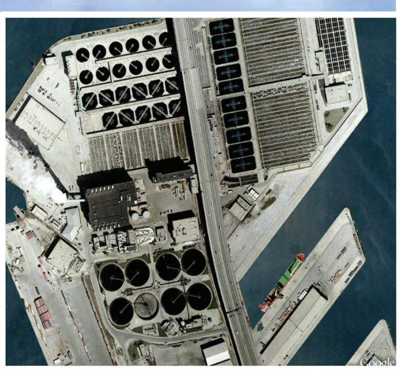
Preserving The Environment • Improving Water Quality

Final

Greenhouse Gas Inventory 2000–2007

February 2010



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Final Report

Greenhouse Gas Inventory 2000–2007

Submitted to

Milwaukee Metropolitan Sewerage District

February 2010

CH2MHILL

Executive Summary

The Milwaukee Metropolitan Sewerage District prepared a greenhouse gas (GHG) inventory that includes the District's water reclamation facilities, conveyance system, and other related District-owned and controlled facilities and programs. This report documents GHG emissions that fall within the District's inventory boundaries for the period 2000 to 2007. The District developed the GHG inventory in anticipation of future regulations and as a good management practice. The District intends to use the results of the inventory to develop strategies for managing GHG issues in the future, including developing policy and emission reduction goals.

The District's GHG inventory includes direct (Scope 1) emissions from mobile and stationary combustion sources and water reclamation processes, indirect (Scope 2) emissions from electricity purchases, and biogenic GHG emissions[1] associated with digester gas combustion and water reclamation processes. The emissions inventory accounts for GHG emissions from carbon dioxide, nitrous oxide, and methane. Estimates were developed using recognized and standardized approaches and principles in accordance with the World Resources Institute (WRI)/World Business Council on Sustainable Development (WBCSD) GHG Protocol. The GHG emissions are reported in terms of carbon dioxide equivalents (CO_{2e}).[2]

Exhibit 1 summarizes the inventory results for calendar year 2007.

EXHIBIT 1
2007 Annual GHG Emissions (tonnes CO_{2e}/year) by Facility and Source (All)

Facility	Stationary Combustion	Purchased Electricity	Water Reclamation Emissions	Mobile Combustion	Total Emissions	Percent of Total District Emissions
Jones Island total	**72,800**	**28,300**	**47,200**[a]		**148,300**	**65%**
South Shore total	**23,400**	**10,400**	**41,200**		**75,000**	**33%**
Headquarters and laboratory	600	1,800			**2,400**	1.0%
Other sources[b]	1,000	2,200			**3,200**	1.4%
All mobile sources				700	**700**	0.3%
Total District Emissions	**97,800**	**42,700**	**88,400**	**700**	**229,600**	
Percent of total	42%	17%	39%	0.3%		

[a]Includes methane emissions from sludge drying.

[b]Other sources include 13th and College facility, flushing station/Alterra coffee shop, interceptor sewer system and the inline storage and pumping system.

[1]GHG emissions considered part of the natural carbon cycle because they are of biogenic origin—recently contained in living organic matter.

[2]The universal unit for comparing emissions of different GHGs expressed in terms of the global warming potential (GWP) of one unit of carbon dioxide.

The District's two water reclamation facilities contribute more than 97 percent of its total GHG emissions: 65 percent from Jones Island and 33 percent from South Shore. All other facilities including mobile sources, headquarters, laboratory, 13th Street, Alterra and the interceptor system account for less than 3 percent of the total emissions.

Approximately 32 percent of the District's total GHG emissions are from stationary combustion sources at Jones Island. Stationary combustion sources are defined as nonvehicle sources that combust fuel including the dryers, boilers, internal combustion engines, and flares. The largest stationary combustion sources are the Jones Island turbines and dryers. Waste heat exhausted from the turbines and natural gas is used in the dryers to dry the solids to produce Milorganite®. Stationary combustion emissions at South Shore are much lower than at Jones Island. They constitute only about 10 percent of the District's emissions.

Exhibit 2 summarizes the inventory results for calendar year 2007 from all sources, including biogenic emissions.

Exhibits 3 and 4 show the trend of GHG emissions between 2000 and 2007. Emissions have decreased about 14 percent during this period. The reduction could be due to several factors—increased digester gas use at South Shore, energy efficiency improvements, and decreased influent solids loadings and Milorganite® production. However, an evaluation of the reasons for the decrease is beyond the scope of the project. Additional evaluation of these trends could be useful for identifying future reduction opportunities.

GHG measurements, estimates, or calculations should be neither over nor under the actual emissions value, and data uncertainty should be reduced as far as practicable to minimize uncertainty regarding emissions. To make the inventory transparent, the District estimated the emission uncertainty using the WRI/WBCSD GHG Protocol guidance on uncertainty assessment. The cumulative uncertainty for the 2007 nonbiogenic emission yielded a range of ± 5.5 percent. This is considered to be a good level of data accuracy.

As part of the GHG project, the District's Greenseams program was evaluated to see if and how it can be used to establish GHG emission credits by demonstrating that the vegetation on the land purchased by the District is reducing GHGs through carbon sequestration. The findings are that the Greenseams program will result in some reduction in emissions based upon avoided deforestation activity and reforestation/restoration activities. Trees have been planted on some parcels, and some parcels have undergone prairie restoration. However, to qualify for verifiable emission reduction credits, the program likely will have to meet requirements in accordance with the standards applicable to the project (e.g., the specific carbon trading program or future regulatory program). The Greenseams program may need to be expanded to include further land use changes, such as additional reforestation, or additional prairie restoration to support such a program.

If the District desires to pursue using the Greenseams program for carbon management purposes, it is recommended that the District evaluate markets for selling carbon credits generated by the program, through either reforestation/afforestation or the conservation of grasslands. The ability to sell carbon credits and the price projected for them should be evaluated against the cost of tree planting and maintenance and the required data management and reporting activities to determine the net cost/benefit.

EXHIBIT 2
2007 Annual GHG Emissions by Source (tonnes CO_{2e}/year) (Including Biogenic)

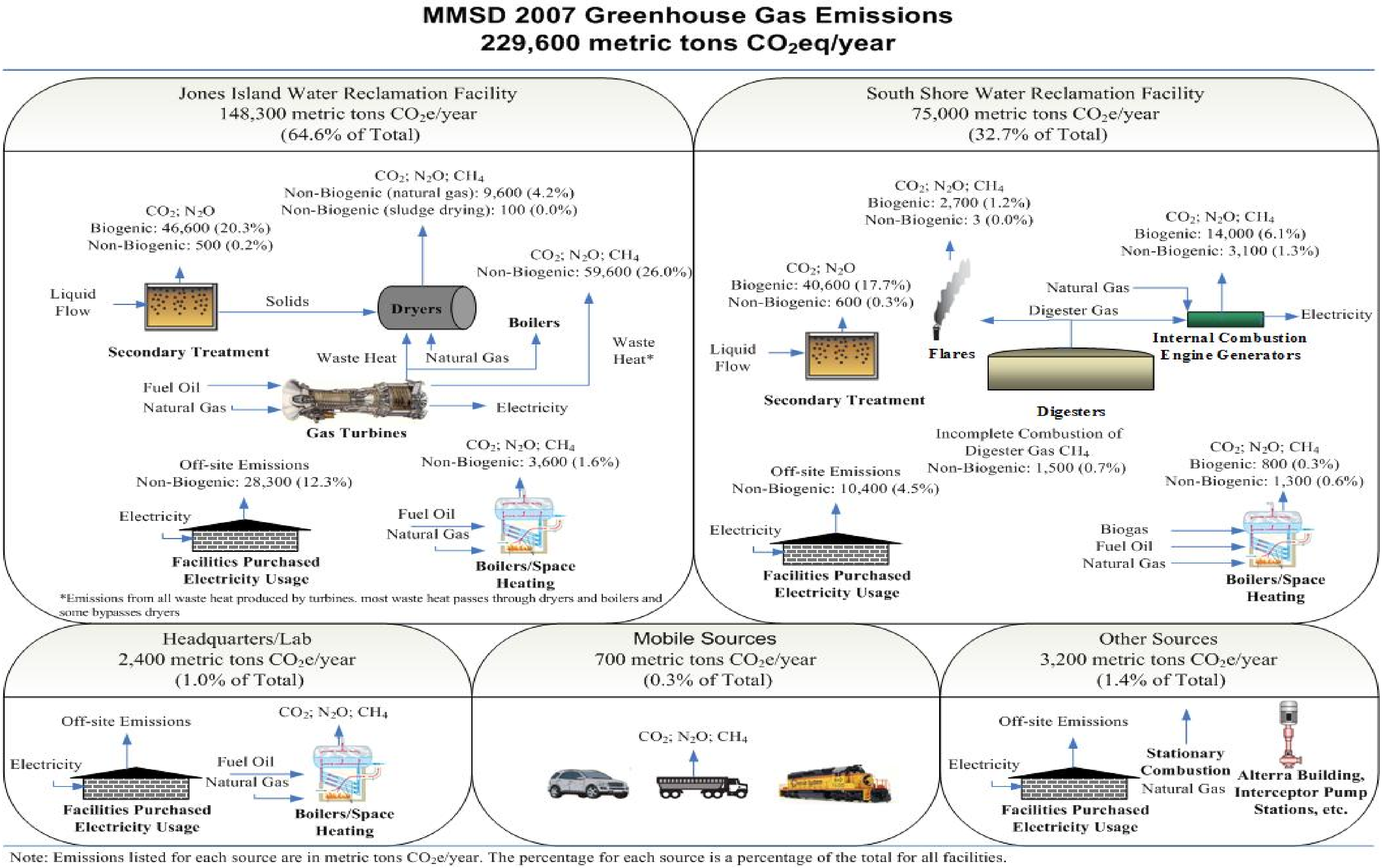
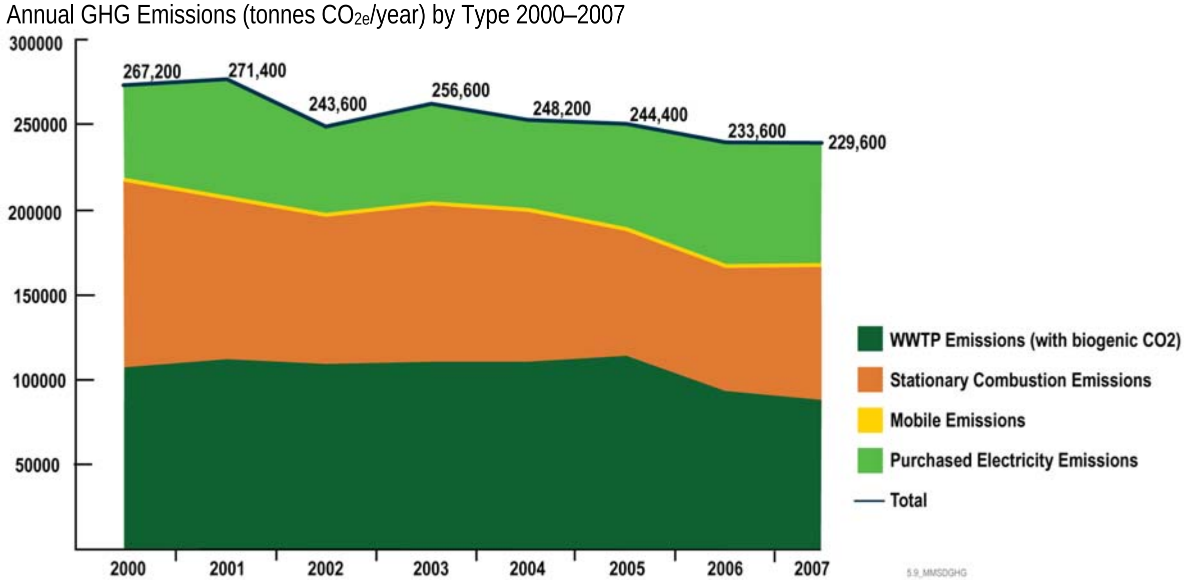


EXHIBIT 3
Annual GHG Emissions (tonnes CO_{2e}/year) by Type 2000–2007

Year	Biogenic Water Reclamation Emissions	Water Reclamation Emissions	Mobile Combustion	Purchased Electricity	Stationary Combustion	Biogenic Stationary Combustion	Total
2000	106,500	1,200	700	39,300	110,900	8,600	267,200
2001	110,900	1,200	700	48,800	97,600	12,200	271,400
2002	108,700	1,100	700	32,300	89,000	11,800	243,600
2003	109,200	1,100	700	38,000	95,300	12,300	256,600
2004	109,000	1,200	700	35,300	89,800	12,200	248,200
2005	103,100	1,200	700	35,700	86,700	17,000	244,400
2006	91,900	1,200	700	50,300	74,400	15,100	233,600
2007	87,200	1,200	700	42,700	80,300	17,500	229,600
% change 2000 to 2007	-18%	0%	0%	+9%	-28%	+103%	-14%

EXHIBIT 4
Annual GHG Emissions (tonnes CO_{2e}/year) by Type 2000–2007



The District may want to consider other benefits in addition to those of carbon sequestration. Trees may be planted strategically to reduce energy use that will cause reductions in GHG emissions associated with power generation. Tree trimming wastes could be as fuel to reduce GHG emissions if the trees are used to replace fossil fuel sources, such as coal or natural gas.

Preparing this emissions inventory has provided important information about the District's GHG emissions profile that the District can use to prepare for and respond to the potential impact of new regulations including documenting early actions taken to reduce GHG emissions. Below are several recommendations for capturing or improving GHG inventory emissions data in the future:

1. Develop a comprehensive system to improve data quality/data management activities for documenting GHG emissions, including procedures to ensure the accuracy, consistency, proper documentation, security, and transparency of the data.
2. Develop procedures to report emissions in accordance with current and potential future applicable federal, state, and local regulations.
3. Identify and determine appropriate organizations or avenues by which to publicly report emissions.
4. Continue to identify other means and methods to reduce GHG emissions, continuing to increase the amount of renewable energy used, and evaluating energy conservation opportunities.
5. As part of its Landfill Gas Utilization Project, the District is undertaking the Jones Island Gas Turbine Replacement Project, which calls for the installation of five new 4.6-MW turbine systems, capable of running on landfill gas and natural gas, by January 2013. The project will replace two 18-MW natural gas turbine generators. As part of the project, the District should continue to evaluate methods to maximize the use of turbine waste heat and pursue the possibility of selling excess renewable energy or selling carbon credits that may result from GHG emission reductions achieved through the project.

Contents

Appendixes

Exhibits

Abbreviations and Acronyms

CARB	California Air Resources Board
CCAR	California Climate Action Registry
CH_4	methane
CO_2	carbon dioxide
CO_{2e}	carbon dioxide equivalents
District	Milwaukee Metropolitan Sewerage District
eGRID	Emission and Generation Resource Integrated Database
USEPA	U.S. Environmental Protection Agency
GHG	greenhouse gas
GWP	global warming potential
ICLEI	International Council for Local Environmental Initiatives
IMP	Inventory Management Plan
IPCC	Intergovernmental Panel on Climate Change
MMBtu	million British thermal units
MMscf	million standard cubic feet
MWh	megawatt-hours
kg	kilograms
kWh	kilowatt-hours
N_2O	nitrous oxide
scf	standard cubic feet
SF_6	sulfur hexafluoride
tonne	metric tonne (2,204.62 pounds)
WBCSD	World Business Council on Sustainable Development
WRI	World Resource Institute

Glossary

Activity data	Data on the magnitude of a human activity resulting in emissions or reductions taking place during a given period. Data on energy use, miles traveled, and influent loading are all examples of activity data that might be used to compute GHG emissions.
Base year	A specific year against which an entity's emissions are tracked over time.
Biogenic emissions	GHG emissions considered part of the natural carbon cycle because they are of biogenic origin—recently contained in living organic matter. CO_2 emissions from biological water reclamation processes can be thought of as a natural result of humans eating carbon-based foods, with the emissions being reused by food plants and other plants, thereby creating no net gain in carbon emissions. Biogenic emissions are considered "carbon neutral."
Carbon dioxide equivalents	The universal unit for comparing emissions of different greenhouse gases (GHGs) expressed in terms of the global warming potential (GWP) of one unit of carbon dioxide.
Control approach	An emissions accounting approach for defining organizational boundaries in which an entity reports 100 percent of the GHG emissions from operations under its financial or operational control.
Direct emissions (Scope 1)	Emissions from sources that are owned or controlled by the reporting entity, including stationary combustion emissions, mobile combustion emissions, process emissions, and fugitive emissions. Some specific examples include: boilers, heaters, generators, cars, trucks, manufacturing equipment, and emissions from piping and valves.
Entity	A reporting entity comprises all the facilities and emission sources delimited by the organizational boundary developed by the entity, taken in their entirety.
Equity share approach	An emissions accounting approach for defining organizational boundaries in which an entity accounts for GHG emissions from each operation according to its share of economic interest in the operation, which is the extent of rights an entity has to the risks and rewards flowing from an operation.
Facility	Any installation or establishment located on a single site or on contiguous or adjacent sites that are owned or operated by an entity. Mobile sources, such as vehicle fleets, which operate outside of the physical boundaries of a facility, are considered discrete facilities.

Financial control	The ability to direct the financial and operating policies of an operation with an interest in gaining economic benefits from its activities. Financial control is one of two ways to define the control approach; the other is operational control, defined below.
Greenhouse gases (GHGs)	For the purposes of this document, GHGs are the six gases identified in the Kyoto Protocol: carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6).
Indirect emissions (Scope 2)	Emissions that are a consequence of the activities of the reporting entity but that occur at sources owned or controlled by another. For example, emissions that occur at a power plant as a result of electricity used by a facility represent the facility's indirect emissions.
Normalization factor or intensity ratio	The ratio of GHG emissions over an appropriate normalizing factor is used to measure GHG intensity. Normalizing factors or intensity ratios are typically measured in physical units (e.g., tons of solids, millions of gallons of water) or economic units. Because of the large variability in economic metrics, there is a preference for using metrics based on physical values, which typically track year-to-year changes in emissions intensity more accurately.
Operational control	Full authority to introduce and implement operating policies at an operation. Operational control is one of two ways to define the control approach; the other is financial control, defined above.
Organizational boundaries	The boundaries that determine the operations owned or controlled by the reporting entity, depending on the consolidation approach taken (either the equity share or control approach).
Organic growth (or decline)	Increases or decreases in GHG emissions as a result of changes in influent flow, biochemical oxygen demand, and total suspended solids, facility closures or construction of new facilities.
Other indirect emissions (Scope 3)	All indirect emissions not covered in Scope 2. Examples include upstream and downstream emissions, emissions resulting from the extraction and production of purchased materials and fuels, transport related activities in vehicles not owned or controlled by the reporting entity, use of sold products and services (e.g., Milorganite®, Agri-Life), outsourced activities, recycling of used products, waste disposal, etc.
Structural change	A change in the organizational or operational boundaries of an entity resulting from a transfer of ownership or control of emissions from one entity to another. Structural changes usually result from a transfer of ownership of emissions, such as mergers, acquisitions, divestitures but can also include insourcing and outsourcing.

1. Introduction

1.1 Criteria and Purpose

The Milwaukee Metropolitan Sewerage District has prepared a greenhouse gas (GHG) inventory that represents a true and fair account of its GHG emissions through the use of standardized approaches and principles in accordance with the World Resources Institute (WRI)/World Business Council on Sustainable Development (WBCSD) GHG Protocol.

The inventory includes the District's water reclamation facilities, conveyance sewer system, and other related District-owned facilities and programs. The GHG emissions inventory accounts for the six greenhouse gases covered by the Kyoto Protocol. The Kyoto Protocol is an international agreement associated with the United Nations Framework Convention on Climate Change, which commits industrialized countries to reducing the following GHG emissions:

- Carbon dioxide, CO_2
- Methane, CH_4
- Nitrous oxide, N_2O
- Hydrofluorocarbons, HFCs
- Perfluorocarbons, PFCs
- Sulfur hexafluoride, SF_6

The object of the inventory is to calculate and document GHG emissions that fall within the District's inventory boundaries, and to ensure the GHG inventory appropriately reflects the GHG emissions of the District for the period 2000 to 2007.

1.2 GHG Accounting and Reporting Principles

The District has used five overarching accounting and reporting principles that are intended to ensure that the District's GHG data represent a faithful, true, and fair account of its GHG emissions. The following principles, adapted from the WRI/WBCSD GHG Protocol, serve to guide the measurement and reporting of emissions.

- **Relevance—**The GHG inventory will appropriately reflect the District's GHG emissions and will be organized to reflect the areas over which the District exerts control and holds responsibility, in order to serve the decision-making needs of users.

- **Completeness—**All GHG emission sources and emissions-causing activities within the inventory boundary are accounted for. Specific exclusions are justified and disclosed.

- **Consistency—**Consistent methodologies are used in the identification of boundaries, analyses of data, and quantification of emissions to enable meaningful trend analysis over time, demonstration of reductions, and comparisons of emissions. Changes to data, inventory boundary, methods, or relevant factors in subsequent inventories will be disclosed.

- **Transparency—**Relevant issues are addressed and documented factually and coherently to provide a trail for review and replication. Relevant data sources and assumptions are disclosed, along with specific descriptions of methodologies and data sources used.
- **Accuracy—**The District's GHG emissions are quantified systematically neither over nor under actual emissions as far as can be judged, and uncertainties are reduced as far as practicable. Sufficient accuracy is achieved to enable users to make decisions with reasonable assurance as to the integrity of the reported information.

The District's policies and practices support the need to report GHG emissions. The District has a commitment to consider the depletion rate of nonrenewable resources and use those resources in the most productive and beneficial way possible to forestall or avoid complete exhaustion of those resources. The GHG emission inventory provides the District with information to develop future strategies for managing resources such as the energy that produces GHG emissions.

1.3 Inventory Management Plan

To ensure that the inventory is maintained in a structured and consistent manner, the District developed a GHG Inventory Management Plan (IMP). The IMP is an internal guidance document that facilitates efficient implementation of the GHG emission inventory process. The IMP is consistent with and tracks closely with globally accepted GHG protocols. It provides a reproducible and transparent inventory and is expected to help improve efficiency of the inventory process through streamlined accountability. The IMP will be updated or modified to stay consistent with regulatory and agency changes following completion of GHG inventories for calendar years 2000 through 2007. Appendix A contains the IMP.

The inventory methodology, as documented in the IMP, is based on guidance and supporting documentation from the following references:

- WRI/WBCSD. The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard, April 2004. http://www.ghgprotocol.org/standards.
- California Air Resources Board (CARB), California Climate Action Registry (CCAR), and Local Governments for Sustainability (ICLEI, International Council for Local Environmental Initiatives). September 2008. *Local Government Operations Protocol: for the quantification and reporting of greenhouse gas emissions inventories,* Version 1.0.
- The Climate Registry (TCR). *General Reporting Protocol for the Voluntary Reporting Program.* March 2008.
- *CCAR Urban Forest Project Reporting Protocol,* Version 1.0. August 2008.
- Intergovernmental Panel on Climate Change (IPCC). 2006. *Guidelines for National Greenhouse Gas Inventories.*
- USEPA, Climate Leaders Greenhouse Gas Inventory Protocol, *Design Principles*. May 2005.
- USEPA, Climate Leaders Greenhouse Gas Inventory Protocol, *Direct Emissions from Mobile Combustion Sources*. May 2008.

- USEPA, Climate Leaders Greenhouse Gas Inventory Protocol, *Direct Emissions from Stationary Combustion Sources*. May 2008.
- USEPA. *Final Rule: Mandatory Reporting of Greenhouse Gases.* September 22, 2009. EPA-HQ-OAR-2008-0508; FRL RIN 2060-A079.

1.4 Objectives

The District developed the GHG inventory in anticipation of future regulations and as a good management practice. The District intends to use the results of the inventory to develop strategies for managing GHG issues in the future, including developing policy and emission reduction goals. The benefits of developing a GHG inventory are numerous and varied, and include the following:

- **Risk Management—**Voluntarily inventorying GHG emissions helps to manage risk by documenting early actions to reduce GHG emissions. Such information may be accepted by future state, federal or international regulatory GHG programs.
- **Readiness for a Carbon Constrained Future—**Identifying emissions sources to develop a GHG profile and management strategies helps to prepare for and respond to the potential impact of new regulations.
- **Stakeholder Education—**Assembling an emissions inventory helps to inform management, constituents, employees, and the public about the District's GHG emissions profile.
- **Recognition as an Environmental Leader—**Voluntarily reporting GHG emissions provides a pathway to recognize, publicize, and promote environmental stewardship.
- **Addressing Inefficiencies—**Accounting for emissions provides better insight into the relationship between improving efficiency and reducing emissions. As a result, some organizations have redesigned operations and processes, implemented technological innovations, improved services, and ultimately saved money and resources.
- **Adherence to District Sustainability Policy—**The District commits to policies and practices that consider the depletion rate of nonrenewable resources. Further, it commits to using those resources when necessary in the most productive and beneficial way possible to forestall or avoid complete exhaustion of those resources.

2. Boundary Conditions

2.1 Organizational Boundaries

Emissions from sources within the District's organizational boundaries are defined as the GHG emissions from operations that the District owns and controls (excluding construction contracts). The WRI/WBSCD GHG Protocol defines *control* as an entity's full authority to introduce and implement operating policies.[1] The District's facilities (Exhibit 2-1) are included in the emissions inventory.

EXHIBIT 2-1
Facilities and Sources in the District's Organizational Boundaries

Facility Name	Address
Jones Island Water Reclamation Facility	700 East Jones Street
South Shore Water Reclamation Facility	8500 South 5th Avenue
Headquarters/Central Lab Building	250 West Seeboth Street 260 West Seeboth Street
Other Sources	
13th and College Facility	6060 South 13th Street
Flushing Station/Alterra Coffee Shop	1701 North Lincoln Memorial Drive
Interceptor sewer system	See Attachment B of Appendix A for a complete list of locations.
Inline storage and pumping system	See Attachment B of Appendix A for a complete list of locations.
Mobile Sources	
District Vehicles	See Attachment C of Appendix A for a complete list of vehicles.
Agri-Life Trucks	
Boats	Pelagos Research Vessel, ORP Research Boat
Locomotive	

2.2 Operational Boundaries

Based upon the available GHG reporting protocols, a reporting entity reports GHG emissions defined by the following four operational categories:

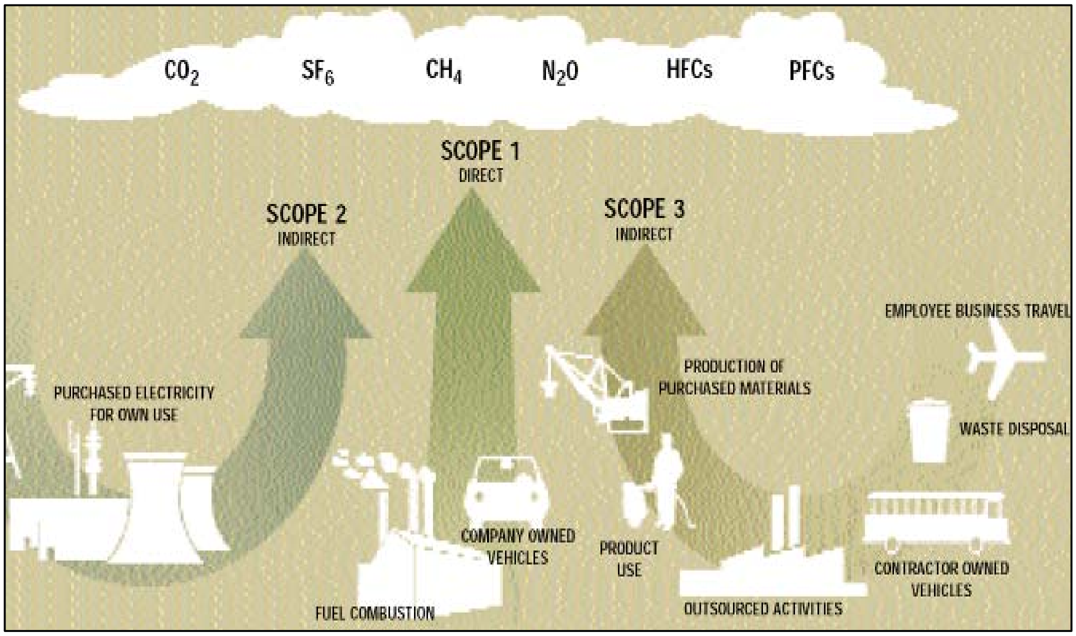
- Direct emissions; also known as Scope 1 emissions
- Indirect emissions; also known as Scope 2 emissions
- Optional or other indirect emissions; also known as Scope 3 emissions

[1]WRI/WBCSD. The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard, April 2004. http://www.ghgprotocol.org/standards.

- Biogenic emissions, considered part of the natural carbon cycle because they are of biogenic origin (recently contained in living organic matter).

The District's GHG inventory includes direct (Scope 1), indirect (Scope 2), and biogenic GHG emissions associated with digester gas combustion and the water reclamation processes. The inventory does not include optional (Scope 3) sources.

2.2.1 Direct Emissions (Scope 1)



Direct emissions include stationary combustion, water reclamation processes, and mobile source emissions. The GHG inventory contains the following general source categories:

- **Stationary Combustion**—Stationary sources that combust natural gas, diesel, or other fuels to produce electricity, steam, heat, or power (boilers, furnaces, dryers, heaters, generators, etc.) including CH_4 and N_2O emissions from combustion of digester gas.
- **Water Reclamation Processes**—CH_4 emissions from incomplete combustion of digester gas, CH_4 from sludge drying, and N_2O emissions from the activated sludge process. Other water reclamation processes have negligible GHG emissions.
- **Mobile**—Includes owned or leased vehicles (trucks, cars, boats, forklifts).

2.2.2 Indirect Emissions (Scope 2)

The District's only indirect emissions are those associated with the generation of electricity that the District purchases. The generation of renewable energy reduces GHG emissions by reducing the amount of fossil fuels that would otherwise be consumed to generate electricity. Purchased electricity generated from renewable energy does not contribute to an entity's GHG emissions but does reduce its GHG footprint. In 2006 and 2007, the District purchased electricity generated from renewable energy from Wisconsin Energy Corporation's Energy for Tomorrow program.

2.2.3 Biogenic Emissions

Following established international GHG management principles, emissions of CO_2 from combustion of digester gas and the water reclamation activated sludge processes are not included as Scope 1 sources because the carbon is of biogenic origin and otherwise would have been emitted to the atmosphere through the natural process of decay.[1]

CO_2 released from digester gas combustion and water reclamation processes is being reported separately as biogenic emissions in accordance with IPCC Guidelines for National Greenhouse Gas Inventories.

The distinction of emissions from digester gas combustion applies only to CO_2 and not to CH_4 and N_2O, which are also emitted from digester gas combustion and water reclamation processes. Unlike CO_2 emissions, CH_4 and N_2O emitted from digester gas combustion, CH_4 emitted from sludge drying processes and N_2O emitted from water reclamation processes are not considered to be of biogenic origin under current guidance, because they are the result of man-made processes. Therefore, CH_4 and N_2O emissions from digester gas combustion, sludge drying and water reclamation processes are included in the District's Scope 1 emissions.

The USEPA's mandatory reporting rule for GHGs includes reporting of CH_4 and N_2O emissions resulting from the combustion of digester gas but does not include reporting of CH_4 and N_2O emissions from water reclamation processes at publicly owned treatment works (POTW). Emissions from POTWs are not included in the reporting rule because, as described in the Wastewater Treatment TSD (EPA-HQ-OAR-2008-0508-035), emissions from POTWs do not exceed the thresholds considered under this rule. However these emissions are included in Chapter 10 of the CARB, CCAR, and ICLEI, September 2008, *Local Government Operations Protocol: for the quantification and reporting of greenhouse gas emissions inventories,* Version 1.0. It is deemed prudent to include these emissions in this inventory for the purposes of completeness and potential for future regulation.

The GHG inventory guidance documents followed do not include emission factors for methane emissions that could be formed and released in the sludge during the drying process. However, methane emissions associated with the sludge drying process have been estimated by calculating the difference between the methane measured during the 2007 dryer/turbine stack test and the uncombusted turbine natural gas. The methane emitted from the uncombusted turbine natural gas was estimated using an emission factor. Given the underlying accuracy of the data, the emissions presented in this report have been rounded to the nearest hundred tonnes.

2.3 Source List

The District maintains a list of specific emission sources. Exhibit 2-2 lists the emission sources included in the inventory by facility.

[1] IPCC. 2006. *Guidelines for National Greenhouse Gas Inventories.*

EXHIBIT 2-2
GHG Emission Source List

Facility Name	Stationary Combustion Emissions	Water Reclamation Emissions	Indirect Emissions
Jones Island Water Reclamation Facility	Dryers (natural gas) Two 16-MW turbines (natural gas, fuel oil) Two Cleaver Brooks boilers (natural gas, fuel oil) Building heat (natural gas and propane)	Biogenic CO_2 and N_2O from aeration basins CH_4 from sludge drying	Purchased electricity
South Shore Water Reclamation Facility	Boilers – three Kewaunee, two Scum, two Cleaver Brooks (natural gas, digester gas) Five IC engine generators (natural gas, digester gas) Building heat (natural gas) Two flares (digester gas)	Biogenic CO_2 and N_2O from aeration basins CH_4 from incomplete combustion of digester gas Biogenic CO_2, and nonbiogenic CH_4 and N_2O are emitted from stationary combustion of digester gas	Purchased electricity
Headquarters and Central Lab Building	Building heat (natural gas)	NA	Purchased electricity
Other sources	Building heat (natural gas)	NA	Purchased electricity

Note: Mobile sources are not tracked at each facility but are tracked at the entity level.

2.4 GHG List

The six GHGs covered by the Kyoto Protocol were considered for inclusion in the GHG inventory. The District's operations emit the following GHGs:

- Biogenic CO_2, nonbiogenic CH_4, and N_2O are emitted from water reclamation processes, and nonbiogenic CH_4 is emitted from sludge drying processes.
- CO_2, CH_4, and N_2O are emitted from stationary combustion, mobile combustion and nonrenewable energy electricity usage. Biogenic CO_2, and nonbiogenic CH_4 and N_2O are emitted from stationary combustion of digester gas and dried sludge.
- Air conditioning and other refrigeration units have been reviewed to determine if their GHG emissions should be included in the inventory. Existing units use refrigeration chemicals that are being phased out under the Montreal Protocol (e.g., CFCs). Montreal Protocol gases are not among the GHGs covered by the Kyoto Protocol and, therefore, are not included in the District's inventory.[1] As the phased-out chemicals are replaced with hydrofluorocarbons or perfluorocarbons, it is recommended that emissions associated with air conditioning and refrigeration be reviewed for possible inclusion in the District's inventory.

[1]WRI/WBSCD. April 2004. *The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard.*

Based upon the USEPA mandatory reporting rule for GHGs and recently proposed cap and trade legislation submitted by Waxman-Markey (U.S. Bill H.R. 2454), the District has identified the water reclamation plant emissions that will likely be reported or regulated in the U.S. (Exhibit 2-3).

EXHIBIT 2-3
Water Reclamation Plant GHG Emissions Likely to be Regulated or Reported

Emissions Sources	CO_2	CH_4	N_2O
Fossil fuels	Yes	Yes	Yes
Digester biogas fuel	No	Yes	Yes
Water reclamation processes	No	No	No
Sludge drying (not including emissions due to fuel combustion)	No	No	NA

3. Calculation Methodology

3.1 Calculation Methodology

The emission calculation methodology used by the District follows the guidance of the WRI/WBCSD GHG Protocol. Additional guidance was obtained from USEPA Climate Leader's GHG Inventory Protocols, CCAR protocols, and TCR protocols when the WRI/WBCSD GHG protocol was incomplete or unclear. Detailed calculation methodologies are documented in the IMP (Appendix A) and the GHG inventory tool. The GHG inventory tool is the tool used for calculating GHG emissions, conducting data analysis and comparisons, and issuing reports. The District uses an Excel spreadsheet as its GHG inventory calculation tool.

An overview of the methodology used to calculate the District's GHG emissions is provided below. Appendix A contains detailed calculation methodologies and emission factors for each source and fuel type, including specific emission factors used for CO_2, CH_4 and N_2O.

3.2 Global Warming Potentials

GHGs have different warming potentials. The Global Warming Potential (GWP) index was developed to compare different GHGs on a common reporting basis. A gas's ability to trap atmospheric heat over a certain lifetime in the atmosphere in reference to the same mass of CO_2 released over the same time period is its GWP. Since GWP is weight-based and time-dependant, GHG emissions commonly are reported as CO_2 equivalents (e.g., tonnes CO_2 e) using the broadly adopted 100-year GWP standard. The District calculates all GHG emissions as tonnes of CO_2 e. Exhibit 3-1 provides GWP values used to calculate CO_2 e emissions.

EXHIBIT 3-1
Global Warming Potentials

GHG	GWP
Carbon dioxide, CO_2	1
Methane, CH_4	21
Nitrous oxide, N_2O	310

Note: 100-year GWP estimates, from the Intergovernmental Panel on Climate Change's *Second Assessment Report* (1995). GWP values are from the *Second Assessment Report* to be consistent with international practices.

3.3 Direct Emissions from Stationary Combustion Sources

Natural gas, digester gas, No. 2 fuel oil, and propane are combusted at the District's facilities. The District uses utility invoice records and the annual air emission inventory report required by the Wisconsin Department of Natural Resources to track annual fuel usage by emission source. Utility invoice records are available for most facilities and reporting years. The air emission inventory report provides fuel usage by specific equipment type for the Jones Island and South Shore facilities.

The approach for estimating CO_2 emissions from stationary combustion sources varies significantly from that for estimating CH_4 and N_2O emissions. Whereas CO_2 can be reasonably estimated by applying an appropriate carbon content and fraction of carbon oxidized factor (with a typical default value of 1, or 100 percent oxidation) to the fuel quantity consumed, estimating CH_4 and N_2O depends not only upon fuel characteristics, but also on technology type and combustion characteristics, usage of pollution control equipment, and ambient environmental conditions. Emissions of these gases also vary with the size, efficiency, and vintage of the combustion technology, as well as maintenance and operational practices. A much greater effort is required to estimate CH_4 and N_2O emissions from stationary sources, and therefore a much higher level of uncertainty exists.[1] To reduce uncertainty, where fuel usage is available for a specific type of combustion unit used at the facility (e.g., turbines, boilers, and dryers), the emission factors for CH_4 and N_2O are based on specific combustion unit and fuel type. For stationary combustion not related to a specific type of combustion unit (e.g., building heat), typical emission factors are based upon fuel type.

3.4 Direct Emissions from Mobile Combustion Sources

Mobile combustion sources include both on-road and nonroad vehicles, such as automobiles, trucks, boats, trains, tractors, and other maintenance vehicles. The combustion of fossil fuels in mobile sources emits CO_2, CH_4, and N_2O. Emissions from mobile combustion are estimated using emission factors, and vehicle fuel use or miles traveled.

The inventory includes mobile combustion emissions from the following:

- District-owned or operated cars and trucks
- Lawn care equipment
- Snow blowers
- Agri-Life vehicles
- Pelagos Research Vessel
- ORP Research Boat
- The locomotive used to transport Milorganite® at Jones Island

Attachment C in Appendix A contains a complete list of the number and type of mobile sources included in the inventory. For most of these mobile sources, actual fuel use or mileage data were not available; therefore fuel consumption was estimated based on estimated annual mileage and vehicle fuel efficiency. Emission factors by fuel type are based upon USEPA Climate Leaders GHG Protocol, Direct Emissions from Mobile Combustion Sources (May 2008).

3.5 Water Reclamation Process Emissions

Water reclamation process emissions include the following:

- Biogenic CO_2 emissions from stabilization, or biodegradation of organic matter from the activated sludge process and digesters
- CH_4 emissions from incomplete combustion of digester gas and from sludge drying processes.

[1] USEPA. May 2008. *Climate Leaders Greenhouse Gas Inventory Protocol, Direct Emissions from Stationary Combustion Sources.*

- N_2O emissions from activated sludge nitrification and from the effluent after it is discharged to Lake Michigan. Emissions from the effluent that may occur in the Lake are outside of the District's organizational boundaries and therefore are not included in the inventory.

Biogenic CO_2 emissions from water reclamation processes at Jones Island and South Shore are calculated based upon estimated CO_2 generation rates for oxidation of biochemical oxygen demand[1] using influent loading data.

Operation of the South Shore anaerobic digesters produces CH_4, which is then combusted in boilers, engines, or flares. Because of small but inherent inefficiencies, the incomplete combustion of digester gas is a source of CH_4 emissions. CH_4 emissions are calculated in accordance with Chapter 10 of the CARB, CCAR, and ICLEI *Local Government Operations Protocol for the Quantification and Reporting of Greenhouse Gas Emissions Inventories,* Version 1.0 (September 2008). The estimate of CH_4 emissions also uses measured digester gas generation rates and the measured fraction of CH_4 in the digester gas.

Methane emissions that occur because of the formation and release of methane from the sludge in the dryers at Jones Island were determined in part using dryer/turbine stack test data collected in 2007. Emissions from the dryer/turbine stack also include emissions from the combustion of the natural gas used to operate the turbines. Therefore the methane emissions associated with the *sludge* are estimated by calculating the difference between the stack test data and the uncombusted methane from the turbine natural gas. Emissions from the uncombusted turbine natural gas were estimated using turbine natural gas emission factors. The turbine emissions from uncombusted methane are included in the stationary combustion source emissions. The methane emissions released from the sludge are included in the water reclamation emissions.

The generation of N_2O may result from the treatment of domestic wastewater during both nitrification and denitrification of the nitrogen present, usually in the form of urea, ammonia, and proteins. These compounds are converted to nitrate (NO_3) through the aerobic process of nitrification, but N_2O emissions also occur during nitrification. Denitrification occurs under anoxic conditions (without free oxygen), and involves the biological conversion of nitrate into dinitrogen gas (N_2). N_2O is a minor, intermediate product of both nitrification and denitrification processes, but it is more often associated with denitrification.[2] The District's reclamation facilities were not designed intentionally to denitrify, although as with all wastewater reclamation plants, some limited denitrification likely occurs under certain operating conditions.

N_2O process emissions from water reclamation processes at Jones Island and South Shore are calculated in accordance with Chapter 10, "Centralized Wastewater Treatment Facilities," of the *Local Government Operations Protocol*, which provides calculation methods using an average N_2O emission factor per person per year and population served data.

[1] Metcalf & Eddy. 1991. *Wastewater Engineering.*

[2] California Air Resources Board, California Climate Action Registry, and ICLEI. September 2008. *Local Government Operations Protocol: for the Quantification and Reporting of Greenhouse Gas Emissions Inventories,* Version 1.0.

3.6 Indirect Emissions

The District's only indirect emissions are those associated with the generation of electricity that the District purchases. The District uses utility invoice records to track electricity consumption for each facility. In 2006 and 2007, the District purchased electricity generated from renewable energy from the Wisconsin Energy Corporation's Energy for Tomorrow program.

GHG emissions from typical electricity generation can be determined by estimating the mix of fuels used to generate the electricity purchased by the District. The USEPA's Emissions and Generation Resource Integrated Database (eGRID), which provides emission factors by geographical location, was used to estimate that mix of fuels. All facilities in the District's inventory are in the Milwaukee area; therefore the eGRID emission factors selected for those facilities are the North American Electric Reliability Corporation region, Reliability First Corporation West factors for CO_2, CH_4 and N_2O.

The generation of renewable energy reduces GHG emissions by reducing the amount of fossil fuels that would otherwise be consumed to generate electricity. Therefore electricity generated from renewable energy sources does not contribute to an entity's GHG emissions but reduces its GHG footprint. Emission reductions for the District's renewable energy are calculated separately by multiplying the amount of renewable energy purchased by the eGRID Subregion Reliability First Corporation West factors for CO_2, CH_4 and N_2O, as it is assumed that these regional emissions are being replaced by renewable energy purchases.

3.7 Base Year and Management of Change

Calendar year 2000 is the internal base year selected for the District's GHG Inventory. A base year is a specific year against which an entity's emissions are tracked over time. For the purpose of this report, the District's base year is defined as the earliest year for which a complete emissions inventory was calculated. Future regulations may define an alternate base year against which future emission reductions must be compared. For example the Waxman-Markey Bill (H.R. 2454) has referenced emission reductions in terms of 2005 levels (e.g., emissions will be reduced by 3 percent below 2005 levels in 2012).

Structural and methodological adjustments to the GHG emission inventory will be reviewed against the base year. Future emission reduction goals will be evaluated against base-year emissions. It is recommended that the GHG inventory be revised if any of the following occurs:

- Additional or more complete activity data become available.
- Emission factors or estimation methodologies improve.
- Structural changes occur (outsourcing or insourcing GHG emitting activities).
- A calculation error is discovered.

If an adjustment is necessary, a description of the change, the person performing the change, and the person authorizing it will be kept in a log with the GHG Inventory and backup documentation will be filed. A structural change involves the transfer of ownership or control of emissions-generating activities or operations from one entity to another (e.g., privatization of wastewater treatment or sludge management activities). Appendix A describes additional structural and methodology changes that could trigger adjustments to the GHG inventory baseline.

4. Inventory Results

Based upon the available data, the District calculated an annual entitywide GHG inventory for each year from 2000 through 2007. This section presents the results for 2007. Appendix B contains the calculations and results for each year. The District's emissions presented below have been rounded to the nearest hundred tonnes.

4.1 2007 Inventory Results Including Biogenic Sources

This section presents a breakdown of entitywide inventory emissions from 2007 as an example. Exhibit 4-1 summarizes the results for calendar year 2007, including biogenic emissions from combustion of digester gas, sludge drying and water reclamation.

EXHIBIT 4-1
2007 Annual GHG Emissions (tonnes CO_{2e}/year) by Facility and Source (All)

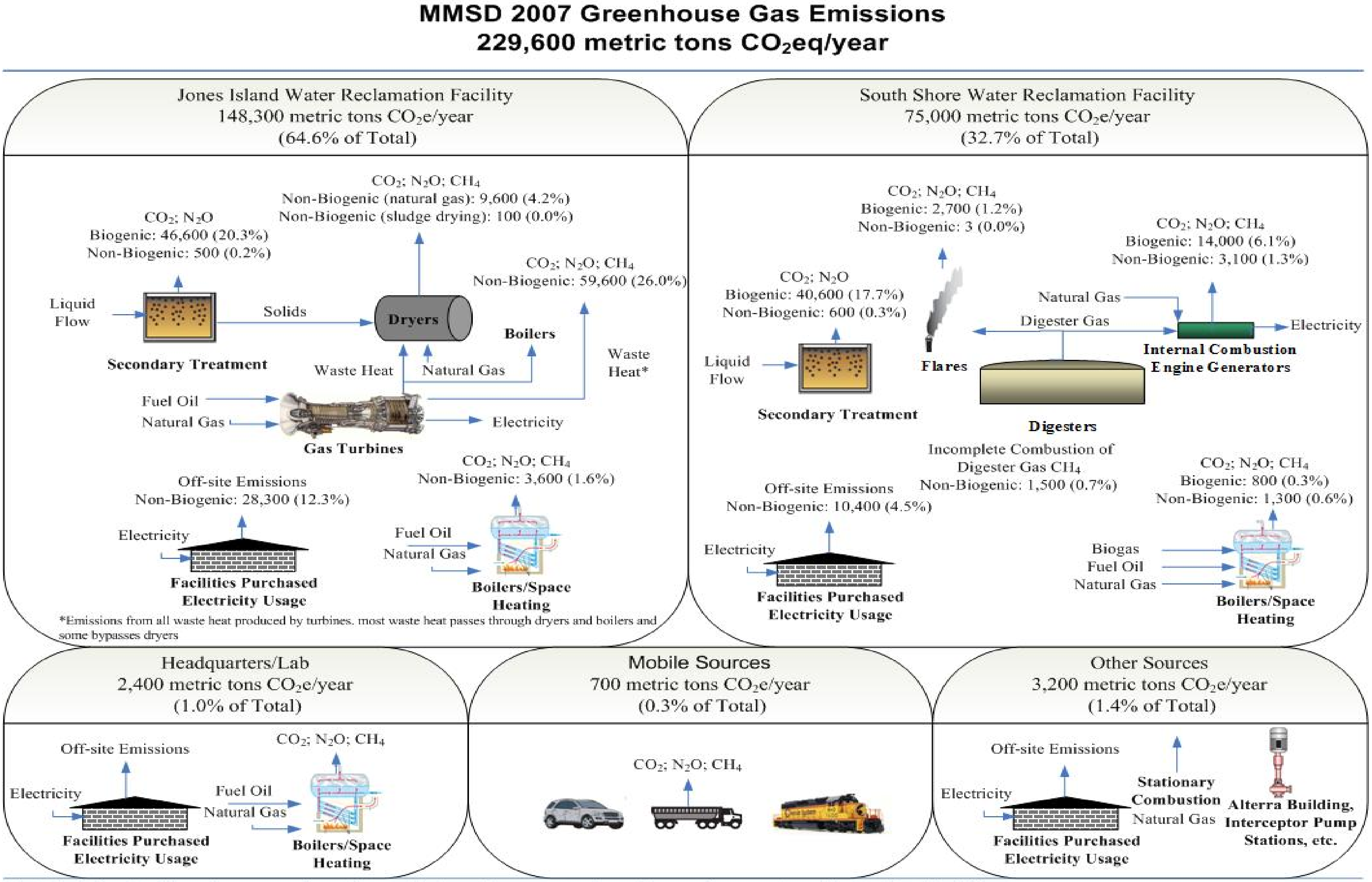
Facility	Stationary Combustion	Purchased Electricity	Water Reclamation Emissions	Mobile Combustion	Total District Emissions	Percent of Total District Emissions
Jones Island (nonbiogenic)	72,800	28,300	600[a]		101,700	44.3%
Jones Island (biogenic)			46,600		46,600	20.3%
Jones Island total	**72,800**	**28,300**	**47,200**		**148,300**	**64.6%**
Percent of Jones Island	49%	19%	32%			
South Shore (nonbiogenic)	5,900	10,400	600		16,900	7.4%
South Shore (biogenic)	17,500		40,600		58,100	25.3%
South Shore total	**23,400**	**10,400**	**41,200**		**75,000**	**32.7%**
Percent of South Shore	31%	14%	55%			
Headquarters and laboratory	600	1,800			**2,400**	1.0%
Other sources[b]	1,000	2,200			**3,200**	1.4%
All mobile sources				700	**700**	0.3%
Total all facilities	**97,800**	**42,700**	**88,400**	**700**	**229,600**	
Percent of total	42.6%	18.6%	38.5%	0.3%		

[a]Includes methane emissions from sludge drying.

[b]Other sources include: 13th and College facility, flushing station/Alterra coffee shop, interceptor sewer system and the inline storage and pumping system.

The District's water reclamation facilities contribute more than 97 percent of its total GHG emissions: almost 65 percent from Jones Island and nearly 33 percent from South Shore. All other facilities including mobile sources, headquarters, laboratory, 13th Street, Alterra and the interceptor system account for less than 3 percent of the total emissions. Exhibit 4-2 summarizes the inventory results for calendar year 2007 from all sources, including biogenic emissions.

EXHIBIT 4-2
2007 Annual GHG Emissions by Source (tonnes CO_{2e}/year) (Including Biogenic)

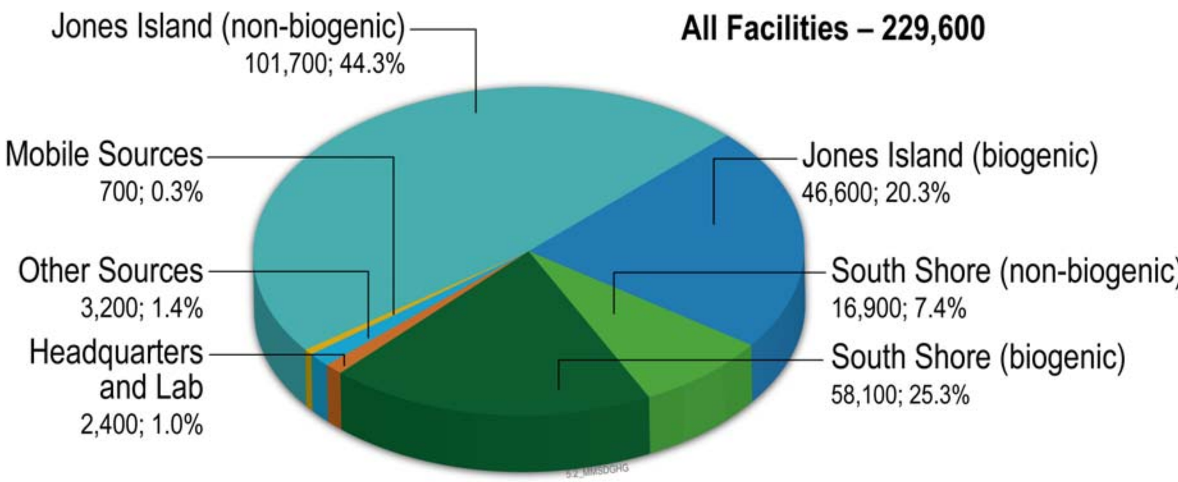


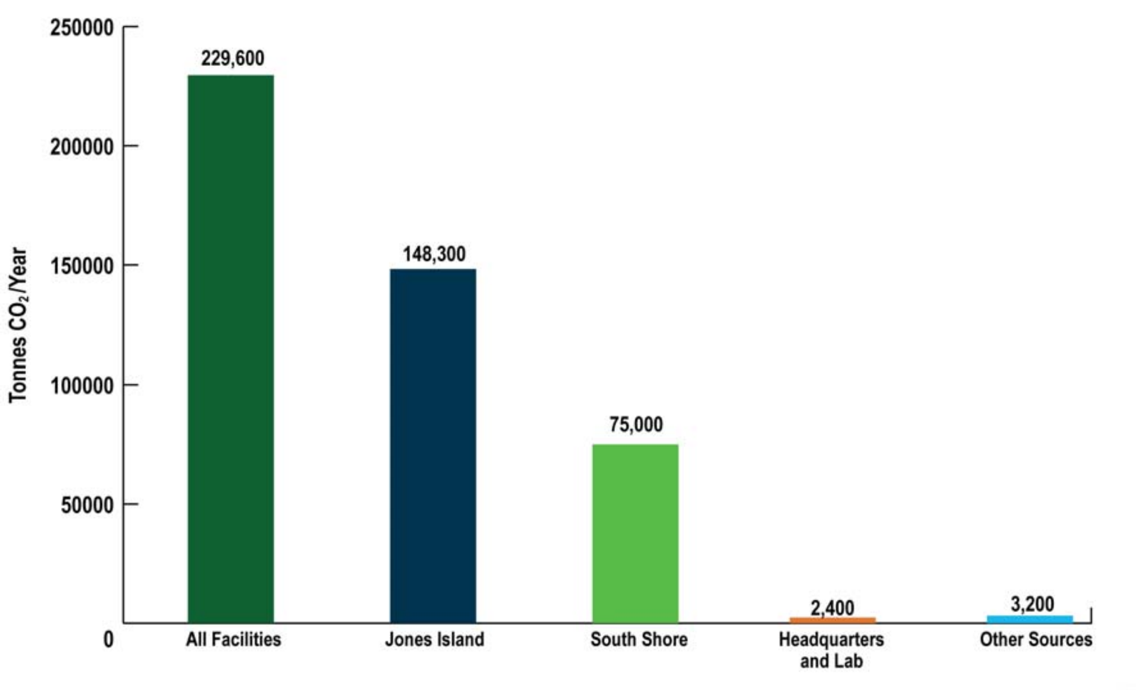
Note: Emissions listed for each source are in metric tons CO_2e/year. The percentage for each source is a percentage of the total for all facilities.

In 2006 and 2007, the District purchased renewable energy for the Headquarters facility from Wisconsin Energy Corporation's Energy for Tomorrow program. The District purchased 175,200 kWh per year in 2006 and 2007. The emission reductions achieved by purchasing renewable energy were calculated using the indirect electricity emission factors and resulted in an emissions reduction of 123 tonnes CO_{2e} per year in 2006 and 2007.

Exhibit 4-3 breaks down entitywide emissions by facility and sources.

EXHIBIT 4-3
2007 Annual GHG Emissions (tonnes CO_{2e}/year) by Facility (Including Biogenic)





Exhibits 4-4 and 4-5 break down the emissions at each water reclamation facility by source.

EXHIBIT 4-4
2007 Annual GHG Emissions (tonnes CO_{2e}/year) at Jones Island by Source (Including Biogenic)

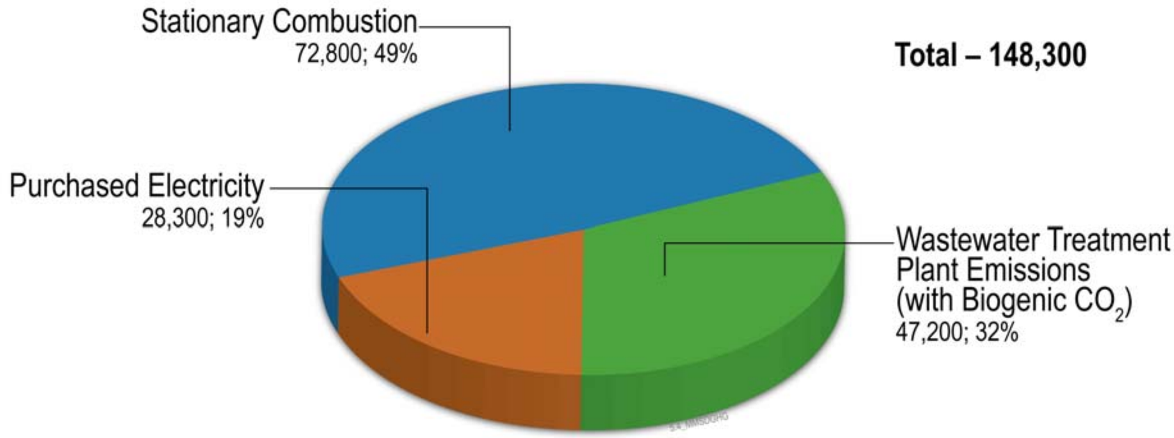
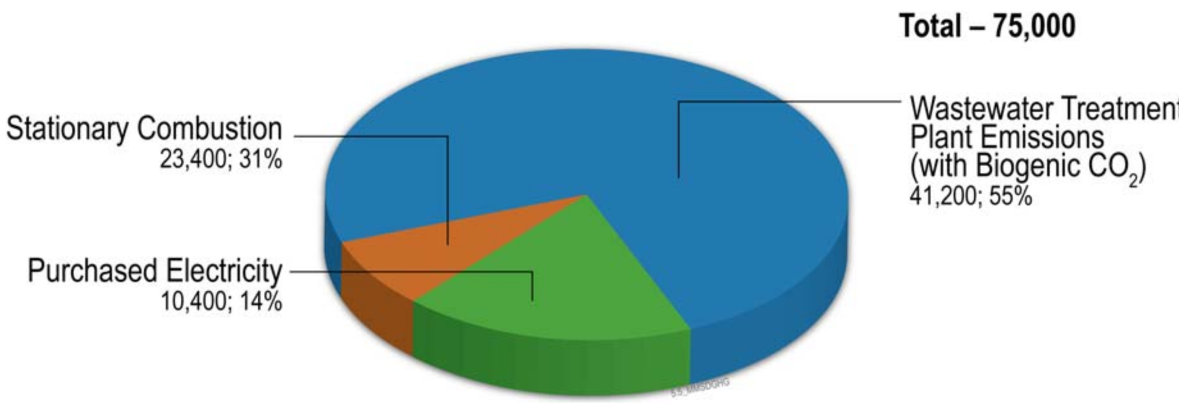


EXHIBIT 4-5
2007 Annual GHG Emissions (tonnes CO_{2e}/year) at South Shore by Source (Including Biogenic)



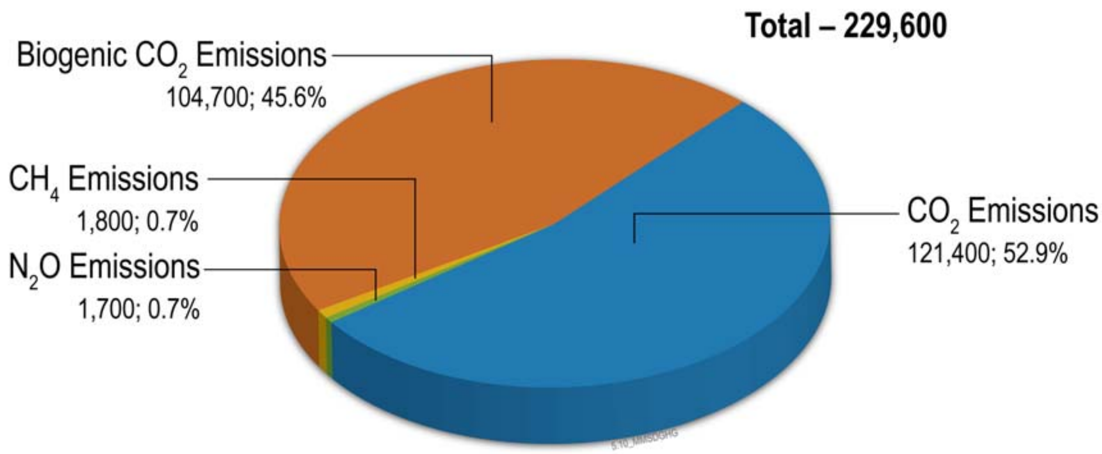
Emissions from stationary combustion sources are the largest contributors of emissions at Jones Island (49 percent), whereas water reclamation emissions (including biogenic) are the largest sources of emissions from South Shore (55 percent).

