

2012 Greenhouse Gas Report

Minneapolis –St. Paul International Airport



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Prepared for:

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Executive Summary

The Metropolitan Airports Commission (MAC) was created by state law in 1943. A public corporation, the commission was designed to provide for coordinated aviation services throughout the Twin Cities metropolitan area. Today, the MAC operates one of the largest aviation systems in the nation, consisting of the Minneapolis-St. Paul International Airport (MSP) and six reliever airports. A board of commissioners appointed by Minnesota's governor and the mayors of Minneapolis and St. Paul sets and interprets the commission's policies. Those policies are implemented by the commission's executive director/CEO and staff.

Aviation is one of the most dynamic, challenging and economically vital industries in the nation. Careful strategic planning, coupled with vigorous, thorough performance, helps ensure people and businesses throughout the region have ready access to reliable air service. As articulated in the MAC's Strategic Plan, the MAC views environmental sustainability as an important organizational value while striving to "demonstrate leadership in sound environmental management."

Greenhouse gases (GHGs) and their effects are being discussed at international, national and local levels. While the body of knowledge continues to evolve and the impacts to the environment continue to be debated, a common emerging theme is to measure GHG emissions, evaluate targets for reduction and undertake reduction initiatives. In 2012, the MAC finalized the MSP 2020 Improvements Environmental Assessment/Environmental Assessment Worksheet (EA/EAW) comparing environmental consequences from alternatives associated with future development at the Minneapolis-St. Paul International Airport (MSP). The EA/EAW included a baseline GHG inventory for 2010 as well as GHG projections associated with alternative development scenarios. The GHG inventory presented in this report builds upon the inventory used as the baseline for the MSP 2020 Improvements EA/EAW.

In addition to completing the EA/EAW, the MAC has evaluated its potential to emit GHGs against the applicable thresholds as adopted by the Minnesota Pollution Control Agency (MPCA) as a result of the Tailoring Rule. Moreover, the United States Environmental Protection Agency (USEPA) Mandatory Reporting Rule for GHGs (40 CFR 98) has the most potential to apply specifically to the MAC-controlled GHG emissions at MSP. The Minnesota Next Generation Energy Act of 2007 may have an impact on MAC activities. This could take the form of additional energy efficiency requirements for state building codes, specification of low-carbon fuel standards or electric generating requirements that ultimately affect the MAC's gas and electric energy suppliers, or other requirements. Additional initiatives by the United States Government (USG) including the Next Generation Air Transportation System (NextGen) Plan and Federal Aviation Administration (FAA) Voluntary Airport Low Emissions (VALE) Program could provide incentives for projects and further development at MSP. Operational changes in addition to infrastructure improvements may have an impact on MAC planning and budget evaluations. These programs and changes have the potential to require additional initial capital outlay in order to access funding for projects with the

ability to reduce costs and emissions in the long-term. Because it is unclear as to exactly how the various GHG initiatives will eventually affect the MAC, ongoing monitoring of and/or participation in these developments is strongly recommended.

With the foregoing as a backdrop, the purpose of this Greenhouse Gas Report is to quantify the GHG emissions in terms of equivalents of carbon dioxide (CO₂e) associated with MAC activities and the activities of others operating at MSP for the year 2012, using the Airport Cooperative Research Program (ACRP) *Guidebook on Preparing Airport GHG Emissions Inventories* (2009), in order to track progress against the baseline while allowing for comparability to other major airports and MSP development options.

Measuring reductions will be useful for demonstrating environmental stewardship, and for demonstrating compliance with reduction goals, should such goals be established by regulatory agencies. This report also evaluates the important distinction between the GHG emissions at MSP that are associated with MAC-owned and MAC-controlled sources and those sources associated with airlines and other tenants, or the general public. This distinction will be critical in the future if regulations are promulgated.

To provide a snapshot of how the emissions have changed over time, the GHG emissions were calculated for 2012 and compared to 2005, 2007, 2009, 2010, and 2011. The analysis and results presented in this report should help MAC staff with planning and prioritizing future reduction initiatives. To provide credibility, the methodologies used in this study to quantify GHG emissions follow the ACRP protocols, which reference international, national and state organizations; published data; and sound engineering principles. The methodologies recommended by the ACRP establish consistency so that potential comparisons could be made to other airports. The approach to calculating GHG emissions recommended by the ACRP relies on methods and/or data published by the Intergovernmental Panel on Climate Change (IPCC), the USEPA, the World Resources Institute (WRI), the World Business Council for Sustainable Development (WBCSD), the International Council for Local Environmental Initiatives (ICLEI), and The Climate Registry.

The primary focus of this study was to determine the annual CO₂e emissions from MAC-owned and -controlled sources at MSP, with a geographic footprint, or total emissions based on geographic boundaries, as opposed to emissions from across an organization in different locations. As such, the geographic scope and related emission sources for purposes of this study are defined as the MSP property. The analysis determined the GHG emissions footprint for MSP as a whole, including the emissions from the airlines, tenants, and general public that use and travel to MSP. These other emission sources are not directly under MAC control, but may be influenced by MAC projects and jurisdictional responsibilities. For the overall MSP emissions, the study boundary was defined as the MSP property on the ground plus the airspace up to 3,000 feet above ground level (AGL). The analysis also quantified the emissions associated with vehicle traffic traveling to the airport and the overall aviation-related CO₂e emissions footprint, which determined the emissions based on the fuel combusted by aircraft and dispensed at MSP but released outside the MSP airspace. These boundaries are consistent with ACRP protocol.

Emissions from 2005, 2007, 2009, 2010, 2011, and 2012 are compared in the following table. It should be noted that emissions from 2005 through 2009 were regrouped from previous reports in order to maintain as much comparability among years where possible. An update in data availability and calculation methodology necessitated the revision to maintain comparability across years.

2005, 2007, 2009, 2010, 2011, and 2012 Total CO₂e Emissions from MSP

User/Source Category	Scope	2005 - Baseline (Metric Tons CO ₂ e)	2007 (Metric Tons CO ₂ e)	2009 (Metric Tons CO ₂ e)	2010 (Metric Tons CO ₂ e)	2011 (Metric Tons CO ₂ e)	2012 (Metric Tons CO ₂ e)	2007 % change from baseline	2009 % change from baseline	2010 % change from baseline	2011 % change from baseline	2012 % change from baseline
<i>Airport Operator Owned/Controlled</i>												
Stationary/Facilities - purchased power	2	5,573	5,413	5,993	7,281	7,155	7,056	-2.9%	7.5%	30.6%	28.4%	26.6%
Stationary/Facilities - combustion	1	4,989	4,350	3,442	3,445	3,671	2,946	-12.8%	-31.0%	-31.0%	-26.4%	-40.9%
Stationary/Facilities - other (refrigerants)	1	-	-	-	675	162	1,648	NA	NA	NA	NA	NA
Fleet	1	3,223	3,029	2,861	2,630	2,628	1,958	-6.0%	-11.2%	-18.4%	-18.5%	-39.3%
<i>subtotal</i>		<i>13,785</i>	<i>12,792</i>	<i>12,296</i>	<i>14,030</i>	<i>13,615</i>	<i>13,608</i>	<i>-7.2%</i>	<i>-10.8%</i>	<i>1.8%</i>	<i>-1.2%</i>	<i>-1.3%</i>
Ground Access Vehicles (public vehicles on Airport roads)	3	23,787	21,601	18,759	22,982	19,471	19,515	-9.2%	-21.1%	-3.4%	-18.1%	-18.0%
Total Airport Operator Owned/Controlled		37,573	34,393	31,055	37,012	33,086	33,123	-8.5%	-17.3%	-1.5%	-11.9%	-11.8%
<i>Airline, Aircraft Operator, or Tenant Owned/Controlled</i>												
Aircraft												
Ground (engine startup, taxi and reverse thrust)	3	132,499	111,824	108,013	163,670	202,613	187,809	-15.6%	-18.5%	23.5%	52.9%	41.7%
Ground to 3,000 ft (takeoff/climbout/approach)	3	276,805	246,696	219,723	205,536	206,450	203,058	-10.9%	-20.6%	-25.7%	-25.4%	-26.6%
Above 3,000 ft (residual/cruise/APU)	3	3,740,026	3,300,080	2,314,090	2,605,588	2,900,631	2,683,899	-11.8%	-38.1%	-30.3%	-22.4%	-28.2%
Aircraft Total	3	4,149,330	3,658,601	2,641,826	2,974,794	3,309,693	3,074,766	-11.8%	-36.3%	-28.3%	-20.2%	-25.9%
Ground Support Equipment	3	14,812	14,805	14,652	25,311	15,757	15,059	0.0%	-1.1%	70.9%	6.4%	1.7%
Ground Access Vehicles	3	See Notes	See Notes	See Notes	See Notes	See Notes	See Notes	NA	NA	NA	NA	NA
Stationary Sources/Facility Power	3	98,766	100,334	114,910	113,547	123,721	118,512	1.6%	16.3%	15.0%	25.3%	20.0%
Total Airline, Aircraft Operator, or Tenant Owned/Controlled		4,262,908	3,773,740	2,771,388	3,113,652	3,449,171	3,208,336	-11.5%	-35.0%	-27.0%	-19.1%	-24.7%
<i>Public Owned/Controlled</i>												
Total Public Owned/Controlled Total		-	-	-	46,506	-	-	NA	NA	NA	NA	NA
Total		4,300,481	3,808,133	2,802,443	3,197,170	3,482,257	3,241,459	-11.4%	-34.8%	-25.7%	-19.0%	-24.6%
Notes:												
<ul style="list-style-type: none"> Fleet emissions based on MAC diesel, gasoline, and E85 dispensed in 2012. 2011 electricity emissions updated based on recently published custom emission factor updates; therefore, emissions from electricity are revised from the 2011 GHG report. MAC Fleet, tenant ground access vehicles, and public vehicles on airport roads were grouped into Ground Access Vehicles based on the model needed for the EA. Changes in calculation methodology and scope are reflected in Ground Access Vehicles for all years as of 2012 inventory. Public-Owned/controlled emissions were collected and reported only for 2010. Data were developed for the MSP 2020 Improvements EA/EAW only and are shown in the summary table. 												

Consistent with airport activities and previous GHG reports, the main source of GHG emissions associated with MSP is fuel combustion from aircraft above 3,000 feet AGL. Though these emissions actually occur away from MSP, such as happens with international flights around the world, they are identified as a method to account for the fuel dispensed at MSP. Based on fuel dispensed at MSP, the overall footprint for aviation-related activities in 2012 was approximately 3.2 million metric tons CO₂e compared to 4.3 million metric tons CO₂e in 2005. A few drivers accounted for the 25 percent reduction:

- Reduced flight operations
- Change in fleet mix
- Increased fuel efficiency in engines
- Increased flight operational efficiency (passengers/flight)
- Change in taxi times and single-engine taxi methodology

As a percentage of the overall aviation CO₂e footprint associated with MSP, the MAC contribution is one percent. For comparison, the Port of Seattle Aviation Division, which is responsible for managing the Seattle-Tacoma Airport (Sea-Tac), reported its 2006 CO₂ emissions as 1.4 percent of the overall CO₂ emissions from Sea-Tac. While Sea-Tac does not have data for all airport operations for more recent years, the Sea-Tac airport operator emissions, those equivalent to MAC emissions, are updated through 2009. The Sea-Tac emissions for 2009 were 43,347 metric tons. Additionally, Philadelphia International Airport (PHL) completed a GHG emissions inventory for 2009. In the inventory, PHL showed emissions of 4.7 million metric tons CO₂e with 87 percent of the total resulting from aircraft fuel consumption. PHL Airport-owned and -controlled sources contributed 4.5 percent to the total despite comparable but fewer passengers than MSP (The Environmental Consulting Group, 2009). PHL stationary combustion and purchased power contributes significantly more emissions to its footprint when compared to the MAC.

The MAC appears to be comparable or more efficient than other similar airports in terms of its direct-controlled GHG emissions. This enables a better understanding of the sources contributing to the MAC-controlled GHG footprint at MSP and helps to identify future opportunities for initiatives and projects that may result in GHG emissions reductions.

Emissions in calendar year 2010 increased significantly when compared to 2009. The 2010 increase was driven by several factors that included increased aircraft operations, emission modeling updates, and changes in weather patterns. Aircraft operations are the largest factor in overall MSP emissions. Consequently, the operations increase in 2010 was the primary driver of increased emissions. Additionally, updated aircraft taxi data from Delta resulted in a reduction in modeled aircraft single-engine taxi time in 2010.

Excluding ground access vehicles, the MAC-controlled GHG emissions for 2012 were determined to be 13,608 metric tons CO₂e. This total accounts for Scope 1 direct emissions from the MAC and Scope 2 indirect emissions from the MAC. Using the ACRP-defined airport operator/owner category which incorporates Scope 3, MAC-controlled GHG emissions in 2012 totaled 33,123 metric tons CO₂e. This category is important because if GHG reductions are someday mandated, the MAC should be held accountable only for the emissions over which it has direct control.

