Draft
Adirondack Park
Greenhouse Gas Inventory

October 2008

Prepared for:

THE WILD CENTER
Adirondack Energy $mart Park Initiative (E$PI)

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List of Abbreviations and Acronyms

CAFÉ	Corporate Average Fuel Economy Standards
CCAP	Center for Clean Air Policy
CH_4	methane
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
°F	degrees Fahrenheit
DTF	(New York State) Department of Taxation and Finance
EIA	Energy Information Administration
EPA	(United States) Environmental Protection Agency
GHG	greenhouse gas
HFC	hydrofluorocarbon
ICLEI	
MPG	miles per gallon
MSW	municipal solid waste
N_2O	nitrous oxide
NYS	New York State
NYSDOT	New York State Department of Transportation
NYSERDA	New York State Energy Research and Development Authority
PFC	perfluorocarbon
RFS	renewable fuel standard
SF_6	sulfur hexafluoride
VMT	vehicle miles traveled

1 Introduction

1.1 Purpose

This inventory of greenhouse gas (GHG) emissions for the Adirondack Park (the Park) has been developed to aid in understanding the sources of GHG emissions in the Park and in planning carbon footprint reduction programs for the Park. This inventory is a component of the Phase II – Design portion of an overall Adirondack carbon offset project.

Two partner organizations in the Adirondacks are pursuing the development of a carbon offset program that directly benefits the Adirondack Park and its communities. The Adirondack carbon offset initiative will mitigate GHG emissions by supporting energy efficiency projects, renewable energy production, sustainable biofuel use, and other offset options, as well as green building capacity within the 6-million-acre Park. It will join the list of voluntary emissions reductions programs currently available in the voluntary carbon market for individuals, corporations, and other organizations. Among the first of its kind as a regional program, it will serve as a replicable model for other regions to establish locally beneficial carbon offset programs. After the partner organizations conducted a Phase I effort to develop a scope of work for the overall Adirondack carbon offset program, the GHG inventory portion began with a kick-off meeting in January 2008 that was attended by critical stakeholders in the Adirondack Park community.

As a scenic and wilderness resource in New York State (NYS), protection of the environment is a top priority of the Park, which includes minimizing impacts of emissions that contribute to an increase in GHGs. Compared to urbanized areas, the Park is a minor source of GHG emissions with respect to the buildup of gases in the atmosphere that can lead to climate change. More importantly, the Park will likely be affected by a changing climate. Although the affects of climate change, or that climate change is actually occurring, is still being debated in the scientific community, the potential affects to Park attributes could be significant. As noted in *A Blueprint for the Blue Line* (APA 2007), the potential for warming in the northeast United States could be as much as 6 to 10 degrees Fahrenheit (°F) in the next 50 to 100 years if current climate models are reasonably accurate.

A warming of this magnitude would undoubtedly have some effect on the character of the Park, whether it is an economic one due to shorter duration of the winter season's snow cover that shortens the skiing and snowmobiling season, or a biological effect due to changes in the types of flora and fauna and amount of bogs and wetlands that make up the Park's ecosystem. Some data suggests that the length of the winter season is already being affected as measured by the length of the "snow season"; a shorter winter snow cover is reflected in lower income for tourism operators.

Thus, it is in the best interests of the Park to do what it can to minimize its emissions of GHG gases and provide opportunities for Park and non-Park entities to perhaps develop carbon footprint mitigation projects within the Park. By being carbon neutral, or a carbon sink rather than a net carbon emitter, the Park can contribute to minimizing global changes that potentially result in alteration of the Park's current characteristics. The GHG emission inventory, as part of the Carbon Offset Project, contributes to an overall strategy to make the Park carbon neutral by 2015.

1.2 The Adirondack Park

The Park occupies approximately 9,000 square miles of NYS's total of 47,213.8 square miles — this is 19% of the total land area in NYS (**[need reference]**). "Legally, the Adirondacks are a state park, regulated by land-use legislation, and administered by a special agency," (Jenkins and Keal 2004*)*. The Park is a mosaic park in terms of ownership and land use; there is private and public land ownership comprising settled and wild areas.

Within the settled areas, residences, small business, government facilities, and, in some communities, industry exist. Throughout the Park, tourism activities occur and range from motorized activities, such as automobile travel/sightseeing, snowmobiling and watercraft use, to non-motorized activities, such as hiking, canoeing/kayaking, camping, and bicycling. Most tourism/recreational activities involve the use to some degree of motorized transportation to access various locations within the Park.

1.3 Greenhouse Gases and Climate Change

Climate change presents significant risks and challenges to the Adirondack Park. The Park could experience shortened winters, lower amounts of snow cover during the winter season, and changes to spring snowmelt and runoff. Warmer winter temperatures and shorter duration of cold "snaps" could affect the quality and duration of inland lake ice, and perhaps even annual average lake temperatures. Climate change could provide longer seasons for camping and other temperate-weather pursuits, providing longer growing seasons for many plants, and improving conditions for species at the northern limits of their range.

In the current state of climate science and climate models, scientists are unable to predict the severity of the consequence of global warming with certainty. It should be remembered that there are many inputs to the Earth's energy balance that vary over time, such as the amount of energy received from our Sun. Current debate in climate science is focusing on the role of the sunspot cycle. It is well understood that when our Sun is actively producing sunspots, the amount of energy received by the Earth is higher than when the Sun is dormant with respect to sunspots. The sunspot cycle (cycle 23) has been waning since reaching a peak in 2000/2001 and is at its minimum as of this writing. During this period some organizations have been reporting a slight decrease in global average temperature. However, looking over a longer time horizon that covers many solar cycles, warming rates suggest that the problem is real with average global temperatures on the Earth's surface increasing about 1.1ºF since the late 19th century.

The buildup of GHGs in the atmosphere consisting of primarily carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) reduces the ability of the atmosphere to allow long-wave radiation (heat) to pass to space. Many scientists believe that the continued addition of GHGs to the atmosphere is likely to increase the warming rate, perhaps raising the Earth's global average temperature by 4 to 7ºF by the year 2100.

Some GHGs are produced from both natural processes and human activity; these include CO_2, CH_4, N_2O, and water vapor. Human activities also result in the emission of other higher global warming potential GHGs including hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6).

1.4 Inventory Methodology

In general, a GHG emission inventory methodology consists of 10 important steps as shown below. The inventory methodology used for this project addresses each step.

1. **Consider Goals.** As noted earlier, the ultimate goal of the inventory is to provide the underlying "starting point" GHG emission data to then enable the definition of carbon offset projects that can be accomplished in the Park;

2. **Consider GHG Accounting Principles.** As described by many GHG reporting protocols and registries, the quality goal is a verifiable inventory following best practices that allow data export into any respected registry or program.

3. **Define Community Boundary.** The community boundary is used to group all the entities that define the character of life in the area and conduct activities that may produce GHG emissions to include in the inventory. For the Park, the community includes residential, small business and commercial activities, industrial, government, tourism, and passive and active recreation. To a lesser extent, agriculture can also be included in the community.

4. **Define Operational Boundaries.** Once entities are identified within the community boundary that has the potential to produce GHG emissions, the operational boundaries of each entity are defined. For example, within the residential category is housing. The operational boundary can be defined

as each individual home, or all residences in a town or village. Further breakdown of the type of GHG emission is accomplished by identifying which emissions are direct (e.g., exhaust gas from a heating system) or indirect (e.g., emission produced at a distant power plant in order to supply electricity to the residence or group of residences).

5. **Select Base Year.** A historic year or group of years against which an entity's emissions can be tracked over time and is often the first year that an entity accounts for its GHG emissions. Selection of the Park's base year is challenging due to the multitude of organizations and categories of potential GHG emitters and how each organization keeps its data up to date.

6. **Identify Emissions Sources.** The Park's GHG emission sources were identified by first considering which categories of emitting sources are present based on a survey of literature about the Adirondacks and discussion with stakeholders in the process. Emission sources fall into three main categories: mobile sources and stationary sources, which are both anthropogenic sources, and biogenic sources. These main categories are then broken out into direct and indirect emission sources.

7. **Calculate Emissions.** The main components of the actual GHG emission calculation procedures include: selecting a GHG calculation approach from available Protocols; collect activity data; choose emission factors; and then apply the emission factors to the activity data using a calculation tool, such as a spreadsheet or model.

8. **Verify Inventory.** When a GHG inventory has been prepared according to accepted procedures and the owner of the GHG inventory wishes to use the data contained within to establish a baseline GHG emission level, or to compare current emissions with a previously established baseline level, verification of the GHG emission inventory is used to establish the credibility of the GHG inventory. This is an important step if the GHG inventory data is to be used in conjunction with offset projects or in market/trading activities.

9. **Report Emissions.** For many organizations or entities, publicly reporting the GHG inventory data demonstrates an organization's activity and concern with respect to GHG emissions. Reporting may be in the form of a GHG inventory report. Reporting may also include populating the results of an entities GHG inventory into an on-line GHG registry.

10. **Establish GHG Reduction Target.** The ultimate goal of understanding the current level of GHG emissions is to develop and apply GHG emission reduction techniques in order to lessen the carbon footprint of the entity. For many entities that are industrial in nature and with large GHG emission levels, a reduction goal is appropriate. For other organizations with

more flexibility to alter their method of operation or ability to develop off-set projects, attain carbon neutrality is a reasonable goal.

The inventory methodology employed for the Park's inventory is a blend of procedures from published GHG emission inventory protocols including Community GHG inventory protocols established by **[define acronym]** ICLEI, National Park Service methodology, and other protocols, such as those prepared by the California Climate Action Registry.

Many of these protocols are applicable to unique types of organizations or activities. The Adirondack Park is unique in that it does not consist of only park-like activities but also does not solely consist of community (i.e. town/city/village) type activities and is not solely a manufacturing organization. It does consist of a blend of some of these activity types with some industrial/manufacturing activity also present. Thus, a blend of various GHG protocol inventory methodologies was used for this study.

