CITY & BOROUGH OF JUNEAU GREENHOUSE GAS EMISSIONS INVENTORY FOR 2007

MARCH 2009

CITY & BOROUGH OF JUNEAU
ALASKA'S CAPITAL CITY

Acknowledgements:

City and Borough of Juneau Assembly
Juneau Commission on Sustainability
Alida Bus, project intern
Maria Gladziszewski, project oversight
Fuel distributors, Alaska Electric Light & Power Co., CBJ staff, and others for providing data
ICLEI—Local Governments for Sustainability, for technical support

TABLE OF CONTENTS

EXECUTIVE SUMMARY

The overwhelming scientific view is that human-induced climate change is among the most pressing environmental problems of our time. Never in the past 1000 years has the planet warmed faster than during the 20th century, and the most recent decade has been the warmest on record. Alaska is ground zero for climate change. The 2008 Arctic Report Card, issued by the National Oceanic and Atmospheric Administration (NOAA) and four partner agencies, catalogs 50% declines in both area and thickness of arctic sea ice compared to the 1970s, broken temperature records, sea level rise, fewer glaciers, more river discharge, and changes in terrestrial vegetation.[1] Data for Juneau indicate a trend toward warmer, rainier winters, and models predict that Juneau will be warmer and wetter, particularly in fall and winter.[2]

Juneau must do its part to combat climate change. Although the United States accounts for a mere 4% of the world's population, it produces 25% of the world's greenhouse gases. In March of 2007, the City and Borough of Juneau Assembly pledged to take action against this trend by passing Resolution 2397 and joining more than 500 U.S. local governments and 1,000 local governments worldwide committed to advancing climate protection and sustainability.[3] In so doing, Juneau committed to ICLEI's Five Milestone Process to combat climate change:

Milestone 1: Conduct a baseline emissions inventory and forecast
Milestone 2: Adopt an emissions reduction target
Milestone 3: Develop a Climate Action Plan for reducing emissions
Milestone 4: Implement policies and measures
Milestone 5: Monitor and verify results.

This report, an inventory of greenhouse gas emissions in Juneau in 2007, is Juneau's baseline inventory and forecast (Milestone 1), the first formal evaluation of the community's emissions. This greenhouse gas emissions inventory is a milestone achievement for Juneau, but is a small first step in the long-term process of making Juneau more sustainable.

This emissions inventory catalogs Juneau's *internal* energy economy and, as such—as is becoming standard protocol for community inventories—is largely an *end-use* based inventory.[4] This accounting considers energy consumed within a community's boundaries. It is not an accounting of our *external* energy economy, also called a *consumption-based* inventory. A consumption-based inventory—an accounting including all the energy needed to run our community—would include barge transport, the cruise ship industry, and the entire fuel budget of airlines serving the community.

Using methodology explained in the remainder of this report, we estimate that Juneau released approximately 441,000 tonnes of CO_2e in 2007.[5] Table 1 presents summarized data on energy and emissions for Juneau for 2007, by sector; Figure 1 illustrates the data presented in Table 1.

---

[1] Full report available online at www.arctic.noaa.gov/reportcard.

[2] Scientific Panel on Climate Change for the City and Borough of Juneau, *Climate Change: Predicted Impacts on Juneau*, April 2007 (available at www.juneau.org/clerk/boards/Climate_Change/CBJ%20_Climate_Report_Final.pdf).

[3] ICLEI—Local Governments for Sustainability (ICLEI) provides resources, tools, and technical assistance to help local governments measure and reduce greenhouse gas emissions. For more information, see www.iclei-usa.org.

[4] In fact, this is a modified *end-use* based inventory because unlike most end-use based inventories, we do include all the fuel pumped at the local airport, as well as all the fuel pumped for marine uses.

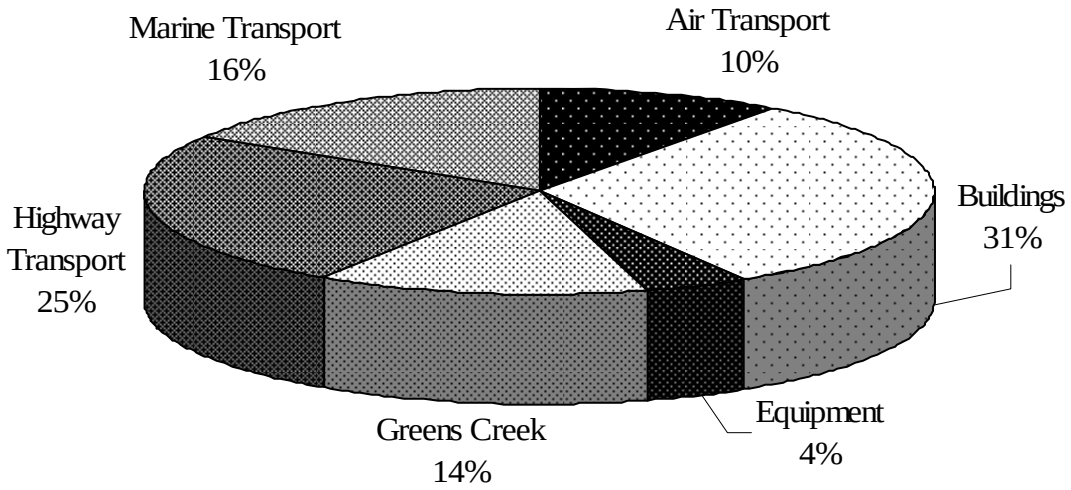
[5] CO2e is an abbreviation for carbon dioxide equivalent, the internationally-recognized measure of greenhouse gas emissions. Different gases vary in their global warming potential and analysts needed a base currency for the purposes of reporting, trading, and offsetting emissions. Worldwide, when a jurisdiction or organization calculates its greenhouse emissions, they are reported in the equivalent weight of carbon dioxide—the carbon dioxide equivalent—in tonnes (also called metric tons). A short ton is 2,000 pounds; a tonne is 1,000 kilograms or 2,205 pounds.

Table 1: Total Emissions from the Juneau Community, by Sector

Sector	MMBtu	CO2e (tonnes)	Percent CO2e
Buildings	3,038,553	138,704	31%
Equipment	237,425	17,410	4%
Greens Creek	819,390.86	60,249	14%
Highway Transport	1,525,939	108,794	25%
Air Transport	620,626	44,164	10%
Marine Transport	970,247	71,224	16%
Waste	-	(3,546)	-
Total	**7,212,181**	**440,545**	100%

See notes following Table 2 for additional information.

Figure 1: Total Emissions from the Juneau Community, by Sector



INTRODUCTION

The completion of this emissions inventory marks a milestone step in a process toward Juneau's contribution to world efforts to combat climate change. By joining ICLEI, the City & Borough of Juneau (CBJ) committed to a five-step process to implement a local approach for reducing global warming and air pollution emissions, with the additional benefit of improving community livability. The milestone process consists of the following:

Milestone 1: Conduct a baseline emissions inventory and forecast
Milestone 2: Adopt an emissions reduction target
Milestone 3: Develop a Climate Action Plan for reducing emissions
Milestone 4: Implement policies and measures
Milestone 5: Monitor and verify results

WHAT IS A GREENHOUSE GAS EMISSIONS INVENTORY?

A greenhouse gas (GHG) emissions inventory is an accounting of the amount of GHGs emitted over a specific period of time within a defined geographic boundary. A GHG emissions inventory provides information on the activities that cause emissions: largely the burning of fossil fuels. A GHG inventory, then, also provides information on the amount of energy and fuel consumed, as well as the amount of solid waste produced.

Carbon dioxide gas is released (with traces of other GHGs) by burning fossil fuels. There are many greenhouse gases, six of which are regulated under the Kyoto Protocol.[6] Local government emissions analyses usually focus on the three major GHGs we analyzed for Juneau's emissions inventory: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).

In reporting GHG emissions, standard convention is to report all data in terms of CO_2 equivalent (CO_2e). Converting all emissions to equivalent carbon dioxide units allows for the quantification of different greenhouse gases—each of which has different heat-trapping properties—in comparable terms. For example, methane is 21 times more powerful than carbon dioxide in its capacity to trap heat, so one tonne of methane is considered equivalent to 21 tonnes of CO_2 (see Table 9 in Appendix B).

This inventory is performed for two separate scales of emissions:

- Community (or geopolitical)—accounts for all emissions generated within the boundaries of the local government (in this case, within the boundaries of the City and Borough of Juneau).
- Local Government—includes emissions from facilities and activities owned and/or operated by the local government, the City and Borough of Juneau (CBJ).

We analyzed these two scales independently for several reasons. First, a much more detailed analysis—similar to a performance measurement analysis—is possible in a government operations inventory. For example, unlike the community inventory, electricity records for the CBJ local government can be examined at the account, building, or department levels.

[6] The Kyoto Protocol is an international agreement linked to the United Nations Framework Convention on Climate Change. It sets binding targets for 37 industrialized countries and the European community for reducing GHG emissions. While the UN Convention on Climate encouraged industrialized countries to stabilize GHG emissions, the Protocol commits them to do so. The U.S. has signed onto and ratified the Convention, but has not ratified the Protocol. See unfccc.int/2860.php for more information.

Second, analyzing both community and local government emissions provides more useful tools when developing policies promoting emissions reduction. For example, a CBJ government procurement policy requiring that certain vehicles in the CBJ's fleet be replaced with hybrid vehicles can be evaluated based on its impact on government fleet emissions. Alternatively, potential education or incentive programs to encourage hybrid vehicle purchases by residents and businesses can be evaluated based on their impact on the transportation emissions of the community as a whole.