Within the aircraft category subsets, a total reduction in emissions for aircraft on the ground and

below 3,000 feet AGL occurred from 2005 to 2012. Comparing the 2012 aircraft landing-takeoff (LTO) cycle data to 2005 LTO cycle data, emissions during all LTO cycle segments except taxi were reduced from 2005 levels. This is due to the change in single-engine taxi calculation methodology. That is, previous inventories assumed that all taxi segments were completed under single-engine taxi. As determined from additional research and guidance from Delta Air Lines, not all taxiing is conducted under single-engine conditions. The taxi time conducted under single-engine taxi used in this analysis was therefore considerably shorter than in inventories prior to 2010. In 2012, taxi emissions including landing roll (including reverse thrust as in previous inventories) were 185,063 metric tons CO₂e. As a result of single-engine taxi practices, approximately 617,467 gallons of jet fuel were saved during 2012, resulting in the reduction of 5,969 metric tons of CO₂e emissions. In addition to changes from taxiing, some of the change in emissions from aircraft on the ground can also be attributed to the change in fleet mix.

Specific to MAC-controlled sources, 2012 emissions decreased 11.8 percent from 2005 levels. Emissions from facility combustion sources decreased by 40.9 percent from 2005, while emissions from purchased power increased by 26.6 percent. Similar to 2010 and 2011, this increase can be a result of several factors including, but not limited to, weather patterns affecting heating and cooling, tenant operations, and airport operational changes. A change in the ground access vehicle data necessitated the inclusion of tenant ground access vehicle in the Airport Owner Controlled subset. The baseline and previous year calculations were revised from previous reports to reflect this change. With the revisions, individual groupings maintain comparability. Accordingly, vehicle traffic decreased in 2012 and contributed to an 18 percent reduction in emissions from ground access vehicles over baseline emissions.

The relatively low emissions generated by the MAC are not surprising given the emphasis the MAC places on environmental stewardship. The MAC has already implemented a number of projects over the years that resulted in lower GHG emissions for its organization, as well as reductions for MSP as a whole. While other airports are considering projects such as fuel hydrant systems to replace fueling trucks, or 400 hertz electric power at the gates to replace less-efficient auxiliary power units, the MAC has already completed these projects. The MAC has financed and implemented projects in the past 10 years that have resulted in GHG emission reductions at MSP of more than 40,000 metric tons per year. These projects were documented in the December 2008 GHG report which detailed the 2005 and 2007 calendar year GHG emissions.

Looking forward, the MAC is already exploring new initiatives and projects that will result in additional GHG emissions reductions. By being proactive, the MAC has positioned itself to be prepared in the event that reduction goals are mandated at some time in the future. If reductions are mandated in the future, the biggest challenge the MAC will face will be to receive credit for the list of reduction efforts it has already implemented. Future regulatory compliance aside, the MAC also continues to demonstrate it is a leader in environmental stewardship, while providing ready access to reliable air transportation services for the region.

With the constantly changing scientific and regulatory setting, the MAC can take away a few main points from this study:

1. At this time, the MAC is in compliance with all current rules and regulations addressing GHGs and climate change.

2. MAC-controlled GHG emissions contribute one percent to the MSP footprint.
3. Regardless of the magnitude of emissions, the MAC continues to study and reduce GHG emissions.
4. Aircraft taxi times and related efficiencies are a primary driver of local emissions.
5. The MAC's changing energy mix has contributed to emissions decreases.

Key Definitions

Greenhouse Gas (GHG) Footprint	Annual emissions in units of metric tons per year of GHGs, such as carbon dioxide equivalents (CO ₂ e), associated with a defined source.
MSP Tenants	Organizations occupying MAC-owned building space and conducting business activity at MSP. Examples include: airlines, cargo companies such as FedEx and UPS, concession organizations found in the terminals, etc.
Total Aviation and Related Activities from MSP	A category of emission sources, defined for this inventory to include: aircraft emissions above 3,000 feet above ground level (considered to be outside the MSP airspace), aircraft emissions at or below 3,000 feet above ground level (considered to be within the MSP airspace), MSP tenants, the general public driving vehicles on MSP property, MAC-controlled sources at MSP and the general public driving to MSP.
MSP Airport	A category of emission sources, defined for this inventory as a subset of the Total Aviation and Related Activities from MSP that includes: aircraft emissions at or below 3,000 feet above ground level, MSP tenants, the general public driving vehicles on MSP property and MAC-controlled sources at MSP.
Airlines and Tenants	A category of emission sources, defined for this inventory as a subset of MSP Airport that includes: aircraft emissions at or below 3,000 feet above ground level and MSP tenants activity (facilities, on-airport equipment, electricity use, etc.).
General Public	A category of emission sources, defined for this inventory as a subset of MSP Airport that includes: vehicle emissions on MSP property from passenger vehicles, MSP employee privately-owned vehicles (non-MAC employees of the airlines, tenants, etc.), shuttles, taxis, cargo and ground courier deliveries, etc.
MAC-controlled Sources	A category of emission sources, defined for this inventory as a subset of MSP Airport that includes: MAC-occupied facility heating/cooling and electricity use, fuel combustion from MAC-operated on-airport vehicles and equipment and MAC employee personal vehicle use while driving to and from work while on MSP property.
Landing and Takeoff (LTO) Cycle	The segments of a flight operation associated with a landing (approach to an airport at or below 3,000 feet above ground level, landing, reverse thrust and taxiing to the gate) or a takeoff (taxiing from the gate, takeoff and climb out to 3,000 feet above ground level).
Flight Operation	The operation of an aircraft that includes an approach to an airport at or below 3,000 feet above ground level, landing, reverse thrust and taxiing to the gate; or taxiing from the gate, takeoff and climb out to 3,000 feet above ground level.
Ground Access Vehicles (Public Vehicles On-airport Roadways)	Vehicles travelling on MSP property and either controlled by the MAC, the tenants and/or the general public. This can include: automobiles, trucks, and heavy equipment from tenant organizations for use on airport property that burn diesel, gasoline and E85 fuels. This category is included as a Scope 3 emission under Airport Operator Owned/Controlled based on indirect control of the roadways on airport property and available data formats.
Public Owned/Controlled (Off-airport Roadways/Vehicles)	This category includes vehicles traveling to MSP (but not on airport roadways) and controlled by the general public (e.g. vehicles driving on I-494, Hwy 5, Hwy 55, Hwy 62, Hwy 77, etc.), MAC employees, airport employees and other tenants. This category was included for the 2010 inventory only , as part of the EA/EAW.

1.0 Introduction

1.1 BACKGROUND

The Metropolitan Airports Commission (MAC) was created by state law in 1943. A public corporation, the commission was designed to provide for coordinated aviation services throughout the Twin Cities metropolitan area. Today, the MAC operates one of the largest aviation systems in the nation, consisting of the Minneapolis-St. Paul International Airport (MSP) and six reliever airports. A board of commissioners appointed by Minnesota's governor and the mayors of Minneapolis and St. Paul sets and interprets the commission's policies. Those policies are implemented by the commission's executive director and staff.

Aviation is one of the most dynamic, challenging and economically vital industries in the nation. Careful strategic planning, coupled with vigorous, thorough performance, helps ensure people and businesses throughout the region have ready access to reliable air service. As articulated in the MAC's Strategic Plan, the MAC views environmental sustainability as an important organizational value while striving to "demonstrate leadership in sound environmental management."

Air quality is one of the important environmental issues for an airport. Fortunately, the general air quality in the Minneapolis – St. Paul area is good compared to some other major metropolitan areas.

In general, the air quality near MSP is in compliance with the National Ambient Air Quality Standards (NAAQS). NAAQS currently exist for six air pollutants: Ozone (O_3), particulate matter ($PM_{2.5}$ and PM_{10}), carbon monoxide (CO), nitrogen oxides (NO_x), sulfur dioxide (SO_2), and lead (Pb). (Currently, there is no NAAQS for carbon dioxide (CO_2)). In Hennepin County, four of the six of these air pollutants are currently below the NAAQS; therefore, the airport area is considered to be in an "attainment" zone for O_3 , $PM_{2.5}$, PM_{10} , NO_x , and Pb. Maintenance areas are areas which had been nonattainment but meet the NAAQS and additional redesignation requirements. Hennepin Country is currently a maintenance area for CO and SO_2 . Furthermore, the MAC's 2010 development plan incorporated a significant number of projects that improve air quality, even though there have been no regulatory drivers that require the MAC to reduce emissions of the six air pollutants mentioned above.

The relatively good air quality has been confirmed by the Minnesota Pollution Control Agency (MPCA) through studies it has conducted. The MPCA monitored air toxic chemicals and $PM_{2.5}$ on MSP property from 2002 to 2007. Additionally, in 2005 the MPCA added two monitoring locations near MSP in Minneapolis and Richfield. In a report published by the MPCA in May 2006 titled *Update on Air Monitoring near the Minneapolis St. Paul International Airport*, the MPCA concluded that the "overall, median and average concentrations of pollutants monitored near MSP Airport are similar to concentrations monitored at other locations in the Twin Cities Metropolitan Area". The MAC has also evaluated air quality impacts from various development scenarios in the MSP 2020

Improvements Environmental Assessment/Environmental Assessment Worksheet (EA/EAW) associated with the *MSP 2030 Long Term Comprehensive Plan Update* (approved in July 2010) to ensure that they are below the level of significance.

As part of the EA/EAW, and associated with the recently-implemented tailoring rule, greenhouse gases (GHG) continue to receive increased attention. GHG is the general term for a number of gases that are instrumental in modifying the temperature of the Earth. The most common GHGs include water vapor, carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O) and ozone, but there are many others. Excess amounts of these GHGs can lead to increases in the Earth's near-surface temperature, which is part of the debate on world climate change. GHGs are generated both by natural and man-made sources, including stationary and mobile sources. Relative to airports, the GHG of primary importance is the CO₂ generated from the burning of fuels.

The MAC's GHG emissions currently are regulated under the United States Environmental Protection Agency's (USEPA) Tailoring Rule. From the perspective of an airport operator, such as the MAC, and the aviation industry in general, the primary initiatives currently addressing greenhouse gases and climate change are:

- **United States Aviation Greenhouse Gas Emission Reduction Plan** – Submitted to the International Civil Aviation Organization (ICAO) in June 2012, the United States Government (USG) developed an approach to achieve carbon-neutral growth for U.S. commercial aviation by 2020, compared to a 2005 baseline. The USG laid out several initiatives to achieve the goal:
 - Aircraft and Engine Technology Improvement
 - FAA Continuous Lower Energy, Emissions and Noise Program (CLEEN) – Five aviation manufacturers partnered to develop technologies for reducing emissions and fuel burn beginning in 2015 while enabling integration of alternative fuels in the future. By 2015, CLEEN aims to demonstrate technology to reduce fuel burn by 33 percent compared with existing technology.
 - NASA Environmentally Responsible Aviation (ERA) Project – NASA is developing the next generation of technology for longer-term development. By 2020, ERA aims to demonstrate technology to reduce fuel burn by 50 percent. By 2030, NASA aims to demonstrate designs slated for introduction into the aircraft fleet beyond 2030 to decrease fuel burn by 70 percent.
 - DoD Adaptive Versatile Engine Technology (ADVENT) – DoD is developing technologies to enable engines to show 25 percent improvement in fuel efficiency by 2020.
 - Operational Improvements via FAA Next Generation Air Transportation System (NextGen) – NextGen “is a comprehensive means for achieving more efficient aircraft operations and reduced GHG emissions through airspace, operational, and infrastructure improvements.” The FAA is working with aviation sector stakeholders to implement the changes with additional support from congress.