1.5 Report Outline

This GHG inventory report presents a summary of GHG emissions summarized by various categories of emitting sources present in the Park in Section 2. In Section 2.1, emissions are summarized by residential, commercial/industrial, government/public, and tourism activities. Emissions within these categories consist of a blend of mobile/stationary and direct/indirect emissions and help show how these segments of the Park community compare with respect to GHG emissions.

Following the summary in Section 2.1, Sections 2.2 through 2.7 present the GHG emissions for stationary combustion, electricity use, waste and wastewater, forestry/biomass, land use, and finally mobile sources/transportation.

2 Greenhouse Gas Emission Inventory

2.1 Stationary Combustion and Electricity Use

Analyses of space heating and electricity use rely on census and assessment data and the calculations are based on numbers of residences and non-residence structures in the Adirondack Park. Because of the availability of household census data, which includes space heating fuel use, residential data allow for a more detailed analysis. Analyses of non-residential space heating and electricity use rely more strictly on parcel data, which allow for less stringent analysis. Analyses of industrial emissions, which rely on state and federal air permit data, are limited by the lack of public reporting for modest industrial emitters and do not capture electricity use.

2.1.1 Residential

The residential analysis is based on 2000 census data, which provides the number of households by county and by type of housing unit, and type of space heating fuel. In addition, Real Property Service (RPS) assessment data was analyzed in order to determine the proportion of households that are within the Adirondack Park. An RPS data set that included all parcels in the 12-county area was obtained, and parcels were coded as within or outside the Adirondack Park using centroid latitude and longitude. The 15 primarily residential property classes were summed into categories corresponding to the four census property types (single family, two to four units, five or more units, and mobile homes). The proportion of each property type within the Park was then used to proportion the county census housing units. Therefore, the overall analysis relies primarily on the census data, which is considered to be most reliable for estimating housing units; the proportioning of structures within and outside the Blue Line relied on RPS data, for which parcel locations were available.

Energy use factors were obtained from the Department of Energy Information Administration (EIA) Residential Energy Consumption Survey (RECS) from 2001. The EIA RECS, which is based on a survey of 5,500 residences across the U.S., provides energy usage by end use and fuel type and is broken out by characteristics such as geographic location and climactic region. The survey defines household types in the same way as the U.S. Bureau of the Census.

Three types of energy use factors were obtained from the RECS: space heating, water heating, and appliances. Space heating was calculated in terms of square feet of livable area (SFLA), and water heating and appliance use were calculated on a per household basis. Space-cooling energy use was estimated to be negligible and was not calculated.

Space heating calculations were performed using RECS space-heating intensity factors for common space heating fuels and electricity. For example, the RECS provides a use factor of cubic feet of natural gas per heating degree day (HDD) and per square feet. The average HDD, estimated to be 8,547, was obtained from the National Weather Service for Lake Placid and represents the average annual HDD from 1970 to 2006.

Square feet of livable area (SFLA) was not available from the New York State RPS data set, as most counties do not report SFLA to the state. Essex County SFLA data were available for its RPS data set. These data were averaged by property type, and this average SFLA for Essex County was used to estimate SFLA for housing units in the other counties. For example, it was found that the average SFLA for an Essex County single-family parcel was 1,527 square feet for the 13,606 parcels reporting SFLA. For the other counties, it was assumed that the SFLA for single-family parcels within the Adirondack Park had the same SFLA. Corresponding estimates were similarly applied to the other 14 RPS primarily residential property classes (see Table 1). While extrapolating SFLA from Essex County is considered valid for areas within the park, it is probably not valid for calculating county-wide estimates for the 12-county region.

Table 1 RPS and Census Property Classes and Average SFLA.

RPS Property Class	Census Property Type	Average SFLA per Unit
210: 1 Family Res	Single-Family	1,488
240: Rural res	Single-Family	1,488
241 Prim res w/ agr	Single-Family	1,488
242: Rurl res & rec	Single-Family	1,488
250: Estate	Single-Family	1,488
260: Seasonal res	Single-Family	1,488
215: 1 Fam Res w/Apt	Two or Four Units	2,172
220: 2 Family Res	Two or Four Units	2,172
230: 3 Family Res	Two or Four Units	2,172
281: Multiple res	Five or more unites	1,923
283 Multi res w/ com	Five or more unites	1,923
280: Multiple res	Five or more units	1,923
270: Mfg housing	Mobile Home	1,106
271: Mfg housings	Mobile Home	NA

Data on unoccupied housing was provided with the Census data. For the Adirondack Park, it was estimated that unoccupied housing primarily reflects seasonal housing. For example, 2,362 of 7,965 housing units in Hamilton County were occupied according to the 2000 census, and this low rate of occupancy results from the large number of seasonally occupied structures. The RECS does not provide estimates of energy use for seasonal housing. It was estimated that seasonal units use 50% and 35% of the electrical energy and fuel energy, respectively, of non-seasonal units.

The census data do not provide water heat and appliance energy source information, or estimates of per housing unit water heat and appliance energy use, by housing type. The nationwide proportion of housing units using fuel oil and LPG for space heating that also use fuel oil and LPG for water heat and for LPG appliances, was determined based on the RECS data. This nationwide proportion was then extrapolated to the Adirondack data. For example, it was found that, nationwide, 45% of households nationwide using LPG for space heating use LPG for water heating. Therefore, for the Adirondacks it was assumed that 45% of households space heating with LPG also heat water with LPG, and the balance heat water with electricity. Total residential fuel and electricity use for residences within the Adirondack Park, by end use, is shown in Table 2.

Table 2 Residential Fuel and Electricity Use by End Use

Space Heating	Fuel or Electricity Consumption
Electricity (kWh)	148,220,508
Fuel Oil/Kerosene (gallons)	31,344,408
LPG (gallons)	8,713,787
Wood (cords)	45,750
Water Heating	
Electricity (kWh)	158,132,989
Fuel Oil (gallons)	4,609,396
LPG (gallons)	692,804
Appliance	
Electricity - Refrigerators (kWh)	129,346,819
Electricity - Other Appliances and Lighting (kWh)	489,379,900
LPG (gallons)	730,542

Total GHG emissions were calculated by applying GHG emissions factors to estimated fuel use by fuel type. Emissions include all Kyoto GHGs and are shown in terms of carbon dioxide equivalent emissions (CO_2e). Factors were obtained from The Climate Registry General Reporting Protocol (Registry GRP) published May 2008. Indirect emissions from electricity use were estimated by applying the U.S. Environmental Protection Agency's eGrid Upstate New York power pool emission factor, which represents 2004 emission rates. GHG emissions, by county, for areas within the Adirondack Park are shown in Table 3. Scope I emissions are direct emissions from stationary combustion. Scope II emissions are indirect emissions from electricity use.

Table 3 Adirondack Park Household Metric Tons CO_2e Emissions by County

County	Scope I	Scope II	Total
Essex	82,428	66,342	148,770
Hamilton	18,235	20,696	38,931
Clinton	22,333	29,364	51,697
Franklin	36,280	34,707	70,986
Fulton	26,947	24,020	50,967
Herkimer	22,241	21,604	43,845
Lewis	4,928	4,999	9,926
Oneida	227	196	423
Saratoga	40,616	40,949	81,565
St. Lawrence	12,079	12,001	24,080
Warren	66,012	67,797	133,809
Washington	9,576	9,057	18,633
Total	**341,901**	**331,732**	**673,633**

Figure 1 shows the residential GHG emissions by county. Indirect emissions from electricity use vary by county as a proportion of total GHG emissions. This partly reflects the varying rate of use of electricity for space heating, as reported in the 2000 census for these counties. Some results appear counterintuitive but are explained by variations in fuel and electricity use. For example, Essex County has more households and lower indirect emissions from electricity use than Warren County. This difference is mostly attributed to higher electricity use for space heating in Warren County; 5.5% of Essex County households use electricity for space heating, while 19.1% of households in Warren County and within the Adirondack Park use electricity for space heating.

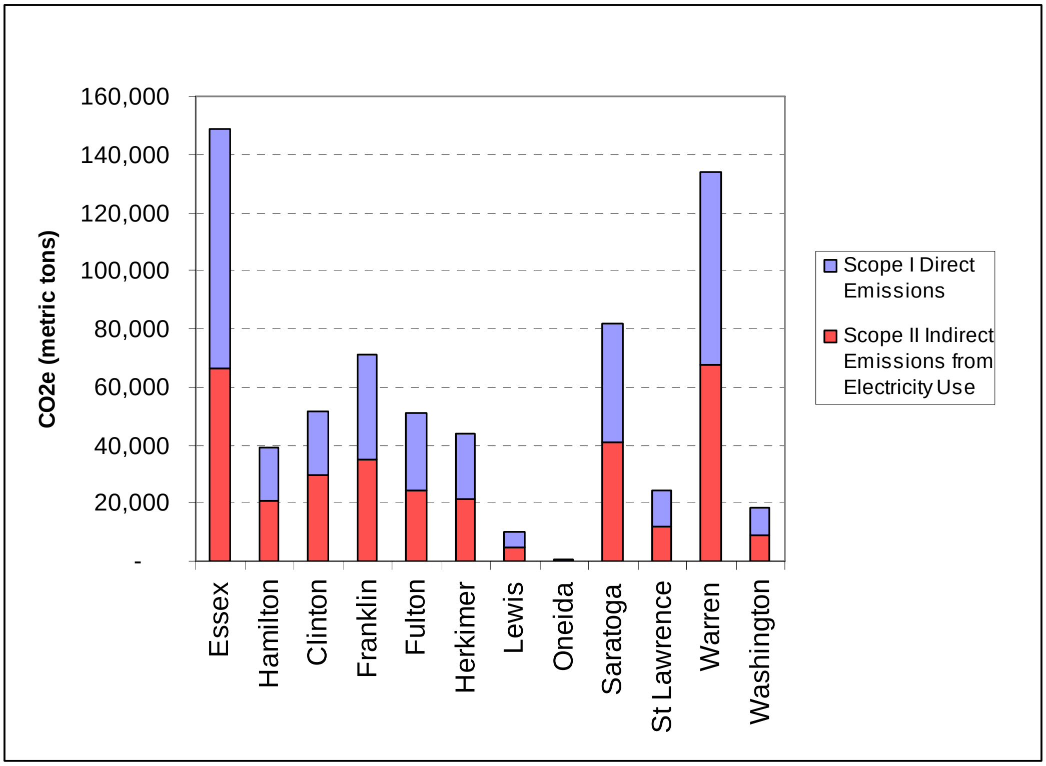

Figure 1 Residential Adirondack Park GHG Emissions by County

Figure 2 shows GHG emissions by property type. The housing mix between census property types is similar to the national average, with the exception that there is a higher rate of mobile homes. Mobile homes make up 13% of the Adirondack housing, compared to 8.2% nationally. Mobile homes tend to be inefficient, using 40-60% more energy per square foot of a single-family residence, according to the EIA RECS, and the large number of mobile homes contributes to high GHG emissions.