METHODS & RESULTS

To create this inventory, we collected information from a variety of sources. We relied primarily on technical support and guidance from ICLEI for data source selection, calculations, and methodology.[7] We received energy data from local companies and public records.[8]

Both the community and municipal operations inventories are based on calendar year 2007. In some cases where calendar year data were unavailable, fiscal year data were used and will be noted.

Calculating precise emissions from energy use is difficult. The results depend upon numerous assumptions, and accuracy is limited by the quantity and quality of available data. We caution readers to think of specific numbers generated as approximations, rather than precise values. This emissions inventory is intended as a policy tool and not an exact measure of Juneau's GHG emissions. We hope this inventory will be improved in future years and be adapted to reflect efforts to reduce greenhouse gas emissions.

To obtain emissions (tonnes CO_2e) from energy consumption data (kWh, gallons, etc), we must include an emission factor in our calculations. Emission factors are ratios used to convert energy usage into associated GHG emissions. They are usually expressed in terms of emissions per energy used (i.e. pounds of CO_2 per kWh). Except for emissions from electricity—which we calculated using a local emissions factor—we used default emission factors provided by ICLEI. See Appendix B for tables with detailed emission factor information. We also made Juneau-specific calculations for emissions from wood use based on the type of wood burned here (90% spruce, 10% hemlock).

ICLEI developed the Clean Air Climate Protection (CACP) software in partnership with the US Environmental Protection Agency. The CACP software determines emissions using specific emission factors according to the type of fuel used. While the software provides the interface for entering data, determining what data to enter is shaped by the emissions protocols. For the majority of our reporting, we calculated emissions independent of the software program. We used the CACP software, however, to calculate emissions in the community waste sector.

Figures 2 and 3 illustrate the fuel sources that make up each sector in the community-scale and local government-scale analyses.

[7] As we worked on this inventory, no nationally agreed-upon community-scale protocol existed. The community protocol for geopolitical boundaries will be developed by ICLEI and partners by early 2009. Currently, for a community-scale analysis, ICLEI staff guide local governments using the *Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard*, developed by the World Business Council for Sustainable Development and the World Resources Institute. For the local government protocol, we relied on the following document: ICLEI—Local Governments for Sustainability, California Air Resources Board, California Climate Action Registry, The Climate Registry, *Local Government GHG Emissions Analysis Protocol*, Release Version 1.0, September 2008 (available online at www.iclei.org/index.php?id=8154).

[8] In order to gather information for energy use in Juneau, we worked with representatives from the following organizations: Delta Western Inc. (Jim Davenport, Facility Manager in Juneau), Petro Marine Services (Jim Cawdery, Plant Manager in Juneau), Taku Oil (Jeff Hansen, Manager), Amerigas (Raymond Bradley, Sales Service Manager for Southeast Alaska), Arrowhead Transfer Inc (Laura Kronsperger in Sitka), Alaska Electric Light & Power (Gayle Wood, Director of Consumer Affairs), Capitol Disposal (Eric Vance, Manager), and Greens Creek mine (Bill Oelklaus, Principal Environmental Advisor).

Figure 2: Community-Scale Emissions-Producing Sectors

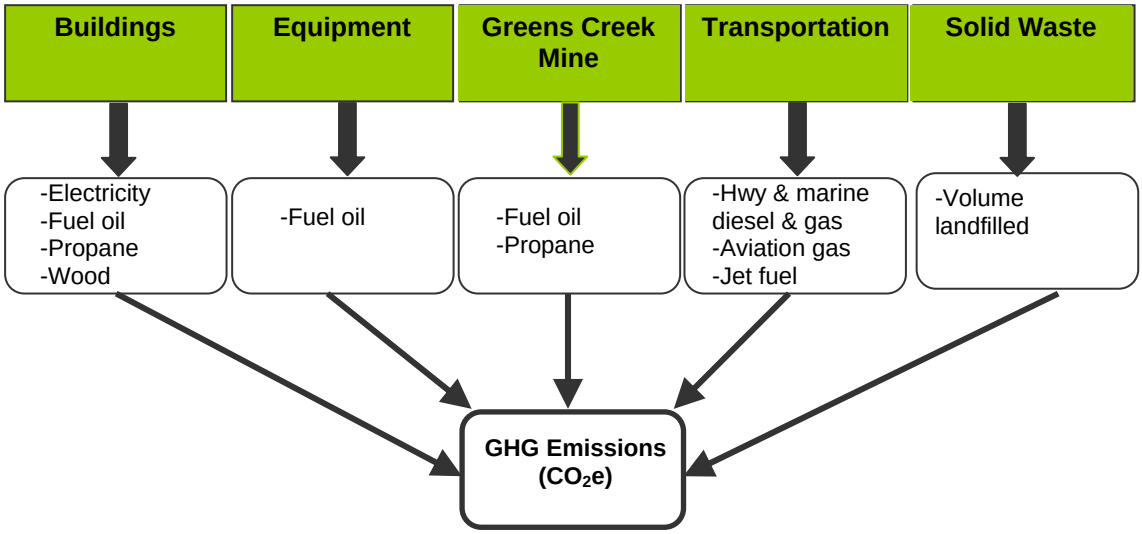
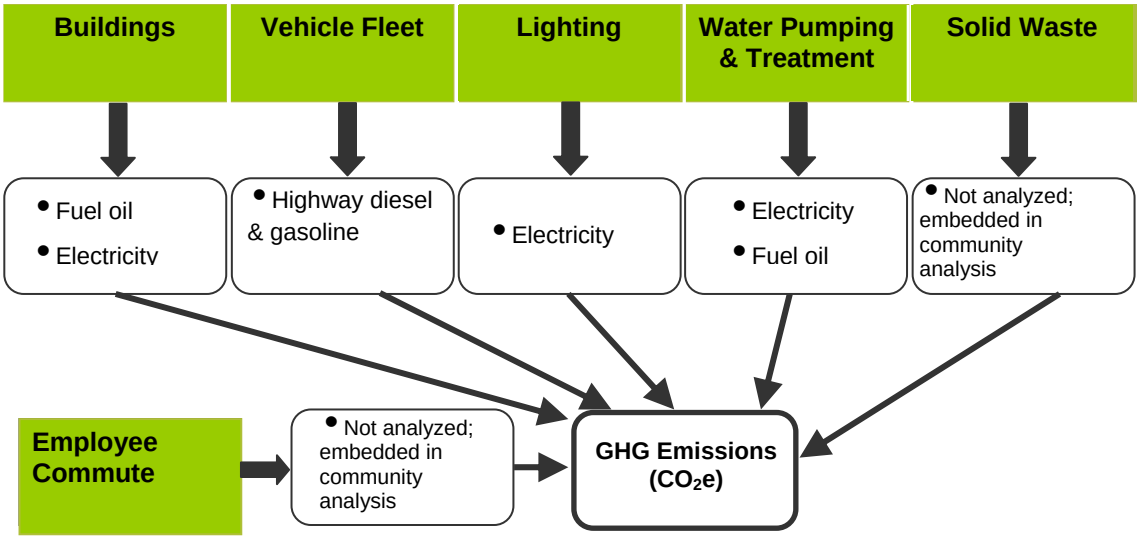


Figure 3: Local Government Emissions-Producing Sectors



We organized our community analysis using the following sectors: transportation, buildings, equipment, solid waste, and Greens Creek.[9] Most community inventories include reporting by residential, commercial, and industrial sectors, but we were unable to obtain data in Juneau to enable that level of analysis. Instead of attempting to extrapolate from Alaska data or estimate based on square footage of residential, commercial, and industrial properties, we obtained actual fuel gallons sold by Juneau's three fuel distributors.

Federal and state tax rates vary depending on whether the fuel is used for highway, marine, or air transport, or whether the fuel is used for heating or to fuel off road equipment (such as construction equipment). For tax reporting purposes, then, fuel distributors keep data on fuel sales based on those categories. Data presented in this inventory follows the same categories (highway, marine, air, heating, equipment).

Table 2 provides data on total emissions from Juneau by sector and source. See notes on the following page for additional details about each sector and source (fuel type).

Table 3 and Figures 4 and 5 illustrate the benefits of hydropower. Petroleum fuel supplies 81% of Juneau's energy yet accounts for 96% of Juneau's GHG emissions. Electricity supplies our community with 17% of its energy but accounts for only 1% of total community emissions.

Table 2: Total Emissions from Juneau Community, by Sector and Source

Sector	Fuel Type	Quantity	Units	MMBtu	CO2e (tonnes)	Percent CO2e
Buildings[a]	Heating Oil[b]	11,880,881	gallons	1,649,179	121,279	28%
	Propane[c]	689,817	gallons	63,069	3,986	1%
	Wood[d]	4,299	cords	90,276	9,081	2%
	Electricity[e]	362,156	MWH	1,236,029	4,358	1%
Equipment[f]	Diesel Fuel	1,710,435	gallons	237,425	17,410	4%
Greens Creek	Propane[g]	8,000	gallons	731.43	46	0%
	Diesel Fuel[h]	5,897,718	gallons	818,659	60,203	14%
Highway Transport[i]	Motor Gasoline & Diesel Fuel	12,023,878	gallons	1,525,939	108,794	25%
Air Tranport[j]	Aviation Gasoline & Jet Fuel	4,646,000	gallons	620,626	44,164	10%
Marine Tranport[k]	Marine Gasoline & Diesel Fuel	7,028,073	gallons	970,247	71,224	16%
Waste[l]	Waste	33,277	tons	-	(3,546)	-
Total	-	-	-	**7,212,181**	**440,545**	**100%**

Notes: see the following page.

[9] The Hecla Greens Creek Mining Company operates on Admiralty Island near Juneau. Fuel distributors report sales to Greens Creek separately from other Juneau sales (they are considered off site sales) and so we were able to report Greens Creek emissions distinct from other Juneau emissions. Data were insufficient to enable us to distinguish other major energy consumers in this way.