Nearly 32 percent of the entitywide emissions are from stationary combustion sources. Those emissions are from combustion of fossil fuels (natural gas and fuel oil) in the turbines and boilers. Waste heat from the turbines and natural gas is used in the dryers to dry biosolids to produce Milorganite®.

Stationary combustion emissions at South Shore are much lower than Jones Island. They comprise only about 10 percent of the entitywide emissions when biogenic CO_2 is included and less than 3 percent without it. The reason is that most of the emissions from the digester gas engines at South Shore are considered biogenic and not counted in the inventory. Biogenic emissions are considered part of the natural carbon cycle, because they were recently contained in living organic matter. CO_2 emissions from biological water reclamation processes can be thought of as a natural result of humans eating carbon-based foods, with the emissions being reused by food plants and other plants, thereby creating no net gain in carbon emissions. In addition, the biosolids at South Shore are applied to land or pumped to Jones Island, rather than dried as done at Jones Island. The inventory includes CH_4 emissions generated during the drying of sludge at Jones Island and CO_2, CH_4, and N_2O emissions generated *from* the combustion of digester gas and CH_4 emissions from the incomplete combustion of digester gas at South Shore. However, CO_2 emissions from the combustion of digester gas are considered biogenic according to GHG protocols and practices.

Exhibit 4-6 summarizes the results for calendar year 2007 by individual GHG emitted. The N_2O and CH_4 emissions have been converted to CO_2 equivalent emissions.

EXHIBIT 4-6
2007 Annual GHG Emissions (tonnes CO_{2e}/year) by GHG (Including Biogenic)



Over 98 percent of the entitywide emissions are CO_2 emissions with biogenic CO_2 emissions slightly less than CO_2 emissions. N_2O emissions and CH_4 emission combined account for less than 2 percent of the inventory.

4.2 2007 Inventory Results for Nonbiogenic Sources

Exhibit 4-7 summarizes the results for calendar year 2007, not including biogenic emissions from water reclamation processes.

Most of the District's GHG nonbiogenic emissions are associated with stationary combustion emissions, which contribute 64 percent of the emissions. Purchased electricity contributes about 34 percent of the nonbiogenic emissions. The remaining 1.5 percent consists of emissions from nonbiogenic water reclamation emissions (N_2O from water reclamation and CH_4 from sludge drying) and mobile sources. Nonbiogenic emissions at Jones Island are 81 percent of the District's total emissions. Emissions from South Shore stationary combustion sources are 14 percent of the total nonbiogenic emissions.

Given that mobile sources are insignificant (less than 1 percent of the entity inventory); it was determined that attempting to continue to locate additional vehicle fuel use and mileage data to refine mobile source emission estimates would not significantly affect the quality of the inventory. The estimated mobile source emissions for 2007 were used as an

EXHIBIT 4-7
2007 Annual GHG Emissions (tonnes CO_{2e}/year) by Facility and Source (Nonbiogenic Only)

Facility	Stationary Combustion	Purchased Electricity	Water Reclamation Emissions[a]	Mobile Combustion	Total	Percent of Total
Jones Island (nonbiogenic)	72,800	28,300	600		101,700	81.4
South Shore (nonbiogenic)	5,900	10,400	600		16,900	13.5
Headquarters and laboratory	600	1,800			2,400	1.9
Other sources[b]	1,000	2,200			3,200	2.6
Mobile sources				700	700	0.6
Total all facilities	**80,300**	**42,700**	**1,200**	**700**	**124,900**	
Percent of total	64.3	34.2	0.9	0.6		

[a]Includes emissions from sludge drying.

[b]Other sources include 13th and College facility, flushing station/Alterra coffee shop, interceptor sewer system, and the inline storage and pumping system.

estimate for mobile source emissions for each annual inventory and therefore do not change from year to year.

4.3 Emission Trend

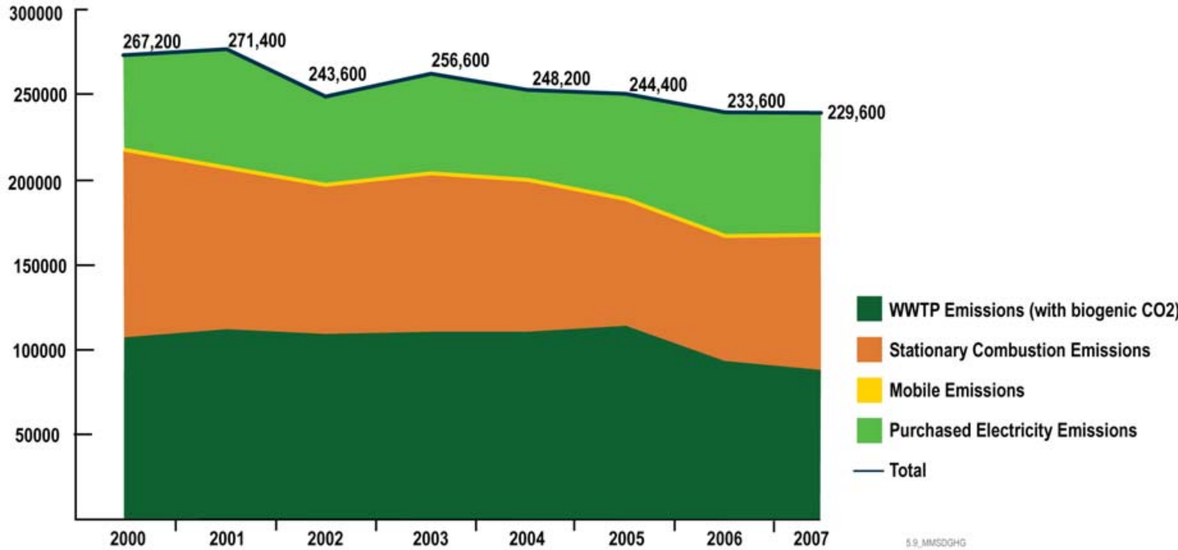
Exhibits 4-8 and 4-9 show the trend of GHG emissions between 2000 and 2007. Emissions have decreased about 14 percent during that period. The reductions are likely due to several factors—increased digester gas use at South Shore, energy efficiency improvements, and decreased Milorganite® production—but the reasons for the decrease were not evaluated in detail.

EXHIBIT 4-8
Annual GHG Emissions (tonnes CO_{2e}/year) by Type 2000–2007

Year	Biogenic Water Reclamation Emissions	Water Reclamation Emissions[a]	Mobile Combustion	Purchased Electricity	Stationary Combustion	Biogenic Stationary Combustion	Total
2000	106,500	1,200	700	39,300	110,900	8,600	267,200
2001	110,900	1,200	700	48,800	97,600	12,200	271,400
2002	108,700	1,100	700	32,300	89,000	11,800	243,600
2003	109,200	1,100	700	38,000	95,300	12,300	256,600
2004	109,000	1,200	700	35,300	89,800	12,200	248,200
2005	103,100	1,200	700	35,700	86,700	17,000	244,400
2006	91,900	1,200	700	50,300	74,400	15,100	233,600
2007	87,200	1,200	700	42,700	80,300	17,500	229,600
% change 2000 to 2007	-18	0	0	+9	-28	+103	-14

[a] Includes emissions from sludge drying.

EXHIBIT 4-9
Annual GHG Emissions (tonnes CO_{2e}/year) by Type 2000–2007



4.4 Mandatory Reporting Rule Requirements

The USEPA proposed a rule on mandatory reporting of GHGs on March 10, 2009. The District has reviewed the rule to determine the potential GHG reporting requirements. A final version of the rule was signed by the acting EPA administrator on September 22, 2009, and published on the EPA's Web site.

Under the final rule, the District is required to provide annual facility level reporting for stationary combustion emissions of 25,000 tonnes/yr CO_2e or more. Stationary combustion emissions, including biogenic CO_2 emissions from combustion of biomass (e.g., solid biomass, landfill or digester biogas) are reportable if a facility triggers threshold quantities from other fossil fuel sources. Biogenic CO_2 emissions do not count toward the 25,000 tonnes/year threshold but are reported separately as biogenic CO_2 emissions. Based upon the threshold and the emissions calculated for 2007, the rule requires reporting of all stationary combustion emissions from the Jones Island Water Reclamation Facility.

The final rule specifies that the first report for calendar year 2010 is due March 31, 2011; thus monitoring and recordkeeping needed to begin in January 2010. USEPA will review the emissions reported, but there is no mandatory third party verification of emissions. Emissions reported under the final rule include stationary combustion source emissions exceeding 25,000 tonnes per year. Below are the types of emissions the District has included in its inventory that would *not* be reported under the final rule:

- Scope 1 emissions from mobile sources
- Scope 2 emissions (indirect emissions from electricity)
- Emissions from emergency generators and flares
- Emissions of other GHGs (e.g., CFCs, HCFCs)
- Process emissions from publicly owned treatment works

Exhibit 4-10 summarizes the emissions from stationary combustion sources by facility for calendar year 2007 and compares the emissions to the reporting rule threshold.

EXHIBIT 4-10
Stationary Combustion: 2007 GHG Emissions by Facility (Tonnes of CO_2e)

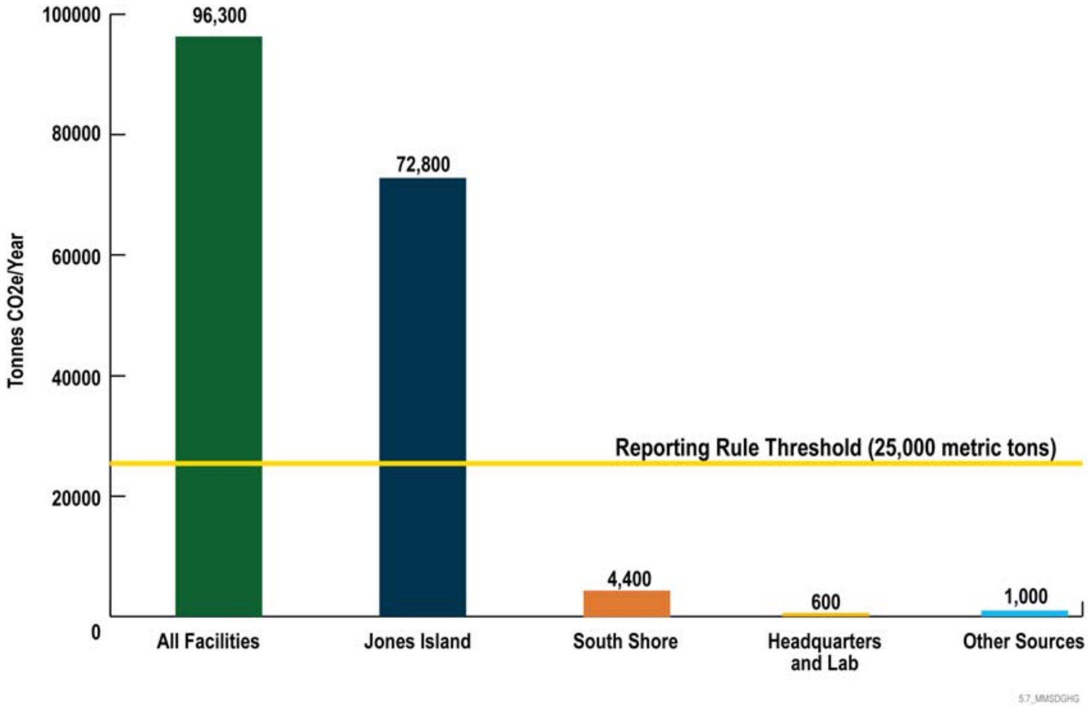


Exhibit 4-11 summarizes the calendar year 2007 stationary combustion emissions by source. Stationary combustion CH_4 emissions from the incomplete combustion of digester gas at South Shore (1,500 tonnes of CO_2e) have been omitted from this data as these emissions are not required to be counted according to the final reporting rule.

EXHIBIT 4-11
2007 Annual GHG Emissions (tonnes CO_{2e}/year) from Stationary Combustion Sources

Emission Source	CO_2e	Biogenic CO_2	Total CO_2e
Jones Island			
Dryers (fuel combustion only)[a]	9,600	NA	9,600
Turbines	59,600	NA	59,600
Cleaver Brooks boilers	300	NA	300
Facility heating	3,300	NA	3,300
Jones Island total	72,800	NA	72,800
South Shore			
Facility heating	1,130	0	1,130
Boilers: Kewaunee, Scum, and Cleaver Brooks	120	800	920
IC engine generators	3,130	14,000	1,7130
Flares	20	2,700	2,720
South Shore total	4,400	17,500	21,900
Headquarters and laboratory	600	NA	600
Other sources	1,000	NA	1,000
Total all sources	**78,800**	**17,500**	**96,300**

[a] Methane emissions released from the sludge as it is dried are not considered stationary combustion source emissions but rather water reclamation process emissions, and are therefore not included herein.

5. Uncertainty Analysis

GHG measurements, estimates, or calculations should be neither over nor under the actual emissions value, and data uncertainty should be reduced as far as practicable to minimize uncertainty regarding emissions. To make the inventory transparent, the District estimated the emission uncertainty using the WRI/WBCSD GHG Protocol guidance on uncertainty assessment.

Through established processes, the District has minimized systemic and inherent uncertainties in the inventory. The District relies almost entirely on the information gathered through its existing air emission inventory records and procedures. Approximately 99.5 percent of the energy data are derived from the paid invoices for fuel and electricity based on energy use meters that are regularly calibrated by the District's energy utilities. The remaining 0.5 percent of the energy data are those used, along with the estimated average fuel efficiency, for estimating emissions from mobile sources (vehicles) that are owned by the District.

The District includes biogenic GHG emissions from water reclamation processes in the inventory. The District considers CO_2 emissions from water reclamation processes to be biogenic and therefore carbon neutral. N_2O emissions from water reclamation processes, CH_4 emissions from the incomplete combustion of digester gas, and CH_4 emissions from the sludge drying process are considered nonbiogenic. Discussions regarding inventory uncertainty are limited to the nonbiogenic sources, thus a discussion on the uncertainty of the biogenic emissions is not included.

GHG emissions associated with energy usage for stationary combustion, mobile combustion, and electricity usage account for 99 percent of the District's nonbiogenic emissions. The remaining 1 percent of the nonbiogenic emissions are CH_4 emissions associated with the incomplete combustion of digester gas, CH_4 emissions from the sludge drying process, and N_2O emissions associated with water reclamation.

The uncertainties have been quantified for the nonbiogenic emission sources using WRI estimating methods. The uncertainty for each source of emissions is partitioned into two components: uncertainty on the measurement of the activity data (energy data gathering), and uncertainty in the emission factors.

Given that the uncertainty associated with the activity data from fossil fuels and electricity from utility bills is managed by accounting procedures and meter calibrations, it was assumed that a range of ± 3 percent would be reasonable. The uncertainty associated with the emission factors for fossil fuels and purchased electricity is assumed to be a range of ±7 percent based upon IPCC guidance.[1] Exhibit 5-1 shows the higher levels of uncertainty assumed for the activity data and emission factors for the other sources.

These uncertainty factors were applied to uncertainty calculations which take into consideration the magnitude of the 2007 emission estimates for each of these sources.

[1]PCC. 2006. *Guidelines for National Greenhouse Gas Inventories.*

EXHIBIT 5-1
Uncertainty Estimates

Data Type	Uncertainty of Activity Data (C)	Uncertainty of Emission Factor (F)	Uncertainty of Calculated Emissions (I) [a, b]	Certainty Ranking
Stationary combustion fuel usage	± 3%	± 7%	± 7.6%	Good
Purchased electricity	± 3%	± 7%	± 7.6%	Good
Mobile combustion fuel usage	± 50%[c]	± 10%	± 51%	Poor
South Shore digester gas CH_4 emissions	± 10%	± 5%	± 11.2%	Good
Sludge drying CH_4 emissions	± 3%	± 50%	± 50.1%	Poor
Water reclamation N_2O emissions	± 10%	± 50%[d]	± 51%	Poor
Overall uncertainty[b]			± 5.5%	Good

[a]The uncertainty of the activity data is combined with the uncertainty of the emission factors to calculate the uncertainty in the emission estimates using the equation: $I = \sqrt{C^2 + F^2}$.

[b]The uncertainty of each data type is combined with the calculated emissions for that data type to account for the magnitude of the impact on the overall uncertainty of the emission inventory. Annual emissions from 2007 were used to calculate the overall uncertainty.

[c]The uncertainty of the mobile combustion source emissions is high because of data on actual fuel usage and miles traveled are limited.

[d]The uncertainty of the water reclamation N_2O source emissions is high because of the inherent uncertainty associated with published emission factors. At the time of this inventory, the best emission factors available were used.

Appendix C contains the complete calculations and emission data to support these uncertainty estimates. The uncertainty of the mobile combustion source emissions and water reclamation N_2O source emissions is high. However the impact of these emission estimates to the overall inventory uncertainty is minimal, because these emissions represent only small fractions—0.6 percent and 0.9 percent, respectively—of the total inventory emissions. Emission estimates for these two sources were based upon the best data and emission factors available at the time of the inventory. As better data become available, the certainty of the emission estimates will improve.

EXHIBIT 5-2
Uncertainty Rankings

Data Accuracy	Interval as Percent of Mean Value
High	± 5%
Good	± 15%
Fair	± 30%
Poor	More than 30%

Source: IPCC. 2006. *Guidelines for National Greenhouse Gas Inventories.*

The cumulative uncertainty for the 2007 nonbiogenic emission yielded a range of ± 5.5 percent. This is considered to be a good level of data accuracy (Exhibit 5-2).

The following improvements could reduce the uncertainty of the emission estimates:

- Obtain utility-specific emission factors for purchased electricity.
- Obtain accurate fuel usage and mileage records for mobile sources.
- Obtain better emission factors for nitrous oxide emissions from water reclamation, as they become published.

Although a higher level of uncertainty is associated with the nonbiogenic water reclamation emissions, the energy emissions are likely to be within 5 percent of the reported entity total, indicating a good degree of certainty in the inventory results as a whole. Likewise, on a source-by-source basis, the District does not expect the emissions from any specific source to differ by more than 5 percent of the total entity emissions.

6. Greenseams Program

6.1 Program Background

The District's Greenseams program is an innovative flood management and stormwater pollution control program that protects lands containing water-absorbing soils. Greenseams identifies and purchases undeveloped, privately owned properties to help reduce the risk of flooding in areas expected to have future significant growth. As part of the GHG project, the Greenseams program was evaluated to see if and how it can be used to establish GHG emission credits by demonstrating that the vegetation on the land purchased by the District is reducing GHGs through carbon sequestration. Appendix D contains data on the type and amount of land included in the Greenseams program.

6.2 Carbon Sequestration Credits

Carbon sequestration programs are undertaken for various reasons, such as generating officially recognized GHG reduction "credits," obtaining recognition for voluntary GHG reductions, and offsetting GHG emissions to meet internal targets for public recognition or other internal strategies. The District evaluated how the Greenseams program could be used for carbon sequestration using the WRI Land Use, Land Use Change, and Forestry Guidance for GHG Project Accounting, the California Climate Action Registry's (CCAR's) Urban Forestry Protocol, and the Voluntary Carbon Standard general guidance on offset quantification and Guidance for Agriculture, Forestry, and Other Land Use.

Two key concepts in documenting GHG reductions from carbon sequestration programs such as Greenseams are "additionality" and determination of the baseline scenario. The baseline scenario represents emissions that would have occurred without the project, and against which the project emissions are evaluated to determine the resulting reduction or sequestration quantity.

The action that created the activity is evaluated according to additionality principles to see if it qualifies as an eligible reduction project: e.g., many projects create reductions, but not all create offsets that can be sold or reductions that can be credited against regulatory programs. The additionality test determines whether the project would have been initiated for reasons other than the resulting environmental benefit.

The baseline can be static, with the assumption nothing would have changed over time, or it can be dynamic, acknowledging some things would have changed even without the actions taken by the project proponent. Then the estimated emissions with the project are subtracted from those without the project to quantify the reduction/offset. It could be argued that without the Greenseams program, development would have occurred on some percentage of Greenseams-purchased land that would have resulted in GHG emissions.

For afforestation and reforestation projects, the baseline scenario often is based on typical practices to convert cropland or pasture to forest, in a given region. The Land Use, Land Use

Change, and Forestry Guidance uses the term *reforestation* broadly to refer to the establishment of forest cover on cleared land that was previously forest (in either the shorter or longer term). In most cases, reforestation is differentiated from afforestation by the time period in which forest last existed on the land. For reforestation, the period usually is shorter than for afforestation; for example, reforested land may have been in forest just 5 years previously, whereas afforestation is the creation of forest on land considered not to have been forest for a longer term (e.g., 50 years).

The information in Exhibit 6-1 indicates how common a practice afforestation or reforestation is in southern Wisconsin. The default rates shown provide background project land use changes that would occur independently of the project activity. These rates are derived from National Resource Inventory data and are from EPA's Reforestation/ Afforestation Project Carbon On-line Estimator (RAPCOE) v.1.0 (2007).

EXHIBIT 6-1
Historical Data for Fate of Cropland and Pasture in Southern Wisconsin

	1982–87	1987–92	1992–97	15-year avg.
Fate of Cropland (% changed over 5-year period)				
Remain as cropland	99.41	99.52	99.30	99.41
To pasture	0.38	0.27	0.34	0.33
To forest	0.02	0.01	0.02	**0.01**
To developed land	0.20	0.21	0.35	0.25
Fate of Pasture (% changed over 5-year period)				
To cropland	1.50	0.71	1.17	1.13
Remain as pasture	97.97	98.54	97.82	98.20
To forest	0.30	0.42	0.55	**0.42**
To developed land	0.23	0.33	0.46	0.34

Carbon released or sequestered by a background land use change becomes part of the baseline. GHG programs should count only GHG reductions from project activities that differ from, or are in addition to, their baseline scenarios.

The Greenseams program will result in some emission reductions based upon avoided deforestation activity and reforestation/restoration activities. Trees have been planted on some parcels, and some parcels have undergone prairie restoration. However, to qualify for verifiable emission reduction credits, the program likely will have to meet additionality requirements and exceed its baseline scenario in accordance with the standards applicable to the project (e.g., the specific carbon trading program or future regulatory program). The Greenseams program may need to be expanded to include further land use changes, such as additional reforestation, or additional prairie restoration to support these principles.

Recent guidance on specifics to support additionality requirements that may be applicable to the Greenseams program are documented in CCAR's Urban Forestry Protocol. Details regarding the protocol and its applicability to the Greenseams program are provided below.

6.3 CCAR's Urban Forestry Protocol

CCAR is a leading source of accurate, transparent, and credible GHG accounting standards for reporting entitywide GHG emission inventories. CCAR applies its knowledge and expertise in GHG accounting to quantifying GHG emission reductions associated with specific project activities, ensuring the environmental integrity of programs based on the data, and supporting international efforts to combat climate change. Through its Climate Action Reserve program, CCAR supplies protocols for quantifying GHG emission reductions, or offsets.

CCAR's Urban Forest Project Reporting Protocol provides guidance to account for and report GHG emission reductions associated with a planned set of urban tree planting and maintenance activities to permanently increase carbon storage in trees. Project developers that implement tree planting programs can use the guidance to register GHG reductions with the Reserve. It provides eligibility rules, methods to calculate reductions, performance monitoring instructions, and procedures for reporting project information to the Reserve. All project reports receive annual, independent verification by Reserve-approved verifiers. Guidance for verifiers to certify reductions is provided in the corresponding Urban Forest Project Verification Protocol.

For the purpose of the protocol, an urban forest GHG project is a planned set of tree planting and maintenance to permanently increase carbon storage, taking into account GHG emissions associated with planting and maintenance of project trees.

Although project trees are planted for the purposes of the urban forest GHG project, tree sites are the primary unit of analysis. A "tree site" contains one tree at a time, but the tree may be replaced over time and the site itself may be moved. This is because trees themselves are subject to mortality and other types of losses and therefore may need to be replaced or relocated during the project lifetime.

Tree plantings should be spaced no less than 5 meters on average. (Biomass equations for estimating carbon stock changes are for open-growing urban trees and assume relatively intensive management.) The location of all project tree sites must be known and recorded (e.g., using GPS). For forest management and conservation activities on large forested tracts within cities (≥ 100 acres contiguously forested), the Forest GHG Protocols should be used.

An entity can assemble several smaller projects into a single project to achieve economies of scale and more efficient reporting. Past work has estimated that a project with at least 1,000 tree sites will benefit from economies of scale. However, reporting, monitoring, and verification practices must follow the Reserve's guidance.

6.3.1 Additionality

The Reserve strives to support only projects that yield surplus GHG reductions beyond what might otherwise have occurred. That is, the reductions are above and beyond business as usual—the baseline case. Project developers satisfy the additionality eligibility rule by passing two tests: the performance standard test and the regulatory test.

6.3.1.1 The Performance Standard Test

Project developers pass the performance standard test by meeting a programwide performance threshold; that is, a performance standard applicable to all urban forest projects. A performance threshold value is determined by analyzing trends to represent "better than business as usual." If the project exceeds the threshold, then it exceeds what would happen under the business as usual scenario and generates surplus/additional GHG reductions. Past performance of individual urban forest projects is not used to determine business as usual; rather, business as usual is established from an assessment of urban forestry programs as a class.

For this protocol, the Reserve uses a practice-based threshold that represents "best practice standard" for urban forest tree planting programs. The project must demonstrate that it will exceed the performance threshold and information confirming this, in accordance with the guidance below, must be provided in the project submittal form.

The performance thresholds for municipalities and educational campuses are measured in terms of net tree gain; that is, the number of trees planted annually by an entity minus the number of trees it removes. Only project activity that exceeds the performance threshold can be registered.

Based on data from high-performing municipal and educational campus entities, the performance threshold has been set at maintaining a stable urban forest population; that is, entities must plant at least as many trees as they remove, for a net tree gain of 0.

A project developer must demonstrate a priori that a project will exceed the threshold by calculating the anticipated net tree gain of the entity based on recent entity activities and anticipated project activities. Specifically, the calculation must be based on the following:

- The annual average number of urban trees[1] planted and removed in the entity over no more than the most recent 5-year period preceding the project start date, or using data from a single year occurring at some point during the past most recent 5-year period
- The expected average annual number of GHG project tree sites to be planted by the project

6.3.1.2 The Regulatory Test

The Reserve subjects all GHG reduction projects to a regulatory test to ensure that the emission reductions achieved would not have occurred in the absence of the project because of federal, state, or local regulations. Urban forest GHG projects must also exceed any applicable regulations or statutes. Examples include municipal ordinances that require street, park, and parking lot tree planting or local mitigation requirements imposed on a project. Local codes, covenants, and restrictions may require tree planting to buffer adjacent land uses or for other purposes. State laws may prescribe minimum levels of tree planting for energy conservation and other reasons. Trees planted to comply with regulatory requirements may not be considered project trees.

[1] Urban trees include trees under the entity's ownership or control and open-grown in managed landscapes.

6.3.2 Permanence

GHG projects involving biological carbon sequestration must address the potential reversibility of sequestered carbon or more precisely the loss of stored carbon after carbon benefits have been reported, verified, and registered. Consistent with guidance from the IPCC, the Reserve's underlying standard for permanence is at least 100 years. That is, the biological carbon should remain stored for 100 years. For example, a reduction of carbon created in 2008 will remain stored until 2108; if reversed, say by mortality, then it must be replaced.

6.3.3 Project Monitoring

Project developers are responsible for monitoring the performance of the project and maintaining records of monitoring data in accordance with the requirements. Monitoring requirements are divided into three categories; Tree Maintenance Plan; Tree Monitoring Plan; and GHG Emissions and Sequestration Activity Data. The Tree Maintenance Plan is used to assess the potential of activity-shifting leakage and other aspects of project performance. The Tree Monitoring Plan and GHG Emissions and Sequestration Activity Data are used to verify GHG emissions and sequestration estimates.

6.3.4 Preliminary Carbon Sequestration Estimates

Preliminary carbon sequestration estimates were calculated using program acreage data, minimum spacing requirements (5 square meters for every tree), and an average sequestration rate (200 pounds (90 kilograms) per tree per year)[1] as listed in Exhibit 6-2. The emission reduction rates would be reduced when emissions for tree planting and maintenance are included in the evaluation.

EXHIBIT 6-2
Preliminary Carbon Sequestration Estimates

Number of Trees Planted per Acre	Number of Acres Planted	Total Number of Trees Planted	Emission Reduction (tonnes CO_2/yr)
160	700	100,000	9,000
160	1,850	300,000	27,000

6.4 Grasslands

The Greenseams program gives the District the opportunity to gain carbon sequestration credits by demonstrating a reduction in net GHG emissions most likely from the conversion of cropland to grassland.

The Voluntary Carbon Standard has developed general guidance on offset quantification including its Guidance for Agriculture, Forestry, and Other Land Use Projects. Land use and management activities that have been demonstrated to reduce net GHG emissions on cropland and grassland (IPCC 2006 GL for Agriculture, Forestry, and Other Land Use) by increasing carbon stocks (in soils and woody biomass) or decreasing CO_2, N_2O, or CH_4

[1]CCAR Urban Forest Project Reporting Protocol, Version 1.0. August 2008.

emissions from soils are eligible for certification under the Voluntary Carbon Standard as Agricultural Land Management projects. Three broad categories of activities are included: improved cropland management; improved grassland management; and cropland and grassland land use conversions. The category most likely to be applicable to the Greenseams program is the cropland and grassland land use conversions. The following key concepts should be considered when evaluating the Greenseams program for eligible offsets:

- The conversion of cropland to perennial grasses can increase soil carbon by increasing belowground carbon inputs and eliminating/reducing soil disturbance.
- Conversion of drained, farmed organic (e.g., peat) soils to perennial nonwoody vegetation, along with reductions or elimination of drainage, can reduce emissions of CO_2 and N_2O from organic soils. However, potential increases in CH_4 emissions would need to be accounted for.
- The cessation or reduction in N fertilizer from cropland conversion to grassland set-aside should not be considered an eligible practice for reducing N_2O emissions because there is a high risk of leakage (e.g., the N fertilizer is simply displaced to cropland production elsewhere).

For projects involving land set-asides (that is, cropland or pastures converted to grassland conservation set-asides), leakage could occur due to displacement of preproject activities to areas outside the project area. For small-scale land set-asides (< 10,000 hectares), leakage due to displaced activities can be assumed to be zero. Projects larger than this should estimate leakage for displacement of preproject activities, taking into account possible reductions in biomass, carbon stocks, and emissions of N_2O, CH_4, and fossil CO_2 emissions.

7. Recommendations for Future Activities

The District has prepared a GHG emissions inventory for calendar years 2000 through 2007. Assembling this emissions inventory has provided important information about the District's GHG emissions profile that the District can use to prepare for and respond to the potential impact of new regulations including documenting early actions taken to reduce GHG emissions. Below are several recommendations for capturing or improving GHG inventory emissions data in the future.

7.1 Prepare for Reporting and Cap and Trade Legislation

The ability to verify the accuracy and origin of activity data collected for the GHG inventory will become increasingly important as the U.S. moves toward federal regulations. It is recommended that the District develop a comprehensive system to improve data quality/data management activities for documenting GHG emissions particularly those that are regulated under the reporting rule or may be regulated as part of cap and trade legislation. Managing data associated with GHG emission from electricity generated onsite by renewable sources is particularly important for selling carbon credits.

7.1.1 Data Collection Systems and Processes

The District's GHG inventory has been developed using several reports and spreadsheets to manually collect the activity data and prepare the emission calculations. If these tools will continue to be used to collect data and calculate GHG emissions, it is important that procedures be developed to ensure the accuracy, consistency, proper documentation and transparency of the data.

It is recommended that procedures be developed to collect activity data at least annually and preferably within the first 3 months of the subsequent calendar year. This will allow the District to be prepared for the USEPA Mandatory Reporting Rule that requires submission of annual GHG emissions by March 31, 2011, for calendar year 2010.

Data security should be considered when setting up the GHG data management system. Security standards should be defined along with user roles and responsibilities and procedures to trace updates and corrections. For example, locate the tools on a central server with access restrictions or write protection to ensure data cannot be modified accidentally by staff with server access who do not own the data. There are sections within the IMP addressing these issues that should be further developed by District staff, who will assume responsibility for managing the District's GHG inventory in the future.

7.1.2 Auditing and Verification

It is recommended that the District evaluate the need to develop an internal auditing program and define corrective actions procedures to be followed upon receipt of findings. It is also recommended the District identify if external verification of emissions will be necessary for trading, reporting, or credit purposes. If so, it is recommended that steps be taken to ensure emission estimates and data are properly documented and retained to support future verification requirements.

7.1.3 Document Retention and Control

It is recommended that documents supporting the design, development and maintenance of the GHG inventory be retained for future verification purposes. This may include the following:

- Documentation of methodology changes in the IMP
- Activity descriptions filed with annual inventory
- Annual inventory
- Backup documentation:
  - Fuel records
  - Utility bills, invoices that show energy use (kWh, therms, or equivalent)
  - Annual air emissions reports
  - Influent flow and BOD data, discharge monitoring reports
  - Air conditioning inventory (including number of units, unit sizes, types, refrigerants, and refrigerant usage)

7.1.4 Intensity Ratios

Stakeholders are interested in two principal aspects of GHG emissions management: the level of absolute GHG emissions, and the reduction of GHG emissions, measured in ratio indicators (sometimes referred to as normalization factors). Ratio indicators provide information on the efficiency of an activity, the intensity of an impact, or the quality of a value or achievement. Ratios can facilitate comparisons between similar processes. They also are used to compare the performance and achievements of one facility to another for better understanding and interpretation of achievements. The data and information collected for the GHG inventory should allow the use of a ratio indicator, such as an intensity ratio.

Intensity ratios are expressed as GHG impact per unit of activity. An example of intensity for the District would be GHG emissions per mass of BOD or solids processed. A declining intensity ratio indicates positive performance improvement. It is recommended that the District evaluate the appropriateness and use of a GHG emission intensity ratio for incorporation in the future.

7.2 Reporting

The District should continue to follow regulatory changes so that mandatory reporting rules are complied with, and to develop procedures to continue to collect data and report emissions in accordance with applicable federal, state, and local regulations.

The District could also identify and determine appropriate organizations or avenues by which to publicly report emissions. Voluntarily reporting GHG emissions provides a pathway to recognize, publicize, and promote environmental stewardship.

The EPA Climate Leader's program is one such voluntary reporting program, but it is not currently available to government institutions. The International Council for Local Environmental Initiatives (ICLEI)–Local Governments for Sustainability is an international association of local governments as well as national and regional local government organizations that have made a commitment to sustainable development. ICLEI provides technical consulting, training, and information services to build capacity, share knowledge, and support local government in the implementation of sustainable development at the local level. The City of Milwaukee is a member of ICLEI and therefore might provide additional insight into the breadth and value of ICLEI’s services and programs.

The District may also wish to consider joining the Climate Ready Water Utilities Working Group of the National Drinking Water Advisory Council. The Working Group will provide drinking water and water reclamation utilities with easy-to-use resources to assess the risk associated with climate change. The group will help water and water reclamation utilities to develop and implement long-range plans that account for climate change impacts.

7.3 Greenseams Program

It is recommended that the District evaluate markets for selling carbon credits generated by the Greenseams program, through either reforestation/afforestation or the conservation of grasslands. The ability to sell carbon credits and the price projected for them should be evaluated against the cost of tree planting and maintenance and the required data management and reporting activities to determine the net cost/benefit.

The District may want to consider other benefits in addition to those of carbon sequestration. Trees may be planted strategically to reduce energy use that will effect reductions in GHG emissions at the power plant. Tree trimming wastes used as fuel in bioenergy plants may reduce GHG emissions if the trees are used to replace fossil fuel sources, such as coal. Tree planting and grassland conservation can provide other benefits, including air and storm water quality improvement, controlling runoff, conserving water, conservation education, neighborhood revitalization, job training, and recycling green waste.

7.4 Future Mitigation Activities

It is recommended that the District continue to identify other means and methods to mitigate GHG emissions. Such activities include evaluating energy conservation opportunities, focusing on large energy users such as aeration blowers and the Inline Pumping system.

The District is undertaking the Jones Island Gas Turbine Replacement Project, which calls for the installation of five new 4.6-MW turbine systems, capable of running on landfill gas and natural gas, by January 2013. This project will replace two 18-MW natural gas turbine generators. As part of the project, the District will continue to evaluate methods to maximize the use of turbine waste heat and continue to pursue the possibility of selling excess renewable energy to Wisconsin Energy. It is recommended that the District pursue selling carbon credits that may result from GHG emission reductions achieved through the project.

Appendix A
Inventory Management Plan

Final Report

Greenhouse Gas Inventory Management Plan

Submitted to

Milwaukee Metropolitan Sewerage District

February 2010

CH2MHILL

Contents

Attachments

Exhibits

Abbreviations and Acronyms

CARB	California Air Resources Board
CCAR	California Climate Action Registry
CH_4	methane
CO_2	carbon dioxide
District	Milwaukee Metropolitan Sewerage District
eGRID	Emission and Generation Resource Integrated Database
USEPA	U.S. Environmental Protection Agency
GHG	greenhouse gas
GWP	global warming potential
ICLEI	International Council for Local Environmental Initiatives
IMP	Inventory Management Plan
IPCC	Intergovernmental Panel on Climate Change
MMBtu	million British thermal units
MMscf	million standard cubic feet
MWh	megawatt-hours
kg	kilograms
kWh	kilowatt-hours
N_2O	nitrous oxide
scf	standard cubic feet
SF_6	sulfur hexafluoride
tonne	metric ton (2204.62 pounds)
WBCSD	World Business Council on Sustainable Development
WRI	World Resource Institute

Glossary

Activity data	Data on the magnitude of a human activity resulting in emissions or reductions taking place during a given period. Data on energy use, miles traveled, and influent loading are all examples of activity data that might be used to compute GHG emissions.
Base year	A specific year against which an entity's emissions are tracked over time.
Biogenic emissions	GHG emissions considered part of the natural carbon cycle because they are of biogenic origin—recently contained in living organic matter. CO_2 emissions from biological water reclamation processes can be thought of as a natural result of humans eating carbon-based foods, with the emissions being reused by food plants and other plants, thereby creating no net gain in carbon emissions. Biogenic emissions are considered "carbon neutral."
Carbon dioxide equivalents	The universal unit for comparing emissions of different greenhouse gases (GHGs) expressed in terms of the global warming potential (GWP) of one unit of carbon dioxide.
Control approach	An emissions accounting approach for defining organizational boundaries in which an entity reports 100 percent of the GHG emissions from operations under its financial or operational control.
Direct emissions (Scope 1)	Emissions from sources that are owned or controlled by the reporting entity, including stationary combustion emissions, mobile combustion emissions, process emissions, and fugitive emissions. Some specific examples include: boilers, heaters, generators, cars, trucks, manufacturing equipment, and emissions from piping and valves.
Entity	A reporting entity comprises all the facilities and emission sources delimited by the organizational boundary developed by the entity, taken in their entirety.
Equity share approach	An emissions accounting approach for defining organizational boundaries in which an entity accounts for GHG emissions from each operation according to its share of economic interest in the operation, which is the extent of rights an entity has to the risks and rewards flowing from an operation.
Facility	Any installation or establishment located on a single site or on contiguous or adjacent sites that are owned or operated by an entity. Mobile sources, such as vehicle fleets, which operate outside of the physical boundaries of a facility, are considered discrete facilities.

Financial control	The ability to direct the financial and operating policies of an operation with an interest in gaining economic benefits from its activities. Financial control is one of two ways to define the control approach; the other is operational control, defined below.
Greenhouse gases (GHGs)	For the purposes of this document, GHGs are the six gases identified in the Kyoto Protocol: carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6).
Indirect emissions (Scope 2)	Emissions that are a consequence of the activities of the reporting entity but that occur at sources owned or controlled by another. For example, emissions that occur at a power plant as a result of electricity used by a facility represent the facility's indirect emissions.
Normalization factor or intensity ratio	The ratio of GHG emissions over an appropriate normalizing factor is used to measure GHG intensity. Normalizing factors or intensity ratios are typically measured in physical units (e.g., tons of solids, millions of gallons of water) or economic units. Because of the large variability in economic metrics, there is a preference for using metrics based on physical values, which typically track year-to-year changes in emissions intensity more accurately.
Operational control	Full authority to introduce and implement operating policies at an operation. Operational control is one of two ways to define the control approach; the other is financial control, defined above.
Organizational boundaries	The boundaries that determine the operations owned or controlled by the reporting entity, depending on the consolidation approach taken (either the equity share or control approach).
Organic growth (or decline)	Increases or decreases in GHG emissions as a result of changes in influent flow, biochemical oxygen demand, and total suspended solids, facility closures or construction of new facilities.
Other indirect emissions (Scope 3)	All indirect emissions not covered in Scope 2. Examples include upstream and downstream emissions, emissions resulting from the extraction and production of purchased materials and fuels, transport related activities in vehicles not owned or controlled by the reporting entity, use of sold products and services (e.g., Milorganite®, Agri-Life), outsourced activities, recycling of used products, waste disposal, etc.
Structural change	A change in the organizational or operational boundaries of an entity resulting from a transfer of ownership or control of emissions from one entity to another. Structural changes usually result from a transfer of ownership of emissions, such as mergers, acquisitions, divestitures but can also include insourcing and outsourcing.

1. Introduction

The Milwaukee Metropolitan Sewerage District maintains a greenhouse gas (GHG) inventory that represents a true and fair account of its GHG emissions through the use of standardized approaches and principles in accordance with the World Resources Institute (WRI)/World Business Council on Sustainable Development (WBCSD) GHG Protocol. To ensure that the inventory is maintained in a structured and consistent manner, the District developed a GHG Inventory Management Plan (IMP). The IMP is an internal guidance document that facilitates efficient implementation of the GHG emission inventory process.

The IMP is consistent with the District's strategic goals and tracks closely with globally accepted GHG protocols. It provides a reproducible and transparent inventory and is expected to help improve efficiency of the inventory process through streamlined accountability. The IMP will be updated or modified to stay consistent with regulatory and agency changes following completion of the GHG inventories for calendar years 2000 through 2007. Changes made to the IMP will be documented and included in Attachment D.

The inventory methodology, as documented in the IMP, is based on guidance and supporting documentation from the following references:

- WRI/WBCSD. The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard, April 2004. http://www.ghgprotocol.org/standards.
- California Air Resources Board (CARB), California Climate Action Registry (CCAR), and Local Governments for Sustainability (ICLEI, International Council for Local Environmental Initiatives). September 2008. *Local Government Operations Protocol: for the quantification and reporting of greenhouse gas emissions inventories,* Version 1.0.
- The Climate Registry (TCR). *General Reporting Protocol for the Voluntary Reporting Program.* March 2008.
- *CCAR Urban Forest Project Reporting Protocol,* Version 1.0. August 2008.
- Intergovernmental Panel on Climate Change (IPCC). 2006. *Guidelines for National Greenhouse Gas Inventories.*
- USEPA, Climate Leaders Greenhouse Gas Inventory Protocol, *Design Principles*. May 2005.
- USEPA, Climate Leaders Greenhouse Gas Inventory Protocol, *Direct Emissions from Mobile Combustion Sources*. May 2008.
- USEPA, Climate Leaders Greenhouse Gas Inventory Protocol, *Direct Emissions from Stationary Combustion Sources*. May 2008.
- USEPA. *Final Rule: Mandatory Reporting of Greenhouse Gases.* September 22, 2009. EPA-HQ-OAR-2008-0508; FRL RIN 2060-A079.

1.1 Criteria and Purpose

The inventory includes the District's water reclamation facilities, conveyance sewer system, and other related District-owned facilities and programs. The GHG emissions inventory accounts for the six greenhouse gases covered by the Kyoto Protocol. The Kyoto Protocol is an international agreement, associated with the United Nations Framework Convention on Climate Change, that commits industrialized countries to reducing the following GHG emissions:

- Carbon dioxide, CO_2
- Methane, CH_4
- Nitrous oxide, N_2O
- Hydrofluorocarbons, HFCs
- Perfluorocarbons, PFCs
- Sulfur hexafluoride, SF_6

The object of the inventory is to calculate and document GHG emissions that fall within the District's inventory boundaries, and to ensure the GHG inventory appropriately reflects the GHG emissions of the District.

1.2 GHG Accounting and Reporting Principles

The District utilizes five overarching accounting and reporting principles to ensure that the its GHG data represent a faithful, true, and fair account of its GHG emissions. The following principles, adapted from the WRI/WBCSD GHG Protocol, serve to guide the measurement and reporting of emissions.

- **Relevance**—The GHG inventory will appropriately reflect the District's GHG emissions and will be organized to reflect the areas over which the District exerts control and holds responsibility, in order to serve the decision-making needs of users.

- **Completeness**—All GHG emission sources and emissions-causing activities within the inventory boundary are accounted for. Specific exclusions are justified and disclosed.

- **Consistency**—Consistent methodologies are used in the identification of boundaries, analyses of data, and quantification of emissions to enable meaningful trend analysis over time, demonstration of reductions, and comparisons of emissions. Changes to data, inventory boundary, methods, or relevant factors in subsequent inventories will be disclosed.

- **Transparency**—Relevant issues are addressed and documented factually and coherently to provide a trail for review and replication. Relevant data sources and assumptions are disclosed, along with specific descriptions of methodologies and data sources used.

- **Accuracy**—The District's GHG emissions are quantified systematically neither over nor under actual emissions as far as can be judged, and uncertainties are reduced as far as practicable. Sufficient accuracy is achieved to enable users to make decisions with reasonable assurance as to the integrity of the reported information.

Additionally, the District's policies and practices support the need to report GHG emissions. The District has a commitment to consider the depletion rate of nonrenewable resources and use those resources in the most productive and beneficial way possible to forestall or avoid complete exhaustion of those resources. The GHG emission inventory provides the District with information to develop future strategies for managing resources such as the energy that produces GHG emissions.

1.3 Objectives

The District developed the GHG inventory in anticipation of future regulations and as a good management practice. The District intends to use the results of the inventory to develop strategies for managing GHG issues in the future, including developing policy and emission reduction goals. The benefits of developing a GHG inventory are numerous and varied, and include the following:

- **Risk Management—**Voluntarily inventorying GHG emissions helps to manage risk by documenting early actions to reduce GHG emissions. Such information may be accepted by future state, federal or international regulatory GHG programs.
- **Readiness for a Carbon Constrained Future—**Identifying emissions sources to develop a GHG profile and management strategies helps to prepare for and respond to the potential impact of new regulations.
- **Stakeholder Education—**Assembling an emissions inventory helps to inform management, constituents, employees, and the public about the District's GHG emissions profile.
- **Recognition as an Environmental Leader—**Voluntarily reporting GHG emissions provides a pathway to recognize, publicize, and promote environmental stewardship.
- **Addressing Inefficiencies—**Accounting for emissions provides better insight into the relationship between improving efficiency and reducing emissions. As a result, some organizations have redesigned operations and processes, implemented technological innovations, improved services, and ultimately saved money and resources.
- **Adherence to District Sustainability Policy—**The District commits to policies and practices that consider the depletion rate of nonrenewable resources. Further, it commits to using those resources when necessary in the most productive and beneficial way possible to "forestall or avoid complete exhaustion of those resources."

2. Agency Information

2.1 Agency Name

Milwaukee Metropolitan Sewerage District

2.2 Agency Address

260 West Seeboth Street
Milwaukee, WI 53204

2.3 GHG Inventory Manager and Contact Information

Urbain Boudjou
260 West Seeboth Street
Milwaukee, WI 53204
414-225-2159

2.4 GHG Inventory Team

The GHG Inventory Team is currently under development. It comprises the individuals responsible for updating the GHG Inventory, calculating the emissions, collecting data, and reviewing data. Preliminary team members are referenced in Attachment A.

3. Boundary Conditions

3.1 Organizational Boundaries

Emissions from sources within the District's organizational boundaries are defined as the GHG emissions from operations that the District owns and controls (excluding construction contracts). The WRI/WBSCD GHG Protocol defines *control* as an entity's full authority to introduce and implement operating policies.[1] The District's facilities (Exhibit 3-1) are included in the emissions inventory.

EXHIBIT 3-1
Facilities and Sources in the District's Organizational Boundaries

Facility Name	Address
Jones Island Water Reclamation Facility	700 East Jones Street
South Shore Water Reclamation Facility	8500 South 5th Avenue
Headquarters/Central Lab Building	250 West Seeboth Street 260 West Seeboth Street
Other Sources	
13th and College Facility	6060 South 13th Street
Flushing Station/Alterra Coffee Shop	1701 North Lincoln Memorial Drive
Interceptor sewer system	See Attachment B for a complete list of locations.
Inline storage and pumping system	See Attachment B for complete list of locations.
Mobile Sources	
District Vehicles	See Attachment C for complete list of vehicles.
Agri-Life Trucks	
Boats	Pelagos research vessel, ORP research boat
Locomotive	

3.2 Operational Boundaries

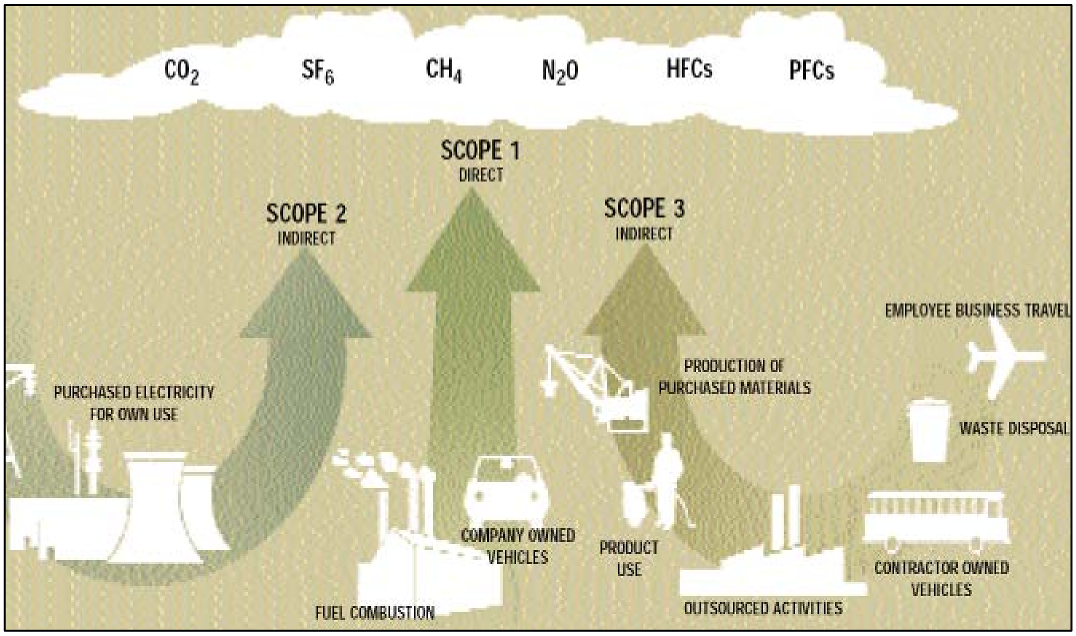
Based upon the available GHG reporting protocols, a reporting entity reports GHG emissions defined by the following four operational categories:

- Direct emissions; also known as Scope 1 emissions
- Indirect emissions; also known as Scope 2 emissions
- Optional or other indirect emissions; also known as Scope 3 emissions

1 WRI/WBCSD. The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard, April 2004. http://www.ghgprotocol.org/standards.

- Biogenic emissions, considered part of the natural carbon cycle because they are of biogenic origin (recently contained in living organic matter)

The District's GHG inventory includes direct (Scope 1), indirect (Scope 2), and biogenic GHG emissions associated with digester gas combustion and the water reclamation processes. The inventory does not include optional (Scope 3) sources.



3.2.1 Direct Emissions (Scope 1)

Direct emissions include stationary combustion, water reclamation process and mobile source emissions. The GHG inventory contains the following general source categories:

- **Stationary Combustion—**Stationary sources that combust natural gas, diesel, or other fuels to produce electricity, steam, heat, or power (boilers, furnaces, dryers, heaters, generators, etc.) including CH_4 and N_2O emissions from combustion of digester gas
- **Water Reclamation Processes—**CH_4 emissions from incomplete combustion of digester gas, CH_4 from sludge drying, and N_2O emissions from the activated sludge process. Other water reclamation processes have negligible GHG emissions.
- **Mobile—**Includes owned or leased vehicles (trucks, cars, boats, forklifts)

3.2.2 Indirect Emissions (Scope 2)

The District's only indirect emissions are those associated with the generation of electricity that the District purchases. The generation of renewable energy reduces GHG emissions by reducing the amount of fossil fuels that would otherwise be consumed to generate electricity. Purchased electricity generated from renewable energy does not contribute to an entity's GHG emissions but does reduce its GHG footprint. In 2006 and 2007, the District purchased electricity generated from renewable energy from Wisconsin Energy Corporation's Energy for Tomorrow program.

3.2.3 Biogenic Emissions

Following established international GHG management principles, emissions of CO_2 from combustion of digester gas and the water reclamation activated sludge processes are not included as Scope 1 sources because the carbon is of biogenic origin and would have otherwise been emitted to the atmosphere through the natural process of decay.[2]

CO_2 released from digester gas combustion and water reclamation processes is being reported separately as biogenic emissions in accordance with IPCC Guidelines for National Greenhouse Gas Inventories.

The distinction of emissions from digester gas combustion applies only to CO_2 and not to CH_4 and N_2O, which are also emitted from digester gas combustion and water reclamation processes. Unlike CO_2 emissions, CH_4 and N_2O emitted from digester gas combustion, CH_4 emitted from sludge drying processes, and N_2O emitted from water reclamation processes are not considered to be of biogenic origin under current guidance because they are the result of man-made processes. Therefore, CH_4 and N_2O emissions from digester gas combustion, sludge drying and water reclamation processes are included in the District's Scope 1 emissions.

The USEPA's mandatory reporting rule for GHGs includes reporting of CH_4 and N_2O emissions resulting from the combustion of digester gas but does not include reporting of CH_4 and N_2O emissions from water reclamation processes at publicly owned treatment works. Emissions from publicly owned treatment works are not included in the reporting rule because, as described in the Wastewater Treatment TSD (EPA-HQ-OAR-2008-0508-035), emissions from such facilities do not exceed the thresholds considered under this rule. However these emissions are included in Chapter 10 of the CARB, CCAR, and ICLEI, September 2008, *Local Government Operations Protocol: For the Quantification and Reporting of Greenhouse Gas Emissions Inventories,* Version 1.0. It is deemed prudent to include these emissions in the inventory for the purposes of completeness and potential for future regulation.

The GHG inventory guidance documents followed do not include emission factors for methane emissions that could be formed and released in the sludge during the drying process. However, methane emissions associated with the sludge drying process have been estimated by calculating the difference between the methane measured during the 2007 dryer/turbine stack test and the uncombusted turbine natural gas. The methane emitted from the uncombusted turbine natural gas was estimated using an emission factor. Given the underlying accuracy of the data, the District's emissions presented in this report have been rounded to the nearest 100 tonnes.

3.3 Source List

The District maintains a list of specific emission sources. Exhibit 3-2 lists the emission sources included in the inventory by facility.

[2] IPCC. 2006. *Guidelines for National Greenhouse Gas Inventories.*

EXHIBIT 3-2
GHG Emission Source List

Facility Name	Stationary Combustion Emissions	Water Reclamation Emissions	Indirect Emissions
Facility	Dryers (natural gas) Two 16-MW turbines (natural gas, fuel oil) Two Cleaver Brooks boilers (natural gas, fuel oil) Building heat (natural gas and propane)	Biogenic CO_2 and N_2O from aeration basins CH_4 from sludge drying	Purchased electricity
South Shore Water Reclamation Facility	Boilers – three Kewaunee, two Scum, two Cleaver Brooks (natural gas, digester gas) Five IC engine generators (natural gas, digester gas) Building heat (natural gas) Two flares (digester gas)	Biogenic CO_2 and N_2O from aeration basins CH_4 from incomplete combustion of digester gas Biogenic CO_2, and nonbiogenic CH_4 and N_2O are emitted from stationary combustion of digester gas	Purchased electricity
Headquarters and Central Lab Building	Building heat (natural gas)	NA	Purchased electricity
Other Sources	Building heat (natural gas)	NA	Purchased electricity

Note: Mobile sources are not tracked at each facility but are tracked at the entity level.

3.4 GHG List

The six GHGs covered by the Kyoto Protocol were considered for inclusion in the GHG Inventory. The District's operations emit the following GHGs:

- Biogenic CO_2 and nonbiogenic CH_4 and N_2O are emitted from water reclamation processes, and nonbiogenic CH_4 is emitted from sludge drying processes.
- CO_2, CH_4, and N_2O are emitted from stationary combustion, mobile combustion and nonrenewable energy electricity usage. Biogenic CO_2 and nonbiogenic CH_4 and N_2O are emitted from stationary combustion of digester gas and dried sludge.
- Air conditioning and other refrigeration units have been reviewed to determine if their GHG emissions should be included in the inventory. Existing units use refrigeration chemicals that are being phased out under the Montreal Protocol (such as CFCs). Montreal Protocol gases are not among the GHGs covered by the Kyoto Protocol and, therefore, are not included in the District's inventory.[3] As the phased-out chemicals are replaced with hydrofluorocarbons or perfluorocarbons, it is recommended that emissions associated with air conditioning and refrigeration be reviewed for possible inclusion in the District's inventory.