- Alternative Fuels Development and Deployment – The Commercial Aviation Alternative Fuels Initiative (CAAIFI), a public/private partnership, was established to research and develop commercialization of alternative aviation fuels leading to lower GHG emissions.
 - Policies, Standards, and Measures
 - Development of Meaningful CO₂ Standard – The USG is working with ICAO to develop a standard for implementation under the Clean Air Act (CAA) in order to incentivize accelerated development of technology.
 - Aviation Fuel Charge – The fuel charge will support implementation of NextGen.
 - Incentives for Equipping Aircraft with Advanced Avionics –The FAA established incentives to support reductions associated with NextGen.
 - Voluntary Airport Low Emissions Program (VALE) – The FAA implemented a program to reduce airport ground emissions by offering funding for lower emissions technology.
 - NextGen Environmental Management System (EMS) – The FAA NextGen EMS will track and measure progress toward the goals while providing transparency.
 - Market-Based Measures – The USG is evaluating the use of additional mechanisms to incentivize development of new technology and further GHG emission reductions.
 - Scientific Understanding and Modeling Analysis – The USG is researching additional impacts while continuing to improve data collection, modeling, and interdependencies of aviation emissions and noise. (USG Aviation GHG Emissions Reduction Plan, 2012)
- **Light-Duty Vehicle Greenhouse Gas Emissions Standards and Corporate Average Fuel Economy Standards** – On April 1, 2010, the USEPA and the United States Department of Transportation (DOT) National Highway Traffic Safety Administration (NHTSA) established rules in accordance with the Fuel Economy Standards Increase. The rules apply to passenger cars, light-duty trucks and medium-duty passenger vehicles starting with model years 2012 through 2016. These vehicles are required to meet an estimated combined average emissions level of 250 grams of carbon dioxide per mile. The equivalent fuel economy is approximately 35.5 mpg. The NHTSA projects that the policy will save 1.8 billion barrels of oil and reduce GHG emissions by approximately 960 million metric tons (USEPA and DOT, 2010).
 - **Kyoto Protocol** – The Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC) is an amendment to the international treaty on climate change, assigning mandatory targets for the reduction of GHG emissions to signatory nations. Countries that ratify the Kyoto Protocol commit to reduce their emissions of carbon dioxide and five other GHGs, or engage in emissions trading if they maintain or increase emissions of these gases.

Governments are separated into two general categories: developed countries, referred to as Annex I countries (which have accepted GHG emission reduction obligations), and developing countries, referred to as Non-Annex I countries (which have no GHG emission reduction obligations). As of August 2007, a total of 171 countries and other governmental entities have ratified the agreement (representing over 62 percent of emissions from Annex I countries). Developing countries, such as India and China, which have ratified the Protocol, are not required to reduce carbon emissions under the present agreement. Although both countries have large populations which lead to large emissions of GHGs, they are not required to reduce emissions because of their status as developing nations. The Kyoto Protocol laid the foundation for international action to address climate change. It should be noted that the United States has never ratified the Kyoto Protocol. The Kyoto Protocol was set to expire at the end of 2012. New agreements are in discussion for implementation in 2015 and 2020. However, no agreements are in place or ratified at this time.

- **Ongoing Scientific Review of Intergovernmental Panel on Climate Change** - Recognizing the problem of potential global climate change, the World Meteorological Organization (WMO) and the United Nations Environment Program (UNEP) established the Intergovernmental Panel on Climate Change (IPCC) in 1988. It is open to all members of the United Nations and the 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 nor does it monitor climate-related data or other relevant parameters. It bases its assessment mainly on peer-reviewed and published scientific/technical literature. The IPCC has completed four assessment reports and developed methodology guidelines for national GHG inventories, special reports and technical papers. The IPCC has three working groups and an emissions inventory task force.
- **Minnesota Next Generation Energy Act of 2007** – This bill established statewide GHG reduction goals from a 2005 baseline of 15 percent by 2015, 30 percent by 2025 and 80 percent by 2050. The bill also endorses the Governor’s Minnesota Climate Change Advisory Group as the entity to develop a comprehensive GHG emission reduction plan to meet those goals. Several of the recommendations for the residential, commercial and industrial sectors that could affect the aviation industry include:
 - Improved uniform building codes;
 - Green building guidelines based on *Architecture 2030*;
 - Reduction of high-global-warming-potential GHGs;
 - Promotion of technology-specific applications;
 - Requiring high State standards in the absence of Federal standards; and
 - GHG inventories, forecasting, reporting and registry.
- **Minnesota Pollution Control Agency “General Guidance for Carbon Footprint Development in Environmental Review”** – The Environmental Quality Board (EQB) promulgated rules containing a mandatory Environmental Assessment

Worksheet (EAW) threshold for CO₂e of 100,000 tons per year. New stationary sources with potential CO₂e emissions greater than 100,000 tons per year or modifications increasing potential emissions by more than 100,000 tons per year require the completion of a mandatory EAW. As a Responsible Government Unit (RGU) designated by the EQB for the preparation of EAWs that fall into this GHG category, the Minnesota Pollution Control Agency (MPCA) issued guidance for sources to address calculation of potential GHG emissions in preparation of EAWs. The MPCA's "General Guidance for Carbon Footprint Development in Environmental Review" contains CO₂ emission factors for Jet-A, aviation gasoline and electricity providers. Additionally, the MPCA is developing a CO₂e inventory reporting system. While specific thresholds and applicability for reporting have not been published, the guidance will provide a basis for the reporting of emissions. It should also be noted that the MPCA guidance follows USEPA and international protocols which align with the basic Airport Cooperative Research Program methodologies.

- **Minnesota Renewable Energy Standard** – The Minnesota Renewable Energy Standard calls for 25 percent of the electricity produced by the state's utilities to come from renewables by 2025.
- **National Environmental Policy Act Climate Change Guidance** – In 2010 the White House Council on Environmental Quality (CEQ) proposed four steps to update the National Environmental Policy Act (NEPA), specifically in regard to climate change. The CEQ released initial draft guidance for public comment on when and how Federal agencies, such as the FAA, must consider GHG emissions and climate change in their actions. This would include organizations affected by those agencies like the MAC. The primary points of the guidance include:
 - Explanation for how Federal agencies should analyze the environmental impacts of GHG emissions and climate change when they describe the environmental impacts under NEPA;
 - A presumptive threshold of 25,000 metric tons of equivalents of carbon dioxide (CO₂e) emissions from the proposed action to trigger a quantitative analysis; and
 - Instructions to agencies on how to assess the effects of climate change on the proposed action and their design.

However, the draft guidance does not apply to land and resource management actions and does not propose to regulate GHGs.

- **USEPA Mandatory Reporting of Greenhouse Gases Rule** – The USEPA issued the Final Mandatory Reporting of GHG Rule on September 22, 2009. The final rule requires reporting of GHG emissions from large sources and suppliers in the United States. In general, the rule applies to those facilities emitting over 25,000 metric tons of GHGs on a CO₂e basis. Owners or operators are required to collect emission data, calculate GHG emissions and follow the specified procedures for quality assurance, missing data, recordkeeping and reporting. For facilities subject to the rule

(i.e., those that meet the 25,000 metric tons of emissions for stationary combustion threshold), the emissions and calculation processes required for annual reporting are: carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O) emissions from each stationary fuel combustion unit. Stationary combustion units include, but are not limited to, boilers, process heaters, and any other miscellaneous combustion sources (not including emergency generators or fire pumps). These emissions are reported under subpart C by following the requirements in 40 CFR part 98, subpart C (General Stationary Fuel Combustion Sources).

- **USEPA GHG Tailoring Rule** – On May 13, 2010, the USEPA finalized the Tailoring Rule for regulating GHG emissions through Prevention of Significant Deterioration (PSD) and Title V air permitting under the CAA. The final rule sets thresholds for CO₂e emissions that define when new permits under the New Source Review PSD and Title V Operating Permit programs are required for new and existing industrial facilities. In response to the Tailoring Rule, Minnesota has adopted its own CO₂e permit thresholds and permit requirements.
- **Congressional Initiatives** – In recent years Congress has introduced several different bills to address energy independence and climate change: the American Clean Energy and Security Act of 2009; the Clean Energy and American Power Act of 2009; and the American Power Act of 2010. While two of the bills have been passed in either the House or Senate, no bill has passed both. The more recent American Power Act has been introduced in the Senate and could replace the Clean Energy and American Power Act. Overall, the bills have several similarities that would impact GHG emissions. The bills set reduction goals of approximately 17 percent by 2020 over 2005 emissions. Each bill sets forth a form of Cap-and-Trade system for utilities and industry as a means to reduce emissions. No bills are currently under consideration.

In 2012, the MAC finalized an MSP 2020 Improvements Environmental Assessment/Environmental Assessment Worksheet (EA/EAW) comparing environmental consequences from alternatives associated with future development at the Minneapolis-St. Paul International Airport (MSP). The EA/EAW included a baseline GHG inventory for 2010 as well as GHG projections associated with alternative development scenarios. The GHG portion of the EA/EAW adheres to Federal Aviation Administration, MPCA and NEPA guidance. The GHG inventory presented in this report builds upon the inventory used as the baseline for the MSP 2020 Improvements EA/EAW.

In addition to completing the GHG inventory for the EA/EAW, the MAC has evaluated its potential to emit CO₂e emissions against the applicable thresholds as adopted by the MPCA as a result of the Tailoring Rule. Moreover, the USEPA Mandatory Reporting Rule for GHGs (40 CFR 98) has the most potential to apply specifically to the MAC-controlled GHG emissions at MSP. It is not clear how the various GHG initiatives will impact the aviation industry as a whole, or airports in particular. The Minnesota Next Generation Energy Act of 2007, cited above, may have an impact on MAC activities. This could take the form of additional energy efficiency requirements for state building codes, specification of low-carbon fuel standards or electric generating requirements that ultimately affect the MAC's gas and electric energy suppliers, or other requirements.

Additional initiatives by the USG including the implementation of NextGen and the FAA VALE Program could provide incentives for projects and further development at MSP. Operational changes, in addition to infrastructure improvements, may have an impact on MAC planning and budget evaluations. These programs and changes have the potential to require additional initial capital outlay in order to access funding for projects with the ability to reduce costs and emissions in the long-term. Because it is unclear as to exactly how the various GHG initiatives will eventually affect the MAC, ongoing monitoring of and/or participation in these developments is strongly recommended.

In summary, while the body of knowledge on GHG emissions continues to evolve and the impacts to the environment continue to be debated, a common emerging theme is to measure GHG emissions, set targets for reduction and undertake reduction initiatives. The MAC continues to measure GHG emissions and incorporates emissions considerations into future development.

Anticipating future regulation of GHGs, and in line with its sustainability commitment to proactively operate safe, secure, customer oriented, economically sound and environmentally responsible airports, the MAC contracted Wenck Associates to update the voluntary GHG emissions report for MSP to build upon the previous GHG inventories and the MSP 2020 Improvements EA/EAW process, specifically identifying emissions under MAC control.

1.2 PURPOSE

The primary purpose of this Greenhouse Gas Report is to quantify the GHG emissions associated with MSP for the year 2012 in order to track changes against the 2005 baseline and to address future GHG emissions with initiatives implemented by the MAC. 2005 was chosen as the baseline year for this inventory to coincide with the baseline year defined by the Minnesota Next Generation Energy Act of 2007. In addition to comparison with the MSP Airport baseline, the inventory has been developed in accordance with the 2009 Airport Cooperative Research Program (ACRP) *Guidebook on Preparing Airport GHG Emissions Inventories* to provide for comparison with other airports.

Secondary objectives of the project were as follows:

1. Perform the inventory such that, in addition to quantifying emissions from the MAC-controlled sources at MSP, GHG emission impacts from the following sources were also quantified:
 - aviation activities at MSP,
 - non-aviation activity at MSP, and
 - public automobile activity at MSP
2. Calculate GHG emissions for 2012, as the most current year, for a comparison with 2005, 2007, 2009, 2010, and 2011 to see how emissions have changed.
3. Establish the data sets necessary to calculate future emissions and the sources of the information for further inventories and calculations in accordance with the ACRP *Guidebook*.
4. Provide the necessary background and understanding of the sources of GHG emissions to assist with identifying, planning and prioritizing future reduction opportunities.

2.0 Emissions Inventory Methodology

This section discusses the methodology and approach used to complete the GHG emissions inventory. In accordance with the Transportation Research Board's (TRB) ACRP *Guidebook on Preparing Airport Greenhouse Gas Emission Inventories* recommendations, the GHG emissions inventory considers the six Kyoto Protocol GHGs – CO₂, CH₄, N₂O, SF₆, HFCs and PFCs, measured in terms of CO₂e. In general, the emission sources were:

- Aircraft: aircraft operations above (within the cruise mode to its destination) and below 3,000 feet above ground level (AGL), and on the ground. Includes engine startup and auxiliary power units (APU).
- Stationary/Facilities: boilers, chillers, heating units and emergency generators located at MSP and operated by the MAC.
- Electricity: indirect emissions associated with power generation for all electricity purchased by the MAC for use at MSP.
- Ground Access Vehicles (Landside Vehicles): vehicle traffic coming and going on MSP Airport property (e.g., passenger and MSP employee vehicles [employees of the MAC, airlines, tenants, etc.], delivery trucks, taxis, shuttles buses, etc.).
- Ground Support Equipment: tenant ground support equipment (GSE) and other fleet vehicles dedicated for use on MSP Airport property by tenants and the MAC.

The primary source of guidance and emission factors used in this GHG inventory is from the recommendations included in the ACRP *Guidebook*, which references protocols based on the USEPA Climate Leaders program, The Climate Registry and the World Resources Institute (WRI). The WRI is an environmental think tank that, in collaboration with the World Business Council for Sustainable Development, has developed comprehensive guidance to assist with preparation of GHG emission inventories.