Notes for Table 2

a) “Buildings” includes energy used to fuel residential, commercial, and industrial operations, the vast majority of it inside buildings. Most emissions are from fuel oil used to heat buildings but the total gallons also include fuel oil used for industrial processes (e.g., fuel oil used to fire the boilers at the brewery), and also electricity for street and marina lighting.

b) Heating oil includes all fuel sold by Delta Western Inc., Petro Marine Services, and Taku Oil as "heating" fuel ("gallons used or delivered for heating" taxed uniquely by the State--AS 43.30). This number overestimates the amount used for “heating” because it includes gallons sold to industrial companies that may use some portion of it to run industrial operations in addition to space heating.

c) Propane includes all propane sold by Amerigas & Arrowhead in 2007 (with Greens Creek gallons reported separately).

d) Wood emissions are based on an Alaska Department of Environmental Conservation Mendenhall Valley 2007-08 wood use survey. This assumes that wood use in the study area—the Mendenhall Valley—represents wood use per capita in the wider community as a whole. Wood burning restrictions were imposed in the study area in the early 1980s and it is possible that fewer Mendenhall Valley residents use wood than their neighbors in other parts of the borough.

e) Electricity includes all electricity sold by Alaska Electric Light & Power's (AEL&P) in 2007. Though mostly hydro-powered, approximately 1.4% of electricity produced by AEL&P in 2007 was generated from diesel. Scott Willis at AEL&P calculated a local CO2 emission factor (emissions per kWh) using the total number of kWh sold and the total number of gallons of diesel used in AEL&P generators throughout 2007.

f) Equipment gallons include fuel not used in or in conjunction with a motor vehicle licensed to be operated on public ways (AS 43.40.030), including fuel for generators and construction equipment. We subtracted approximately 425,000 gallons from the totals given to us by fuel distributors for this category to account for the fuel used by AEL&P in its generators (as we already accounted for those gallons through electricity sales). The majority of remaining fuel in this “equipment” category is used to power large projects off the road system (both for construction and for electricity generation), including the Kensington mine, Lake Dorothy, and Snettisham.

g) Greens Creek propane is used mainly to provide heat during winter to warm air drawn into the mine for ventilation, with a minor amount of propane going to kitchen stoves and a furnace used to melt and mold gold/silver into bars.

h) Fuel sold to Greens Creek is considered “off site” and reported separately by fuel distributors. We received annual fuel use data from Greens Creek's Principal Environmental Advisor, Bill Oelklaus. According to Mr. Oelklaus, this diesel is used mostly to generate electricity with lesser amounts for vehicles, and even less for space heating and hot water.

i) Highway emissions are calculated using total gallons reported by fuel distributors as sold for “highway” purposes (including, in 2007, fuel for large projects such as the trucks hauling material for construction of the Sunny Point grade-separated intersection).

j) Air transport includes gallons of aviation gasoline and jet fuel pumped at the Juneau International Airport in FY 2007 (data from fuel flowage fee records compiled by the Juneau International Airport). The emissions tally includes gallons pumped on-site (including Alaska Airlines) and does not include fuel from Era helicopter operations on North Douglas Island and aircraft operations at the downtown docks. See note in the air transportation section of this report.

k) Similar to heating, equipment, and highway fuel gallons, marine fuel is taxed uniquely by the State (AS 43.30). We totaled fuel distributors' marine diesel & gasoline sold in 2007. This number includes the Alaska Marine Highway System ferry fuel & other marine fuel that is pumped in Juneau. This does not include the amount of fuel used to ship goods to Juneau nor does it include the fuel used by cruise ships.

l) Waste tonnage includes municipal solid waste and construction & demolition debris deposited in the Capitol Disposal landfill in 2007. The ICLEI software calculates emissions based on the volume landfilled, assigning lifetime emissions of the 2007 tonnage to this analysis year. Carbon sequestration occurs due to methane capture from the landfill's cover & passive flare system; when presenting summary data for the community, however, we have factored waste emissions as net zero.

Table 3: Community Total Emissions and Energy, by Source

Source	MMBtu	Percent MMBtu	CO2e (tonnes)	Percent CO2e
Electricity	1,236,029	17%	4,358	1%
Petroleum	5,822,076	81%	399,303	96%
Propane	63,800	1%	4,032	1%
Wood	90,276	1%	9,081	2%
Total	**7,212,181**	**100%**	**416,775**	**100%**

Note: Petroleum includes diesel #1, diesel #2, jet fuel, aviation gasoline, marine gasoline, highway gasoline, light heating oil and other distillate fuel oils.

Figure 4: Total Emissions from the Juneau Community, by Source

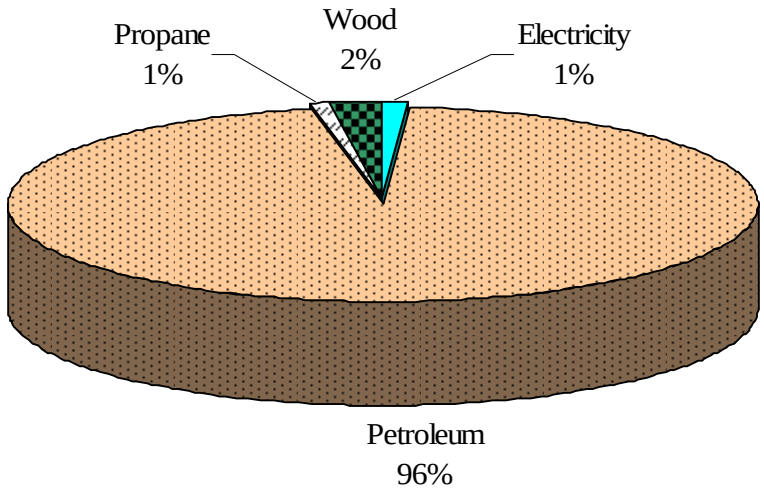
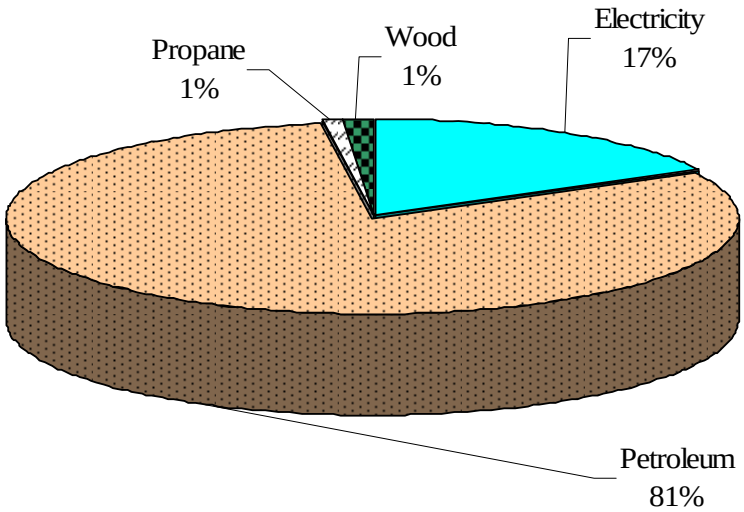


Figure 5: Total Energy Use by the Juneau Community, by Source



COMMUNITY BUILDINGS

COMMUNITY PETROLEUM

We estimated petroleum usage by totaling gallons sold by Juneau fuel distributors, assuming gallons sold in 2007 were used in 2007. For buildings, equipment, and marine transportation petroleum fuel usage, we aggregated data from fuel distributors' 2007 annual sales reports.[10] For tax purposes, fuel distributors keep data on fuel sales based on the following categories: heating, highway, marine, air, and equipment.[11]

See Appendix B: Tables 11-13 for petroleum fuel emission factors and heat content.

COMMUNITY ELECTRICITY

Alaska Electric Light & Power (AEL&P) produces all the electricity for our community, independent of an external grid system. The vast majority of Juneau's electricity is generated by hydroelectric means; however, some diesel generation always occurs. In 2007, approximately 1.4% of Juneau's electricity consumption was generated using diesel.[12] For our community electricity analysis, AEL&P provided us with usage data which we combined with local emission factors to determine total emissions (see Appendix B: Table 10 for electricity emission factors).

COMMUNITY WOOD

The most recent wood use study in the Juneau area was conducted in 2007-08.[13] We extrapolated community wood use from this study of homes in the Mendenhall Valley.[14] We determined the weight and energy in wood burned locally (spruce and hemlock).[15] From average energy content (20.75 MMBtu/cord) and weight (2267.5 pounds/cord) per cord of this Juneau wood prototype, we converted wood use (pellets and cords) into energy units (MMBtu) and, finally, into emissions. [16] Table 4 outlines the process used for estimating emissions from Juneau wood use.

---

[10] In order to gather information for fuel sales in Juneau, we worked with representatives from the following organizations: Delta Western Inc. (Jim Davenport, Facility Manager in Juneau Petro Marine Services (Jim Cawdery, plant manager in Juneau), Taku Oil (Jeff Hansen, manager), Amerigas (Raymond Bradley, Sales Service Manager for Southeast Alaska), and Arrowhead Transfer Inc (Laura Kronsperger, in Sitka).

[11] The following fuel categories are reported separately on motor fuel tax forms filed with the State: marine fuel, highway fuel, jet fuel, aviation gasoline, and heating fuel –AS 43.30. An authorization for a refund on equipment (non-highway) gallons is available --AS 43.40.030.

[12] Scott Willis at AEL&P calculated a CO2 emissions coefficient associated with electricity in Juneau. Emissions coefficients for CH4 and N2O were not available from AEL&P and were derived using a ratio of the Alaska electricity grid data to the local AEL&P CO2 emission factor (U.S. EPA eGRID2006 Version 2.1 (2004 data)). In future analyses, these CH4 and N20 emission factors, though small, should be tailored to AEL&P using available emission factors.