Based upon the USEPA mandatory reporting rule for GHGs and recently proposed cap and trade legislation submitted by Waxman-Markey (U.S. Bill H.R. 2454), the District has

[3] WRI/WBSCD. April 2004. *The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard.*

identified the water reclamation plant emissions that will likely be reported or regulated in the U.S. (Exhibit 3-3).

EXHIBIT 3-3
Water Reclamation Plant GHG Emissions Likely to be Regulated or Reported

Emission Source	CO_2	CH_4	N_2O
Fossil fuels	Yes	Yes	Yes
Digester biogas fuel	No	Yes	Yes
Water reclamation processes	No	No	No
Sludge drying (not including emissions due to fuel combustion)	No	No	NA

4. Calculation Methodology

The emission calculation methodology used by the District follows the guidance of the WRI/WBCSD GHG Protocol. Additional guidance was obtained from the USEPA Climate Leader's GHG Inventory Protocols, CCAR protocols, and TCR protocols when the WRI/WBCSD GHG protocol was incomplete or unclear. Detailed calculation methodologies are documented in the GHG inventory tool. The GHG inventory tool is the tool used for calculating GHG emissions, conducting data analysis and comparisons, and issuing reports. The District uses an Excel spreadsheet as its GHG inventory calculation tool.

4.1 Global Warming Potentials

GHGs have different warming potentials. The Global Warming Potential (GWP) index was developed to compare different GHGs on a common reporting basis. A gas's ability to trap atmospheric heat over a certain lifetime in the atmosphere in reference to the same mass of CO_2 released over the same period is its GWP. Since GWP is weight-based and time-dependant, GHG emissions commonly are reported as CO_2 equivalents (for example, tonnes CO_2e) using the broadly adopted 100-year GWP standard. The District calculates all GHG emissions as tonnes of CO_2 e. Exhibit 4-1 provides GWP values used to calculate CO_2 e emissions.

EXHIBIT 4-1
Global Warming Potentials
MMSD GHG Inventory Management Plan

GHG	GWP[a]
Carbon dioxide, CO_2	1
Methane, CH_4	21
Nitrous oxide, N_2O	310

Note: 100-year GWP estimates, from the Intergovernmental Panel on Climate Change's *Second Assessment Report* (1995). GWP values are from the *Second Assessment Report* to be consistent with international practices.

4.2 Direct Emissions from Stationary Combustion Sources

Natural gas, digester gas, No. 2 fuel oil, and propane are combusted at the District's facilities. Estimating emissions from stationary combustion involves six steps:

1. Determine annual consumption of each fuel combusted at your facility.
2. Determine the appropriate CO_2 emission factors for each fuel.
3. Determine the appropriate CH_4 and N_2O emission factors for each fuel.
4. Calculate each fuel's CO_2 emissions.
5. Calculate each fuel's CH_4 and N_2O emissions.
6. Convert CH_4 and N_2O emissions to CO_2 equivalents and total emissions.

These six steps are described below.

4.2.1 Determine Annual Consumption of Each Fuel Combusted

Natural gas, digester gas, No. 2 fuel oil, and propane are combusted at the District's facilities. The District uses utility invoice records and the annual air emission inventory report required by the Wisconsin Department of Natural Resources to track annual fuel usage by emission source. Utility invoice records are available for most facilities and reporting years. The air emission inventory report provides fuel usage by specific equipment type for the Jones Island and South Shore facilities.

The utility records are based on calibrated utility meters and assumed to be more accurate than data records collected for each piece of equipment included in the air emission inventory report. Therefore the air emission inventory data is used to calculate the percentage of the total annual fuel usage at the facility by equipment type. These percentages are applied to the total annual fuel usage provided by the utility records to calculate fuel usage by equipment type. For some reporting years, utility records are unavailable. In those instances, air emission inventory fuel usage values were used for Jones Island and South Shore. Estimates from the previous year were used for all other facilities.

For the South Shore and Jones Island facilities, measured heat content factors are provided for specific fuels in the air emission inventory and used to convert fuel data to energy units. For all other facilities, utility records for natural gas were provided in therms and converted to MMBtu.

4.2.2 Determine Appropriate CO_2 Emission Factor for Each Fuel

Because the measured carbon content of specific fuels was unavailable, the District uses default CO_2 emission factors provided by fuel type from The Climate Registry's General Reporting Protocol Version 1.1 (Exhibit 4-2). Emission factors are provided in units of CO_2 per unit energy and CO_2 per unit mass or volume. These emission factors were selected because, at the time, they were deemed most likely to be used in future federal regulations. It is recommended that these emission factors be reviewed against the USEPA Mandatory GHG Reporting Rule or other federal GHG regulations (for example, carbon cap and trade) that may be passed by Congress in the future.

EXHIBIT 4-2
Stationary Combustion CO_2 Emission Factors
MMSD GHG Inventory Management Plan

Fuel/Source Type	CO_2 Emission Factor (kg/MMBtu)
Natural gas (1,025 to 1,050 Btu/scf)	53.06
Wastewater treatment biogas	52.07
Distillate fuel oil (#1, 2, &4)	73.15
Propane	63.07

Source: TCR General Reporting Protocol Version 1.1, Table 12.1

4.2.3 Determine the Appropriate CH_4 and N_2O Emission Factors for Each Fuel

Estimating CH_4 and N_2O depends not only upon fuel characteristics but also on technology type, combustion characteristics, usage of pollution control equipment, and ambient environmental conditions. Emissions vary with the size, efficiency, and vintage of the combustion technology, and also maintenance and operational practices. A much greater effort is required to estimate CH_4 and N_2O emissions from stationary sources, and therefore a much higher level of uncertainty exists.[1] To reduce uncertainty, where fuel usage is available for a specific type of combustion unit used at the facility (turbines, boilers, dryers), the emission factors for CH_4 and N_2O are based on specific combustion unit and fuel type. For

[1] USEPA. May 2008. *Climate Leaders Greenhouse Gas Inventory Protocol, Direct Emissions from Stationary Combustion Sources.*

stationary combustion not related to a specific type of combustion unit (for example, building heat), typical emission factors are based upon fuel type.

Where fuel usage is available for a specific type of combustion equipment used at the facility (turbines, boilers, dryers), the emission factors are based on the specific combustion equipment and fuel type. For stationary combustion not related to a specific type of combustion equipment (for example, building heat), emission factors are based upon fuel type. Exhibit 4-3 lists the N_2O and CH_4 emission factors used for the District's stationary combustion emissions.

EXHIBIT 4-3
Stationary Combustion N_2O and CH_4 Emission Factors
MMSD GHG Inventory Management Plan

Fuel/Source Type	N_2O Emission Factor	CH_4 Emission Factor	N_2O and CH_4 Emission Factor Source
Natural gas: nonspecific	0.1 g/MMBtu	1 g/MMBtu	The Climate Registry General Reporting Protocol Version 1.1, Table 12.9, page 81
Natural gas: turbines	0.9 g/MMBtu	3.8 g/MMBtu	The Climate Registry General Reporting Protocol Version 1.1, Table 12.7, page 79 (Industrial Sector, >3MW)
Natural gas: boilers or dryers	0.9 g/MMBtu	0.9 g/MMBtu	The Climate Registry General Reporting Protocol Version 1.1, Table 12.7, page 79
Wastewater treatment digester gas	0.1 g/MMBtu	0.9 g/MMBtu	USEPA Proposed Rule: Mandatory Reporting of GHG, March 10, 2009. Table C-3.
Distillate fuel oil (#1, #2, #4)	0.3 g/MMBtu	3.0 g/MMBtu	The Climate Registry General Reporting Protocol Version 1.1, Table 12.7, page 79
Propane	0.9 lb/10^3 gal.	0.2 lb/10^3 gal.	AP-42, Section 1.5 Liquefied Petroleum Gas Combustion, Table 1.5-1, July 2008

4.2.4 Calculate Each Fuel's CO_2 Emissions and Convert to Metric Tons

To determine CO_2 emissions from stationary combustion, fuel use is multiplied by the CO_2 emission factor and converted to metric tons. This calculation is repeated for each fuel type and then summed. Where fuel use is expressed in different units (such as short tons, cubic feet, MMBtu, etc.), "gallons" is replaced in the equation with the appropriate unit of measure.

Calculating CO_2 emissions from stationary combustion (fuel use in MMBtu)

$$CO_2 emissions\ \ (tonnes) = fuel\ \ consumed\ \ (MMBtu) \times emission\ \ factor\left(\frac{kg\ CO_2}{MMBtu}\right) \div \left(\frac{1{,}000\ kg}{tonnes}\right)$$

4.2.5 Calculate Each Fuel's CH_4 and N_2O Emissions and Convert to Metric Tons

To determine CH_4 emissions from stationary combustion, fuel use is multiplied by the CH_4 emission factor, and then converted from grams to metric tons. The calculation is repeated for each fuel and technology type, and then summed. Where fuel use is expressed in different units (such as gallons, short tons, cubic feet, etc.) the fuel use data is converted to units of MMBtu using the fuel's heat content. The same procedure is followed to calculate total emissions of N_2O.

Calculating CH_4 and N_2O emissions from stationary combustion (fuel use in MMBtu)

$$CH_4 emissions\ (tonnes) = fuel\ consumed\ (MMBtu) \times emission\ factor\left(\frac{g\ CH_4}{MMBtu}\right) \div \left(\frac{1{,}000{,}000 g}{tonnes}\right)$$

$$N_2O emissions\ (tonnes) = fuel\ consumed\ (MMBtu) \times emission\ factor\left(\frac{g\ N_2O}{MMBtu}\right) \div \left(\frac{1{,}000{,}000 g}{tonnes}\right)$$

4.2.6 Convert CH_4 and N_2O Emissions to Units of CO_2 Equivalent

The GWP factors are used to convert CH_4 and N_2O emissions to units of CO_2 equivalent. Then emissions are summed of all three gases to determine the total emissions from stationary combustion.

$$CH_4\ emissions\ (tonnes\ CO_2e) = CH_4\ emissions\ (tonnes) \times 21\ (GWP)$$

$$N_2O\ emissions\ (tonnes\ CO_2e) = N_2O\ emissions\ (tonnes) \times 310\ (GWP)$$

$$Total\ Emissions\ (tonnes\ CO_2e) = CO_2 + CH_4\ emissions\ (tonnes\ CO_2e) + N_2O\ \text{emissions}\ (tonnes\ CO_2e)$$

4.3 Direct Emissions from Mobile Combustion Sources

Mobile combustion sources include both on-road and nonroad vehicles, such as automobiles, trucks, boats, trains, tractors, and other maintenance vehicles. The combustion of fossil fuels in mobile sources emits CO_2, CH_4, and N_2O. Emissions from mobile combustion are estimated using emission factors, and vehicle fuel use or miles traveled.

The inventory includes mobile combustion emissions from the following:

- District-owned or operated cars and trucks
- Lawn care equipment
- Snow blowers
- Agri-Life vehicles
- Pelagos research vessel
- ORP research boat
- The locomotive used to transport Milorganite® at Jones Island

CO_2 emissions, which account for most of the emissions from mobile sources, are directly related to the quantity of fuel combusted and thus can be calculated using fuel consumption data. CH_4 and N_2O emissions depend more on the vehicle distance traveled. Calculating emissions of CH_4 and N_2O requires data on vehicle miles traveled. Estimating emissions from mobile sources involves the following six steps:

1. Identify total annual fuel consumption and mileage by vehicle type.
2. Determine the appropriate CO_2 emission factors for each vehicle type.
3. Determine the appropriate CH_4 and N_2O emission factors for each vehicle type.
4. Calculate CO_2 emissions for each vehicle type.
5. Calculate total CH_4 and N_2O emissions.

6. Convert CH_4 and N_2O emissions to CO_2 equivalent and determine total emissions.

These six steps are described in detail in the following sections.

4.3.1 Identify Total Annual Fuel Consumption by Fuel Type

The preferred approach is to obtain data on actual fuel consumption by fuel type. Methods include direct measurements of fuel use (official logs of vehicle fuel gauges or storage tanks); collected fuel receipts; and purchase records for bulk storage fuel purchases (as when fuel for a fleet is stored at a facility).

CH_4 and N_2O emissions depend CH_4 and N_2O emissions depend largely on the emissions control equipment used (for example, type of catalytic converter) and vehicle miles traveled more than volume of fuel combusted. The preferred approach is to use vehicle miles traveled data by vehicle type. Sources of annual mileage data include odometer readings or trip manifests that include distance to destinations.

For most District mobile sources, actual fuel use or mileage data were not available; therefore, fuel consumption was estimated using the following procedure:

1. Identify vehicle make, model, fuel type, and model year for each vehicle operated.
2. Estimate the annual distance traveled by vehicle type.
3. Estimate the fuel economy for each vehicle type.
4. Convert annual mileage to fuel consumption.

The District maintains a complete list of vehicles and equipment. Annual mileage is estimated by considering the frequency of use for the vehicle type as shown in Exhibit 4-4. Fuel efficiency is estimated from the U.S. Department of Transportation Federal Highway Administration Annual Vehicle Distance Traveled in Miles and Related Data—2006, http://www.fhwa.dot.gov and USEPA Climate Leaders GHG Protocol, Direct Emissions from Mobile Combustion Sources (May 2008) (Exhibit 4-5). The estimated mileage is multiplied by the estimated fuel efficiency to calculate the fuel usage in gallons.

For the Pelagos research vessel, actual annual fuel records are available. The ORP research vessel annual fuel usage is assumed to be equal to that of the Pelagos.

For the trucks used to transport Agri-Life for land spreading, each Agri-Life delivery is tracked by land owner location and metric tons delivered. The number of trips/trucks for each delivery is estimated by dividing the total metric tons delivered by the approximate weight capacity of a truck. This is assumed to be 71,057 lb/truck based on a 6,000-gallon truck for an average sized truck multiplied by a sludge density of 11.84 lb/gal. (assumes specific gravity of 1.42). The number of trips to each land owner location is multiplied by the approximate round trip distance for that location. The mileage is summed and multiplied by a fuel efficiency factor of 5.9 mpg, provided in Climate Leaders GHG Protocol, Direct Emissions from Mobile Combustion Sources (May 2008).

EXHIBIT 4-4
Mobile Vehicles/Trucks Fuel Usage Estimate
MMSD GHG Inventory Management Plan

Vehicle Type	No. of Vehicles[a]	Avg Miles per yr per vehicle	Total Miles per year	mpg[b]	Gallons of Fuel	Fuel Type	Comments/ Assumptions
MMSD cars and light trucks	29	10,000	290,000	22.1	13,122	gasoline	
Veolia cars and light trucks	62	5,000	310,000	17.7	17,514	gasoline	
Televising and manhole trucks	12	5,000	60,000	17.7	3,390	diesel	
Class 8 trucks	12	5,000	60,000	8.3	7,229	diesel	
Light, medium, and heavy dump trucks	10	5,000	50,000	5.9	8,450	diesel	
Wheel loaders and skidloaders	9	500	4,500	5	900	diesel	
Straddle carriers	2	500	1,000	5	200	diesel	
Burden carriers and ATVs	38	500	19,000	5	3,800	gasoline	
Tractors and lawn mowers	27	250	6,750	5	1,350	gasoline	
Snow blowers	16	250	4,000	5	800	gasoline	
Generators	20				1,000	diesel	50 gal./yr/generator
Agri-Life trucks	31		40,000	5.9	6,780	diesel	Based upon solids disposal records.

[a] No. of vehicles for each type based on list provided in Attachment C.
[b] Mile per gallon (mpg) basis for each vehicle type is provided in Exhibit 4-5.

EXHIBIT 4-5
Mobile Vehicles/Trucks Miles per Gallon Estimates
MMSD GHG Inventory Management Plan

Vehicle Type	Avg mpg	Source
Passenger cars	22.1	U.S. Department of Transportation Federal Highway Administration Annual Vehicle Distance Traveled in Miles and Related Data- 2006, http://www.fhwa.dot.gov
Other 2-axle, 4-tire vehicles	17.7	U.S. Department of Transportation Federal Highway Administration Annual Vehicle Distance Traveled in Miles and Related Data- 2006, http://www.fhwa.dot.gov
Single unit 2-axle 6-tire or more trucks	8.3	U.S. Department of Transportation Federal Highway Administration Annual Vehicle Distance Traveled in Miles and Related Data- 2006, http://www.fhwa.dot.gov
Combination trucks	5.9	Climate Leaders GHG Protocol, Direct Emissions from Mobile Combustion Sources (May 2008)
Other vehicles	5.00	Assumed all other small vehicles (loaders, carriers, tractors, snow blowers) get an average of 5 mpg

The District operates a diesel locomotive to transport Milorganite®. Fuel usage for the locomotive is estimated using Milorganite® production data. The annual total tons of Milorganite® produced and an average daily load size based on a 365 days/year operating schedule are used to estimate the weight of the locomotive. The weight of the locomotive is multiplied by the estimated mileage to calculate average ton-mile (per day). The average ton-mile (per day) is multiplied by an emission factor of 337 Btu/ton-mile provided in Climate Leaders GHG Protocol, Direct Emissions from Mobile Combustion Sources, May 2008, and converted to gallons/year.

$$Fuel\ Use\ (gal) = Dist.\ (miles) \div Fuel\ Economy\ (mpg)$$

Because more than one type of vehicle is operated at the District, the fuel use and mileage for each vehicle type is calculated and then summed together.

The fuel usage estimates were completed using the most recent available data. This included a comprehensive vehicle list generated in 2009, and Agri-Life landspreading and Milorganite® production records from 2007. Given the insignificance of these sources relative to the District's other sources (mobile sources account for less than one percent of the GHG emissions inventory), these estimates were applied to mobile emission estimates for all reporting years from 2000 through 2007. Only the fuel consumption data for the boats were updated from year to year based upon data availability.

4.3.2 Select Appropriate Emission Factor for Each Fuel

CO_2 emission factors by fuel type are based upon USEPA Climate Leaders GHG Protocol, Direct Emissions from Mobile Combustion Sources, May 2008. The CO_2 emission factors used for the District's mobile combustion source emissions are provided in Exhibit 4-6.

EXHIBIT 4-6
Mobile Combustion CO_2, N_2O, and CH_4 Emission Factors
MMSD GHG Inventory Management Plan

Vehicle/Fuel Type	CO_2 Emission Factor (kg CO_2/ gal)	N_2O Emission Factor	CH_4 Emission Factor	N_2O and CH_4 Emission Factor Units
Gasoline passenger cars	8.81	0.0197	0.178	grams/mile
Gasoline light-duty trucks	8.81	0.022	0.2024	grams/mile
Gasoline heavy duty vehicles	8.81	0.0497	0.4604	grams/mile
Diesel heavy-duty vehicles	10.15	0.0048	0.0051	grams/mile
Gas small utility	8.81	0.22	0.5	grams/gal
Gasoline agricultural equipment	8.81	0.22	1.26	grams/gal
Diesel construction equipment	10.15	0.26	0.58	grams/gal
Gasoline ships and boats	8.81	0.22	0.64	grams/gal
Diesel locomotives	10.15	0.26	0.8	grams/gal

Source: Climate Leaders GHG Protocol, Direct Emissions from Mobile Combustion Sources (May 2008).

4.3.3 Calculate Total CO_2 Emissions and Convert to Metric Tons

To determine CO_2 emissions from mobile combustion, fuel use is multiplied by the CO_2 emission factor and then converted from kilograms to metric tons. The calculation for each fuel type is repeated, then summed

$$Fuel\ A\ CO_2 emissions\ \ (tonnes) = fuel\ \ consumed\ \ (gal)\ \times emission\ factor\left(\frac{kg\ CO_2}{gal}\right) \div \left(\frac{1{,}000\ kg}{tonnes}\right)$$

$$Fuel\ B\ CO_2 emissions\ \ (tonnes) = fuel\ \ consumed\ \ (gal)\ \times emission\ factor\left(\frac{kg\ CO_2}{gal}\right) \div \left(\frac{1{,}000\ kg}{tonnes}\right)$$

$$Total\ CO_2\ emissions\ (tonnes) = CO_2\ \ from\ Fuel\ A\ (tonnes) + CO_2\ \ from\ Fuel\ B\ (tonnes)$$

4.3.4 Select the Appropriate CH_4 and N_2O Emission Factor for Each Fuel

CO_2 emission factors by fuel type in are based upon USEPA Climate Leaders GHG Protocol, Direct Emissions from Mobile Combustion Sources (May 2008) as provided in Exhibit 4-5. Exhibit 4-6 lists the N_2O and CH_4 emission factors used for the District's mobile combustion source emissions.

4.3.5 Calculate CH_4 and N_2O Emissions by Vehicle Type

Calculate CH_4 emissions by vehicle type, convert to metric tons, and obtain total CH_4 emissions. The procedure is then repeated using N_2O emissions.

Calculating CH_4 Emissions from Mobile Combustion

$$Vehicle\ \ Type\ A\ CH_4 emissions\ (tonnes) = Annual\ Dist.(miles) \times emission\ \ factor\left(\frac{g\ CH_4}{Mile}\right) \div \left(\frac{1{,}000{,}000 g}{tonnes}\right)$$

$$Vehicle\ \ Type\ B\ CH_4 emissions\ (tonnes) = Annual\ Dist.(miles) \times emission\ \ factor\left(\frac{g\ CH_4}{Mile}\right) \div \left(\frac{1{,}000{,}000 g}{tonnes}\right)$$

$$Total\ CH_4 emissions\ (tonnes) = Vehicle\ \ Type\ \mathrm{A}\ CH_4 emissions\ (tonnes) + Vehicle\ \ Type\ B\ CH_4 emissions\ (tonnes)$$

Calculating N_2O Emissions from Mobile Combustion

$$Vehicle\ \ Type\ \mathrm{A}\ \mathrm{N_2O}\ emissions\ (tonnes) = Annual\ Dist.(miles) \times emission\ \ factor\left(\frac{g\ \mathrm{N_2O}}{Mile}\right) \div \left(\frac{1{,}000{,}000 g}{tonnes}\right)$$

$$Vehicle\ \ Type\ B\ \mathrm{N_2O}\ emissions\ (tonnes) = Annual\ Dist.(miles) \times emission\ \ factor\left(\frac{g\ \mathrm{N_2O}}{Mile}\right) \div \left(\frac{1{,}000{,}000 g}{tonnes}\right)$$

$$Total\ \mathrm{N_2O}\ emissions\ (tonnes) = Vehicle\ \ Type\ \mathrm{A}\ \mathrm{N_2O} emissions\ (tonnes) + Vehicle\ \ Type\ B\ \mathrm{N_2O}\ emissions\ (tonnes)$$

4.3.6 Convert CH_4 and N_2O Emissions to Units of CO_2 Equivalent

The GWP factors are used to convert CH_4 and N_2O emissions to units of CO_2 equivalent. Then emissions of all three gases are summed to determine your total emissions from mobile combustion.

Converting to CO_2 equivalent and determining total emissions

$$CH_4\ emissions\ (tonnes\ CO_2e) = CH_4\ emissions\ (tonnes) \times 21\ (GWP)$$

$$N_2O\ emissions\ (tonnes\ CO_2e) = N_2O\ emissions\ (tonnes) \times 310\ (GWP)$$

$$Total\ Emissions\ (tonnes\ CO_2e) = CO_2 + CH_4\ emissions\ (tonnes\ CO_2e) + N_2O\ \text{emissions}\ (tonnes\ CO_2e)$$

Attachment C contains a complete list of the number and type of mobile sources included in the inventory. For most mobile sources, actual fuel use or mileage data were not available; therefore, fuel consumption was estimated based on estimated annual mileage and vehicle fuel efficiency. Emission factors by fuel type are based upon USEPA Climate Leaders GHG Protocol, Direct Emissions from Mobile Combustion Sources (May 2008).

4.4 Water Reclamation Process Emissions

Water reclamation process emissions include:

- Biogenic CO_2 emissions from stabilization, or biodegradation of organic matter from the activated sludge process and digesters.
- CH_4 emissions from incomplete combustion of digester gas and from sludge drying processes.
- N_2O emissions from activated sludge nitrification and from the effluent after it is discharged to Lake Michigan. Emissions from the effluent that may occur in the lake are outside of the District's organizational boundaries and therefore are not included in the inventory.

Biogenic CO_2 emissions from water reclamation processes at Jones Island and South Shore are calculated based upon estimated CO_2 generation rates for oxidation of biochemical oxygen demand[2] using influent loading data in the equation

$$CO_2\left[\frac{metric\ tons\ CO_2}{year}\right] \equiv BOD_5 Load\left[\frac{kg\ BOD_5}{day}\right] \times EF_{biogenic\ CO_2}\left[\frac{kg\ CO_2}{kg\ BOD_5}\right] \times F_{oxidation} \times 365\left[\frac{day}{year}\right] \times 10^{-3}\left[\frac{metric\ ton}{kg}\right]$$

Where:

Term	Description	Value	Source of Data
BOD_5 load	Average amount of BOD_5 loading per day [kg BOD_5/day]	Input value	Annual Discharge Monitoring Report
$EF_{biogenic\ CO2}$	Emission factor [kg CO_2/kg BOD_5]	2	Metcalf & Eddy Wastewater Engineering
$F_{oxidation}$	Factor for level of oxidation for a centralized WWTP with an anaerobic or aerobic sludge digester	0.8	Metcalf & Eddy Wastewater Engineering
365	Conversion factor number of days per year	365	Conversion factor
10^{-3}	Conversion from kg to metric ton	10^{-3}	Conversion factor

Operation of the South Shore anaerobic digesters produces CH_4, which is combusted in boilers, engines, or flares. Because of small but inherent inefficiencies, the incomplete

2 Metcalf & Eddy. 1991. *Wastewater Engineering.*

combustion of digester gas is a source of CH_4 emissions. The CH_4 emissions are calculated in accordance with Chapter 10 of the CARB, CCAR, and ICLEI *Local Government Operations Protocol for the Quantification and Reporting of Greenhouse Gas Emissions Inventories,* Version 1.0 (September 2008). The estimate of CH_4 emissions also uses measured digester gas generation rates and the measured fraction of CH_4 in the digester gas in the equation

$$CH_4\left[\frac{metric\ tons}{year}\right] \equiv Digester\ Gas\left[\frac{ft^3}{yr}\right] \times F_{CH_4} \times \rho(_{CH_4})\left[\frac{g}{m^3}\right] \times (1 - DE) \times 0.0283\left[\frac{m^3}{ft^3}\right] \times 10^{-6}\left[\frac{metric\ ton}{g}\right]$$

Where:

Term	Description	Value	Source of Data
Digester gas	Measured standard cubic feet of digester gas produced per day [ft^3/yr]	Input value	Annual emission inventory report
F_{CH4}	Measured fraction of CH_4 in biogas	Input value	Annual emission inventory report
$\rho(CH_4)$	Density of methane at standard conditions [g/m^3]	662.0	Protocol default value
DE	CH_4 destruction efficiency from flaring or burning in engine	0.99	Protocol default value
0.0283	Conversion from ft^3 to m^3	0.0283	Conversion factor
10^{-6}	Conversion from g to metric ton	10^{-6}	Conversion factor

Methane emissions that occur because of the formation and release of methane from the sludge in the dryers at Jones Island were determined in part using dryer/turbine stack test data collected in 2007. Emissions from the dryer/turbine stack also include emissions from the combustion of the natural gas used to operate the turbines. Therefore the methane emissions associated with the *sludge* are estimated by calculating the difference between the stack test data and the uncombusted methane from the turbine natural gas. Emissions from the uncombusted turbine natural gas were estimated using turbine natural gas emission factors. The turbine emissions from uncombusted methane are included in the stationary combustion source emissions. The methane emissions released from the sludge are included in the water reclamation emissions.

$$CH_4\left[\frac{metric\ tons\ CH_4}{year}\right] \equiv EF_{sludge\ \ drying\ CH_4}\left[\frac{kg\ CH_4}{ton\ \ BSD}\right] \times \left[\frac{ton\ \ BSD}{year}\right] \times 10^{-3}\left[\frac{metric\ ton}{kg}\right]$$

Where:

Term	Description	Value	Source of Data
Ton BSD	Ton of blended sludge dried per year [ton BSD /year]	Input value	Annual air emissions inventory
$EF_{sludge\ \ drying\ CH_4}$	emission factor [kg CH_4/tons BSD] from sludge drying	0.07	Calculated from dryer stack test data, corrected to remove methane contributed by natural gas in waste heat from turbines
10^{-3}	conversion from kg to metric ton	10^{-3}	Conversion factor

The generation of N_2O may result from the treatment of domestic wastewater during both nitrification and denitrification of the nitrogen present, usually in the form of urea, ammonia, and proteins. These compounds are converted to nitrate (NO_3) through the aerobic process of nitrification, but N_2O emissions also occur during nitrification. Denitrification occurs under anoxic conditions (without free oxygen), and involves the biological conversion of nitrate into dinitrogen gas (N_2). N_2O is a minor, intermediate product of both nitrification and denitrification processes, but is more often associated with denitrification.[3] The District's reclamation facilities were not designed intentionally to denitrify, although as with all wastewater reclamation plants, some limited denitrification likely occurs under certain operating conditions.

N_2O process emissions from water reclamation processes at Jones Island and South Shore are calculated in accordance with Chapter 10, "Centralized Wastewater Treatment Facilities," of the *Local Government Operations Protocol*, which provides calculation methods using an average N_2O emission factor per person per year and population served data in the equation

$$N_2O\left[\frac{metric\ tons}{year}\right] \equiv P_T\left[person\right] \times \frac{Plant\ Flow}{DISTRICT\ Flow}\left[\frac{\frac{MG}{year}}{\frac{MG}{year}}\right] \times EF_{nit/denit}\left[\frac{g\ N_2O}{person \times year}\right] \times 10^{-6}\left[\frac{metric\ ton}{g}\right]$$

Where:

Term	Description	Value	Source of Data
P_T	total population served by the District, person	Input value	Annual report
Plant flow	plant influent wastewater flow, MG/year	Input value	Annual Discharge Monitoring Report (each individual plant, South Shore or Jones Island)
District flow	District influent wastewater flow, MG/year	Input value	Annual Discharge Monitoring Report (South Shore and Jones Island combined)
$EF_{nit/denit}$	Emission factor for a WWTP without nitrification/denitrification	3.2	Protocol default value
10^{-6}	Conversion from g to metric ton	10^{-6}	Conversion factor

The population served for each plant is calculated based upon the ratio of each plant's influent flow to the total influent flow for the District multiplied by the total population served by the District.

4.5 Refrigeration Units

Emissions from refrigerants (such as fire suppression systems) and air conditioning units are included if HFCs or PFCs are used. Emissions from these sources result from equipment leaks or occur when the equipment is repaired or disposed of. Emissions are estimated based on applying annual loss rate factors to the equipment charge capacities. The 100-year GWPs for each refrigerant are used to convert emissions to CO_2 equivalents.

Air conditioning and other refrigeration units have been reviewed. Existing units are using refrigeration chemicals that are being phased-out under the Montreal Protocol and are

[3] California Air Resources Board, California Climate Action Registry, and ICLEI. September 2008. *Local Government Operations Protocol: for the Quantification and Reporting of Greenhouse Gas Emissions Inventories,* Version 1.0.

therefore considered nonreportable in accordance with standard GHG protocol methodologies. As the phased-out refrigeration chemicals are replaced, estimates of HFC and PFC emissions associated with air conditioning and refrigeration will be updated and reviewed for possible inclusion in the inventory.

4.6 Indirect Emissions

The District's only indirect emissions are those associated with the generation of electricity that the District purchases. The District uses utility invoice records to track electricity consumption for each facility. In 2006 and 2007, the District purchased electricity generated from renewable energy from the Wisconsin Energy Corporation's Energy for Tomorrow program.

4.6.1 Purchased Electricity

GHG emissions from typical electricity generation can be determined by estimating the mix of fuels used to generate the electricity purchased by the District. The USEPA's Emissions and Generation Resource Integrated Database (eGRID), which provides emission factors by geographical location, was used to estimate that mix of fuels. All facilities in the District's inventory are in the Milwaukee area; therefore the eGRID emission factors selected for those facilities are the North American Electric Reliability Corporation region Reliability First Corporation West (RFCW) factors for CO_2, CH_4, and N_2O.

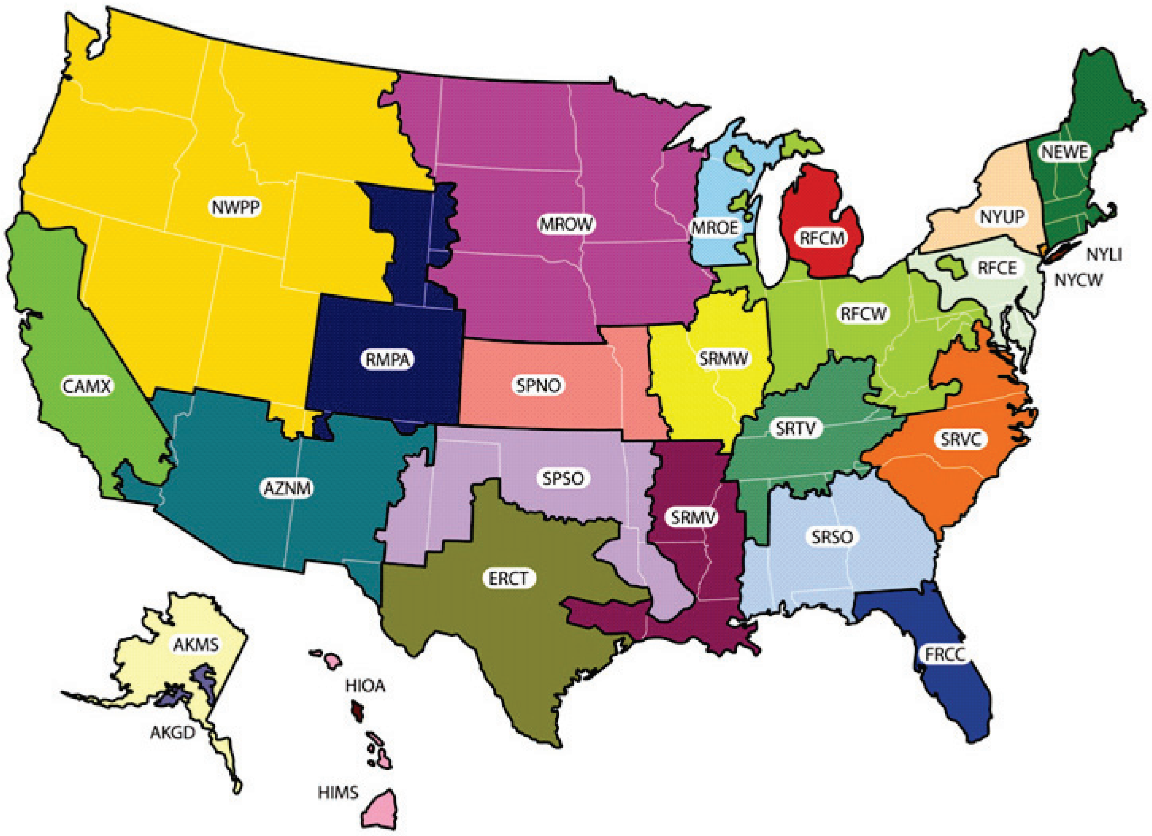
Most of eGRID's subregions consist of one or more power control areas. eGRID subregions generally represent sections of the power grid that have similar emissions and resource mix characteristics and may be partially isolated by transmission constraints. Exhibit 4-7 is a map of the eGRID subregions.

All facilities in the District's inventory are in Milwaukee; therefore the eGRID factors selected for them are those for the Subregion RFCW (Exhibit 4-8). The eGRID emission factor data are updated annually by USEPA; see http://www.epa.gov/cleanenergy/energy-resources/egrid/index.html. The same emission factors were applied to electricity data from 2000 through 2007. Using the same emission factors year to year yields emission rates that allow for analysis of the impact of energy reduction efforts that are under the District's control, as opposed to the impact of emission factor rates dictated by the utility's power sources. It is recommended that these emission factors be updated periodically (that is, at a frequency that corresponds with established reduction goal setting periods, typically 5 or 10 years) to better understand the actual impact of the District's indirect emissions on the local environment.

4.6.2 Purchased Renewable Energy

The generation of renewable energy reduces GHG emissions by reducing the amount of fossil fuels that would otherwise be consumed to generate electricity. Therefore electricity generated from renewable energy sources does not contribute to an entity's GHG emissions but reduces its GHG footprint. Emission reductions for the District's renewable energy are calculated separately by multiplying the amount of renewable energy purchased or generated by the eGRID Subregion RFCW factors for CO_2, CH_4, and N_2O, as it is assumed that these regional emissions are being replaced by renewable energy purchases. The District began generating

EXHIBIT 4-7
eGRID Subregions



renewable energy through an installation of solar panels on Jones Island's drying and dewatering buildings in May 2008.

EXHIBIT 4-8
Indirect Electricity Emission Factors
MMSD GHG Inventory Management Plan

GHG	RFCW Emission Factor[a]
Carbon dioxide, CO_2	1,537.82 lb/MWh
Methane, CH_4	0.01823 lb/MWh
Nitrous oxide, N_2O	0.02571 lb/MWh

[a]These are USEPA's eGRID 2007 Version 1.1, December 2008 emission factors for Subregion RFC West.

5. Base Year and Management of Change

Calendar year 2000 is the internal base year selected for the District's GHG Inventory. A base year is a specific year against which an entity's emissions are tracked over time. For the purpose of this report, the District's base year is defined as the earliest year for which a complete emissions inventory was calculated. Future regulations may define an alternate base year against which future emission reductions must be compared. For example, the Waxman-Markey Bill (H.R. 2454) has referenced emission reductions in terms of 2005 levels (that is, emissions will be reduced by 3 percent below 2005 levels in 2012).

Structural and methodological adjustments to the GHG emission inventory will be reviewed against the base year. Future emission reduction goals will be evaluated against base-year emissions. It is recommended that the GHG inventory be revised if any of the following occurs:

- Additional or more complete activity data become available.
- Emission factors or estimation methodologies improve.
- Structural changes occur (outsourcing or insourcing GHG emitting activities).
- A calculation error is discovered.

If adjustment is necessary, a description of the change, the person performing the change, and the person authorizing it will be kept in a log with the GHG inventory, and backup documentation will be filed. Structural and methodology changes that could trigger GHG inventory baseline adjustments are described below.

5.1 Adjustment for Structural and Activity Changes

A structural change involves the transfer of ownership or control of emissions-generating activities or operations from one entity to another (for example, privatization of wastewater treatment or sludge management activities). In the event of a structural change to a facility that existed during the base year, the facility's base-year emissions will be added to or subtracted from the entity's emissions. If the facility did not exist in the base year, no adjustment to the entity's baseline will be made.

In the event of organic growth or decline, no adjustments will be made to the baseline. Organic growth or decline is defined as the increase or decrease in operating sites or activities not associated with structural changes.

In the event of an activity change at a facility or within an entity such as a change in chemical use or treatment technology, no adjustments will be made to the baseline.

5.2 Adjustment for Methodology Changes

Methodology changes can be because of updated guidance, regulatory requirements, revised calculation methods, updated emission factors, and errors. In general, a change based on calculation methodology or errors will require updates from the base year forward. Changes due to updated guidance documents, updated emission factors, or higher quality data will result in a change going forward from the year the guidance or factor change or data availability is effective. Methodology changes made to the IMP will be documented with the annual inventory.

6. Data Management

6.1 Data Collection Systems and Processes

The District's GHG inventory was developed using several reports and spreadsheets to assemble the activity data and to prepare the emission calculations. If these tools are to continue to be used to collect data and calculate GHG emissions, it is important that procedures be developed to ensure the accuracy, consistency, proper documentation, and transparency of the data.

6.2 Data Quality Assurance

Primary systems include data collection methods for other purposes (air emission inventory reports, utility invoices, etc.). A subset of the existing data is then compiled into an Excel spreadsheet to calculate the GHG emissions.

The ability to verify the accuracy and origin of activity data collected for the GHG inventory will become increasingly important as the U.S. moves toward federal regulations. It is recommended that the District develop a comprehensive system to improve data quality/data management activities for documenting GHG emissions, particularly those that are regulated under the reporting rule or that may be regulated as part of cap and trade legislation. Managing data associated with GHG emission from electricity generated onsite by renewable sources is particularly important for selling carbon credits. This may include adding quality assurance standards, such as data entry and verification standards that the GHG inventory team will meet.

6.3 Data Security

Data security should be considered when setting up the GHG data management system. Security standards should be defined along with user roles and responsibilities and procedures to trace updates and corrections. For example, locate the tools on a central server with access restrictions or write protection to ensure data cannot be modified accidentally by staff with server access who do not own the data. Procedures to trace updates and corrections should be considered.

6.4 Data Collection Frequency

It is recommended that procedures be developed to collect activity data at least annually, preferably within the first 3 months of the subsequent calendar year. This will allow the District to report emissions under programs such as the USEPA Mandatory Reporting Rule that requires submission of annual GHG emissions by March 31, 2011, for calendar year 2010.

6.5 Intensity Ratios

Stakeholders are interested in two principal aspects of GHG emissions management: the level of absolute GHG emissions, and the reduction of GHG emissions, measured in ratio indicators (sometimes referred to as normalization factors). Ratio indicators provide information on the efficiency of an activity, the intensity of an impact, or the quality of a value or achievement. Ratios can facilitate comparisons between similar processes. They also are used to compare the performance and achievements of one facility to another for better understanding and interpretation of achievements. The data and information collected for the GHG inventory should allow the use of a ratio indicator, such as an intensity ratio.

Intensity ratios are expressed as GHG impact per unit of activity. An example of intensity for the District would be GHG emissions per mass of BOD or solids processed. A declining intensity ratio indicates positive performance improvement. It is recommended that the District evaluate the appropriateness and use of a GHG emission intensity ratio for incorporation in the future.

7. Management Tools

7.1 Roles and Responsibilities

The GHG inventory was compiled from several information sources. Team members consulted in preparing the emission inventory are listed in Attachment A. The list includes each individual's name, operational area, and contact information.

The GHG Inventory Team is responsible for completing the annual emissions inventory. It is the team's responsibility to collect the data needed for emission estimates and to ensure consistent application. The information needed for intensity rations is the team's responsibility. The team also is responsible for updates to the IMP. Additional roles and responsibilities will be defined as necessary.

7.2 Training

To be defined over time.

7.3 Document Retention and Control

It is recommended that documents supporting the design, development and maintenance of the GHG inventory be retained for future verification purposes. This may include the following:

- Documentation of methodology changes in the IMP
- Activity descriptions filed with annual inventory
- Annual inventory
- Backup documentation:
  - Fuel records
  - Utility bills, invoices that show energy use (kWh, therms, or equivalent)
  - Annual air emissions reports
  - Influent flow and BOD data, discharge monitoring reports
  - Air conditioning inventory (including number of units, unit sizes, types, refrigerants, and refrigerant usage)

8. Auditing and Verification

It is recommended that the District evaluate the need to develop an internal auditing program and define corrective actions procedures to be followed upon receipt of findings. It is also recommended the District identify whether external verification of emissions will be necessary for trading, reporting, or credit purposes. If so, it is recommended that steps be taken to ensure emission estimates and data are properly documented and retained to support future verification requirements.

8.1 Internal Auditing

To be defined over time.

8.2 External Validation or Verification (as Appropriate)

External verification of facility emissions will be performed in accordance with applicable federal, state, and local regulations. Project emissions will be verified to comply with specific program requirements as deemed necessary for trading or credit purposes.

8.3 Corrective Action

To be defined over time.

9. Reporting

The District should continue to follow regulatory changes in order to comply with mandatory reporting rules and to develop procedures to continue to collect data and report emissions in accordance with applicable federal, state, and local regulations.

The District could also identify and determine appropriate organizations or avenues by which to publicly report emissions. Voluntarily reporting GHG emissions provides a pathway to recognize, publicize, and promote environmental stewardship.

The EPA Climate Leader's program is one such voluntary reporting program, but it is not currently available to government institutions. The International Council for Local Environmental Initiatives (ICLEI)–Local Governments for Sustainability is an international association of local governments as well as national and regional local government organizations that have made a commitment to sustainable development. ICLEI provides technical consulting, training, and information services to build capacity, share knowledge, and support local government in the implementation of sustainable development at the local level. The City of Milwaukee is a member of ICLEI and, therefore, might provide additional insight into the breadth and value of ICLEI's services and programs.

The District may wish to consider joining the Climate Ready Water Utilities Working Group of the National Drinking Water Advisory Council. The group will provide drinking water and water reclamation utilities with easy-to-use resources to assess the risk associated with climate change. The group will help water and water reclamation utilities to develop and implement long-range plans that account for climate change impacts.

9.1 Internal Reporting

To be defined over time.

9.2 External Reporting

External reporting will be in accordance with applicable federal, state, and local regulations. Any external reporting, other than regulatory reporting, will be approved by the District's Commissioners.

Content, structure, public availability and methods of dissemination of the GHG reports will depend on the requirements of applicable GHG programs, internal reporting needs and the needs of the intended users of the report.

Attachment A
GHG Inventory Team

ATTACHMENT A

GHG Inventory Team

Urbain Boudjou, GHG Inventory Project Manager

Susan Anthony, Senior Staff Attorney

Karen Sands, Manager of Sustainability

Tim Bate, Engineering Planning Manager

Jeff Schilling, Air Emissions Inventory Contact

David Grusznski, Greenseams Program Manager

Michael Martin, Director of Technical Services

Attachment B
Other Facilities List

TABLE B-1
Facility Addresses
MMSD GHG Inventory Report

Facility	Account #	Address
S13th	5082910679	6060 S 13th St
Alterra Coffee	3497419818	1701 N Lincoln Memorial Dr
Other Sources - does not include JI, SS, HQ, Lab, Alterra or S13th	7662623008	12308 W Underwood Pkwy
	4806474255	5022 N Port Washington Rd
	3496646893	8950 W Watertown Plank Rd
	8843753835	4830 N 32nd St
	3057683363	701 E Pearson St
	1216304685	1500 S 124th St
	7444358077	2644 S Chase Ave
	6828526107	7509 N Beach Dr
	1484995129	1300 W Green Tree Rd
	7454952292	1610 W Canal St
	3477284471	9415 N Lake Dr
	1676934812	4298 W Monarch Pl
	6244439447	715 E Erie St
	8803801129	4400 N Port Washington Rd
	8417073242	3500 W Manitoba St
	9453904365	300 W Seeboth St
	8408104270	250 W Seeboth St
	4811367356	2120 S 4th St
	7808283497	101 N 25th St
	9494612019	2690 S 6th St
	7056065409	1711 N Commerce St
	1045842350	162 N 44th St
	880431201	4021 N 31st St
	1479966367	301 N 42nd St
	7042053339	5101 W Hampton Ave
	1894095250	1944 N Commerce St
	7039522638	3070 S 6th St
	1062725689	1349 E Park Pl
	2895452974	1800 E Ontario St
	9453239443	610 S Water St
	3241609382	2323 S 1st St
	244262093	1370 E Chambers St
	8068663256	2644 S Chase Ave
	6263604231	5200 N Milwaukee River Pkwy
	6832439000	4002 N Humboldt Blvd
	8226244004	1240 N Old World 3rd St
	3621342651	171 W Hampton Ave
	1826700913	S 74th St & W Oklahoma Ave
	4896039511	401 N Water St
	4899576708	3701 W Juneau Ave
	5861212512	2616 W Villard Ave
	7467280698	5901 W State St
	3006783403	2211 S Bay St
	2866126107	1100 N Hawley Rd
	1658069189	2902 W Mill Rd
	7634462746	1883 N Water St
	7070768176	9225 N Green Bay Rd
	1844360613	3499 N Cambridge Ave

TABLE B-1
Facility Addresses
MMSD GHG Inventory Report

Facility	Account #	Address
	5616879732	4998 N Lydell Ave
	6886897192	4300 S Barland Ave NE Corner
	5471652664	4390 N Richards St
	5427071159	8400 W Wisconsin Ave
	5233536603	8401 N Range Line Rd
	4160481	2425 E Saint Francis Ave
	4609782358	100 W Saint Paul Ave Bridge
	7041623677	703 E Pearson St
	4872394659	8000 W Wisconsin Ave
	8833961281	W Ryan Rd .1 Mi E Cmstp N
	7082694029	450 N 44th St
	8400706745	2121 N Humboldt Ave
	8027943619	5790 W State St
	2048768567	5800 W Roosevelt Dr Approx
	8016211777	4302 W Dean Rd
	8466257454	501 W Green Tree Rd
	4089283978	10600 W Fisher Pkwy
	9036356661	7900 Portland Ave on Serv 4/13/07
	6403938023	301 E Erie St
	9000309427	575 W Warnimont Ave
	8802805132	3891 S 27th St
	847737615	Forest Hill Ext E of Chicago Ave
	5062017953	4703 S Howell Ave
	6092603182	3500 N Menomonee River Pkwy
	4832238887	100 W Cherry St
	1033051241	9520 S Pennsylvania Ave
	5659186094	S 84th & W Walker St
	4247768238	942 N Hawley Rd
	7023919054	2601 W Pioneer Rd
	1064839891	500 S 84th St
	7016743433	700 S Hawley Rd
	5247904397	E College 1700'N on ROW W of Penn
	3083696096	3075 S 6th St
	1289207497	6001 W Cascade Dr
	6460386605	11601 W Greenfield Ave
	412749458	3701 N 28th St
	2021696393	W156N8731 Pilgrim Rd
	7448705223	2200 S Bay St
	9217586385	100 E Lincoln Ave
	68052620	N75w13889 Appleton Ave
	8852206910	4183 S Pennsylvania Ave
	8263599746	5739 W Rita Dr
	5630696780	2701 W Ryan Rd
	4499288750	9180 W Bradley Rd 80N
	476293688	6925 W Capitol Dr
	1432172767	3203 S 27th St
	7274829647	2411 S Saint Clair St
	6808616217	1300 W Clybourn St
	9283599832	2224 S 84th St
	8603495065	5196 N 124th St

TABLE B-1
Facility Addresses
MMSD GHG Inventory Report

Facility	Account #	Address
	2844149535	6245 N 101st St
	1041169841	4580 S Whitnall Ave
	7626715023	320 W White Oak Way
	690749912	W156N8419 Pilgrim Rd
	2040910863	N85w15940 Appleton Ave
	6622803503	Grange Ave & We ROW W of Penn
	5816652388	2103 S 81st St
	1243102302	4100 E American Ave
	884865409	1251 Legion Dr
	3410946961	9911 W Concordia Ave
	7459385871	11060 W Hampton Ave
	8079612292	1901 N Menomonee River Pkwy
	8256980479	1651 Menomonee River Pkwy
	7614205174	11847 W Denis Ave
	861191460	8519 N Teutonia Ave 42w
	7835237232	2200 N 113th St
	8687250799	7602 W Oklahoma Ave
	95464136	2100 W Ranch Rd
	6422703844	2909 E Forest Hill Ave
	3095975959	5000 W Forest Home Ave
	4414193154	6312 S 92nd St SE Cor
	4211196033	3705 W Good Hope Rd 72N
	5418596465	8100 W Cleveland Ave
	6648769202	360 E Brown Deer Rd
	9496470402	4400 N 68th St
	3239048431	1804 W Bradley Rd
	9034960676	3500 N Morris Blvd
	5659565979	6202 W Villard Ave 52N
	1403961269	11840 N Port Washington Rd
	7802259040	5025 W Lincoln Ave
	6825728154	3301 W College Ave
	1647366631	6019 W State St
	6249725920	4021 S 27 St Approx #
	3400100917	475 W Howard Ave
	3090234319	9011 W Forest Home Ave
	1022875637	4002 N 35th St
	8409361162	Wepco ROW 1000 Ft South of E
	274781985	4703 N Wilson Dr
	4222473103	2808 Monterey Blvd
	7206038429	S 60th St & KK River Pkwy
	1814000453	3500 S 116th St
	1456551000	4730 S 13th St Approx
	8094573009	4950 W National Ave
	7655281965	3421 N Cambridge Ave
	2462692479	9292 W Forest Home Ave
	8848818680	840 S 35th St
	3285402201	9140 N 51st St
	3473458635	13653 Watertown Plank Rd
	2625045509	11600 W Fairview St
	5674742589	3218 S 43rd St

TABLE B-1
Facility Addresses
MMSD GHG Inventory Report

Facility	Account #	Address
	7209593525	4011 N 68th St
	8279779741	1547 W Ramsey Ave
	9209109561	5220 S Nicholson Ave Approx
	7875298148	5109 N 76th St
	8008058015	7100 N Milwaukee River Pkwy
	1055383788	3366 N 51st Blvd
	446114941	W180s8035 Pioneer Dr
	1818500650	4005 N 124th St F
	6409509259	9661 W Greentree Rd 70N
	9213519431	6000 W Martin Dr
	2624047036	3160 S Vermont Ave
	9225863908	206 S Underwood Creek Pkwy
	636972980	9567 S Nicholson Rd
	3284122991	5367 N Long Island Dr 20w
	6255872458	6151 W Dickinson St
	7880535532	11590 W Greenfield Ave
	1865295817	10720 W Coldspring Rd
	4654938140	4501 W National Ave
	6239657568	13600 Juneau Blvd
	4253687226	6526 W Constance Ave
	7215414624	2403 W Dean Rd W85
	7687778004	7518 W Villard Ave 52N
	9487956257	6620 W Loomis Rd
	241105082	6113 N Hopkins St 44w
	455450370	9445 S Howell Ave
	4022047369	1302 S 92nd St
	4828993633	5020 W Congress St
	6823994516	198 E Fairmount Ave
	8259348642	5681 N 55th St
	3497959291	3947 N 36th St
	6215532260	5706 W Rawson Ave
	7438961844	S Ryan Green Ct
	4867486855	3203 E Edgerton Ave Approx
	4846570263	12010 W Godsell Ave
	6456776093	759 S 12th St
	6434585954	16252 W Rogers Dr
	4844997748	3526 W Hope Ave
	8078660874	330 S 5th St
	2038660045	7239 W Drexel Ave
	1062442836	851 S 92nd St
	3863069786	548 W Laramie Ln
	3440041773	2675 N Menomonee
	6480448919	6312 S 92nd St East
	6847888588	4540 W State St
	874552735	1123 E Vienna Ave
	2250622310	2750 W Silver Spring Dr N56
	3090294682	4645 N Wilson Dr 6e
	4270086803	11510 W Watertown Plank Rd
	8809372332	7501 S Pennsylvania Ave
	9498383797	W Hayes & S 81st St NW Cor

TABLE B-1
Facility Addresses
MMSD GHG Inventory Report

Facility	Account #	Address
	629711771	7133 N 91st St
	1650703264	2701 S Chase St
	8474551738	5702 S 108th St
	7885487200	4900 W Burnham St
	5008128439	3710 S Clement Ave
	3460124764	4930 N 31st St
	5010938285	1804 W Plainfield Ave
	7805890490	2685 S 43rd St
	1810690040	16400 W Coachlight Dr
	5049699822	2290 W Lincoln Creek Pkwy 52N
	6813847733	3105 N Menomonee River Pkwy
	1828433139	6605 W Brown Deer Rd 88N
	9445065939	6020 W Arthur Ave
	223767468	3974 N 51st Blvd
	6417004969	2800 E Norwich Ave
	6673715552	1335 E Randolph Ct
	3271980854	1810 W Mill Rd 64N
	255645508	2431 S 124th St
	6412508828	N Lovers Lane Rd & W Hampton Ave
	9033568052	5604 W Silver Spring Dr
	9411412362	3020 E Ramsey Ave
	7693188543	616 S 35th St
	8412347309	6421 W Stark St 49N
	7620830174	8317 W Green Tree Rd
	457133603	7704 W Congress St
	8677876389	7602 N Sherman Blvd
	3216932136	5600 W Mequon Rd
	7675307611	6223 W Forest Home Ave
	5049257575	Montclaire Ave & N Lydell
	426852342	1015 E Bradley Rd 80N
	7881261942	4200 N Eastbrook Pkwy
	5686674318	2955 S Chase Ave
	7600078678	4050 W National Ave
	8846130772	N 46th & W State St
	9203579121	11304 N Buntrock Ave
	1217989155	8002 W Oklahoma Ave
	3899844844	4751 N Sherman Blvd
	6279966028	10518 W Grantosa Dr
	809561840	1359 S 84th St
	2292885380	5420 N 76th St
	4086532214	10450 W Coldspring Rd
	8435318913	2894 S Root River Pkwy
	9087604509	3200 S Root River Pkwy
	4044123957	N Point Dr & Indian Crk Pkwy
	2898670545	9465 N Green Bay Ave
	8252816683	6691 S 68th St
	9251795766	1600 E Drexel Ave 100' S on ROW
	680147228	7948 N Port Washington Rd
	8209519146	S 108 St & W Kelm Rd SW Cor
	4041572261	2037 W Wildwood Dr Approx

TABLE B-1
Facility Addresses
MMSD GHG Inventory Report

Facility	Account #	Address
	1648209706	9910 W Silver Spring Dr 56N
	4881206591	9517 N Broadmoor Rd
	6661298144	W184s8130 Racine Ave Rr
	8438050427	Silver Spring & N 52 St Median
	5081484107	4115 W Roosevelt Dr
	1045119141	4515 S Lake Dr
	5048572582	6624 N 84th St
	8408714105	1600 E College Ave - 2250' S on ROW
	6848951204	3755 S 6th St
	7851195748	S73w14005 Woods Rd
	9240774948	3961 E Allerton Ave
	2879864027	2720 Clearwater Dr So Side
	3040070936	5120 W Hampton Ave 49N
	8060412855	1505 S 124th St F
	5232575142	1600 E Rawson Ave 1675s
	2815471037	8500 S 5th Ave
	4843416762	12402 W Grange Ave
	2899234847	1980 W Ryan Rd
	3471218437	4300 S Barland Ave
	4288603523	5133 S 76th St
	2030635899	6005 W Mitchell St
	3268352775	6550 W Loomis Rd
	8873519958	5100 W Lincoln Creek Pkwy
	5026684190	4762 N 60th St
	5603996260	5701 W Hampton Ave
	5832578814	850 E Jones St
	39487253	W168N11447 El Camino Dr
	493956460	Meno Riv Dr & Center SE Corner
	2660882488	4640 S Lake Dr
	2698771025	6750 W Honey Creek Pkwy
	3073009545	S 41st & W Scott St
	3206023120	1800 S Harbor Dr
	4625103188	5746 W Rita Dr
	5018078688	3507 W Roosevelt Dr
	5412985860	Burnham 50' E W Electric N
	7669966926	5826 W Pierce St
	8017040398	2440 S Lincoln Memorial Dr
	8476687928	6165 W KK River Pkwy
	9008324168	2610 S Bay St
	1274291432	5000 W Lincoln Ave
	2269393608	1820 W Mill Rd
	3680299060	N116w17801 Main St
	3672898488	3013 S 35th St
	4024090466	9415 N Lake Dr
	4033216567	N48w13820 Hampton Ave
	4452278370	5022 N Port Washington Rd
	5429172266	4125 W Mount Vernon Ave
	8613298194	E St Francis & S KK SW Corner
	8855332346	3507 W Roosevelt Dr
	8823262842	9415 N Lake Dr