GHG emissions were categorized by ownership and control in the following manner: (1) emissions related to MAC activities were assigned to the airport category; (2) emissions related to airport tenants were assigned to the tenant category; and (3) emissions related to the public, such as private automobiles, were assigned to the public category.

- Category 1 – GHG emissions from sources that are owned and controlled by the reporting entity (i.e., the MAC). Category 1 typically represents sources that are owned by the entity, or sources that are not owned by the entity but over which the entity can exert control. At MSP, these sources include MAC-owned and -controlled stationary sources (e.g., boilers, generators, etc.), fleet vehicles and purchased electricity. On-airport ground transportation is included as Category 1 emissions as they are partly controlled by the MAC.
- Category 2 – This category comprises sources owned and controlled by airlines and airport tenants, and includes aircraft (on-ground, within the landing/takeoff cycle up to 3,000 feet, within the cruise mode), GSE/APU and electrical consumption.

- Category 3 – This category generally comprises GHG emissions associated with passenger ground access vehicles. These include public automobiles, taxis, limousines, buses, shuttle vans, etc. operating on the off-airport roadway network.

Consistent with the ACRP guidelines, once the ownership categories were determined the operational boundaries were also set, reflecting the Scope of the emission source. These Scopes include:

- Scope 1 / Direct – GHG emissions from sources that are owned and controlled by the reporting entity (i.e., the MAC) such as stationary sources and MAC-owned fleet motor vehicles. Direct GHG emissions include the following sources:
 - Natural gas, Jet-A, fuel oil #2 and propane combustion and refrigerant usage in MAC-owned and MAC-occupied facilities (*Stationary/Facilities-facility power*)
 - Diesel fuel combustion in MAC-owned emergency back-up power generators (*Stationary/Facilities-combustion*)
 - Gasoline, E85 and diesel fuel consumption in MAC-owned airport maintenance vehicles and equipment on airport roadways (*Fleet*)
- Scope 2 / Indirect – GHG emissions associated with the generation of purchased electricity.
 - Electricity consumption in MAC-owned and MAC-occupied facilities (*Stationary/Facilities-purchased power*)
 - Electricity consumption from MSP tenants occupying MAC-owned facilities who reimburse the MAC for their electrical power needs (*Stationary/Facilities-purchased power*)
- Scope 3 / Indirect and Optional – GHG emissions that are associated with the activities of the reporting entity (i.e., the MAC) but are emitted from sources that are owned and controlled by others. These include aircraft-related emissions and emissions from airport tenant activities, as well as ground transportation to and from the airport.
 - Gasoline, E85 and diesel fuel consumption in tenant equipment at the airport (*GSE*)
 - MAC employee vehicles driven to offices and facilities on MSP property and other public vehicles (shuttles, taxis, personal vehicles, buses) driven to the airport on airport roads (*Ground Access Vehicles, public*)
 - Aircraft emissions on the ground, at or below 3,000 feet AGL, above 3,000 feet AGL
 - Aircraft emissions from engine startup and APU associated with aircraft
 - MSP tenant natural gas and propane combustion for facility use (tenants occupying MAC-owned facilities who reimburse the MAC for their natural gas and propane needs) (*Stationary/Facilities-combustion*)
 - Diesel fuel combustion in emergency back-up power generators known to be operated by MSP tenants (*Stationary/Facilities-combustion*)
 - Tenant fleet and employee public vehicle use while on MSP property (employees, passengers, cargo delivery, etc.) (*Ground Access Vehicles, public*)

2.1 APPROACH

As provided by the ACRP *Guidebook*, WRI and USEPA emission factors and calculation protocols were used to quantify GHG emissions associated with the MAC and MSP Airport. This section discusses the specific calculation methodology, data sources and assumptions used to estimate GHG

emissions. Based on the types of sources at MSP, emissions were quantified as aircraft emissions, stationary source emissions (both direct and indirect from electricity consumption), and non-aircraft mobile source emissions. These emission sources and the approach to developing their emissions are described further.

As described in the ACRP *Guidebook*, carbon emission factors are based on the carbon content of the fuel combusted, per unit volume or per unit energy, in addition to the percent oxidized and the CO₂-to-carbon ratio. Similarly, CH₄ and N₂O are two other Kyoto Protocol GHGs emitted during combustion. The CH₄ and N₂O emission factors provide a mass of constituent per unit volume of fuel consumed. The mass of constituent is then multiplied by its respective global warming potential (GWP) in order to provide an equivalent CO₂e basis. CO₂e equivalent values are based upon the GWP values of one (1) for CO₂, 25 for CH₄, and 298 for N₂O (based on a 100-year period) as presented in the IPCC Fourth Assessment Report. Based on these CO₂e factors, one ton of CH₄ is 25 times more “potent” than one ton of CO₂ and is weighted as such in the GHG emissions inventory. For refrigerants, the GWP value for HFC-134a of 1,430 was used.

2.1.1 Aircraft Emissions

Aircraft-related greenhouse gas (GHG) emission sources include aircraft within the ground-based taxi and queue; aircraft within the landing and takeoff (LTO) cycle including engine startup, approach, takeoff, and climbout operating modes, and aircraft within the cruise mode to a destination. Auxiliary power units (APUs) and ground support equipment (GSE) are also sources of emissions.

The 2012 aircraft-related GHG emissions inventory for Minneapolis – St Paul International Airport (MSP) was conducted according to methodologies within the Transportation Research Board’s (TRB) Airport Cooperative Research Program (ACRP) *Guidebook on Preparing Airport Greenhouse Gas Emission Inventories* (ACRP Report 11).¹ The Federal Aviation Administration’s (FAA) *Emissions and Dispersion Modeling System* (EDMS version 5.1.3)², the FAA-required and the U.S. Environmental Protection Agency (USEPA) preferred model, was used to calculate GHG emissions. The calculations were based on total fuel usage of 318,032,621 gallons of Jet A and 15,621 gallons of aviation gasoline (AvGas), as well as 650,991 gallons of diesel and 946,192 gallons of gasoline for GSE.

2.1.1.1 Aircraft Activity Levels and Fleet Mix

Aircraft activity levels (aircraft arrival and departure operations) and aircraft assignments for MSP were based on a data set obtained from the MAC Noise and Operations Monitoring System (MACNOMS). The MACNOMS output contains airline, aircraft type, tail number, operation type (i.e., arrival/departure), date and time of operation, runway assignment, stage length, and flight origin/destination.

As the MACNOMS does not capture 100 percent of the aircraft operations based on transponder activity for certain aircraft classes, the aircraft fleet mix was adjusted (by aircraft category) to match

¹ Transportation Research Board, Airport Cooperative Research Program, ACRP Report 11, Project 02-06, *Guidebook on Preparing Airport Greenhouse Gas Emissions Inventories*. See http://onlinepubs.trb.org/onlinepubs/acrp/acrp_rpt_011.pdf for the full report.

² Federal Aviation Administration, *Emissions and Dispersion Modeling System (EDMS) User’s Manual*. Version 5.1, September 19, 2008.

the annual FAA’s Air Traffic Activity Data System (ATADS). Table 2-1 contains the annual operations by aircraft category used in the emissions inventory.

Table 2-1

Aircraft Fleet Mix	
Aircraft Category	Operations
Air Carrier	282,186
Air Taxi	128,267
General Aviation	12,030
Military	2,445
Total	424,928

Source: FAA ATADS, 2013.

2.1.1.2 Aircraft Engine Assignments

Aircraft engine assignments were based on EDMS default values or airline specific information. The combinations of airline/aircraft type/engine types operating at MSP were derived using the *JP Airline-Fleets International 2012/2013 (JP Fleets)*³ that contain engine type information for each airline and cargo operator. Aircraft engine types specific to Delta Air Lines⁴ were modeled in EDMS, while default engine assignments were assumed for other airlines and cargo operators.

For general aviation and military aircraft, the default engine type in EDMS was used. If a default engine type was not available in EDMS, the most common engine type for that particular aircraft type was assigned.

2.1.1.3 Aircraft Fuel Usage Rates and Operating Modes

EDMS contains a database of aircraft/engine-specific fuel usage factors based on engine manufacturer, model, and operational mode. The level of aircraft-related fuel usage is reflective of the time that an aircraft operates in each of the operational modes within the entire LTO cycle. An LTO cycle consists of the following operational modes:

- “*Taxi/Idle*” includes the time an aircraft taxis between the runway and a terminal, and all ground-based delay incurred through the aircraft route. The taxi/idle-delay mode includes the landing roll, which is the movement of an aircraft from touchdown through deceleration to taxi speed or full stop.
- “*Approach*” begins when an aircraft descends below the atmospheric mixing height and ends when an aircraft touches down on a runway.

³ These data comprise a comprehensive reference of the aircraft fleet for all known commercial aircraft operators including current registration, type, serial number, previous identity, date of manufacture, date of delivery, engine type and number, maximum take-off weight, configuration, fleet number, name, etc. for every aircraft weighing over 3,000 pounds. The database represents more than 6,000 operators and over 50,000 aircraft.

⁴ Delta Air Lines and its regional partners represent over 69 percent of the airport operations.

- “*Takeoff*” begins when full power is applied to an aircraft and ends when an aircraft reaches approximately 500 to 1,000 feet. At this altitude, pilots typically power back for a gradual ascent.
- “*Climbout*” begins when an aircraft powers back from the takeoff mode and ascends above the atmospheric mixing height.
- Aircraft emissions also account for the period of *engine startup* which occurs within the gate terminal area prior to departure.

Fuel usage within the aircraft engine startup mode was estimated using engine startup fuel flow rates, based on published guidance⁵, and was applied to the number of non-piston aircraft operations.

With the exception of ground-based taxi-in/taxi-out operations, including apron idling and departure runway queue delay, the default operating times in EDMS were used. MSP-specific times-in-mode for taxi-in and taxi-out were developed from the Bureau of Transportation Statistics (BTS)⁶ databases. The BTS provides airport average taxi-in and -out times of 6.69 and 17.14 minutes, respectively, for 2012. The average taxi-in and -out times for Delta Air Lines of 6.21 and 17.22 minutes were reported by BTS. As described within the following section, Delta Air Lines also incorporates a single-engine taxi procedure, which effectively adjusts the taxi-in and -out times.

2.1.1.4 Single Engine Taxiing

A methodology^{7,8,9} was developed to account for single-engine taxi procedures during the taxi-in or -out modes. The single-engine taxi operations were assigned to Delta Air Lines operations only. Of note, single-engine taxi challenges include: 1) excessive thrust and associated issues; 2) maneuverability problems, particularly related to tight taxiway turns and weather; 3) problems starting the second engine; and 4) distractions and workload issues. Thus, single-engine taxiing does not occur during each aircraft operation, and when it does occur, it does not occur during the entire operation, and it occurs far less often during taxi-out. To account for these variances, the following assumptions were developed based on available information such as aircraft pilot surveys:

- Practiced during 75 percent of the arrivals. When practiced, conducted 3.1 minutes after landing (to account for engines cool down period).
 - Thus, the 2012 taxi-in time of 6.21 minutes would involve 3.1 minutes of required full engine usage; of the remaining 3.11 minutes. A single-engine taxi procedure would be employed 75 percent of the time during aircraft arrival operations. The resultant effective taxi-in time would be 5.04 minutes.
- Practiced during 10 percent of the departures. When practiced, conducted 4.6 minutes before takeoff (to account for engines warm up period).

⁵ International Civil Aviation Organization (ICAO)/Committee on Aviation Environmental Protection (CAEP) Working Group 3, May 5, 2006, Engine Starting Emissions.

⁶ Bureau of Transportation Statistics, <http://www.bts.gov/xml/ontimesummarystatistics/src/index.xml>.

⁷ A Survey of Airline Pilots Regarding Fuel Conservation Procedures for Taxi Operations, Massachusetts Institute of Technology.

⁸ Opportunities for Reducing Surface Emissions through Airport Surface Movement Optimization, Massachusetts Institute of Technology, 2008.

⁹ Analysis of Emissions Inventory for Single Engine Taxi-out Operations, Center for Air Transportation Systems Research.

- Thus, the 2012 taxi-out time of 17.22 minutes would involve 4.6 minutes of required full engine usage, of the remaining 12.62 minutes; a single-engine taxi procedure would be employed 10 percent of the time during aircraft departure operations. The resultant taxi-out time would be 16.59 minutes.
- Practiced with aircraft with two engines, but not aircraft with more than two engines.
- Applicable for Delta Air Lines operations only.