[13] Edwards, A., *Mendenhall Valley Home Heating Survey, Winter 2007-08*, Alaska Department of Environmental Conservation, 2008.

[14] Projections from the Mendenhall Valley were determined using the City's population report by area Community Development Department, *2008 Juneau Population by Geographic Area*, City & Borough of Juneau. Retrieved August 2008 from www.juneau.org/cddftp/documents/2008Population_000.pdf.

[15] A local wood seller, Floyd Branson, estimated that wood sold for firewood is 90% spruce and 10% hemlock.

[16] Consumer Energy Center, "*Wood Heating and Weight Values*," California Energy Commission, 2006. Retrieved 11 September 2008 from www.consumerenergycenter.org/home/heating_cooling/firewood.html.

Table 4: Energy and GHG Emissions from Wood Use

Estimated Number of Cords per household (a)	Estimated Number of Pellet pounds per household (a)	Estimated Number of CBJ Households with Wood Use (b)	Cords Used (c)	Total pellet pounds used (d)	Weight (pounds/dry cord) of Juneau wood (e)	Total Cords (f)	MMBtu (g)	CO2e tonnes (h)
0.55	117.9	7141	3,928	841,924	2,268	4,299	90,276	9,081

NOTES:

(a) In the Alaska Department of Conservation survey (Edwards, A., *Mendenhall Valley Home Heating Survey*, Winter 2007-08, Alaska Department of Environmental Conservation, 2008), a random sample of households were contacted and asked, "Approximately how many 40-pound bags of pellets does your household burn" (Questions 2c & 2d) and "Approximately how many cords of wood does your household burn" (Question 7) during the summer (June-September) and winter (October-May) months. From this survey we determined the number of 40 lb. bags of pellets and the number of cords in the summer and winter periods, which we totaled to find annual usage per household for cords and pounds of pellets.

(b) From a CBJ population estimate, we totaled the number of Single Family, Duplex, and Zero-Lot households to exclude households types that would not heat with wood (excluded 'Apt in Single Family', 'Condo/Townhouse', 'Multifamily', 'Mobile Home', 'Boats', and 'RV's') in Juneau.

(c) We multiplied annual cords per household, part (a), by the household number, part (b), to get the total cords for Juneau.

d) We multiplied annual pellet pounds per household, part (a), by the household number, part (b), to get the total pellet pounds for Juneau.

(e) We created a Juneau-specific wood prototype using a local wood seller's approximation that wood sold for firewood is 90% spruce and 10% hemlock. We combined these percentages with average weight values per cord of wood type from a worksheet at the Consumer Energy Center website to determine the weight and energy content of the Juneau wood prototype.

(f) To convert total pellet pounds, part (d), to cords, we used the weight of Juneau wood prototype, part (e). For total cords, we combined total pellet pounds in cords [part (d) + part (e)] with total cords, part c.

(g) We determined average energy content for a Juneau wood prototype from the Community Energy Center worksheet as discussed in part (e). We multiplied this value (21 MMBtu/cord) by total cords, part (f), to get total units of energy (MMBtu) from wood use.

(h) For total CO_2e emissions, we totaled CO_2e emissions from CO_2, CH_4 and N_2O. For CO_2e emissions from CO_2, we used the default CO_2 emission factor for "Wood and Wood Waste" from Local Government Operations Protocol's fuel type, 93.87 kg CO_2/MMBtu. For CO_2e emissions from CH_4 and N_2O, we used Table G.3 'Default CH_4 and N_2O Emission Factors By Fuel Type and Sector.'

GREENS CREEK MINE

Fuel sales to the Greens Creek Mine on Admiralty Island are considered "off site" sales and were not included in data supplied to us by the fuel distributors. In order to obtain fuel use data for Greens Creek operations, we contacted the mine's Principal Environmental Advisor, Bill Oelklaus.

According to Mr. Oelklaus, diesel is used mostly to generate electricity with lesser amounts for vehicles, and even less for space heating and hot water. Greens Creek propane is used mainly to provide heat during the winter to the air drawn into the mine for its ventilation, with a minor amount of propane going to kitchen stoves and a furnace used to melt and mold ore into bars.

COMMUNITY TRANSPORTATION

The debate is not yet settled regarding how emissions from air and marine transportation should be calculated. There are two main reasons for this uncertainty. First, a significant portion of emissions from air and marine travel occur outside geopolitical boundaries of the community in which they originate and it is nearly impossible to determine which portion occurred on one side of a boundary or another. Second, harbors and airports serve a region rather than an individual community, so while airport emissions may be attributed to the local community, it is likely that a large portion of passengers are neither from, nor traveling to, the community.

Although there is no accepted standard for accounting for air and marine travel emissions, ICLEI has developed guidance for local governments wishing to account for these emissions. Though most communities choose not to include these emissions, we thought it fair to include fuel loaded in Juneau's airport and harbors because Juneau residents are highly dependent on both air and marine transportation and the community should consider these emissions when planning its future. When comparing Juneau's emissions to the emissions of other communities, it would be important to note whether air and marine transport was included or omitted. Including air and marine transport as we did, makes this emissions inventory a modified end-use based inventory.

COMMUNITY AIR TRANSPORTATION

The Juneau International Airport is owned and operated by the City and Borough of Juneau (CBJ). Since the local government operates the airport, emissions associated with the operation of the airport (e.g. the fuel used by vehicles servicing the airplanes and the electricity used in the terminals) have been counted in the local government inventory.

The emissions associated with the operation of aircraft at Juneau's airport are counted in the community analysis. The CBJ levies a fuel flowage fee on all fuel sold at the airport and so keeps data on total annual gallons of aviation gasoline and jet fuel. This figure includes only gallons pumped at the airport. It does not include fuel used to operate Era helicopters nor any fuel pumped into floatplanes on the downtown Wings of Alaska docks.[17] The flowage fee data were available by fiscal year only and so these figures are for FY 2007 (July 1, 2006-June 30 2007), not calendar year 2007.

[17] We were unable to reconcile data supplied to us by fuel distributors (jet fuel and aviation gas gallons) with data kept at the airport (fuel flowage fee gallons). We judged the airport records more accurate and so used the fuel flowage fee data. We had no way of knowing which of the aviation gallons reported by the fuel distributors were used at the airport versus on the downtown docks or by ERA Aviation, and so we have not accounted for those gallons of fuel in this analysis.

COMMUNITY MARINE TRANSPORTATION

Emissions associated with local government operation of ports and marinas (e.g. the electricity used in the port's facilities) are counted in total electricity use in the government analysis. To determine the total amount of fuel used by boats on journeys originating within the jurisdiction, we used fuel sold in Juneau as marine diesel or marine gasoline (as reported by the fuel distributors).

COMMUNITY HIGHWAY TRANSPORTATION

When attempting to account for emissions from highway transportation, most other communities use Vehicle Miles Traveled (VMT) to estimate emissions.[18] Because we received data on gallons sold by Juneau's three fuel distributors, we were able to use actual gallons rather than VMT to estimate Juneau highway emissions. Juneau's geography and transportation infrastructure—no road in or out of town—means we are fairly certain that the vast majority of the gasoline purchased in Juneau is used within borough boundaries. Using actual gallons rather than VMT to estimate emissions give us a more accurate estimate of GHG emissions due to highway transportation.

[18] VMT data for Juneau are available from the Alaska Department of Transportation and Public Facilities (Jack Stickel, Highway Data). DOT collects data on daily traffic counts by road segment. To calculate a VMT estimate for Juneau, one would multiply the daily traffic count per road segment by the length in miles of that segment, then multiply that daily VMT by 330 days (to account for lighter traffic on weekends and holidays).

COMMUNITY WASTE

Juneau's waste is landfilled at Capitol Disposal landfill in the Lemon Creek valley. In 2007, total annual waste tonnage added to the landfill was 25,545 tons for municipal solid waste and 7,732 tons for construction & demolition debris.[19] We entered these figures into CACP software to calculate the total CO_2e tonnage. Table 5 below shows tonnage of solid waste added to the Juneau landfill in 2007.

We determined our waste emissions using the methane commitment method (programmed in the software). This methodology quantifies the net lifetime greenhouse gas emissions from waste disposed in the active year. In other words, although each landfill will emit gases over time, the methane commitment method attributes all future emissions to the year in which the waste was produced.

The methane recovery factor is the percentage of methane produced that is captured by a recovery system (flared or captured for energy). Since the Capitol Disposal Landfill does not keep data on the amount of methane that moves through a passive flare system in the landfill, we used a default methane recovery factor of 68%.[20]

While waste is categorized as either municipal solid waste or construction and demolition debris, Juneau's landfill does not keep further data on the composition of its waste stream. We matched Juneau waste types from a 2008 waste model to waste type defaults in the software.[21]

The total CO_2e tonnage associated with waste emissions is negative (note we do not subtract this figure from our total emissions, just factor them as net zero). Why are these emissions negative? According to the waste industry, some level of net carbon sequestration in the landfilling process is expected. Protocol for GHG inventory recognizes that "when wastes of a biogenic origin are deposited in landfills and do not completely decompose, the carbon that remains is effectively removed from the global carbon cycle, or sequestered."[22]

Table 5: Waste Disposed at the Juneau Landfill

Landfill Waste	Tons
Construction & Demolition Debris	7,732
Municipal Solid Waste	25,545

Source: Capitol Disposal manager Eric Vance, July 2008.

[19] Eric Vance, manager at Capitol Disposal landfill, July 2008

[20] The methane recovery factor is taken from SCS Engineers. '*Current MSW Industry Position and State-of-the-Practice on LFG Collection Efficiency, Methane Oxidation, and Carbon Sequestration in Landfills,*' pages 10-11, 2007. This percentage is a mid-range default value for the 50-85% efficiency for a landfill or landfills "that are under daily cover with an active LFG collection system installed but does not have a Resource Conservation and Recovery Act (RCRA) Subtitle D equivalent liner." The most commonly used default methane recovery factor is 75% and typically ranges from 60-85%.

