the Earth's surface. It contains small amounts of gaseous ozone (O3), which filters out about 99 percent of the incoming harmful ultraviolet (UV) radiation. Most commercial airline flights operate at a cruising altitude in the lower stratosphere.

Stratospheric Ozone: See **Ozone Layer**.

Sulfur Dioxide (SO_2): A compound composed of one sulfur and two oxygen molecules. Sulfur dioxide emitted into the atmosphere through natural and anthropogenic processes is changed in a complex series of chemical reactions in the atmosphere to sulfate aerosols. These aerosols are believed to result in negative radiative forcing (i.e., tending to cool the Earth's surface) and do result in acid deposition (e.g., acid rain).

Sulfur Hexafluoride (SF_6): A colorless gas soluble in alcohol and ether, slightly soluble in water. A very powerful greenhouse gas used primarily in electrical transmission and distribution systems and as a dielectric in electronics. The global warming potential of SF_6 is 23,900.

Temperature: Measure of the average speed of motion of the atoms or molecules in a substance or combination of substances at a given moment.

Terrestrial: Pertaining to land.

Terrestrial Radiation: The total infrared radiation emitted by the Earth and its atmosphere in the temperature range of approximately 200 to 300 Kelvin. Terrestrial radiation provides a major part of the potential energy changes necessary to drive the atmospheric wind system and is responsible for maintaining the surface air temperature within limits of livability.

Troposphere: The lowest layer of the atmosphere and contains about 95 percent of the mass of air in the Earth's atmosphere. The troposphere extends from the Earth's surface up to about 10 to 15 kilometers. All weather processes take place in the troposphere. Ozone that is formed in the troposphere plays a significant role in both the greenhouse gas effect and urban smog.

Ultraviolet Radiation (UV): A portion of the electromagnetic spectrum with wavelengths shorter than visible light. The sun produces UV, which is commonly split into three bands of decreasing wavelength. Shorter wavelength radiation has a greater potential to cause biological damage on living organisms. The longer wavelength ultraviolet band, UVA, is not absorbed by ozone in the atmosphere. UVB is mostly absorbed by ozone, although some reaches the Earth. The shortest wavelength band, UVC, is completely absorbed by ozone and normal oxygen in the atmosphere.

United Nations Framework Convention on Climate Change (UNFCCC): The international treaty unveiled at the United Nations Conference on Environment and Development (UNCED) in June, 1992. The UNFCCC commits signatory countries to stabilize anthropogenic (i.e., human-induced) greenhouse gas emissions to "levels that would prevent dangerous anthropogenic interference with the climate system". The UNFCCC also requires that all signatory parties develop and update national inventories of anthropogenic emissions of all greenhouse gases not otherwise controlled by the Montreal Protocol. http://www.ipcc.ch/

Vehicle Miles Traveled (VMT): One vehicle traveling the distance of one mile. Thus, total vehicle miles is the total mileage traveled by all vehicles.

Volatile Organic Compounds (VOCs): Organic compounds that evaporate readily into the atmosphere at normal temperatures. VOCs contribute significantly to photochemical smog production and certain health problems.

Water Vapor: The most abundant greenhouse gas; it is the water present in the atmosphere in gaseous form. Water vapor is an important part of the natural greenhouse effect. While humans are not significantly increasing its concentration, it contributes to the enhanced greenhouse effect because the warming influence of greenhouse gases leads to a positive water vapor feedback. In addition to its role as a natural greenhouse gas, water vapor plays an important role in regulating the temperature of the planet because clouds form when excess water vapor in the atmosphere condenses to form ice and water droplets and precipitation.

Weather: Weather is the specific condition of the atmosphere at a particular place and time. It is measured in terms of such things as wind, temperature, humidity, atmospheric pressure, cloudiness, and precipitation. In most places, weather can change from hour-to-hour, day-to-day, and season-to-season. Climate is the average of weather over time and space. A simple way of remembering the difference is that climate is what you expect (e.g. cold winters) and 'weather' is what you get (e.g. a blizzard).