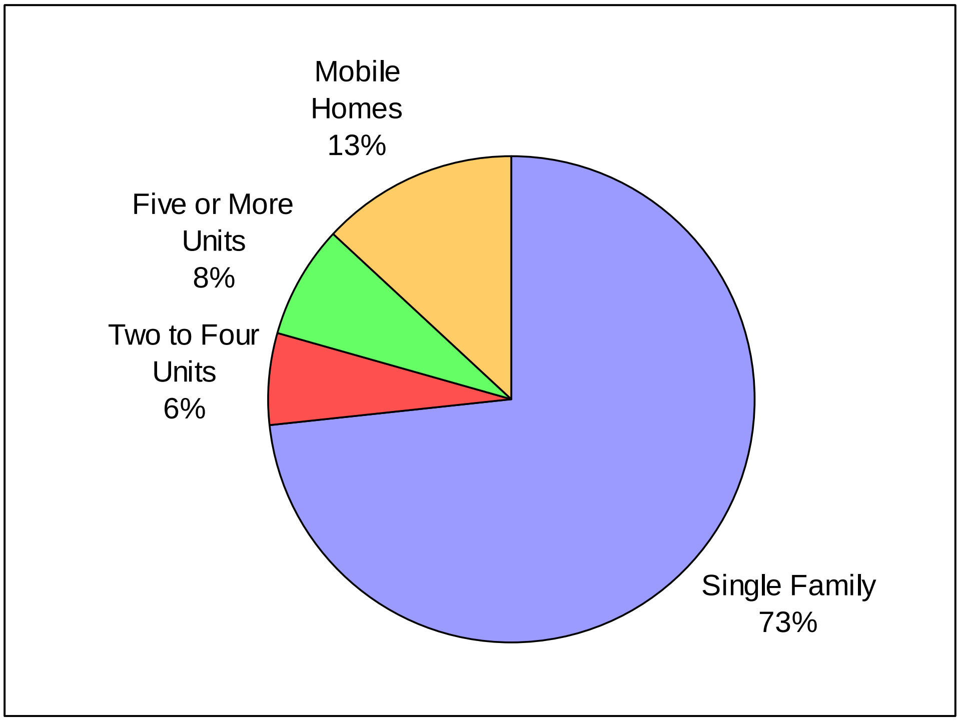

Figure 2 GHG Source by Property Type

Direct and indirect emissions by energy source and energy end use are shown in Figure 3. Note that electricity is used for a relatively high proportion of space heating in the Adirondacks, with an estimated 19% of households within the park heating with electricity. For comparison, the EIA RECS shows that, nationwide, only 9% of households in climactic regions with greater than 7,000 HDD heat with electricity. Water heating fuel corresponds to space heating fuel, although the EIA RECS finds that, nationally, about 38% of homes heating with fuel oil or LPG heat water with electricity.

Using electricity for space heating and water heating is relatively GHG intense. In the Adirondacks, heating with fuel oil or LPG emits approximately 90% and 72%, respectively, of the emissions from electrical space heating use. Electricity emissions are somewhat mitigated by the high proportion of zero emissions generation in Upstate New York, including hydro, nuclear, and increasingly, wind energy.

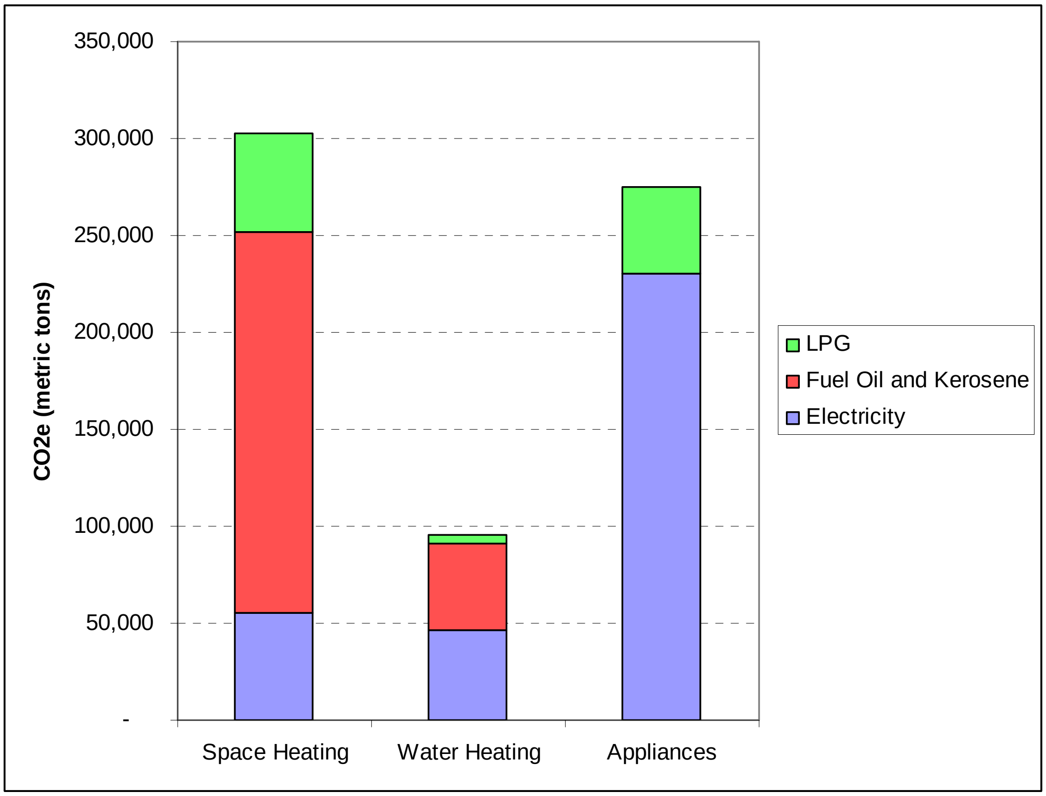

Figure 3 Indirect and Direct Residential GHG Emissions by Energy Source and Energy End Use

2.1.2 Commercial Emissions

Analysis complete. Text pending. Commercial is defined as per DOE EIA as all non-residential, non-industrial, and non-agricultural structures.

