Appendix A: Our data collection and conversion methods

All the data in Table 2 for sectors 1 (Buildings and Facilities) through 5 (Wastewater Facilities) were calculated using the ICLEI CACP protocols. Th e data for sector 6, Other Indirect Emissions–including the greenhouse gas impact of village employee commutation and business travel, the village's use of solvents and fertilizer, and generation of solid waste–needed to be calculated using methods outside the CACP protocols. Th ese non-CACP methods are explained briefly here. We welcome feedback with an eye toward improving the collection and analysis tools.

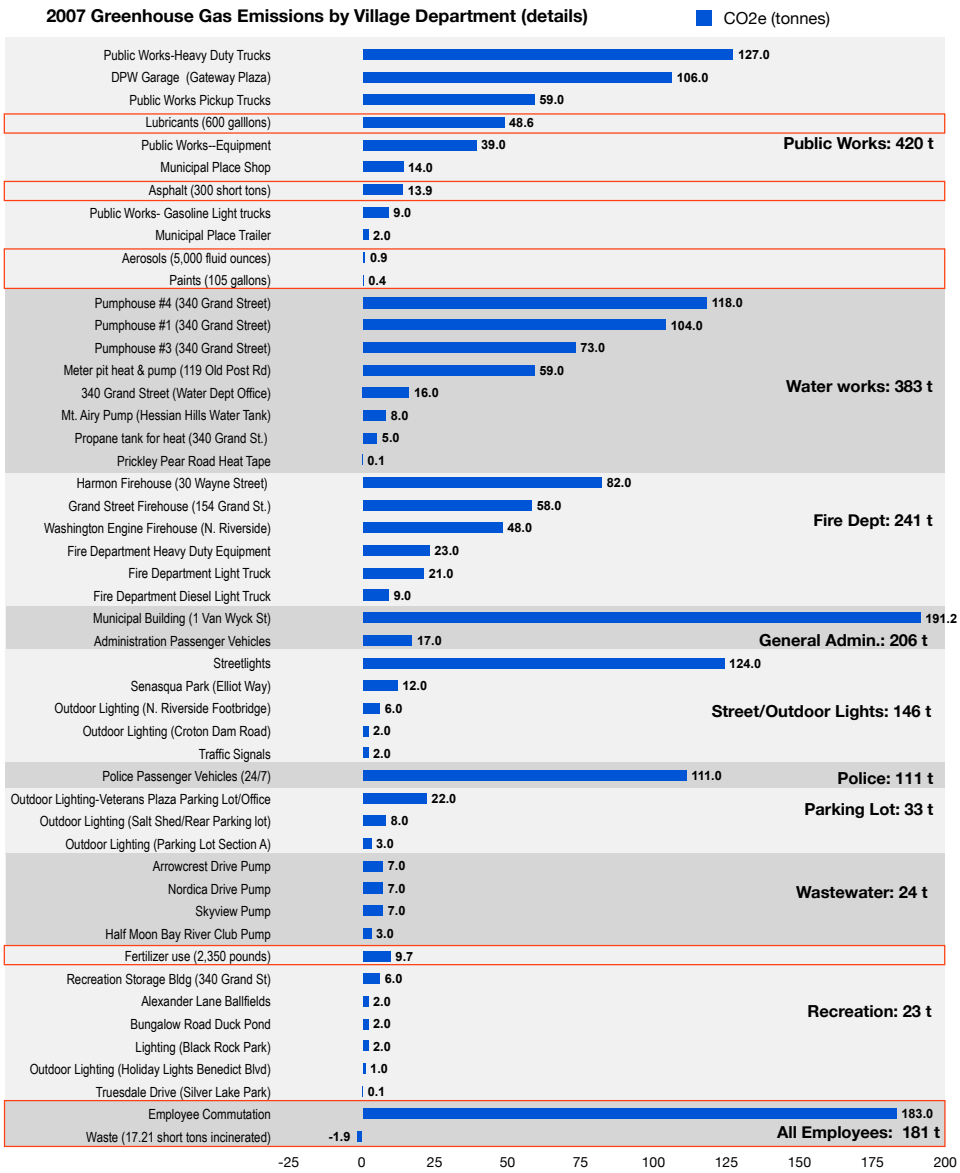

Figure A1: Bar chart of detailed emission sources by village department

The horizontal scale shows metric tonnes of CO_2e (tCO_2e) for each source within a village department. The departments are arranged in descending tonnage order and within departments by order of descending sources Emission inside a red box are indirect sources (See sector 6 in Table 2). The initial inventory yielded ~1,550 tCO_2e. These indirect sources added another ~250 tCO_2e, once they were identified and calculated. Had we limited our inventory to the direct sources available from our energy purchases, we would have underestimated the greenhouse gas emissions of village operations by about 16%.