[21] Waste share composition values for the Juneau landfill are taken from Table 4: Composition Model for CBJ Disposed Municipal Solid Waste in WIH Resource Group and Zia Engineering, *Solid Waste Management Strategy for the City/Borough of Juneau,* 2008.

[22] SCS Engineers, *Current MSW Industry Position and State-of-the-Practice on LFG Collection Efficiency, Methane Oxidation, and Carbon Sequestration in Landfills*, pages 1-4, 2007. This report also cites a U.S. EPA study of Municipal Solid Waste landfilling, the USEPA found "the projected national average of net GHG emissions for landfills was minus 0.02 MTCE/Wet Ton, showing that landfills are 'carbon sinks.'"

LOCAL GOVERNMENT (CBJ) EMISSIONS

We separated local government operations into seven categories: school facilities, other facilities, waste water treatment, water pumping, lighting, capital transit system, and vehicle fleet. Table 6 provides an estimate of local government emission by these categories. Table 7 lists local government emissions from facilities by department. Table 8 lists vehicle fleet emissions by department.

The types of energy analyzed in the local government analysis are electricity and fuel oil—used in facilities, schools (a type of facility), waste water and water treatment, capital transit, and the vehicle fleet. Similar to the community-scale inventory, most emissions from City & Borough of Juneau (CBJ) operations are from fuel oil.

We obtained data from energy use from CBJ and AEL&P staff. Alaska Electric Light & Power (AEL&P) provided data on CBJ electricity by account.[23] We added details to that data, including facility and department name.

Petroleum use in local government operations comes from heating fuel in buildings (stationary combustion), motor diesel and gasoline in the capital transit system and vehicle fleet (mobile combustion), and treatment of waste water using fuel oil. Mobile combustion by Capital Transit and the vehicle fleet will be discussed in the 'Local Government Vehicle Fleet' section. For data on petroleum fuel usage for local government, we used semi-annual reports provided by CBJ's purchasing division.[24]

Local government total emissions in 2007 were approximately 14,000 tonnes CO_2e. Facilities account for 57% of total local government emissions. The next largest sector is wastewater treatment, accounting for 17% of the total.[25]

[23] Docks and harbors have metered electricity that includes lighting (responsibility of CBJ local government) and also boats (private individuals' use, not CBJ government). To avoid counting private boats' electricity use, CBJ Harbors Port Director separated boat AEL&P accounts from CBJ AEL&P accounts. In cases where the meter included both boats and lighting, he estimated a percentage attributed to boats' use, the amounts of which we excluded in our totals.

[24] These are reported to CBJ by the contracted fuel provider. We paired them to get the dates for our calendar year. These reports are listed by tank number which matched to a detailed list of CBJ tanks to discern usage by facility, department, and fuel type. We assigned the source (vehicle fleet, facilities, or waste water treatment) associated with tanks and departments.

[25] A significant amount of fuel oil is used to power the incinerator that burns sludge at the Juneau-Douglas Treatment Plant on Thane Road. In addition, fuel oil is used to heat the Mendenhall Treatment Plant building.

Table 6: Local Government Total Emissions, by Sector

Sector	MMBtu	CO2e (tonnes)	% CO2e
Facilities	121,756	5,749	41%
School Facilities	54,598	2,186	16%
Waste Water Treatment	52,044	2,315	17%
Capital Transit	19,141	1,407	10%
Vehicle Fleet	30,814	2,222	16%
Lighting	6,443	22	0%
Water Pumping	7,243	24	0%
Total Local Gov't Emissions	**292,038**	**13,925**	**100%**

Note: Emissions from lighting and water are small because they are fueled solely by electricity, 98% of which was generated using hydro-power in 2007. Lighting includes street lighting, traffic signals, and marina lighting.

Figure 6: Local Government Total Emissions, by Sector

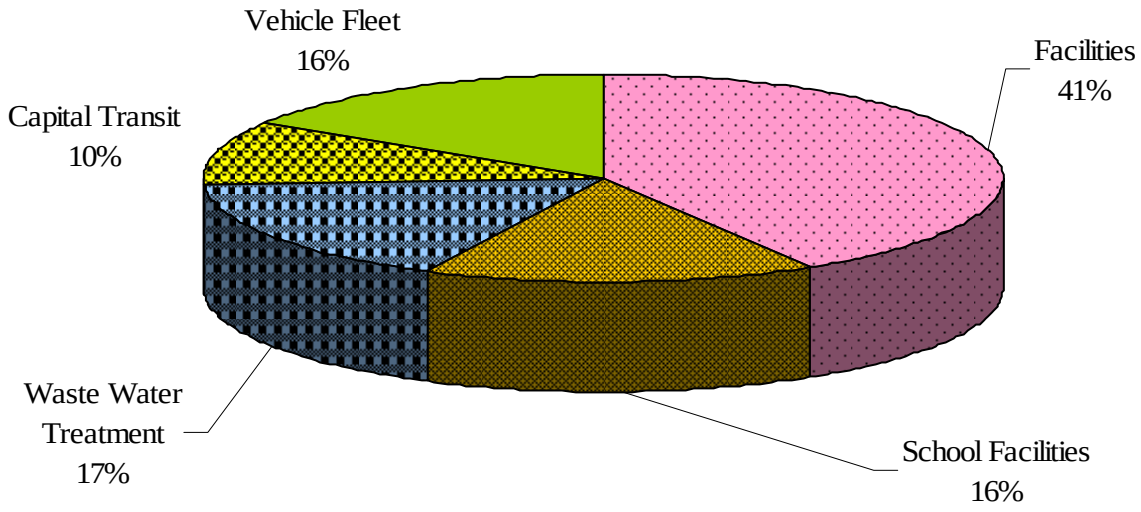
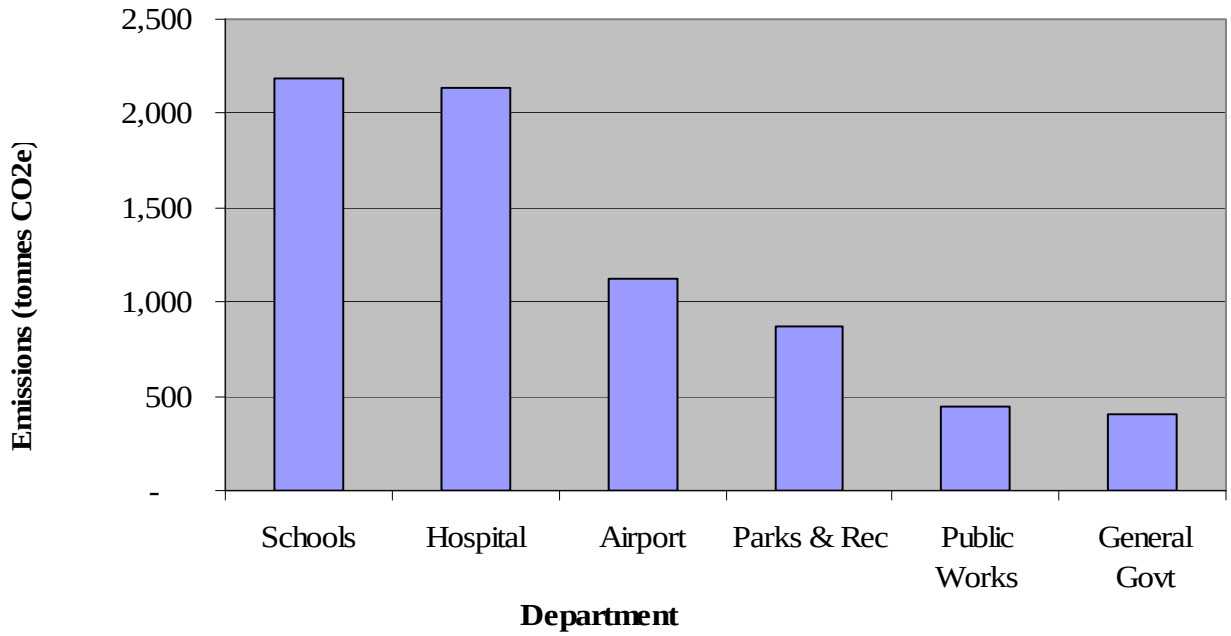


Table 7: Local Government Emissions from Facilities, by Department

	Fuel		Electricity			
Department	**CO2e**	**Gal**	**CO2e**	**kWh**	**Total CO2e**	**% CO2e**
Schools	2,099	205,641	87	7,633,498	2,186	28%
Hospital	2,079	203,630	55	4,817,569	2,134	27%
Airport	1,091	106,884	34	2,978,771	1,125	14%
Parks & Recreation	843	82,620	23	1,996,810	866	11%
Public Works	439	43,030	7	610,547	446	6%
General Government	385	37,709	20	1,757,733	405	5%
Fire	366	35,861	9	752,470	375	5%
Police	307	30,027	8	692,282	314	4%
Harbors	67	6,531	4	340,665	71	1%
Total	**7,676**	**751,933**	**246**	**21,580,345**	**7,922**	**100%**

Note: The 'general government' "department" was created for our analysis and includes Centennial Hall, City Hall, the downtown library, the Douglas library/Douglas fire hall, and miscellaneous city facilities such as the engineering department's quarry electricity and the Thane warehouse.

Figure 7: Local Government Emissions from Facilities, by Department



LOCAL GOVERNMENT VEHICLE FLEET

CBJ's vehicle fleet inventory includes mobile combustion emissions from highway diesel and gasoline used by the local government. Mobile combustion sources include both on-road and off-road vehicles such as automobiles, trucks, capital transit buses, and construction equipment (does not include marine vessels or aircraft). Emissions from mobile combustion were analyzed using fuel consumption data from the equipment maintenance section of the Public Works Department.[26] The Capital Transit bus system accounts for 39% of total emissions in the vehicle fleet.