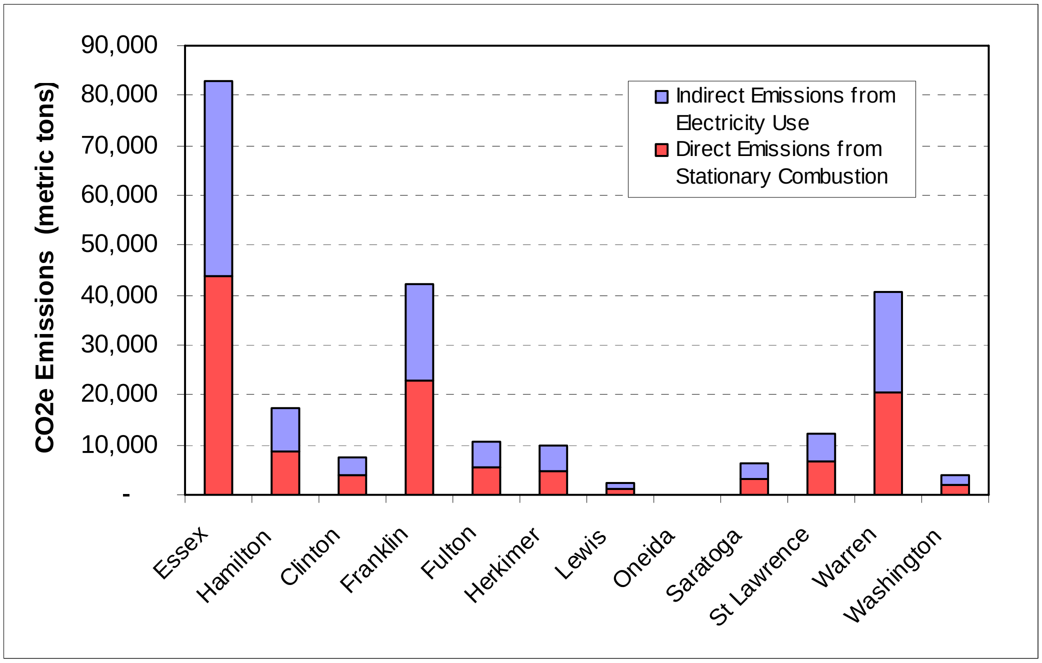

Figure X. Adirondack Park Commercial GHG Emissions by County

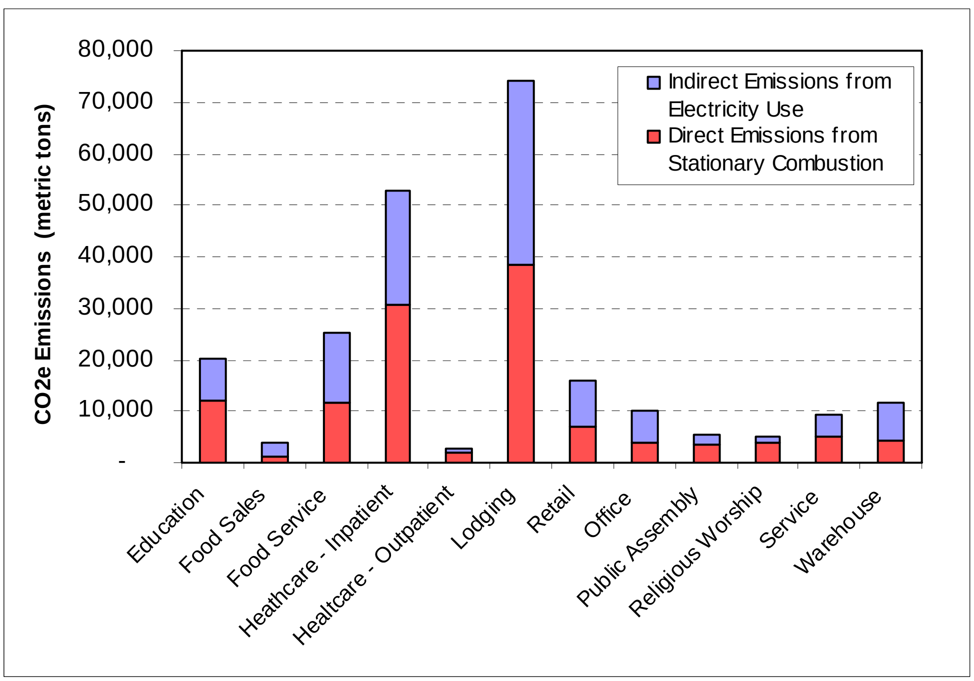

Figure Y. Adirondack Park Commercial GHG Emissions by Property Type.

2.1.3 Industrial Emitters

Analysis complete. Text pending.

Business	Scope I Emissions (metric tons CO2e)	Scope II Emissions (metric tons CO2e)
IP Ticonderoga Mill	425,836	25,821.01
Oval Wood Dish	2,135	900.90
NYCO Minerals	5,144	1,511.48
Barton Mines	584	171.61
Lewis Concrete	356	104.73
Lincoln Log Homes	330	96.89
Commonwealth Home Fashions	1,067	208.13
Other Industrial Emitters	8,054	3,398.50
Total	**443,505**	**32,213**

2.1.4 Other Large Emitters

This will have brief emissions estimates for three organizations that have provided us with energy use data (ORDA, NYS DOC, and Paul Smith College).

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2.2 Mobile Sources/Transportation

2.2.1 Mobile Combustion Emissions

Mobile combustion emissions are very significant in the Adirondack Region, particularly with its low population density, large distance between population centers, and high proportion of light trucks. The typical method to assess mobile source emissions is to obtain gasoline and diesel fuel use data, and apply appropriate emission factors. Unfortunately, bulk fuel deliveries to the region are not centrally tracked, and fuel distributors and retailers consider sales volumes to be proprietary. In order to best estimate GHG emissions, two approaches were employed, one relying on a New York State Energy Research and Development Authority (NYSERDA) study and based on sales tax data (Sales Tax Approach), and a second using vehicle miles traveled (VMT) and vehicle registration data (VMT Approach).

Sales Tax Approach

In January 2008, NYSERDA published a study of energy use trends in New York that includes a table of average annual gasoline consumption by county. The analysis supporting the gasoline data relies on tax data reported to the NYS Department of Taxation and Finance (DTF). Per gallon, state excise taxes are collected at the point of import into New York State and there is no per gallon tax information available at the county level. DTF does receive tax receipts for sales tax on fuel sold at individual fueling stations. This data is aggregated resulting the combining of on-road diesel, off-road diesel, different grades of gasoline, and kerosene, and only the value of the sale is reported, not the fuel quantity. An additional complication is that fuel prices change daily and vary between locations. NYSERDA estimates the county gasoline sales by estimating average fuel prices for each fuel type and assuming proportions of fuel types. This is an estimate of sales in a given location and not necessarily consumption since a vehicle may travel significant distance on the fuel purchase. For this reason and because of the other challenges in creating this estimate, the NYSERDA results should be viewed as approximate.

Fuel use and carbon dioxide equivalent (CO_2e) emissions for gasoline consumption using NYSERDA data are shown by county in Table 2-1, emissions are calculated for entire counties and proportioned by population to provide Adirondack Park emissions. CO_2e emissions are calculated from gallons of gasoline using USEPA emission factors. As almost all diesel or gasoline fuel is oxidized in an internal combustion engine, the amount of CO_2 emitted per gallon of fuel is nearly constant across engines and only varies by fuel type. There is greater variation in emission rates for NO_2 and CH_4, particularly for gasoline vehicles with catalytic converters. But as NO_2 and CH_4 are less than 1% of total GHG emissions, this variation is not significant to this inventory. The EPA fleet-wide NO_2 and CH_4 emission factors are applied in this report and are used to calculate CO_2e emissions.

Table 2-1 Sales Tax Approach, GHG Emissions

County	County Wide Gasoline (gallons)	Adirondack Park Gasoline (gallons)	County Wide CO_2e (metric tons)	Adirondack Park CO_2e (metric tons)
Saratoga	94,898,000	3,574,372	880,054	33,148
Warren	41,007,000	16,004,280	380,286	148,419
Washington	20,389,000	1,099,580	189,081	10,197
Herkimer	57,264,000	3,229,083	531,048	29,945
Oneida	110,923,000	161,578	1,028,665	1,498
Essex	21,041,000	21,038,834	195,128	195,107
Fulton	27,737,000	5,260,526	257,224	48,784
Hamilton	2,743,000	2,743,000	25,438	25,438
Clinton	43,065,000	8,512,849	399,371	78,945
Franklin	16,962,000	5,747,986	157,300	53,305
Lewis	13,265,000	446,040	123,015	4,136
St. Lawrence	40,424,000	1,292,199	374,879	11,983
Total	**489,718,000**	**69,110,327**	**4,541,490**	**640,907**

VMT Approach

Given the limits of the Sales Tax Approach and its consideration of gasoline sales, but no analysis of diesel sales, a second method was employed using VMT and other data obtained from the New York State Department of Transportation (NYSDOT) and the EPA. Periodically, NYSDOT estimates total VMT by county for use in transportation planning and for emissions reporting to the EPA. The most recent estimate is from 2002. These values are derived from a complex analysis that primarily relies on traffic count data obtained by the Highway Performance Monitoring System, which measures vehicle traffic on most state and federal highways. The analysis also includes population data, economic data, total road miles, and vehicle registration data to arrive at total county VMT, including both state and non-state roadways. County VMT data is shown in Figure 2-1, by roadway type.

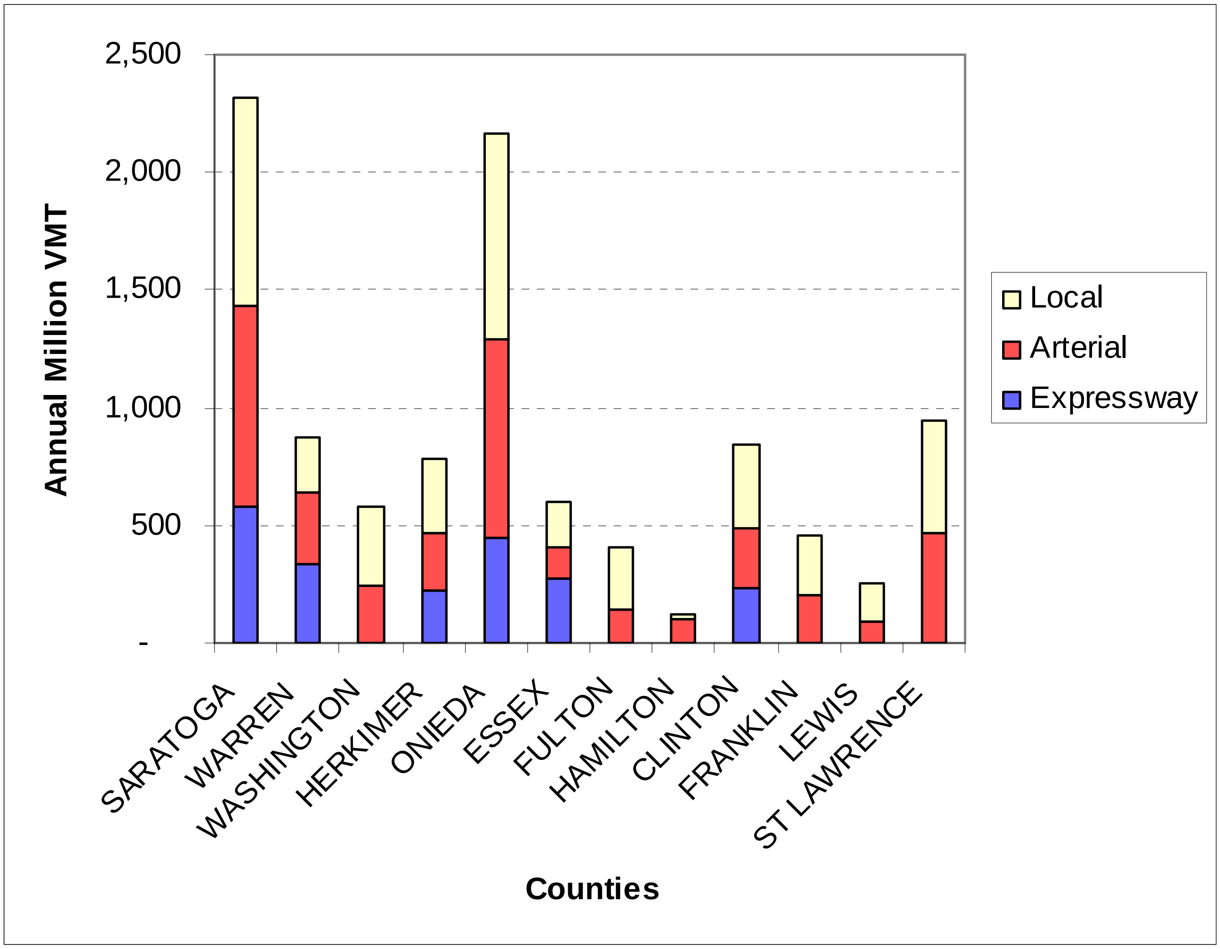


Figure 2-1 2002 Countywide Vehicle Miles Traveled by Roadway Type

NYSDOT provided the proportion of driving by road functional class (e.g., rural expressway, and urban arterial), and by county. NYSDOT also provided vehicle type distribution data (proportion of cars, trucks by size, and buses) by NYSDOT region and by roadway functional class. This functional class and vehicle distribution data were used to disaggregate the total county VMT data to VMT by individual roadway functional classes and vehicle classes. Vehicle class specific emissions factors were provided by the EPA and were developed using the MOBILE6.2 emission factor model that represents 2008 national fleet average emissions. These factors were then applied to the county-specific, functional class specific VMT data to provide countywide and Adirondack Park GHG emissions.