Figure A1 shows the major components of each department's emissions. Note that only one item, "Waste" under General Administration, offers a negative net emission value. Why? Because the village's solid waste is incinerated through the Westchester County facility in Peekskill, operated by Wheelabrator. Incineration to generate energy from waste avoids the methane release from landfill that same material. Hence the net reduction in greenhouse gas emission for this one item. (See Figure A1.)

The most significant indirect emission source is commutation by village employees. We used a survey completed by 57 out of 81 employees to determine commuting distances, modes, and the extent of any village-related business travel. The survey was made available to all employees in either paper or digital form. The digital form employed the free "basic"tool available at Surveymonkey.com. The survey analysis is summarized in Table A1. The text of the survey and number of responses per question is depicted in Table A3.

Table A1: Converting Employee Commutation and Travel to Emission Impacts

Employee Commute and Travel Data (2007)		
Average roundtrip commute	24.4	miles
Average number of days in 2007 commuted	208	days
Total commute miles reported by survey respondents	297,492	miles
Percent of commuters who drove automobile	100.0%	%
Percent of employees who responded to survey	70%	% (57 out of 81 employees)
Extrapolated commutation vehicle miles for all employees	**411,091**	miles
Employee Travel for Village business outside Westchester County		
Number of out of county trips	39	trips (in all modes of travel)
Percent of trips in which village employees carpooled	33%	trips (13 out of 39 total trips)
Total passenger vehicles miles for those trips	**1,875**	miles (22 solo and 13 carpool trips)
Total rail miles for travel	**1,150**	miles (3 trips)
Total airplane miles for travel.	**850**	miles (1 trip)
Cumulative Greenhouse Gas Emission Impacts from Employee Commutation and Travel		
	miles	**GHG impact (tCO2e)**
6.1a. Total Village Employee Passenger Car miles	**412,966**	**181.710**
6.1b. Total Village Employee Passenger Rail miles	**1,150**	**0.082**
6.1c. Total Village Employee Air Travel miles	**850**	**0.826**
		182.618

Notes on conversion of miles to emission impacts *(Table A1)*

6.1a. Employee passenger car miles: Assuming an automatic 4 cylinder (2.2 liter) 2003 model sedan using regular gasoline with average 20 miles per gallon emits 8.806 kg CO_2/gallon, over the 412,996 commutation and business travel miles in 2007 by village employees, the emission result is (412,966 miles/20 mpg) * (8.8 kg CO_2/g)/1000= **181.71 tCO_2e.**

6.1b Employee passenger rail miles: Assuming commuter rail diesel fuel efficiency of 134.43 passenger miles/gallon, and 9.987 kg CO_2/gallon, the 1,150 passenger rail miles by village employees in 2007, the emission result is: (1,150 miles/134.43 mpg) * (9,987 kg CO_2/kg)/1000= **0.082 tCO_2e.**

6.1c. Employee air travel miles: Assuming air travel emission of 0.972 kg/CO_2 mile, the emission result is (0.972 kg/CO_2) * (850 miles)/1000= **0.826 tCO_2e.**

See conversion factors from Clen Air–Cool Planet below (in Table A2):

Table A2: Emissions conversion by fuel type

	kg CO_2 / Gallon	MMBtu/passenger mile	kg CO_2/mile	kg CH_4/mile	kg N_2O/mile
Gasoline Fleet	8.806370549				
Diesel Fleet	9.987005662				
Air		0.004931815	0.971806514	0.00000953	0.000011
Train		0.002806075	0.225702106	0.0000036	0.00000353

[Source: Clear Air–Cool Planet www.cleanair-coolplanet.org]

Table A3: Employee Commutation Questionnaire

Q1. I worked for the village for some or all of period between January 1, 2007 and December 31, 2007.
[answered question; 58 of which 50 (86%) were employees in 2007; skipped question 0]

Q2. How far did you travel each trip to work in 2007? (Enter the number of miles in a typical round trip. For most people this is the distance between your home and place of work. Round off to the nearest mile.)
[answered question 57; skipped question 1]

Average distance	24.3 miles (range: 1 - 90 miles)

Q3. What was the most common way that you commuted to your village job during 2007? (check one)
[answered question 55 ; skipped question 3]

Walk	0%
Bicycle	0%
Passenger car	100%
Mass transit bus only	0%
Mass transit train only	0%
Mass transit combination of bus and train	0%