World Resource Institute (WRI): The World Resources Institute (WRI) is an environmental think tank. WRI, in combination with the World Business Council for Sustainable Development published guidance in 2005 concerning the development of greenhouse gas inventories. www.wri.org

References

Airport Carbon Accreditation https://www.airportcarbonaccreditation.org/

Airport Cooperative Research Program (ACRP) Report 11 *Guidebook on Preparing Airport Greenhouse Gas Inventories*, 2009. http://www.trb.org/Publications/Blurbs/160829.aspx

Center for Climate Strategies, *Final Colorado Greenhouse Gas Inventory and Reference Case Projections 1990-2020*, October 2007. Available at http://www.coloradoclimate.org/ewebeditpro/items/O14F13894.pdf

Energy Information Administration (EIA). *Emissions of Greenhouse Gases in the United States 2005*. Office of the Integrated Analysis and Forecasting, U.S. Department of Energy. DOE/EIA-0573(2005). Washington, DC. November 2017.

FAA. *Aviation & Emissions: A Primer,* Office of Environment and Energy, January 2005.

Intergovernmental Panel on Climate Change (IPCC). *2017 IPCC Guidelines for National Greenhouse Gas Inventories.* Volume 2, Energy. Chapter 3, Mobile Combustion. Section 3.6, Civil Aviation. 2017.

Intergovernmental Panel on Climate Change (IPCC). *Aviation and The Global Atmosphere*, Chapter 8.3.3 "Intermodality". 1999

International Council for Local Environmental Initiatives (ICLEI), http://www.iclei.org

US Department of Energy; *Transportation Energy Data Book: Edition 37* **;** Oak Ridge National Laboratory, January 2019.

US Environmental Protection Agency (USEPA). *Methods for Estimating Methane and Nitrous Oxide Emissions From Mobile Combustion.* EPA 430-R-07-002. Washington, DC. August 2004.

US General Accounting Office. *Aviation and The Environment: Aviation's Effect on the Global Atmosphere Are Potentially Significant and Expected to Grow,* Report to the Honorable James L. Oberstar, Ranking Democratic Member, Committee on Transportation and Infrastructure, House of Representatives, February 2000.

World Resource Institute (WRI), *The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard: Revised Edition*, 2004

World Resource Institute (WRI), *The Greenhouse Gas Protocol: The GHG Protocol for Project Accounting*, 2004

Appendix B

Friedman Memorial Airport Greenhouse Gas Calculations

Values from ACRP Report 11

Emission Factors			
CO2 Emission Factors	Jet A Fuel Avgas	21.095 18.355	lbs CO2/gallon lbs CO2/gallon
CH4 Emission Factors	Jet A Fuel Avgas	0.27 7.04	g CH4/gal g CH4/gal
N2O Emission Factors	Jet A Fuel Avgas	0.21 0.11	g N2O/gal g N2O/gal
Conversion Constants			
Convert to metric tons	pounds grams	0.000454 0.000001	metric ton/lbs metric ton/g
Convert to gallons	Jet A Fuel Avgas	6.84 6	lbs/gal lbs/gal

Aircraft Emissions

2020	Jet A	Avgas	Metric tons CO2		CO2 Equivalent
Airport Data (gallons)	***2,045,175***	***54,437***	**Jet A**	**AvGas**	
CO2 Emissions (lbs)	43,967,891.9	997,495.9	19,943.84	452.46	20,396.30
CH4 Emissions (grams)	0.0	384,325.2	0	0.38432522	9.61
N2O Emissions (grams)	613,552.5	5,988.1	0.6135525	0.00598807	184.62
				Total	**20,590.531**

Values from ACRP Report 11

Motor gasoline	19.37	lbs CO2/gal
Diesel	22.46	lbs CO2/gal

100-year GWPs from IPCC Fourth Assessment Report

Pollutant	GWP100
CO2 Equivalent (ACRP 11)	1
CH4	25
N2O	298
SF6	22,800

Airline Ground Support Equipment (gallons of diesel)

2020	SkyWest	Alaska	Total
Airport Data (gallons)	2,400	600	
CO2 Emissions (lbs)	53,901.3	13,475.3	
CO2 Emissions (metric tons)	24.450	6.112	30.562

Airport Ground Support Equipment

2020	Gasoline	Diesel	Total
Airport Data (gallons)	1,436.9	9,638.7	
CO2 Emissions (lbs)	27829.21845	216474.4136	
CO2 Emissions (metric tons)	12.623	98.193	110.816

Conversion Factors for Energy

Steam and Heat		
CO2 Factor	66.33	kg/mmBtu
CH4 Factor	1.25	g/mmBtu
N2O Factor	0.125	g/mmBtu
Values from ACRP Report 11		
Convert kWh to MWh	0.001	kWh/MWh
Convert therm to mmBTU	0.1	Therms/mmBTU
Convert to Metric tons	0.0004536	metric ton/lbs
	0.001	metric ton/kg
	1.00E-06	metric ton/g