Attachment C
Mobile Source List

TABLE C-1
Mobile Source List
MMSD GHG Inventory Management Plan

Veolia Cars and Light Trucks

EQNUM	Location	Description
401017	27800000	VEHICLE #UWS107, 2002 FORD F-150 REGULAR CAB
400077	28500000	VEHICLE #200 1990 GMC SIERRA PICKUP
400559	28500000	COMPRESSOR, UNDERHOOD VEHICLE #200
400566	28500000	PACK, STARTER VEHICLE #200
400093	27900000	VEHICLE #218 1991 GMC 1/2 TON PICKUP
400097	38000000	VEHICLE #223 1993 FORD EXPLORER 4X4
400098	10400000	VEHICLE #224 1993 CHEV. CREWCAB
400102	10400000	VEHICLE #228 1993 FORD E250 VAN
400115	38000000	VEHICLE #241 1995 FORD CREW CAB PICKUP
400116	31100000	VEHICLE #242 1995 GMC JIMMY 4X4
400117	31100000	VEHICLE #243 1995 GMC JIMMY 4X4
400119	27900SAFE	VEHICLE #245 1995 GMC CARGO VAN
400121	10400000	VEHICLE #248 1995 GMC YUKON 4X4
400122	27900SAFE	VEHICLE #249 1995 GMC YUKON 4X4 auctioned
400126	28000000	VEHICLE #253 1996 BUICK WAGON
400135	38000000	VEHICLE #263 1998 CHEV. PICKUP
400136	38000000	VEHICLE #264 1998 CHEV. PICKUP
400137	38000000	VEHICLE #265 1998 CHEV. PICKUP
400491	28000000	VEHICLE #276 2000 CHEVY SILVERADO 3/4 TON PICKUP
400494	280100WARE	VEHICLE #277 2000 CHEV. ASTRO VAN
400522	38000000	VEHICLE #278 2000 CHEVY SILVERADO 3/4 TON PICKUP
400523	28000000	VEHICLE #279 2000 CHEVY SILVERADO 3/4 TON PICKUP
400524	38000000	VEHICLE #280 2000 CHEVY SILVERADO 3/4 TON PICKUP
400534	27800000	VEHICLE #282 2000 GMC 3500 SERIES CARGO VAN
400571	38000000	VEHICLE #285 2001 FORD F-250 3/4 TON PICK-UP
400572	27800000	VEHICLE #286 2001 FORD F-250 4 X 2 CREW CAB
400577	10400000	VEHICLE #288 2001 S-10 CHEVY BLAZER LS
400579	28000000	VEHICLE #290 2001 FORD F250 PICK-UP 4 X 2
400580	38300000	VEHICLE #291 2001 FORD F250 PICK-UP 4 X 4
400581	28000000	VEHICLE #292 2001 FORD F350 FLAT BED CHASS 4 X 2
400582	10400000	VEHICLE #293 2001 CHEVY SILVERADO 3500 4 WHEEL
400608	27900000	VEHICLE #300 2002 CHEV. BLAZER 4X4
400609	38000000	VEHICLE #301 2002 CHEV. BLAZER 4X4
400610	30000000	VEHICLE #302 2002 FORD F25 PICKUP TRUCK
400611	10400000	VEHICLE #303 2002 CHEV. EXPRESS VAN
400612	30000000	VEHICLE #304 2002 CHEV. ASTRO VAN
400613	10400000	VEHICLE #305, 2002 CHEV. SILVERADO TRUCK
400616	10400000	COMPRESSOR, UNDERHOOD AIR VEHICLE #305
400617	10400000	PACK, STARTER FOR VEHICLE #305
400625	27800000	VEHICLE # 308 2003 CHEVROLET BLAZER
400983	28000000	VEHICLE #309 2003 FORD F250 PICKUP (PIPF)
400627	27800000	VEHICLE #310 2003 FORD F350 P-UP
400626	27800000	VEHICLE #311 - 2003 CHEVY EXPRESS CARGO VAN
400986	38000000	VEHICLE #314 2004 CHEVY COLORADO 4 X 2 PICK-UP
400987	38300000	VEHICLE #315 2004 FORD F250 4 X 4 EXTENDED CAB
400988	38100000	VEHICLE #316 2004 FORD F250 4 X 2 PICK-UP
400989	38000000	VEHICLE #317 2004 FORD F250 4 X 2 PICK-UP
401001	27800000	VEHICLE #319 2004 GMC 4 X 2 SIERRA CREW CAB
401002	27800000	VEHICLE #320 2004 GMC 4 X 2 SIERRA CREW CAB

TABLE C-1
Mobile Source List
MMSD GHG Inventory Management Plan

Veolia Cars and Light Trucks

EQNUM	Location	Description
401004	27800000	VEHICLE #321 CHEVY BLAZER 4 X 4
401016	27800000	VEHICLE #324 2005 CHEVY COLORADO 4 X 4 PICK-UP
401019	27800000	VEHICLE #325 2005 CHEVY SERVICE VAN
401032	27800000	VEHICLE #328 (2007 FORD ESCAPE HYBRID)
401039	280FLDTECH	VEHICLE #330 (2006 CHEVROLET/EXPRESS VAN)
401047	27800000	VEHICLE #332 (2007 CHEVROLET PICK-UP)
401048	27800000	VEHICLE #333, 2007 CHEV. 4W/D W/CREW CAB
401049	10400000	VEHICLE #334 2007 CHEVY UPLANDER VAN
401050	280FLDTECH	VEHICLE #335 2007 CHEVY EXPRESS WORK VAN (H-D)
401051	280FLDTECH	VEHICLE #336 2007 CHEVY EXPRESS WORK VAN (H-D)
	27800000	VEHICLE #339 2008 DODGE DURANGO 4-W/D
	27800000	VEHICLE #342 2009 FORD ESCAPE (HYBRID) 4-W/D
	27800000	VEHICLE #343 2009 FORD ESCAPE (HYBRID) 4-W/D

MMSD Cars and Light Trucks

EQNUM	Location	Description
400118	10500000	VEHICLE #244 1995 GMC/SAFARI/MINI-VAN (MMSD)
400127	10400000	VEHICLE #254 1996 GMC/G-3500/CARGO VAN (MMSD)
400128	10400000	VEHICLE #255 1996 GMC/G-3500/CARGO VAN (MMSD)
400130	10500000	VEHICLE #257 1997 DODGE NEON SEDAN (MMSD)
400133	10500000	VEHICLE #261 1998 FORD TAURUS WAGON (MMSD)
400134	10500000	VEHICLE #262 1999 GMC/C-1500/SUBURBAN (MMSD)
400138	10700000	VEHICLE #266 1998 CHEV/G-1500/VAN (MMSD)
400413	10400000	VEHICLE #269 1999 FORD EXPLORER (MMSD)
400414	10500000	VEHICLE #270 1999 FORD EXPLORER (MMSD)
400430	10500000	VEHICLE #271 1999 CHEV MALIBU (MMSD)
400450	10400000	VEHICLE #272 1999 GMC/G-3500/CUT-AWAY VAN (MMSD)
400451	10400000	VEHICLE #273 1999 GMC/G-3500/CUT-AWAY VAN (MMSD)
400480	10500000	VEHICLE #274 2000 CHEV. CAVALIER (MMSD)
400545	10500000	VEHICLE #283 2000 GMC/G-3500/CUT-AWAY VAN (MMSD)
400568	10500000	VEHICLE #284 2001 CHEVY/C-2500/SUBURBAN (MMSD)
400575	10500000	VEHICLE #287 2001 CHEVY LUMINA (MMSD)
400578	10400000	VEHICLE #289 2001 CHEVY/T-15/BLAZER (MMSD)
400583	10400000	VEHICLE #294 2001 CHEVY/G-3500/CUT-AWAY VAN (MMSD)
400605	10500000	VEHICLE #297 2002 BUICK/CENTURY-SEDAN (MMSD)
400606	10500000	VEHICLE #298 2002 CHEVY/T-15 BLAZER (MMSD)
400607	10500000	VEHICLE #299 2002 CHEVY/T-15 BLAZER (MMSD)
400624	10400000	VEHICLE #307 2002 GMC/G-3500/CUT-AWAY VAN (MMSD)
400985	10400000	VEHICLE #313 2003 GMC/G-3500/CUT-AWAY VAN (MMSD)
401000	10500000	VEHICLE #318 2004 FORD EXPEDITION (MMSD)
401006	10400000	VEHICLE #322 2005 FORD/E-350/CUT-AWAT VAN (MMSD)
401015	10400000	VEHICLE #323 2005 GMC/G-3500/CUT-AWAY VAN (MMSD)
401043	10400000	VEHICLE #331 2006 FORD/E-350/CUT-AWAY VAN (MMSD)
401052	10400000	VEHICLE #337 2007/CHEVY/G-3500 CUT-AWAY VAN (MMSD)
401053	10400000	VEHICLE #338 2007/CHEVY/G-3500 CUT-AWAY VAN (MMSD)

TABLE C-1
Mobile Source List
MMSD GHG Inventory Management Plan

Televising and Manhole Trucks

EQNUM	Location	Description
400139	27800000	VEHICLE #UWS101 1998 CHEV. TV TRUCK
400548	27800000	GENERATOR, ONAN #UWS101
400454	27800000	TRANSPORTER, CAMERA (T.V. TRUCK)
400544	27800000	VEHICLE #UWS105 1984 GMC CUBE VAN (TV TRUCK) (AA
400549	27800000	GENERATOR, ONAN #UWS105
401038	27800000	VEHICLE #UWS109, 2006 CHEVY TV CUBE VAN G3500
401045	27800000	GENERATOR, HONDA #UWS109
400427	278SEWER	TRACTOR, STORM (FOR TV TRUCK)
400478	278SEWER	TRACTOR, STORM (SMALL) (FOR TV TRUCK)
400971	27800000	VEHICLE #UWS106., 2003 FORD E250 CREW VAN
400050	280FLDTECH	VEHICLE #164 1987 GMC HIGH CUBE VAN
400563	280FLDTECH	GENERATOR, ONAN VEHICLE #164

Class 8 Trucks

EQNUM	Location	Description
400140	27800000	VEHICLE #UWS102 VACTOR TRUCK
400027	278SEWER	VEHICLE #118 1985 IHC VACTOR
400395	28000000	VEHICLE #268 1998 INTERNATIONAL VACTOR
400584	38000000	VEHICLE #295 2002 SUPER SUCKER,STERLING CHASSIS
	27800000	VEHICLE #340 2008 VAC-CON VACTOR TRUCK
400067	28000000	VEHICLE #188 1990/VOLVO W/TRUCK MOUNTED CRANE
400490	38000000	VEHICLE #275 2000/VOLVO W/TRUCK MOUNTED CRANE
	27800000	VEHICLE #341, 2008 FORD/F-450 SERVICE TRUCK W/UTILITY BODY & CRANE
400376	20100000	VEHICLE #UWS103 1978 MAC LUGGER MOVER (OOS)
400394	258CHAFF	VEHICLE #UWS104 1978 ROLL OFF CONTAINER MOVER
401026	20100000	VEHICLE #UWS108 1995 MAC LUGGER MOVER
400042	10400000	VEHICLE #154 1986 FORD SEMI-TRACTOR

Light, Medium and Heavy Dump Trucks

EQNUM	Location	Description
400527	38000000	VEHICLE #281 2000 GMC 1 TON 4 WHEEL DUMP
400585	28000000	VEHICLE #296 2002 F350 4 X 4 FORD 1 TON PICK UP
400623	27800000	VEHICLE No 306 2002 CHEVROLET K-3500 4W/D CAB/CHAS
400628	27800000	VEHICLE #312 2003 SIERRA 3500 TRUCK 4 X 4 DUMP
401033	27800000	VEHICLE #329 (2006 CHEVROLET SILVERADO)
400113	20100000	VEHICLE #239 1995 GMC MEDIUM DUMP TRUCK
400123	27800000	VEHICLE #250 1996 FORD MEDIUM DUMP TRUCK
401020	38100000	VEHICLE #326 2005 GMC TC 8500 SINGLE AXLE DUMP
401023	27800000	VEHICLE #327 2005 GMC 5500 DUMP TRUCK
400124	27800000	VEHICLE #251 1996 FORD HEAVY DUMP TRUCK

TABLE C-1
Mobile Source List
MMSD GHG Inventory Management Plan

Wheel Loaders and Skid Loaders

EQNUM	Location	Description
400217	28000000	ENDLOADER #10 CATERPILLAR (PLANT MAINT)
400586	38000000	ENDLOADER #12 (JOHN DEERE)
401013	28000000	ENDLOADER #13 2005 JOHN DEERE HIGH LIFT
401040	27800000	BACKHOE LOADER, #1 (2006/JOHN DEERE/410G)
400258	38300000	SKIDSTEER LOADER #1 BOBCAT (SS)
400221	38000000	SKIDSTEER LOADER #2 NEW HOLLAND (SS)
400219	28000000	SKIDSTEER LOADER #3 BOBCAT (FO)
400220	28000000	SKIDSTEER LOADER #5 CASE (JI)
400157	27800000	SKIDSTEER LOADER #6 BOBCAT (FO)

Straddle Carriers

EQNUM	Location	Description
400154	36000000	STRADDLE CARRIER #1
400155	36000000	STRADDLE CARRIER #2

Burden Carriers and ATVs

EQNUM	Location	Description
400346	10500000	BURDEN CARRIER #1 (HQ)
400181	28900000	BURDEN CARRIER #01 (PHEL)
400182	28900000	BURDEN CARRIER #02 (PHMM)
400183	28000000	BURDEN CARRIER #03 (MACH)
400290	28000000	BURDEN CARRIER #05 (WELDER)
400186	28000000	BURDEN CARRIER #07 (TECH)
400187	28000000	BURDEN CARRIER #08 (MACH)
400188	28000000	BURDEN CARRIER #09 (ELEC)
400189	28000000	BURDEN CARRIER #10 (PIPF)
400190	28000000	BURDEN CARRIER #11 (ELEC)
400193	28000000	BURDEN CARRIER #17 (PHCT)
400197	28000000	BURDEN CARRIER #23 (ELEC) GOING TO AUCTION MAY 2009
400198	28000000	BURDEN CARRIER #24 (FT & ST)
400199	28000000	BURDEN CARRIER #25 (PLANT MAINT) GOING TO AUCTION MAY 2009
400202	28000000	BURDEN CARRIER 1989 EZ-GO #28
400203	28000000	BURDEN CARRIER #29 1990 EZGO XT-500 (MACH)
400204	28900000	BURDEN CARRIER #30 (PHMM)
400206	28000000	BURDEN CARRIER #32 (FT & ST)
400208	28000000	BURDEN CARRIER #34
400209	28000000	BURDEN CARRIER #35 1991 COLUMBIA (MACH)
400210	28000000	BURDEN CARRIER 1991 COLUMBIA #36 (PIPF)
400211	27900000	BURDEN CARRIER 1991 COLUMBIA #37 (OPS)
400212	28000000	BURDEN CARRIER #38 (STORE ROOM)
400264	28000000	BURDEN CARRIER 1991 NORDSKOG #39 (GARAGE)
400214	27900000	BURDEN CARRIER #41 (OPS)
400215	28000000	BURDEN CARRIER #42 (TECH)
400216	28900000	BURDEN CARRIER #43 (PHMM)
400984	28000000	BURDEN CARRIER #44 (FPMW)
401028	25800000	BURDEN CARRIER #45 (LUBS)
		BURDEN CARRIER #46 (
		BURDEN CARRIER #47 (
		BURDEN CARRIER #48 (
400246	38000000	BURDEN CARRIER #003 (SOUTH SHORE)
400291	38000000	BURDEN CARRIER #005 (SS)
400243	38000000	BURDEN CARRIER #006 KAWASAKI 1994
400244	38000000	BURDEN CARRIER #007 (SS)
400245	38000000	BURDEN CARRIER #008
400576	27800000	ATV, 2000 MULE 2510 4 X 4 (fo)
400614	27800000	ATV, JOHN-DEERE GATOR DIESEL 6 WHEEL (JI)

TABLE C-1
Mobile Source List
MMSD GHG Inventory Management Plan

Tractors and Lawn Mowers

EQNUM	Location	Description
400172	38000000	TRACTOR, INTERNATIONAL, 2424 (SS)
400340	30000000	TRACTOR, MASSEY FERGUSON #1 (SS)
400261	38000000	MOWER, #8 JACOBSEN TRACTOR (SS)
400309	38000000	HUSTLER #2 640-D (SS)
400330	38000000	HUSTLER #6 (640) (JI), (LTS)
400389	38000000	HUSTLER #1 640-D (FO)
400310	27800000	HUSTLER #3 640-D (FO)
401046	27800000	MOWER, RIDING #2 TORO GROUNDMASTER (FO)
400163	104VEHICLE	MOWER, RIDING #4 HONDA RIDER (13th)
400323	27800000	MOWER, RIDING #3 SNAPPER Z-RIDER (FO) going to auction may 2009
400487	27800000	MOWER, RIDING #7 SNAPPER Z-RIDER (JI)
400488	27800000	MOWER, RIDING #8 SNAPPER Z-RIDER (SS)
400378	38000000	MOWER, RIDING #7 SNAPPER Z-RIDER (SS) going to auction may 2009
401018	38000000	MOWER, RIDING #9 GRAVELY 60" RIDER (SS)
400329	28000000	MOWER, RIDING #2 SNAPPER Z-RIDER (JI) going to auction may 2009
400405	27800000	MOWER, LAWN #1 KEE'S (FO)
400531	27800000	MOWER, LAWN #4 KEE'S (FO)
400407	28000000	MOWER, LAWN #5 SNAPPER, 36" (FO)
400622	27800000	MOWER, LAWN #6 SNAPPER, 36" (FO)
400539	27800000	MOWER, LAWN #9 LAWNBOY (FO)
400540	27800000	MOWER, LAWN #10 LAWNBOY (FO)
400587	38100000	MOWER, LAWN #1 SNAPPER, 20" (SS)
400404	38000000	MOWER, LAWN #3 SNAPPER, 20" (SS)
400399	38000000	MOWER, LAWN #4 TORO, 20" (SS)
401029	38000000	MOWER, LAWN #7 TORO, 20" (SS)
401031	38000000	MOWER, LAWN #9 TORO, 20" (SS)
400435	28000000	MOWER, LAWN #2 SNAPPER, 20" (JI)
401009	28000000	MOWER, LAWN #6 SNAPPER, 20" (JI)
401010	28000000	MOWER, LAWN #7 SNAPPER, 20" (JI)

Snow Throwers

EQNUM	Location	Description
400392	10500000	BLOWER, SNOW #1 (HQ)
400159	10400000	BLOWER, SNOW #T3 (13th)
400476	104VEHICLE	BLOWER, SNOW #T4 (13th)
400417	27800000	BLOWER, SNOW #T2 (FO)
400551	27800000	BLOWER, SNOW #3 (FO)
400552	27800000	BLOWER, SNOW #4 (FO)
401011	27800000	BLOWER, SNOW #5 TORO (FO)
401012	27800000	BLOWER, SNOW #6 TORO (FO)
400385	28000000	BLOWER, SNOW #1 (JI)
400386	28000000	BLOWER, SNOW #2 (JI)
400448	27800000	BLOWER, SNOW #3 YAMAHA (JI)
400387	28000000	BLOWER, SNOW #4 (JI)
400388	28000000	BLOWER, SNOW #5 (JI)
400416	38000000	BLOWER, SNOW #4 (SS)
400447	38000000	BLOWER, SNOW #5 (SS)
400391	38000000	BLOWER, SNOW #6 (SS)
400415	38100000	BLOWER, SNOW #7 (SS)

TABLE C-1
Mobile Source List
MMSD GHG Inventory Management Plan

Generators

EQNUM	Location	Fuel Tank Size	Description
400300	28000000		GENERATOR, PORTABLE 1.5KW, DAYTON (JI) GASOLINE
400423	10500000		GENERATOR, PORTABLE #6, HONDA, 2500 WATT (MMSD), GASOLINE
400431	10500000		GENERATOR, PORTABLE #7, HONDA, 2500 WATT (MMSD), GASOLINE
400301	30000000		GENERATOR, PORTABLE #11, 2.5KW GENERATOR (SS), GASOLINE
400303	30000000		GENERATOR, PORTABLE #12, 2.5KW GENERATOR (SS), GASOLINE
401024	27800000		GENERATOR, PORTABLE #13, 5.6 KW WACKER (FO)GASOLINE
401025	280FLDTECH		GENERATOR, PORTABLE #14, 1,000 WATT HONDA (FO) GASOLINE
401027	27800000		GENERATOR, PORTABLE #15, 5.0KW HONDA (FO) GASOLINE
	27800000		GENERATOR, PORTABLE #16, 2,500 WATT WACKER (FO) GASOLINE
	27800000		GENERATOR, PORTABLE #17, 2,500 WATT WACKER (FO) GASOLINE
400355	27800000		GENERATOR, PORTABLE TRAILER MTD.50KW SET PERKINS (FO), DIESEL
400546	10700000		GENERATOR # 2, PORTABLE TRAILER MTD. 25KW SET GENERAC (MMSD), DIESEL
401044	10700000		GENERATOR, #3, PORTABLE TRAILER MTD. 25KW BALDOR (MMSD), DIESEL
1BS050203	30300000		STATIONARY GENERATOR, 450KW SET (SOUTH SHORE BLDG. 303) DIESEL
1BS050501	1BS0505	32 GAL	STATIONARY GENERATOR, 50KW SET (27TH & VILLARD) DIESEL
1BS050102	1BS 0501	37 GAL	STATIONARY GENERATOR, 60KW SET (RICHARDS & CONGRESS) DIESEL
1BS060101	1BS0601	114 GAL	STATIONARY GENERATOR, 200KW SET (35TH. & MANITOBA) DIESEL
1BS050603	1BS0506	32 GAL	STATIONARY GENERATOR, 35KW SET (RANGELINE RD.) DIESEL
1BS030301	1BS0303	74 GAL	STATIONARY GENERATOR, 125KW SET (74TH. & OKLAHOMA) DIESEL
1PS030214	1PS0302	647 GAL	STATIONARY GENERATOR, 1,250 KW SET (UNDERWOOD), DIESEL

Boats

EQNUM	Location	Description
400374	10500000	BOAT, PELAGOS RESEARCH
400375	10500000	BOAT, ORP RESEACH

Locomotive

EQNUM	Location	Description
400235	28500000	LOCOMOTIVE #3 auctioned

TABLE C-1
Mobile Source List
MMSD GHG Inventory Management Plan

Agrilife Equipment		
EQNUM	**Location**	**Description**
400141	38300000	TANKER, AGRI-LIFE SEMI #1
400144	38300000	TANKER, AGRI-LIFE SEMI #2
400145	38300000	TANKER, AGRI-LIFE SEMI #3
400146	38300000	TANKER, AGRI-LIFE SEMI #4
400147	38300000	TANKER, AGRI-LIFE SEMI #5
400148	38300000	TANKER, AGRI-LIFE SEMI #6
400149	38300000	TANKER, AGRI-LIFE SEMI #7
400150	38300000	TANKER, AGRI-LIFE SEMI #8
400151	38300000	TANKER, AGRI-LIFE SEMI #9
400369	38300000	TANKER, AGRI-LIFE SEMI #10
400143	38300000	TANKER, AGRI-LIFE SEMI #11
400266	38300000	TANKER, AGRI-LIFE SEMI #12
400267	38300000	TANKER, AGRI-LIFE SEMI #13
400268	38300000	TANKER, AGRI-LIFE SEMI #14
400269	38300000	TANKER, AGRI-LIFE SEMI #15
400271	38300000	TANKER, AGRI-LIFE SEMI #17
400272	38300000	TANKER, AGRI-LIFE SEMI #18
400273	38300000	TANKER, AGRI-LIFE SEMI #19
400274	38300000	TANKER, AGRI-LIFE SEMI #20
400275	38300000	TANKER, AGRI-LIFE SEMI #21
400276	38300000	TANKER, AGRI-LIFE SEMI #22
400277	38300000	TANKER, AGRI-LIFE SEMI #23
400278	38300000	TANKER, AGRI-LIFE SEMI #24
400279	38300000	TANKER, AGRI-LIFE SEMI #25
400280	38300000	TANKER, AGRI-LIFE SEMI #26
400282	38300000	TANKER, AGRI-LIFE SEMI #28
400283	38300000	TANKER, AGRI-LIFE SEMI #29
400284	38300000	TANKER, AGRI-LIFE SEMI #30
400285	38300000	TANKER, AGRI-LIFE SEMI #31
400286	38300000	TANKER, AGRI-LIFE SEMI #32
400287	38300000	TANKER, AGRI-LIFE SEMI #33

Attachment D
Document Revisions

ATTACHMENT D

Document Revisions

TABLE D-1
Document Revisions
MMSD GHG Inventory Management Plan

Revision	Date Revised	Approved By

Appendix B
GHG Inventory Data 2000–2007

Inventory Calculations: 2000

Non-Biogenic GHG Emissions (metric tons CO_2eq/year) by Facility and Source

Greenhouse Gas Inventory for MMSD in Milwaukee, WI
2000 Annual GHG Emissions

Facility	Stationary Combustion	Purchased Electricity	Water Reclamation Emissions	Mobile Combustion	Total	% of Total All Facilities
Jones Island (non-biogenic)	104,700	23,300	600		**128,700**	80.1%
Percentage of Jones Island	*81%*	*18%*	*0%*			
South Shore (non-biogenic)	13,100	11,900	500		**25,500**	15.9%
Percentage of South Shore	*51%*	*47%*	*2%*			
Headquarters and Laboratory	600	2,200			**2,800**	1.7%
Other Stationary Sources	1,000	1,900			**2,900**	1.8%
Mobile Sources				700	**700**	0.4%
Total All Facilities	**119,400**	**39,300**	**1,100**	**700**	**160,600**	
Percentage of Total	74.3%	24.5%	0.7%	0.4%		

Biogenic and Non-Biogenic GHG Emissions (metric tons CO_2eq/year) by Facility and Source

Greenhouse Gas Inventory for MMSD in Milwaukee, WI
2000 Annual GHG Emissions

Facility	Stationary Combustion	Purchased Electricity	Water Reclamation Emissions	Mobile Combustion	Total	% of Total All Facilities
Jones Island (non-biogenic)	104,700	23,300	600		**128,700**	49.8%
Jones Island (biogenic)			72,100		**72,100**	27.9%
Jones Island Subtotal	*104,700*	*23,300*	*72,700*		***200,800***	*77.6%*
Percentage of Jones Island	*52%*	*12%*	*36%*			
South Shore (non-biogenic)	4,600	11,900	500		**17,000**	6.6%
South Shore (biogenic)	8,600		34,400		**34,400**	13.3%
South Shore Subtotal	*13,200*	*11,900*	*34,900*		***51,400***	*19.9%*
Percentage of South Shore	*26%*	*23%*	*68%*			
Headquarters and Laboratory	600	2,200			**2,800**	1.1%
Other Stationary Sources	1,000	1,900			**2,900**	1.1%
Mobile Sources				700	**700**	0.3%
Total All Facilities	**119,500**	**39,300**	**107,600**	**700**	**258,600**	
Percentage of Total	46.2%	15.2%	41.6%	0.3%		

GHG Emissions (metric tons CO_2eq/year) by Type

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2000 Annual GHG Emissions

Scope 1: Direct Fossil Fuel Emissions	**110,915**	**metric tons CO_2eq/year**
Scope 2: Indirect Energy Emissions	**39,333**	**metric tons CO_2eq/year**
Emissions Unique to Water Reclamation Facilities	**107,561**	**metric tons CO_2eq/year**

	CO_2 Emissions	Biogenic CO_2 Emissions	CH_4 Emissions	N_2O Emissions	Total Emissions	% of Total	Total Emissions w/out Biogenic CO_2	% of Total w/out Biogenic CO_2
Stationary Combustion (Scope 1: direct emissions)	109,337	N/A	1,034.1	536.0	110,907	43.0%	110,907	73.3%
Mobile Combustion (Scope 1: direct emissions)	8	N/A	0.01	0.1	8	0.0%	8	0.0%
Purchased Electricity (Scope 2: indirect emissions)	39,121	N/A	10	203	39,333	15.3%	39,333	26.0%
Water Reclamation Emissions	0	106,504	83	1,057	107,561	41.7%	1,057	0.7%
Biogenic CO_2 emissions from water reclamation processes	N/A	106,504	N/A	N/A	106,504	41.3%	0	0.0%
N_2O emissions from water reclamation processes	N/A	N/A	N/A	1,057	1,057	0.4%	1,057	0.7%
CH_4 emissions from sludge drying	N/A	N/A	83	N/A	83	0.0%	83	0.1%
Total	**148,466**	**106,504**	**1,126**	**1,796**	**257,810**		**151,306**	**151,306**
% of Total	57.6%	41.3%	0.4%	0.7%				

Definitions (WRI Protocol terminology)

Scope 1 emissions: All direct GHG emissions, with the exception of direct CO_2 emissions from biogenic sources.

Direct emissions: Emissions from sources within the reporting entity's organizational boundaries that are owned or controlled by the reporting entity, including stationary combustion emissions, mobile combustion emissions, process emissions, and fugitive emissions.

Scope 2 emissions: Indirect GHG emissions associated with the consumption of purchased or acquired electricity, heating, cooling, or steam.

Indirect emissions: Emissions that are a consequence of activities that take place within the organizational boundaries of the reporting entity, but that occur at sources owned or controlled by another entity.

Biogenic carbon: Carbon derived from biogenic (plant or animal) sources excluding fossil carbon.

GHG Emissions (metric tons CO_2eq/year) by Facility and Type

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2000 Annual GHG Emissions

			Water Reclamation Facility Emissions w/ Biogenic CO_2					
	Stationary Combustion[a]	Purchased Electricity	Total WRF Emissions	Biogenic CO_2 Emissions[b]	Sludge Drying CH_4 Emissions[b]	Plant N_2O Emissions[b]	Total	% of Total
All Facilities								
CO_2 Emissions	109,337	39,121		N/A	N/A	N/A	**148,458**	56%
Biogenic CO_2 Emissions	8,576	N/A		106,504	N/A	N/A	**115,080**	43%
CH_4 Emissions	1,034	10		N/A	83	N/A	**1,126**	0%
N_2O Emissions	536	203		N/A	N/A	1,057	**1,796**	1%
Total CO_2e Emissions	**119,483**	**39,333**	**107,644**	**106,504**	**83**	**1,057**	**266,461**	
Percentage of Total (including biogenic emissions)	45%	15%	40%	40%	0%	0%		
Percentage of Total (not including biogenic emissions)	75%	25%		N/A	0%	1%	**159,956**	
Jones Island								
CO_2 Emissions	104,049	23,216		N/A	N/A	N/A	**127,265**	63%
Biogenic CO_2 Emissions	N/A	N/A		72,101	N/A	N/A	**72,101**	36%
CH_4 Emissions	148	5.7		N/A	83	N/A	**236**	0.1%
N_2O Emissions	517	120.3		N/A	N/A	533	**1,171**	1%
Total CO_2e Emissions	**104,714**	**23,342**	**72,717**	**72,101**	**83**	**533**	**200,774**	
Percentage of Total (including biogenic emissions)	52%	12%	36%	36%	0%	0%		
Percentage of Total (not including biogenic emissions)	81%	18%		N/A	0%	0%	**128,672**	
South Shore								
CO_2 Emissions	3,666	11,819		N/A	N/A	N/A	**15,486**	26%
Biogenic CO_2 Emissions	8,576	N/A		34,403	N/A	N/A	**42,979**	72%
CH_4 Emissions	886	2.9		N/A	N/A	N/A	**888**	1%
N_2O Emissions	17	61.2		N/A	N/A	524	**602**	1%
Total CO_2e Emissions	**13,145**	**11,883**	**34,927**	**34,403**	N/A	**524**	**59,955**	
Percentage of Total (including biogenic emissions)	22%	20%	58%	57%	N/A	1%		
Percentage of Total (not including biogenic emissions)	51%	47%		N/A	N/A	2%	**25,552**	
Headquarters & Lab								
CO_2 Emissions	632	2,148		N/A	N/A	N/A	**2,780**	99.6%
Biogenic CO_2 Emissions	N/A	N/A		N/A	N/A	N/A	**N/A**	0%
CH_4 Emissions	0.3	0.53		N/A	N/A	N/A	**1**	0.0%
N_2O Emissions	0.4	11.13		N/A	N/A	N/A	**11**	0.4%
Total CO_2 Emissions	**633**	**2,159**	N/A	N/A	N/A	N/A	**2,792**	
Percentage of Total	23%	77%						
Other Sources[c]								
CO_2 Emissions	989	1,938		N/A	N/A	N/A	**2,927**	99.6%
Biogenic CO_2 Emissions	N/A	N/A		N/A	N/A	N/A	**N/A**	0%
CH_4 Emissions	0	0.48		N/A	N/A	N/A	**1**	0.0%
N_2O Emissions	1	10.04		N/A	N/A	N/A	**12**	0.4%
Total CO_2 Emissions	**991**	**1,949**	N/A	N/A	N/A	N/A	**2,940**	
Percentage of Total	34%	66%						

[a] Include methane emissions from incomplete combustion of biogas for South Shore.

[b] Emissions from water reclamation processes.

[c] Other sources include: 13th street, Alterra, and the Interceptor Pumping Stations.

Direct Emissions: Stationary Combustion Sources

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2000 Annual GHG Emissions

Facility/Emission Sources	Fuel/Emission Source Type	Energy Use (MMBTU/yr)[a]	Fuel Use (1000 gal/yr)[a]	CO_2 Emission Factor (kg/MMBtu)	CO_2 Emissions (kg/year)[b]	N_2O Emission Factor (g/MMBtu or lb/1000 gal)[c]	N_2O Emissions (kg/year)	CH_4 Emission Factor (g/MMBtu or lb/1000 gal)[c]	CH_4 Emissions (kg/year)	Total CO_2e Emissions (kg/yr)[d]	Total CO_2e Emissions (metric tons/yr)[d]
Jones Island											
Rotary Sludge Dryers	Stationary Natural Gas - Boilers or Dryers	20,345		53.06	1,079,531	0.9	18	0.9	18	**1,085,592**	1,086
(2) 16MW Turbines	Stationary Natural Gas - Turbines	1,786,311		53.06	94,781,654	0.9	1,608	3.8	6,788	**95,422,583**	95,423
(2) 16MW Turbines	Stationary Distillate Fuel Oil (#1, 2, &4)	51,328		73.15	3,754,625	0.3	15	3	154	**3,762,632**	3,763
(2) Cleaver Brooks Boilers	Stationary Natural Gas - Boilers or Dryers	22,301		53.06	1,183,310	0.9	20	0.9	20	**1,189,953**	1,190
(2) Cleaver Brooks Boilers	Stationary Distillate Fuel Oil (#1, 2, &4)	217		73.15	15,857	0.3	0	3	1	**15,891**	16
Facility Space Heaters & Boilers <5 mmbtu/hr	Stationary Natural Gas - Default	60,873		53.06	3,229,923	0.1	6	1	61	**3,233,088**	3,233
Facility Space Heaters & Boilers <5 mmbtu/hr	Stationary Propane	72.5	1.8	63.07	4,572	0.9	0	0.2	0	**4,572**	5
					104,049,472		1,668		7,042	**104,714,312**	**104,714**

Direct Emissions: Stationary Combustion Sources
Greenhouse Gas Inventory for MMSD in Milwaukee, WI
2000 Annual GHG Emissions

Facility/Emission Sources	Fuel/Emission Source Type	Energy Use (MMBTU/yr)[a]	Fuel Use (1000 gal/yr)[a]	CO_2 Emission Factor (kg/MMBtu)	CO_2 Emissions (kg/year)[b]	N_2O Emission Factor (g/MMBtu or lb/1000 gal)[c]	N_2O Emissions (kg/year)	CH_4 Emission Factor (g/MMBtu or lb/1000 gal)[c]	CH_4 Emissions (kg/year)	Total CO_2e Emissions (kg/yr)[d]	Total CO_2e Emissions (metric tons/yr)[d]
South Shore											
Facility Space Heaters & Boilers <5 mmbtu/hr	Stationary Natural Gas - Boilers or Dryers	39,877		53.06	2,115,874	0.9	36	0.9	36	**2,127,753**	2,128
Boilers - (3) Kewaunee, (2) Scum, (2) Cleaver Brooks	Stationary Natural Gas - Boilers or Dryers	239		53.06	12,681	0.9	0	0.9	0	**12,753**	13
IC Engine Generators (5)	Stationary Natural Gas - Default	28,983		53.06	1,537,838	0.1	3	1	29	**1,539,345**	1,539
Boilers - (3) Kewaunee, (2) Cleaver Brooks [b]	Stationary Wastewater Treatment Biogas	11,262		52.07	*586,407*	0.1	1	0.9	10	**586,969**	587
IC Engine Generators (5)[b]	Stationary Wastewater	152,486		52.07	*7,939,972*	0.1	15	0.9	137	**7,947,581**	7,948
Flares[b]	Stationary Wastewater	951		52.07	*49,520*	0.1	0	0.9	1	**49,567**	50
					12,242,291		55		213	**12,263,967**	**12,264**
Headquarters & Lab											
Building Heat	Stationary Natural Gas - Default	11,916		53.06	632,242	0.1	1	1	12	**632,861**	633
Other Sources											
S. 13th Street Boilers	Stationary Natural Gas - Boilers or Dryers	3,621		53.06	192,136	0.9	3	0.9	3	**193,214**	193
Alterra Building Heat	Stationary Natural Gas - Default	280		53.06	14,841	0.1	0	1	0	**14,855**	15
Pump Stations, etc.	Stationary Natural Gas - Default	14,740		53.06	782,120	0.1	1	1	15	**782,887**	783
					989,097		5		18		**991**
All Facilities					117,913,102		1,729		7,285		**118,602**

[a] Energy/fuel usage data obtained from purchasing records and annual air emission inventory reports.

[b] CO_2 emissions from wastewater treatment biogas are considered biogenic and not reported as scope 1 emissions.

[c] CH_4 and N_2O emission factors for propane are in lb/1000 gal.

[d] CO_2 equivalents are calculated by multiplying the global warming potential (GWP) by the CO_2 emissions. The GWP for CO_2 is 1, N_2O is 310 and CH_4 is 21.

Indirect Emissions: Purchased Electricity

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2000 Annual GHG Emissions

Facility	Electricity Use (MWh)[a]	CO_2 Emission Factor[b] (lb/MWh)	CO_2 Emissions (kg/year)	N_2O Emission Factor[b] (lb/MWh)	N_2O Emissions (kg/year)	CH_4 Emission Factor[b] (lb/MWh)	CH_4 Emissions (kg/year)	Total CO_2e Emissions (kg/yr)[c]	Total CO_2e Emissions (metric tons/yr)[c]
Jones Island	33,282	1537.82	23,215,975	0.0257	388	0.018	272	23341957	23,342
South Shore	16,944	1537.82	11,819,311	0.0257	198	0.018	138	11883448.6	11,883
Headquarters & Lab	3,079	1537.82	2,147,507	0.0257	36	0.018	25	2159160.58	2,159
Other Sources									
S. 13th Street	423	1537.82	295,287	0.0257	5	0.018	3	296889.489	297
Alterra Coffee Shop	14	1537.82	9,877	0.0257	0	0.018	0	9930.91554	10
Pump Stations, Gate	2,341	1537.82	1,633,103	0.0257	27	0.018	19	1641964.67	1,642
									1,949

[a] Electricity usage data obtained from purchasing records.

[b] Emission factors are from the eGRID Sub Region Emission Rates for RFC West.

[c]CO_2 equivalents are calculated by multiplying the global warming potential (GWP) by the CO_2 emissions. and CH_4 is 21.

The GWP for CO_2 is 1, N_2O is 310

Direct Emissions: Mobile Combustion Sources/Equipment

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2000 Annual GHG Emissions

Facility	Fuel and Mobile Source	Miles Traveled[a]	Fuel usage (gal.)[b]	CO_2 Emission Factor (kg/gal)	CO_2 Emissions (kg/year)	N_2O Emission Factor (g/mile or g/gal.)	N_2O Emissions (kg/year)	CH_4 Emission Factor (g/mile or g/gal.)	CH_4 Emissions (kg/year)	Total CO_2e Emissions (kg/yr)[f]	Total CO_2e Emissions (metric tons/yr)[f]
MMSD Cars and Light Trucks	Gasoline Passenger Cars	290,000	13,122	8.81	115,606	0.0197	6	0.178	52	118,461	118.46
Veolia Cars and Light Trucks	Gasoline Light-Duty Trucks	310,000	17,514	8.81	154,299	0.022	7	0.2024	63	157,731	157.73
Televising & Manhole Trucks	Gasoline Heavy Duty Vehicles	60,000	3,390	8.81	29,864	0.0497	3	0.4604	28	31,369	31.37
Class 8 Trucks	Diesel Heavy-Duty Vehicles	60,000	7,229	10.15	73,373	0.0048	0	0.0051	0	73,469	73.47
Light Med & Heavy Dump Trucks	Diesel Heavy-Duty Vehicles	50,000	8,450	10.15	85,768	0.0048	0	0.0051	0	85,847	85.85
Wheel loaders & Skid Loaders	Gasoline Heavy Duty Vehicles	4,500	900	8.81	7,929	0.0497	0	0.4604	2	8,042	8.04
Straddle Carriers	Gasoline Heavy Duty Vehicles	1,000	200	8.81	1,762	0.0497	0	0.4604	0	1,787	1.79
Burden Carriers & ATVs	Gas Small Utility	19,500	3,900	8.81	34,359	0.22	1	0.5	2	34,666	34.67
Tractors & Lawn Mowers	Gasoline Agricultural Equipment	7,250	1,450	8.81	12,775	0.22	0	1.26	2	12,912	12.91
Snow Blowers	Gas Small Utility	4,250	850	8.81	7,489	0.22	0	0.5	0	7,555	7.56
Diesel Generators	Diesel Construction Equipment		1,000	10.15	10,150	0.26	0	0.58	1	10,243	10.24
Gasoline Generators	Gasoline Heavy Duty Vehicles		1,000	8.81	8,810	0.0497	0	0.4604	0	8,810	8.81
Pelagos Research Vessel [c]	Gasoline Ships and Boats		1,585	8.81	13,964	0.22	0	0.64	1	14,093	14.09
ORP Research Boat [c]	Gasoline Ships and Boats		1,585	8.81	13,964	0.22	0	0.64	1	14,093	14.09
AgriLife Land Spreading [d]	Diesel Heavy-Duty Vehicles	40,000	6,760	10.15	68,614	0.0048	0	0.0051	0	68,678	68.68
Locomotive[e]	Diesel Locomotives		795	10.15	8,069	0.26	0	0.8	1	8,147	8.15
Total Mobile Sources					646,795		19		153	655,904	656

Direct Emissions: Mobile Combustion Sources/Equipment

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2000 Annual GHG Emissions

[a] Miles traveled based upon number of vehicles and estimated annual average mileage as shown below. The number of vehicles for each type based upon 2009 vehicle data provided by MMSD "Complete Vehicle and Equipment list, revised 4-09.xls".

	No. of Vehicles	Estimated Avg. Miles per Year per Vehicle	Total Miles per Year
MMSD Cars and Light Trucks:	29	10,000	290,000
Veolia Cars and Light Trucks:	62	5,000	310,000
Televising & Manhole Trucks:	12	5,000	60,000
Class 8 Trucks	12	5,000	60,000
Light Med & Heavy Dump Trucks	10	5,000	50,000
Wheel loaders & Skidloaders	9	500	4,500
Straddle Carriers	2	500	1,000
Burden Carriers & ATVs	38	500	19,000
Tractors & Lawn Mowers	27	250	6,750
Snow Blowers	16	250	4,000

[b] The following factors were used to estimate gallons of fuel consumed based on estimated miles driven per vehicle type:

Vehicle Type	Avg mpg	Source
Passenger Cars	22.1	
Other 2-axle, 4-tire vehicles	17.7	U.S. Department of Transportation Federal Highway Administration Annual Vehicle Distance Traveled in Miles and
Single unit 2-axle 6-tire or more trucks	8.3	Related Data- 2006, http://www.fhwa.dot.gov
Combination Trucks	5.9	Climate Leaders GHG Protocol, Direct Emissions from Mobile Combustion Sources, May 2008.
Other Vehicles	5.00	Assumed all other small vehicles (e.g. Loaders, Carriers, Tractors and Snow Blowers) get an average of 5 mpg

[c] Pelagos Research Vessel based upon fuel purchases in 2007, assumed ORP Research Boat fuel usage was equal to Pelagos Research Vessel fuel usage.

[d] Annual mileage based upon 2007 Agri Life sludge landspreading records.

[e] Locomotive fuel usage estimated based upon 2007 annual tons of milorganite produced, a distance of 3 miles to transport the Milorganite, and a Btu/ton-mile factor of 337 (EPA Climate Leader's Mobile Source guidance document).

[f] CO_2 equivalents are calculated by multiplying the global warming potential (GWP) by the CO_2 emissions. The GWP for CO_2 is 1, N_2O is 310 and CH_4 is 21.

Direct Emissions: Water Reclamation Facility Emissions
South Shore Water Reclamation Facility
Greenhouse Gas Inventory for MMSD in Milwaukee, WI
2000 Annual GHG Emissions

Methodology:
Calculation methodology from California Climate Action Registry (CCAR) Local Government Operations Protocol, chapter 10 on Centralized Wastewater Treatment Facilities (except for biogenic CO_2 emissions which are based upon data obtained from Metcalf and Eddy Wastewater Engineering Treatment, Disposal, and Reuse). CCAR equations use the EPA Inventory of US Greenhouse Gas Emissions and Sinks: 1990–2006, Chapter 8, 8–9 (2008) Calculation methodology to estimate biogenic CO_2 emissions from wastewater treatment processes, such as the use of aeration basins, sludge digesters and combustion of biogas may be included in the future CCAR wastewater treatment industry GHG protocol scheduled to be released in 2010).

Biogenic CO_2 from Water Reclamation Processes[a]

$$CO_2\left[\frac{metric\ tons\ CO_2}{year}\right] \equiv BOD_5 Load\left[\frac{kg\ BOD_5}{day}\right] \times EF_{biogenic\ CO_2}\left[\frac{kg\ CO_2}{kg\ BOD_5}\right] \times F_{oxidation} \times 365\left[\frac{day}{year}\right] \times 10^{-3}\left[\frac{metric\ ton}{kg}\right]$$

where

Term	Description	Value	GHG Emissions (metric ton CO_2e/year)[b]	Source of Data
Biogenic CO_2	= biogenic CO_2 emissions from a centralized WWTP [metric ton CO_2/year]	**34,403**	**34,403**	
BOD_5 load	= average amount of BOD_5 produced per day [kg BOD_5/day]	58,909		Annual Discharge Monitoring Report
$EF_{biogenic\ CO2}$	= emission factor [kg CO_2/kg BOD_5]	2		Metcalf & Eddy Wastewater Engineering
$F_{oxidation}$	= factor for level of oxidation for a centralized WWTP with an anaerobic or aerobic sludge digester	0.8		Metcalf & Eddy Wastewater Engineering
365	= conversion factor [day/year]	365		Conversion factor
10^{-3}	= conversion from kg to metric ton [metric ton/kg]	1.E-03		Conversion factor

Direct Emissions: Water Reclamation Facility Emissions
South Shore Water Reclamation Facility
Greenhouse Gas Inventory for MMSD in Milwaukee, WI
2000 Annual GHG Emissions

Methane from Incomplete Combustion of Digester Gas (included with Stationary Combustion Emissions)

$$CH_4\left[\frac{metric\ tons}{year}\right] \equiv Digester\ Gas\left[\frac{ft^3}{yr}\right] \times F_{CH_4} \times \rho\left(_{CH_4}\right)\left[\frac{g}{m^3}\right] \times (1 - DE) \times 0.0283\left[\frac{m^3}{ft^3}\right] \times 10^{-6}\left[\frac{metric\ ton}{g}\right]$$

where

Term	Description	Value	GHG Emissions (metric ton CO_2e/year)	Source of Data
CH_4 incomplete combustion of digester gas	= CH_4 emissions from incomplete combustion of digester gas [metric ton CH_4/year]	**42.0**	**881**	
Digester Gas	= measured standard cubic feet of digester gas produced per day [ft^3/year]	373,249,000		Annual Emission Inventory Report
F_{CH4}	= measured fraction of CH_4 in biogas	0.6		Annual Emission Inventory Report
$\rho(CH_4)$	= density of methane at standard conditions [g/m^3]	662.00		Protocol default value.
DE	= CH_4 destruction efficiency from flaring or burning in engine	0.99		Protocol default value.
0.0283	= conversion from ft^3 to m^3 [m^3/ft^3]	0.0283		Conversion factor
10^{-6}	= conversion from g to metric ton [metric ton/g]	1.E-06		Conversion factor

Direct Emissions: Water Reclamation Facility Emissions
South Shore Water Reclamation Facility
Greenhouse Gas Inventory for MMSD in Milwaukee, WI
2000 Annual GHG Emissions

Process Emissions from Water Reclamation Processes

$$N_2O\left[\frac{metric\ tons}{year}\right] \equiv P_T\left[person\right] \times \frac{Plant\ Flow}{DISTRICT\ Flow}\left[\frac{\frac{MG}{year}}{\frac{MG}{year}}\right] \times EF_{nit/denit}\left[\frac{g\ N_2O}{person \times year}\right] \times 10^{-6}\left[\frac{metric\ ton}{g}\right]$$

where

Term	Description	Value	GHG Emissions (metric ton CO_2e/year)	Source of Data
N_2O plant	= N_2O emissions from a centralized WWTP [metric ton N_2O/year]	**1.69**	**524**	
P_P	= total population served by the WWTP, person	527,868		Population served by Jones Island calculated based upon total population served times % of total annual flow treated by Jones Island.
P_T	= total population served by the DISTRICT, person	1,065,603		MMSD annual financial report
Plant Flow	= plant flow [MG/year]	107.00		Annual Discharge Monitoring Report
DISTRICT Flow	= DISTRICT flow [MG/year]	216.00		Annual Discharge Monitoring Report
EF nit/denit	= emission factor for a WWTP without nitrification/denitrification [g N_2O/year]	3.2		Protocol default value for plants without nitrification/denitrification.
10^{-6}	= conversion from g to metric ton [metric ton/g]	1.E-06		Conversion factor

[a] Methodology for calculating biogenic CO_2 is not included in the CCAR Local Government Operations Protocol, but may be included in the CCAR wastewater treatment industry protocol that is scheduled to be released in 2010.

[b] CO_2 equivalents are calculated by multiplying the global warming potential (GWP) by the CO_2 emissions. The GWP for CO_2 is 1, N_2O is 310 and CH_4 is 21.

Direct Emissions: Water Reclamation Facility Emissions

Jones Island Water Reclamation Facility

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2000 Annual GHG Emissions

Methodology:

Calculation methodology from California Climate Action Registry (CCAR) Local Government Operations Protocol, chapter 10 on Centralized Wastewater Treatment Facilities (except for biogenic CO^2 emissions which are based upon data obtained from Metcalf and Eddy Wastewater Engineering Treatment, Disposal, and Reuse). CCAR equations use the EPA Inventory of US Greenhouse Gas Emissions and Sinks: 1990–2006, Chapter 8, 8–9 (2008) Calculation methodology to estimate biogenic CO2 emissions from wastewater treatment processes, such as the use of aeration basins, sludge digesters and combustion of biogas may be included in the future CCAR wastewater treatment industry GHG protocol scheduled to be released in 2010).

Biogenic CO_2 from Water Reclamation Processes[a]

$$CO_2\left[\frac{metric\ tons\ CO_2}{year}\right] \equiv BOD_5 Load\left[\frac{kg\ BOD_5}{day}\right] \times EF_{biogenic\ CO_2}\left[\frac{kg\ CO_2}{kg\ BOD_5}\right] \times F_{oxidation} \times 365\left[\frac{day}{year}\right] \times 10^{-3}\left[\frac{metric\ ton}{kg}\right]$$

where

Term	Description	Value	GHG Emissions (metric ton CO_2e/year)[b]	Source of Data
Biogenic CO_2	= biogenic CO_2 emissions from a centralized WWTP [metric ton CO_2/year]	**72,101**	**72,101**	
BOD_5 load	= average amount of BOD_5 produced per day [kg BOD_5/day]	123,461		Annual Discharge Monitoring Report
$EF_{biogenic\ CO2}$	= emission factor [kg CO_2/kg BOD_5]	2		Metcalf & Eddy Wastewater Engineering
$F_{oxidation}$	= factor for level of oxidation for a centralized WWTP with an anaerobic or aerobic sludge digester	0.8		Metcalf & Eddy Wastewater Engineering
365	= conversion factor [day/year]	365		Conversion factor
10^{-3}	= conversion from kg to metric ton [metric ton/kg]	1.E-03		Conversion factor

Direct Emissions: Water Reclamation Facility Emissions

Jones Island Water Reclamation Facility

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2000 Annual GHG Emissions

Methane from Incomplete Combustion of Digester Gas (included with Stationary Combustion Emissions)

Digester Gas is not burned at Jones Island

$$CH_4\left[\frac{metric\ tons}{year}\right] \equiv Digester\ Gas\left[\frac{ft^3}{yr}\right] \times F_{CH_4} \times \rho\left(_{CH_4}\right)\left[\frac{g}{m^3}\right] \times (1-DE) \times 0.0283\left[\frac{m^3}{ft^3}\right] \times 10^{-6}\left[\frac{metric\ ton}{g}\right]$$

where

Term	Description	Value	GHG Emissions (metric ton CO_2e/year)	Source of Data
CH_4 incomplete combustion of digester gas	= CH_4 emissions from incomplete combustion of digester gas [metric ton CH_4/year]	**0.0**	**0**	
Digester Gas	= measured standard cubic feet of digester gas produced per day [ft^3/year]	0		Annual Emission Inventory Report
F_{CH4}	= measured fraction of CH_4 in biogas	0		Annual Emission Inventory Report
$\rho(CH_4)$	= density of methane at standard conditions [g/m^3]	662.00		Protocol default value.
DE	= CH_4 destruction efficiency from flaring or burning in engine	0.99		Protocol default value.
0.0283	= conversion from ft^3 to m^3 [m^3/ft^3]	0.0283		Conversion factor
10^{-6}	= conversion from g to metric ton [metric ton/g]	1.E-06		Conversion factor

Direct Emissions: Water Reclamation Facility Emissions

Jones Island Water Reclamation Facility

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2000 Annual GHG Emissions

Process Emissions from Water Reclamation Processes

$$N_2O\left[\frac{metric\ tons}{year}\right] \equiv P_T\left[person\right] \times \frac{Plant\ Flow}{DISTRICT\ Flow}\left[\frac{\frac{MG}{year}}{\frac{MG}{year}}\right] \times EF_{nit/denit}\left[\frac{g\ N_2O}{person \times year}\right] \times 10^{-6}\left[\frac{metric\ ton}{g}\right]$$

where

Term	Description	Value	GHG Emissions (metric ton CO_2e/year)	Source of Data
N_2O plant	= N_2O emissions from a centralized WWTP [metric ton N_2O/year]	**1.72**	**533**	
P_P	= total population served by the WWTP, person	537,735		Population served by Jones Island calculated based upon total population served times % of total annual flow treated by Jones Island.
P_T	= total population served by the DISTRICT, person	1,065,603		MMSD annual financial report
Plant Flow	= plant flow [MG/year]	109.00		Annual Discharge Monitoring Report
DISTRICT Flow	= DISTRICT flow [MG/year]	216.00		Annual Discharge Monitoring Report
EF nit/denit	= emission factor for a WWTP without nitrification/denitrification [g N_2O/year]	3.2		Protocol default value for plants without nitrification/denitrification.
10^{-6}	= conversion from g to metric ton [metric ton/g]	1.E-06		Conversion factor

Process Emissions from Sludge Drying

$$CH_4\left[\frac{metric\ tons}{year}\right] \equiv BSD\left[\frac{tons}{year}\right] \times EF\left[\frac{kg\,CH_4}{tonBSD}\right] \times 10^{-3}\left[\frac{metric\ ton}{kg}\right]$$

where

Term	Description	Value	GHG Emissions (metric ton CO_2e/year)	Source of Data
CH_4	= CH_4 emissions from a sludge drying [metric ton CH_4/year]	**3.94**	**83**	
BSD	= blended sludge through dryers [dry tons/year]	54,981		Air Emission Inventory Report throughput for P01
EF	= emission factor for drying sludge [kg CH_4/ton dry solids]	0.072		December 2007 JI Dryer Stack Test Data, average of 3 tests, methane from natural gas combustion from turbine waste heat is subtracted.
10^{-3}	= conversion from g to metric ton [metric ton/kg]	1.E-03		Conversion factor

[a] Methodology for calculating biogenic CO_2 is not included in the CCAR Local Government Operations Protocol, but may be included in the CCAR wastewater treatment industry protocol that is scheduled to be released in 2010.
[b] CO_2 equivalents are calculated by multiplying the global warming potential (GWP) by the CO_2 emissions. The GWP for CO_2 is 1, N_2O is 310 and CH_4 is 21.

Inventory Calculations: 2001

Non-Biogenic GHG Emissions (metric tons CO_2eq/year) by Facility and Source

Greenhouse Gas Inventory for MMSD in Milwaukee, WI
2001 Annual GHG Emissions

Facility	Stationary Combustion	Purchased Electricity	Water Reclamation Emissions	Mobile Combustion	Total	% of Total All Facilities
Jones Island (non-biogenic)	91,700	35,500	600		**127,900**	81.6%
Percentage of Jones Island	*72%*	*28%*	*0%*			
South Shore (non-biogenic)	12,800	9,300	500		**22,600**	14.4%
Percentage of South Shore	*57%*	*41%*	*2%*			
Headquarters and Laboratory	600	2,000			**2,600**	1.7%
Other Stationary Sources	900	2,000			**2,900**	1.9%
Mobile Sources				700	**700**	0.4%
Total All Facilities	**106,000**	**48,800**	**1,100**	**700**	**156,700**	
Percentage of Total	67.6%	31.1%	0.7%	0.4%		

Biogenic and Non-Biogenic GHG Emissions (metric tons CO_2eq/year) by Facility and Source

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2001 Annual GHG Emissions

Facility	Stationary Combustion	Purchased Electricity	Water Reclamation Emissions	Mobile Combustion	Total	% of Total All Facilities
Jones Island (non-biogenic)	91,700	35,500	600		**127,900**	49.4%
Jones Island (biogenic)			73,400		**73,400**	28.3%
Jones Island Subtotal	*91,700*	*35,500*	*74,000*		***201,300***	*77.7%*
Percentage of Jones Island	*46%*	*18%*	*37%*			
South Shore (non-biogenic)	4,200	9,300	500		**14,000**	5.4%
South Shore (biogenic)	8,500		37,500		**37,500**	14.5%
South Shore Subtotal	*12,700*	*9,300*	*38,000*		***60,000***	*23.2%*
Percentage of South Shore	*21%*	*16%*	*63%*			
Headquarters and Laboratory	600	2,000			**2,600**	1.0%
Other Stationary Sources	900	2,000			**2,900**	1.1%
Mobile Sources				700	**700**	0.3%
Total All Facilities	**105,900**	**48,800**	**112,000**	**700**	**259,000**	
Percentage of Total	40.9%	18.8%	43.2%	0.3%		

GHG Emissions (metric tons CO_2eq/year) by Type

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2001 Annual GHG Emissions

Scope 1: Direct Fossil Fuel Emissions	**97,574**	**metric tons CO_2eq/year**
Scope 2: Indirect Energy Emissions	**48,760**	**metric tons CO_2eq/year**
Emissions Unique to Water Reclamation Facilities	**111,924**	**metric tons CO_2eq/year**

	CO_2 Emissions	Biogenic CO_2 Emissions	CH_4 Emissions	N_2O Emissions	Total Emissions	% of Total	Total Emissions w/out Biogenic CO_2	% of Total w/out Biogenic CO_2
Stationary Combustion (Scope 1: direct emissions)	96,198	N/A	900.8	466.5	97,566	37.8%	97,566	66.2%
Mobile Combustion (Scope 1: direct emissions)	8	N/A	0.01	0.1	8	0.0%	8	0.0%
Purchased Electricity (Scope 2: indirect emissions)	48,496	N/A	12	251	48,760	18.9%	48,760	33.1%
Water Reclamation Emissions	0	110,878	88	1,046	111,924	43.3%	1,046	0.7%
Biogenic CO_2 emissions from water reclamation processes	N/A	110,878	N/A	N/A	110,878	42.9%	0	0.0%
N_2O emissions from water reclamation processes	N/A	N/A	N/A	1,046	1,046	0.4%	1,046	0.7%
CH_4 emissions from sludge drying	N/A	N/A	88	N/A	88	0.0%	88	0.1%
Total	**144,703**	**110,878**	**1,001**	**1,764**	**258,257**		**147,380**	**147,380**
% of Total	56.0%	42.9%	0.4%	0.7%				

Definitions (WRI Protocol terminology)

Scope 1 emissions: All direct GHG emissions, with the exception of direct CO_2 emissions from biogenic sources.