Q4. Did you drive to work alone or carpool in 2007? (check one) We want to know the most common pattern you followed. (54 responses)
[answered question 54 ; skipped question 4]

alone	53
carpool	1

Q5. How many days per year do you travel to work? (fill in number) You would have commuted 250 days in a year, if you worked 5 days a week for the 50 weeks and took a 2 week vacation. A typical work year has 260 work days. (57 responses)
[answered question 57 ; skipped question 1]

Average # commuting days:	209

Q6. If you travelled outside Westchester County for village-related business during 2007, tell us about the trips by selecting the transportation mode and distance for each one (trip) below. If you repeated a trip on more than one occasion in 2007, indicate that in the third menu column below.
[answered question 20 ; skipped question 38]

# of Trips	Travel Mode	# of Trips	Roundtrip Distance
22 trips	Passenger car alone	22	< 100 miles
13	Passenger car carpool	7	between 100-200 miles
3	Train	1	between 201-300 miles
0	Bus	6	between 301-400 miles
1	Airplane	1	between 401-500 miles
0	Other	1	between 501-800 miles
39	total trips	1	more than 801 mile
		39	total trips

Q7. You can leave any other comments here in this text box. Thank you.
[answered question 7 with comment; skipped question 51]

The Village contracts with the turf maintenance firm for upkeep on its lawns and athletic fields. In 2007, this work deployed fertilizer four times between early April and late October for a total of 2,350 pounds of various fertilizer compounds. We estimate this volume to have released 9.67 tCO_2e. (See Table A4).

Table A4: Converting fertilizer use to emission impacts

Converting fertilizer use to emission		
6.2. Fertilizer Use		**units**
a) volume by weight	2,350	*pounds*
b) conversion factor	0.004166173	*tCO_2e/lb*
total (a*b)	**9.79**	***tCO_2e***

How did the Village address the use of solvents in this inventory? Based in invoices and expenditures for calendar 2007, the staff came up with the following usage estimates: 600 gallons of lubricants (motor oils, grease, transmission fluid); 5,000 fluid ounces of aerosol solvents; 300 tons of asphalt; and 105 gallons of paint. (See Table A5.)

Table A5: Converting solvent volumes to emission impacts

Solvent volume to emission conversion

6.3a. **Lubricants**		**units**
a) volume	**600**	***gallons***
b) CO_2 content in lb/gallons	7.5	*lb/gal*
c) CO_2 in lb per lb of oil	23.8	*lb/gal/lb oil*
d) GWP	1	*na*
e) subtotal	107,100	*CO_2e in lbs*
f) conversion to metric tonnes	0.00045372	*metric tonne/lbs*
total (a*b*c*d*e*f)	**0.00**	***tCO_2e***

6.3b. **Asphalt**		**units**
a) volume	**300**	***short tons***
b) CO_2 content in lb/gallons	7.5	*lb/gal*
c) fuel needed per ton of asphalt mix	2	*gallons/ton mix*
d) GWP	6.8	*$1/CO_2e$*
e) subtotal	30,600	*CO_2e in lbs*
f) conversion to metric tonnes	0.00045372	*metric tonne/lbs*
total (a*b*c*d*e*f)	**13.88**	***tCO_2e***

6.3c. **Aerosols**		**units**
a1) volume	**5,000**	***fluid ounces***
a2) volume conversion to gallons	128	*fluid ounces/ gallons*
b) CO_2 content in lb/gallons	7.5	*lb/gal*
c) fuel needed	1	*na*
d) GWP	6.8	*$1/CO_2e$*
e) subtotal	1,992	*CO_2e in lbs*
f) conversion to metric tonnes	0.00045372	*metric tonne/lbs*
total (a1*a2*b*c*d*e*f)	**0.00**	***tCO_2e***

6.3d. **Paint**		**units**
a1) volume	**105**	***gallons***
a2) volume conversion to gallons	0.1	*VOC evaporation rate*
b) CO_2 content in lb/gallons	12	*lb/gal*
c) fuel needed	1	na
d) GWP	6.8	*$1/CO_2e$*
e) subtotal	856.8	*CO_2e in lbs*
f) conversion to metric tonnes	0.00045372	*metric tonne/lbs*
total (a1*a2*b*c*d*e*f)	**0.39**	***tCO_2e***

What is the amount of trash per employee figure that a municipality should use? That depends on a number of factors: Is there active recycling of paper, plastics, metals at the workplace? How is the resulting solid waste handled downstream? Does the municipality measure the solid waste its own operations create? Is organic waste matter handled separately?