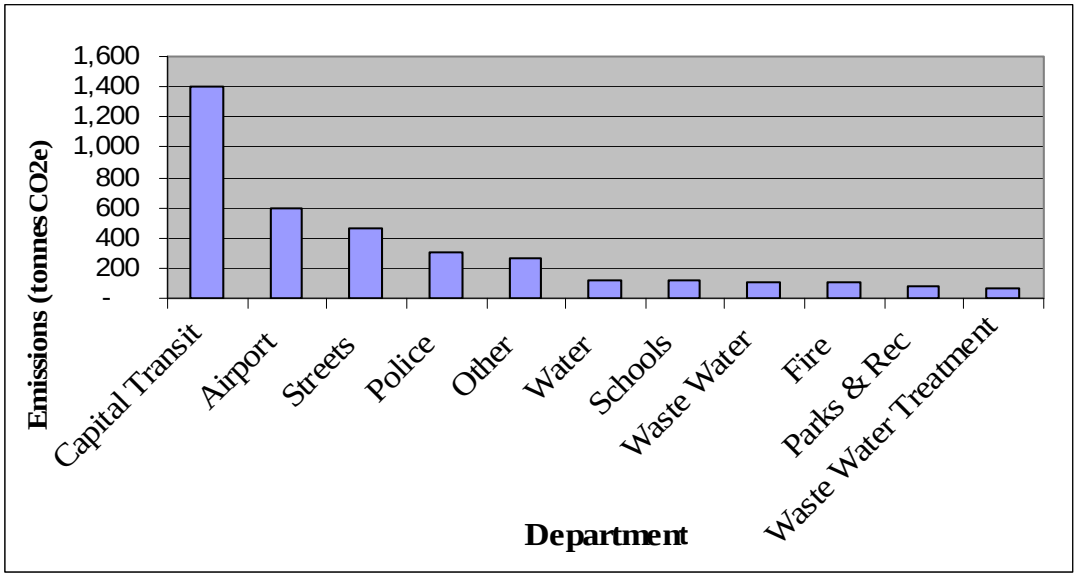
We calculated tonnes of CO_2e using CO_2, CH_4 and N_2O emission factors for the transport fuels (see Appendix B). CBJ's equipment maintenance database includes vehicle fleet data by fiscal year, not calendar year, and so vehicle fleet figures are for Fiscal Year 2007. Table 8 and Figure 8 highlight the local government vehicle fleet emissions by department.

[26] Scott Klawonn, Automotive Shop Supervisor for Public Works' equipment maintenance section, provided access to a 'Consumption Statistics' report from an internal database with gallons of diesel and gas by department. Note that the total number of gallons per department includes bulk fuel, which sometimes will be used in stationary combustion generators, making the data less accurate for pinpointing emissions from mobile combustion engines in the vehicle fleet. The database excludes the airport; we received airport fleet data separately from John Coleman, CBJ Airport Administrative Officer (these gallons include Airport and Glacier Fire Station vehicles). An alternative data source for vehicle fleet was gallons purchased, available from CBJ purchasing semi-annual reports from the fuel provider. According to purchasing buyer Diane Andresen, the Fleet database is a more accurate accounting of total vehicle fleet gallons and, hence, we used the fleet database data.

Table 8: Local Government Vehicle Fleet Emissions, by Department

Department	Diesel (gal)	Gasoline (gal)	CO2e (tonnes)	Percent CO2e
Capital Transit	135,670	2,467	1,407	39%
Airport	50,623	8,524	592	16%
Streets	31,500	16,069	464	13%
Police	21	34,597	307	8%
Water	1,233	12,655	125	3%
Schools	767	12,415	118	3%
Waste Water	2,463	9,422	109	3%
Fire	5,901	4,987	104	3%
Parks & Recreation - Park Maintenance	1,828	6,487	76	2%
Mendenhall/Auke Waste Water Treatment Plant	4,475	2,230	65	2%
Other	4,425	24,486	262	7%
Total	**238,906**	**134,339**	**3,629**	**100%**

Figure 8: Local Government Vehicle Fleet Emissions, by Department



Notes: Other includes the following departments: P&R Bldg Maint, Harbors, Hospital, P&R Landscape, Eaglecrest, CDD Building Division, JD Treatment, Fleet Maint, Engineering, P&R Recreation, Assessors, Police Community Service, Public Works/Admin, P&R Jensen-Olson Arboretum, Streets--downtown sweeping, CDD admin, Risk Mgmt/Human Resources, Emergency Program Mgmt, P&R Ice Arena

EMPLOYEE COMMUTE

We have not collected employee commute data for CBJ employees. The only employee commute data that has been collected was on a community-wide scale for the Census 2000. Among the questions included in the long form questionnaire were: "How did this person usually get to work last week," and "How many people, including this person, usually rode to work in the car, truck, or van," and, "How many minutes did it usually take this person to get from home to work." The Census gives totals of the number and percentage of Juneau's employed civilian population 16 years and over who commute to work by car, truck or van alone or by carpool, by public transportation (including taxi cab), by walking, or by other means, and the mean travel time of this commute. Given that these data are community-wide, it would be a good baseline for a community-wide indicator but not for a local government employee commute baseline. An employee commute survey could be conducted.

LOCAL GOVERNMENT WASTE

Except for the amounts recycled, all of the CBJ's waste is picked up by Arrow Refuse and hauled to the Capitol Disposal landfill. While CBJ has record in Accounts Payable of what is paid to Arrow Refuse for pickup, there is no record of the weight or volume picked up. The California Integrated Waste Management Board does have a calculation for estimating government office employee waste generation, determined by multiplying by the number of full time employees (FTE) in the analysis year by an average annual waste generation tonnage. We did not see that this had useful implications for our emission reduction measures, and so have not included an analysis of CBJ emissions from waste generation.

CONCLUSION

CBJ should follow through on the Assembly's commitment to ICLEI's Five Milestone Process, including Milestone 2 (adopting an emissions reduction target) and Milestone 3, developing a Juneau Climate Action Plan, including adaptation and mitigation measures specific to Juneau for meeting a GHG reduction target.

CBJ should direct City departments to keep records of energy use and cost in a manner that will enable future greenhouse gas emissions inventories to be completed easily.

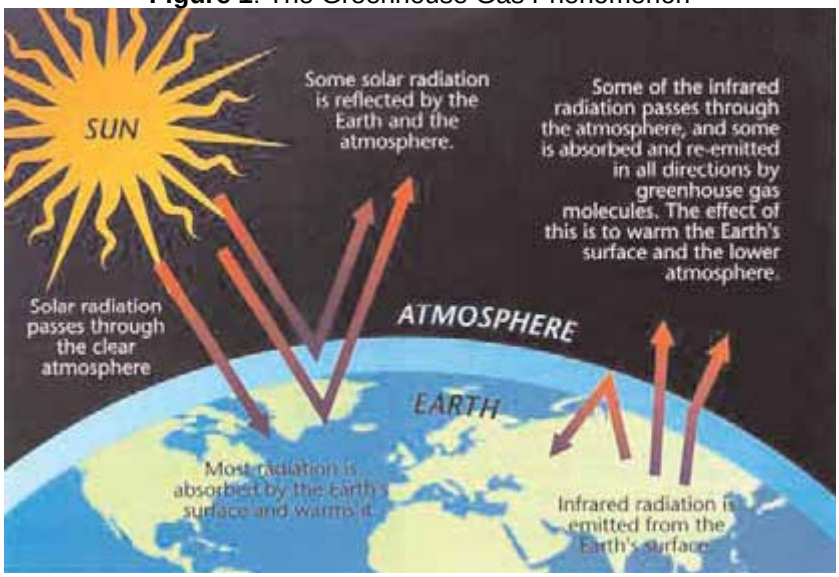
CBJ should conduct another emissions inventory in 2012 to monitor expected improvements as a result of mitigation measures implemented as part of a Climate Action Plan.

APPENDICES

APPENDIX A: WHAT IS CLIMATE CHANGE?

The Earth's atmosphere is naturally composed of a number of gases that act like the glass panes of a greenhouse, retaining heat to keep the temperature of the Earth stable and hospitable for life at an average temperature of 60ºF. Carbon dioxide (CO_2) is the most prolific of these gases. Other contributing gases include methane (CH_4), nitrous oxide (NO_2), ozone (0_3) and halocarbons. Without the natural warming effect of these gases the Earth's surface temperature would be too cold to support life. (Figure 1)

Figure 1: The Greenhouse Gas Phenomenon



Source: US Environmental Protection Agency

Recently elevated concentrations of these gases in the atmosphere, however, have had a destabilizing effect on the global climate, fueling the phenomenon commonly referred to as climate change. The global average surface temperature increased during the 20th century by about 1°F.[27] According to NASA scientists, the 1990s were the warmest decade of the century, and the first decade of the 21st century is well on track to be another record-breaker. The years 2002, 2003, 2004 and 2005, along with 1998, were the warmest five years since the 1890s, with 2005 being the warmest year in over a century.[28]

Scientific Facts and Projections:

The atmospheric concentration of carbon dioxide (CO_2) during the last two decades has increased at the rate of 0.4% every year. Current CO_2 concentrations are higher than they have been in the last 420,000 years, and according to some research, the last 20 million years. About three-quarters of the CO_2 emissions produced by human activity during the past 20 years are due to the burning of fossil fuels.[29]

[27] United Nations Intergovernmental Panel on Climate Change (IPCC) Third Assessment Report. "Climate Change 2001: Synthesis Report. Summary for Policy Makers" http://www.ipcc.ch/pub/un/syreng/spm.pdf

[28] NASA Goddard Institute for Space Studies, http://www.nasa.gov/vision/earth/environment/2005_warmest.html

[29] The UN Intergovernmental Panel on Climate Change (IPCC) TAR: Summary for Policy Makers

The climate and the atmosphere do not react in a linear fashion to increased greenhouse gases. That is to say that you cannot simply predict that for each ton of carbon dioxide emitted from a power plant or a vehicle's tailpipe, the Earth will warm a certain amount. The Earth's climate has a number of feedback loops and tipping points that scientists fear will accelerate global warming beyond the rate at which it is currently occurring. For example, as CO_2 emissions have increased in recent human history, the oceans have been absorbing a significant portion of these gases, but as the oceans become more permeated with CO_2, scientists anticipate they will reach a saturation point, after which each ton of anthropogenic emissions of CO_2 will have a more substantial impact.[30] Another example of this compounding can be found in the polar ice caps. Ice is highly reflective and acts effectively like a giant mirror, reflecting the sun's rays back into space. As the planet warms and some of this ice melts away, a darker land or ocean surface is revealed. This darker surface will absorb more heat, accelerating the speed at which the planet warms with each ton of greenhouse gas emitted. As these examples illustrate, the stakes are high, and there is no time to lose in the race against climate change.