Therefore, the resulting taxi times (relative to the use of two engines) at MSP during 2012 would be reduced from 6.21 to 5.04 minutes (taxi-in) and from 17.22 to 16.59 minutes (taxi-out), or an eight percent reduction in total taxi time (and fuel usage during taxiing) for applicable aircraft operations.

2.1.1.5 Auxiliary Power Units

Auxiliary power units (APUs) are small turbine engines used by many commercial jet aircraft to start the main engines and provide electrical power to aircraft radios, lights, and other equipment; and to power the onboard air conditioning (heating and cooling) system when the main jet engines are off. When an aircraft arrives at a terminal gate, the pilot has the option of shutting off power to the main jet engines and operating the onboard APU, which is fueled by the aircraft's jet fuel. Alternately, an aircraft can receive 400 Hz gate power and pre-conditioned air (PCA) from mobile ground power units (GPU) and air conditioning equipment, or receive electrical power and PCA from connections at the gate. In most cases, gate power connections are built into the passenger loading bridge used to connect the terminal building to the aircraft for loading and unloading passengers.

At MSP, Concourses A, B, C, D, F, and H have gate power and PCA at all available gate positions. For Concourse E, six of the 16 gates have gate power and PCA. For Concourse G, 24 of 26 gates have gate power and PCA. At gates with gate power and PCA, APUs would tend to be used less often and/or for a reduced duration.

Based on default estimates, gates without gate power and PCA would require an APU to operate for a minimum of 13 minutes on arrival and 13 minutes on departure. Gates with gate power and PCA would require an APU to operate for a minimum of 3.5 minutes on arrival and 3.5 minutes on departure. Based on a survey of operations at MSP, APUs were determined to operate the minimum values plus an additional 4 to 6 minutes depending on concourse. The average airport APU operating times were determined to be 9.5 minutes on arrival and 9.5 minutes on departure. For general aviation, cargo, and military operations, default APU operating times (13 minutes on arrival and 13 minutes on departure) were assumed, where applicable. Of note, many general aviation aircraft do not have APUs.

The fuel usage was estimated based on manufacturer fuel flow rates for respective APUs (typically from 50 to 860 pounds per hour) or other appropriate methods.

2.1.1.6 Ground Support Equipment

Ground support equipment (GSE) is a term used to describe the vehicles that service aircraft after arrival and before departure at an airport. The number, types of GSE, fuel type, and operational times that are used to service each category of aircraft were based on information provided by the airlines and developed during a site visit. Emissions from these sources are based on the number and type of equipment used to service each aircraft along with the amount of time the equipment is in use per aircraft landing-takeoff cycle. The types of GSE at MSP include aircraft tugs, baggage tugs, fuel trucks, food trucks, cargo trailers, water trucks, lavatory trucks, cabin service, belt loaders, and cargo loaders.

GSE fuel usage is tracked by MSP airline tenants and was used to determine the GHG emissions.

2.1.1.7 Mixing Height

Mixing heights (also referred to as mixing depths) are used by meteorologists to quantify the vertical height of pollutant mixing that occurs in the atmosphere. Consistent with *ACRP Report 11*, the GHG emissions inventory assessed emissions with a mixing height of 3,000 feet. Mixing height is used in the calculations for the approach and climbout aircraft operating modes.

2.1.1.8 Emission Factors

Each GHG emission factor provides a mass of CO₂ per unit volume of fuel. Table 2-2 provides the GHG emission factors used for aircraft and GSE fuels.

Table 2-2

GHG Emission Factors – Aircraft-related Sources				
Fuel	CO₂	N₂O	CH₄	Units
Jet-A	21.095	0.000683	0.000595	lb/gallon
Avgas	18.355	0.000243	0.0155	lb/gallon
Diesel	22.384	0.0001928	0.000534	lb/gallon
Gasoline	19.54	0.0002	0.00055	lb/gallon

Source: Transportation Research Board's ACRP Report 11, http://onlinepubs.trb.org/onlinepubs/acrp/acrp_rpt_011.pdf and Energy Information Administration, <http://www.eia.doe.gov/oiaf/1605/coefficients.html>.

2.1.2 Stationary Source Emissions

Stationary sources at MSP include the following:

- Boilers and chillers for facility use
- Snowmelters
- Heaters
- Emergency and peak shaving power generators
- Purchased electricity

Emissions from stationary sources were calculated in accordance with the ACRP *Guidebook* which references the USEPA *Climate Leaders Greenhouse Gas Inventory Protocol Core Module Guidance: Direct Emissions from Stationary Combustion Sources* (May 2008).

CO₂ emissions for each stationary source, excluding purchased electricity, were calculated by multiplying total fuel combusted by its associated carbon emission factor as provided in the ACRP *Guidebook* and the Energy Information Administration *Voluntary Reporting of Greenhouse Gases Program*. Total fuel combusted was calculated from fuel purchase and dispenser records. The respective CH₄ and N₂O factors were also used to determine emissions of those constituents. GWP values were then used to convert the masses to a CO₂e basis.

Table 2-3 provides the emission factors for stationary sources. GHG emission factors for electrical consumption are based on data from the Minnesota Pollution Control Agency for Xcel Energy.

Table 2-3
GHG Emission Factors – Stationary Sources

Fuel	CO₂	N₂O	CH₄	Units
Natural gas	11.6976	2.20E-05	1.10E-03	lb/therm
No. 2 Oil	22.384	1.84E-04	3.06E-03	lb/gallon
Jet-A	21.095	1.79E-04	2.98E-03	lb/gallon
Propane	12.669	1.20E-04	2.01E-03	lb/gallon
Electrical	1.3380	2.90E-05	2.80E-05	lb/kwh

Emissions from purchased electricity were also calculated in accordance with the ACRP and USEPA protocol. Total electricity purchased, based on invoices, was multiplied by the emission factors to determine CO₂e emissions. However, the carbon emission factor is based on continuous emissions monitoring system (CEMS) data and is specific to Xcel Energy electricity production in the Midwest. Xcel emission factors were updated based on the Corporate Responsibility Report for 2012 (<https://www.xcelenergy.com/staticfiles/xcel/Corporate/CRR2012/environment/emission-reduction/carbon-dioxide.html>). The 2011 factor was updated based on the revised information in the 2012 report. It should be noted that the 2012 CO₂ emission factor is revised in the report to 1.3900 lbs/kwh versus the historically used 1.31717 lbs/kwh. These factors contribute a 5.5 percent increase to the electricity factor for 2011 and 1.6 percent factor increase for 2012 when compared to historical custom factors.

Calculations did not include minor sources such as cutting torches, welding operations, or fugitive emissions associated with maintenance activities due to the relative insignificance of those emissions when compared to overall emissions.

GHG emissions from refrigerant usage was based on material balancing of the emissions, taking into account the charging, usage and disposal of refrigerants, and were calculated using maintenance records indicating total annual compound recharged. The MAC uses 1,1,1,2-Tetrafluoroethane (or HFC-134a), classified as a GHG, within its refrigerant systems.

2.1.3 Motor Vehicles

Motor vehicle sources at MSP include the following:

- **Fleet Vehicles:** Automobiles, trucks and heavy equipment owned and controlled by the MAC and/or tenant organizations for use on airport property. These vehicles burn diesel, gasoline and E85 fuels.
- **Ground Access Vehicles (GAV):** This category of mobile sources includes vehicles driven onto the MSP property from outside the airport. This includes passenger and airport employee vehicles (airlines, tenants, etc.), taxis, shuttles, buses, delivery trucks (FedEx/UPS, other), etc. With the exception of MAC employees, who were accounted for separately, the landside vehicle category characterizes emissions from the general public while driving on MSP property.

Emissions from motor vehicles were calculated in accordance with the ACRP *Guidebook on Preparing Airport Greenhouse Gas Emission Inventories (ACRP Report 11)*.

Emission factors and other data used to develop emissions for motor vehicles were obtained from the ACRP *Guidebook*, the United States Energy Information Administration¹⁰, the American Association of State Highway and Transportation Officials (AASHTO) Standing Committee on the Environment¹¹ and from the USEPA's MOBILE6.2.

2.1.3.1 Fleet Vehicles

Emission calculations for on-airport vehicles and equipment (MAC and tenant fleet) were completed using total fuel combusted as provided by dispenser records and fuel purchase receipts to determine total GHG emissions. Emissions for each mobile source were then calculated by multiplying total fuel combusted by its associated emission factors, considering fuel type. Table 2-4 provides the emission factors for fleet vehicles. Emission factors for N₂O and CH₄ for E85 fuel-vehicles are based on emission factors for gasoline and ethanol.

Table 2-4

GHG Emission Factors – Fleet Vehicles and Ground Access Vehicles

Fuel	CO ₂	N ₂ O	CH ₄	Units
Diesel	22.384	-	-	lb/gallon
Gasoline	19.6911	-	-	lb/gallon
E85	2.95	-	-	lb/gallon
Diesel	-	3.30E-06	2.20E-06	lb/mile
Gasoline	-	7.93E-06	3.81E-05	lb/mile
E85	-	1.48E-04	1.21E-04	lb/mile

¹⁰ Energy Information Administration, www.eia.doe.gov/oiaf/1605/coefficients.html

¹¹ ICF International, *Greenhouse Gas Emission Inventory Methodologies for State Transportation Departments*, July 2011.

2.1.3.2 Ground Access Vehicles

Emission calculations from landside vehicles were completed using a bottom-up approach and updated to account for airport tenant changes in 2012. The bottom-up approach uses distance traveled multiplied by a fuel economy factor to determine total GHG emissions. Fuel economy factors were obtained from the USEPA's MOBILE6.2 model. Fuel efficiencies were developed by vehicle type and fuel type. The vehicle class distribution percentage was multiplied by its respective fuel economy factor to get a single fuel economy from the weighted average for diesel and gasoline. Motor vehicle volumes and mileage traveled were based on traffic study data and on-airport and off-airport roadway networks.

The calculated fuel economy factors were multiplied by the number of vehicles visiting the airport, respective distribution and distance traveled within the MSP property to get a total quantity of fuel combusted for gasoline and diesel. The total volume of each fuel combusted was then multiplied by the respective emission factors found within the American Association of State Highway and Transportation Officials' *Greenhouse Gas Emission Inventory Methodologies for State Transportation Departments*. GHG emissions from ground access vehicles include running and idling activities. Emission factors used for Ground Access Vehicles are presented in Table 2-4.

More specifically, the following assumptions and data sources were used for the on-airport roadway calculation:

- Airport loop based on GIS measurements of the MSP loop road equaling 2.25 miles
- It is assumed that the employees work 250 days per year on average
- It is assumed that 25 percent of employees leave for lunch daily
- Fuel Economy and Percentage of vehicles taken from DOT statistics and the 2004 MSP traffic study giving a weighted-average fuel economy of 20.1 miles per gallon
- CH₄ and N₂O emission factors were calculated using distribution from DOT statistics and respective emission factors for model year and converting to CO₂e using GWP and mass conversion factors (1 metric ton/1000 kg)
- Annual Numbers or Vehicles Visiting the Airport were set equal to the number of enplanements; using Grand Total from 2013 Enplanements by the Concourse report published at <http://mspairport.com/about-msp/statistics/operations-and-passenger-reports.aspx>
- Total Badged Employees were used to represent the subset of vehicles and all airport employees visiting the airport
- FAA, Control Tower, MAC Employees, Lot Parkers, and General Aviation are now subsets of Total Badged Employees
- Taxi Permits are collected for tracking purposes but are included in vehicles visiting airport
- Cargo Summary Total used to represent traffic on west side of airport replacing Mesaba, FedEx/UPS Employees from previous inventories.
- Freight total from Year End Operations Reports – Year End 2012 - Cargo Summary Total (lbs) published at <http://mspairport.com/about-msp/statistics/operations-and-passenger-reports.aspx>
- Semi weight = 38,000 lbs (loaded 80,000 minus 42,000 unloaded weight)
- Panel Van max capacity 10,000 lbs (loaded 12,000 minus 2,000 lbs unloaded weight)
- Split of 2/3 panel vans to 1/3 semi-trucks based on 2004 study split

- Three operational elements per round trip for loading, unloading, accounting for three primary carriers and less-than-truckload and less-than-capacity (by weight) loads
- Trip Calculation multiplies gross freight by truck split divided by available weight to get trips
- Emissions multiplies trips by loop distance by emission factor divided by fuel economy by three and converted to metric tons

It should be noted that this methodology is revised from the previous years based on data availability. The inventory for the MSP 2020 Improvements EA/EAW used data that grouped all ground access vehicles together. Therefore, the subsequent years will use this approach to maintain comparability. Note: The previous years have been revised in this report to reflect the methodology update. When considering the previous data sources and sum of the tenant and airport operator ground access vehicles, the methodology caused an increase of 26 percent for the 2005 baseline ground access vehicles included in the Airport Operator Owned/Controlled category. 2007 decreased by two percent and 2009 by less than one percent using this new methodology. This new approach will provide a more consistent data source that is publicly available for review.