Countywide and Adirondack Park estimated fuel consumption and GHG emissions, by county, are shown in Table 2-2. Note that the resulting total county-wide CO_2e using the VMT Approach (4,493,621 metric tons) is very similar to that the total county-wide CO_2e using the Sales Tax Approach (4,541,490 metric tons).

Table 2-2 VMT Approach, GHG Emissions

County	CO_2e From Gasoline Vehicles (metric tons)		CO_2e From Diesel Vehicles (metric tons)		Total CO_2e From Vehicles (metric tons)	
	Countywide	Adirondack Park	Countywide	Adirondack Park	Countywide	Adirondack Park
Saratoga	1,003,632	37,802	176,549	6,650	1,180,181	44,452
Warren	376,334	146,876	86,775	33,867	463,109	180,743
Washington	255,786	13,795	38,609	2,082	294,395	15,877
Herkimer	338,401	19,082	65,312	3,683	403,712	22,765
Oneida	938,029	1,366	154,944	226	1,092,973	1,592
Essex	255,913	255,886	74,556	74,548	330,469	330,435
Fulton	180,397	34,214	24,564	4,659	204,961	38,872
Hamilton	53,659	53,659	9,497	9,497	63,156	63,156
Clinton	362,365	71,630	77,949	15,408	440,314	87,039
Franklin	201,064	68,135	30,771	10,428	231,835	78,563
Lewis	113,568	3,819	17,487	588	131,055	4,407
St. Lawrence	414,474	13,249	62,834	2,009	477,308	15,258
Total	**4,493,621**	**719,515**	**819,846**	**163,644**	**5,313,467**	**883,158**

Countywide mobile source emissions are dominated by the effect of large population centers within each county. For counties that are only partially within the Adirondack Park, most of the mobile source emissions in these counties are outside of the blue line, as shown on Figure 2-2. Essex County, which is entirely within the Park, has the highest annual mobile emissions within the Park.

Non Road Equipment

The sales tax and VMT approaches do not capture diesel fuel used for non road equipment. This category includes off-road mobile sources used in logging, construction, and farm equipment. Given the proprietary nature of fuel distribution, data to support analysis of off-road equipment emissions is relatively unavailable. In order to provide an order of magnitude type estimate for non-road equipment, the proportion of on road to off road diesel fuel use was extrapolated from an end use study of 2006 fuel sales published by the United States Department of Energy's Energy Information Administration (EIA). The application of the EIA study results for the non-road activity in the Park must be considered as an approximation given the high amount of use of non-road equipment for forestry activity in the Park. The ratio of non-road to on-road diesel fuel use may be higher than the EIA study. Thus, the resulting actual emissions from non-road diesel fuel use may be greater that estimated here. Figures 2-3 and 2-4 show the GHG emissions by fuel type for the countywide and Adirondack Park regions, respectively. It is estimated that non road sources constitute about 1% of the mobile combustion inventory.

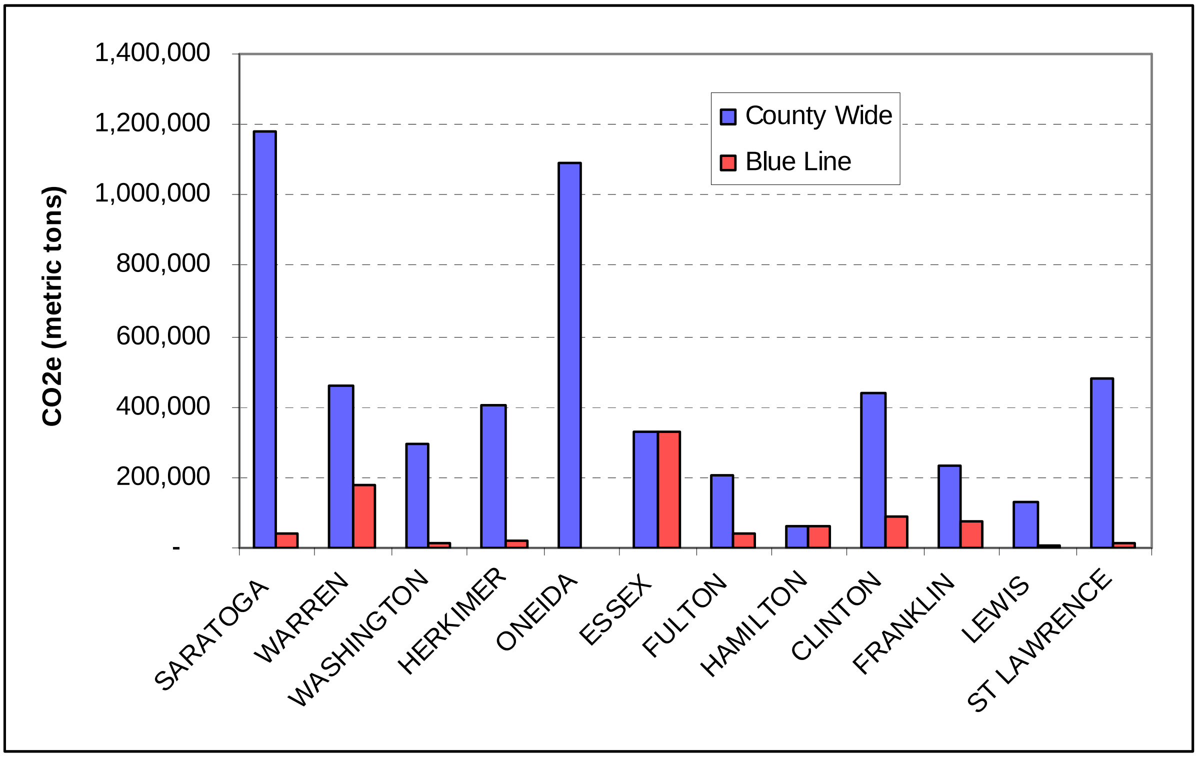


Figure 2-2 VMT Approach, Annual GHG Emissions by County

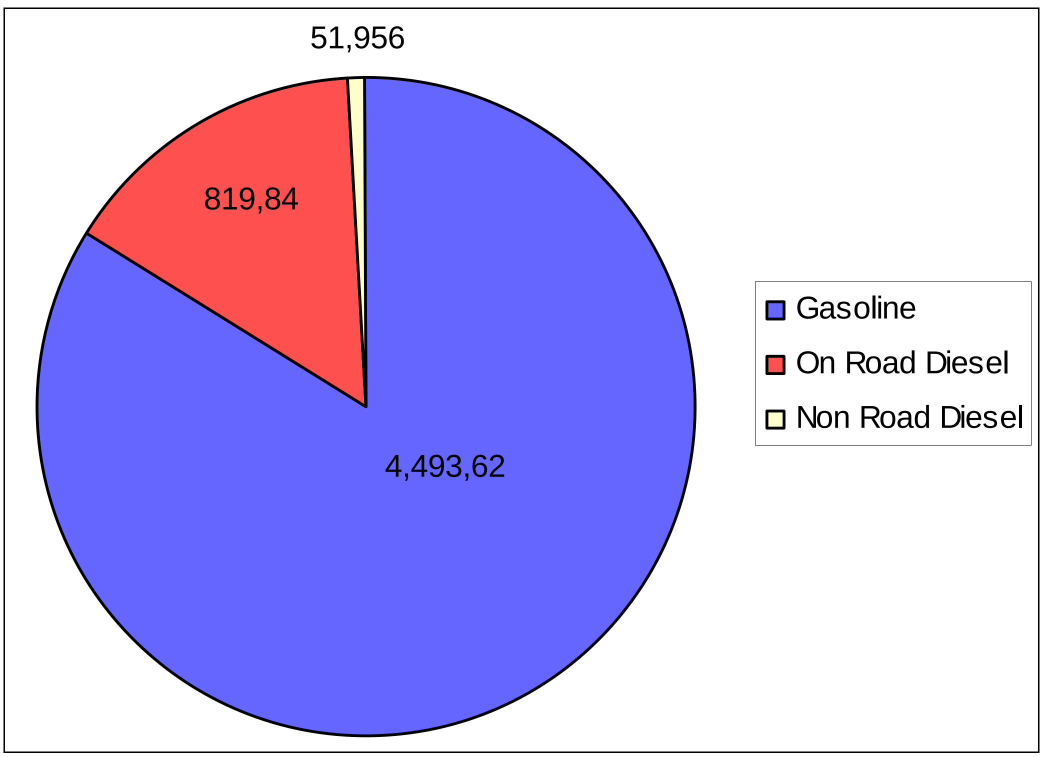


Figure 2-3 Countywide GHG Emissions by Fuel Type (CO2e metric tons)