	Therms	Convert to mmBTu	
Intermountain Gas	34,425	3442.5	
	Emissions	**Metric tons**	**CO2 Equiv (metric tons)**
CO2 Factor (kg)	228,341.03	228.34	228.34
CH4 Factor (g)	4,303.13	0.00	0.11
N2O Factor (g)	430.31	0.00	0.13
Total			**228.58**

	kWh	Convert to MWh
Airport Energy Use	1,182,867	1182.867
	Emissions (lbs)	**Emissions (metric tons)**
CO2	845,986.48	383.7
CH4	80.43	0.04
N2O	11.83	0.01
Total	**846,078.7**	**383.8**

Rental Car Travel

Assumed rental contracts days	6
Avg distance/rental contract	85

Employee Commute Data			
Zip Code	**VMT**	**Employees**	**Weight**
83301	70	1	0.93%
83313	7	19	17.87%
83320	27	3	3.05%
83327	40	5	4.92%
83333	5	67	62.20%
83213	70	2	1.87%
83338	58	2	2.12%
83340	16	2	1.99%
83349	45	1	0.93%
83352	41	4	4.11%
Weighted Avg	12.77040498		Check
Vehicle Type	**Owned**	**Percentage**	
SUV	30	24.5%	
Truck	27	21.8%	
Car	66	53.8%	

	Hertz	Avis/Budget	Enterprise
Number of Cars	100	100	80
Rental Days	27,099	15,000	27,985
Rental Contracts	4,517	2,500	4,664
SUV	70%	60%	70%
Truck	5%	0%	7%
Car	25%	40%	23%
Total Rental Miles	383,902.50	212,500.00	396,454.17
SUV Miles	268731.75	127500.00	277510.83
Truck Miles	19195.13	0.00	27738.33
Car Miles	95975.63	85000.00	91205.00
SUV Fuel Consumption (gal)	11291.25	5357.14	11660.12
Truck Fuel Consumption (gal)	999.75	0.00	1444.70
Car Fuel Consumption (gal)	3027.62	2681.39	2877.13
SUV Emissions (CO2 lbs/gal)	218,683.74	103,754.68	225,827.82
Truck Emissions (CO2 lbs/gal)	19,362.62	-	27,980.38
Car Emissions (CO2 lbs/gal)	58,637.60	51,931.89	55,722.92
Total Emissions (CO2 lbs/gal)	296,683.96	155,686.57	309,531.12
Total Emissions (metric tons)	134.58	70.62	140.40
Total	**345.60**		

Calendar Year	2020	2019	% Change
Enplanements	47,590	91,485	-48.0%
Passengers (Enplanements x 2)	95,180	182,970	-48.0%
Operations	24,067	24,577	-2.1%

Passenger Vehicle Travel

Enplanements (2020)	47,590
Total Passengers (2020)	95,180
Total Pax minus rental pax	86,147
Passenger Parties	43,074
Assumed Average Travel Distance	12.77
Passengers per party	2

On Airport			
	SUV	Truck	Car
Vehicles	10,539	9,374	23,161
MPG	23.8	19.2	31.7
Miles Traveled	7,377.22	6,561.65	16,212.58
Fuel Consumption (gal)	309.97	341.75	511.44
Emissions (CO2 lbs/gal)	6,003.30	6,618.90	9,905.29
Emissions (metric tons)	2.72	3.00	4.49
Total	**10.22**		
Off Airport			
Miles Traveled	127,208.61	113,145.35	279,560.63
Fuel Consumption (gal)	5,344.90	5,892.99	8,818.95
Emissions (CO2 lbs/gal)	103,517.56	114,132.66	170,801.32
Emissions (metric tons)	46.96	51.77	77.48
Total	**176.20**		

Airport/Tenant/Airline/Operator Employee Commute

			52 weeks/year		% Owned
Airport Employees	**# Employees**	**Trips/Week**	**Annual Trips**	SUV	18%
Full Time (5 Days)	12	120	6,240	Truck	59%
Part Time (2 Days)	5	20	1,040	Car	24%
Total			7,280		
Home Zip Code	**VMT/Trip**	**% Employees**	**# Trips/Year by Emp**	**Total VMT by Zip**	
83333	5	47%	3,426	17,129	
83313	7	35%	2,569	17,986	
83327	40	12%	856	34,259	
83320	27	6%	428	11,562	
Total			7,280	80,936	
EPA Vehicle Type	**VMT by Vehicle**	**Fuel Consumption**	**Emissions (lbs)**	**Emissions (tons)**	
Truck SUV	14,283	600	11,623	5	
Pickup	47,610	2,480	48,025	22	