3.0 Results

The results of this study help to understand the sources of GHG emissions associated with the Minneapolis-St. Paul International Airport (MSP). This knowledge can be used to focus on areas of the most significance and operational control to assist with GHG emissions reduction initiatives.

As shown in Figure 3.1a, by far the most significant source of emissions associated with MSP is attributed to fuel combustion from aircraft operations. Of the total 3.2 million metric tons of CO₂e emissions, approximately 95 percent of these are from aircraft fuel combustion. The contribution from MAC-controlled sources, as defined by the ACRP, is one percent.

Figure 3.1a
2012 CO₂e Emissions from Total Aviation and Related Activities from MSP

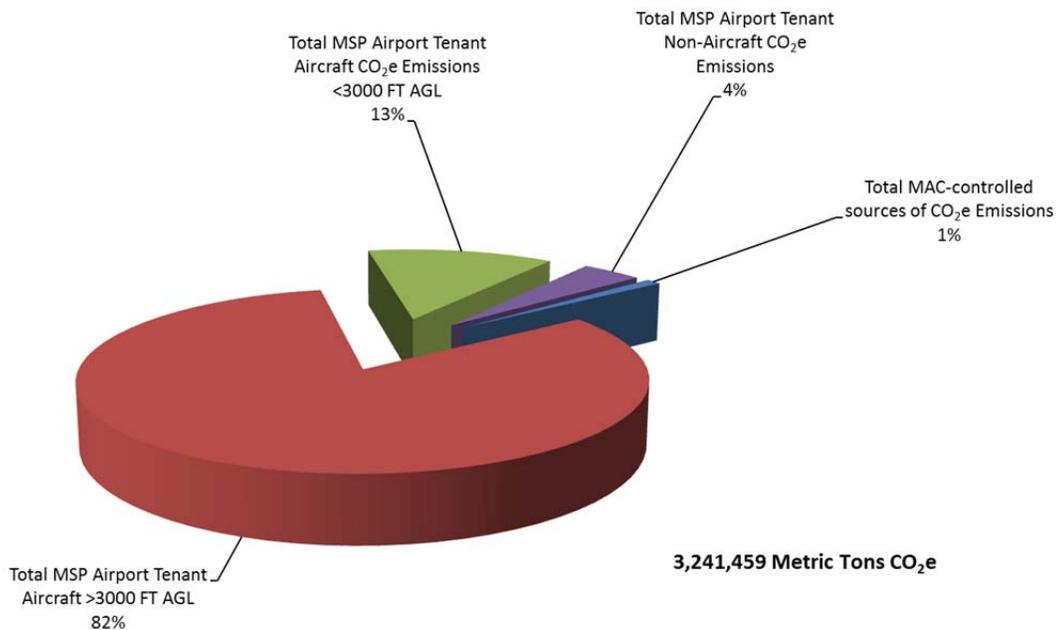


Table 3-1 provides a summary of the aircraft-related GHG emissions inventory for 2012. GHG emissions from aircraft-related sources for 2012 are approximately seven percent less than 2011 emissions and three percent greater than 2010 emissions; generally due to changes in reported Jet-A fuel usage and taxi times (which in turn is a function of the annual operations), although GSE fuel usage decreased within the period. Notably, the total airport operations from 2010, 2011, and 2012 are 437,075, 436,506, and 424,928 operations, respectively. The 2012 calculations are based on total fuel usage of 318,032,621 gallons of Jet-A, 15,621 gallons of AvGas, 650,991 gallons of diesel in GSE, and 946,192 gallons of gasoline in GSE.

Table 3-1
Aircraft-related GHG Emissions (metric tons/year)

Source	CO ₂	N ₂ O	CH ₄	CO ₂ e
Aircraft - Ground				
Taxi-In	51,984	1.7	1.5	52,523
Taxi-Out	131,181	4.2	3.7	132,540
Engine Startup	2,718	0.1	0.1	2,747
Aircraft – LTO Cycle				
Approach	65,216	2.1	1.8	65,892
Climbout	50,596	1.6	1.4	51,120
Takeoff	85,163	2.8	2.4	86,045
Aircraft - Cruise to destination	2,636,351	85.4	74.5	2,663,665
Ground Support Equipment	15,006	0.1	0.4	15,059
Auxiliary Power Units	20,026	0.6	0.6	20,234
Total	3,058,241	98.6	86.4	3,089,825

Source: KB Environmental Sciences, Inc., 2013.

Figure 3.1b is a graphical representation of the total CO₂e emissions for 2010, 2011, and 2012. As depicted, the emissions do not correlate directly with operations. Aircraft-related GHG emissions are the largest source of emissions on a net basis. However, the primary driver of the increased emissions is taxi time. Cruise is the secondary driver on an efficiency basis (or metric tons of CO₂e/operation). Taxi efficiency dropped and emissions increased from 0.37 metric tons CO₂e/operation in 2010 to 0.46 metric tons CO₂e/operation in 2011. In 2012, taxiing improved slightly over the previous year to 0.44 metric tons CO₂e/operation. This represents a 24 percent and 18 percent reduction in taxi efficiency over 2010. 2012 improved by 5 percent over 2011 taxi efficiency. Similarly, cruise efficiency decreased by 11 percent in 2011 and by 6 percent in 2012 over 2010 levels. On the other hand, GSE efficiency increased 38 percent and 39 percent over the same timeframe, respectively.

Figure 3.1b
2012 CO₂e Emissions from Total Aviation and Related Activities from MSP

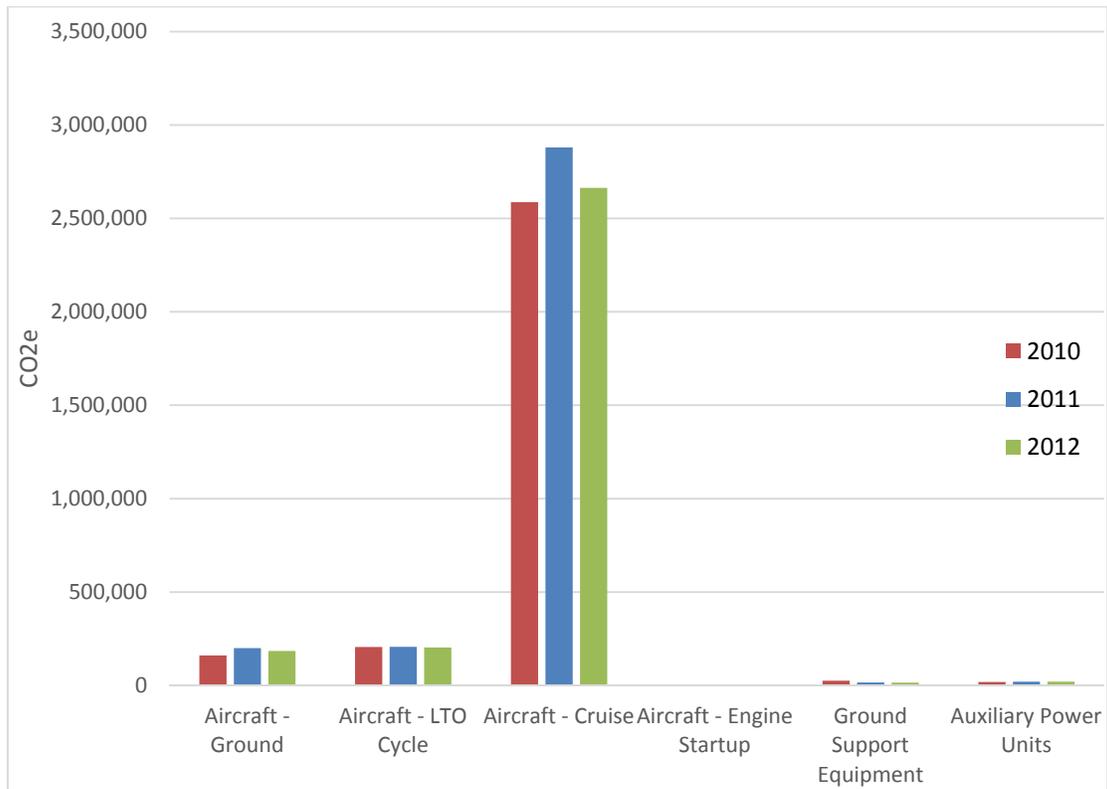
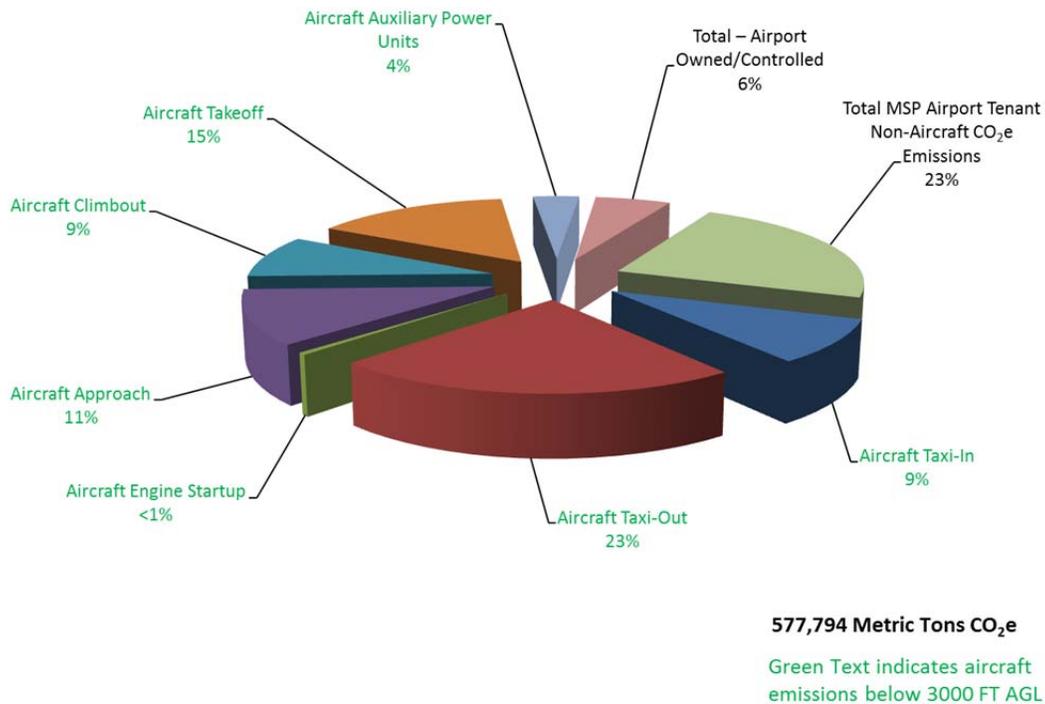


Figure 3.2 depicts the CO₂e footprint from MSP on a more local level. Fuel combustion from aircraft at or below 3,000 feet AGL is still the predominant source of CO₂e emissions. The MAC’s direct and indirect contribution to the local GHG footprint at MSP accounts for only 6 percent of the total CO₂e emissions from MSP.

As shown in Figure 3.2, 71 percent of the 577,794 metric tons of CO₂e emissions for the local MSP footprint (<3,000 feet AGL) in 2012 came from aircraft fuel combustion during the landing-takeoff (LTO) cycle. Figure 3.2 also shows how the various segments of the LTO cycle contribute to the overall GHG footprint. Assessing the emissions in this way allows the MAC to identify areas where it may influence activities that contribute to the overall footprint. For example, 32 percent of the local MSP emissions come from taxiing aircraft with landing roll. As discussed above, the taxiing efficiency has fluctuated thereby contributing to varied emissions despite a decrease in operations over the last three years. How the MAC manages the design of future terminal improvements, and supports NextGen implementation (especially in the form of Optimized Profile Descent arrival procedures) may have the potential to reduce aircraft fuel burn and, therefore, reduce the GHG emissions at MSP.

Figure 3.2
2012 CO₂e Emissions from MSP Airport



Note: Total may be greater than 100% due to rounding.

In 2012, the MAC-controlled Scope 1 and 2 sources at MSP emitted 13,608 metric tons of CO₂e. When including the Scope 3 emissions, resulting from public vehicles on airport roads, (in accordance with the ACRP protocol), the total Airport Operator-owned and -controlled GHG emissions were 33,123 metric tons CO₂e. The ACRP categorization includes Scope 3 emissions resulting from public vehicles on airport roads. Though emissions from public vehicle traffic on MSP property account for only 3.4 percent of the total local emissions, this is another area where the MAC can influence activities that contribute to this source of emissions. The MAC has undertaken several projects at MSP associated with general public traffic management that have resulted in significant decreases in GHG emissions. These projects were documented in the December 2008 GHG report which detailed the 2005 and 2007 calendar year GHG emissions. The MAC is currently implementing additional projects to reduce emissions and evaluating a path forward for future reductions.