The Village offices do recycle. Organic waste principally in the form of yard waste is handled separately, but was not calculated for 2007 as the volume data was not readily available. The remaining solid waste is handled as part of the County's refuse district. This district uses the Charles Point Resource Recovery Facility in Peekskill, an energy from waste incineration plant, that is operated by Wheelabrator (For more, visit "Environmental Facilities Department" at www.westchestergov.com.). (See Table A6.)

Table A6: Converting office employee waste to emission impact

Converting office waste to emission		
6.4. **Waste**		**units**
a) estimated per employee day	1.7	*pounds*
b) # employees	81	
c) workdays/ year	250	
d) annual waste (a*b*c)	34425	***lbs/yr***
e) conversion to short tons (d/2000)	17.21	***short tons/yr***
f) conversion factor (incineration with energy from waste)	-0.11	*tCO_2e/ short ton*
total (e*f)	**-1.89**	***tCO_2e***

Notes on conversion of fertilizer to greenhouse gas emission impact (Table A4)

6.2 Fertilizer applications: In 2007, Turf managment records showed the following applications: April, Calvacade @ 400 lbs; May, Greenyard W&F @400 lbs; June, Greenyard W&F @ 500 lbs and Triplet @ 3 gallons; September, Bifenthrin@ 500 lbs; October, 18-24-12 fertilzer @ 500 lbs. We assumed worst case that these all comprised synthetic compounds that yield 0.004166173 tCO_2e/lb in a mix of CO2, N2O, and CH4, versus 0.004166173 tCO_2e/lb from organic fertilizers. [Source: Clear Air–Cool Planet www.cleanair-coolplanet.org]

Notes on conversion of solvent to greenhouse gas emission impact (Table A5)

6.3a Lubricants: We assumed 600 gallons of lubricants (motor oils, grease, transmission fluid) would have the emission impacts as as #2 oil. The big question is how it was disposed of. We made a worst case assumption, all of it was burned in a waste boiler, since that is common. The emission impact of burning #2 oil is 7.5 lb/gallon. For 600 gallons, this yields 7.5 lb/gal x 600 = 4500 lbs @ 23.8 lb CO_2 / lb of oil / 2204 lb per tonne = **48.59 tCO_2e**.

6.3b Asphalt: Assuming 2 gallons of fuel is consumed per ton of hot asphalt mix produced, this equates to about 50 lbs CO_2e per ton mix. Multiplying this by 300 tons of asphalt yields: 300 tons x 2 gal/ton x 7.5 lb/gal x 6.8 GWP = **13.88 tCO_2e**.

[Source http://www.hotmix.org/index.php?option=com_content&task=view&id=449&itemid=72]

6.3c Aerosols: Under the conservative assumption for aerosols that both the propellant and fluid content are comprised of volatile organic compounds of with emission content of 7.5 lbs CO_2e per gallon and GWP of 6.8 factor, 5000 fluid ounces at 128 ounces per gallon and 7.5 lb /gallon yields 5000/128 x 7.5 = 293 lb x 6.8 lb CO_2e/lb = **0.90 tCO_2e**.

6.3d Paint: The paint volume–10 gallons for the Municipal Garage plus 25 gallons of primer and 50 gallons of paint for Municipal Building, plus 30 gallons for other miscellaneous work, bollards, fences, signs, outdoor recreation courts, etc. (assuming 300 square feet/gallon)–yields a total of 105 gallons. At 10% volatile organic compound (VOC) evaporation from the paint and an average global warming potential (GWP) in terms of CO_2e for VOC of 6.8, this yields 105 gal x .1 x 12 lb/gal x 6.8 = 856.8 lbs CO_2e/ 2204 lbs= **0.39 tCO_2e**.

Notes on conversion of village office waste to greenhouse gas emission impact (Table A6)

6.4 Solid Waste: The waste per village employee calculation relied on an average of the 1.7 pounds per workday per employee. For 81 people and 250 workdays/year, that yields 34,425 lb/yr, or 17.21 short tons per year. Incineration in energy from waste facilities eliminates any option for methane formation as would occur were the trash to be landfilled, but it also adds a component for the fuel used to burn the garbage. CACP rev. 6.4 shows a net credit for energy from waste incineration since it eliminates that methane formation: it subtracts 0.11 tCO_2e per short ton of trash. Multiplying that factor by the 17.21 short tons of office trash yields a credit of 1.89 tCO_2e. [Source: Keep America Beautiful Toolbox www.kabtoolbox.org/aboutus2.asp?id=389 :under Tools, click on Overview.]