Sedan/Wagon	19,044	601	11,635	5	
Total	80,936	3,681	71,283	**32**	

					% Owned
Skywest	**# Employees**	**Trips/Week**	**Annual Trips**	SUV	15%
Full Time (5 Days)	6	60	3,120	Truck	15%
Part Time (2 Days)	33	132	6,864	Car	70%
Total			9,984		
Home Zip Code	**VMT/Trip**	**% Employees**	**# Trips/Year by Emp**	**Total VMT by Zip**	
83333	5	85%	8,486	42,432	
83313	7	15%	1,498	10,483	
Total			9,984	52,915	
EPA Vehicle Type	**VMT by Vehicle**	**Fuel Consumption**	**Emissions (lbs)**	**Emissions (tons)**	
Truck SUV	7,937	333	6,459	3	
Pickup	7,937	413	8,007	4	
Sedan/Wagon	37,041	1,168	22,630	10	
Total	52,915	1,915	37,096	**17**	

					% Owned
Alaska	**# Employees**	**Trips/Week**	**Annual Trips**	SUV	20%
Full Time (5 Days)	1	10	520	Truck	0%
Part Time (3 Days)	9	54	2,808	Car	80%
Total			3,328		
Home Zip Code	**VMT/Trip**	**% Employees**	**# Trips/Year by Emp**	**Total VMT by Zip**	
83333	5	60%	1,997	9,984	
83313	7	10%	333	2,330	
83340	16	10%	333	5,325	
83327	40	10%	333	13,312	
83301	70	10%	333	23,296	
Total			3,328	54,246	
EPA Vehicle Type	**VMT by Vehicle**	**Fuel Consumption**	**Emissions (lbs)**	**Emissions (tons)**	
Truck SUV	10,849	456	8,829	4	
Pickup	0	0	0	0	
Sedan/Wagon	43,397	1,369	26,514	12	
Total	54,246	1,825	35,343	**16**	

					% Owned
TSA	**# Employees**	**Trips/Week**	**Annual Trips**	SUV	0%
Full Time (5 Days)	16	160	8,320	Truck	10%
Part Time (2 Days)	1	4	208	Car	90%
Total			8,528		
Home Zip Code	**VMT/Trip**	**% Employees**	**# Trips/Year by Emp**	**Total VMT by Zip**	
83333	5	20%	1,706	8,528	
83313	7	13%	1,137	7,959	
83340	16	7%	569	9,097	
83320	27	13%	1,137	30,701	
83327	40	13%	1,137	45,483	
83352	41	20%	1,706	69,930	
83338	58	13%	1,137	65,950	
Total			8,528	221,159	
EPA Vehicle Type	**VMT by Vehicle**	**Fuel Consumption**	**Emissions (lbs)**	**Emissions (tons)**	
Truck SUV	0	0	0	0	
Pickup	22,116	1,152	22,309	10	
Sedan/Wagon	199,044	6,279	121,608	55	
Total	221,159	7,431	143,917	**65**	

					% Owned
Car Park	**# Employees**	**Trips/Week**	**Annual Trips**	SUV	0%
Full Time (5 Days)	1	10	520	Truck	50%
Part Time (1 Days)	1	2	104	Car	50%
Total			624		
Home Zip Code	**VMT/Trip**	**% Employees**	**# Trips/Year by Emp**	**Total VMT by Zip**	
83333	5	50%	312	1,560	
83313	7	50%	312	2,184	
			624	3,744	
EPA Vehicle Type	**VMT by Vehicle**	**Fuel Consumption**	**Emissions (lbs)**	**Emissions (tons)**	
Truck SUV	0	0	0	0	
Pickup	1,872	98	1,888	1	
Sedan/Wagon	1,872	59	1,144	1	
Total	3,744	157	3,032	**1**	