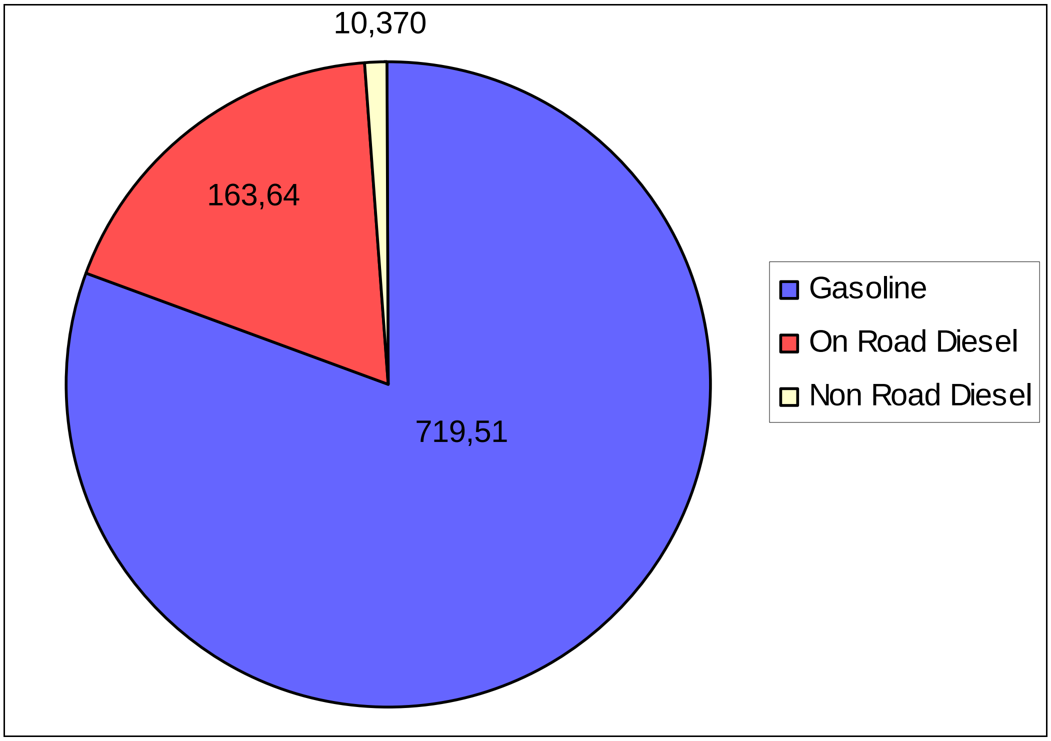
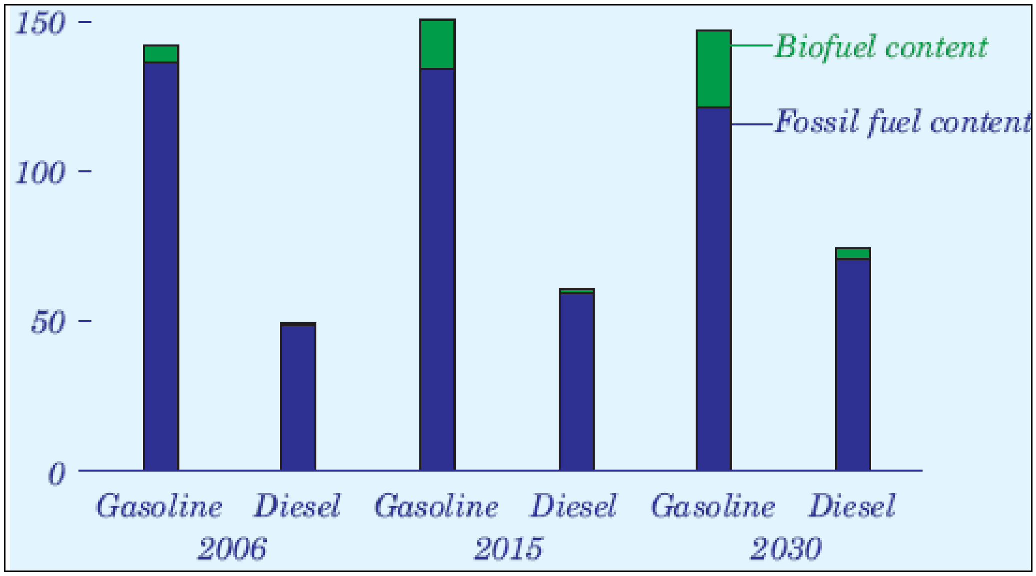


Figure 2-4 Adironдack Park Emissions by Fuel Type (CO2e metric tons)

Mobile Combustion Reductions

Transportation emission reductions can be viewed as taking one of three forms: increasing vehicle fuel efficiency, reducing fuel GHG intensity, and reducing VMT. Recently there have been national policy initiatives that will affect vehicle fuel efficiency and fuel GHG intensity in the Adirondack Park. The Energy Independence and Security Act of 2007 (EISA2007) updated the federal Corporate Average Fuel Economy Standards (CAFE) for the first time in 30 years. The new CAFE standard removes exemptions for most SUVs and light trucks and requires fleetwide fuel economy for all new cars and light trucks of 35 miles per gallon (MPG) by 2020 (versus 27.5 MPG and 20.7 MPG for cars and trucks today).

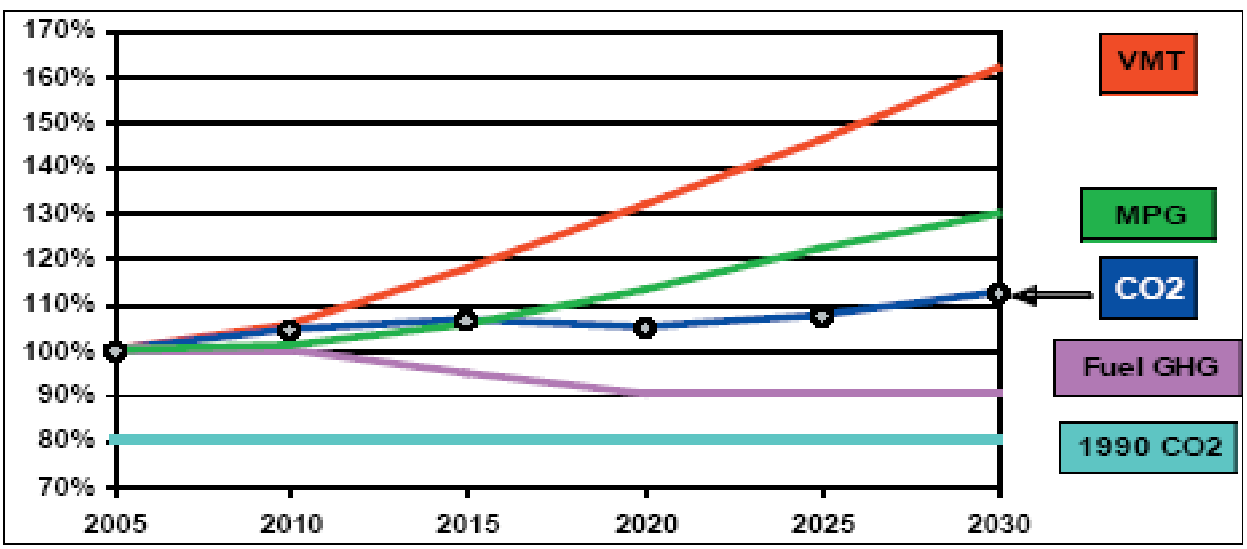
The U.S. primary fuel GHG intensity reduction program is the Renewable Fuel Standard (RFS). Each year, the EPA sets an annual standard representing the amount of renewable fuel that must be used to ensure the RFS set by Congress is achieved (the 2008 RFS announced by EPA on November 27, 2007 was 4.66%). EISA2007 extended and increased the requirements of the RFS, requiring 36 billion gallons of renewable fuels by 2022. EIA projects that the fossil fuel content of gasoline and diesel will be reduced from 96% today to 83% by 2030 through the use of biofuels such as ethanol and biodiesel (see Figure 2-5). Note that biofuels do have significant GHG impacts over their life cycle, and reduction of fossil fuel content in this context does not reflect a proportional reduction in anthropogenic GHG emissions.



Source: EIA 2008.

Figure 2-5 Biofuel Content of U.S. Motor Fuel Supply Trends

Figure 2-6 shows an analysis by the Center for Clean Air Policy (CCAP), which projects effects of fuel economy and fuel GHG intensity initiatives, in the context of increasing VMT in relative terms versus the 2005 base year. For reference, 1990 emissions are shown. The 2020 CAFE standard and a 10% reduction in GHG fuel intensity is applied.



Source: Center for Clean Air Policy.
Assumes: 1. 2020 CAFE Standard of 35 MPG.
2. 10% reduction in fuel GHG intensity.
3. 100% represents 2005 emissions.

Figure 2-6 U.S. Projected Growth in CO2 Emissions from Cars and Light Trucks

Clearly, even with the RFS resulting in a 10% GHG emissions reduction and the increase in the CAFE standard, the increase in national VMT overwhelms the effects of the reduction initiatives, and GHG emissions greatly exceed stabilization targets. By 2030 VMT in the United States increases by 60%, and CCAP estimates that even with the EISA2007 initiatives, GHG emissions will increase more than 10% for on-road vehicles.

Between 2002 and 2028, NYSDOT predicts a 45% increase in the 12-county Adirondack region VMT. This is an unsophisticated estimate used for transportation planning and simply projects forward the historic growth rate. VMT growth is driven both by increases in population, economic growth, and changes in land use. Following the CCAP analysis approach, a roughly 5 to 10% decrease from 2005 emissions would be expected by 2030 given the two reduction initiatives discussed above (see Figure 2-7). Even with the lower VMT projection for the Adirondacks, it is projected that increases in VMT will mostly negate reductions from the CAFE standard and RPS.