GLOBAL IMPACTS

Changes in temperature and climate will have a dramatic impact on plants and animals that are adapted to conditions that will no longer prevail. Surface temperatures are on course to increase by between 2.5 and 10.5ºF by the year 2100, with regions in the northern parts of North America and Asia heating by 40% above the mean increase.[31] In addition to causing average temperature increases, rising levels of greenhouse gases have a destabilizing effect on a number of different microclimates, conditions and systems.

The increase in the temperature of the oceans is projected to accelerate the water cycle, thereby increasing the severity and rate of both storms and drought, which, along with decreased snow pack, could disrupt ecosystems, agricultural systems and water supplies.

Globally, snow cover has decreased by 10% in the last forty years. Average sea level has risen between 1/3 and 2/3 of a foot over the course of the 20th century and is projected to rise by at least another 1/3 of a foot and up to almost 3 feet by the year 2100.[32] These coastal infringements on such a large scale could lead to not only significant environmental and ecosystem disturbances, but also major population displacement and economic upheaval.

STATE IMPACTS

The Immediate Action Workgroup subcommittee of the Governors' Subcabinet on Climate Change has identified steps for immediate action to be taken in Alaska to prevent loss of life and property facing the state as a result of climate change impacts. Recommendations to the Subcabinet include evacuation and relocation plans for six coastal Western Alaska communities experiencing coastal erosion. The recommendations also include policy recommendations and are intended to help the Subcabinet in developing a State Climate Change Strategy. The following summary is from the State of Alaska Climate Change Strategy website: [33]

---

[30] United Nations Intergovernmental Panel on Climate Change (IPCC) Third Assessment Report. "Climate Change 2001: Synthesis Report. Summary for Policy Makers" http://www.ipcc.ch/pub/un/syreng/spm.pdf

[31] Ibid

[32] Ibid

[33] The following summary of state impacts is quoted from State of Alaska. Alaska Climate Change Strategy. *What will Climate Change Mean to Alaska?* Available from: http://www.climatechange.alaska.gov/cc-ak.htm

Global warming is currently impacting Alaska and will continue to impact it in a number of ways. These impacts include melting polar ice, the retreat of glaciers, increasing storm intensity, wildfires, coastal flooding, droughts, crop failures, loss of habitat and threatened plant and animal species.

Globally, 2005 was the warmest year on record (using records dating back to 1880) with a sustained period of warming in the arctic during 2000-2005. Convincing evidence includes NASA satellite data that shows Arctic perennial sea ice decreasing by 9% per decade since 1979. Less ice means more open water-which means greater absorption of solar energy-which leads to increased warming in the ocean, and in turn accelerates more ice loss. This has led to a wide range of impacts in Alaska, including:

- **melting glaciers, rising sea levels, and flooding of coastal communities.** Warming of oceans and melting of land-based ice increases the volume of ocean water. Loss of sea-ice cover changes habitat for arctic species and leaves coastal communities more exposed to larger waves generated by severe storms.
- **thawing permafrost, increased storm severity,** and related infrastructure damage to roads, utility infrastructure, pipelines and buildings. Extremes in weather patterns, precipitation and rising sea levels will affect safe water sources in villages, and contributes to increased erosion along Alaska coasts and rivers and undermines Alaska boreal forests. The villages of Newtok, Shishmaref, Kivalina, Koyukuk, Unalakleet, and Shaktoolik in Western Alaska are experiencing dramatic coastal erosion impacts and residents are being evacuated and relocated.
- **loss of the subsistence way of life** as animal habitat and migration patterns shift and as hunting and fishing become more dangerous with changing sea and river ice. Warming streams and increased silt from melting glaciers affect fish habitat. Boreal forests advance northward and to higher elevations, displacing tundra. Invasive species compete with native vegetation. Humans, animals and plants may be exposed to new infectious diseases as habitat changes.
- **forest fires and insect infestations** increasing in frequency and intensity. In the past decade, Alaska has witnessed a record loss of forests to fires and spruce bark beetles.

LOCAL IMPACTS

At the request of Juneau Mayor Bruce Botelho, a Scientific Panel on Climate Change completed a report on local impacts of climate change. This report provides the most current information about potential impacts to Juneau related to climate change.

From the executive summary of *Climate Change: Predicted Impacts on Juneau*:[34]

> Globally, atmospheric temperatures are rising in large part due to increased greenhouse gases in the atmosphere. Temperatures in Juneau have increased as much as 3.6°F during the 20th century, with the largest increase occurring during the winter months. Rates of warming were higher in the later part of the 20th century, and Juneau's average winter time temperature rose by 1.5 - 3°F in the past 60 years. The average winter temperature in the City and Borough of Juneau reached the freezing point of water in the early 1980s. The average winter snowfall at sea level in the City and Borough of Juneau decreased from 109 inches to 93 inches in the past 60 years. The average winter precipitation including rain and snow (reported as inches of liquid water), however, increased by 2.6 inches or more.
>
> Climate models, refined and validated using records of past climates, predict continued warming at rates that will depend on future emissions of greenhouse gases. The models predict that the City and Borough of Juneau will see overall warmer and wetter weather, particularly in Fall and Winter. The Juneau Icefield will continue to retreat. Global sea level is rising as a result of the melting of glaciers and ice sheets and the warming of ocean

[34] Scientific Panel on Climate Change, *Climate Change: Predicted Impacts on Juneau,* 2007. Full report is available at www.juneau.org/clerk/boards/Climate_Change/CBJ%20_Climate_Report_Final.pdf

waters (thermal expansion). Over the next century, global sea level is projected to rise 0.3 feet to 3.0 feet In the City and Borough of Juneau, however, the land surface is rising as a result of the loss of glacial ice (isostatic rebound), and the rate of uplift is greater than the projected rate of global sea level rise. Over the next century, the relative sea level in the CBJ likely will *decrease* between 1.0 and 3.6 ft.

Projections for Juneau include:

• Average air temperatures in Juneau will increase by approximately 10°F by the end of the current century.

• By the end of the 21st century, shrubs and trees will have colonized elevations currently characterized as alpine or tundra habitat in southeastern Alaska.

• Many ecological responses to climate change will not be predictable and some may be counterintuitive. For example, yellow cedar trees are freezing in spring as temperature warms due to a loss of insulating snow cover.

• Increasing temperature and precipitation likely will alter the ecology of salmon in southeastern Alaska. Early entry into the marine environment - when food resources are low or absent - will decrease growth and survival.

• Increased intensity and frequency of coastal storms will negatively impact shoreline and wetland nursery areas for many marine species.

• Changes in climate may out pace the capacity of some plants and animals to adapt, resulting in local or global extinctions.

• Rapid changes in the ecology of terrestrial and marine environments will alter commercial, subsistence, and recreational harvesting in ways that cannot be readily predicted.

• While large regions of Alaska are expected to suffer damage to infrastructure associated with rises in sea level, coastal erosion, melting of permafrost, and reductions in sea ice, those impacts will be minimal for the CBJ.

• Reductions in winter snow cover at lower elevations will negatively impact winter recreational activities in the CBJ.

• Limiting the impacts of greenhouse gas emissions will require reductions in the consumption of fossil fuels. Those reductions will negatively impact transportation to and within the CBJ.

• An audit of energy consumption in the CBJ will be needed to fully assess the impacts of climate change on the borough.

• Economic costs of community responses to climate change are likely to increase over time, and proactive responses will minimize negative impacts.

APPENDIX B: TECHNICAL NOTES

INVENTORY SCOPES

In addition to distinguishing inventory boundaries based on operational control (local government versus community scale), it is important to distinguish emissions by scope: direct, indirect, and optional emissions. To separately account for direct and indirect emissions, to improve transparency, and to provide utility for different types of climate policies and goals, the ICLEI protocol categorizes direct and indirect emissions into "scopes" as follows:

Scope 1: All direct GHG emissions (with the exception of direct CO2 emissions from biogenic sources, further discussion below).

Scope 2: Indirect GHG emissions associated with the consumption of purchased or acquired electricity, steam, heating, or cooling (irrelevant in Juneau, see further discussion below).

Scope 3: All other indirect emissions not covered in Scope 2, such as 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 (e.g., employee commuting and business travel), air travel, marine travel, waste disposal. Barge transport is considered a scope 3 emission, but is not included in our inventory.[35]

The combustion of biomass-based fuels (such as wood or landfill gas) emits greenhouse gases, but these emissions are different from Scope 1 emissions generated by the combustion of fossil fuels. Emissions from fossil fuels are considered anthropogenic, while emissions from biomass are considered biogenic and should be tracked and reported separately as scope 3 emissions (ICLEI et al., 2008).