Direct emissions: Emissions from sources within the reporting entity's organizational boundaries that are owned or controlled by the reporting entity, including stationary combustion emissions, mobile combustion emissions, process emissions, and fugitive emissions.

Scope 2 emissions: Indirect GHG emissions associated with the consumption of purchased or acquired electricity, heating, cooling, or steam.

Indirect emissions: Emissions that are a consequence of activities that take place within the organizational boundaries of the reporting entity, but that occur at sources owned or controlled by another entity.

Biogenic carbon: Carbon derived from biogenic (plant or animal) sources excluding fossil carbon.

GHG Emissions (metric tons CO_2eq/year) by Facility and Type

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2001 Annual GHG Emissions

			Water Reclamation Facility Emissions w/ Biogenic CO_2					
	Stationary Combustion[a]	Purchased Electricity	Total WRF Emissions	Biogenic CO_2 Emissions[b]	Sludge Drying CH_4 Emissions[b]	Plant N_2O Emissions[b]	Total	% of Total
All Facilities								
CO_2 Emissions	96,198	48,496		N/A	N/A	N/A	**144,695**	54%
Biogenic CO_2 Emissions	8,518	N/A		110,878	N/A	N/A	**119,396**	45%
CH_4 Emissions	901	12		N/A	88	N/A	**1,001**	0%
N_2O Emissions	466	251		N/A	N/A	1,046	**1,764**	1%
Total CO_2e Emissions	**106,084**	**48,760**	**112,012**	**110,878**	**88**	**1,046**	**266,855**	
Percentage of Total (including biogenic emissions)	40%	18%	42%	42%	0%	0%		
Percentage of Total (not including biogenic emissions)	68%	31%		N/A	0%	1%	**155,977**	
Jones Island								
CO_2 Emissions	91,179	35,328		N/A	N/A	N/A	**126,506**	63%
Biogenic CO_2 Emissions	N/A	N/A		73,415	N/A	N/A	**73,415**	36%
CH_4 Emissions	109	8.7		N/A	88	N/A	**206**	0.1%
N_2O Emissions	452	183.0		N/A	N/A	533	**1,168**	1%
Total CO_2e Emissions	**91,740**	**35,519**	**74,036**	**73,415**	**88**	**533**	**201,295**	
Percentage of Total (including biogenic emissions)	46%	18%	37%	36%	0%	0%		
Percentage of Total (not including biogenic emissions)	72%	28%		N/A	0%	0%	**127,880**	
South Shore								
CO_2 Emissions	3,438	9,263		N/A	N/A	N/A	**12,701**	21%
Biogenic CO_2 Emissions	8,518	N/A		37,462	N/A	N/A	**45,980**	77%
CH_4 Emissions	791	2.3		N/A	N/A	N/A	**793**	1%
N_2O Emissions	13	48.0		N/A	N/A	513	**575**	1%
Total CO_2e Emissions	**12,760**	**9,313**	**37,976**	**37,462**	N/A	**513**	**60,050**	
Percentage of Total (including biogenic emissions)	21%	16%	63%	62%	N/A	1%		
Percentage of Total (not including biogenic emissions)	56%	41%		N/A	N/A	2%	**22,587**	
Headquarters & Lab								
CO_2 Emissions	632	1,951		N/A	N/A	N/A	**2,583**	99.6%
Biogenic CO_2 Emissions	N/A	N/A		N/A	N/A	N/A	**N/A**	0%
CH_4 Emissions	0.3	0.48		N/A	N/A	N/A	**1**	0.0%
N_2O Emissions	0.4	10.11		N/A	N/A	N/A	**10**	0.4%
Total CO_2 Emissions	**633**	**1,962**	N/A	N/A	N/A	N/A	**2,594**	
Percentage of Total	24%	76%						
Other Sources[c]								
CO_2 Emissions	949	1,955		N/A	N/A	N/A	**2,904**	99.6%
Biogenic CO_2 Emissions	N/A	N/A		N/A	N/A	N/A	**N/A**	0%
CH_4 Emissions	0	0.48		N/A	N/A	N/A	**1**	0.0%
N_2O Emissions	1	10.13		N/A	N/A	N/A	**11**	0.4%
Total CO_2 Emissions	**951**	**1,965**	N/A	N/A	N/A	N/A	**2,916**	
Percentage of Total	33%	67%						

[a] Include methane emissions from incomplete combustion of biogas for South Shore.

[b] Emissions from water reclamation processes.

[c] Other sources include: 13th street, Alterra, and the Interceptor Pumping Stations.

Direct Emissions: Stationary Combustion Sources
Greenhouse Gas Inventory for MMSD in Milwaukee, WI
2001 Annual GHG Emissions

Facility/Emission Sources	Fuel/Emission Source Type	Energy Use (MMBTU/yr)[a]	Fuel Use (1000 gal/yr)[a]	CO_2 Emission Factor (kg/MMBtu)	CO_2 Emissions (kg/year)[b]	N_2O Emission Factor (g/MMBtu or lb/1000 gal)[c]	N_2O Emissions (kg/year)	CH_4 Emission Factor (g/MMBtu or lb/1000 gal)[c]	CH_4 Emissions (kg/year)	Total CO_2e Emissions (kg/yr)[d]	Total CO_2e Emissions (metric tons/yr)[d]
Jones Island											
Rotary Sludge Dryers	Stationary Natural Gas - Boilers or Dryers	353,125		53.06	18,736,813	0.9	318	0.9	318	**18,842,008**	18,842
(2) 16MW Turbines	Stationary Natural Gas - Turbines	1,230,567		53.06	65,293,885	0.9	1,108	3.8	4,676	**65,735,412**	65,735
(2) 16MW Turbines	Stationary Distillate Fuel Oil (#1, 2, &4)	41,992		73.15	3,071,716	0.3	13	3	126	**3,078,267**	3,078
(2) Cleaver Brooks Boilers	Stationary Natural Gas - Boilers or Dryers	14,458		53.06	767,132	0.9	13	0.9	13	**771,439**	771
(2) Cleaver Brooks Boilers	Stationary Distillate Fuel Oil (#1, 2, &4)	98		73.15	7,187	0.3	0	3	0	**7,203**	7
Facility Space Heaters & Boilers <5 mmbtu/hr	Stationary Natural Gas - Default	62,179		53.06	3,299,218	0.1	6	1	62	**3,302,451**	3,302
Facility Space Heaters & Boilers <5 mmbtu/hr	Stationary Propane	43.8	1.8	63.07	2,763	0.9	0	0.2	0	**2,763**	3
					91,178,714		1,457		5,195	**91,739,543**	**91,740**

Direct Emissions: Stationary Combustion Sources
Greenhouse Gas Inventory for MMSD in Milwaukee, WI
2001 Annual GHG Emissions

Facility/Emission Sources	Fuel/Emission Source Type	Energy Use (MMBTU/yr)[a]	Fuel Use (1000 gal/yr)[a]	CO_2 Emission Factor (kg/MMBtu)	CO_2 Emissions (kg/year)[b]	N_2O Emission Factor (g/MMBtu or lb/1000 gal)[c]	N_2O Emissions (kg/year)	CH_4 Emission Factor (g/MMBtu or lb/1000 gal)[c]	CH_4 Emissions (kg/year)	Total CO_2e Emissions (kg/yr)[d]	Total CO_2e Emissions (metric tons/yr)[d]
South Shore											
Facility Space Heaters & Boilers <5 mmbtu/hr	Stationary Natural Gas - Boilers or Dryers	23,090		53.06	1,225,155	0.9	21	0.9	21	**1,232,034**	1,232
Boilers - (3) Kewaunee, (2) Scum, (2) Cleaver Brooks	Stationary Natural Gas - Boilers or Dryers	1,298		53.06	68,872	0.9	1	0.9	1	**69,259**	69
IC Engine Generators (5)	Stationary Natural Gas - Default	40,412		53.06	2,144,261	0.1	4	1	40	**2,146,362**	2,146
Boilers - (3) Kewaunee, (2) Cleaver Brooks [b]	Stationary Wastewater Treatment Biogas	7,855		52.07	*408,989*	0.1	1	0.9	7	**409,381**	409
IC Engine Generators (5)[b]	Stationary Wastewater	155,418		52.07	*8,092,592*	0.1	16	0.9	140	**8,100,347**	8,100
Flares[b]	Stationary Wastewater	314		52.07	*16,334*	0.1	0	0.9	0	**16,350**	16
					11,956,203		42		210	**11,973,732**	**11,957**
Headquarters & Lab											
Building Heat	Stationary Natural Gas - Default	11,916		53.06	632,242	0.1	1	1	12	**632,861**	633
Other Sources											
S. 13th Street Boilers	Stationary Natural Gas - Boilers or Dryers	2,870		53.06	152,293	0.9	3	0.9	3	**153,148**	153
Alterra Building Heat	Stationary Natural Gas - Default	280		53.06	14,841	0.1	0	1	0	**14,855**	15
Pump Stations, etc.	Stationary Natural Gas - Default	14,740		53.06	782,120	0.1	1	1	15	**782,887**	783
					949,254		4		18		**951**
All Facilities					104,716,412		1,505		5,435		**105,281**

[a] Energy/fuel usage data obtained from purchasing records and annual air emission inventory reports.

[b] CO_2 emissions from wastewater treatment biogas are considered biogenic and not reported as scope 1 emissions.

[c] CH_4 and N_2O emission factors for propane are in lb/1000 gal.

[d] CO_2 equivalents are calculated by multiplying the global warming potential (GWP) by the CO_2 emissions. The GWP for CO_2 is 1, N_2O is 310 and CH_4 is 21.

Indirect Emissions: Purchased Electricity

Greenhouse Gas Inventory for MMSD in Milwaukee, WI
2001 Annual GHG Emissions

Facility	Electricity Use (MWh)[a]	CO_2 Emission Factor[b] (lb/MWh)	CO_2 Emissions (kg/year)	N_2O Emission Factor[b] (lb/MWh)	N_2O Emissions (kg/year)	CH_4 Emission Factor[b] (lb/MWh)	CH_4 Emissions (kg/year)	Total CO_2e Emissions (kg/yr)[c]	Total CO_2e Emissions (metric tons/yr)[c]
Jones Island	50,645	1537.82	35,327,586	0.0257	590	0.018	414	35519292	35,519
South Shore	13,279	1537.82	9,262,950	0.0257	155	0.018	108	9313215	9,313
Headquarters & Lab	2,797	1537.82	1,950,965	0.0257	33	0.018	23	1961552	1,962
Other Sources									
S. 13th Street	447	1537.82	311,897	0.0257	5	0.018	4	313589.7	314
Alterra Coffee Shop	14	1537.82	9,877	0.0257	0	0.018	0	9930.916	10
Pump Stations, Gate	2,341	1537.82	1,633,103	0.0257	27	0.018	19	1641965	1,642
									1,965

[a] Electricity usage data obtained from purchasing records.

[b] Emission factors are from the eGRID Sub Region Emission Rates for RFC West.

[c]CO_2 equivalents are calculated by multiplying the global warming potential (GWP) by the CO_2 emissions. and CH_4 is 21.

The GWP for CO_2 is 1, N_2O is 310.

Direct Emissions: Mobile Combustion Sources/Equipment

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2001 Annual GHG Emissions

Facility	Fuel and Mobile Source	Miles Traveled[a]	Fuel usage (gal.)[b]	CO_2 Emission Factor (kg/gal)	CO_2 Emissions (kg/year)	N_2O Emission Factor (g/mile or g/gal.)	N_2O Emissions (kg/year)	CH_4 Emission Factor (g/mile or g/gal.)	CH_4 Emissions (kg/year)	Total CO_2e Emissions (kg/yr)[f]	Total CO_2e Emissions (metric tons/yr)[f]
MMSD Cars and Light Trucks	Gasoline Passenger Cars	290,000	13,122	8.81	115,606	0.0197	6	0.178	52	118,461	118.46
Veolia Cars and Light Trucks	Gasoline Light-Duty Trucks	310,000	17,514	8.81	154,299	0.022	7	0.2024	63	157,731	157.73
Televising & Manhole Trucks	Gasoline Heavy Duty Vehicles	60,000	3,390	8.81	29,864	0.0497	3	0.4604	28	31,369	31.37
Class 8 Trucks	Diesel Heavy-Duty Vehicles	60,000	7,229	10.15	73,373	0.0048	0	0.0051	0	73,469	73.47
Light Med & Heavy Dump Trucks	Diesel Heavy-Duty Vehicles	50,000	8,450	10.15	85,768	0.0048	0	0.0051	0	85,847	85.85
Wheel loaders & Skid Loaders	Gasoline Heavy Duty Vehicles	4,500	900	8.81	7,929	0.0497	0	0.4604	2	8,042	8.04
Straddle Carriers	Gasoline Heavy Duty Vehicles	1,000	200	8.81	1,762	0.0497	0	0.4604	0	1,787	1.79
Burden Carriers & ATVs	Gas Small Utility	19,500	3,900	8.81	34,359	0.22	1	0.5	2	34,666	34.67
Tractors & Lawn Mowers	Gasoline Agricultural Equipment	7,250	1,450	8.81	12,775	0.22	0	1.26	2	12,912	12.91
Snow Blowers	Gas Small Utility	4,250	850	8.81	7,489	0.22	0	0.5	0	7,555	7.56
Diesel Generators	Diesel Construction Equipment		1,000	10.15	10,150	0.26	0	0.58	1	10,243	10.24
Gasoline Generators	Gasoline Heavy Duty Vehicles		1,000	8.81	8,810	0.0497	0	0.4604	0	8,810	8.81
Pelagos Research Vessel [c]	Gasoline Ships and Boats		1,585	8.81	13,964	0.22	0	0.64	1	14,093	14.09
ORP Research Boat [c]	Gasoline Ships and Boats		1,585	8.81	13,964	0.22	0	0.64	1	14,093	14.09
AgriLife Land Spreading [d]	Diesel Heavy-Duty Vehicles	40,000	6,760	10.15	68,614	0.0048	0	0.0051	0	68,678	68.68
Locomotive[e]	Diesel Locomotives		795	10.15	8,069	0.26	0	0.8	1	8,147	8.15
Total Mobile Sources					646,795		19		153	655,904	656

Direct Emissions: Mobile Combustion Sources/Equipment

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2001 Annual GHG Emissions

[a] Miles traveled based upon number of vehicles and estimated annual average mileage as shown below. The number of vehicles for each type based upon 2009 vehicle data provided by MMSD "Complete Vehicle and Equipment list, revised 4-09.xls".

	No. of Vehicles	Estimated Avg. Miles per Year per Vehicle	Total Miles per Year
MMSD Cars and Light Trucks:	29	10,000	290,000
Veolia Cars and Light Trucks:	62	5,000	310,000
Televising & Manhole Trucks:	12	5,000	60,000
Class 8 Trucks	12	5,000	60,000
Light Med & Heavy Dump Trucks	10	5,000	50,000
Wheel loaders & Skidloaders	9	500	4,500
Straddle Carriers	2	500	1,000
Burden Carriers & ATVs	38	500	19,000
Tractors & Lawn Mowers	27	250	6,750
Snow Blowers	16	250	4,000

[b] The following factors were used to estimate gallons of fuel consumed based on estimated miles driven per vehicle type:

Vehicle Type	Avg mpg	Source
Passenger Cars	22.1	
Other 2-axle, 4-tire vehicles	17.7	U.S. Department of Transportation Federal Highway Administration Annual Vehicle Distance Traveled in Miles and
Single unit 2-axle 6-tire or more trucks	8.3	Related Data- 2006, http://www.fhwa.dot.gov
Combination Trucks	5.9	Climate Leaders GHG Protocol, Direct Emissions from Mobile Combustion Sources, May 2008.
Other Vehicles	5.00	Assumed all other small vehicles (e.g. Loaders, Carriers, Tractors and Snow Blowers) get an average of 5 mpg

[c] Pelagos Research Vessel based upon fuel purchases in 2007, assumed ORP Research Boat fuel usage was equal to Pelagos Research Vessel fuel usage.

[d] Annual mileage based upon 2007 Agri Life sludge landspreading records.

[e] Locomotive fuel usage estimated based upon 2007 annual tons of milorganite produced, a distance of 3 miles to transport the Milorganite, and a Btu/ton-mile factor of 337 (EPA Climate Leader's Mobile Source guidance document).

[f] CO_2 equivalents are calculated by multiplying the global warming potential (GWP) by the CO_2 emissions. The GWP for CO_2 is 1, N_2O is 310 and CH_4 is 21.

Direct Emissions: Water Reclamation Facility Emissions
South Shore Water Reclamation Facility
Greenhouse Gas Inventory for MMSD in Milwaukee, WI
2001 Annual GHG Emissions

Methodology:
Calculation methodology from California Climate Action Registry (CCAR) Local Government Operations Protocol, chapter 10 on Centralized Wastewater Treatment Facilities (except for biogenic CO_2 emissions which are based upon data obtained from Metcalf and Eddy Wastewater Engineering Treatment, Disposal, and Reuse). CCAR equations use the EPA Inventory of US Greenhouse Gas Emissions and Sinks: 1990–2006, Chapter 8, 8–9 (2008) Calculation methodology to estimate biogenic CO_2 emissions from wastewater treatment processes, such as the use of aeration basins, sludge digesters and combustion of biogas may be included in the future CCAR wastewater treatment industry GHG protocol scheduled to be released in 2010).

Biogenic CO_2 from Water Reclamation Processes[a]

$$CO_2\left[\frac{metric\ tons\ CO_2}{year}\right] \equiv BOD_5Load\left[\frac{kg\ BOD_5}{day}\right]\times EF_{biogenic\ CO_2}\left[\frac{kg\ CO_2}{kg\ BOD_5}\right]\times F_{oxidation}\times 365\left[\frac{day}{year}\right]\times 10^{-3}\left[\frac{metric\ ton}{kg}\right]$$

where

Term	Description	Value	GHG Emissions (metric ton CO_2e/year)[b]	Source of Data
Biogenic CO_2	= biogenic CO_2 emissions from a centralized WWTP [metric ton CO_2/year]	**37,462**	**37,462**	
BOD_5 load	= average amount of BOD_5 produced per day [kg BOD_5/day]	64,148		Annual Discharge Monitoring Report
$EF_{biogenic\ CO2}$	= emission factor [kg CO_2/kg BOD_5]	2		Metcalf & Eddy Wastewater Engineering
$F_{oxidation}$	= factor for level of oxidation for a centralized WWTP with an anaerobic or aerobic sludge digester	0.8		Metcalf & Eddy Wastewater Engineering
365	= conversion factor [day/year]	365		Conversion factor
10^{-3}	= conversion from kg to metric ton [metric ton/kg]	1.E-03		Conversion factor

Direct Emissions: Water Reclamation Facility Emissions
South Shore Water Reclamation Facility
Greenhouse Gas Inventory for MMSD in Milwaukee, WI
2001 Annual GHG Emissions

Methane from Incomplete Combustion of Digester Gas (included with Stationary Combustion Emissions)

$$CH_4\left[\frac{metric\ tons}{year}\right] \equiv Digester\ Gas\left[\frac{ft^3}{yr}\right] \times F_{CH_4} \times \rho\left(_{CH_4}\right)\left[\frac{g}{m^3}\right] \times (1 - DE) \times 0.0283\left[\frac{m^3}{ft^3}\right] \times 10^{-6}\left[\frac{metric\ ton}{g}\right]$$

where

Term	Description	Value	GHG Emissions (metric ton CO_2e/year)	Source of Data
CH_4 incomplete combustion of digester gas	= CH_4 emissions from incomplete combustion of digester gas [metric ton CH_4/year]	**37.5**	**787**	
Digester Gas	= measured standard cubic feet of digester gas produced per day [ft^3/year]	333,278,000		Annual Emission Inventory Report
F_{CH4}	= measured fraction of CH_4 in biogas	0.6		Annual Emission Inventory Report
$\rho(CH_4)$	= density of methane at standard conditions [g/m^3]	662.00		Protocol default value.
DE	= CH_4 destruction efficiency from flaring or burning in engine	0.99		Protocol default value.
0.0283	= conversion from ft^3 to m^3 [m^3/ft^3]	0.0283		Conversion factor
10^{-6}	= conversion from g to metric ton [metric ton/g]	1.E-06		Conversion factor

Direct Emissions: Water Reclamation Facility Emissions
South Shore Water Reclamation Facility
Greenhouse Gas Inventory for MMSD in Milwaukee, WI
2001 Annual GHG Emissions

Process Emissions from Water Reclamation Processes

$$N_2O\left[\frac{metric\ tons}{year}\right] \equiv P_T\left[person\right] \times \frac{Plant\ Flow}{DISTRICT\ Flow}\left[\frac{\frac{MG}{year}}{\frac{MG}{year}}\right] \times EF_{nit/denit}\left[\frac{g\ N_2O}{person \times year}\right] \times 10^{-6}\left[\frac{metric\ ton}{g}\right]$$

where

Term	Description	Value	GHG Emissions (metric ton CO_2e/year)	Source of Data
N_2O plant	= N_2O emissions from a centralized WWTP [metric ton N_2O/year]	**1.66**	**513**	
P_P	= total population served by the WWTP, person	517,548		Population served by South Shore calculated based upon total population served times % of total annual flow treated by South Shore.
P_T	= total population served by the DISTRICT, person	1,054,627		MMSD annual financial report
Plant Flow	= plant flow [MG/year]	106.00		Annual Discharge Monitoring Report
DISTRICT Flow	= DISTRICT flow [MG/year]	216.00		Annual Discharge Monitoring Report
EF nit/denit	= emission factor for a WWTP without nitrification/denitrification [g N_2O/year]	3.2		Protocol default value for plants without nitrification/denitrification.
10^{-6}	= conversion from g to metric ton [metric ton/g]	1.E-06		Conversion factor

[a] Methodology for calculating biogenic CO_2 is not included in the CCAR Local Government Operations Protocol, but may be included in the CCAR wastewater treatment industry protocol that is scheduled to be released in 2010.

[b] CO_2 equivalents are calculated by multiplying the global warming potential (GWP) by the CO_2 emissions. The GWP for CO_2 is 1, N_2O is 310 and CH_4 is 21.

Direct Emissions: Water Reclamation Facility Emissions

Jones Island Water Reclamation Facility

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2001 Annual GHG Emissions

Methodology:

Calculation methodology from California Climate Action Registry (CCAR) Local Government Operations Protocol, chapter 10 on Centralized Wastewater Treatment Facilities (except for biogenic CO^2 emissions which are based upon data obtained from Metcalf and Eddy Wastewater Engineering Treatment, Disposal, and Reuse). CCAR equations use the EPA Inventory of US Greenhouse Gas Emissions and Sinks: 1990–2006, Chapter 8, 8–9 (2008) Calculation methodology to estimate biogenic CO2 emissions from wastewater treatment processes, such as the use of aeration basins, sludge digesters and combustion of biogas may be included in the future CCAR wastewater treatment industry GHG protocol scheduled to be released in 2010).

Biogenic CO_2 from Water Reclamation Processes[a]

$$CO_2\left[\frac{metric\ tons\ CO_2}{year}\right] \equiv BOD_5 Load\left[\frac{kg\ BOD_5}{day}\right] \times EF_{biogenic\ CO_2}\left[\frac{kg\ CO_2}{kg\ BOD_5}\right] \times F_{oxidation} \times 365\left[\frac{day}{year}\right] \times 10^{-3}\left[\frac{metric\ ton}{kg}\right]$$

where

Term	Description	Value	GHG Emissions (metric ton CO_2e/year)[b]	Source of Data
Biogenic CO_2	= biogenic CO_2 emissions from a centralized WWTP [metric ton CO_2/year]	**73,415**	**73,415**	
BOD_5 load	= average amount of BOD_5 produced per day [kg BOD_5/day]	125,711		Annual Discharge Monitoring Report
$EF_{biogenic\ CO2}$	= emission factor [kg CO_2/kg BOD_5]	2		Metcalf & Eddy Wastewater Engineering
$F_{oxidation}$	= factor for level of oxidation for a centralized WWTP with an anaerobic or aerobic sludge digester	0.8		Metcalf & Eddy Wastewater Engineering
365	= conversion factor [day/year]	365		Conversion factor
10^{-3}	= conversion from kg to metric ton [metric ton/kg]	1.E-03		Conversion factor

Direct Emissions: Water Reclamation Facility Emissions

Jones Island Water Reclamation Facility

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2001 Annual GHG Emissions

Methane from Incomplete Combustion of Digester Gas (included with Stationary Combustion Emissions)

Digester Gas is not burned at Jones Island

$$CH_4\left[\frac{metric\ tons}{year}\right] \equiv Digester\ Gas\left[\frac{ft^3}{yr}\right] \times F_{CH_4} \times \rho\left(_{CH_4}\right)\left[\frac{g}{m^3}\right] \times (1 - DE) \times 0.0283\left[\frac{m^3}{ft^3}\right] \times 10^{-6}\left[\frac{metric\ ton}{g}\right]$$

where

Term	Description	Value	GHG Emissions (metric ton CO_2e/year)	Source of Data
CH_4 incomplete combustion of digester gas	= CH_4 emissions from incomplete combustion of digester gas [metric ton CH_4/year]	**0.0**	**0**	
Digester Gas	= measured standard cubic feet of digester gas produced per day [ft^3/year]	0		Annual Emission Inventory Report
F_{CH4}	= measured fraction of CH_4 in biogas	0		Annual Emission Inventory Report
$\rho(CH_4)$	= density of methane at standard conditions [g/m^3]	662.00		Protocol default value.
DE	= CH_4 destruction efficiency from flaring or burning in engine	0.99		Protocol default value.
0.0283	= conversion from ft^3 to m^3 [m^3/ft^3]	0.0283		Conversion factor
10^{-6}	= conversion from g to metric ton [metric ton/g]	1.E-06		Conversion factor

Direct Emissions: Water Reclamation Facility Emissions

Jones Island Water Reclamation Facility

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2001 Annual GHG Emissions

Process Emissions from Water Reclamation Processes

$$N_2O\left[\frac{metric\ tons}{year}\right] \equiv P_T\left[person\right]\times\frac{Plant\ Flow}{DISTRICT\ Flow}\left[\frac{\frac{MG}{year}}{\frac{MG}{year}}\right]\times EF_{nit/denit}\left[\frac{g\ N_2O}{person\times year}\right]\times 10^{-6}\left[\frac{metric\ ton}{g}\right]$$

where

Term	Description	Value	GHG Emissions (metric ton CO_2e/year)	Source of Data
N_2O plant	= N_2O emissions from a centralized WWTP [metric ton N_2O/year]	**1.72**	**533**	
P_P	= total population served by the WWTP, person	537,079		Population served by Jones Island calculated based upon total population served times % of total annual flow treated by Jones Island.
P_T	= total population served by the DISTRICT, person	1,054,627		MMSD annual financial report
Plant Flow	= plant flow [MG/year]	110.00		Annual Discharge Monitoring Report
DISTRICT Flow	= DISTRICT flow [MG/year]	216.00		Annual Discharge Monitoring Report
EF nit/denit	= emission factor for a WWTP without nitrification/denitrification [g N_2O/year]	3.2		Protocol default value for plants without nitrification/denitrification.
10^{-6}	= conversion from g to metric ton [metric ton/g]	1.E-06		Conversion factor

Direct Emissions: Water Reclamation Facility Emissions

Jones Island Water Reclamation Facility

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2001 Annual GHG Emissions

Process Emissions from Sludge Drying

$$CH_4\left[\frac{metric\ tons}{year}\right] \equiv BSD\left[\frac{tons}{year}\right] \times EF\left[\frac{kg\,CH_4}{tonBSD}\right] \times 10^{-3}\left[\frac{metric\ ton}{kg}\right]$$

where

Term	Description	Value	GHG Emissions (metric ton CO_2e/year)	Source of Data
CH_4	= CH_4 emissions from a sludge drying [metric ton CH_4/year]	**4.19**	**88**	
BSD	= blended sludge through dryers [dry tons/year]	58,481		Air Emission Inventory Report throughput for P01
EF	= emission factor for drying sludge [kg CH_4/ton dry solids]	0.072		December 2007 JI Dryer Stack Test Data, average of 3 tests, methane from natural gas combustion from turbine waste heat is subtracted.
10^{-3}	= conversion from g to metric ton [metric ton/kg]	1.E-03		Conversion factor

[a] Methodology for calculating biogenic CO_2 is not included in the CCAR Local Government Operations Protocol, but may be included in the CCAR wastewater treatment industry protocol that is scheduled to be released in 2010.

[b] CO_2 equivalents are calculated by multiplying the global warming potential (GWP) by the CO_2 emissions. The GWP for CO_2 is 1, N_2O is 310 and CH_4 is 21.

Inventory Calculations: 2002

Non-Biogenic GHG Emissions (metric tons CO_2eq/year) by Facility and Source

Greenhouse Gas Inventory for MMSD in Milwaukee, WI
2002 Annual GHG Emissions

Facility	Stationary Combustion	Purchased Electricity	Water Reclamation Emissions	Mobile Combustion	Total	% of Total All Facilities
Jones Island (non-biogenic)	83,800	19,800	600		**104,300**	77.3%
Percentage of Jones Island	*80%*	*19%*	*1%*			
South Shore (non-biogenic)	15,300	8,500	500		**24,300**	18.0%
Percentage of South Shore	*63%*	*35%*	*2%*			
Headquarters and Laboratory	600	2,000			**2,600**	1.9%
Other Stationary Sources	1,000	2,000			**3,000**	2.2%
Mobile Sources				700	**700**	0.5%
Total All Facilities	**100,700**	**32,300**	**1,100**	**700**	**134,900**	
Percentage of Total	74.6%	23.9%	0.8%	0.5%		

Biogenic and Non-Biogenic GHG Emissions (metric tons CO_2eq/year) by Facility and Source

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2002 Annual GHG Emissions

Facility	Stationary Combustion	Purchased Electricity	Water Reclamation Emissions	Mobile Combustion	Total	% of Total All Facilities
Jones Island (non-biogenic)	83,800	19,800	600		**104,300**	42.8%
Jones Island (biogenic)			66,600		**66,600**	27.3%
Jones Island Subtotal	*83,800*	*19,800*	*67,200*		***170,900***	*70.2%*
Percentage of Jones Island	*49%*	*12%*	*39%*			
South Shore (non-biogenic)	3,600	8,500	500		**24,300**	10.0%
South Shore (biogenic)	11,800		42,100		**42,100**	17.3%
South Shore Subtotal	*15,400*	*8,500*	*42,600*		***66,400***	*27.3%*
Percentage of South Shore	*23%*	*13%*	*64%*			
Headquarters and Laboratory	600	2,000			**2,600**	1.1%
Other Stationary Sources	1,000	2,000			**3,000**	1.2%
Mobile Sources				700	**700**	0.3%
Total All Facilities	**100,800**	**32,300**	**109,800**	**700**	**243,600**	
Percentage of Total	41.4%	13.3%	45.1%	0.3%		

GHG Emissions (metric tons CO_2eq/year) by Type

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2002 Annual GHG Emissions

Scope 1: Direct Fossil Fuel Emissions	**88,995**	**metric tons CO_2eq/year**
Scope 2: Indirect Energy Emissions	**32,303**	**metric tons CO_2eq/year**
Emissions Unique to Water Reclamation Facilities	**109,784**	**metric tons CO_2eq/year**

	CO_2 Emissions	Biogenic CO_2 Emissions	CH_4 Emissions	N_2O Emissions	Total Emissions	% of Total	Total Emissions w/out Biogenic CO_2	% of Total w/out Biogenic CO_2
Stationary Combustion (Scope 1: direct emissions)	87,452	N/A	1,101.1	434.1	88,987	38.5%	88,987	72.7%
Mobile Combustion (Scope 1: direct emissions)	8	N/A	0.01	0.1	8	0.0%	8	0.0%
Purchased Electricity (Scope 2: indirect emissions)	32,129	N/A	8	166	32,303	14.0%	32,303	26.4%
Water Reclamation Emissions	0	108,735	81	1,049	109,784	47.5%	1,049	0.9%
Biogenic CO_2 emissions from water reclamation processes	N/A	108,735	N/A	N/A	108,735	47.1%	0	0.0%
N_2O emissions from water reclamation processes	N/A	N/A	N/A	1,049	1,049	0.5%	1,049	0.9%
CH_4 emissions from sludge drying	N/A	N/A	81	N/A	81	0.0%	81	0.1%
Total	**119,589**	**108,735**	**1,190**	**1,650**	**231,083**		**122,348**	**122,348**
% of Total	51.8%	47.1%	0.5%	0.7%				

Definitions (WRI Protocol terminology)

Scope 1 emissions: All direct GHG emissions, with the exception of direct CO_2 emissions from biogenic sources.

Direct emissions: Emissions from sources within the reporting entity's organizational boundaries that are owned or controlled by the reporting entity, including stationary combustion emissions, mobile combustion emissions, process emissions, and fugitive emissions.

Scope 2 emissions: Indirect GHG emissions associated with the consumption of purchased or acquired electricity, heating, cooling, or steam.

Indirect emissions: Emissions that are a consequence of activities that take place within the organizational boundaries of the reporting entity, but that occur at sources owned or controlled by another entity.

Biogenic carbon: Carbon derived from biogenic (plant or animal) sources excluding fossil carbon.

GHG Emissions (metric tons CO_2eq/year) by Facility and Type

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2002 Annual GHG Emissions

			Water Reclamation Facility Emissions w/ Biogenic CO_2					
	Stationary Combustion[a]	Purchased Electricity	Total WRF Emissions	Biogenic CO_2 Emissions[b]	Sludge Drying CH_4 Emissions[b]	Plant N_2O Emissions[b]	Total	% of Total
All Facilities								
CO_2 Emissions	87,452	32,129		N/A	N/A	N/A	**119,581**	49%
Biogenic CO_2 Emissions	11,767	N/A		108,735	N/A	N/A	**120,502**	50%
CH_4 Emissions	1,101	8		N/A	81	N/A	**1,190**	0%
N_2O Emissions	434	166		N/A	N/A	1,049	**1,650**	1%
Total CO_2e Emissions	**100,755**	**32,303**	**109,865**	**108,735**	**81**	**1,049**	**242,923**	
Percentage of Total (including biogenic emissions)	41%	13%	45%	45%	0%	0%		
Percentage of Total (not including biogenic emissions)	75%	24%		N/A	0%	1%	**134,188**	
Jones Island								
CO_2 Emissions	83,278	19,742		N/A	N/A	N/A	**103,020**	60%
Biogenic CO_2 Emissions	N/A	N/A		66,632	N/A	N/A	**66,632**	39%
CH_4 Emissions	116	4.9		N/A	81	N/A	**202**	0.1%
N_2O Emissions	416	102.3		N/A	N/A	527	**1,046**	1%
Total CO_2e Emissions	**83,811**	**19,849**	**67,240**	**66,632**	**81**	**527**	**170,900**	
Percentage of Total (including biogenic emissions)	49%	12%	39%	39%	0%	0%		
Percentage of Total (not including biogenic emissions)	80%	19%		N/A	0%	1%	**104,268**	
South Shore								
CO_2 Emissions	2,559	8,455		N/A	N/A	N/A	**11,014**	17%
Biogenic CO_2 Emissions	11,767	N/A		42,103	N/A	N/A	**53,870**	81%
CH_4 Emissions	984	2.1		N/A	N/A	N/A	**986**	1%
N_2O Emissions	16	43.8		N/A	N/A	522	**582**	1%
Total CO_2e Emissions	**15,326**	**8,501**	**42,625**	**42,103**	N/A	**522**	**66,452**	
Percentage of Total (including biogenic emissions)	23%	13%	64%	63%	N/A	1%		
Percentage of Total (not including biogenic emissions)	63%	35%		N/A	N/A	2%	**24,349**	
Headquarters & Lab								
CO_2 Emissions	632	1,934		N/A	N/A	N/A	**2,566**	99.6%
Biogenic CO_2 Emissions	N/A	N/A		N/A	N/A	N/A	**N/A**	0%
CH_4 Emissions	0.3	0.48		N/A	N/A	N/A	**1**	0.0%
N_2O Emissions	0.4	10.02		N/A	N/A	N/A	**10**	0.4%
Total CO_2 Emissions	**633**	**1,945**	N/A	N/A	N/A	N/A	**2,577**	
Percentage of Total	25%	75%						
Other Sources[c]								
CO_2 Emissions	983	1,997		N/A	N/A	N/A	**2,980**	99.6%
Biogenic CO_2 Emissions	N/A	N/A		N/A	N/A	N/A	**N/A**	0%
CH_4 Emissions	0	0.49		N/A	N/A	N/A	**1**	0.0%
N_2O Emissions	1	10.35		N/A	N/A	N/A	**12**	0.4%
Total CO_2 Emissions	**985**	**2,008**	N/A	N/A	N/A	N/A	**2,993**	
Percentage of Total	33%	67%						

[a] Include methane emissions from incomplete combustion of biogas for South Shore.

[b] Emissions from water reclamation processes.

[c] Other sources include: 13th street, Alterra, and the Interceptor Pumping Stations.

Direct Emissions: Stationary Combustion Sources

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2002 Annual GHG Emissions

Facility/Emission Sources	Fuel/Emission Source Type	Energy Use (MMBTU/yr)[a]	Fuel Use (1000 gal/yr)[a]	CO_2 Emission Factor (kg/MMBtu)	CO_2 Emissions (kg/year)[b]	N_2O Emission Factor (g/MMBtu or lb/1000 gal)[c]	N_2O Emissions (kg/year)	CH_4 Emission Factor (g/MMBtu or lb/1000 gal)[c]	CH_4 Emissions (kg/year)	Total CO_2e Emissions (kg/yr)[d]	Total CO_2e Emissions (metric tons/yr)[d]
Jones Island											
Rotary Sludge Dryers	Stationary Natural Gas - Boilers or Dryers	67,471		53.06	3,580,011	0.9	61	0.9	61	**3,600,111**	3,600
(2) 16MW Turbines	Stationary Natural Gas - Turbines	1,409,893		53.06	74,808,923	0.9	1,269	3.8	5,358	**75,314,792**	75,315
(2) 16MW Turbines	Stationary Distillate Fuel Oil (#1, 2, &4)	19,237		73.15	1,407,187	0.3	6	3	58	**1,410,188**	1,410
(2) Cleaver Brooks Boilers	Stationary Natural Gas - Boilers or Dryers	1,515		53.06	80,386	0.9	1	0.9	1	**80,837**	81
(2) Cleaver Brooks Boilers	Stationary Distillate Fuel Oil (#1, 2, &4)	21		73.15	1,536	0.3	0	3	0	**1,539**	2
Facility Space Heaters & Boilers <5 mmbtu/hr	Stationary Natural Gas - Default	63,977		53.06	3,394,620	0.1	6	1	64	**3,397,946**	3,398
Facility Space Heaters & Boilers <5 mmbtu/hr	Stationary Propane	84	1.8	63.07	5,306	0.9	0	0.2	0	**5,306**	5
					83,277,968		1,343		5,541	**83,810,720**	**83,811**

Direct Emissions: Stationary Combustion Sources

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2002 Annual GHG Emissions

Facility/Emission Sources	Fuel/Emission Source Type	Energy Use (MMBTU/yr)[a]	Fuel Use (1000 gal/yr)[a]	CO_2 Emission Factor (kg/MMBtu)	CO_2 Emissions (kg/year)[b]	N_2O Emission Factor (g/MMBtu or lb/1000 gal)[c]	N_2O Emissions (kg/year)	CH_4 Emission Factor (g/MMBtu or lb/1000 gal)[c]	CH_4 Emissions (kg/year)	Total CO_2e Emissions (kg/yr)[d]	Total CO_2e Emissions (metric tons/yr)[d]
South Shore											
Facility Space Heaters & Boilers <5 mmbtu/hr	Stationary Natural Gas - Boilers or Dryers	29,973		53.06	1,590,367	0.9	27	0.9	27	**1,599,296**	1,599
Boilers - (3) Kewaunee, (2) Scum, (2) Cleaver Brooks	Stationary Natural Gas - Boilers or Dryers	73		53.06	3,873	0.9	0	0.9	0	**3,895**	4
IC Engine Generators (5)	Stationary Natural Gas - Default	18,178		53.06	964,525	0.1	2	1	18	**965,470**	965
Boilers - (3) Kewaunee, (2) Cleaver Brooks [b]	Stationary Wastewater Treatment Biogas	13,555		52.07	*705,821*	0.1	1	0.9	12	**706,498**	706
IC Engine Generators (5)[b]	Stationary Wastewater	208,486		52.07	*10,855,891*	0.1	21	0.9	188	**10,866,294**	10,866
Flares[b]	Stationary Wastewater	3,951		52.07	*205,742*	0.1	0	0.9	4	**205,939**	206
					14,326,219		51		249	**14,347,392**	**14,347**
Headquarters & Lab											
Building Heat	Stationary Natural Gas - Default	11,916		53.06	632,242	0.1	1	1	12	**632,861**	633
Other Sources											
S. 13th Street Boilers	Stationary Natural Gas - Boilers or Dryers	3,505		53.06	185,965	0.9	3	0.9	3	**187,009**	187
Alterra Building Heat	Stationary Natural Gas - Default	280		53.06	14,841	0.1	0	1	0	**14,855**	15
Pump Stations, etc.	Stationary Natural Gas - Default	14,740		53.06	782,120	0.1	1	1	15	**782,887**	783
					982,926		5		18		**985**
All Facilities					99,219,355		1,400		5,820		**99,776**

[a] Energy/fuel usage data obtained from purchasing records and annual air emission inventory reports.

[b] CO_2 emissions from wastewater treatment biogas are considered biogenic and not reported as scope 1 emissions.

[c] CH_4 and N_2O emission factors for propane are in lb/1000 gal.

[d] CO_2 equivalents are calculated by multiplying the global warming potential (GWP) by the CO_2 emissions. The GWP for CO_2 is 1, N_2O is 310 and CH_4 is 21.

Indirect Emissions: Purchased Electricity

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2002 Annual GHG Emissions

Facility	Electricity Use (MWh)[a]	CO_2 Emission Factor[b] (lb/MWh)	CO_2 Emissions (kg/year)	N_2O Emission Factor[b] (lb/MWh)	N_2O Emissions (kg/year)	CH_4 Emission Factor[b] (lb/MWh)	CH_4 Emissions (kg/year)	Total CO_2e Emissions (kg/yr)[c]	Total CO_2e Emissions (metric tons/yr)[c]
Jones Island	28,302	1537.82	19,742,346	0.0257	330	0.018	231	19849477.8	19,849
South Shore	12,122	1537.82	8,455,405	0.0257	141	0.018	99	8501288.01	8,501
Headquarters & Lab	2,773	1537.82	1,934,140	0.0257	32	0.018	23	1944635.97	1,945
Other Sources									
S. 13th Street	508	1537.82	354,202	0.0257	6	0.018	4	356123.613	356
Alterra Coffee Shop	14	1537.82	9,877	0.0257	0	0.018	0	9930.91554	10
Pump Stations, Gate	2,341	1537.82	1,633,103	0.0257	27	0.018	19	1641964.67	1,642
									2,008

[a] Electricity usage data obtained from purchasing records.

[b] Emission factors are from the eGRID Sub Region Emission Rates for RFC West.

[c]CO_2 equivalents are calculated by multiplying the global warming potential (GWP) by the CO_2 emissions. and CH_4 is 21.

The GWP for CO_2 is 1, N_2O is 310

Direct Emissions: Mobile Combustion Sources/Equipment

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2002 Annual GHG Emissions

Facility	Fuel and Mobile Source	Miles Traveled[a]	Fuel usage (gal.)[b]	CO_2 Emission Factor (kg/gal)	CO_2 Emissions (kg/year)	N_2O Emission Factor (g/mile or g/gal.)	N_2O Emissions (kg/year)	CH_4 Emission Factor (g/mile or g/gal.)	CH_4 Emissions (kg/year)	Total CO_2e Emissions (kg/yr)[f]	Total CO_2e Emissions (metric tons/yr)[f]
MMSD Cars and Light Trucks	Gasoline Passenger Cars	290,000	13,122	8.81	115,606	0.0197	6	0.178	52	118,461	118.46
Veolia Cars and Light Trucks	Gasoline Light-Duty Trucks	310,000	17,514	8.81	154,299	0.022	7	0.2024	63	157,731	157.73
Televising & Manhole Trucks	Gasoline Heavy Duty Vehicles	60,000	3,390	8.81	29,864	0.0497	3	0.4604	28	31,369	31.37
Class 8 Trucks	Diesel Heavy-Duty Vehicles	60,000	7,229	10.15	73,373	0.0048	0	0.0051	0	73,469	73.47
Light Med & Heavy Dump Trucks	Diesel Heavy-Duty Vehicles	50,000	8,450	10.15	85,768	0.0048	0	0.0051	0	85,847	85.85
Wheel loaders & Skid Loaders	Gasoline Heavy Duty Vehicles	4,500	900	8.81	7,929	0.0497	0	0.4604	2	8,042	8.04
Straddle Carriers	Gasoline Heavy Duty Vehicles	1,000	200	8.81	1,762	0.0497	0	0.4604	0	1,787	1.79
Burden Carriers & ATVs	Gas Small Utility	19,500	3,900	8.81	34,359	0.22	1	0.5	2	34,666	34.67
Tractors & Lawn Mowers	Gasoline Agricultural Equipment	7,250	1,450	8.81	12,775	0.22	0	1.26	2	12,912	12.91
Snow Blowers	Gas Small Utility	4,250	850	8.81	7,489	0.22	0	0.5	0	7,555	7.56
Diesel Generators	Diesel Construction Equipment		1,000	10.15	10,150	0.26	0	0.58	1	10,243	10.24
Gasoline Generators	Gasoline Heavy Duty Vehicles		1,000	8.81	8,810	0.0497	0	0.4604	0	8,810	8.81
Pelagos Research Vessel [c]	Gasoline Ships and Boats		1,585	8.81	13,964	0.22	0	0.64	1	14,093	14.09
ORP Research Boat [c]	Gasoline Ships and Boats		1,585	8.81	13,964	0.22	0	0.64	1	14,093	14.09
AgriLife Land Spreading [d]	Diesel Heavy-Duty Vehicles	40,000	6,760	10.15	68,614	0.0048	0	0.0051	0	68,678	68.68
Locomotive[e]	Diesel Locomotives		795	10.15	8,069	0.26	0	0.8	1	8,147	8.15
Total Mobile Sources					646,795		19		153	655,904	656

Direct Emissions: Mobile Combustion Sources/Equipment

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2002 Annual GHG Emissions

[a] Miles traveled based upon number of vehicles and estimated annual average mileage as shown below. The number of vehicles for each type based upon 2009 vehicle data provided by MMSD "Complete Vehicle and Equipment list, revised 4-09.xls".

	No. of Vehicles	Estimated Avg. Miles per Year per Vehicle	Total Miles per Year
MMSD Cars and Light Trucks:	29	10,000	290,000
Veolia Cars and Light Trucks:	62	5,000	310,000
Televising & Manhole Trucks:	12	5,000	60,000
Class 8 Trucks	12	5,000	60,000
Light Med & Heavy Dump Trucks	10	5,000	50,000
Wheel loaders & Skidloaders	9	500	4,500
Straddle Carriers	2	500	1,000
Burden Carriers & ATVs	38	500	19,000
Tractors & Lawn Mowers	27	250	6,750
Snow Blowers	16	250	4,000

[b] The following factors were used to estimate gallons of fuel consumed based on estimated miles driven per vehicle type:

Vehicle Type	Avg mpg	Source
Passenger Cars	22.1	
Other 2-axle, 4-tire vehicles	17.7	U.S. Department of Transportation Federal Highway Administration Annual Vehicle Distance Traveled in Miles and
Single unit 2-axle 6-tire or more trucks	8.3	Related Data- 2006, http://www.fhwa.dot.gov
Combination Trucks	5.9	Climate Leaders GHG Protocol, Direct Emissions from Mobile Combustion Sources, May 2008.
Other Vehicles	5.00	Assumed all other small vehicles (e.g. Loaders, Carriers, Tractors and Snow Blowers) get an average of 5 mpg

[c] Pelagos Research Vessel based upon fuel purchases in 2007, assumed ORP Research Boat fuel usage was equal to Pelagos Research Vessel fuel usage.

[d] Annual mileage based upon 2007 Agri Life sludge landspreading records.

[e] Locomotive fuel usage estimated based upon 2007 annual tons of milorganite produced, a distance of 3 miles to transport the Milorganite, and a Btu/ton-mile factor of 337 (EPA Climate Leader's Mobile Source guidance document).

[f] CO_2 equivalents are calculated by multiplying the global warming potential (GWP) by the CO_2 emissions. The GWP for CO_2 is 1, N_2O is 310 and CH_4 is 21.

Direct Emissions: Water Reclamation Facility Emissions
South Shore Water Reclamation Facility
Greenhouse Gas Inventory for MMSD in Milwaukee, WI
2002 Annual GHG Emissions

Methodology:
Calculation methodology from California Climate Action Registry (CCAR) Local Government Operations Protocol, chapter 10 on Centralized Wastewater Treatment Facilities (except for biogenic CO_2 emissions which are based upon data obtained from Metcalf and Eddy Wastewater Engineering Treatment, Disposal, and Reuse). CCAR equations use the EPA Inventory of US Greenhouse Gas Emissions and Sinks: 1990–2006, Chapter 8, 8–9 (2008) Calculation methodology to estimate biogenic CO_2 emissions from wastewater treatment processes, such as the use of aeration basins, sludge digesters and combustion of biogas may be included in the future CCAR wastewater treatment industry GHG protocol scheduled to be released in 2010).

Biogenic CO_2 from Water Reclamation Processes[a]

$$CO_2\left[\frac{metric\ tons\ CO_2}{year}\right] \equiv BOD_5 Load\left[\frac{kg\ BOD_5}{day}\right] \times EF_{biogenic\ CO_2}\left[\frac{kg\ CO_2}{kg\ BOD_5}\right] \times F_{oxidation} \times 365\left[\frac{day}{year}\right] \times 10^{-3}\left[\frac{metric\ ton}{kg}\right]$$

where

Term	Description	Value	GHG Emissions (metric ton CO_2e/year)[b]	Source of Data
Biogenic CO_2	= biogenic CO_2 emissions from a centralized WWTP [metric ton CO_2/year]	**42,103**	**42,103**	
BOD_5 load	= average amount of BOD_5 produced per day [kg BOD_5/day]	72,094		Annual Discharge Monitoring Report
$EF_{biogenic\ CO2}$	= emission factor [kg CO_2/kg BOD_5]	2		Metcalf & Eddy Wastewater Engineering
$F_{oxidation}$	= factor for level of oxidation for a centralized WWTP with an anaerobic or aerobic sludge digester	0.8		Metcalf & Eddy Wastewater Engineering
365	= conversion factor [day/year]	365		Conversion factor
10^{-3}	= conversion from kg to metric ton [metric ton/kg]	1.E-03		Conversion factor

Direct Emissions: Water Reclamation Facility Emissions
South Shore Water Reclamation Facility
Greenhouse Gas Inventory for MMSD in Milwaukee, WI
2002 Annual GHG Emissions

Methane from Incomplete Combustion of Digester Gas (included with Stationary Combustion Emissions)

$$CH_4\left[\frac{metric\ tons}{year}\right] \equiv Digester\ Gas\left[\frac{ft^3}{yr}\right] \times F_{CH_4} \times \rho\left(_{CH_4}\right)\left[\frac{g}{m^3}\right] \times (1-DE) \times 0.0283\left[\frac{m^3}{ft^3}\right] \times 10^{-6}\left[\frac{metric\ ton}{g}\right]$$

where

Term	Description	Value	GHG Emissions (metric ton CO_2e/year)	Source of Data
CH_4 incomplete combustion of digester gas	= CH_4 emissions from incomplete combustion of digester gas [metric ton CH_4/year]	**46.6**	**979**	
Digester Gas	= measured standard cubic feet of digester gas produced per day [ft^3/year]	414,666,000		Annual Emission Inventory Report
F_{CH4}	= measured fraction of CH_4 in biogas	0.6		Annual Emission Inventory Report
$\rho(CH_4)$	= density of methane at standard conditions [g/m^3]	662.00		Protocol default value.
DE	= CH_4 destruction efficiency from flaring or burning in engine	0.99		Protocol default value.
0.0283	= conversion from ft^3 to m^3 [m^3/ft^3]	0.0283		Conversion factor
10^{-6}	= conversion from g to metric ton [metric ton/g]	1.E-06		Conversion factor

Direct Emissions: Water Reclamation Facility Emissions
South Shore Water Reclamation Facility
Greenhouse Gas Inventory for MMSD in Milwaukee, WI
2002 Annual GHG Emissions

Process Emissions from Water Reclamation Processes

$$N_2O\left[\frac{metric\ tons}{year}\right] \equiv P_T\left[person\right] \times \frac{Plant\ Flow}{DISTRICT\ Flow}\left[\frac{\frac{MG}{year}}{\frac{MG}{year}}\right] \times EF_{nit/denit}\left[\frac{g\ N_2O}{person \times year}\right] \times 10^{-6}\left[\frac{metric\ ton}{g}\right]$$

where

Term	Description	Value	GHG Emissions (metric ton CO_2e/year)	Source of Data
N_2O plant	= N_2O emissions from a centralized WWTP [metric ton N_2O/year]	**1.68**	**522**	
P_P	= total population served by the WWTP, person	525,963		Population served by South Shore calculated based upon total population served times % of total annual flow treated by South Shore.
P_T	= total population served by the DISTRICT, person	1,057,404		MMSD annual financial report
Plant Flow	= plant flow [MG/year]	96		Annual Discharge Monitoring Report
DISTRICT Flow	= DISTRICT flow [MG/year]	193		Annual Discharge Monitoring Report
EF nit/denit	= emission factor for a WWTP without nitrification/denitrification [g N_2O/year]	3.2		Protocol default value for plants without nitrification/denitrification.
10^{-6}	= conversion from g to metric ton [metric ton/g]	1.E-06		Conversion factor

[a] Methodology for calculating biogenic CO_2 is not included in the CCAR Local Government Operations Protocol, but may be included in the CCAR wastewater treatment industry protocol that is scheduled to be released in 2010.

[b] CO_2 equivalents are calculated by multiplying the global warming potential (GWP) by the CO_2 emissions. The GWP for CO_2 is 1, N_2O is 310 and CH_4 is 21.

Direct Emissions: Water Reclamation Facility Emissions

Jones Island Water Reclamation Facility

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2002 Annual GHG Emissions

Methodology:

Calculation methodology from California Climate Action Registry (CCAR) Local Government Operations Protocol, chapter 10 on Centralized Wastewater Treatment Facilities (except for biogenic CO^2 emissions which are based upon data obtained from Metcalf and Eddy Wastewater Engineering Treatment, Disposal, and Reuse). CCAR equations use the EPA Inventory of US Greenhouse Gas Emissions and Sinks: 1990–2006, Chapter 8, 8–9 (2008) Calculation methodology to estimate biogenic CO2 emissions from wastewater treatment processes, such as the use of aeration basins, sludge digesters and combustion of biogas may be included in the future CCAR wastewater treatment industry GHG protocol scheduled to be released in 2010).