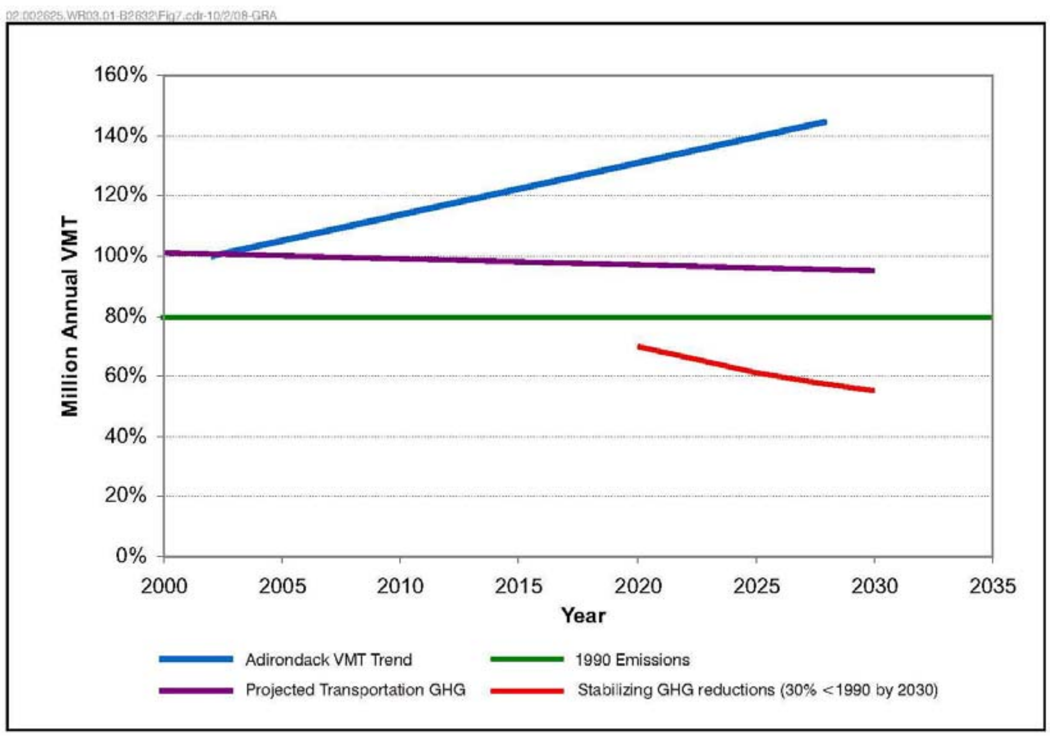


Figure 2-7 Adirondack VMT and GHG Trend

Initiatives that target VMT, such as access to public transportation, ride sharing, trip reduction, and land use planning, probably will need to be part of initiatives aimed at reducing transportation GHG emissions.

This inventory and projections suggest that mobile combustion is very significant to the Adirondacks and that a primary driver is sharply increasing vehicle use, which corresponds to but is somewhat less than the national trend. Recommendations for mitigating mobile emissions are beyond the scope of this inventory, but clearly an array of efforts will be needed that may include initiatives that reduce vehicle use.

2.4 Solid Waste and Wastewater Treatment

This sector is comprised of two main categories: generation of solid waste by entities within the Park and generation of wastewater in the Park that is collected and treated at municipal waste water treatment plants or treated with septic systems. Each is discussed separately and evaluated for GHG emission potential below.

2.4.1 Solid Waste

The solid waste category consists of any unwanted solid materials generated by human activity within the Park that are disposed of after removing recyclable materials. Solid waste is generated from households, commercial activities, industry, and municipal organizations. The majority of solid waste is collected by waste transport companies and trucked to transfer stations and ultimately to a disposal site.

Solid waste, generally called municipal solid waste (MSW), produces "landfill" gas when disposed of in a landfill. Methane (CH_4) and carbon dioxide (CO_2) are the primary gases produced from the decomposition of organic materials (i.e., materials containing carbon) in an anaerobic (oxygen-limited) environment. Both are greenhouse gases, but methane has a global warming potential approximately 21 times greater than carbon dioxide. Landfill gas can be directly emitted to the atmosphere either by leaking out of the ground through pores or cracks in landfill covers, from vents in a landfill gas collection system that does not have a combustion control system installed, or as fugitive emissions from active landfill cells. If the landfill gas is captured by a landfill gas collection system and burned in a flare or landfill gas to energy facility, only emission of CO_2 will result. The NYSDEC general estimate for landfill gas generation rate is 0.15 cubic feet per pound per year (reference NYSDEC Web site for solid waste management).

Closed Landfills

There are currently no open landfills (e.g., landfills accepting waste) within the Park's boundary. Historically, many landfills existed in the Park; approximately 60 landfills existed at one time or another during the 1900s (see Table 2-3 summarized from Jenkins 2004). Many of these landfills were simply unlined pits into which municipal solid waste and construction debris was deposited. Active landfills ceased operation in the Park by year 2000; the most recent landfill closures include the Essex County Landfill, and smaller landfills in Lake Pleasant and Indian Lake. Although these landfills are no longer accepting waste, the waste that is in the landfill continues to decompose and generate landfill gas. As part of the closure process for some of these landfills, gas venting and collection systems were installed.

Table 2-3 Closed Landfills in the Adirondack park

County	Closed Landfills within Park Boundary
Franklin	8
Clinton	2

Essex	14
Warren/Washington	14
Fulton	2
Hamilton	8
Herkimer/Oneida/Lewis	2
St. Lawrence	8
Saratoga	2

Estimates of landfill gas emissions from all closed landfills within the Park cannot be completed due to difficulty in finding information regarding the amount of MSW that was disposed of in the landfill and the landfill closure date. If this data becomes available, an estimate of landfill gas emission from these closed landfills will be made.

Current MSW Management

Currently, MSW is collected via trucks, transported to a transfer station, and then compacted and shipped out of the Park to landfills or a waste to energy facility. Table 2-3 shows a summary of the solid waste stream data and the waste destination. The collection and transport of MSW in this manner results in emissions of GHGs from transport trucks. Emissions associated with collection and transport of waste is captured in the mobile source/transportation activity section of the GHG inventory (see Section 2.2). The landfilling and/or incineration of solid waste at facilities outside of Park boundaries results in GHG emissions that are directly related to activity within the Park.

These relatively large "regional" landfills consist of several cells, with some cells full of waste and closed, other cells open and actively accepting waste, and some cells under construction for receipt of waste in the future. All regional landfills are of sufficient size to require (per NYSDEC regulation) the installation of landfill gas collection systems. Waste deposited into active cells begins generating landfill gas after a short period of time (approximately one week); landfill gas from active cells can be controlled if the landfill incorporates the proper design (wells and collection trenches) for active cells. The major regional landfills and the characteristics of their landfill gas collection and treatment systems are discussed below.

The Rodman landfill, operated by the Development Authority of the North Country, accepts waste from Hamilton County and portions of Herkimer/Oneida/Lewis counties within the Park. This landfill controls emissions of landfill gas via a gas collection system and newly constructed landfill-gas-to-energy power plant, which is scheduled to become operational in late fall 2008. Landfill gas generated from decomposition of the waste is collected in wells and piped to a facility that burns the gas to generate heat/steam and electrical power. In this process, methane (a more potent greenhouse gas per ton emitted) is combusted which results in the emission of CO_2 that has a lower global warming potential per ton emitted. The Rodman landfill recently completed an expansion of its capacity, installed additional landfill gas collection wells, and connected these new wells to its landfill gas to energy plant.

The Westville landfill, operated by the County of Franklin Solid Waste Management Authority accepts waste from Franklin, Essex and St. Lawrence counties. Private individuals, waste haulers and trucks from the Authority's transfer stations in Tupper Lake, Lake Clear, and Malone (outside the Park) bring waste to the landfill. According to the final scoping document, issued in June 2008, for a planned expansion of the landfill, the current landfill operates a landfill gas collection system and would install a gas collection system for the expansion. Expansion of the landfill's capacity is currently under study and an environmental impact statement (EIS) is being prepared; the EIS will contain an analysis of GHG emissions and a discussion of potential mitigation measures.

The Clinton County (Schuyler Falls) landfill, owned by Clinton County and operated by New England Waste Services of New York, accepts waste from Clinton County. Approximately 46% of the land area of Clinton County is located within the Park boundary. However, the portion of Clinton County within the Park has a small fraction of the County's population and thus generates a very small fraction of Clinton County's annual total solid waste. The landfill has an active gas collection system that captures the landfill gas and directs it via piping for treatment by combustion with open flares. Both closed and active cells are connected to this gas collection system.

The Hudson Falls Waste to Energy Plant, owned by the Washington and Warren County IDA and operated by Wheelabrator Inc., accepts waste from several Adirondack counties as shown in Table 2-4. This facility combusts solid waste and uses the heat to produce electricity. The plant has a capacity to burn 500 tons per day of waste; the waste generated in the portions of counties within the Park that go to this facility contribute approximately 47 tons per day on average. Thus approximately 10% of the annual emissions of GHG from this plant can be attributed to waste generated within the Park.

The Fulton County (Johnstown) landfill is owned and operated by Fulton County. Approximately 4,070 tons of solid waste generated in the Park portions of Fulton and Saratoga counties were sent to this landfill in year 2000. This waste quantity is approximately 5% of the average annual acceptance rate of 83,000 tons at the Fulton County landfill. The landfill has installed a landfill gas collection system

Some solid waste that is generated has value as a recyclable material. Collection and transport of recyclables still generates emissions during the transport phase as is the case for waste that is disposed of. In most cases, recycling sorting is conducted at the source and hauled separately to the transfer station. Table 2-4 shows the percent of solid waste that is recycled for counties in the Park.