As shown in Figure 3.3, 30 percent of the MAC total was related to purchased electricity and stationary combustion (natural gas, diesel, Jet-A, fuel oil #2) for MAC-occupied facilities at MSP. Six percent of the MAC emissions were from fuel combustion for use in on-airport vehicles used to

maintain the airfield and MSP property. This percentage has decreased as the MAC has continued to shift to alternative fuels for its fleet vehicles. Overall, 2012 electricity and combustion emissions decreased significantly from 2011. The decrease can be attributed to two items: 1) a lowered GHG output per MWh by Xcel as it continues to improve its energy generation, and 2) decreased natural gas consumption. This could be driven by improved operations, increased efficiency, and changing weather. While the combustion and electrical emissions decreased, the primary contributor to the MAC 2012 stationary emissions (maintenance associated with chiller units) remained close to 2011 levels. The MAC performed additional recharge of refrigerant in 2012 which contributed 1,648 metric tons CO₂e as compared to 162 metric tons CO₂e in 2011. The refrigerant contribution is projected to return to 2011 levels based on anticipated maintenance schedules.

Figure 3.3
2012 MAC-controlled CO₂e Emissions by Source

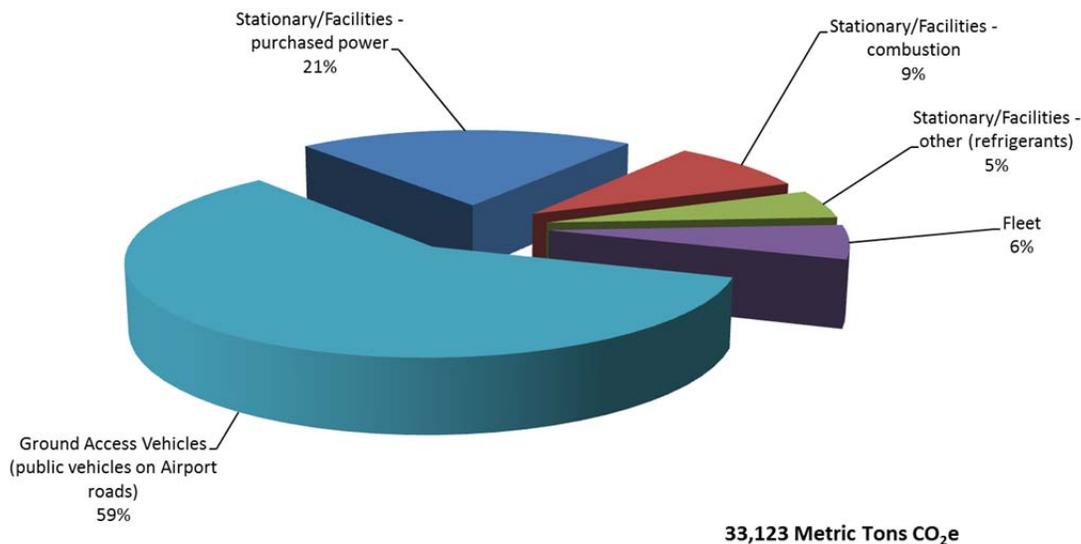


Table 3-2 presents the detailed 2012 GHG inventory as calculated according to the methodology described in Section 2.0 of this report.

As a percentage of the overall aviation CO₂e footprint associated with MSP, the MAC contribution is one percent. For comparison, the Port of Seattle Aviation Division, which is responsible for managing the Seattle-Tacoma Airport (Sea-Tac), reported its 2006 CO₂ emissions as 1.4 percent of the overall CO₂ emissions from Sea-Tac. While Sea-Tac does not have data for all airport operations for more recent years, the Sea-Tac airport operator emissions, those equivalent to MAC emissions, are updated through 2009. The Sea-Tac emissions for 2009 were 43,347 metric tons. Additionally,

Philadelphia International Airport (PHL) completed a GHG emissions inventory for 2009. In the inventory, PHL showed emissions of 4.7 million metric tons CO₂e with 87 percent of the total resulting from aircraft fuel consumption. PHL Airport-owned and -controlled sources contributed 4.5 percent to the total despite comparable but fewer passengers than MSP (The Environmental Consulting Group, 2009). PHL stationary combustion and purchased power contributes notably more emissions to its footprint when compared to the MAC.

The MAC appears to be comparable or more efficient than other similar airports in terms of its direct-controlled GHG emissions. This comparison to other airports will enable the MAC to have a better understanding of the sources contributing to the MAC-controlled GHG footprint at MSP and helps to identify future opportunities for initiatives and projects that may result in GHG emissions reductions.

Table 3-2
2012 Total Detailed CO₂e Emissions from MSP

User/Source Category	Scope	CO2	CH4	N2O	CO2e	% Source in User Category	% of Total
<i>Airport Owned/Controlled</i>							
Stationary Sources - Combustion	1	2,938	0.28	0.01	2,946	8.9%	0.1%
Stationary Sources - Refrigerants	1	NA	NA	NA	1,648	5.0%	0.05%
MAC Fleet	1	1,931	0.09	0.08	1,958	5.9%	0.06%
Electrical Consumption	2	7,007	0.15	0.15	7,056	21.3%	0.2%
On-airport Roadways	3	19,231	4	62	19,515	58.9%	0.6%
Total – Airport Owned/Controlled		31,107	4.89	62.26	33,123	100.0%	1.0%
<i>Tenant Owned/Controlled</i>							
Aircraft (Ground-based)	3	183,165	6	5	185,063	5.8%	5.7%
Aircraft (Ground to 3,000 feet)	3	200,975	7	6	203,058	6.3%	6.3%
Aircraft (Above 3,000 feet)	3	2,636,351	85	74	2,663,665	83.0%	82.2%
Aircraft - Engine Startup	3	2,718	0.09	0.08	2,747	0.1%	0.1%
APU	3	20,026	0.65	0.57	20,234	0.6%	0.6%
Total MSP Airport Tenant Aircraft CO ₂ e Emissions <3000 FT AGL					411,101	12.8%	12.7%
Subtotal - Aircraft		3,043,236	99	86	3,074,766	95.8%	94.9%
GSE	3	15,006	0.14	0.39	15,059	0.5%	0.5%
Stationary Sources - Combustion	3	24,423	2.3	0.05	24,495	0.8%	0.8%
Electrical Consumption	3	93,365	2	2	94,017	2.9%	2.9%
Total MSP Airport Tenant Non-Aircraft CO ₂ e Emissions					133,570	4.2%	4.1%
Total – Tenant Owned/Controlled		3,176,031	103	88	3,208,336	100.0%	99.0%
Totals		3,207,138	108	151	3,241,459		100.0%
All units in metric tons							
GWPs - CO2 = 1, CH4 = 25, N2O = 298, per 2007 IPCC FAR as recommended by ACRP							

Table 3-3 presents the 2005, 2007, 2009, 2010, 2011 and 2012 GHG emissions from all the sources, as recommended by the ACRP, which are included in this analysis. It should be noted that emissions from 2005 through 2009 were regrouped and recalculated from previous reports in order to maintain as much comparability among years where possible. An update in data availability and calculation methodology necessitated the revision to maintain comparability across years. Auxiliary power unit (APU) emissions are included in the “Above 3000 ft” category and Engine Startup is included in “Ground” to allow comparability among inventories where possible. That is, previous data sources and calculations necessitated grouping APU with the “Above 3000 ft” category due to

limited ability to separate out the individual emissions. The APU calculations are now available in the detailed emissions but grouped in the “Above 3000 ft” category to provide comparability to baseline calculations. The APU emissions represent 0.6 percent of the total emissions.

Table 3-3
2005, 2007, 2009, 2010, 2011, and 2012 Total CO₂e Emissions from MSP

User/Source Category	Scope	2005 - Baseline (Metric Tons CO ₂ e)	2007 (Metric Tons CO ₂ e)	2009 (Metric Tons CO ₂ e)	2010 (Metric Tons CO ₂ e)	2011 (Metric Tons CO ₂ e)	2012 (Metric Tons CO ₂ e)	2007 % change from baseline	2009 % change from baseline	2010 % change from baseline	2011 % change from baseline	2012 % change from baseline
<i>Airport Operator Owned/Controlled</i>												
Stationary/Facilities - purchased power	2	5,573	5,413	5,993	7,281	7,155	7,056	-2.9%	7.5%	30.6%	28.4%	26.6%
Stationary/Facilities - combustion	1	4,989	4,350	3,442	3,445	3,671	2,946	-12.8%	-31.0%	-31.0%	-26.4%	-40.9%
Stationary/Facilities - other (refrigerants)	1	-	-	-	675	162	1,648	NA	NA	NA	NA	NA
Fleet	1	3,223	3,029	2,861	2,630	2,628	1,958	-6.0%	-11.2%	-18.4%	-18.5%	-39.3%
<i>subtotal</i>		<i>13,785</i>	<i>12,792</i>	<i>12,296</i>	<i>14,030</i>	<i>13,615</i>	<i>13,608</i>	<i>-7.2%</i>	<i>-10.8%</i>	<i>1.8%</i>	<i>-1.2%</i>	<i>-1.3%</i>
Ground Access Vehicles (public vehicles on Airport roads)	3	23,787	21,601	18,759	22,982	19,471	19,515	-9.2%	-21.1%	-3.4%	-18.1%	-18.0%
Total Airport Operator Owned/Controlled		37,573	34,393	31,055	37,012	33,086	33,123	-8.5%	-17.3%	-1.5%	-11.9%	-11.8%
<i>Airline, Aircraft Operator, or Tenant Owned/Controlled</i>												
Aircraft												
Ground (engine startup, taxi and reverse thrust)	3	132,499	111,824	108,013	163,670	202,613	187,809	-15.6%	-18.5%	23.5%	52.9%	41.7%
Ground to 3,000 ft (takeoff/climbout/approach)	3	276,805	246,696	219,723	205,536	206,450	203,058	-10.9%	-20.6%	-25.7%	-25.4%	-26.6%
Above 3,000 ft (residual/cruise/APU)	3	3,740,026	3,300,080	2,314,090	2,605,588	2,900,631	2,683,899	-11.8%	-38.1%	-30.3%	-22.4%	-28.2%
Aircraft Total	3	4,149,330	3,658,601	2,641,826	2,974,794	3,309,693	3,074,766	-11.8%	-36.3%	-28.3%	-20.2%	-25.9%
Ground Support Equipment	3	14,812	14,805	14,652	25,311	15,757	15,059	0.0%	-1.1%	70.9%	6.4%	1.7%
Ground Access Vehicles	3	See Notes	See Notes	See Notes	See Notes	See Notes	See Notes	NA	NA	NA	NA	NA
Stationary Sources/Facility Power	3	98,766	100,334	114,910	113,547	123,721	118,512	1.6%	16.3%	15.0%	25.3%	20.0%
Total Airline, Aircraft Operator, or Tenant Owned/Controlled		4,262,908	3,773,740	2,771,388	3,113,652	3,449,171	3,208,336	-11.5%	-35.0%	-27.0%	-19.1%	-24.7%
<i>Public Owned/Controlled</i>												
Total Public Owned/Controlled Total		-	-	-	46,506	-	-	NA	NA	NA	NA	NA
Total		4,300,481	3,808,133	2,802,443	3,197,170	3,482,257	3,241,459	-11.4%	-34.8%	-25.7%	-19.0%	-24.6%
Notes:												
<ul style="list-style-type: none"> Fleet emissions based on MAC diesel, gasoline, and E85 dispensed in 2012. 2011 electricity emissions updated based on recently published custom emission factor updates; therefore, emissions from electricity are revised from the 2011 GHG report. MAC Fleet, tenant ground access vehicles, and public vehicles on airport roads were grouped into Ground Access Vehicles based on the model needed for the EA. Changes in calculation methodology and scope are reflected in Ground Access Vehicles for all years as of 2012 inventory. Public-Owned/controlled emissions were collected and reported only for 2010. Data were developed for the MSP 2020 Improvements EA/EAW only and are shown in the summary table. 												

Consistent with airport activities and previous GHG reports, the main source of GHG emissions associated with MSP is fuel combustion from aircraft above 3,000 feet AGL. Though these emissions actually occur away from MSP, such as happens with international flights around the world, they are identified as a method to account for the fuel dispensed at MSP. Based on fuel dispensed at MSP, the overall footprint for aviation-related activities in 2012 was approximately 3.2 million metric tons CO₂e compared to 4.3 million metric tons CO₂e in 2005. A few drivers accounted for the 25 percent reduction:

- Reduced flight operations
- Change in fleet mix
- Increased fuel efficiency in engines
- Increased flight operational efficiency (passengers/flight)
- Change in taxi times and single-engine taxi methodology

The overall magnitude of these CO₂e emissions is comparable to and, in some cases, more efficient than other airports the size of MSP as described previously.