Biogenic CO_2 from Water Reclamation Processes[a]

$$CO_2\left[\frac{metric\ tons\ CO_2}{year}\right] \equiv BOD_5 Load\left[\frac{kg\ BOD_5}{day}\right] \times EF_{biogenic\ CO_2}\left[\frac{kg\ CO_2}{kg\ BOD_5}\right] \times F_{oxidation} \times 365\left[\frac{day}{year}\right] \times 10^{-3}\left[\frac{metric\ ton}{kg}\right]$$

where

Term	Description	Value	GHG Emissions (metric ton CO_2e/year)[b]	Source of Data
Biogenic CO_2	= biogenic CO_2 emissions from a centralized WWTP [metric ton CO_2/year]	**66,632**	**66,632**	
BOD_5 load	= average amount of BOD_5 produced per day [kg BOD_5/day]	114,096		Annual Discharge Monitoring Report
$EF_{biogenic\ CO2}$	= emission factor [kg CO_2/kg BOD_5]	2		Metcalf & Eddy Wastewater Engineering
$F_{oxidation}$	= factor for level of oxidation for a centralized WWTP with an anaerobic or aerobic sludge digester	0.8		Metcalf & Eddy Wastewater Engineering
365	= conversion factor [day/year]	365		Conversion factor
10^{-3}	= conversion from kg to metric ton [metric ton/kg]	1.E-03		Conversion factor

Direct Emissions: Water Reclamation Facility Emissions

Jones Island Water Reclamation Facility

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2002 Annual GHG Emissions

Methane from Incomplete Combustion of Digester Gas (included with Stationary Combustion Emissions)

Digester Gas is not burned at Jones Island

$$CH_4\left[\frac{metric\ tons}{year}\right] \equiv Digester\ Gas\left[\frac{ft^3}{yr}\right] \times F_{CH_4} \times \rho\left(_{CH_4}\right)\left[\frac{g}{m^3}\right] \times (1-DE) \times 0.0283\left[\frac{m^3}{ft^3}\right] \times 10^{-6}\left[\frac{metric\ ton}{g}\right]$$

where

Term	Description	Value	GHG Emissions (metric ton CO_2e/year)	Source of Data
CH_4 incomplete combustion of digester gas	= CH_4 emissions from incomplete combustion of digester gas [metric ton CH_4/year]	**0.0**	**0**	
Digester Gas	= measured standard cubic feet of digester gas produced per day [ft^3/year]	0		Annual Emission Inventory Report
F_{CH4}	= measured fraction of CH_4 in biogas	0		Annual Emission Inventory Report
$\rho(CH_4)$	= density of methane at standard conditions [g/m^3]	662.00		Protocol default value.
DE	= CH_4 destruction efficiency from flaring or burning in engine	0.99		Protocol default value.
0.0283	= conversion from ft^3 to m^3 [m^3/ft^3]	0.0283		Conversion factor
10^{-6}	= conversion from g to metric ton [metric ton/g]	1.E-06		Conversion factor

Direct Emissions: Water Reclamation Facility Emissions

Jones Island Water Reclamation Facility

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2002 Annual GHG Emissions

Process Emissions from Water Reclamation Processes

$$N_2O\left[\frac{metric\ tons}{year}\right] \equiv P_T\left[person\right] \times \frac{Plant\ Flow}{DISTRICT\ Flow}\left[\frac{\frac{MG}{year}}{\frac{MG}{year}}\right] \times EF_{nit/denit}\left[\frac{g\ N_2O}{person \times year}\right] \times 10^{-6}\left[\frac{metric\ ton}{g}\right]$$

where

Term	Description	Value	GHG Emissions (metric ton CO_2e/year)	Source of Data
N_2O plant	= N_2O emissions from a centralized WWTP [metric ton N_2O/year]	**1.70**	**527**	
P_P	= total population served by the WWTP, person	531,441		Population served by Jones Island calculated based upon total population served times % of total annual flow treated by Jones Island.
P_T	= total population served by the DISTRICT, person	1,057,404		MMSD annual financial report
Plant Flow	= plant flow [MG/year]	97		Annual Discharge Monitoring Report
DISTRICT Flow	= DISTRICT flow [MG/year]	193		Annual Discharge Monitoring Report
EF nit/denit	= emission factor for a WWTP without nitrification/denitrification [g N_2O/year]	3.2		Protocol default value for plants without nitrification/denitrification.
10^{-6}	= conversion from g to metric ton [metric ton/g]	1.E-06		Conversion factor

Direct Emissions: Water Reclamation Facility Emissions

Jones Island Water Reclamation Facility

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2002 Annual GHG Emissions

Process Emissions from Sludge Drying

$$CH_4\left[\frac{metric\ tons}{year}\right] \equiv BSD\left[\frac{tons}{year}\right] \times EF\left[\frac{kg\, CH_4}{tonBSD}\right] \times 10^{-3}\left[\frac{metric\ ton}{kg}\right]$$

where

Term	Description	Value	GHG Emissions (metric ton CO_2e/year)	Source of Data
CH_4	= CH_4 emissions from a sludge drying [metric ton CH_4/year]	**3.86**	**81**	
BSD	= blended sludge through dryers [dry tons/year]	53,911		Air Emission Inventory Report throughput for P01
EF	= emission factor for drying sludge [kg CH_4/ton dry solids]	0.072		December 2007 JI Dryer Stack Test Data, average of 3 tests, methane from natural gas combustion from turbine waste heat is subtracted.
10^{-3}	= conversion from g to metric ton [metric ton/kg]	1.E-03		Conversion factor

[a] Methodology for calculating biogenic CO_2 is not included in the CCAR Local Government Operations Protocol, but may be included in the CCAR wastewater treatment industry protocol that is scheduled to be released in 2010.

[b] CO_2 equivalents are calculated by multiplying the global warming potential (GWP) by the CO_2 emissions. The GWP for CO_2 is 1, N_2O is 310 and CH_4 is 21.

Inventory Calculations: 2003

Non-Biogenic GHG Emissions (metric tons CO_2eq/year) by Facility and Source

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2003 Annual GHG Emissions

Facility	Stationary Combustion	Purchased Electricity	Water Reclamation Emissions	Mobile Combustion	Total	% of Total All Facilities
Jones Island (non-biogenic)	89,700	24,100	600		**114,400**	77.6%
Percentage of Jones Island	*78%*	*21%*	*1%*			
South Shore (non-biogenic)	16,000	10,500	500		**27,100**	18.4%
Percentage of South Shore	*59%*	*39%*	*2%*			
Headquarters and Laboratory	700	1,900			**2,500**	1.7%
Other Stationary Sources	1,200	1,600			**2,800**	1.9%
Mobile Sources				700	**700**	0.5%
Total All Facilities	**107,600**	**38,100**	**1,100**	**700**	**147,500**	
Percentage of Total	72.9%	25.8%	0.7%	0.5%		

Biogenic and Non-Biogenic GHG Emissions (metric tons CO_2eq/year) by Facility and Source

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2003 Annual GHG Emissions

Facility	Stationary Combustion	Purchased Electricity	Water Reclamation Emissions	Mobile Combustion	Total	% of Total All Facilities
Jones Island (non-biogenic)	89,700	24,100	600		**114,400**	42.5%
Jones Island (biogenic)			65,200		**65,200**	24.2%
Jones Island Subtotal	*89,700*	*24,100*	*65,800*		***179,600***	*66.8%*
Percentage of Jones Island	*50%*	*13%*	*37%*			
South Shore (non-biogenic)	3,700	10,500	500		**27,100**	10.1%
South Shore (biogenic)	12,300		44,000		**56,300**	20.9%
South Shore Subtotal	*16,000*	*10,500*	*44,500*		***83,400***	*31.0%*
Percentage of South Shore	*19%*	*13%*	*53%*			
Headquarters and Laboratory	700	1,900			**2,500**	0.9%
Other Stationary Sources	1,200	1,600			**2,800**	1.0%
Mobile Sources				700	**700**	0.3%
Total All Facilities	**107,600**	**38,100**	**110,300**	**700**	**269,000**	
Percentage of Total	40.0%	14.2%	41.0%	0.3%		

GHG Emissions (metric tons CO_2eq/year) by Type

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2003 Annual GHG Emissions

Scope 1: Direct Fossil Fuel Emissions	**95,214**	**metric tons CO_2eq/year**
Scope 2: Indirect Energy Emissions	**38,029**	**metric tons CO_2eq/year**
Emissions Unique to Water Reclamation Facilities	**110,331**	**metric tons CO_2eq/year**

	CO_2 Emissions	Biogenic CO_2 Emissions	CH_4 Emissions	N_2O Emissions	Total Emissions	% of Total	Total Emissions w/out Biogenic CO_2	% of Total w/out Biogenic CO_2
Stationary Combustion (Scope 1: direct emissions)	93,577	N/A	1,162.0	467.0	95,206	39.1%	95,206	70.9%
Mobile Combustion (Scope 1: direct emissions)	8	N/A	0.01	0.1	8	0.0%	8	0.0%
Purchased Electricity (Scope 2: indirect emissions)	37,824	N/A	9	196	38,029	15.6%	38,029	28.3%
Water Reclamation Emissions	0	109,281	80	1,050	110,331	45.3%	1,050	0.8%
Biogenic CO_2 emissions from water reclamation processes	N/A	109,281	N/A	N/A	109,281	44.9%	0	0.0%
N_2O emissions from water reclamation processes	N/A	N/A	N/A	1,050	1,050	0.4%	1,050	0.8%
CH_4 emissions from sludge drying	N/A	N/A	80	N/A	80	0.0%	80	0.1%
Total	**131,408**	**109,281**	**1,251**	**1,713**	**243,574**		**134,293**	**134,293**
% of Total	54.0%	44.9%	0.5%	0.7%				

Definitions (WRI Protocol terminology)

Scope 1 emissions: All direct GHG emissions, with the exception of direct CO_2 emissions from biogenic sources.

Direct emissions: Emissions from sources within the reporting entity's organizational boundaries that are owned or controlled by the reporting entity, including stationary combustion emissions, mobile combustion emissions, process emissions, and fugitive emissions.

Scope 2 emissions: Indirect GHG emissions associated with the consumption of purchased or acquired electricity, heating, cooling, or steam.

Indirect emissions: Emissions that are a consequence of activities that take place within the organizational boundaries of the reporting entity, but that occur at sources owned or controlled by another entity.

Biogenic carbon: Carbon derived from biogenic (plant or animal) sources excluding fossil carbon.

GHG Emissions (metric tons CO_2eq/year) by Facility and Type

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2003 Annual GHG Emissions

			Water Reclamation Facility Emissions w/ Biogenic CO_2					
	Stationary Combustion[a]	Purchased Electricity	Total WRF Emissions	Biogenic CO_2 Emissions[b]	Sludge Drying CH_4 Emissions[b]	Plant N_2O Emissions[b]	Total	% of Total
All Facilities								
CO_2 Emissions	93,577	37,824		N/A	N/A	N/A	**131,400**	51%
Biogenic CO_2 Emissions	12,326	N/A		109,281	N/A	N/A	**121,607**	48%
CH_4 Emissions	1,162	9		N/A	80	N/A	**1,251**	0%
N_2O Emissions	467	196		N/A	N/A	1,050	**1,713**	1%
Total CO_2e Emissions	**107,531**	**38,029**	**110,411**	**109,281**	**80**	**1,050**	**255,971**	
Percentage of Total (including biogenic emissions)	42%	15%	43%	43%	0%	0.4%		
Percentage of Total (not including biogenic emissions)	73%	26%		N/A	0%	1%	**146,690**	
Jones Island								
CO_2 Emissions	89,147	23,949		N/A	N/A	N/A	**113,096**	63%
Biogenic CO_2 Emissions	N/A	N/A		65,268	N/A	N/A	**65,268**	36%
CH_4 Emissions	119	5.9		N/A	80	N/A	**205**	0.1%
N_2O Emissions	449	124.1		N/A	N/A	513	**1,086**	1%
Total CO_2e Emissions	**89,716**	**24,079**	**65,861**	**65,268**	**80**	**513**	**179,655**	
Percentage of Total (including biogenic emissions)	50%	13%	37%	36%	0%	0.3%		
Percentage of Total (not including biogenic emissions)	78%	21%		N/A	0%	0%	**114,387**	
South Shore								
CO_2 Emissions	2,604	10,474		N/A	N/A	N/A	**13,077**	18%
Biogenic CO_2 Emissions	12,326	N/A		44,013	N/A	N/A	**56,338**	79%
CH_4 Emissions	1,042	2.6		N/A	N/A	N/A	**1,045**	1%
N_2O Emissions	16	54.3		N/A	N/A	537	**607**	1%
Total CO_2e Emissions	**15,987**	**10,530**	**44,550**	**44,013**	N/A	**537**	**71,067**	
Percentage of Total (including biogenic emissions)	22%	15%	63%	62%	N/A	1%		
Percentage of Total (not including biogenic emissions)	59%	39%		N/A	N/A	2%	**27,055**	
Headquarters & Lab								
CO_2 Emissions	653	1,830		N/A	N/A	N/A	**2,483**	99.6%
Biogenic CO_2 Emissions	N/A	N/A		N/A	N/A	N/A	**N/A**	0%
CH_4 Emissions	0.3	0.45		N/A	N/A	N/A	**1**	0.0%
N_2O Emissions	0.4	9.48		N/A	N/A	N/A	**10**	0.4%
Total CO_2 Emissions	**654**	**1,840**	N/A	N/A	N/A	N/A	**2,494**	
Percentage of Total	26%	74%						
Other Sources[c]								
CO_2 Emissions	1,173	1,571		N/A	N/A	N/A	**2,744**	99.6%
Biogenic CO_2 Emissions	N/A	N/A		N/A	N/A	N/A	**N/A**	0%
CH_4 Emissions	0	0.39		N/A	N/A	N/A	**1**	0.0%
N_2O Emissions	2	8.14		N/A	N/A	N/A	**10**	0.4%
Total CO_2 Emissions	**1,175**	**1,580**	N/A	N/A	N/A	N/A	**2,755**	
Percentage of Total	43%	57%						

[a] Include methane emissions from incomplete combustion of biogas for South Shore.

[b] Emissions from water reclamation processes.

[c] Other sources include: 13th street, Alterra, and the Interceptor Pumping Stations.

Direct Emissions: Stationary Combustion Sources
Greenhouse Gas Inventory for MMSD in Milwaukee, WI
2003 Annual GHG Emissions

Facility/Emission Sources	Fuel/Emission Source Type	Energy Use (MMBTU/yr)[a]	Fuel Use (1000 gal/yr)[a]	CO_2 Emission Factor (kg/MMBtu)	CO_2 Emissions (kg/year)[b]	N_2O Emission Factor (g/MMBtu or lb/1000 gal)[c]	N_2O Emissions (kg/year)	CH4 Emission Factor (g/MMBtu or lb/1000 gal)[b]	CH_4 Emission Factor (g/MMBtu or lb/1000 gal)[c]	Total CO_2e Emissions (kg/yr)[c]	Total CO_2e Emissions (metric tons/yr)[c]
Jones Island											
Rotary Sludge Dryers	Stationary Natural Gas - Boilers or Dryers	163,446		53.06	8,672,445	0.9	147	0.9	147	**8,721,135**	8,721
(2) 16MW Turbines	Stationary Natural Gas - Turbines	1,427,583		53.06	75,747,554	0.9	1,285	3.8	5,425	**76,259,771**	76,260
(2) 16MW Turbines	Stationary Distillate Fuel Oil (#1, 2, &4)	8,433		73.15	616,874	0.3	3	3	25	**618,189**	618
(2) Cleaver Brooks Boilers	Stationary Natural Gas - Boilers or Dryers	9,701		53.06	514,735	0.9	9	0.9	9	**517,625**	518
(2) Cleaver Brooks Boilers	Stationary Distillate Fuel Oil (#1, 2, &4)	54		73.15	3,950	0.3	0	3	0	**3,959**	4
Facility Space Heaters & Boilers <5 mmbtu/hr	Stationary Natural Gas - Default	67,565		53.06	3,584,999	0.1	7	1	68	**3,588,512**	3,589
Facility Space Heaters & Boilers <5 mmbtu/hr	Stationary Propane	100.9	1.8	63.07	6,364	0.9	0	0.2	0	**6,364**	6
					89,146,920		1,450		5,674	**89,715,555**	**89,716**

Direct Emissions: Stationary Combustion Sources
Greenhouse Gas Inventory for MMSD in Milwaukee, WI
2003 Annual GHG Emissions

Facility/Emission Sources	Fuel/Emission Source Type	Energy Use (MMBTU/yr)[a]	Fuel Use (1000 gal/yr)[a]	CO_2 Emission Factor (kg/MMBtu)	CO_2 Emissions (kg/year)[b]	N_2O Emission Factor (g/MMBtu or lb/1000 gal)[c]	N_2O Emissions (kg/year)	CH4 Emission Factor (g/MMBtu or lb/1000 gal)[b]	CH_4 Emission Factor (g/MMBtu or lb/1000 gal)[c]	Total CO_2e Emissions (kg/yr)[c]	Total CO_2e Emissions (metric tons/yr)[c]
South Shore											
Facility Space Heaters & Boilers <5 mmbtu/hr	Stationary Natural Gas - Boilers or Dryers	21,481		53.06	1,139,782	0.9	19	0.9	19	**1,146,181**	1,146
Boilers - (3) Kewaunee, (2) Scum, (2) Cleaver Brooks	Stationary Natural Gas - Boilers or Dryers	5,566		53.06	295,332	0.9	5	0.9	5	**296,990**	297
IC Engine Generators (5)	Stationary Natural Gas - Default	22,022		53.06	1,168,487	0.1	2	1	22	**1,169,632**	1,170
Boilers - (3) Kewaunee, (2) Cleaver Brooks [b]	Stationary Wastewater Treatment Biogas	21,263		52.07	*1,107,165*	0.1	2	0.9	19	**1,108,226**	1,108
IC Engine Generators (5)[b]	Stationary Wastewater	158,925		52.07	*8,275,237*	0.1	16	0.9	143	**8,283,167**	8,283
Flares[b]	Stationary Wastewater	56,525		52.07	*2,943,253*	0.1	6	0.9	51	**2,946,074**	2,946
					14,929,256		50		259	**14,950,270**	**14,950**
Headquarters & Lab											
Building Heat	Stationary Natural Gas - Default	12,306		53.06	652,978	0.1	1	1	12	**653,618**	654
Other Sources											
S. 13th Street Boilers	Stationary Natural Gas - Boilers or Dryers	3,496		53.06	185,477	0.9	3	0.9	3	**186,518**	187
Alterra Building Heat	Stationary Natural Gas - Default	1		53.06	27	0.1	0	1	0	**27**	0
Pump Stations, etc.	Stationary Natural Gas - Default	18,612		53.06	987,574	0.1	2	1	19	**988,542**	989
					1,173,077		5		22		**1,175**
All Facilities					105,902,231		1,506		5,967		**106,495**

[a] Energy/fuel usage data obtained from purchasing records and annual air emission inventory reports.

[b] CO_2 emissions from wastewater treatment biogas are considered biogenic and not reported as scope 1 emissions.

[c] CH_4 and N_2O emission factors for propane are in lb/1000 gal.

[d] CO_2 equivalents are calculated by multiplying the global warming potential (GWP) by the CO_2 emissions. The GWP for CO_2 is 1, N_2O is 310 and CH_4 is 21.

Indirect Emissions: Purchased Electricity

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2003 Annual GHG Emissions

Facility	Electricity Use (MWh)[a]	CO_2 Emission Factor[b] (lb/MWh)	CO_2 Emissions (kg/year)	N_2O Emission Factor[b] (lb/MWh)	N_2O Emissions (kg/year)	CH_4 Emission Factor[b] (lb/MWh)	CH_4 Emissions (kg/year)	Total CO_2e Emissions (kg/yr)[c]	Total CO_2e Emissions (metric tons/yr)[c]
Jones Island	34,333	1537.82	23,948,712	0.0257	400	0.018	280	24078670	24,079
South Shore	15,015	1537.82	10,473,557	0.0257	175	0.018	123	10530392	10,530
Headquarters & Lab	2,624	1537.82	1,830,261	0.0257	31	0.018	21	1840193	1,840
Other Sources									
S. 13th Street	491	1537.82	342,163	0.0257	6	0.018	4	344019.3	344
Alterra Coffee Shop	13	1537.82	9,208	0.0257	0	0.018	0	9257.633	9
Pump Stations, Gate	2,239	1537.82	1,561,858	0.0257	26	0.018	18	1570334	1,570
									1,924

[a] Electricity usage data obtained from purchasing records.

[b] Emission factors are from the eGRID Sub Region Emission Rates for RFC West.

[c]CO_2 equivalents are calculated by multiplying the global warming potential (GWP) by the CO_2 emissions. and CH_4 is 21.

The GWP for CO_2 is 1, N_2O is 310

Direct Emissions: Mobile Combustion Sources/Equipment

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2003 Annual GHG Emissions

Facility	Fuel and Mobile Source	Miles Traveled[a]	Fuel usage (gal.)[b]	CO_2 Emission Factor (kg/gal)	CO_2 Emissions (kg/year)	N_2O Emission Factor (g/mile or g/gal.)	N_2O Emissions (kg/year)	CH_4 Emission Factor (g/mile or g/gal.)	CH_4 Emissions (kg/year)	Total CO_2e Emissions (kg/yr)[f]	Total CO_2e Emissions (metric tons/yr)[f]
MMSD Cars and Light Trucks	Gasoline Passenger Cars	290,000	13,122	8.81	115,606	0.0197	6	0.178	52	118,461	118.46
Veolia Cars and Light Trucks	Gasoline Light-Duty Trucks	310,000	17,514	8.81	154,299	0.022	7	0.2024	63	157,731	157.73
Televising & Manhole Trucks	Gasoline Heavy Duty Vehicles	60,000	3,390	8.81	29,864	0.0497	3	0.4604	28	31,369	31.37
Class 8 Trucks	Diesel Heavy-Duty Vehicles	60,000	7,229	10.15	73,373	0.0048	0	0.0051	0	73,469	73.47
Light Med & Heavy Dump Trucks	Diesel Heavy-Duty Vehicles	50,000	8,450	10.15	85,768	0.0048	0	0.0051	0	85,847	85.85
Wheel loaders & Skid Loaders	Gasoline Heavy Duty Vehicles	4,500	900	8.81	7,929	0.0497	0	0.4604	2	8,042	8.04
Straddle Carriers	Gasoline Heavy Duty Vehicles	1,000	200	8.81	1,762	0.0497	0	0.4604	0	1,787	1.79
Burden Carriers & ATVs	Gas Small Utility	19,500	3,900	8.81	34,359	0.22	1	0.5	2	34,666	34.67
Tractors & Lawn Mowers	Gasoline Agricultural Equipment	7,250	1,450	8.81	12,775	0.22	0	1.26	2	12,912	12.91
Snow Blowers	Gas Small Utility	4,250	850	8.81	7,489	0.22	0	0.5	0	7,555	7.56
Diesel Generators	Diesel Construction Equipment		1,000	10.15	10,150	0.26	0	0.58	1	10,243	10.24
Gasoline Generators	Gasoline Heavy Duty Vehicles		1,000	8.81	8,810	0.0497	0	0.4604	0	8,810	8.81
Pelagos Research Vessel [c]	Gasoline Ships and Boats		1,585	8.81	13,964	0.22	0	0.64	1	14,093	14.09
ORP Research Boat [c]	Gasoline Ships and Boats		1,585	8.81	13,964	0.22	0	0.64	1	14,093	14.09
AgriLife Land Spreading [d]	Diesel Heavy-Duty Vehicles	40,000	6,760	10.15	68,614	0.0048	0	0.0051	0	68,678	68.68
Locomotive[e]	Diesel Locomotives		795	10.15	8,069	0.26	0	0.8	1	8,147	8.15
Total Mobile Sources					646,795		19		153	655,904	656

Direct Emissions: Mobile Combustion Sources/Equipment

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2003 Annual GHG Emissions

[a] Miles traveled based upon number of vehicles and estimated annual average mileage as shown below. The number of vehicles for each type based upon 2009 vehicle data provided by MMSD "Complete Vehicle and Equipment list, revised 4-09.xls".

	No. of Vehicles	Estimated Avg. Miles per Year per Vehicle	Total Miles per Year
MMSD Cars and Light Trucks:	29	10,000	290,000
Veolia Cars and Light Trucks:	62	5,000	310,000
Televising & Manhole Trucks:	12	5,000	60,000
Class 8 Trucks	12	5,000	60,000
Light Med & Heavy Dump Trucks	10	5,000	50,000
Wheel loaders & Skidloaders	9	500	4,500
Straddle Carriers	2	500	1,000
Burden Carriers & ATVs	38	500	19,000
Tractors & Lawn Mowers	27	250	6,750
Snow Blowers	16	250	4,000

[b] The following factors were used to estimate gallons of fuel consumed based on estimated miles driven per vehicle type:

Vehicle Type	Avg mpg	Source
Passenger Cars	22.1	
Other 2-axle, 4-tire vehicles	17.7	U.S. Department of Transportation Federal Highway Administration Annual Vehicle Distance Traveled in Miles and
Single unit 2-axle 6-tire or more trucks	8.3	Related Data- 2006, http://www.fhwa.dot.gov
Combination Trucks	5.9	Climate Leaders GHG Protocol, Direct Emissions from Mobile Combustion Sources, May 2008.
Other Vehicles	5.00	Assumed all other small vehicles (e.g. Loaders, Carriers, Tractors and Snow Blowers) get an average of 5 mpg

[c] Pelagos Research Vessel based upon fuel purchases in 2007, assumed ORP Research Boat fuel usage was equal to Pelagos Research Vessel fuel usage.

[d] Annual mileage based upon 2007 Agri Life sludge landspreading records.

[e] Locomotive fuel usage estimated based upon 2007 annual tons of milorganite produced, a distance of 3 miles to transport the Milorganite, and a Btu/ton-mile factor of 337 (EPA Climate Leader's Mobile Source guidance document).

[f] CO_2 equivalents are calculated by multiplying the global warming potential (GWP) by the CO_2 emissions. The GWP for CO_2 is 1, N_2O is 310 and CH_4 is 21.

Direct Emissions: Water Reclamation Facility Emissions
South Shore Water Reclamation Facility
Greenhouse Gas Inventory for MMSD in Milwaukee, WI
2003 Annual GHG Emissions

Methodology:
Calculation methodology from California Climate Action Registry (CCAR) Local Government Operations Protocol, chapter 10 on Centralized Wastewater Treatment Facilities (except for biogenic CO_2 emissions which are based upon data obtained from Metcalf and Eddy Wastewater Engineering Treatment, Disposal, and Reuse). CCAR equations use the EPA Inventory of US Greenhouse Gas Emissions and Sinks: 1990–2006, Chapter 8, 8–9 (2008) Calculation methodology to estimate biogenic CO_2 emissions from wastewater treatment processes, such as the use of aeration basins, sludge digesters and combustion of biogas may be included in the future CCAR wastewater treatment industry GHG protocol scheduled to be released in 2010).

Biogenic CO_2 from Water Reclamation Processes[a]

$$CO_2\left[\frac{metric\ tons\ CO_2}{year}\right] \equiv BOD_5 Load\left[\frac{kg\ BOD_5}{day}\right] \times EF_{biogenic\ CO_2}\left[\frac{kg\ CO_2}{kg\ BOD_5}\right] \times F_{oxidation} \times 365\left[\frac{day}{year}\right] \times 10^{-3}\left[\frac{metric\ ton}{kg}\right]$$

where

Term	Description	Value	GHG Emissions (metric ton CO_2e/year)[b]	Source of Data
Biogenic CO_2	= biogenic CO_2 emissions from a centralized WWTP [metric ton CO_2/year]	**44,013**	**44,013**	
BOD_5 load	= average amount of BOD_5 produced per day [kg BOD_5/day]	75,364		Annual Discharge Monitoring Report
$EF_{biogenic\ CO2}$	= emission factor [kg CO_2/kg BOD_5]	2		Metcalf & Eddy Wastewater Engineering
$F_{oxidation}$	= factor for level of oxidation for a centralized WWTP with an anaerobic or aerobic sludge digester	0.8		Metcalf & Eddy Wastewater Engineering
365	= conversion factor [day/year]	365		Conversion factor
10^{-3}	= conversion from kg to metric ton [metric ton/kg]	1.E-03		Conversion factor

Direct Emissions: Water Reclamation Facility Emissions
South Shore Water Reclamation Facility
Greenhouse Gas Inventory for MMSD in Milwaukee, WI
2003 Annual GHG Emissions

Methane from Incomplete Combustion of Digester Gas (included with Stationary Combustion Emissions)

$$CH_4\left[\frac{metric\ tons}{year}\right] \equiv Digester\ Gas\left[\frac{ft^3}{yr}\right]\times F_{CH_4}\times \rho\left(_{CH_4}\right)\left[\frac{g}{m^3}\right]\times(1-DE)\times 0.0283\left[\frac{m^3}{ft^3}\right]\times 10^{-6}\left[\frac{metric\ ton}{g}\right]$$

where

Term	Description	Value	GHG Emissions (metric ton CO_2e/year)	Source of Data
CH_4 incomplete combustion of digester gas	= CH_4 emissions from incomplete combustion of digester gas [metric ton CH_4/year]	**49.4**	**1037**	
Digester Gas	= measured standard cubic feet of digester gas produced per day [ft^3/year]	439,171,000		Annual Emission Inventory Report
F_{CH4}	= measured fraction of CH_4 in biogas	0.6		Annual Emission Inventory Report
$\rho(CH_4)$	= density of methane at standard conditions [g/m^3]	662.00		Protocol default value.
DE	= CH_4 destruction efficiency from flaring or burning in engine	0.99		Protocol default value.
0.0283	= conversion from ft^3 to m^3 [m^3/ft^3]	0.0283		Conversion factor
10^{-6}	= conversion from g to metric ton [metric ton/g]	1.E-06		Conversion factor

Direct Emissions: Water Reclamation Facility Emissions
South Shore Water Reclamation Facility
Greenhouse Gas Inventory for MMSD in Milwaukee, WI
2003 Annual GHG Emissions

Process Emissions from Water Reclamation Processes

$$N_2O\left[\frac{metric\ tons}{year}\right] \equiv P_T\left[person\right] \times \frac{Plant\ Flow}{DISTRICT\ Flow}\left[\frac{\frac{MG}{year}}{\frac{MG}{year}}\right] \times EF_{nit/denit}\left[\frac{g\ N_2O}{person \times year}\right] \times 10^{-6}\left[\frac{metric\ ton}{g}\right]$$

where

Term	Description	Value	GHG Emissions (metric ton CO_2e/year)	Source of Data
N_2O plant	= N_2O emissions from a centralized WWTP [metric ton N_2O/year]	**1.73**	**537**	
P_P	= total population served by the WWTP, person	541,827		Population served by South Shore calculated based upon total population served times % of total annual flow treated by South Shore.
P_T	= total population served by the DISTRICT, person	1,058,742		MMSD annual financial report
Plant Flow	= plant flow [MG/year]	87		Annual Discharge Monitoring Report
DISTRICT Flow	= DISTRICT flow [MG/year]	170		Annual Discharge Monitoring Report
EF nit/denit	= emission factor for a WWTP without nitrification/denitrification [g N_2O/year]	3.2		Protocol default value for plants without nitrification/denitrification.
10^{-6}	= conversion from g to metric ton [metric ton/g]	1.E-06		Conversion factor

[a] Methodology for calculating biogenic CO_2 is not included in the CCAR Local Government Operations Protocol, but may be included in the CCAR wastewater treatment industry protocol that is scheduled to be released in 2010.
[b] CO_2 equivalents are calculated by multiplying the global warming potential (GWP) by the CO_2 emissions. The GWP for CO_2 is 1, N_2O is 310 and CH_4 is 21.

Direct Emissions: Water Reclamation Facility Emissions

Jones Island Water Reclamation Facility

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2003 Annual GHG Emissions

Methodology:

Calculation methodology from California Climate Action Registry (CCAR) Local Government Operations Protocol, chapter 10 on Centralized Wastewater Treatment Facilities (except for biogenic CO^2 emissions which are based upon data obtained from Metcalf and Eddy Wastewater Engineering Treatment, Disposal, and Reuse). CCAR equations use the EPA Inventory of US Greenhouse Gas Emissions and Sinks: 1990–2006, Chapter 8, 8–9 (2008) Calculation methodology to estimate biogenic CO2 emissions from wastewater treatment processes, such as the use of aeration basins, sludge digesters and combustion of biogas may be included in the future CCAR wastewater treatment industry GHG protocol scheduled to be released in 2010).

Biogenic CO_2 from Water Reclamation Processes[a]

$$CO_2\left[\frac{metric\ tons\ CO_2}{year}\right] \equiv BOD_5 Load\left[\frac{kg\ BOD_5}{day}\right] \times EF_{biogenic\ CO_2}\left[\frac{kg\ CO_2}{kg\ BOD_5}\right] \times F_{oxidation} \times 365\left[\frac{day}{year}\right] \times 10^{-3}\left[\frac{metric\ ton}{kg}\right]$$

where

Term	Description	Value	GHG Emissions (metric ton CO_2e/year)[b]	Source of Data
Biogenic CO_2	= biogenic CO_2 emissions from a centralized WWTP [metric ton CO_2/year]	**65,268**	**65,268**	
BOD_5 load	= average amount of BOD_5 produced per day [kg BOD_5/day]	111,761		Annual Discharge Monitoring Report
$EF_{biogenic\ CO2}$	= emission factor [kg CO_2/kg BOD_5]	2		Metcalf & Eddy Wastewater Engineering
$F_{oxidation}$	= factor for level of oxidation for a centralized WWTP with an anaerobic or aerobic sludge digester	0.8		Metcalf & Eddy Wastewater Engineering
365	= conversion factor [day/year]	365		Conversion factor
10^{-3}	= conversion from kg to metric ton [metric ton/kg]	1.E-03		Conversion factor

Direct Emissions: Water Reclamation Facility Emissions

Jones Island Water Reclamation Facility

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2003 Annual GHG Emissions

Methane from Incomplete Combustion of Digester Gas (included with Stationary Combustion Emissions)

Digester Gas is not burned at Jones Island

$$CH_4\left[\frac{metric\ tons}{year}\right] \equiv Digester\ Gas\left[\frac{ft^3}{yr}\right] \times F_{CH_4} \times \rho\left(_{CH_4}\right)\left[\frac{g}{m^3}\right] \times (1 - DE) \times 0.0283\left[\frac{m^3}{ft^3}\right] \times 10^{-6}\left[\frac{metric\ ton}{g}\right]$$

where

Term	Description	Value	GHG Emissions (metric ton CO_2e/year)	Source of Data
CH_4 incomplete combustion of digester gas	= CH_4 emissions from incomplete combustion of digester gas [metric ton CH_4/year]	**0.0**	**0**	
Digester Gas	= measured standard cubic feet of digester gas produced per day [ft^3/year]	0		Annual Emission Inventory Report
F_{CH4}	= measured fraction of CH_4 in biogas	0		Annual Emission Inventory Report
$\rho(CH_4)$	= density of methane at standard conditions [g/m^3]	662.00		Protocol default value.
DE	= CH_4 destruction efficiency from flaring or burning in engine	0.99		Protocol default value.
0.0283	= conversion from ft^3 to m^3 [m^3/ft^3]	0.0283		Conversion factor
10^{-6}	= conversion from g to metric ton [metric ton/g]	1.E-06		Conversion factor

Direct Emissions: Water Reclamation Facility Emissions

Jones Island Water Reclamation Facility

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2003 Annual GHG Emissions

Process Emissions from Water Reclamation Processes

$$N_2O\left[\frac{metric\ tons}{year}\right] \equiv P_T\left[person\right] \times \frac{Plant\ Flow}{DISTRICT\ Flow}\left[\frac{\frac{MG}{year}}{\frac{MG}{year}}\right] \times EF_{nit/denit}\left[\frac{g\ N_2O}{person \times year}\right] \times 10^{-6}\left[\frac{metric\ ton}{g}\right]$$

where

Term	Description	Value	GHG Emissions (metric ton CO_2e/year)	Source of Data
N_2O plant	= N_2O emissions from a centralized WWTP [metric ton N_2O/year]	**1.65**	**513**	
P_P	= total population served by the WWTP, person	516,915		Population served by Jones Island calculated based upon total population served times % of total annual flow treated by Jones Island.
P_T	= total population served by the DISTRICT, person	1,058,742		MMSD annual financial report
Plant Flow	= plant flow [MG/year]	83		Annual Discharge Monitoring Report
DISTRICT Flow	= DISTRICT flow [MG/year]	170		Annual Discharge Monitoring Report
EF nit/denit	= emission factor for a WWTP without nitrification/denitrification [g N_2O/year]	3.2		Protocol default value for plants without nitrification/denitrification.
10^{-6}	= conversion from g to metric ton [metric ton/g]	1.E-06		Conversion factor

Direct Emissions: Water Reclamation Facility Emissions

Jones Island Water Reclamation Facility

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2003 Annual GHG Emissions

Process Emissions from Sludge Drying

$$CH_4\left[\frac{metric\ tons}{year}\right] \equiv BSD\left[\frac{tons}{year}\right] \times EF\left[\frac{kg\,CH_4}{tonBSD}\right] \times 10^{-3}\left[\frac{metric\ ton}{kg}\right]$$

where

Term	Description	Value	GHG Emissions (metric ton CO_2e/year)	Source of Data
CH_4	= CH_4 emissions from a sludge drying [metric ton CH_4/year]	**3.81**	**80**	
BSD	= blended sludge through dryers [dry tons/year]	53,237		Air Emission Inventory Report throughput for P01
EF	= emission factor for drying sludge [kg CH_4/ton dry solids]	0.072		December 2007 JI Dryer Stack Test Data, average of 3 tests, methane from natural gas combustion from turbine waste heat is subtracted.
10^{-3}	= conversion from g to metric ton [metric ton/kg]	1.E-03		Conversion factor

[a] Methodology for calculating biogenic CO_2 is not included in the CCAR Local Government Operations Protocol, but may be included in the CCAR wastewater treatment industry protocol that is scheduled to be released in 2010.

[b] CO_2 equivalents are calculated by multiplying the global warming potential (GWP) by the CO_2 emissions. The GWP for CO_2 is 1, N_2O is 310 and CH_4 is 21.

Inventory Calculations: 2004

Non-Biogenic GHG Emissions (metric tons CO_2eq/year) by Facility and Source

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2004 Annual GHG Emissions

Facility	Stationary Combustion	Purchased Electricity	Water Reclamation Emissions	Mobile Combustion	Total	% of Total All Facilities
Jones Island (non-biogenic)	84,400	21,000	600		**106,000**	76.1%
Percentage of Jones Island	*80%*	*20%*	*1%*			
South Shore (non-biogenic)	15,900	10,400	600		**26,900**	19.3%
Percentage of South Shore	*59%*	*39%*	*2%*			
Headquarters and Laboratory	600	1,900			**2,500**	1.8%
Other Stationary Sources	1,100	2,000			**3,100**	2.2%
Mobile Sources				700	**700**	0.5%
Total All Facilities	**102,000**	**35,300**	**1,200**	**700**	**139,200**	
Percentage of Total	73.3%	25.4%	0.9%	0.5%		

Biogenic and Non-Biogenic GHG Emissions (metric tons CO_2eq/year) by Facility and Source

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2004 Annual GHG Emissions

Facility	Stationary Combustion	Purchased Electricity	Water Reclamation Emissions	Mobile Combustion	Total	% of Total All Facilities
Jones Island (non-biogenic)	84,400	21,000	600		**106,000**	44.9%
Jones Island (biogenic)			64,000		**64,000**	27.1%
Jones Island Subtotal	*84,400*	*21,000*	*64,600*		***170,000***	*72.0%*
Percentage of Jones Island	*50%*	*12%*	*38%*			
South Shore (non-biogenic)	3,700	10,400	600		**14,700**	6.2%
South Shore (biogenic)	12,200		45,000		**45,000**	19.1%
South Shore Subtotal	*15,900*	*10,400*	*45,600*		***59,700***	*25.3%*
Percentage of South Shore	*27%*	*17%*	*76%*			
Headquarters and Laboratory	600	1,900			**2,500**	1.1%
Other Stationary Sources	1,100	2,000			**3,100**	1.3%
Mobile Sources				700	**700**	0.3%
Total All Facilities	**102,000**	**35,300**	**110,200**	**700**	**236,000**	
Percentage of Total	43.2%	15.0%	46.7%	0.3%		

GHG Emissions (metric tons CO_2eq/year) by Type

Greenhouse Gas Inventory for MMSD in Milwaukee, WI
2004 Annual GHG Emissions

Scope 1: Direct Fossil Fuel Emissions	**89,857**	**metric tons CO_2eq/year**
Scope 2: Indirect Energy Emissions	**35,273**	**metric tons CO_2eq/year**
Emissions Unique to Water Reclamation Facilities	**110,112**	**metric tons CO_2eq/year**

	CO_2 Emissions	Biogenic CO_2 Emissions	CH_4 Emissions	N_2O Emissions	Total Emissions	% of Total	Total Emissions w/out Biogenic CO_2	% of Total w/out Biogenic CO_2
Stationary Combustion (Scope 1: direct emissions)	88,263	N/A	1,145.0	440.9	89,849	38.2%	89,849	71.2%
Mobile Combustion (Scope 1: direct emissions)	8	N/A	0.01	0.1	8	0.0%	8	0.0%
Purchased Electricity (Scope 2: indirect emissions)	35,082	N/A	9	182	35,273	15.0%	35,273	28.0%
Water Reclamation Emissions	0	109,062	83	1,050	110,112	46.8%	1,050	0.8%
Biogenic CO_2 emissions from water reclamation processes	N/A	109,062	N/A	N/A	109,062	46.4%	0	0.0%
N_2O emissions from water reclamation processes	N/A	N/A	N/A	1,050	1,050	0.4%	1,050	0.8%
CH_4 emissions from sludge drying	N/A	N/A	83	N/A	83	0.0%	83	0.1%
Total	**123,353**	**109,062**	**1,236**	**1,673**	**235,241**		**126,179**	**126,179**
% of Total	52.4%	46.4%	0.5%	0.7%				

Definitions (WRI Protocol terminology)

Scope 1 emissions: All direct GHG emissions, with the exception of direct CO_2 emissions from biogenic sources.

Direct emissions: Emissions from sources within the reporting entity's organizational boundaries that are owned or controlled by the reporting entity, including stationary combustion emissions, mobile combustion emissions, process emissions, and fugitive emissions.

Scope 2 emissions: Indirect GHG emissions associated with the consumption of purchased or acquired electricity, heating, cooling, or steam.

Indirect emissions: Emissions that are a consequence of activities that take place within the organizational boundaries of the reporting entity, but that occur at sources owned or controlled by another entity.

Biogenic carbon: Carbon derived from biogenic (plant or animal) sources excluding fossil carbon.

GHG Emissions (metric tons CO_2eq/year) by Facility and Type

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2004 Annual GHG Emissions

	Stationary Combustion[a]	Purchased Electricity	Water Reclamation Facility Emissions w/ Biogenic CO_2				Total	% of Total
			Total WRF Emissions	Biogenic CO_2 Emissions[b]	Sludge Drying CH_4 Emissions	Plant N_2O Emissions[b]		
All Facilities								
CO_2 Emissions	88,263	35,082		N/A	N/A	N/A	**123,345**	50%
Biogenic CO_2 Emissions	12,174	N/A		109,062	N/A	N/A	**121,236**	49%
CH_4 Emissions	1,145	9		N/A	83	N/A	**1,236**	0%
N_2O Emissions	441	182		N/A	N/A	1,050	**1,673**	1%
Total CO_2e Emissions	**102,022**	**35,273**	**110,195**	**109,062**	**83**	**1,050**	**247,490**	
Percentage of Total (including biogenic emissions)	41%	14%	45%	44%	0%	0%		
Percentage of Total (not including biogenic emissions)	74%	25%		N/A	0%	1%	**138,428**	
Jones Island								
CO_2 Emissions	83,871	20,877		N/A	N/A	N/A	**104,749**	62%
Biogenic CO_2 Emissions	N/A	N/A		64,046	N/A	N/A	**64,046**	38%
CH_4 Emissions	121	5.1		N/A	83	N/A	**208**	0.1%
N_2O Emissions	424	108.2		N/A	N/A	479	**1,011**	1%
Total CO_2e Emissions	**84,416**	**20,991**	**64,607**	**64,046**	**83**	**479**	**170,014**	
Percentage of Total (including biogenic emissions)	50%	12%	38%	38%	0%	0%		
Percentage of Total (not including biogenic emissions)	80%	20%		N/A	0%	0%	**105,968**	
South Shore								
CO_2 Emissions	2,667	10,317		N/A	N/A	N/A	**12,984**	18%
Biogenic CO_2 Emissions	12,174	N/A		45,016	N/A	N/A	**57,190**	80%
CH_4 Emissions	1,024	2.5		N/A	N/A	N/A	**1,026**	1%
N_2O Emissions	15	53.4		N/A	N/A	571	**640**	1%
Total CO_2e Emissions	**15,879**	**10,373**	**45,588**	**45,016**	N/A	**571**	**71,840**	
Percentage of Total (including biogenic emissions)	22%	14%	63%	63%	N/A	1%		
Percentage of Total (not including biogenic emissions)	59%	39%		N/A	N/A	2%	**26,823**	
Headquarters & Lab								
CO_2 Emissions	630	1,851		N/A	N/A	N/A	**2,482**	99.6%
Biogenic CO_2 Emissions	N/A	N/A		N/A	N/A	N/A	**N/A**	0%
CH_4 Emissions	0.2	0.46		N/A	N/A	N/A	**1**	0.0%
N_2O Emissions	0.4	9.59		N/A	N/A	N/A	**10**	0.4%
Total CO_2 Emissions	**631**	**1,861**	N/A	N/A	N/A	N/A	**2,492**	
Percentage of Total	25%	75%						
Other Sources[c]								
CO_2 Emissions	1,094	2,037		N/A	N/A	N/A	**3,131**	99.6%
Biogenic CO_2 Emissions	N/A	N/A		N/A	N/A	N/A	**N/A**	0%
CH_4 Emissions	0	0.50		N/A	N/A	N/A	**1**	0.0%
N_2O Emissions	1	10.55		N/A	N/A	N/A	**12**	0.4%
Total CO_2 Emissions	**1,096**	**2,048**	N/A	N/A	N/A	N/A	**3,144**	
Percentage of Total	35%	65%						

[a] Include methane emissions from incomplete combustion of biogas for South Shore.

[b] Emissions from water reclamation processes.

[c] Other sources include: 13th street, Alterra, and the Interceptor Pumping Stations.

Direct Emissions: Stationary Combustion Sources
Greenhouse Gas Inventory for MMSD in Milwaukee, WI
2004 Annual GHG Emissions

Facility/Emission Sources	Fuel/Emission Source Type	Energy Use (MMBTU/yr)[a]	Fuel Use (1000 gal/yr)[a]	CO_2 Emission Factor (kg/MMBtu)	CO_2 Emissions (kg/year)[b]	N_2O Emission Factor (g/MMBtu or lb/1000 gal)[c]	N_2O Emissions (kg/year)	CH_4 Emission Factor (g/MMBtu or lb/1000 gal)[c]	CH_4 Emissions (kg/year)	Total CO_2e Emissions (kg/yr)[d]	Total CO_2e Emissions (metric tons/yr)[d]
Jones Island											
Rotary Sludge Dryers	Stationary Natural Gas - Boilers or Dryers	16,892		53.06	896,290	0.9	15	0.9	15	**901,322**	901
(2) 16MW Turbines	Stationary Natural Gas - Turbines	1,487,854		53.06	78,945,533	0.9	1,339	3.8	5,654	**79,479,375**	79,479
(2) 16MW Turbines	Stationary Distillate Fuel Oil (#1, 2, &4)	0		73.15	0	0.3	0	3	0	**-**	-
(2) Cleaver Brooks Boilers	Stationary Natural Gas - Boilers or Dryers	7,740		53.06	410,684	0.9	7	0.9	7	**412,990**	413
(2) Cleaver Brooks Boilers	Stationary Distillate Fuel Oil (#1, 2, &4)	62		73.15	4,535	0.3	0	3	0	**4,545**	5
Facility Space Heaters & Boilers <5 mmbtu/hr	Stationary Natural Gas - Default	68,018		53.06	3,609,035	0.1	7	1	68	**3,612,572**	3,613
Facility Space Heaters & Boilers <5 mmbtu/hr	Stationary Propane	84.1	1.8	63.07	5,306	0.9	0	0.2	0	**5,306**	5
					83,871,384		1,368		5,744	**84,416,110**	**84,416**

Direct Emissions: Stationary Combustion Sources

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2004 Annual GHG Emissions

Facility/Emission Sources	Fuel/Emission Source Type	Energy Use (MMBTU/yr)[a]	Fuel Use (1000 gal/yr)[a]	CO_2 Emission Factor (kg/MMBtu)	CO_2 Emissions (kg/year)[b]	N_2O Emission Factor (g/MMBtu or lb/1000 gal)[c]	N_2O Emissions (kg/year)	CH_4 Emission Factor (g/MMBtu or lb/1000 gal)[c]	CH_4 Emissions (kg/year)	Total CO_2e Emissions (kg/yr)[d]	Total CO_2e Emissions (metric tons/yr)[d]
South Shore											
Facility Space Heaters & Boilers <5 mmbtu/hr	Stationary Natural Gas - Boilers or Dryers	19,369		53.06	1,027,719	0.9	17	0.9	17	**1,033,489**	1,033
Boilers - (3) Kewaunee, (2) Scum, (2) Cleaver Brooks	Stationary Natural Gas - Boilers or Dryers	5,957		53.06	316,078	0.9	5	0.9	5	**317,853**	318
IC Engine Generators (5)	Stationary Natural Gas - Default	24,935		53.06	1,323,051	0.1	2	1	25	**1,324,348**	1,324
Boilers - (3) Kewaunee, (2) Cleaver Brooks[b]	Stationary Wastewater Treatment Biogas	15,224		52.07	*792,711*	0.1	2	0.9	14	**793,471**	793
IC Engine Generators (5)[b]	Stationary Wastewater	150,356		52.07	*7,829,049*	0.1	15	0.9	135	**7,836,552**	7,837
Flares[b]	Stationary Wastewater	68,212		52.07	*3,551,793*	0.1	7	0.9	61	**3,555,197**	3,555
					14,840,402		49		258	**14,860,910**	**14,861**
Headquarters & Lab											
Building Heat	Stationary Natural Gas - Default	11,878		53.06	630,225	0.1	1	1	12	**630,843**	631
Other Sources											
S. 13th Street Boilers	Stationary Natural Gas - Boilers or Dryers	2,980		53.06	158,124	0.9	3	0.9	3	**159,012**	159
Alterra Building Heat	Stationary Natural Gas - Default	0		53.06	16	0.1	0	1	0	**16**	0
Pump Stations, etc.	Stationary Natural Gas - Default	17,643		53.06	936,143	0.1	2	1	18	**937,060**	937
					1,094,283		4		20		**1,096**
All Facilities					100,436,294		1,422		6,035		**101,004**

[a] Energy/fuel usage data obtained from purchasing records and annual air emission inventory reports.

[b] CO_2 emissions from wastewater treatment biogas are considered biogenic and not reported as scope 1 emissions.

[c] CH_4 and N_2O emission factors for propane are in lb/1000 gal.

[d] CO_2 equivalents are calculated by multiplying the global warming potential (GWP) by the CO_2 emissions. The GWP for CO_2 is 1, N_2O is 310 and CH_4 is 21.

Indirect Emissions: Purchased Electricity

Greenhouse Gas Inventory for MMSD in Milwaukee, WI
2004 Annual GHG Emissions

Facility	Electricity Use (MWh)[a]	CO_2 Emission Factor[b] (lb/MWh)	CO_2 Emissions (kg/year)	N_2O Emission Factor[b] (lb/MWh)	N_2O Emissions (kg/year)	CH_4 Emission Factor[b] (lb/MWh)	CH_4 Emissions (kg/year)	Total CO_2e Emissions (kg/yr)[c]	Total CO_2e Emissions (metric tons/yr)[c]
Jones Island	29,929	1537.82	20,877,216	0.0257	349	0.018	244	20990506	20,991
South Shore	14,790	1537.82	10,316,693	0.0257	172	0.018	121	10372676	10,373
Headquarters & Lab	2,654	1537.82	1,851,299	0.0257	31	0.018	22	1861345	1,861
Other Sources									
S. 13th Street	457	1537.82	319,005	0.0257	5	0.018	4	320736.3	321
Alterra Coffee Shop	14	1537.82	9,877	0.0257	0	0.018	0	9930.916	10
Pump Stations, Gate	2,449	1537.82	1,708,080	0.0257	29	0.018	20	1717348	1,717
									2,048

[a] Electricity usage data obtained from purchasing records.

[b] Emission factors are from the eGRID Sub Region Emission Rates for RFC West.

[c]CO_2 equivalents are calculated by multiplying the global warming potential (GWP) by the CO_2 emissions. and CH_4 is 21.

The GWP for CO_2 is 1, N_2O is 310

Direct Emissions: Mobile Combustion Sources/Equipment

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2004 Annual GHG Emissions

Facility	Fuel and Mobile Source	Miles Traveled[a]	Fuel usage (gal.)[b]	CO_2 Emission Factor (kg/gal)	CO_2 Emissions (kg/year)	N_2O Emission Factor (g/mile or g/gal.)	N_2O Emissions (kg/year)	CH_4 Emission Factor (g/mile or g/gal.)	CH_4 Emissions (kg/year)	Total CO_2e Emissions (kg/yr)[f]	Total CO_2e Emissions (metric tons/yr)[f]
MMSD Cars and Light Trucks	Gasoline Passenger Cars	290,000	13,122	8.81	115,606	0.0197	6	0.178	52	118,461	118.46
Veolia Cars and Light Trucks	Gasoline Light-Duty Trucks	310,000	17,514	8.81	154,299	0.022	7	0.2024	63	157,731	157.73
Televising & Manhole Trucks	Gasoline Heavy Duty Vehicles	60,000	3,390	8.81	29,864	0.0497	3	0.4604	28	31,369	31.37
Class 8 Trucks	Diesel Heavy-Duty Vehicles	60,000	7,229	10.15	73,373	0.0048	0	0.0051	0	73,469	73.47
Light Med & Heavy Dump Trucks	Diesel Heavy-Duty Vehicles	50,000	8,450	10.15	85,768	0.0048	0	0.0051	0	85,847	85.85
Wheel loaders & Skid Loaders	Gasoline Heavy Duty Vehicles	4,500	900	8.81	7,929	0.0497	0	0.4604	2	8,042	8.04
Straddle Carriers	Gasoline Heavy Duty Vehicles	1,000	200	8.81	1,762	0.0497	0	0.4604	0	1,787	1.79
Burden Carriers & ATVs	Gas Small Utility	19,500	3,900	8.81	34,359	0.22	1	0.5	2	34,666	34.67
Tractors & Lawn Mowers	Gasoline Agricultural Equipment	7,250	1,450	8.81	12,775	0.22	0	1.26	2	12,912	12.91
Snow Blowers	Gas Small Utility	4,250	850	8.81	7,489	0.22	0	0.5	0	7,555	7.56
Diesel Generators	Diesel Construction Equipment		1,000	10.15	10,150	0.26	0	0.58	1	10,243	10.24
Gasoline Generators	Gasoline Heavy Duty Vehicles		1,000	8.81	8,810	0.0497	0	0.4604	0	8,810	8.81
Pelagos Research Vessel [c]	Gasoline Ships and Boats		1,585	8.81	13,964	0.22	0	0.64	1	14,093	14.09
ORP Research Boat [c]	Gasoline Ships and Boats		1,585	8.81	13,964	0.22	0	0.64	1	14,093	14.09
AgriLife Land Spreading [d]	Diesel Heavy-Duty Vehicles	40,000	6,760	10.15	68,614	0.0048	0	0.0051	0	68,678	68.68
Locomotive[e]	Diesel Locomotives		795	10.15	8,069	0.26	0	0.8	1	8,147	8.15
Total Mobile Sources					646,795		19		153	655,904	656

Direct Emissions: Mobile Combustion Sources/Equipment

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2004 Annual GHG Emissions

[a] Miles traveled based upon number of vehicles and estimated annual average mileage as shown below. The number of vehicles for each type based upon 2009 vehicle data provided by MMSD "Complete Vehicle and Equipment list, revised 4-09.xls".

	No. of Vehicles	Estimated Avg. Miles per Year per Vehicle	Total Miles per Year
MMSD Cars and Light Trucks:	29	10,000	290,000
Veolia Cars and Light Trucks:	62	5,000	310,000
Televising & Manhole Trucks:	12	5,000	60,000
Class 8 Trucks	12	5,000	60,000
Light Med & Heavy Dump Trucks	10	5,000	50,000
Wheel loaders & Skidloaders	9	500	4,500
Straddle Carriers	2	500	1,000
Burden Carriers & ATVs	38	500	19,000
Tractors & Lawn Mowers	27	250	6,750
Snow Blowers	16	250	4,000

[b] The following factors were used to estimate gallons of fuel consumed based on estimated miles driven per vehicle type:

Vehicle Type	Avg mpg	Source
Passenger Cars	22.1	
Other 2-axle, 4-tire vehicles	17.7	U.S. Department of Transportation Federal Highway Administration Annual Vehicle Distance Traveled in Miles and
Single unit 2-axle 6-tire or more trucks	8.3	Related Data- 2006, http://www.fhwa.dot.gov
Combination Trucks	5.9	Climate Leaders GHG Protocol, Direct Emissions from Mobile Combustion Sources, May 2008.
Other Vehicles	5.00	Assumed all other small vehicles (e.g. Loaders, Carriers, Tractors and Snow Blowers) get an average of 5 mpg

[c] Pelagos Research Vessel based upon fuel purchases in 2007, assumed ORP Research Boat fuel usage was equal to Pelagos Research Vessel fuel usage.

[d] Annual mileage based upon 2007 Agri Life sludge landspreading records.

[e] Locomotive fuel usage estimated based upon 2007 annual tons of milorganite produced, a distance of 3 miles to transport the Milorganite, and a Btu/ton-mile factor of 337 (EPA Climate Leader's Mobile Source guidance document).

[f] CO_2 equivalents are calculated by multiplying the global warming potential (GWP) by the CO_2 emissions. The GWP for CO_2 is 1, N_2O is 310 and CH_4 is 21.

Direct Emissions: Water Reclamation Facility Emissions
South Shore Water Reclamation Facility
Greenhouse Gas Inventory for MMSD in Milwaukee, WI
2004 Annual GHG Emissions

Methodology:
Calculation methodology from California Climate Action Registry (CCAR) Local Government Operations Protocol, chapter 10 on Centralized Wastewater Treatment Facilities (except for biogenic CO_2 emissions which are based upon data obtained from Metcalf and Eddy Wastewater Engineering Treatment, Disposal, and Reuse). CCAR equations use the EPA Inventory of US Greenhouse Gas Emissions and Sinks: 1990–2006, Chapter 8, 8–9 (2008) Calculation methodology to estimate biogenic CO_2 emissions from wastewater treatment processes, such as the use of aeration basins, sludge digesters and combustion of biogas may be included in the future CCAR wastewater treatment industry GHG protocol scheduled to be released in 2010).