Table 2-4 Characteristics of Current Solid Waste Management for Waste Generated within the Park

County	Tons of waste (year 2000)[1]	Recycling Percentage, Approximate	Tons of Waste to Landfill or Incineration	Landfill Gas Combustion System Installed?	Waste Destination
Franklin	9,900	3	9,600	No	Franklin County Regional (Westville) Landfill
Clinton	800	10	720	Yes	Clinton County (Schuyler Falls) Landfill
Essex	14,800	30	10,360	Not applicable	Hudson Falls Incinerator
Warren/Washington	15,900	63	5,883	Not applicable	Hudson Falls Incinerator
Fulton	3,500	12	3,080	No	Fulton County (Johnstown) Landfill
Hamilton	6,500	16	5,460	No	DANC (Rodman) Landfill
Herkimer/Oneida/Lewis	2,000	45	1,100	No	DANC (Rodman) landfill and Utica-Rome Transfer
St. Lawrence	800	30	560	No	Franklin County Regional (Westville) and DANC (Rodman) landfills
Saratoga	2,100	6	1,974	Not applicable No	Hudson Falls Incinerator Fulton County (Johnstown) Landfill
Total	**56,300**	**NA**	**38,737**		

Data Source: Jenkins and Keal 2004.

Note:
1. From the portion of the county within the Adirondack Park boundary.

Key:
DANC = Development Authority of the North Country
NA = Not applicable.

The GHG emission estimate for solid waste management is shown in Table 2-5.

Table 2-5 Greenhouse Gas Emission Estimate for Solid Waste Management

Waste Destination	Tons of Waste in year 2000	Amount of Landfill Gas Generated (ft^3)[1]	Methane (CO_2e metric tons)[2]	CO_2 (metric tons)
Landfill	21,507	6,452,100	4,156	181
Waste to Energy Plant	17,230	Not applicable	none	3,177
Total	**-**	**-**	**9,011 metric tons CO_2e**	

Notes:

1 Tons of waste *2,000 lb/ton * 0.15 cubic feet per pound per year = gas generated. Assume gas is 50/50 methane/carbon dioxide. Convert cubic feet to cubic meters, multiply by CH_4 (1.82 kg/m^3) and CO_2 (1.98 kg/m^3) to get raw emissions, convert to CO_2e and to metric tons.

2 Landfill gas resulting from waste decomposition in the Clinton County landfill is treated with a landfill gas flaring system resulting in emissions of only CO_2. The amount of waste sent to this landfill from the portion of the Park in Clinton County is a very small fraction of the total waste received, therefore the emissions were assumed to be methane only. Since, the Rodman landfill waste to energy facility is expected to begin operation in late 2008, existing emissions of landfill gas are assumed to not pass through the combustion control system.

Key:
CO_2 = Carbon dioxide.
CO_2e = Carbon dioxide equivalent.
ft^3 = Cubic feet.

The estimates are based on the amount of waste generated in the Park and sent to the four regional landfills and the Hudson Falls Waste to Energy Facility (according to year 2000 data [Jenkins and Keal 2004]). For MSW sent to landfills, the annual GHG emission estimate is derived by using the NYSDEC general landfill gas generation rate of 0.15 cubic feet per pound of waste per year multiplied by the total amount of waste sent to landfills and assuming that 50% of the landfill gas is methane and 50% is CO_2. For the Hudson Falls waste to energy plant, total CO_2 emissions from the plant and amount of waste combusted were obtained for year 2000 from the United States Department of Energy's Energy Information Administration data base. The proportion of the facility's CO_2 emissions from waste sent to the plant from Adirondack Park counties (or portions of counties in the Park) was derived from the ratio of total waste burned at the facility to the amount of waste sent to the plant from the Park.

2.4.2 Wastewater Treatment

While all old municipal solid waste management facilities within the Park have been closed and solid waste transported to regional landfills or to a waste to energy plant, wastewater treatment plants (WWTP) are by necessity located in many villages and towns within the Park and continue to operate. In addition, many residences not connected to a municipal WWTP utilize a septic system to treat their wastewater.

Wastewater treatment can produce methane and nitrous oxide (N_2O) emissions. The treatment process generally consists of the application of methods to remove soluble organic material, suspended solids, organisms, and chemicals. Microorganisms are used in a biological process to remove the soluble organic material which generates a biomass (sludge). Other mechanical and chemical treatment processes are used to remove suspended solids, kill pathogenic organisms, and remove chemicals. The decomposition of the soluble organic material by microorganisms and the further decomposition of the sludge results in the generation of methane if purposely (or accidentally) conducted in an anaerobic condition (i.e., limited oxygen). Nitrous oxide can be emitted from wastewater treatment due to the interaction of nitrogen bearing compounds such as urea, ammonia, or proteins in the wastewater with the treatment process. Operation of equipment at the WWTP uses electricity and results in indirect emissions of GHGs. Nationally, the EPA estimates that 0.64% of the country's GHG emissions originate from wastewater treatment (NYSDEC 2008).

The quantity of methane generated at a WWTP primarily depends on the amount of incoming biological material in the wastewater and the degree or percentage of the process that is conducted anaerobically. N_2O emissions are dependent on the amount of nitrogen in the incoming wastewater.

The quantity of sludge generated and the fate of the sludge also contribute to the quantity of methane generated. Sludge may be shipped off-site to a landfill or treated on-site at the WWTP. If the sludge decomposition occurs in an anaerobic environment, such as in a landfill or an on-site anaerobic sludge digester, the methane can be captured. However, methane can be emitted during the handling of the sludge prior to receipt of the sludge at a landfill or prior to entering an on-site anaerobic digester.

The NYSDEC Division of Water's Descriptive Data of Municipal Wastewater Treatment Plants in New York State (January 2004) was used to identify WWTPs in the counties within or partially within the Park. The list was then narrowed to identify just those facilities within the Park or very near the Park boundary. There are 26 municipal WWTPs treating a combined design flow of 19.5 million gallons per day and serving 75,176 people (NYSDEC 2004).

The remaining population within the Park is assumed to use septic systems. The exact population living within the Park is not known but is approximated at 150,000 (Jenkins and Keal 2004). Thus, taking the total Park population and subtracting the people served by municipal WWTP results in a population of about 75,000 using septic systems.

According to the NYSDEC Division of Air list of facilities with either Title V or State Facility air operating permits, none of the WWTPs within the Park has an air permit. This indicates that these facilities do not contain point source emissions. The single WWTP facility in the Adirondack region (but not within the Park) with a State Facility air permit is the Glens Falls WWTP due to its use of a sludge incinerator.

Table 2-6 lists the 10 largest WWTPs within the Park in terms of population served.

Table 2-6 Ten Largest Municipal WWTP Within the Adirondack Park

WWTP Name	County	Receiving Waterbody	Design Flow (MGD)	Population Served	Type of Sludge Digestion	Sludge Disposal
Lake George (Town and Village)	Warren	Groundwater	1.750	20,000	anaerobic	composting
North Elba (Lake Placid)	Essex	Chubb River	2.500	15,000	anaerobic	landfill
Saranac Lake WWTP	Essex	Saranac River	3.660	7,500	anaerobic	landfill
Dannemora WWTP	Clinton	Saranac River	1.500	4,004	none	not specified
Port Henry/ Moriah Joing WWTP	Essex	Lake Champlain	0.440	4,000	none	not specified
Tupper Lake WWTP	Franklin	Raquette River	4.500	4,000	none	not specified
Corinth WWTP	Saratoga	Hudson River	0.600	3,700	none	not specified
Ticonderoga WWTP SD #5	Essex	Lachute River	1.700	3,500	none	not specified
Schroon Lake WPCP	Essex	Schroon Lake	0.350	2,950	none	not specified
Speculator WWTF	Hamilton	Sacandaga River	0.120	2,500	aerobic	land spreading

Key:
WWTP = Waste water treatment plant.
WWTF = Waste water treatment facility.
WPCP = Water Pollution Control Plant

Methane emissions from wastewater treatment within the Park are a sum of the emissions from septic system use and municipal WWTPs. For the municipal WWTPs, all biological treatment processes are assumed to be aerobic. Since aerobic systems may accidentally operate anaerobically at times, it was assumed that 10% of the aerobic systems, on average, operate anaerobically. Three of the aerobic systems as shown in Table 2-4.4 use anaerobic sludge digestion. None of the anaerobic digester systems were found to have a flare or other combustion device, thus for these systems it is assumed the methane is released to the atmosphere. Methane emissions from wastewater treatment systems (septic systems, centrally treated aerobic systems, and anaerobic digesters) were derived using the methodology from the EPA Inventory of United States Greenhouse Gas Emissions and Sinks (2008), Chapter 8.2. Total methane emissions were converted to metric tons of CO_2e using a global warming potential factor of 21 and are shown in Table 2-7.

Nitrous oxide emissions from wastewater treatment are the sum of emission from the WWTP and from wastewater effluent discharged to aquatic environments. The method of calculation of N_2O emissions from a WWTP depends on whether the WWTP applies or does not apply nitrification and/or denitrification in the treatment process. For the WWTPs within the Park, none of the facilities use nitrification/denitrification in the treatment process according to 2004 NYSDEC WWTP data (NYSDEC 2004). Also, the emission of N_2O from discharge of effluent to aquatic environments is determined but is calculated using national default values for some of the parameters in the equation. Nitrous oxide emissions were derived using the methodology from the EPA Inventory of United States Greenhouse Gas Emissions and Sinks (2008), Chapter 8.2. Using a global warming potential factor of 310 for N_2O, emissions are shown in Table 2-7 in terms of metric tons of CO_2e.

Table 2-7 Estimated Greenhouse Gas Emissions from Wastewater Treatment

Wastewater Emission Source	Methane (metric tons CO_2e)	Nitrous Oxide (metric tons CO_2e)	Total CO_2e (metric tons)
Septic System	15,532	None	15,532
Aerobic WWTP	555	4,377	4,932
Anaerobic Digestion	7,388	None	7,388
Totals	**23,475**	**4,377**	**27,852**

Key:
CO_2 = Carbon dioxide.
CO_2e = Carbon dioxide equivalent.
WWTP = Waste water treatment plant.
Notes:
Nitrous oxide emission from WWTP assumed to occur from plants with no nitrification/denitrification and effluent discharge to waterbodies.

Distribution of wastewater processed by septic and WWTP based on population served by WWTP versus total estimated Park population.

2.5 Forestry

Colin Beier – In progress

2.6 Discussion and Recommendations

3 References

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