Emissions in calendar year 2010 increased significantly when compared to 2009. The 2010 increase was driven by several factors that included increased aircraft operations, emission modeling updates, and changes in weather patterns. Aircraft operations are the largest factor in overall MSP emissions. Consequently, the operations increase in 2010 was the primary driver of increased emissions. Additionally, updated aircraft taxi data from Delta resulted in a reduction in modeled aircraft single-engine taxi time in 2010.

Excluding ground access vehicles, the MAC-controlled GHG emissions for 2012 were determined to be 13,608 metric tons CO₂e. This total accounts for Scope 1 and 2 emissions as defined earlier in this report. Using the ACRP-defined airport operator/owner category which incorporates part of Scope 3, MAC-controlled GHG emissions in 2012 totaled 33,123 metric tons CO₂e. This category is important because if GHG reductions are someday mandated, the MAC should be held accountable only for the emissions over which it has direct control.

Within the aircraft category subsets, a total reduction in emissions for aircraft on the ground and below 3,000 feet AGL occurred from 2005 to 2012. Comparing the 2012 aircraft LTO cycle data to 2005 LTO cycle data, emissions during all LTO cycle segments, except taxi, were reduced from 2005 levels. The higher 2012 taxi emissions are due to a change in the single-engine taxi calculation methodology from 2005 to 2012. Previous inventories assumed that all taxi segments were completed under single-engine taxi. As determined from additional research and guidance from Delta Air Lines, not all taxiing is conducted under single-engine conditions. The taxi time conducted under single-engine taxi used in this analysis was therefore considerably shorter than in inventories prior to 2010. In 2012, taxi emissions, including landing roll. (which includes reverse thrust as in previous inventories) were 185,063 metric tons CO₂e. As a result of single engine taxi practices, approximately 617,467 gallons of jet fuel were saved during 2012; resulting in the reduction of 5,969 metric tons of CO₂e emissions. In addition to changes from taxiing, some of the change in emissions from aircraft on the ground can also be attributed to the change in fleet mix.

Specific to MAC-controlled sources, 2012 emissions decreased 11.8 percent from 2005 levels. Emissions from facility combustion sources decreased by 40.9 percent from 2005, while emissions

from purchased power increased by 26.6 percent. Similar to 2010 and 2011, this increase can be a result of several factors including, but not limited to, weather patterns affecting heating and cooling, tenant operations, and airport operational changes. A change in the ground access vehicle data necessitated the inclusion of tenant ground access vehicle in the Airport Owner Controlled subset. The baseline and previous year calculations were revised from previous reports to reflect this change. With the revisions, individual groupings maintain comparability. Accordingly, vehicle traffic decreased in 2012 and contributed to an 18 percent reduction in emissions from ground access vehicles over baseline emissions.

4.0 Conclusions

With the constantly changing scientific and regulatory setting, the MAC can take away a few main points from this study:

1. **At this time, the MAC is in compliance with all current rules and regulations addressing GHGs and climate change.** The MAC has continued to be proactive in its environmental stewardship by addressing new issues and the management of GHGs. By evaluating development alternatives with respect to GHGs, the MAC has positioned itself to mitigate risks associated with GHGs including environmental impacts, regulatory action and uncertain costs. Though regulations and rules continue to change almost daily, the MAC can continue to use these GHG inventories as a planning tool for navigating in an uncertain future. As a leader in the community, the MAC further demonstrates the responsibility to find solutions for controversial and constantly changing issues while still serving the community.
2. **MAC-controlled GHG emissions contribute one percent to the MSP footprint.** As detailed in the inventory, the MAC contributes one percent of the GHG emissions associated with the operations and activities conducted at MSP.
3. **Regardless of the magnitude of emissions, the MAC continues to study and reduce GHG emissions.** While the MAC contributes a minimal level of emissions to the region when compared to activities controlled by others at the airport, the organization strives to reduce emissions where possible.
4. **Aircraft taxi times and related efficiencies are a primary driver of local emissions.** Taxi times and efficiencies were a primary driver in aircraft-related emissions below 3000 feet AGL not directly correlating with operations levels. Evaluation of taxi alternatives and traffic patterns should be completed to determine potential decreases in emissions at the local level.
5. **Elements of NextGen implementation offer possible significant GHG emission reduction opportunities.** Given that aircraft operations generate approximately 95 percent of the GHG emission from MSP, the FAA's implementation of aircraft procedures that reduce fuel burn will provide substantive GHG emissions reduction. Based on current FAA proposals, the implementation of Area Navigation (RNAV) Standard Terminal Arrival Routes integrating Optimized Profile Descents (OPD) provides the biggest opportunity in this regard.
6. **The MAC's changing energy mix has contributed to emissions decreases.** MAC emissions from Scope 1 sources have continued to drop from 2005 as a result of operations and weather patterns. MAC Scope 2 emissions have increased but not enough to offset the gains from the Scope 1 sources. Furthermore, MAC fleet emissions have decreased as use of alternative fuel vehicles have increased versus gasoline and diesel vehicles. The MAC should continue to evaluate the efficiency of electric power and supply options versus the natural gas equipment located onsite. Efficiency projects for both sources can provide additional decreases when comparing energy consumption on the whole.

In consideration of potential environmental impacts and future legislation and regulation, the MAC can use this study and previous studies to analyze both current and future projects with respect to GHG emissions. It is strongly recommended that the MAC monitor state and federal GHG initiatives closely and continue to track its own emissions. This will allow the MAC to be ready not only to meet or exceed reduction goals and/or new standards as they are promulgated in the future, but to do so in a manner that builds on the noteworthy GHG reductions already accomplished to date.

5.0 Initiatives and Projects

5.1 INITIATIVES

One of the MAC's Value Statements pledges that the organization will "demonstrate leadership in sound environmental management". The projects described in this GHG inventory report (and previous reports) are a testament to the MAC's longtime leadership in operating an airport in a manner that is safe, secure, customer-oriented, economically-sound and environmentally responsible, and that reflects the goals of the MAC's Stewards of Tomorrow's Airport Resources (STAR) program.

5.2 MAC ENERGY CONSERVATION PROGRAM (MECP) PROJECTS

Envisioning a long-term strategy of energy conservation, the MAC established the Energy Conservation Program (MECP) to provide a framework with which to develop and implement projects at MSP. Under the MECP, the MAC has implemented numerous projects that have reduced energy consumption, thereby lowering GHG emissions. Since 1989, the MECP projects have saved approximately 22,282 MWH and reduced emissions by an estimated 8,300 metric tons CO₂e per year. The projects include the following:

- Boiler projects
 - Economizer set back
 - Heat recovery
 - Recommissioning
 - Steam trap replacement and monitoring
- Chilled water projects
 - Delta-t improvements
 - Piping modifications
- Condenser projects
 - Deaeration
 - Filtration
 - Piping modification
 - Variable-frequency drive pumps
- Cooling upgrades
- Energy Cooperation Programs
- Electrical and lighting upgrades
- Flight Information Display System (FIDS) Monitors
- High-efficiency chiller plant addition
- Open Architecture Building Automation (OABA)
- Winter cooling water savings

Other projects and details have been discussed in previous reports. In addition, the MSP 2020 Improvements EA/EAW quantified the emissions changes associated with different project scenarios. The MAC is currently implementing ongoing projects while developing and planning for future projects as well. These projects continue the MAC's leadership in energy reduction as part of the MECP. Details on specific projects are presented below:

- Phases 12 and 13 –Construction for Phases 12 and 13 began in 2010, and projects are now providing efficiency gains throughout MSP. Project accounting has not yet quantified the benefit.
 - Mechanical – A heat recovery system was installed on Boiler 4 at Terminal-1-Lindbergh. The recovery system eliminates the need for steam to heat the combustion air and reduces natural gas consumption.
 - Electrical – Power factor correction capacitors were installed to reduce energy consumption on moving escalators by up to 23 percent.
 - Lighting – Lighting controls, including occupancy sensors and timed switches as well as load shedding, were installed to reduce electrical consumption throughout the terminals.
 - Architectural – Weather stripping was installed to reduce leakage and increase energy efficiency throughout the terminals.
- Phases 14, 15, and 16 – In 2011, the MECP Phases 14, 15 and 16 projects were completed. These projects built upon the gains from previous phases.
 - Mechanical – Similar to Phases 12 and 13, stack heat recovery systems were installed on boilers at Terminal 2-Humphrey, resulting in reduced natural gas consumption. Chilled water cooling systems were expanded to reduce energy consumption associated with chillers. Air handlers were also equipped with sensors to reduce energy associated loss of make-up air due to infiltration.
 - Electrical – Power factor correction was installed at the Glycol Facility to reduce electrical consumption similar to the escalator projects. High-efficiency electrical transformers were installed in the E and F Concourses. Motor efficiency controllers were installed on moving walkway and escalators as well.
 - Architectural – Additional weather sealing was completed on jet-way doors, overhead doors, and sliding doors leading to the parking ramps.
- Phases 17, 18, and 19 – Initiated in 2011, projects in Phases 17, 18 and 19 continue the progress from the previous MECP Phases. Implementation began in 2012.
 - Mechanical – Boiler stack heat recovery completion for Boilers 2 and 3 began. The first-ever mechanical solar thermal heating system in a MAC building was added to support snow melting and truck washing, and to heat domestic water while reducing the load on the existing boilers at the Trades Building.
 - Electrical – Motor efficiency controllers were to be added to escalators and moving walkways. Transformers were replaced with higher-efficiency models. Electrical demand use flattening will be analyzed to provide additional opportunities.
 - Lighting – Lighting upgrades were continued. Additional opportunities for these upgrades in new areas underwent evaluation.
 - Architectural – Daylighting was assessed to determine areas available for reduced electrical consumption during daylight hours.

5.3 TRANSPORTATION PROJECTS

The MAC also focuses on fleet and infrastructure improvements at MSP in order to reduce emissions. These improvements influence reductions in both the direct and indirect emissions at MSP. Individual projects have not been quantified but overall emissions reflect the efforts implemented by the MAC.

As discussed in the results section, the MAC fleet has continued to reduce emissions due to increased efficiency and fuel switching. Additionally, ground access vehicle emissions have decreased. As discussed in the MSP 2020 Improvements EA/EAW, roadway improvements will offset and, in some cases, reduce emissions from vehicles around the airport. Completed vehicle and infrastructure projects completed include the following:

2009

- Terminal 1-Lindbergh – New Parking Entrance/Transit Gate
- Airport Lane/34th Ave Access Re-Configuration
- One electric vehicle added
- Two hybrid vehicles added
- Two E-85 vehicles added

2010

- One electric vehicle added

2011

- Taxiway C Extension to Humphrey Remote

2012

- Terminal 2 – Humphrey Helix Access Gates/Loops
- Diesel Exhaust Retrofit (of Field Maintenance equipment)
- One electric vehicle added
 - The MAC currently has 60 E-85 vehicles
- NOC/MAC evaluated and supported the FAA’s design and implementation of RNAV STARs incorporating OPD in to aircraft arrival operations at MSP

5.4 SUSTAINABLE MANAGEMENT PLAN

During the drafting of this report MAC staff began the process of developing a scope and plan for the development of a comprehensive Sustainable Management Plan (SMP) for the MAC–MSP. This included an evaluation of the resources required to complete the planning process. In an effort to secure the needed resources for this project, a Letter of Interest (LOI) was submitted to the Federal Aviation Administration (FAA) for Airport Improvement Program (AIP) funding through the FAA’s emerging Sustainable Master/Management Planning Program.

The 2014 the MAC Capital Improvement Program includes \$700,000 for the development of a SMP for the MAC–MSP as a project that qualifies for AIP funding. The FAA has extended a grant offer totaling \$517,500 (providing approximately 75 percent federal discretionary funding).

Using the FAA’s guidance for developing Sustainable Management Plans as a starting point, the preliminary planning scope for the MAC–MSP planning process includes activities focused on:

- Executive management engagement and sustainability vision-mission and policy statement development
- Airport sustainability benchmarking
- Identifying and engaging MAC-MSP stakeholders, including the development and operation of working committees in the planning process
- Public/stakeholder participation, outreach, and communication
- Defining sustainability categories
- Conducting baseline inventory assessment
- Sustainability goal-setting
- Identifying sustainability initiatives and developing implementation plans
- Management system planning
- Document publication

The resulting Sustainable Management Plan will provide a foundation for the formal integration of sustainability into the MAC’s organizational culture, while providing a coordinated and accountable approach to establishing metrics, goals, strategies, and assessment and improvement frameworks that address long-term environmental, operational, financial, and social needs.

The planning process will begin in April of 2014 with completion of the SMP planned by the end of 2015.

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