Biogenic CO_2 from Water Reclamation Processes[a]

$$CO_2\left[\frac{metric\ tons\ CO_2}{year}\right] \equiv BOD_5 Load\left[\frac{kg\ BOD_5}{day}\right] \times EF_{biogenic\ CO_2}\left[\frac{kg\ CO_2}{kg\ BOD_5}\right] \times F_{oxidation} \times 365\left[\frac{day}{year}\right] \times 10^{-3}\left[\frac{metric\ ton}{kg}\right]$$

where

Term	Description	Value	GHG Emissions (metric ton CO_2e/year)[b]	Source of Data
Biogenic CO_2	= biogenic CO_2 emissions from a centralized WWTP [metric ton CO_2/year]	**45,016**	**45,016**	
BOD_5 load	= average amount of BOD_5 produced per day [kg BOD_5/day]	77,083		Annual Discharge Monitoring Report
$EF_{biogenic\ CO2}$	= emission factor [kg CO_2/kg BOD_5]	2		Metcalf & Eddy Wastewater Engineering
$F_{oxidation}$	= factor for level of oxidation for a centralized WWTP with an anaerobic or aerobic sludge digester	0.8		Metcalf & Eddy Wastewater Engineering
365	= conversion factor [day/year]	365		Conversion factor
10^{-3}	= conversion from kg to metric ton [metric ton/kg]	1.E-03		Conversion factor

Direct Emissions: Water Reclamation Facility Emissions
South Shore Water Reclamation Facility
Greenhouse Gas Inventory for MMSD in Milwaukee, WI
2004 Annual GHG Emissions

Methane from Incomplete Combustion of Digester Gas (included with Stationary Combustion Emissions)

$$CH_4\left[\frac{metric\ tons}{year}\right] \equiv Digester\ Gas\left[\frac{ft^3}{yr}\right] \times F_{CH_4} \times \rho\left(_{CH_4}\right)\left[\frac{g}{m^3}\right] \times (1-DE) \times 0.0283\left[\frac{m^3}{ft^3}\right] \times 10^{-6}\left[\frac{metric\ ton}{g}\right]$$

where

Term	Description	Value	GHG Emissions (metric ton CO_2e/year)	Source of Data
CH_4 incomplete combustion of digester gas	= CH_4 emissions from incomplete combustion of digester gas [metric ton CH_4/year]	**48.5**	**1018**	
Digester Gas	= measured standard cubic feet of digester gas produced per day [ft^3/year]	431,367,000		Annual Emission Inventory Report
F_{CH4}	= measured fraction of CH_4 in biogas	0.6		Annual Emission Inventory Report
$\rho(CH_4)$	= density of methane at standard conditions [g/m^3]	662.00		Protocol default value.
DE	= CH_4 destruction efficiency from flaring or burning in engine	0.99		Protocol default value.
0.0283	= conversion from ft^3 to m^3 [m^3/ft^3]	0.0283		Conversion factor
10^{-6}	= conversion from g to metric ton [metric ton/g]	1.E-06		Conversion factor

Direct Emissions: Water Reclamation Facility Emissions
South Shore Water Reclamation Facility
Greenhouse Gas Inventory for MMSD in Milwaukee, WI
2004 Annual GHG Emissions

Process Emissions from Water Reclamation Processes

$$N_2O\left[\frac{metric\ tons}{year}\right] \equiv P_T\left[person\right] \times \frac{Plant\ Flow}{DISTRICT\ Flow}\left[\frac{\frac{MG}{year}}{\frac{MG}{year}}\right] \times EF_{nit/denit}\left[\frac{g\ N_2O}{person \times year}\right] \times 10^{-6}\left[\frac{metric\ ton}{g}\right]$$

where

Term	Description	Value	GHG Emissions (metric ton CO_2e/year)	Source of Data
N_2O plant	= N_2O emissions from a centralized WWTP [metric ton N_2O/year]	**1.84**	**571**	
P_P	= total population served by the WWTP, person	576,000		Population served for all of MMSD obtained from MMSD annual financial report. Population served by South Shore calculated based upon total population served times % of total annual flow treated by South Shore.
P_T	= total population served by the DISTRICT, person	1,058,595		MMSD annual financial report
Plant Flow	= plant flow [MG/year]	111.00		Annual Discharge Monitoring Report
DISTRICT Flow	= DISTRICT flow [MG/year]	204.00		Annual Discharge Monitoring Report
EF nit/denit	= emission factor for a WWTP without nitrification/denitrification [g N_2O/year]	3.2		Protocol default value for plants without nitrification/denitrification.
10^{-6}	= conversion from g to metric ton [metric ton/g]	1.E-06		Conversion factor

[a] Methodology for calculating biogenic CO_2 is not included in the CCAR Local Government Operations Protocol, but may be included in the CCAR wastewater treatment industry protocol that is scheduled to be released in 2010.
[b] CO_2 equivalents are calculated by multiplying the global warming potential (GWP) by the CO_2 emissions. The GWP for CO_2 is 1, N_2O is 310 and CH_4 is 21.

Direct Emissions: Water Reclamation Facility Emissions

Jones Island Water Reclamation Facility

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2004 Annual GHG Emissions

Methodology:

Calculation methodology from California Climate Action Registry (CCAR) Local Government Operations Protocol, chapter 10 on Centralized Wastewater Treatment Facilities (except for biogenic CO^2 emissions which are based upon data obtained from Metcalf and Eddy Wastewater Engineering Treatment, Disposal, and Reuse). CCAR equations use the EPA Inventory of US Greenhouse Gas Emissions and Sinks: 1990–2006, Chapter 8, 8–9 (2008) Calculation methodology to estimate biogenic CO2 emissions from wastewater treatment processes, such as the use of aeration basins, sludge digesters and combustion of biogas may be included in the future CCAR wastewater treatment industry GHG protocol scheduled to be released in 2010).

Biogenic CO_2 from Water Reclamation Processes[a]

$$CO_2\left[\frac{metric\ tons\ CO_2}{year}\right] \equiv BOD_5 Load\left[\frac{kg\ BOD_5}{day}\right] \times EF_{biogenic\ CO_2}\left[\frac{kg\ CO_2}{kg\ BOD_5}\right] \times F_{oxidation} \times 365\left[\frac{day}{year}\right] \times 10^{-3}\left[\frac{metric\ ton}{kg}\right]$$

where

Term	Description	Value	GHG Emissions (metric ton CO_2e/year)[b]	Source of Data
Biogenic CO_2	= biogenic CO_2 emissions from a centralized WWTP [metric ton CO_2/year]	**64,046**	**64,046**	
BOD_5 load	= average amount of BOD_5 produced per day [kg BOD_5/day]	109,667		Annual Discharge Monitoring Report
$EF_{biogenic\ CO2}$	= emission factor [kg CO_2/kg BOD_5]	2		Metcalf & Eddy Wastewater Engineering
$F_{oxidation}$	= factor for level of oxidation for a centralized WWTP with an anaerobic or aerobic sludge digester	0.8		Metcalf & Eddy Wastewater Engineering
365	= conversion factor [day/year]	365		Conversion factor
10^{-3}	= conversion from kg to metric ton [metric ton/kg]	1.E-03		Conversion factor

Direct Emissions: Water Reclamation Facility Emissions

Jones Island Water Reclamation Facility

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2004 Annual GHG Emissions

Methane from Incomplete Combustion of Digester Gas (included with Stationary Combustion Emissions)

Digester Gas is not burned at Jones Island

$$CH_4\left[\frac{metric\ tons}{year}\right] \equiv Digester\ Gas\left[\frac{ft^3}{yr}\right] \times F_{CH_4} \times \rho\left(_{CH_4}\right)\left[\frac{g}{m^3}\right] \times (1 - DE) \times 0.0283\left[\frac{m^3}{ft^3}\right] \times 10^{-6}\left[\frac{metric\ ton}{g}\right]$$

where

Term	Description	Value	GHG Emissions (metric ton CO_2e/year)	Source of Data
CH_4 incomplete combustion of digester gas	= CH_4 emissions from incomplete combustion of digester gas [metric ton CH_4/year]	**0.0**	**0**	
Digester Gas	= measured standard cubic feet of digester gas produced per day [ft^3/year]	0		Annual Emission Inventory Report
F_{CH4}	= measured fraction of CH_4 in biogas	0		Annual Emission Inventory Report
$\rho(CH_4)$	= density of methane at standard conditions [g/m^3]	662.00		Protocol default value.
DE	= CH_4 destruction efficiency from flaring or burning in engine	0.99		Protocol default value.
0.0283	= conversion from ft^3 to m^3 [m^3/ft^3]	0.0283		Conversion factor
10^{-6}	= conversion from g to metric ton [metric ton/g]	1.E-06		Conversion factor

Direct Emissions: Water Reclamation Facility Emissions

Jones Island Water Reclamation Facility

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2004 Annual GHG Emissions

Process Emissions from Water Reclamation Processes

$$N_2O\left[\frac{metric\ tons}{year}\right] \equiv P_T\left[person\right] \times \frac{Plant\ Flow}{DISTRICT\ Flow}\left[\frac{\frac{MG}{year}}{\frac{MG}{year}}\right] \times EF_{nit/denit}\left[\frac{g\ N_2O}{person \times year}\right] \times 10^{-6}\left[\frac{metric\ ton}{g}\right]$$

where

Term	Description	Value	GHG Emissions (metric ton CO_2e/year)	Source of Data
N_2O plant	= N_2O emissions from a centralized WWTP [metric ton N_2O/year]	**1.54**	**479**	
P_P	= total population served by the WWTP, person	482,595		Population served for all of MMSD obtained from MMSD annual financial report. Population served by Jones Island calculated based upon total population served times % of total annual flow treated by Jones Island.
P_T	= total population served by the DISTRICT, person	1,058,595		MMSD annual financial report
Plant Flow	= plant flow [MG/year]	93.00		Annual Discharge Monitoring Report
DISTRICT Flow	= DISTRICT flow [MG/year]	204.00		Annual Discharge Monitoring Report
EF nit/denit	= emission factor for a WWTP without nitrification/denitrification [g N_2O/year]	3.2		Protocol default value for plants without nitrification/denitrification.
10^{-6}	= conversion from g to metric ton [metric ton/g]	1.E-06		Conversion factor

Direct Emissions: Water Reclamation Facility Emissions

Jones Island Water Reclamation Facility

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2004 Annual GHG Emissions

Process Emissions from Sludge Drying

$$CH_4\left[\frac{metric\ tons}{year}\right] \equiv BSD\left[\frac{tons}{year}\right] \times EF\left[\frac{kg\,CH_4}{tonBSD}\right] \times 10^{-3}\left[\frac{metric\ ton}{kg}\right]$$

where

Term	Description	Value	GHG Emissions (metric ton CO_2e/year)	Source of Data
CH_4	= CH_4 emissions from a sludge drying [metric ton CH_4/year]	**3.93**	**83**	
BSD	= blended sludge through dryers [dry tons/year]	54,977		Air Emission Inventory Report throughput for P01
EF	= emission factor for drying sludge [kg CH_4/ton dry solids]	0.072		December 2007 JI Dryer Stack Test Data, average of 3 tests, methane from natural gas combustion from turbine waste heat is subtracted.
10^{-3}	= conversion from g to metric ton [metric ton/kg]	1.E-03		Conversion factor

[a] Methodology for calculating biogenic CO_2 is not included in the CCAR Local Government Operations Protocol, but may be included in the CCAR wastewater treatment industry protocol that is scheduled to be released in 2010.

[b] CO_2 equivalents are calculated by multiplying the global warming potential (GWP) by the CO_2 emissions. The GWP for CO_2 is 1, N_2O is 310 and CH_4 is 21.

Inventory Calculations: 2005

Non-Biogenic GHG Emissions (metric tons CO_2eq/year) by Facility and Source

Greenhouse Gas Inventory for MMSD in Milwaukee, WI
2005 Annual GHG Emissions

Facility	Stationary Combustion	Purchased Electricity	Water Reclamation Emissions	Mobile Combustion	Total	% of Total All Facilities
Jones Island (non-biogenic)	80,700	22,600	600		**103,900**	73.6%
Percentage of Jones Island	*78%*	*22%*	*1%*			
South Shore (non-biogenic)	21,300	9,500	500		**31,300**	22.2%
Percentage of South Shore	*68%*	*30%*	*2%*			
Headquarters and Laboratory	600	1,800			**2,400**	1.7%
Other Stationary Sources	1,000	1,900			**2,900**	2.1%
Mobile Sources				700	**700**	0.5%
Total All Facilities	**103,600**	**35,800**	**1,100**	**700**	**141,200**	
Percentage of Total	73.4%	25.4%	0.8%	0.5%		

Biogenic and Non-Biogenic GHG Emissions (metric tons CO_2eq/year) by Facility and Source

Greenhouse Gas Inventory for MMSD in Milwaukee, WI
2005 Annual GHG Emissions

Facility	Stationary Combustion	Purchased Electricity	Water Reclamation Emissions	Mobile Combustion	Total	% of Total All Facilities
Jones Island (non-biogenic)	80,700	22,600	600		**103,800**	45.7%
Jones Island (biogenic)			60,000		**60,000**	26.4%
Jones Island Subtotal	*80,700*	*22,600*	*60,600*		***163,800***	*72.1%*
Percentage of Jones Island	*49%*	*14%*	*37%*			
South Shore (non-biogenic)	4,400	9,500	500		**14,400**	6.3%
South Shore (biogenic)	17,000		43,100		**43,100**	19.0%
South Shore Subtotal	*21,400*	*9,500*	*43,600*		***57,500***	*25.3%*
Percentage of South Shore	*37%*	*17%*	*76%*			
Headquarters and Laboratory	600	1,800			**2,400**	1.1%
Other Stationary Sources	1,000	1,900			**2,900**	1.3%
Mobile Sources				700	**700**	0.3%
Total All Facilities	**103,700**	**35,800**	**104,200**	**700**	**227,300**	
Percentage of Total	45.6%	15.8%	45.8%	0.3%		

GHG Emissions (metric tons CO_2eq/year) by Type

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2005 Annual GHG Emissions

Scope 1: Direct Fossil Fuel Emissions	**86,654**	**metric tons CO_2eq/year**
Scope 2: Indirect Energy Emissions	**35,715**	**metric tons CO_2eq/year**
Emissions Unique to Water Reclamation Facilities	**104,137**	**metric tons CO_2eq/year**

	CO_2 Emissions	Biogenic CO_2 Emissions	CH_4 Emissions	N_2O Emissions	Total Emissions	% of Total	Total Emissions w/out Biogenic CO_2	% of Total w/out Biogenic CO_2
Stationary Combustion (Scope 1: direct emissions)	84,666	N/A	1,551.5	428.7	86,646	38.3%	86,646	70.2%
Mobile Combustion (Scope 1: direct emissions)	8	N/A	0.01	0.1	8	0.0%	8	0.0%
Purchased Electricity (Scope 2: indirect emissions)	35,522	N/A	9	184	35,715	15.8%	35,715	28.9%
Water Reclamation Emissions	0	103,087	75	1,051	104,137	46.0%	1,051	0.9%
Biogenic CO_2 emissions from wastewater processes	N/A	103,087	N/A	N/A	103,087	45.5%	0	0.0%
N_2O emissions from wastewater processes	N/A	N/A	N/A	1,051	1,051	0.5%	1,051	0.9%
CH_4 emissions from sludge drying	N/A	N/A	75	N/A	75	0.0%	75	0.1%
Total	**120,196**	**103,087**	**1,635**	**1,663**	**226,506**		**123,420**	**123,420**
% of Total	53.1%	45.5%	0.7%	0.7%				

Definitions (WRI Protocol terminology)

Scope 1 emissions: All direct GHG emissions, with the exception of direct CO_2 emissions from biogenic sources.

Direct emissions: Emissions from sources within the reporting entity's organizational boundaries that are owned or controlled by the reporting entity, including stationary combustion emissions, mobile combustion emissions, process emissions, and fugitive emissions.

Scope 2 emissions: Indirect GHG emissions associated with the consumption of purchased or acquired electricity, heating, cooling, or steam.

Indirect emissions: Emissions that are a consequence of activities that take place within the organizational boundaries of the reporting entity, but that occur at sources owned or controlled by another entity.

Biogenic carbon: Carbon derived from biogenic (plant or animal) sources excluding fossil carbon.

GHG Emissions (metric tons CO_2eq/year) by Facility

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2005 Annual GHG Emissions

	Stationary Combustion[a]	Purchased Electricity	Water Reclamation Facility Emissions w/ Biogenic CO_2: Total WRF Emissions	Biogenic CO_2 Emissions[b]	Sludge Drying CH_4 Emissions	Plant N_2O Emissions[b]	Total	% of Total
All Facilities								
CO_2 Emissions	84,666	35,522		N/A	N/A	N/A	**120,188**	49%
Biogenic CO_2 Emissions	16,966	N/A		103,087	N/A	N/A	**120,053**	49%
CH_4 Emissions	1,551	9		N/A	75	N/A	**1,635**	1%
N_2O Emissions	429	184		N/A	N/A	1,051	**1,663**	1%
Total CO_2e Emissions	**103,612**	**35,715**	**104,212**	**103,087**	**75**	**1,051**	**243,539**	
Percentage of Total (including biogenic emissions)	43%	15%	43%	42%	0.0%	0%		
Percentage of Total (not including biogenic emissions)	74%	25%		N/A	0%	1%	**140,453**	
Jones Island								
CO_2 Emissions	80,142	22,449		N/A	N/A	N/A	**102,592**	63%
Biogenic CO_2 Emissions	N/A	N/A		60,025	N/A	N/A	**60,025**	37%
CH_4 Emissions	114	5.5		N/A	75	N/A	**195**	0.1%
N_2O Emissions	407	116.3		N/A	N/A	507	**1,030**	1%
Total CO_2e Emissions	**80,663**	**22,571**	**60,608**	**60,025**	**75**	**507**	**163,842**	
Percentage of Total (including biogenic emissions)	49%	14%	37%	37%	0%	0%		
Percentage of Total (not including biogenic emissions)	78%	22%		N/A	0%	0%	**103,817**	
South Shore								
CO_2 Emissions	2,915	9,418		N/A	N/A	N/A	**12,334**	17%
Biogenic CO_2 Emissions	16,966	N/A		43,061	N/A	N/A	**60,028**	81%
CH_4 Emissions	1,437	2.3		N/A	N/A	N/A	**1,439**	2%
N_2O Emissions	20	48.8		N/A	N/A	544	**612**	1%
Total CO_2e Emissions	**21,339**	**9,469**	**43,605**	**43,061**	**N/A**	**544**	**74,413**	
Percentage of Total (including biogenic emissions)	29%	13%	59%	58%	N/A	1%		
Percentage of Total (not including biogenic emissions)	68%	30%		N/A	N/A	2%	**31,352**	
Headquarters & Lab								
CO_2 Emissions	579	1,797		N/A	N/A	N/A	**2,376**	99.6%
Biogenic CO_2 Emissions	N/A	N/A		N/A	N/A	N/A	**N/A**	0%
CH_4 Emissions	0.2	0.44		N/A	N/A	N/A	**1**	0.0%
N_2O Emissions	0.3	9.31		N/A	N/A	N/A	**10**	0.4%
Total CO_2 Emissions	**580**	**1,807**	N/A	N/A	N/A	N/A	**2,387**	
Percentage of Total	24%	76%						
Other Sources[c]								
CO_2 Emissions	1,029	1,857		N/A	N/A	N/A	**2,886**	99.6%
Biogenic CO_2 Emissions	N/A	N/A		N/A	N/A	N/A	**N/A**	0%
CH_4 Emissions	0	0.46		N/A	N/A	N/A	**1**	0.0%
N_2O Emissions	1	9.62		N/A	N/A	N/A	**11**	0.4%
Total CO_2 Emissions	**1,031**	**1,867**	N/A	N/A	N/A	N/A	**2,898**	
Percentage of Total	36%	64%						

[a] Include methane emissions from incomplete combustion of biogas for South Shore.

[b] Emissions from water reclamation processes.

[c] Other sources include: 13th street, Alterra, and the Interceptor Pumping Stations.

Direct Emissions: Stationary Combustion Sources
Greenhouse Gas Inventory for MMSD in Milwaukee, WI
2005 Annual GHG Emissions

Facility/Emission Sources	Fuel/Emission Source Type	Energy Use (MMBTU/yr)[a]	Fuel Use (1000 gal/yr)[a]	CO_2 Emission Factor (kg/MMBtu)	CO_2 Emissions (kg/year)	CO_2 Emissions (kg/year)[b]	N_2O Emissions (kg/year)	CH_4 Emission Factor (g/MMBtu or lb/1000 gal)[c]	CH_4 Emissions (kg/year)	Total CO_2e Emissions (kg/yr)[d]	Total CO_2e Emissions (metric tons/yr)[d]
Jones Island											
Rotary Sludge Dryers	Stationary Natural Gas - Boilers or Dryers	37,663		53.06	1,998,399	0.9	34	0.9	34	**2,009,619**	2,010
(2) 16MW Turbines	Stationary Natural Gas - Turbines	1,399,604		53.06	74,262,988	0.9	1,260	3.8	5,318	**74,765,166**	74,765
(2) 16MW Turbines	Stationary Distillate Fuel Oil (#1, 2, &4)	0		73.15	0	0.3	0	3	0	**-**	-
(2) Cleaver Brooks Boilers	Stationary Natural Gas - Boilers or Dryers	15,226		53.06	807,892	0.9	14	0.9	14	**812,427**	812
(2) Cleaver Brooks Boilers	Stationary Distillate Fuel Oil (#1, 2, &4)	54		73.15	3,950	0.3	0	3	0	**3,959**	4
Facility Space Heaters & Boilers <5 mmbtu/hr	Stationary Natural Gas - Default	57,845		53.06	3,069,256	0.1	6	1	58	**3,072,264**	3,072
Facility Space Heaters & Boilers <5 mmbtu/hr	Stationary Propane	0.0	1.8	63.07	0	0.9	0	0.2	0	**-**	-
					80,142,484		1,313		5,424	**80,663,434**	**80,663**

Direct Emissions: Stationary Combustion Sources
Greenhouse Gas Inventory for MMSD in Milwaukee, WI
2005 Annual GHG Emissions

Facility/Emission Sources	Fuel/Emission Source Type	Energy Use (MMBTU/yr)[a]	Fuel Use (1000 gal/yr)[a]	CO_2 Emission Factor (kg/MMBtu)	CO_2 Emissions (kg/year)	CO_2 Emissions (kg/year)[b]	N_2O Emissions (kg/year)	CH_4 Emission Factor (g/MMBtu or lb/1000 gal)[c]	CH_4 Emissions (kg/year)	Total CO_2e Emissions (kg/yr)[d]	Total CO_2e Emissions (metric tons/yr)[d]
South Shore											
Facility Space Heaters & Boilers <5 mmbtu/hr	Stationary Natural Gas - Boilers or Dryers	32,026		53.06	1,699,300	0.9	29	0.9	29	**1,708,840**	1,709
Boilers - (3) Kewaunee, (2) Scum, (2) Cleaver Brooks	Stationary Natural Gas - Boilers or Dryers	769		53.06	40,803	0.9	1	0.9	1	**41,032**	41
IC Engine Generators (5)	Stationary Natural Gas - Default	22,151		53.06	1,175,332	0.1	2	1	22	**1,176,484**	1,176
Boilers - (3) Kewaunee, (2) Cleaver Brooks [b]	Stationary Wastewater Treatment Biogas	8,147		52.07	*424,239*	0.1	1	0.9	7	**424,645**	425
IC Engine Generators (5)[b]	Stationary Wastewater	295,151		52.07	*15,368,490*	0.1	30	0.9	266	**15,383,218**	15,383
Flares[b]	Stationary Wastewater	22,538		52.07	*1,173,576*	0.1	2	0.9	20	**1,174,701**	1,175
					19,881,740		64		345	**19,908,921**	**19,909**
Headquarters & Lab											
Building Heat	Stationary Natural Gas - Default	10,916		53.06	579,219	0.1	1	1	11	**579,787**	580
Other Sources											
S. 13th Street Boilers	Stationary Natural Gas - Boilers or Dryers	2,976		53.06	157,885	0.9	3	0.9	3	**158,772**	159
Alterra Building Heat	Stationary Natural Gas - Default	0		53.06	5	0.1	0	1	0	**5**	0
Pump Stations, etc.	Stationary Natural Gas - Default	16,416		53.06	871,049	0.1	2	1	16	**871,903**	872
					1,028,940		4		19		**1,031**
All Facilities					101,632,383		1,383		5,799		**102,183**

[a] Energy/fuel usage data obtained from purchasing records and annual air emission inventory reports.

[b] CO_2 emissions from wastewater treatment biogas are considered biogenic and not reported as scope 1 emissions.

[c] CH_4 and N_2O emission factors for propane are in lb/1000 gal.

[d] CO_2 equivalents are calculated by multiplying the global warming potential (GWP) by the CO_2 emissions. The GWP for CO_2 is 1, N_2O is 310 and CH_4 is 21.

Indirect Emissions: Purchased Electricity

Greenhouse Gas Inventory for MMSD in Milwaukee, WI
2005 Annual GHG Emissions

Facility	Electricity Use (MWh)[a]	CO_2 Emission Factor[b] (lb/MWh)	CO_2 Emissions (kg/year)	N_2O Emission Factor[b] (lb/MWh)	N_2O Emissions (kg/year)	CH_4 Emission Factor[b] (lb/MWh)	CH_4 Emissions (kg/year)	Total CO_2e Emissions (kg/yr)[c]	Total CO_2e Emissions (metric tons/yr)[c]
Jones Island	32,183	1537.82	22,449,227	0.0257	375	0.018	263	22571048	22,571
South Shore	13,502	1537.82	9,418,301	0.0257	157	0.018	110	9469410	9,469
Headquarters & Lab	2,576	1537.82	1,797,225	0.0257	30	0.018	21	1806978	1,807
Other Sources									
S. 13th Street	456	1537.82	317,842	0.0257	5	0.018	4	319567.2	320
Alterra Coffee Shop	13	1537.82	9,291	0.0257	0	0.018	0	9341.793	9
Pump Stations, Gate	2,193	1537.82	1,529,932	0.0257	26	0.018	18	1538234	1,538
									1,867

[a] Electricity usage data obtained from purchasing records.

[b] Emission factors are from the eGRID Sub Region Emission Rates for RFC West.

[c]CO_2 equivalents are calculated by multiplying the global warming potential (GWP) by the CO_2 emissions. and CH_4 is 21.

The GWP for CO_2 is 1, N_2O is 310

Direct Emissions: Mobile Combustion Sources/Equipment

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2005 Annual GHG Emissions

Facility	Fuel and Mobile Source	Miles Traveled[a]	Fuel usage (gal.)[b]	CO_2 Emission Factor (kg/gal)	CO_2 Emissions (kg/year)	N_2O Emission Factor (g/mile or g/gal.)	N_2O Emissions (kg/year)	CH_4 Emission Factor (g/mile or g/gal.)	CH_4 Emissions (kg/year)	Total CO_2e Emissions (kg/yr)[f]	Total CO_2e Emissions (metric tons/yr)[f]
MMSD Cars and Light Trucks	Gasoline Passenger Cars	290,000	13,122	8.81	115,606	0.0197	6	0.178	52	118,461	118.46
Veolia Cars and Light Trucks	Gasoline Light-Duty Trucks	310,000	17,514	8.81	154,299	0.022	7	0.2024	63	157,731	157.73
Televising & Manhole Trucks	Gasoline Heavy Duty Vehicles	60,000	3,390	8.81	29,864	0.0497	3	0.4604	28	31,369	31.37
Class 8 Trucks	Diesel Heavy-Duty Vehicles	60,000	7,229	10.15	73,373	0.0048	0	0.0051	0	73,469	73.47
Light Med & Heavy Dump Trucks	Diesel Heavy-Duty Vehicles	50,000	8,450	10.15	85,768	0.0048	0	0.0051	0	85,847	85.85
Wheel loaders & Skid Loaders	Gasoline Heavy Duty Vehicles	4,500	900	8.81	7,929	0.0497	0	0.4604	2	8,042	8.04
Straddle Carriers	Gasoline Heavy Duty Vehicles	1,000	200	8.81	1,762	0.0497	0	0.4604	0	1,787	1.79
Burden Carriers & ATVs	Gas Small Utility	19,500	3,900	8.81	34,359	0.22	1	0.5	2	34,666	34.67
Tractors & Lawn Mowers	Gasoline Agricultural Equipment	7,250	1,450	8.81	12,775	0.22	0	1.26	2	12,912	12.91
Snow Blowers	Gas Small Utility	4,250	850	8.81	7,489	0.22	0	0.5	0	7,555	7.56
Diesel Generators	Diesel Construction Equipment		1,000	10.15	10,150	0.26	0	0.58	1	10,243	10.24
Gasoline Generators	Gasoline Heavy Duty Vehicles		1,000	8.81	8,810	0.0497	0	0.4604	0	8,810	8.81
Pelagos Research Vessel [c]	Gasoline Ships and Boats		1,585	8.81	13,964	0.22	0	0.64	1	14,093	14.09
ORP Research Boat [c]	Gasoline Ships and Boats		1,585	8.81	13,964	0.22	0	0.64	1	14,093	14.09
AgriLife Land Spreading [d]	Diesel Heavy-Duty Vehicles	40,000	6,760	10.15	68,614	0.0048	0	0.0051	0	68,678	68.68
Locomotive[e]	Diesel Locomotives		795	10.15	8,069	0.26	0	0.8	1	8,147	8.15
Total Mobile Sources					646,795		19		153	655,904	656

Direct Emissions: Mobile Combustion Sources/Equipment

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2005 Annual GHG Emissions

[a] Miles traveled based upon number of vehicles and estimated annual average mileage as shown below. The number of vehicles for each type based upon 2009 vehicle data provided by MMSD "Complete Vehicle and Equipment list, revised 4-09.xls".

	No. of Vehicles	Estimated Avg. Miles per Year per Vehicle	Total Miles per Year
MMSD Cars and Light Trucks:	29	10,000	290,000
Veolia Cars and Light Trucks:	62	5,000	310,000
Televising & Manhole Trucks:	12	5,000	60,000
Class 8 Trucks	12	5,000	60,000
Light Med & Heavy Dump Trucks	10	5,000	50,000
Wheel loaders & Skidloaders	9	500	4,500
Straddle Carriers	2	500	1,000
Burden Carriers & ATVs	38	500	19,000
Tractors & Lawn Mowers	27	250	6,750
Snow Blowers	16	250	4,000

[b] The following factors were used to estimate gallons of fuel consumed based on estimated miles driven per vehicle type:

Vehicle Type	Avg mpg	Source
Passenger Cars	22.1	
Other 2-axle, 4-tire vehicles	17.7	U.S. Department of Transportation Federal Highway Administration Annual Vehicle Distance Traveled in Miles and
Single unit 2-axle 6-tire or more trucks	8.3	Related Data- 2006, http://www.fhwa.dot.gov
Combination Trucks	5.9	Climate Leaders GHG Protocol, Direct Emissions from Mobile Combustion Sources, May 2008.
Other Vehicles	5.00	Assumed all other small vehicles (e.g. Loaders, Carriers, Tractors and Snow Blowers) get an average of 5 mpg

[c] Pelagos Research Vessel based upon fuel purchases in 2007, assumed ORP Research Boat fuel usage was equal to Pelagos Research Vessel fuel usage.

[d] Annual mileage based upon 2007 Agri Life sludge landspreading records.

[e] Locomotive fuel usage estimated based upon 2007 annual tons of milorganite produced, a distance of 3 miles to transport the Milorganite, and a Btu/ton-mile factor of 337 (EPA Climate Leader's Mobile Source guidance document).

[f] CO_2 equivalents are calculated by multiplying the global warming potential (GWP) by the CO_2 emissions. The GWP for CO_2 is 1, N_2O is 310 and CH_4 is 21.

Direct Emissions: Water Reclamation Facility Emissions
South Shore Water Reclamation Facility
Greenhouse Gas Inventory for MMSD in Milwaukee, WI
2005 Annual GHG Emissions

Methodology:
Calculation methodology from California Climate Action Registry (CCAR) Local Government Operations Protocol, chapter 10 on Centralized Wastewater Treatment Facilities (except for biogenic CO_2 emissions which are based upon data obtained from Metcalf and Eddy Wastewater Engineering Treatment, Disposal, and Reuse). CCAR equations use the EPA Inventory of US Greenhouse Gas Emissions and Sinks: 1990–2006, Chapter 8, 8–9 (2008) Calculation methodology to estimate biogenic CO_2 emissions from wastewater treatment processes, such as the use of aeration basins, sludge digesters and combustion of biogas may be included in the future CCAR wastewater treatment industry GHG protocol scheduled to be released in 2010).

Biogenic CO_2 from Water Reclamation Processes[a]

$$CO_2\left[\frac{metric\ tons\ CO_2}{year}\right] \equiv BOD_5 Load\left[\frac{kg\ BOD_5}{day}\right] \times EF_{biogenic\ CO_2}\left[\frac{kg\ CO_2}{kg\ BOD_5}\right] \times F_{oxidation} \times 365\left[\frac{day}{year}\right] \times 10^{-3}\left[\frac{metric\ ton}{kg}\right]$$

where

Term	Description	Value	GHG Emissions (metric ton CO_2e/year)[b]	Source of Data
Biogenic CO_2	= biogenic CO_2 emissions from a centralized WWTP [metric ton CO_2/year]	**43,061**	**43,061**	
BOD_5 load	= average amount of BOD_5 produced per day [kg BOD_5/day]	73,735		Annual Discharge Monitoring Report
$EF_{biogenic\ CO2}$	= emission factor [kg CO_2/kg BOD_5]	2		Metcalf & Eddy Wastewater Engineering
$F_{oxidation}$	= factor for level of oxidation for a centralized WWTP with an anaerobic or aerobic sludge digester	0.8		Metcalf & Eddy Wastewater Engineering
365	= conversion factor [day/year]	365		Conversion factor
10^{-3}	= conversion from kg to metric ton [metric ton/kg]	1.E-03		Conversion factor

Direct Emissions: Water Reclamation Facility Emissions
South Shore Water Reclamation Facility
Greenhouse Gas Inventory for MMSD in Milwaukee, WI
2005 Annual GHG Emissions

Methane from Incomplete Combustion of Digester Gas (included with Stationary Combustion Emissions)

$$CH_4\left[\frac{metric\ tons}{year}\right] \equiv Digester\ Gas\left[\frac{ft^3}{yr}\right] \times F_{CH_4} \times \rho\left(_{CH_4}\right)\left[\frac{g}{m^3}\right] \times (1 - DE) \times 0.0283\left[\frac{m^3}{ft^3}\right] \times 10^{-6}\left[\frac{metric\ ton}{g}\right]$$

where

Term	Description	Value	GHG Emissions (metric ton CO_2e/year)	Source of Data
CH_4 incomplete combustion of digester gas	= CH_4 emissions from incomplete combustion of digester gas [metric ton CH_4/year]	**68.1**	**1430**	
Digester Gas	= measured standard cubic feet of digester gas produced per day [ft^3/year]	605,649,000		Annual Emission Inventory Report
F_{CH4}	= measured fraction of CH_4 in biogas	0.6		Annual Emission Inventory Report
$\rho(CH_4)$	= density of methane at standard conditions [g/m^3]	662.00		Protocol default value.
DE	= CH_4 destruction efficiency from flaring or burning in engine	0.99		Protocol default value.
0.0283	= conversion from ft^3 to m^3 [m^3/ft^3]	0.0283		Conversion factor
10^{-6}	= conversion from g to metric ton [metric ton/g]	1.E-06		Conversion factor

Direct Emissions: Water Reclamation Facility Emissions
South Shore Water Reclamation Facility
Greenhouse Gas Inventory for MMSD in Milwaukee, WI
2005 Annual GHG Emissions
Process Emissions from Water Reclamation Processes

$$N_2O\left[\frac{metric\ tons}{year}\right] \equiv P_T\left[person\right] \times \frac{Plant\ Flow}{DISTRICT\ Flow}\left[\frac{\frac{MG}{year}}{\frac{MG}{year}}\right] \times EF_{nit/denit}\left[\frac{g\ N_2O}{person \times year}\right] \times 10^{-6}\left[\frac{metric\ ton}{g}\right]$$

where

Term	Description	Value	GHG Emissions (metric ton CO_2e/year)	Source of Data
N_2O plant	= N_2O emissions from a centralized WWTP [metric ton N_2O/year]	**1.75**	**544**	
P_P	= total population served by the WWTP, person	548,021		Population served for all of MMSD obtained from MMSD annual financial report. Population served by South Shore calculated based upon total population served times % of total annual flow treated by South Shore.
P_T	= total population served by the DISTRICT, person	1,059,096		MMSD annual financial report
Plant Flow	= plant flow [MG/year]	89.00		Annual Discharge Monitoring Report
DISTRICT Flow	= DISTRICT flow [MG/year]	172.00		Annual Discharge Monitoring Report
EF nit/denit	= emission factor for a WWTP without nitrification/denitrification [g N_2O/year]	3.2		Protocol default value for plants without nitrification/denitrification.
10^{-6}	= conversion from g to metric ton [metric ton/g]	1.E-06		Conversion factor

[a] Methodology for calculating biogenic CO_2 is not included in the CCAR Local Government Operations Protocol, but may be included in the CCAR wastewater treatment industry protocol that is scheduled to be released in 2010.

[b] CO_2 equivalents are calculated by multiplying the global warming potential (GWP) by the CO_2 emissions. The GWP for CO_2 is 1, N_2O is 310 and CH_4 is 21.

Direct Emissions: Water Reclamation Facility Emissions

Jones Island Water Reclamation Facility

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2005 Annual GHG Emissions

Methodology:

Calculation methodology from California Climate Action Registry (CCAR) Local Government Operations Protocol, chapter 10 on Centralized Wastewater Treatment Facilities (except for biogenic CO^2 emissions which are based upon data obtained from Metcalf and Eddy Wastewater Engineering Treatment, Disposal, and Reuse). CCAR equations use the EPA Inventory of US Greenhouse Gas Emissions and Sinks: 1990–2006, Chapter 8, 8–9 (2008) Calculation methodology to estimate biogenic CO2 emissions from wastewater treatment processes, such as the use of aeration basins, sludge digesters and combustion of biogas may be included in the future CCAR wastewater treatment industry GHG protocol scheduled to be released in 2010).

Biogenic CO_2 from Water Reclamation Processes[a]

$$CO_2\left[\frac{metric\ tons\ CO_2}{year}\right] \equiv BOD_5 Load\left[\frac{kg\ BOD_5}{day}\right] \times EF_{biogenic\ CO_2}\left[\frac{kg\ CO_2}{kg\ BOD_5}\right] \times F_{oxidation} \times 365\left[\frac{day}{year}\right] \times 10^{-3}\left[\frac{metric\ ton}{kg}\right]$$

where

Term	Description	Value	GHG Emissions (metric ton CO_2e/year)[b]	Source of Data
Biogenic CO_2	= biogenic CO_2 emissions from a centralized WWTP [metric ton CO_2/year]	**60,025**	**60,025**	
BOD_5 load	= average amount of BOD_5 produced per day [kg BOD_5/day]	102,783		Annual Discharge Monitoring Report
$EF_{biogenic\ CO2}$	= emission factor [kg CO_2/kg BOD_5]	2		Metcalf & Eddy Wastewater Engineering
$F_{oxidation}$	= factor for level of oxidation for a centralized WWTP with an anaerobic or aerobic sludge digester	0.8		Metcalf & Eddy Wastewater Engineering
365	= conversion factor [day/year]	365		Conversion factor
10^{-3}	= conversion from kg to metric ton [metric ton/kg]	1.E-03		Conversion factor

Direct Emissions: Water Reclamation Facility Emissions

Jones Island Water Reclamation Facility

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2005 Annual GHG Emissions

Methane from Incomplete Combustion of Digester Gas (included with Stationary Combustion Emissions)

Digester Gas is not burned at Jones Island

$$CH_4\left[\frac{metric\ tons}{year}\right] \equiv Digester\ Gas\left[\frac{ft^3}{yr}\right] \times F_{CH_4} \times \rho\left(_{CH_4}\right)\left[\frac{g}{m^3}\right] \times (1 - DE) \times 0.0283\left[\frac{m^3}{ft^3}\right] \times 10^{-6}\left[\frac{metric\ ton}{g}\right]$$

where

Term	Description	Value	GHG Emissions (metric ton CO_2e/year)	Source of Data
CH_4 incomplete combustion of digester gas	= CH_4 emissions from incomplete combustion of digester gas [metric ton CH_4/year]	**0.0**	**0**	
Digester Gas	= measured standard cubic feet of digester gas produced per day [ft^3/year]	0		Annual Emission Inventory Report
F_{CH4}	= measured fraction of CH_4 in biogas	0		Annual Emission Inventory Report
$\rho(CH_4)$	= density of methane at standard conditions [g/m^3]	662.00		Protocol default value.
DE	= CH_4 destruction efficiency from flaring or burning in engine	0.99		Protocol default value.
0.0283	= conversion from ft^3 to m^3 [m^3/ft^3]	0.0283		Conversion factor
10^{-6}	= conversion from g to metric ton [metric ton/g]	1.E-06		Conversion factor

Direct Emissions: Water Reclamation Facility Emissions

Jones Island Water Reclamation Facility

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2005 Annual GHG Emissions

Process Emissions from Water Reclamation Processes

$$N_2O\left[\frac{metric\ tons}{year}\right] \equiv P_T\left[person\right] \times \frac{Plant\ Flow}{DISTRICT\ Flow}\left[\frac{\frac{MG}{year}}{\frac{MG}{year}}\right] \times EF_{nit/denit}\left[\frac{g\ N_2O}{person \times year}\right] \times 10^{-6}\left[\frac{metric\ ton}{g}\right]$$

where

Term	Description	Value	GHG Emissions (metric ton CO_2e/year)	Source of Data
N_2O plant	= N_2O emissions from a centralized WWTP [metric ton N_2O/year]	**1.64**	**507**	
P_P	= total population served by the WWTP, person	511,075		Population served for all of MMSD obtained from MMSD annual financial report. Population served by Jones Island calculated based upon total population served times % of total annual flow treated by Jones Island.
P_T	= total population served by the DISTRICT, person	1,059,096		MMSD annual financial report
Plant Flow	= plant flow [MG/year]	83.00		Annual Discharge Monitoring Report
DISTRICT Flow	= DISTRICT flow [MG/year]	172.00		Annual Discharge Monitoring Report
EF nit/denit	= emission factor for a WWTP without nitrification/denitrification [g N_2O/year]	3.2		Protocol default value for plants without nitrification/denitrification.
10^{-6}	= conversion from g to metric ton [metric ton/g]	1.E-06		Conversion factor

Direct Emissions: Water Reclamation Facility Emissions

Jones Island Water Reclamation Facility

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2005 Annual GHG Emissions

Process Emissions from Sludge Drying

$$CH_4\left[\frac{metric\ tons}{year}\right] \equiv BSD\left[\frac{tons}{year}\right] \times EF\left[\frac{kg\ CH_4}{tonBSD}\right] \times 10^{-3}\left[\frac{metric\ ton}{kg}\right]$$

where

Term	Description	Value	GHG Emissions (metric ton CO_2e/year)	Source of Data
CH_4	= CH_4 emissions from a sludge drying [metric ton CH_4/year]	**3.58**	**75**	
BSD	= blended sludge through dryers [dry tons/year]	50,084		Air Emission Inventory Report throughput for P01
EF	= emission factor for drying sludge [kg CH_4/ton dry solids]	0.072		December 2007 JI Dryer Stack Test Data, average of 3 tests, methane from natural gas combustion from turbine waste heat is subtracted.
10^{-3}	= conversion from g to metric ton [metric ton/kg]	1.E-03		Conversion factor

[a] Methodology for calculating biogenic CO_2 is not included in the CCAR Local Government Operations Protocol, but may be included in the CCAR wastewater treatment industry protocol that is scheduled to be released in 2010.

[b] CO_2 equivalents are calculated by multiplying the global warming potential (GWP) by the CO_2 emissions. The GWP for CO_2 is 1, N_2O is 310 and CH_4 is 21.

Inventory Calculations: 2006

Non-Biogenic GHG Emissions (metric tons CO_2eq/year) by Facility and Source

Greenhouse Gas Inventory for MMSD in Milwaukee, WI
2006 Annual GHG Emissions

Facility	Stationary Combustion	Purchased Electricity	Water Reclamation Emissions	Mobile Combustion	Total	% of Total All Facilities
Jones Island (non-biogenic)	67,400	35,000	600		**103,000**	72.7%
Percentage of Jones Island	*65%*	*34%*	*1%*			
South Shore (non-biogenic)	20,400	11,600	600		**32,600**	23.0%
Percentage of South Shore	*63%*	*36%*	*2%*			
Headquarters and Laboratory	600	1,800			**2,400**	1.7%
Other Stationary Sources	1,100	1,900			**3,000**	2.1%
Mobile Sources				700	**700**	0.5%
Total All Facilities	**89,500**	**50,300**	**1,200**	**700**	**141,700**	
Percentage of Total	63.2%	35.5%	0.8%	0.5%		

Biogenic and Non-Biogenic GHG Emissions (metric tons CO_2eq/year) by Facility and Source

Greenhouse Gas Inventory for MMSD in Milwaukee, WI
2006 Annual GHG Emissions

Facility	Stationary Combustion	Purchased Electricity	Water Reclamation Emissions	Mobile Combustion	Total	% of Total All Facilities
Jones Island (non-biogenic)	67,400	35,000	600		**103,000**	44.1%
Jones Island (biogenic)			48,600		**48,600**	20.8%
Jones Island Subtotal	*67,400*	*35,000*	*49,200*		**151,600**	*64.9%*
Percentage of Jones Island	*44%*	*23%*	*32%*			
South Shore (non-biogenic)	5,300	11,600	600		**17,500**	7.5%
South Shore (biogenic)	15,100		43,300		**58,400**	25.0%
South Shore Subtotal	*20,400*	*11,600*	*43,900*		***75,900***	*32.5%*
Percentage of South Shore	*27%*	*15%*	*58%*			
Headquarters and Laboratory	600	1,800			**2,400**	1.0%
Other Stationary Sources	1,100	1,900			**3,000**	1.3%
Mobile Sources				700	**700**	0.3%
Total All Facilities	**89,500**	**50,300**	**93,100**	**700**	**233,600**	
Percentage of Total	38.3%	21.5%	39.9%	0.3%		

GHG Emissions (metric tons CO_2eq/year) by Type

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2006 Annual GHG Emissions

Scope 1: Direct Fossil Fuel Emissions	**74,329**	**metric tons CO_2eq/year**
Scope 2: Indirect Energy Emissions	**50,336**	**metric tons CO_2eq/year**
Emissions Unique to Water Reclamation Facilities	**92,912**	**metric tons CO_2eq/year**

	CO_2 Emissions	Biogenic CO_2 Emissions	CH_4 Emissions	N_2O Emissions	Total Emissions	% of Total	Total Emissions w/out Biogenic CO_2	% of Total w/out Biogenic CO_2
Stationary Combustion (Scope 1: direct emissions)	72,589	N/A	1,375.7	356.1	74,321	34.2%	74,321	59.1%
Mobile Combustion (Scope 1: direct emissions)	8	N/A	0.01	0.1	8	0.0%	8	0.0%
Purchased Electricity (Scope 2: indirect emissions)	50,064	N/A	12	259	50,336	23.1%	50,336	40.0%
Water Reclamation Emissions	0	91,862	65	1,050	92,912	42.7%	1,050	0.8%
Biogenic CO_2 emissions from wastewater processes	N/A	91,862	N/A	N/A	91,862	42.2%	0	0.0%
N_2O emissions from wastewater processes	N/A	N/A	N/A	1,050	1,050	0.5%	1,050	0.8%
CH_4 emissions from sludge drying	N/A	N/A	65	N/A	65	0.0%	65	0.1%
Total	**122,661**	**91,862**	**1,453**	**1,665**	**217,577**		**125,715**	**125,715**
% of Total	56.4%	42.2%	0.7%	0.8%				

Definitions (WRI Protocol terminology)

Scope 1 emissions: All direct GHG emissions, with the exception of direct CO_2 emissions from biogenic sources.

Direct emissions: Emissions from sources within the reporting entity's organizational boundaries that are owned or controlled by the reporting entity, including stationary combustion emissions, mobile combustion emissions, process emissions, and fugitive emissions.

Scope 2 emissions: Indirect GHG emissions associated with the consumption of purchased or acquired electricity, heating, cooling, or steam.

Indirect emissions: Emissions that are a consequence of activities that take place within the organizational boundaries of the reporting entity, but that occur at sources owned or controlled by another entity.

Biogenic carbon: Carbon derived from biogenic (plant or animal) sources excluding fossil carbon.

GHG Emissions (metric tons CO_2eq/year) by Facility and Type

Greenhouse Gas Inventory for MMSD in Milwaukee, WI
2006 Annual GHG Emissions

			Water Reclamation Facility Emissions w/ Biogenic CO_2					
	Stationary Combustion[a]	Purchased Electricity	Total WRF Emissions	Biogenic CO_2 Emissions[b]	Sludge Drying CH_4 Emissions[b]	Plant N_2O Emissions[b]	Total	% of Total
All Facilities								
CO_2 Emissions	72,589	50,064		N/A	N/A	N/A	**122,653**	53%
Biogenic CO_2 Emissions	15,129	N/A		91,862	N/A	N/A	**106,991**	46%
CH_4 Emissions	1,376	12		N/A	65	N/A	**1,453**	1%
N_2O Emissions	356	259		N/A	N/A	1,050	**1,665**	1%
Total CO_2e Emissions	**89,449**	**50,336**	**92,976**	**91,862**	**65**	**1,050**	232,762	
Percentage of Total (including biogenic emissions)	38%	22%	40%	39%	0%	0%		
Percentage of Total (not including biogenic emissions)	63%	36%		N/A	0%	1%	**140,900**	
Jones Island								
CO_2 Emissions	66,948	34,860		N/A	N/A	N/A	**101,808**	67%
Biogenic CO_2 Emissions	N/A	N/A		48,611	N/A	N/A	**48,611**	32%
CH_4 Emissions	84	8.6		N/A	65	N/A	**157**	0.1%
N_2O Emissions	337	180.6		N/A	N/A	483	**1,001**	1%
Total CO_2e Emissions	**67,369**	**35,050**	**49,159**	**48,611**	**65**	**483**	151,577	
Percentage of Total (including biogenic emissions)	44%	23%	32%	32%	0%	0%		
Percentage of Total (not including biogenic emissions)	65%	34%		N/A	0%	0%	**102,966**	
South Shore								
CO_2 Emissions	3,994	11,515		N/A	N/A	N/A	**15,509**	20%
Biogenic CO_2 Emissions	15,129	N/A		43,251	N/A	N/A	**58,380**	77%
CH_4 Emissions	1,291	2.8		N/A	N/A	N/A	**1,294**	2%
N_2O Emissions	17	59.7		N/A	N/A	567	**643**	1%
Total CO_2e Emissions	**20,431**	**11,577**	**43,818**	**43,251**	N/A	**567**	75,826	
Percentage of Total (including biogenic emissions)	27%	15%	58%	57%	N/A	1%		
Percentage of Total (not including biogenic emissions)	63%	36%		N/A	N/A	2%	**32,575**	
Headquarters & Lab								
CO_2 Emissions	584	1,746		N/A	N/A	N/A	**2,331**	99.6%
Biogenic CO_2 Emissions	N/A	N/A		N/A	N/A	N/A	**N/A**	0%
CH_4 Emissions	0.2	0.43		N/A	N/A	N/A	**1**	0.0%
N_2O Emissions	0.3	9.05		N/A	N/A	N/A	**9**	0.4%
Total CO_2 Emissions	**585**	**1,756**	N/A	N/A	N/A	N/A	**2,341**	
Percentage of Total	25%	75%						
Other Sources[c]								
CO_2 Emissions	1,063	1,943		N/A	N/A	N/A	**3,005**	99.6%
Biogenic CO_2 Emissions	N/A	N/A		N/A	N/A	N/A	**N/A**	0%
CH_4 Emissions	0	0.48		N/A	N/A	N/A	**1**	0.0%
N_2O Emissions	1	10.07		N/A	N/A	N/A	**11**	0.4%
Total CO_2 Emissions	**1,064**	**1,953**	N/A	N/A	N/A	N/A	**3,018**	
Percentage of Total	35%	65%						

[a] Include methane emissions from incomplete combustion of biogas for South Shore.

[b] Emissions from water reclamation processes.

[c] Other sources include: 13th street, Alterra, and the Interceptor Pumping Stations.

Direct Emissions: Stationary Combustion Sources
Greenhouse Gas Inventory for MMSD in Milwaukee, WI
2006 Annual GHG Emissions

Facility/Emission Sources	Fuel/Emission Source Type	Energy Use (MMBTU/yr)[a]	Fuel Use (1000 gal/yr)[a]	CO_2 Emission Factor (kg/MMBtu)	CO_2 Emissions (kg/year)[b]	N_2O Emission Factor (g/MMBtu or lb/1000 gal)[c]	N_2O Emissions (kg/year)	CH_4 Emission Factor (g/MMBtu or lb/1000 gal)[c]	CH_4 Emissions (kg/year)	Total CO_2e Emissions (kg/yr)[d]	Total CO_2e Emissions (metric tons/yr)[d]
Jones Island											
Rotary Sludge Dryers	Stationary Natural Gas - Boilers or Dryers	207,888		53.06	11,030,537	0.9	187	0.9	187	**11,092,467**	11,092
(2) 16MW Turbines	Stationary Natural Gas - Turbines	979,841		53.06	51,990,363	0.9	882	3.8	3,723	**52,341,930**	52,342
(2) 16MW Turbines	Stationary Distillate Fuel Oil (#1, 2, &4)	804		73.15	58,813	0.3	0	3	2	**58,938**	59
(2) Cleaver Brooks Boilers	Stationary Natural Gas - Boilers or Dryers	14,642		53.06	776,905	0.9	13	0.9	13	**781,266**	781
(2) Cleaver Brooks Boilers	Stationary Distillate Fuel Oil (#1, 2, &4)	75		73.15	5,486	0.3	0	3	0	**5,498**	5
Facility Space Heaters & Boilers <5 mmbtu/hr	Stationary Natural Gas - Default	58,030		53.06	3,079,072	0.1	6	1	58	**3,082,089**	3,082
Facility Space Heaters & Boilers <5 mmbtu/hr	Stationary Propane	105.3	1.8	63.07	6,641	0.9	0	0.2	0	**6,641**	7
					66,947,817		1,088		3,984	**67,368,830**	**67,369**

Direct Emissions: Stationary Combustion Sources

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2006 Annual GHG Emissions

Facility/Emission Sources	Fuel/Emission Source Type	Energy Use (MMBTU/yr)[a]	Fuel Use (1000 gal/yr)[a]	CO_2 Emission Factor (kg/MMBtu)	CO_2 Emissions (kg/year)[b]	N_2O Emission Factor (g/MMBtu or lb/1000 gal)[c]	N_2O Emissions (kg/year)	CH_4 Emission Factor (g/MMBtu or lb/1000 gal)[c]	CH_4 Emissions (kg/year)	Total CO_2e Emissions (kg/yr)[d]	Total CO_2e Emissions (metric tons/yr)[d]
South Shore											
Facility Space Heaters & Boilers <5 mmbtu/hr	Stationary Natural Gas - Boilers or Dryers	18,500		53.06	981,610	0.9	17	0.9	17	**987,121**	987
Boilers - (3) Kewaunee, (2) Scum, (2) Cleaver Brooks	Stationary Natural Gas - Boilers or Dryers	4,881		53.06	258,986	0.9	4	0.9	4	**260,440**	260
IC Engine Generators (5)	Stationary Natural Gas - Default	51,897		53.06	2,753,655	0.1	5	1	52	**2,756,353**	2,756
Boilers - (3) Kewaunee, (2) Cleaver Brooks [b]	Stationary Wastewater Treatment Biogas	15,718		52.07	*818,451*	0.1	2	0.9	14	**819,236**	819
IC Engine Generators (5)[b]	Stationary Wastewater Treatment Biogas	205,132		52.07	*10,681,214*	0.1	21	0.9	185	**10,691,450**	10,691
Flares[b]	Stationary Wastewater Treatment Biogas	69,692		52.07	*3,628,880*	0.1	7	0.9	63	**3,632,358**	3,632
					19,122,796		55		334	**19,146,958**	**19,147**
Headquarters & Lab											
Building Heat	Stationary Natural Gas - Default	11,014		53.06	584,408	0.1	1	1	11	**584,981**	585
Other Sources											
S. 13th Street Boilers	Stationary Natural Gas - Boilers or Dryers	2,792		53.06	148,165	0.9	3	0.9	3	**148,997**	149
Alterra Building Heat	Stationary Natural Gas - Default	0		53.06	16	0.1	0	1	0	**16**	0
Pump Stations, etc.	Stationary Natural Gas - Default	17,234		53.06	914,431	0.1	2	1	17	**915,327**	915
					1,062,611		4		20		**1,064**
All Facilities					87,717,633		1,149		4,350		**88,165**

[a] Energy/fuel usage data obtained from purchasing records and annual air emission inventory reports.

[b] CO_2 emissions from wastewater treatment biogas are considered biogenic and not reported as scope 1 emissions.

[c] CH_4 and N_2O emission factors for propane are in lb/1000 gal.

[d] CO_2 equivalents are calculated by multiplying the global warming potential (GWP) by the CO_2 emissions. The GWP for CO_2 is 1, N_2O is 310 and CH_4 is 21.

Indirect Emissions: Purchased Electricity

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2006 Annual GHG Emissions

Facility	Electricity Use (MWh)[a]	CO_2 Emission Factor[b] (lb/MWh)	CO_2 Emissions (kg/year)	N_2O Emission Factor[b] (lb/MWh)	N_2O Emissions (kg/year)	CH_4 Emission Factor[b] (lb/MWh)	CH_4 Emissions (kg/year)	Total CO_2e Emissions (kg/yr)[c]	Total CO_2e Emissions (metric tons/yr)[c]
Jones Island	49,975	1537.82	34,860,330	0.0257	583	0.018	408	35,049,500	35,050
South Shore	16,507	1537.82	11,514,669	0.0257	192	0.018	135	11,577,153	11,577
Headquarters &	2,504	1537.82	1,746,499	0.0257	29	0.018	20	1,755,977	1,756
Renewable Energy [e]	*175*	*1537.82*	*122,211*	*0.0257*	*2*	*0.018*	*1*	*122,874*	*123*
Other Sources									
S. 13th Street	405	1537.82	282,724	0.0257	5	0.018	3	284,258	284
Alterra Coffee Shop	11	1537.82	7,366	0.0257	0	0.018	0	7,406	7
Pump Stations, Gate	2,369	1537.82	1,652,753	0.0257	28	0.018	19	1,661,722	1,662
									1,953

[a] Electricity usage data obtained from purchasing records.

[b] Emission factors are from the eGRID Sub Region Emission Rates for RFC West.

[c]CO_2 equivalents are calculated by multiplying the global warming potential (GWP) by the CO_2 emissions. and CH_4 is 21.
The GWP for CO_2 is 1, N_2O is 310

[d] In 2007, 14,600 kwhrs/month of electricity purchased was green energy (175,200 kwhr/year). Emissions reductions for green power purchases are calculated separately.

[e]Calculated emissions are reductions estimated from green power purchases and are therefore not included as inventory emissions.

Direct Emissions: Mobile Combustion Sources/Equipment

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2006 Annual GHG Emissions

Facility	Fuel and Mobile Source	Miles Traveled[a]	Fuel usage (gal.)[b]	CO_2 Emission Factor (kg/gal)	CO_2 Emissions (kg/year)	N_2O Emission Factor (g/mile or g/gal.)	N_2O Emissions (kg/year)	CH_4 Emission Factor (g/mile or g/gal.)	CH_4 Emissions (kg/year)	Total CO_2e Emissions (kg/yr)[f]	Total CO_2e Emissions (metric tons/yr)[f]
MMSD Cars and Light Trucks	Gasoline Passenger Cars	290,000	13,122	8.81	115,606	0.0197	6	0.178	52	118,461	118.46
Veolia Cars and Light Trucks	Gasoline Light-Duty Trucks	310,000	17,514	8.81	154,299	0.022	7	0.2024	63	157,731	157.73
Televising & Manhole Trucks	Gasoline Heavy Duty Vehicles	60,000	3,390	8.81	29,864	0.0497	3	0.4604	28	31,369	31.37
Class 8 Trucks	Diesel Heavy-Duty Vehicles	60,000	7,229	10.15	73,373	0.0048	0	0.0051	0	73,469	73.47
Light Med & Heavy Dump Trucks	Diesel Heavy-Duty Vehicles	50,000	8,450	10.15	85,768	0.0048	0	0.0051	0	85,847	85.85
Wheel loaders & Skid Loaders	Gasoline Heavy Duty Vehicles	4,500	900	8.81	7,929	0.0497	0	0.4604	2	8,042	8.04
Straddle Carriers	Gasoline Heavy Duty Vehicles	1,000	200	8.81	1,762	0.0497	0	0.4604	0	1,787	1.79
Burden Carriers & ATVs	Gas Small Utility	19,500	3,900	8.81	34,359	0.22	1	0.5	2	34,666	34.67
Tractors & Lawn Mowers	Gasoline Agricultural Equipment	7,250	1,450	8.81	12,775	0.22	0	1.26	2	12,912	12.91
Snow Blowers	Gas Small Utility	4,250	850	8.81	7,489	0.22	0	0.5	0	7,555	7.56
Diesel Generators	Diesel Construction Equipment		1,000	10.15	10,150	0.26	0	0.58	1	10,243	10.24
Gasoline Generators	Gasoline Heavy Duty Vehicles		1,000	8.81	8,810	0.0497	0	0.4604	0	8,810	8.81
Pelagos Research Vessel[c]	Gasoline Ships and Boats		1,585	8.81	13,964	0.22	0	0.64	1	14,093	14.09
ORP Research Boat[c]	Gasoline Ships and Boats		1,585	8.81	13,964	0.22	0	0.64	1	14,093	14.09
AgriLife Land Spreading[d]	Diesel Heavy-Duty Vehicles	40,000	6,760	10.15	68,614	0.0048	0	0.0051	0	68,678	68.68
Locomotive[e]	Diesel Locomotives		795	10.15	8,069	0.26	0	0.8	1	8,147	8.15
Total Mobile Sources					646,795		19		153	655,904	656

Direct Emissions: Mobile Combustion Sources/Equipment

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2006 Annual GHG Emissions

[a] Miles traveled based upon number of vehicles and estimated annual average mileage as shown below. The number of vehicles for each type based upon 2009 vehicle data provided by MMSD "Complete Vehicle and Equipment list, revised 4-09.xls".