					% Owned
Coffee House	**# Employees**	**Trips/Week**	**Annual Trips**	SUV	20%
Full Time (5 Days)	3	30	1,560	Truck	0%
Part Time (4 Days)	2	16	832	Car	80%
Total			2,392		
Home Zip Code	**VMT/Trip**	**% Employees**	**# Trips/Year by Emp**	**Total VMT by Zip**	
83333	5	100%	2,392	11,960	
			2,392	11,960	
EPA Vehicle Type	**VMT by Vehicle**	**Fuel Consumption**	**Emissions (lbs)**	**Emissions (tons)**	
Truck SUV	2,392	101	1,947	1	
Pickup	0	0	0	0	
Sedan/Wagon	9,568	302	5,846	3	
Total	11,960	402	7,792	**4**	

					% Owned
Hertz	**# Employees**	**Trips/Week**	**Annual Trips**	SUV	33%
Full Time (5 Days)	4	40	2,080	Truck	33%
Part Time (3 Days)	2	12	624	Car	33%
Total			2,704		
Home Zip Code	**VMT/Trip**	**% Employees**	**# Trips/Year by Emp**	**Total VMT by Zip**	
83333	5	33%	901	4,507	
83313	7	33%	901	6,309	
83349	45	17%	451	20,280	
83352	41	17%	451	18,477	
			2,704	49,573	
EPA Vehicle Type	**VMT by Vehicle**	**Fuel Consumption**	**Emissions (lbs)**	**Emissions (tons)**	
Truck SUV	16,524	694	13,447	6	
Pickup	16,524	861	16,669	8	
Sedan/Wagon	16,524	521	10,096	5	
Total	49,573	2,076	40,211	**18**	

					% Owned
Avis/Budget	**# Employees**	**Trips/Week**	**Annual Trips**	SUV	50%
Full Time (5 Days)	2	20	1,040	Truck	0%
Part Time (4 Days)	2	16	832	Car	50%
Total			1,872		
Home Zip Code	**VMT/Trip**	**% Employees**	**# Trips/Year by Emp**	**Total VMT by Zip**	
83333	5	75%	1,404	7,020	
83313	7	25%	468	3,276	
Total			1,872	10,296	
EPA Vehicle Type	**VMT by Vehicle**	**Fuel Consumption**	**Emissions (lbs)**	**Emissions (tons)**	
Truck SUV	5,148	216	4,189	2	
Pickup	0	0	0	0	
Sedan/Wagon	5,148	162	3,145	1	
Total	10,296	379	7,334	**3**	

					% Owned
Enterprise	**# Employees**	**Trips/Week**	**Annual Trips**	SUV	60%
Full Time (5 Days)	3	30	1,560	Truck	20%
Part Time (3 Days)	2	12	624	Car	20%
Total			2,184		
Home Zip Code	**VMT/Trip**	**% Employees**	**# Trips/Year by Emp**	**Total VMT by Zip**	
83333	5	100%	2,184	10,920	
Total			2,184	10,920	
EPA Vehicle Type	**VMT by Vehicle**	**Fuel Consumption**	**Emissions (lbs)**	**Emissions (tons)**	
Truck SUV	6,552	275	5,332	2	
Pickup	2,184	114	2,203	1	
Sedan/Wagon	2,184	69	1,334	1	
Total	10,920	458	8,869	**4**	

FBO VMT/Trip by Car and Zip Code				
Home Zip Code	**VMT/Trip**	**SUV**	**Pickup**	**Car**
83313	7	2	2	
83213	70		2	
83301	70			1
83320	27	1		
83333	5	8	1	
% Annual Trips by vehicle		**SUV**	**Pickup**	**Car**
83313		11.76%	11.76%	0.00%
83213		0.00%	11.76%	0.00%
83301		0.00%	0.00%	5.88%
83320		5.88%	0.00%	0.00%
83333		47.06%	5.88%	0.00%
# Trips/Year by Emp		**SUV**	**Pickup**	**Car**
83313		1040	1040	0
83213		0	1040	0
83301		0	0	520
83320		520	0	0
83333		4160	520	0
Total VMT by vehicle by Zip				
Zip Code	**VMT/Trip**	**SUV**	**Pickup**	**Car**
83313	7	7,280	7,280	0
83213	70	0	72,800	0
83301	70	0	0	36,400
83320	27	14,040	0	0
83333	5	20,800	2,600	0
EPA Vehicle Type	**VMT by Vehicle**	**Fuel Consumption**	**Emissions (lbs)**	**Emissions (tons)**
Truck SUV	42,120	1,770	34,276	16
Pickup	82,680	4,306	83,401	38
Sedan/Wagon	36,400	1,148	22,239	10
Total	161,200	7,224	139,916	**63**

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&Hunt