Juneau's electricity supply is unique to most U.S. communities in that it is produced within the City & Borough of Juneau's geopolitical boundaries. Therefore, Juneau does not have any scope 2 emissions associated with purchased electricity, as would a city that acquires electricity from a grid system.

Air and marine transportation can be significant sources of emissions, but are unique for several reasons. First, a significant portion of the emissions associated with these travel methods occur outside of the geopolitical boundaries of the community, and it is nearly impossible to determine which portion occurred on one side of the boundary or the other. Second, it can be argued that in many cases airports and marinas serve a region rather than an individual community, so while the airport's emissions might be attributed to the community in which it happens to reside, it is likely that a large proportion of the passengers are neither residents of, nor traveling to, that community.

In our analysis, most emissions are considered scope 1. The scope 3 emissions sources analyzed here include wood use, waste disposal, marine transportation, and air transportation. Note the distinction between scopes is relevant for reporting emissions at higher levels; for our inventory all scopes are embedded in total Juneau emissions.

[35] Alaska Marine Lines (AML) expects to publish an emissions inventory for their barge transportation in 2009 (Andrew Heuscher, Director of HSE/Claims Manager, AML, personal communication, September 2008).

Table 9: Global Warming Potential of Greenhouse Gases

Greenhouse Gas	Global Warming Potential
CO_2	1
CH_4	21
N_2O	310

Source: Local Government Operations Protocol, Appendix E, Table E.1, based on Intergovernmental Panel on Climate Change (IPCC) Second Assessment Report published in 1995

Table 10: Electricity Emission Factors

CO_2 (tons/MMBtu)	CH_4 (g/MMBtu)	N_2O (g/MMBtu)
0.00368	0.07064	0.00887

Source: Alaska Electric Light & Power company provided the CO2 emission factor.

Notes: We derived net CH_4 and N_2O emission factors from the utility by scaling the CO_2 factor from the utility by a ratio from the Alaska egrid data (U.S. EPA eGRID2006 Version 2.1 (2004 data))

Table 11: Petroleum Fuel CO_2 Emission Factors

Fuel Type	CO2 Emission Factor (kg CO_2/gal)
Aviation Gasoline	8.32
Distillate Fuel Oil (#1,2 & 4)	10.15
Jet Fuel	9.57
Propane	5.74
Motor Gasoline	8.81

Source: Local Government Operation Protocol (2008), Table G.1, based on U.S. EPA, Inventory of Greenhouse Gas Emissions and Sinks: 1990-2005 (2007), Annex 2.1, Tables A-31, A-32, A-35, and A-36

Table 12: Petroleum Fuel Heat Content

Fuel Type	Heat Content (MMBtu/barrel)
Aviation Gasoline	5.048
Distillate Fuel Oil (#1,2 & 4)	5.825
Jet Fuel	5.67
Propane	3.824
Motor Gasoline	5.218

Source: Local Government Operation Protocol (2008), Table G.1, based on U.S. EPA, Inventory of Greenhouse Gas Emissions and Sinks: 1990-2005 (2007), Annex 2.1, Tables A-31, A-32, A-35, and A-36

Table 13: Petroleum Fuel CH4 and N2O Emission Factors, by End-Use Sector

End-Use Sector	CH_4 Emission Factor (g/MMBtu)	N_2O Emission Factor (g/MMBtu)
Residential	11	0.6
Commercial	11	0.6
Industrial	3	0.6

Source: Local Government Operation Protocol (2008), Table G.3, based on EPA Climate Leaders, Stationary Combustion Guidance (2007), Table A-1, based on U.S. EPA, Inventory of Greenhouse Gas Emissions and Sinks: 1990-2005 (2007), Annex 3.1.

APPENDIX C: CBJ RESOLUTION 2397

Presented by: Mayor Botelho
Introduced: 03/19/2007
Drafted by: J.W. Hartle

RESOLUTION OF THE CITY AND BOROUGH OF JUNEAU, ALASKA

Serial No. 2397(b)

A Resolution Regarding CBJ Participation in the Cities for Climate Protection Campaign.

WHEREAS, scientific consensus has developed that carbon dioxide and other greenhouse gases released into the atmosphere have a profound effect on the earth's climate; and

WHEREAS, in 2006, the U.S. National Climatic Data Center confirmed clear evidence of human influences on climate due to changes in greenhouse gases, a conclusion underscored in 2007 findings of the Intergovernmental Panel on Climate Change; and

WHEREAS, energy consumption, specifically the burning of fossil fuels, accounts for more than 80 percent of U.S. greenhouse gas emissions; and

WHEREAS, the United States, joined by 161 other countries, pledged to reduce greenhouse gas emissions under the United Nations Framework Convention on Climate Change; and

WHEREAS, local governments influence communities' emissions through land use, transportation, construction, waste management, and energy management decisions; and

WHEREAS, local government actions taken to reduce greenhouse gas emissions and increase energy efficiency provide multiple local benefits by decreasing air pollution, creating jobs, reducing energy expenditures, and saving money for the local government, its local businesses, and its residents; and

WHEREAS, the U.S. Conference of Mayors has endorsed the 2005 U.S. Mayors' Climate Protection Agreement initiated by Seattle Mayor Nickels and signed by 418 mayors in the United States as of March, 2007; and

WHEREAS, over the past 40 years, annual temperatures in Alaska have increased 3° to 5°F, and winter temperatures have warmed 8° to 10°F, and over the next 100 years, under a moderate emissions scenario, annual average temperatures are projected to rise 5° to 9°F over land and up to 13°F over the oceans; and

WHEREAS, climate change poses a serious long term threat to the economy of Alaska, including the possible need to relocate coastal villages, damage to roads and utility infrastructure, pipelines, and buildings, the availability of groundwater and surface water, and contributing to increased erosion along coasts and rivers; and

WHEREAS, the City and Borough of Juneau formed a scientific panel on climate change in 2005 to examine the impacts of change on our community; and

WHEREAS, the findings of the scientific panel show that changes in Juneau are consistent with those that have occurred, or are expected to occur, on a statewide basis, specifically:

- Over the past 60 years, the average winter snowfall at sea level in CBJ has decreased from 106 inches to 82 inches - average winter precipitation (rain plus snow reported as inches of liquid water) has increased by approximately 6 inches;

- During the same period, average winter time temperature has risen by approximately 4°F. The average winter temperature in the CBJ increased above the freezing point of water in the early 1980s;

- By the end of the 21st century, shrubs and trees will have colonized elevations currently characterized as alpine or tundra habitat in southeastern Alaska;

- Many ecological responses to climate change will not be predictable and some may be counterintuitive. For example, yellow cedar trees are freezing in spring as temperature warms due to a loss of insulating snow cover;

- Increasing temperature and precipitation likely will alter the ecology of salmon in southeastern Alaska. Early entry into the marine environment - when food resources are low or absent - will decrease growth and survival;

- Increased intensity and frequency of coastal storms will negatively impact shoreline and wetland nursery areas for many marine species;

- Rapid changes in the ecology of terrestrial and marine environments will alter commercial, subsistence, and recreational harvesting in ways that cannot be readily predicted;

- While large regions of Alaska are expected to suffer damage to infrastructure associated with rises in sea level, coastal erosion, melting of permafrost, and reductions in sea ice, those impacts will be minimal for the CBJ;

- Reductions in winter snow cover will negatively impact winter recreational activities in the CBJ;

- Limiting the impacts of greenhouse gas emissions will require reductions in the consumption of fossil fuels. Those reductions will negatively impact transportation to and within the CBJ;

- An audit of energy consumption in the CBJ will be needed to fully assess the impacts of climate change on the borough; and

- Economic costs of community responses to climate change are likely to increase over time, and proactive responses will minimize negative impacts.

WHEREAS, many Juneau residents have expressed a readiness to undertake local action to contribute to worldwide efforts in managing the change; and

WHEREAS, energy efficient buildings, waste reduction, and recycling saves Juneau taxpayers and residents money through decreasing energy and material costs; and

WHEREAS, the Cities for Climate Protection® Campaign sponsored by International Council for Local Environmental Initiatives - Local Governments for Sustainability has invited the City and Borough of Juneau to join ICLEI and become a partner in the Cities for Climate Protection Campaign.

NOW, THEREFORE, BE IT RESOLVED BY THE ASSEMBLY OF THE CITY AND BOROUGH OF JUNEAU, ALASKA:

Section 1. That the City and Borough of Juneau, Alaska, will join ICLEI as a Full Member and participate in the Cities for Climate Protection Campaign and, as a participant, pledges to take a leadership role in promoting public awareness about the causes and impacts of climate change.

Section 2. That the City and Borough will undertake the Cities for Climate Protection Campaign's five milestones to reduce both greenhouse gas and air pollution emissions throughout the community, and specifically:

- Conduct a greenhouse gas emissions inventory and forecast to determine the source and quantity of greenhouse gas emissions in the City and Borough;
- Establish a greenhouse gas emissions reduction target;
- Develop an action plan with both existing and future actions, which when implemented will meet the local greenhouse gas reduction target;
- Implement the action plan as approved by the Assembly; and
- Monitor and report progress.

Section 3. That the City and Borough requests assistance from ICLEI's Cities for Climate Protection Campaign as it progresses through the milestones.

Section 4. That the Assembly recognizes that the development and implementation of any action plan for which City and Borough expenditures are proposed is subject to the Assembly's legislative and appropriation process.

Section 5. Effective Date. This resolution shall be effective immediately upon adoption.

Adopted this 19th day of March, 2007.

Bruce Botelho, Mayor

Attest:

Laurie J. Sica, Clerk