	No. of Vehicles	Estimated Avg. Miles per Year per Vehicle	Total Miles per Year
MMSD Cars and Light Trucks:	29	10,000	290,000
Veolia Cars and Light Trucks:	62	5,000	310,000
Televising & Manhole Trucks:	12	5,000	60,000
Class 8 Trucks	12	5,000	60,000
Light Med & Heavy Dump Trucks	10	5,000	50,000
Wheel loaders & Skidloaders	9	500	4,500
Straddle Carriers	2	500	1,000
Burden Carriers & ATVs	38	500	19,000
Tractors & Lawn Mowers	27	250	6,750
Snow Blowers	16	250	4,000

[b] The following factors were used to estimate gallons of fuel consumed based on estimated miles driven per vehicle type:

Vehicle Type	Avg mpg	Source
Passenger Cars	22.1	
Other 2-axle, 4-tire vehicles	17.7	U.S. Department of Transportation Federal Highway Administration Annual Vehicle Distance Traveled in Miles and
Single unit 2-axle 6-tire or more trucks	8.3	Related Data- 2006, http://www.fhwa.dot.gov
Combination Trucks	5.9	Climate Leaders GHG Protocol, Direct Emissions from Mobile Combustion Sources, May 2008.
Other Vehicles	5.00	Assumed all other small vehicles (e.g. Loaders, Carriers, Tractors and Snow Blowers) get an average of 5 mpg

[c] Pelagos Research Vessel based upon fuel purchases in 2007, assumed ORP Research Boat fuel usage was equal to Pelagos Research Vessel fuel usage.

[d] Annual mileage based upon 2007 Agri Life sludge landspreading records.

[e] Locomotive fuel usage estimated based upon 2007 annual tons of milorganite produced, a distance of 3 miles to transport the Milorganite, and a Btu/ton-mile factor of 337 (EPA Climate Leader's Mobile Source guidance document).

[f] CO_2 equivalents are calculated by multiplying the global warming potential (GWP) by the CO_2 emissions. The GWP for CO_2 is 1, N_2O is 310 and CH_4 is 21.

Direct Emissions: Water Reclamation Facility Emissions
South Shore Water Reclamation Facility
Greenhouse Gas Inventory for MMSD in Milwaukee, WI
2006 Annual GHG Emissions

Methodology:
Calculation methodology from California Climate Action Registry (CCAR) Local Government Operations Protocol, chapter 10 on Centralized Wastewater Treatment Facilities (except for biogenic CO_2 emissions which are based upon data obtained from Metcalf and Eddy Wastewater Engineering Treatment, Disposal, and Reuse). CCAR equations use the EPA Inventory of US Greenhouse Gas Emissions and Sinks: 1990–2006, Chapter 8, 8–9 (2008) Calculation methodology to estimate biogenic CO_2 emissions from wastewater treatment processes, such as the use of aeration basins, sludge digesters and combustion of biogas may be included in the future CCAR wastewater treatment industry GHG protocol scheduled to be released in 2010).

Biogenic CO_2 from Water Reclamation Processes[a]

$$CO_2\left[\frac{metric\ tons\ CO_2}{year}\right] \equiv BOD_5 Load\left[\frac{kg\ BOD_5}{day}\right] \times EF_{biogenic\ CO_2}\left[\frac{kg\ CO_2}{kg\ BOD_5}\right] \times F_{oxidation} \times 365\left[\frac{day}{year}\right] \times 10^{-3}\left[\frac{metric\ ton}{kg}\right]$$

where

Term	Description	Value	GHG Emissions (metric ton CO_2e/year)[b]	Source of Data
Biogenic CO_2	= biogenic CO_2 emissions from a centralized WWTP [metric ton CO_2/year]	**43,251**	**43,251**	
BOD_5 load	= average amount of BOD_5 produced per day [kg BOD_5/day]	74,060		Annual Discharge Monitoring Report
$EF_{biogenic\ CO2}$	= emission factor [kg CO_2/kg BOD_5]	2		Metcalf & Eddy Wastewater Engineering
$F_{oxidation}$	= factor for level of oxidation for a centralized WWTP with an anaerobic or aerobic sludge digester	0.8		Metcalf & Eddy Wastewater Engineering
365	= conversion factor [day/year]	365		Conversion factor
10^{-3}	= conversion from kg to metric ton [metric ton/kg]	1.E-03		Conversion factor

Direct Emissions: Water Reclamation Facility Emissions
South Shore Water Reclamation Facility
Greenhouse Gas Inventory for MMSD in Milwaukee, WI
2006 Annual GHG Emissions

Methane from Incomplete Combustion of Digester Gas (included with Stationary Combustion Emissions)

$$CH_4\left[\frac{metric\ tons}{year}\right] \equiv Digester\ Gas\left[\frac{ft^3}{yr}\right] \times F_{CH_4} \times \rho\left(_{CH_4}\right)\left[\frac{g}{m^3}\right] \times (1-DE) \times 0.0283\left[\frac{m^3}{ft^3}\right] \times 10^{-6}\left[\frac{metric\ ton}{g}\right]$$

where

Term	Description	Value	GHG Emissions (metric ton CO_2e/year)	Source of Data
CH_4 incomplete combustion of digester gas	= CH_4 emissions from incomplete combustion of digester gas [metric ton CH_4/year]	**61.2**	**1284**	
Digester Gas	= measured standard cubic feet of digester gas produced per day [ft^3/year]	544,087,000		Annual Emission Inventory Report
F_{CH4}	= measured fraction of CH_4 in biogas	0.6		Annual Emission Inventory Report
$\rho(CH_4)$	= density of methane at standard conditions [g/m^3]	662.00		Protocol default value.
DE	= CH_4 destruction efficiency from flaring or burning in engine	0.99		Protocol default value.
0.0283	= conversion from ft^3 to m^3 [m^3/ft^3]	0.0283		Conversion factor
10^{-6}	= conversion from g to metric ton [metric ton/g]	1.E-06		Conversion factor

Direct Emissions: Water Reclamation Facility Emissions
South Shore Water Reclamation Facility
Greenhouse Gas Inventory for MMSD in Milwaukee, WI
2006 Annual GHG Emissions

Process Emissions from Water Reclamation Processes

$$N_2O\left[\frac{metric\ tons}{year}\right] \equiv P_T\left[person\right] \times \frac{Plant\ Flow}{DISTRICT\ Flow}\left[\frac{\frac{MG}{year}}{\frac{MG}{year}}\right] \times EF_{nit/denit}\left[\frac{g\ N_2O}{person \times year}\right] \times 10^{-6}\left[\frac{metric\ ton}{g}\right]$$

where

Term	Description	Value	GHG Emissions (metric ton CO_2e/year)	Source of Data
N_2O plant	= N_2O emissions from a centralized WWTP [metric ton N_2O/year]	**1.83**	**567**	
P_P	= total population served by the WWTP, person	571,239		Population served for all of MMSD obtained from MMSD annual financial report. Population served by South Shore calculated based upon total population served times % of total annual flow treated by South Shore.
P_T	= total population served by the DISTRICT, person	1,057,992		
Plant Flow	= plant flow [MG/year]	102.57		
DISTRICT Flow	= DISTRICT flow [MG/year]	189.97		
EF nit/denit	= emission factor for a WWTP without nitrification/denitrification [g N_2O/year]	3.2		Protocol default value for plants without nitrification/denitrification.
10^{-6}	= conversion from g to metric ton [metric ton/g]	1.E-06		Conversion factor

[a] Methodology for calculating biogenic CO_2 is not included in the CCAR Local Government Operations Protocol, but may be included in the CCAR wastewater treatment industry protocol that is scheduled to be released in 2010.

[b] CO_2 equivalents are calculated by multiplying the global warming potential (GWP) by the CO_2 emissions. The GWP for CO_2 is 1, N_2O is 310 and CH_4 is 21.

Direct Emissions: Water Reclamation Facility Emissions

Jones Island Water Reclamation Facility

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2006 Annual GHG Emissions

Methodology:

Calculation methodology from California Climate Action Registry (CCAR) Local Government Operations Protocol, chapter 10 on Centralized Wastewater Treatment Facilities (except for biogenic CO^2 emissions which are based upon data obtained from Metcalf and Eddy Wastewater Engineering Treatment, Disposal, and Reuse). CCAR equations use the EPA Inventory of US Greenhouse Gas Emissions and Sinks: 1990–2006, Chapter 8, 8–9 (2008) Calculation methodology to estimate biogenic CO2 emissions from wastewater treatment processes, such as the use of aeration basins, sludge digesters and combustion of biogas may be included in the future CCAR wastewater treatment industry GHG protocol scheduled to be released in 2010).

Biogenic CO_2 from Water Reclamation Processes[a]

$$CO_2\left[\frac{metric\ tons\ CO_2}{year}\right] \equiv BOD_5 Load\left[\frac{kg\ BOD_5}{day}\right] \times EF_{biogenic\ CO_2}\left[\frac{kg\ CO_2}{kg\ BOD_5}\right] \times F_{oxidation} \times 365\left[\frac{day}{year}\right] \times 10^{-3}\left[\frac{metric\ ton}{kg}\right]$$

where

Term	Description	Value	GHG Emissions (metric ton CO_2e/year)[b]	Source of Data
Biogenic CO2	= biogenic CO_2 emissions from a centralized WWTP [metric ton CO_2/year]	**48,611**	**48,611**	
BOD_5 load	= average amount of BOD_5 produced per day [kg BOD_5/day]	83,238		Annual Discharge Monitoring Report
$EF_{biogenic\ CO2}$	= emission factor [kg CO_2/kg BOD_5]	2		Metcalf & Eddy Wastewater Engineering
$F_{oxidation}$	= factor for level of oxidation for a centralized WWTP with an anaerobic or aerobic sludge digester	0.8		Metcalf & Eddy Wastewater Engineering
365	= conversion factor [day/year]	365		Conversion factor
10^{-3}	= conversion from kg to metric ton [metric ton/kg]	1.E-03		Conversion factor

Direct Emissions: Water Reclamation Facility Emissions

Jones Island Water Reclamation Facility

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2006 Annual GHG Emissions

Methane from Incomplete Combustion of Digester Gas (included with Stationary Combustion Emissions)

Digester Gas is not burned at Jones Island

$$CH_4\left[\frac{metric\ tons}{year}\right] \equiv Digester\ Gas\left[\frac{ft^3}{yr}\right] \times F_{CH_4} \times \rho\left(_{CH_4}\right)\left[\frac{g}{m^3}\right] \times (1 - DE) \times 0.0283\left[\frac{m^3}{ft^3}\right] \times 10^{-6}\left[\frac{metric\ ton}{g}\right]$$

where

Term	Description	Value	GHG Emissions (metric ton CO_2e/year)	Source of Data
CH_4 incomplete combustion of digester gas	= CH_4 emissions from incomplete combustion of digester gas [metric ton CH_4/year]	**0.0**	**0**	
Digester Gas	= measured standard cubic feet of digester gas produced per day [ft^3/year]	0		Annual Emission Inventory Report
F_{CH4}	= measured fraction of CH_4 in biogas	0		Annual Emission Inventory Report
$\rho(CH_4)$	= density of methane at standard conditions [g/m^3]	662.00		Protocol default value.
DE	= CH_4 destruction efficiency from flaring or burning in engine	0.99		Protocol default value.
0.0283	= conversion from ft^3 to m^3 [m^3/ft^3]	0.0283		Conversion factor
10^{-6}	= conversion from g to metric ton [metric ton/g]	1.E-06		Conversion factor

Direct Emissions: Water Reclamation Facility Emissions

Jones Island Water Reclamation Facility

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2006 Annual GHG Emissions

Process Emissions from Water Reclamation Processes

$$N_2O\left[\frac{metric\ tons}{year}\right] \equiv P_T\left[person\right] \times \frac{Plant\ Flow}{DISTRICT\ Flow}\left[\frac{\frac{MG}{year}}{\frac{MG}{year}}\right] \times EF_{nit/denit}\left[\frac{g\ N_2O}{person \times year}\right] \times 10^{-6}\left[\frac{metric\ ton}{g}\right]$$

where

Term	Description	Value	GHG Emissions (metric ton CO_2e/year)	Source of Data
N_2O plant	= N_2O emissions from a centralized WWTP [metric ton N_2O/year]	**1.56**	**483**	
P_P	= total population served by the WWTP, person	486,753		Population served for all of MMSD obtained from MMSD annual financial report. Population served by Jones Island calculated based upon total population served times % of total annual flow treated by Jones Island.
P_T	= total population served by the DISTRICT, person	1,057,992		
Plant Flow	= plant flow [MG/year]	87.40		
DISTRICT Flow	= DISTRICT flow [MG/year]	189.97		
EF nit/denit	= emission factor for a WWTP without nitrification/denitrification [g N_2O/year]	3.2		Protocol default value for plants without nitrification/denitrification.
10^{-6}	= conversion from g to metric ton [metric ton/g]	1.E-06		Conversion factor

Direct Emissions: Water Reclamation Facility Emissions

Jones Island Water Reclamation Facility

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2006 Annual GHG Emissions

Process Emissions from Sludge Drying

$$CH_4\left[\frac{metric\ tons}{year}\right] \equiv BSD\left[\frac{tons}{year}\right] \times EF\left[\frac{kg\,CH_4}{tonBSD}\right] \times 10^{-3}\left[\frac{metric\ ton}{kg}\right]$$

where

Term	Description	Value	GHG Emissions (metric ton CO_2e/year)	Source of Data
CH_4	= CH_4 emissions from a sludge drying [metric ton CH_4/year]	**3.09**	**65**	
BSD	= blended sludge through dryers [dry tons/year]	43,120		Air Emission Inventory Report throughput for P01
EF	= emission factor for drying sludge [kg CH_4/ton dry solids]	0.072		December 2007 JI Dryer Stack Test Data, average of 3 tests, methane from natural gas combustion from turbine waste heat is subtracted.
10^{-3}	= conversion from g to metric ton [metric ton/kg]	1.E-03		Conversion factor

[a] Methodology for calculating biogenic CO_2 is not included in the CCAR Local Government Operations Protocol, but may be included in the CCAR wastewater treatment industry protocol that is scheduled to be released in 2010.

[b]CO_2 equivalents are calculated by multiplying the global warming potential (GWP) by the CO_2 emissions. The GWP for CO_2 is 1, N_2O is 310 and CH_4 is 21.

Inventory Calculations: 2007

Non-Biogenic GHG Emissions (metric tons CO_2eq/year) by Facility and Source

Greenhouse Gas Inventory for MMSD in Milwaukee, WI
2007 Annual GHG Emissions

Facility	Stationary Combustion	Purchased Electricity	Water Reclamation Emissions	Mobile Combustion	Total	% of Total All Facilities
Jones Island (non-biogenic)	72,800	28,300	600		**101,700**	81.4%
Percentage of Jones Island	*72%*	*28%*	*0.6%*			
South Shore (non-biogenic)	5,900	10,400	600		**16,900**	13.5%
Percentage of South Shore	*35%*	*62%*	*4%*			
Headquarters and Laboratory	600	1,800			**2,400**	1.9%
Other Stationary Sources	1,000	2,200			**3,200**	2.6%
Mobile Sources				700	**700**	0.6%
Total All Facilities	**80,300**	**42,700**	**1,200**	**700**	**124,900**	
Percentage of Total	64.3%	34.2%	1.0%	0.6%		

Biogenic and Non-Biogenic GHG Emissions (metric tons CO_2eq/year) by Facility and Source

Greenhouse Gas Inventory for MMSD in Milwaukee, WI
2007 Annual GHG Emissions

Facility	Stationary Combustion	Purchased Electricity	Water Reclamation Emissions	Mobile Combustion	Total	% of Total All Facilities
Jones Island (non-biogenic)	72,800	28,300	600		**101,700**	44.3%
Jones Island (biogenic)			46,600		**46,600**	20.3%
Jones Island Subtotal	*72,800*	*28,300*	*47,200*		***148,300***	*64.6%*
Percentage of Jones Island	*49%*	*19%*	*32%*			
South Shore (non-biogenic)	5,900	10,400	600		**16,900**	7.4%
South Shore (biogenic)	17,500		40,600		**58,100**	25.3%
South Shore Subtotal	*23,400*	*10,400*	*41,200*		***75,000***	*32.7%*
Percentage of South Shore	*31%*	*14%*	*55%*			
Headquarters and Laboratory	600	1,800			**2,400**	1.0%
Other Stationary Sources	1,000	2,200			**3,200**	1.4%
Mobile Sources				700	**700**	0.3%
Total All Facilities	**97,800**	**42,700**	**88,400**	**700**	**229,600**	
Percentage of Total	42.6%	18.6%	38.5%	0.3%		

GHG Emissions (metric tons CO_2eq/year) by Type

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2007 Annual GHG Emissions

Scope 1: Direct Fossil Fuel Emissions	**81,036**	**metric tons CO_2eq/year**
Scope 2: Indirect Energy Emissions	**42,606**	**metric tons CO_2eq/year**
Emissions Unique to Water Reclamation Facilities	**88,270**	**metric tons CO_2eq/year**

	CO_2 Emissions	Biogenic CO_2 Emissions	CH_4 Emissions	N_2O Emissions	Total Emissions	% of Total	Total Emissions w/out Biogenic CO_2	% of Total w/out Biogenic CO_2
Stationary Combustion (Scope 1: direct emissions)	78,354	17,451	1,641.5	384.2	97,831	42.7%	80,380	64.5%
Mobile Combustion (Scope 1: direct emissions)	647	N/A	3.21	5.9	656	0.3%	656	0.5%
Purchased Electricity (Scope 2: indirect emissions)	42,376	N/A	10	220	42,606	18.6%	42,606	34.2%
Water Reclamation Emissions	0	87,219	70	1,051	88,270	38.5%	1,051	0.8%
Biogenic CO_2 emissions from water reclamation processes	N/A	87,219	N/A	N/A	87,219	38.0%	0	0.0%
N_2O emissions from water reclamation processes	N/A	N/A	N/A	1,051	1,051	0.5%	1,051	0.8%
CH_4 emissions from sludge drying	N/A	N/A	70	N/A	70	0.0%	70	0.1%
Total	**121,378**	**104,670**	**1,726**	**1,661**	**229,364**		**124,693**	**124,693**
% of Total	52.9%	45.6%	0.8%	0.7%				

Definitions (WRI Protocol terminology)

Scope 1 emissions: All direct GHG emissions, with the exception of direct CO_2 emissions from biogenic sources.

Direct emissions: Emissions from sources within the reporting entity's organizational boundaries that are owned or controlled by the reporting entity, including stationary combustion emissions, mobile combustion emissions, process emissions, and fugitive emissions.

Scope 2 emissions: Indirect GHG emissions associated with the consumption of purchased or acquired electricity, heating, cooling, or steam.

Indirect emissions: Emissions that are a consequence of activities that take place within the organizational boundaries of the reporting entity, but that occur at sources owned or controlled by another entity.

Biogenic carbon: Carbon derived from biogenic (plant or animal) sources excluding fossil carbon.

GHG Emissions (metric tons CO_2eq/year) by Facility and Type

Greenhouse Gas Inventory for MMSD in Milwaukee, WI
2007 Annual GHG Emissions

			Water Reclamation Facility Emissions w/ Biogenic CO_2					
	Stationary Combustion[a]	Purchased Electricity	Total WRF Emissions	Biogenic CO_2 Emissions[b]	Sludge Drying CH_4 Emissions[b]	Plant N_2O Emissions[b]	Total	% of Total
All Facilities								
CO_2 Emissions	78,354	42,376		N/A	N/A	N/A	**120,731**	53%
Biogenic CO_2 Emissions	17,451	N/A		87,219	N/A	N/A	**104,670**	46%
CH_4 Emissions	1,641	10		N/A	70	N/A	**1,722**	1%
N_2O Emissions	384	220		N/A	N/A	1,051	**1,655**	1%
Total CO_2e Emissions	**97,831**	**42,606**	**88,341**	**87,219**	**70**	**1,051**	**228,778**	
Percentage of Total (including biogenic emissions)	43%	19%	39%	38%	0%	0%		
Percentage of Total (not including biogenic emissions)	69%	30%		N/A	0%	1%	**141,559**	
Jones Island								
CO_2 Emissions	72,345	28,161		N/A	N/A	N/A	**100,506**	68%
Biogenic CO_2 Emissions	N/A	N/A		46,652	N/A	N/A	**46,652**	31%
CH_4 Emissions	94	6.9		N/A	70	N/A	**171**	0.1%
N_2O Emissions	364	145.9		N/A	N/A	479	**989**	1%
Total CO_2e Emissions	**72,803**	**28,313**	**47,201**	**46,652**	**70**	**479**	**148,317**	
Percentage of Total (including biogenic emissions)	49%	19%	32%	31%	0%	0%		
Percentage of Total (not including biogenic emissions)	72%	28%		N/A	0%	0%	**101,666**	
South Shore								
CO_2 Emissions	4,361	10,321		N/A	N/A	N/A	**14,682**	20%
Biogenic CO_2 Emissions	17,451	N/A		40,568	N/A	N/A	**58,019**	77%
CH_4 Emissions	1,547	2.5		N/A	N/A	N/A	**1,550**	2%
N_2O Emissions	19	53.5		N/A	N/A	572	**644**	1%
Total CO_2e Emissions	**23,378**	**10,377**	**41,140**	**40,568**	N/A	**572**	**74,895**	
Percentage of Total (including biogenic emissions)	31%	14%	55%	54%	N/A	1%		
Percentage of Total (not including biogenic emissions)	68%	30%		N/A	N/A	2%	**34,328**	
Headquarters & Lab								
CO_2 Emissions	613	1,736		N/A	N/A	N/A	**2,349**	99.6%
Biogenic CO_2 Emissions	N/A	N/A		N/A	N/A	N/A	**N/A**	0%
CH_4 Emissions	0.2	0.43		N/A	N/A	N/A	**1**	0.0%
N_2O Emissions	0.4	8.99		N/A	N/A	N/A	**9**	0.4%
Total CO_2 Emissions	**614**	**1,745**	N/A	N/A	N/A	N/A	**2,359**	
Percentage of Total	26%	74%						
Other Sources[c]								
CO_2 Emissions	1,035	2,158		N/A	N/A	N/A	**3,193**	99.6%
Biogenic CO_2 Emissions	N/A	N/A		N/A	N/A	N/A	**N/A**	0%
CH_4 Emissions	0	0.53		N/A	N/A	N/A	**1**	0.0%
N_2O Emissions	1	11.18		N/A	N/A	N/A	**12**	0.4%
Total CO_2 Emissions	**1,037**	**2,170**	N/A	N/A	N/A	N/A	**3,207**	
Percentage of Total	32%	68%						

[a] Include methane emissions from incomplete combustion of biogas for South Shore.

[b] Emissions from water reclamation processes.

[c] Other sources include: 13th street, Alterra, and the Interceptor Pumping Stations.

Direct Emissions: Stationary Combustion Sources

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2007 Annual GHG Emissions

Facility/Emission Sources	Fuel/Emission Source Type	Energy Use (MMBTU/yr)[a]	Fuel Use (1000 gal/yr)[a]	CO_2 Emission Factor (kg/MMBtu)	CO_2 Emissions (kg/year)[b]	N_2O Emission Factor (g/MMBtu or lb/1000 gal)[c]	N_2O Emissions (kg/year)	CH_4 Emission Factor (g/MMBtu or lb/1000 gal)[c]	CH_4 Emissions (kg/year)	Total CO_2e Emissions (kg/yr)[d]	Total CO_2e Emissions (metric tons/yr)[d]
Jones Island											
Rotary Sludge Dryers	Stationary Natural Gas - Boilers or Dryers	179,751		53.06	9,537,588	0.9	162	0.9	162	**9,591,136**	9,591
(2) 16MW Turbines	Stationary Natural Gas - Turbines	1,110,316		53.06	58,913,367	0.9	999	3.8	4,219	**59,311,748**	59,312
(2) 16MW Turbines	Stationary Distillate Fuel Oil (#1, 2, &4)	3,759		73.15	274,980	0.3	1	3	11	**275,566**	276
(2) Cleaver Brooks Boilers	Stationary Natural Gas - Boilers or Dryers	5,923		53.06	314,274	0.9	5	0.9	5	**316,039**	316
(2) Cleaver Brooks Boilers	Stationary Distillate Fuel Oil (#1, 2, &4)	69		73.15	5,057	0.3	0	3	0	**5,068**	5
Facility Space Heaters & Boilers <5 mmbtu/hr	Stationary Natural Gas - Default	61,997		53.06	3,289,561	0.1	6	1	62	**3,292,785**	3,293
Facility Space Heaters & Boilers <5 mmbtu/hr	Stationary Propane	164.3	1.8	63.07	10,363	0.9	0	0.2	0	**10,363**	10
					72,345,191		1,174		4,460	**72,802,705**	**72,803**
South Shore											
Facility Space Heaters & Boilers <5 mmbtu/hr	Stationary Natural Gas - Boilers or Dryers	21,087		53.06	1,118,876	0.9	19	0.9	19	**1,125,158**	1,125
Boilers - (3) Kewaunee, (2) Scum, (2) Cleaver Brooks	Stationary Natural Gas - Boilers or Dryers	2,247		53.06	119,226	0.9	2	0.9	2	**119,895**	120
IC Engine Generators (5)	Stationary Natural Gas - Default	58,855		53.06	3,122,846	0.1	6	1	59	**3,125,907**	3,126
Boilers - (3) Kewaunee, (2) Cleaver Brooks [b]	Stationary Wastewater Treatment Biogas	15,506		52.07	*807,389*	0.1	2	0.9	14	**808,163**	808
IC Engine Generators (5)[b]	Stationary Wastewater Treatment	267,968		52.07	*13,953,080*	0.1	27	0.9	241	**13,966,451**	13,966
Flares[b]	Stationary Wastewater Treatment	51,672		52.07	*2,690,583*	0.1	5	0.9	47	**2,693,161**	2,693
					21,812,000		60		381	**21,838,735**	**21,839**

Direct Emissions: Stationary Combustion Sources
Greenhouse Gas Inventory for MMSD in Milwaukee, WI
2007 Annual GHG Emissions

Facility/Emission Sources	Fuel/Emission Source Type	Energy Use (MMBTU/yr)[a]	Fuel Use (1000 gal/yr)[a]	CO_2 Emission Factor (kg/MMBtu)	CO_2 Emissions (kg/year)[b]	N_2O Emission Factor (g/MMBtu or lb/1000 gal)[c]	N_2O Emissions (kg/year)	CH_4 Emission Factor (g/MMBtu or lb/1000 gal)[c]	CH_4 Emissions (kg/year)	Total CO_2e Emissions (kg/yr)[d]	Total CO_2e Emissions (metric tons/yr)[d]
Headquarters & Lab											
Building Heat	Stationary Natural Gas - Default	11,561		53.06	613,421	0.1	1	1	12	**614,023**	614
Other Sources											
S. 13th Street Boilers	Stationary Natural Gas - Boilers or Dryers	2,777		53.06	147,321	0.9	2	0.9	2	**148,148**	148
Alterra Building Heat	Stationary Natural Gas - Default	0		53.06	0	0.1	0	1	0	**-**	-
Pump Stations, etc.	Stationary Natural Gas - Default	16,728		53.06	887,566	0.1	2	1	17	**888,436**	888
					1,034,888		4		19		**1,037**
All Facilities					95,805,500		1,239		4,872		**96,292**

[a] Energy/fuel usage data obtained from purchasing records and annual air emission inventory reports.

[b] CO_2 emissions from wastewater treatment biogas are considered biogenic and not reported as scope 1 emissions.

[c] CH_4 and N_2O emission factors for propane are in lb/1000 gal.

[d] CO_2 equivalents are calculated by multiplying the global warming potential (GWP) by the CO_2 emissions. The GWP for CO_2 is 1, N_2O is 310 and CH_4 is 21.

Indirect Emissions: Purchased Electricity

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2007 Annual GHG Emissions

Facility	Electricity Use (MWh)[a]	CO_2 Emission Factor[b] (lb/MWh)	CO_2 Emissions (kg/year)	N_2O Emission Factor[b] (lb/MWh)	N_2O Emissions (kg/year)	CH_4 Emission Factor[b] (lb/MWh)	CH_4 Emissions (kg/year)	Total CO_2e Emissions (kg/yr)[c]	Total CO_2e Emissions (metric tons/yr)[c]
Jones Island	40,371	1537.82	28,160,651	0.0257	471	0.018	330	28,313,465	28,313
South Shore	14,797	1537.82	10,321,461	0.0257	172	0.018	121	10,377,470	10,377
Headquarters & Lab[d]	2,488	1537.82	1,735,841	0.0257	29	0.018	20	1,745,260	1,745
Renewable Energy[e]	*175*	*1537.82*	*122,211*	*0.0257*	*2*	*0.018*	*1*	*122,874*	*123*
Other Sources									
S. 13th Street	364	1537.82	253,708	0.0257	4	0.018	3	255,085	255
Alterra Coffee Shop	12	1537.82	8,119	0.0257	0	0.018	0	8,164	8
Pump Stations, Gate	2,719	1537.82	1,896,639	0.0257	32	0.018	22	1,906,931	1,907
									2,170

[a] Electricity usage data obtained from purchasing records.

[b] Emission factors are from the eGRID Sub Region Emission Rates for RFC West.

[c]CO_2 equivalents are calculated by multiplying the global warming potential (GWP) by the CO_2 emissions. and CH_4 is 21.

The GWP for CO_2 is 1, N_2O is 310

[d] In 2007, 14,600 kwhrs/month of electricity purchased was green energy (175,200 kwhr/year). Emissions reductions for green power purchases are calculated separately.

[e]Calculated emissions are reductions estimated from green power purchases and are therefore not included as inventory emissions.

Direct Emissions: Mobile Combustion Sources/Equipment

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2007 Annual GHG Emissions

Facility	Fuel and Mobile Source	Miles Traveled[a]	Fuel usage (gal.)[b]	CO_2 Emission Factor (kg/gal)	CO_2 Emissions (kg/year)	N_2O Emission Factor (g/mile or g/gal.)	N_2O Emissions (kg/year)	CH_4 Emission Factor (g/mile or g/gal.)	CH_4 Emissions (kg/year)	Total CO_2e Emissions (kg/yr)[f]	Total CO_2e Emissions (metric tons/yr)[f]
MMSD Cars and Light Trucks	Gasoline Passenger Cars	290,000	13,122	8.81	115,606	0.0197	6	0.178	52	118,461	118.46
Veolia Cars and Light Trucks	Gasoline Light-Duty Trucks	310,000	17,514	8.81	154,299	0.022	7	0.2024	63	157,731	157.73
Televising & Manhole Trucks	Gasoline Heavy Duty Vehicles	60,000	3,390	8.81	29,864	0.0497	3	0.4604	28	31,369	31.37
Class 8 Trucks	Diesel Heavy-Duty Vehicles	60,000	7,229	10.15	73,373	0.0048	0	0.0051	0	73,469	73.47
Light Med & Heavy Dump Trucks	Diesel Heavy-Duty Vehicles	50,000	8,450	10.15	85,768	0.0048	0	0.0051	0	85,847	85.85
Wheel loaders & Skid Loaders	Gasoline Heavy Duty Vehicles	4,500	900	8.81	7,929	0.0497	0	0.4604	2	8,042	8.04
Straddle Carriers	Gasoline Heavy Duty Vehicles	1,000	200	8.81	1,762	0.0497	0	0.4604	0	1,787	1.79
Burden Carriers & ATVs	Gas Small Utility	19,500	3,900	8.81	34,359	0.22	1	0.5	2	34,666	34.67
Tractors & Lawn Mowers	Gasoline Agricultural Equipment	7,250	1,450	8.81	12,775	0.22	0	1.26	2	12,912	12.91
Snow Blowers	Gas Small Utility	4,250	850	8.81	7,489	0.22	0	0.5	0	7,555	7.56
Diesel Generators	Diesel Construction Equipment		1,000	10.15	10,150	0.26	0	0.58	1	10,243	10.24
Gasoline Generators	Gasoline Heavy Duty Vehicles		1,000	8.81	8,810	0.0497	0	0.4604	0	8,810	8.81
Pelagos Research Vessel [c]	Gasoline Ships and Boats		1,585	8.81	13,964	0.22	0	0.64	1	14,093	14.09
ORP Research Boat [c]	Gasoline Ships and Boats		1,585	8.81	13,964	0.22	0	0.64	1	14,093	14.09
AgriLife Land Spreading [d]	Diesel Heavy-Duty Vehicles	40,000	6,760	10.15	68,614	0.0048	0	0.0051	0	68,678	68.68
Locomotive[e]	Diesel Locomotives		795	10.15	8,069	0.26	0	0.8	1	8,147	8.15
Total Mobile Sources					646,795		19		153	655,904	656

Direct Emissions: Mobile Combustion Sources/Equipment

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2007 Annual GHG Emissions

[a] Miles traveled based upon number of vehicles and estimated annual average mileage as shown below. The number of vehicles for each type based upon 2009 vehicle data provided by MMSD "Complete Vehicle and Equipment list, revised 4-09.xls".

	No. of Vehicles	Estimated Avg. Miles per Year per Vehicle	Total Miles per Year
MMSD Cars and Light Trucks:	29	10,000	290,000
Veolia Cars and Light Trucks:	62	5,000	310,000
Televising & Manhole Trucks:	12	5,000	60,000
Class 8 Trucks	12	5,000	60,000
Light Med & Heavy Dump Trucks	10	5,000	50,000
Wheel loaders & Skidloaders	9	500	4,500
Straddle Carriers	2	500	1,000
Burden Carriers & ATVs	38	500	19,000
Tractors & Lawn Mowers	27	250	6,750
Snow Blowers	16	250	4,000

[b] The following factors were used to estimate gallons of fuel consumed based on estimated miles driven per vehicle type:

Vehicle Type	Avg mpg	Source
Passenger Cars	22.1	
Other 2-axle, 4-tire vehicles	17.7	U.S. Department of Transportation Federal Highway Administration Annual Vehicle Distance Traveled in Miles and
Single unit 2-axle 6-tire or more trucks	8.3	Related Data- 2006, http://www.fhwa.dot.gov
Combination Trucks	5.9	Climate Leaders GHG Protocol, Direct Emissions from Mobile Combustion Sources, May 2008.
Other Vehicles	5.00	Assumed all other small vehicles (e.g. Loaders, Carriers, Tractors and Snow Blowers) get an average of 5 mpg

[c] Pelagos Research Vessel based upon fuel purchases in 2007, assumed ORP Research Boat fuel usage was equal to Pelagos Research Vessel fuel usage.

[d] Annual mileage based upon 2007 Agri Life sludge landspreading records.

[e] Locomotive fuel usage estimated based upon 2007 annual tons of milorganite produced, a distance of 3 miles to transport the Milorganite, and a Btu/ton-mile factor of 337 (EPA Climate Leader's Mobile Source guidance document).

[f] CO_2 equivalents are calculated by multiplying the global warming potential (GWP) by the CO_2 emissions. The GWP for CO_2 is 1, N_2O is 310 and CH_4 is 21.

Direct Emissions: Water Reclamation Facility Emissions
South Shore Water Reclamation Facility
Greenhouse Gas Inventory for MMSD in Milwaukee, WI
2007 Annual GHG Emissions

Methodology:
Calculation methodology from California Climate Action Registry (CCAR) Local Government Operations Protocol, chapter 10 on Centralized Wastewater Treatment Facilities (except for biogenic CO_2 emissions which are based upon data obtained from Metcalf and Eddy Wastewater Engineering Treatment, Disposal, and Reuse). CCAR equations use the EPA Inventory of US Greenhouse Gas Emissions and Sinks: 1990–2006, Chapter 8, 8–9 (2008) Calculation methodology to estimate biogenic CO_2 emissions from water reclamation processes, such as the use of aeration basins, sludge digesters and combustion of biogas may be included in the future CCAR wastewater treatment industry GHG protocol scheduled to be released in 2010).

Biogenic CO_2 from Water Reclamation Processes[a]

$$CO_2\left[\frac{metric\ tons\ CO_2}{year}\right] \equiv BOD_5 Load\left[\frac{kg\ BOD_5}{day}\right] \times EF_{biogenic\ CO_2}\left[\frac{kg\ CO_2}{kg\ BOD_5}\right] \times F_{oxidation} \times 365\left[\frac{day}{year}\right] \times 10^{-3}\left[\frac{metric\ ton}{kg}\right]$$

where

Term	Description	Value	GHG Emissions (metric ton CO_2e/year)[b]	Source of Data
Biogenic CO_2	= biogenic CO_2 emissions from a centralized WWTP [metric ton CO_2/year]	**40,568**	**40,568**	
BOD_5 load	= average amount of BOD_5 produced per day [kg BOD_5/day]	69,465		Annual Discharge Monitoring Report
$EF_{biogenic\ CO2}$	= emission factor [kg CO_2/kg BOD_5]	2		Metcalf & Eddy Wastewater Engineering
$F_{oxidation}$	= factor for level of oxidation for a centralized WWTP with an anaerobic or aerobic sludge digester	0.8		Metcalf & Eddy Wastewater Engineering
365	= conversion factor [day/year]	365		Conversion factor
10^{-3}	= conversion from kg to metric ton [metric ton/kg]	1.E-03		Conversion factor

Direct Emissions: Water Reclamation Facility Emissions
South Shore Water Reclamation Facility
Greenhouse Gas Inventory for MMSD in Milwaukee, WI
2007 Annual GHG Emissions

Methane from Incomplete Combustion of Digester Gas (included with Stationary Combustion Emissions)

$$CH_4\left[\frac{metric\ tons}{year}\right] \equiv Digester\ Gas\left[\frac{ft^3}{yr}\right] \times F_{CH_4} \times \rho\left(_{CH_4}\right)\left[\frac{g}{m^3}\right] \times (1-DE) \times 0.0283\left[\frac{m^3}{ft^3}\right] \times 10^{-6}\left[\frac{metric\ ton}{g}\right]$$

where

Term	Description	Value	GHG Emissions (metric ton CO_2e/year)	Source of Data
CH_4 incomplete combustion of digester gas	= CH_4 emissions from incomplete combustion of digester gas [metric ton CH_4/year]	**73.3**	**1539**	
Digester Gas	= measured standard cubic feet of digester gas produced per day [ft^3/year]	652,035,000		Annual Emission Inventory Report
F_{CH4}	= measured fraction of CH_4 in biogas	0.6		Annual Emission Inventory Report
$\rho(CH_4)$	= density of methane at standard conditions [g/m^3]	662.00		Protocol default value.
DE	= CH_4 destruction efficiency from flaring or burning in engine	0.99		Protocol default value.
0.0283	= conversion from ft^3 to m^3 [m^3/ft^3]	0.0283		Conversion factor
10^{-6}	= conversion from g to metric ton [metric ton/g]	1.E-06		Conversion factor

Direct Emissions: Water Reclamation Facility Emissions
South Shore Water Reclamation Facility
Greenhouse Gas Inventory for MMSD in Milwaukee, WI
2007 Annual GHG Emissions

Process Emissions from Water Reclamation Processes

$$N_2O\left[\frac{metric\ tons}{year}\right] \equiv P_T\left[person\right] \times \frac{Plant\ Flow}{DISTRICT\ Flow}\left[\frac{\frac{MG}{year}}{\frac{MG}{year}}\right] \times EF_{nit/denit}\left[\frac{g\ N_2O}{person \times year}\right] \times 10^{-6}\left[\frac{metric\ ton}{g}\right]$$

where

Term	Description	Value	GHG Emissions (metric ton CO_2e/year)	Source of Data
N_2O plant	= N_2O emissions from a centralized WWTP [metric ton N_2O/year]	**1.85**	**572**	
P_P	= total population served by the WWTP, person	576,786		Population served by South Shore calculated based upon total population served times % of total annual flow treated by South Shore.
P_T	= total population served by the DISTRICT, person	1,059,502		MMSD annual financial report
Plant Flow	= plant flow [MG/year]	100.31		Annual Discharge Monitoring Report
DISTRICT Flow	= DISTRICT flow [MG/year]	184.26		Annual Discharge Monitoring Report
EF nit/denit	= emission factor for a WWTP without nitrification/denitrification [g N_2O/year]	3.2		Protocol default value for plants without nitrification/denitrification.
10^{-6}	= conversion from g to metric ton [metric ton/g]	1.E-06		Conversion factor

[a] Methodology for calculating biogenic CO_2 is not included in the CCAR Local Government Operations Protocol, but may be included in the CCAR wastewater treatment industry protocol that is scheduled to be released in 2010.

[b] CO_2 equivalents are calculated by multiplying the global warming potential (GWP) by the CO_2 emissions. The GWP for CO_2 is 1, N_2O is 310 and CH_4 is 21.

Direct Emissions: Water Reclamation Facility Emissions

Jones Island Water Reclamation Facility

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2007 Annual GHG Emissions

Methodology:

Calculation methodology from California Climate Action Registry (CCAR) Local Government Operations Protocol, chapter 10 on Centralized Wastewater Treatment Facilities (except for biogenic CO^2 emissions which are based upon data obtained from Metcalf and Eddy Wastewater Engineering Treatment, Disposal, and Reuse). CCAR equations use the EPA Inventory of US Greenhouse Gas Emissions and Sinks: 1990–2006, Chapter 8, 8–9 (2008) Calculation methodology to estimate biogenic CO2 emissions from wastewater treatment processes, such as the use of aeration basins, sludge digesters and combustion of biogas may be included in the future CCAR wastewater treatment industry GHG protocol scheduled to be released in 2010).

Biogenic CO_2 from Water Reclamation Processes[a]

$$CO_2\left[\frac{metric\ tons\ CO_2}{year}\right] \equiv BOD_5 Load\left[\frac{kg\ BOD_5}{day}\right] \times EF_{biogenic\ CO_2}\left[\frac{kg\ CO_2}{kg\ BOD_5}\right] \times F_{oxidation} \times 365\left[\frac{day}{year}\right] \times 10^{-3}\left[\frac{metric\ ton}{kg}\right]$$

where

Term	Description	Value	GHG Emissions (metric ton CO_2e/year)[b]	Source of Data
Biogenic CO_2	= biogenic CO_2 emissions from a centralized WWTP [metric ton CO_2/year]	**46,652**	**46,652**	
BOD_5 load	= average amount of BOD_5 produced per day [kg BOD_5/day]	79,883		Annual Discharge Monitoring Report
$EF_{biogenic\ CO2}$	= emission factor [kg CO_2/kg BOD_5]	2		Metcalf & Eddy Wastewater Engineering
$F_{oxidation}$	= factor for level of oxidation for a centralized WWTP with an anaerobic or aerobic sludge digester	0.8		Metcalf & Eddy Wastewater Engineering
365	= conversion factor [day/year]	365		Conversion factor
10^{-3}	= conversion from kg to metric ton [metric ton/kg]	1.E-03		Conversion factor

Direct Emissions: Water Reclamation Facility Emissions

Jones Island Water Reclamation Facility

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2007 Annual GHG Emissions

Methane from Incomplete Combustion of Digester Gas (included with Stationary Combustion Emissions)

Digester Gas is not burned at Jones Island

$$CH_4\left[\frac{metric\ tons}{year}\right] \equiv Digester\ Gas\left[\frac{ft^3}{yr}\right] \times F_{CH_4} \times \rho\left(_{CH_4}\right)\left[\frac{g}{m^3}\right] \times (1-DE) \times 0.0283\left[\frac{m^3}{ft^3}\right] \times 10^{-6}\left[\frac{metric\ ton}{g}\right]$$

where

Term	Description	Value	GHG Emissions (metric ton CO_2e/year)	Source of Data
CH_4 incomplete combustion of digester gas	= CH_4 emissions from incomplete combustion of digester gas [metric ton CH_4/year]	**0.0**	**0**	
Digester Gas	= measured standard cubic feet of digester gas produced per day [ft^3/year]	0		Annual Emission Inventory Report
F_{CH4}	= measured fraction of CH_4 in biogas	0		Annual Emission Inventory Report
$\rho(CH_4)$	= density of methane at standard conditions [g/m^3]	662.00		Protocol default value.
DE	= CH_4 destruction efficiency from flaring or burning in engine	0.99		Protocol default value.
0.0283	= conversion from ft^3 to m^3 [m^3/ft^3]	0.0283		Conversion factor
10^{-6}	= conversion from g to metric ton [metric ton/g]	1.E-06		Conversion factor

Direct Emissions: Water Reclamation Facility Emissions

Jones Island Water Reclamation Facility

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2007 Annual GHG Emissions

Process Emissions from Water Reclamation Processes

$$N_2O\left[\frac{metric\ tons}{year}\right] \equiv P_T\left[person\right] \times \frac{Plant\ Flow}{DISTRICT\ Flow}\left[\frac{\frac{MG}{year}}{\frac{MG}{year}}\right] \times EF_{nit/denit}\left[\frac{g\ N_2O}{person \times year}\right] \times 10^{-6}\left[\frac{metric\ ton}{g}\right]$$

where

Term	Description	Value	GHG Emissions (metric ton CO_2e/year)	Source of Data
N_2O plant	= N_2O emissions from a centralized WWTP [metric ton N_2O/year]	**1.54**	**479**	
P_P	= total population served by the WWTP, person	482,716		Population served by Jones Island calculated based upon total population served times % of total annual flow treated by Jones Island.
P_T	= total population served by the DISTRICT, person	1,059,502		MMSD annual financial report
Plant Flow	= plant flow [MG/year]	83.95		Annual Discharge Monitoring Report
DISTRICT Flow	= DISTRICT flow [MG/year]	184.26		Annual Discharge Monitoring Report
EF nit/denit	= emission factor for a WWTP without nitrification/denitrification [g N_2O/year]	3.2		Protocol default value for plants without nitrification/denitrification.
10^{-6}	= conversion from g to metric ton [metric ton/g]	1.E-06		Conversion factor

Direct Emissions: Water Reclamation Facility Emissions

Jones Island Water Reclamation Facility

Greenhouse Gas Inventory for MMSD in Milwaukee, WI

2007 Annual GHG Emissions

Process Emissions from Sludge Drying

$$CH_4\left[\frac{metric\ tons}{year}\right] \equiv BSD\left[\frac{tons}{year}\right] \times EF\left[\frac{kg\ CH_4}{tonBSD}\right] \times 10^{-3}\left[\frac{metric\ ton}{kg}\right]$$

where

Term	Description	Value	GHG Emissions (metric ton CO_2e/year)	Source of Data
CH_4	= CH_4 emissions from a sludge drying [metric ton CH_4/year]	**3.36**	**70**	
BSD	= blended sludge through dryers [dry tons/year]	46,899		Air Emission Inventory Report throughput for P01
EF	= emission factor for drying sludge [kg CH_4/ton dry solids]	0.072		December 2007 JI Dryer Stack Test Data, average of 3 tests, methane from natural gas combustion from turbine waste heat is subtracted.
10^{-3}	= conversion from g to metric ton [metric ton/kg]	1.E-03		Conversion factor

[a] Methodology for calculating biogenic CO_2 is not included in the CCAR Local Government Operations Protocol, but may be included in the CCAR wastewater treatment industry protocol that is scheduled to be released in 2010.

[b] CO_2 equivalents are calculated by multiplying the global warming potential (GWP) by the CO_2 emissions. The GWP for CO_2 is 1, N_2O is 310 and CH_4 is 21.

Appendix C
Uncertainty Estimates

APPENDIX C

Calculation of Uncertainties for All Nonbiogenic Emission Sources

MMSD GHG Inventory Report

Source description	Activity Data (e.g. Quantity of fuel used)	Unit used to measure activity data	Uncertainty of activity data (Confidence interval expressed in ± percent)	GHG emission factor	Unit of GHG emission factor (for kg CO2)	Uncertainty of emission factor data (Confidence interval expressed in ± percent)	CO_2 emissions in kg	CO_2 emissions in metric tonnes	Uncertainty of calculated emissions	Certainty Ranking	Auxiliary Variable 1	Auxiliary Variable 2
							A * D	G/1000	$I=\sqrt{C^2+F^2}$		(H*I)	K^2
Stationary Combustion Fuel Usage	1,475,234	MMBtu	±3.0%	53.43	kg CO2 / MMBTU	+/- 7.0%	78,824,272	78,824	±7.6%	Good	6,003	36,036,942
Mobile Combustion Fuel Usage	69,730	gal	±50.0%	9.41	kg CO2/ gallon	+/- 10.0%	655,904	656	±51.0%	Poor	334	111,855
Purchased Electricity	60,750	MWhr	±3.0%	699.31	kg CO2/ MWhr	+/- 7.0%	42,483,501	42,484	±7.6%	Good	3,235	10,468,117
South Shore WWTP Biogas Combustion	652,035	mmcu ft	±10.0%	0.03	kg CO2/mmcuft	+/- 5.0%	16,724	17	±11.2%	Good	2	3
South Shore WWTP Biogas	652,035	mmcu ft	±10.0%	2.36	kg CO2/mmcuft	+/- 50.0%	1,539,167	1,539	±51.0%	Poor	785	615,949
Jones Island CH4 from Sludge Drying	46,899	dry tons blended sludge	±3.0%	3.5169	kg CO2/dry ton	+/- 50.0%	164,941	165	±50.1%	Poor	83	6,826
WW Nitrogen Emissions	1,059,502	person	±10.0%	0.99	kg CO2/person	+/- 50.0%	1,051,026	1,051	±51.0%	Poor	536	287,210

Note: For individual uncertainties greater than 60%, the results of the tool are not valid

Sum CO_2 Emissions (M):	**124,735,535**	**124,736**

			Aggregated Certainty Ranking
Cumulated Uncertainty:	$\pm u = \pm \frac{\sqrt{\sum_{i=1}^{n}(H_i * I_i)^2}}{M}$	**+/- 5.53%**	**Good**

80,380,164

Source:

Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reporting Instructions

APPENDIX C
Uncertainty Data from the IPCC
MMSD GHG Inventory Report

Uncertainties due to Emission Factors and Activity Data				
1	2	3	4	5
Gas	**Source Category**	**Emission factor**	**Activity data**	**Overall Uncertainty**
CO_2	Energy	7%	7%	10%
CO_2	Industrial Processes	7%	7%	10%
CO_2	Land Use Change and Forestry	33%	50%	60%
CH_4	Biomass Burning	50%	50%	100%
CH_4	Oil and Nat. Gas Activities	55%	20%	60%
CH_4	Rice cultivation	3/4	1/4	1
CH_4	Waste	2/3	1/3	1
CH_4	Animals	25%	10%	20%
CH_4	Animal waste	20%	10%	20%
N_2O	Industrial Processes	35%	35%	50%
N_2O	Agricultural Soils			2 orders of magnitude
N_2O	Biomass Burning			100%

Note: Individual uncertainties that appear to be greater than ± 60% are not shown. Instead judgement as to the relative importance of emissions factor and activity data uncertainties are shown as fractions which sum to one.

This table was generated by the IPCC for the uncertainty assessment of National Inventory Data. As the uncertainties for several categories are quite high, it is recommended to apply these data only if the collection of site specific data is not pos

Source: Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reporting Instructions

Appendix D
Greenseams Data

TABLE D-1

GreenSeams Property List as of December 16, 2008

MMSD GHG Inventory Report

Landowner	Watershed	Agriculture	Grassland	Submerged/ Wetland	Native Prarie	Woodland	Total	Landuse	Restoration Activities	Transferred (ownership)
Anderson	Menomonee					22.00	22.00	Woodland		MMSD
Babiasz	Menomonee	12.00				17.00	29.00	Woodland and AG(12ac)		MMSD
Beer Line Trail	Milwaukee					4.50	4.50	Woodland		Non-profit easement
Bielinski Easement	Menomonee			24.97		24.97	49.93	Woodland and Submerged Grassland		Private easement
Boehlke	Menomonee		10.50			10.50	21.00	Woodland and Grassland (assume 1/2 woodland)		MMSD
Brookfield (7parcels)	Menomonee		14.91				14.91	Grassland		City of Brookfield
Burant Easement	Milwaukee		3.96				3.96	Grassland		Private easement
Burczyk	Menomonee				32.00	30.00	62.00	Woodland and Grassland (32 acre native prairie)	32 acres seeded winter 2004/2005	City of Mequon
Cannon	Oak Creek		15.74				15.74	Grassland		MMSD
Conley	Menomonee		5.50				5.50	Grassland		MMSD
Derouin	Root					3.48	3.48	Woodland		MMSD
Dilworth	Root	5.41					5.41	AG(5ac)		MMSD
Dobberfuhl	Menomonee					10.00	10.00	Woodland		MMSD
Donges Bay Gorge Easement	Lake Michigan					23.00	23.00	Woodland		Non-profit easement
Elger	Menomonee					11.07	11.07	Woodland		MMSD
Ernst	Menomonee				17.00	17.49	34.49	Woodland and Grassland (17 acre native prairie)	17 acres seeded spring 2008	MMSD
Finke	Oak Creek			4.20			4.20	Submerged Grassland		City of Oak Creek
Gebhard	Menomonee					10.00	10.00	Woodland		Village of Germantown
Gengler	Milwaukee	21.00		9.66		9.66	40.32	Woodland, submerged wetland and AG(21ac)		MMSD
Grall	Oak Creek			22.60			22.60	Open Wetland and Grassland	17 acres seeded summer 2006	MMSD
Hack	Root	32.00		17.89			49.89	Submerged Wetland and AG (32ac)		MMSD

TABLE D-1

GreenSeams Property List as of December 16, 2008

MMSD GHG Inventory Report

Landowner	Watershed	Agriculture	Grassland	Submerged/ Wetland	Native Prarie	Woodland	Total	Landuse	Restoration Activities	Transferred (ownership)
Hoerig	Menomonee	52.00		20.10			72.10	AG (52ac)		MMSD
Holl	Menomonee					20.00	20.00	Woodland		MMSD
Huntington Park Easement	Menomonee					90.59	90.59	Woodland		Private easement
Kaiser	Menomonee		42.50			42.50	85.00	Woodland and Grassland		MMSD
Knull	Menomonee					1.25	1.25	Woodland		City of Brookfield
Kohlwey	Menomonee	18.00		14.22			32.22	AG(18ac), Woodland, and Submerged Grassland		MMSD
Kons	Menomonee	22.00		11.73		11.73	45.45	AG(22ac), woodland and submerged grassland		MMSD
Larsen	Milwaukee					7.00	7.00	Woodland		MMSD
Lesch	Oak Creek			14.00			14.00	Submerged Grassland		City of Oak Creek
Leung	Root	5.00				4.15	9.15	Woodland and AG(5ac)		MMSD
Lucht	Menomonee				14.00	18.02	32.02	Woodland and Grassland (14 acre native prairie)	16 acres seeded winter 2003/2004	Village of Germantown
Marti	Milwaukee	26.00				28.73	54.73	Woodland and AG(26ac)		MMSD
Minor	Menomonee					51.71	51.71	Woodland		MMSD
Mollgaard	Menomonee			7.17			7.17	Submerged Grassland and Woodland		MMSD
Polzer	Milwaukee	33.00		6.41			39.41	AG(33ac)		MMSD
Pyritz	Menomonee					15.49	15.49	Woodland		MMSD
Rades	Menomonee			54.00			54.00	Submerged Grassland		Village of Germantown
Reinders	Menomonee		14.50		65.00		79.50	Grassland (65 acre native prairie)	35 acres seed summer 2005, 30 acres seeded spring 2008	MMSD
Robarge	Root					0.88	0.88	Woodland		MMSD
Rowan	Oak Creek			35.04			35.04	Submerged Grassland and Open Wetland		MMSD
Schloemer	Menomonee					25.00	25.00	Woodland		MMSD

TABLE D-1

GreenSeams Property List as of December 16, 2008

MMSD GHG Inventory Report

Landowner	Watershed	Agriculture	Grassland	Submerged/ Wetland	Native Prarie	Woodland	Total	Landuse	Restoration Activities	Transferred (ownership)
Schurn	Root	17.00		34.43			51.43	Woodland, AG(17ac), and Submerged Grassland		In Process to MKE CO Parks
Schwefel	Menomonee		24.70			24.70	49.40	Woodland and Grassland		MMSD
Sikhs	Menomonee		5.00	12.79			17.79	Submerged Grassland and Grassland (5 acre native prairie)	5 acres seeded in early summer of 2005	City of Mequon
Spirit Life Easement	Milwaukee	18.00		9.31			27.31	AG(18ac)		Non-profit easement
Stauffacher	Menomonee	27.00		13.36			40.36	Wooded, Submerged Grassland, and AG(27ac)		MMSD
Stauffacher Easement	Menomonee		5.00				5.00	Grassland		Private easement
Stauss	Menomonee	95.00				72.35	167.35	Wooded and AG(95ac)		MMSD
Vanden Boom	Root	40.00		23.72			63.72	Open wetland, Submerged Grassland, and AG(40 ac)		In Process to WI DNR
Vanselow Easement	Root			10.29			10.29	Submerged Grassland		City of Oak Creek
Vanselow, Robert	Root	13.00		1.00			14.00	AG(13ac)		In Process to MKE CO Parks
Victory Creek	Root				50.00	20.00	70.00	Woodland and Grassland (50 acre native prairie)	50 acres seeded early summer of 2003	City of Franklin
Weiland	Menomonee		7.31			7.31	14.62	Woodland and Grassland		Non-profit easement
Weiss	Oak Creek			9.25			9.25	Submerged Grassland		MMSD
Weiss (Mequon)	Milwaukee			41.83		41.83	83.65	Woodland, Submerged Grassland, and Open Wetland		MMSD
Weiss 3	Oak Creek			9.71			9.71	Submerged Grassland		In Process to MKE CO Parks
Total Acres:		**436.41**	**149.62**	**407.67**	**178.00**	**676.90**	**1848.59**			

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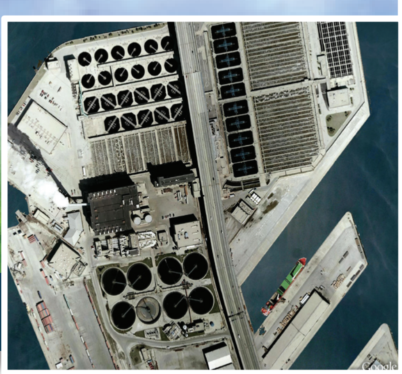

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