The Carbon Footprint of Hollins University 2003-2007

PREPARED FOR THE HOLLINS ENVIRONMENTAL ADVISORY BOARD AND UNIVERSITY ADMINISTRATION

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Summary

Recent scientific evidence indicates that our world is rapidly warming and that historic and current emissions of greenhouse gases are the primary agents of this climate change. In order to avert some of the more catastrophic consequences of global climate change, decisive action is needed to reduce emissions of greenhouse gases. In June of 2006, President Nancy Gray signed the American College and University Presidents Climate Commitment. Signatory institutions must establish their carbon footprint within a year and must then develop a strategic plan for becoming carbon neutral.

Using a carbon calculator developed by Renee Godard based on data from a variety of governmental sources, we calculated a greenhouse gas emissions inventory for the Hollins University Campus for the past 5 years (02/03 – 06/07). Each annual carbon footprint combines greenhouse gas emissions from purchased electricity, on-campus generation of steam and chilled water, commuting, air travel, waste generation, and agriculture.

There are several different gases that contribute to global warming including carbon dioxide (CO_2), methane (CH4), fluorocarbons, and nitrous oxides (NOx). The carbon calculator we used evaluates all greenhouse gases that are produced while providing a combined output score in tons of carbon dioxide equivalent emissions (TCDE). In this report, we include only the TCDE values as it provides a singular measure of greenhouse gas emissions from each sector. Assumptions made for all calculations can be found in the appendix of this document.

Our footprint was 15,991 short tons of carbon dioxide equivalent emissions (TCDE) in 2002/2003 (Fig 1). It increased annually ~4% each year through 2005/2006 to a high of 18,143.5 TCDE. In 2006/2007 our footprint decreased 0.3% to 18,086 TCDE. As shown in Fig. 2, the bulk of our greenhouse gas production comes from our consumption of electricity (~67% of footprint) and the generation of steam/chilled water (~27% of footprint). Detailed descriptions of the calculations of each of the sectors in our footprint are included below.

Currently we offset 1.35% (245 TCDE) of or greenhouse gas output by protection of forested campus property and ~*0.2-1*% through recycling. We hope that this document can be used to clearly focus our efforts to become carbon neutral. As we reduce our greenhouse gas output, the value of our carbon offsets will increase.

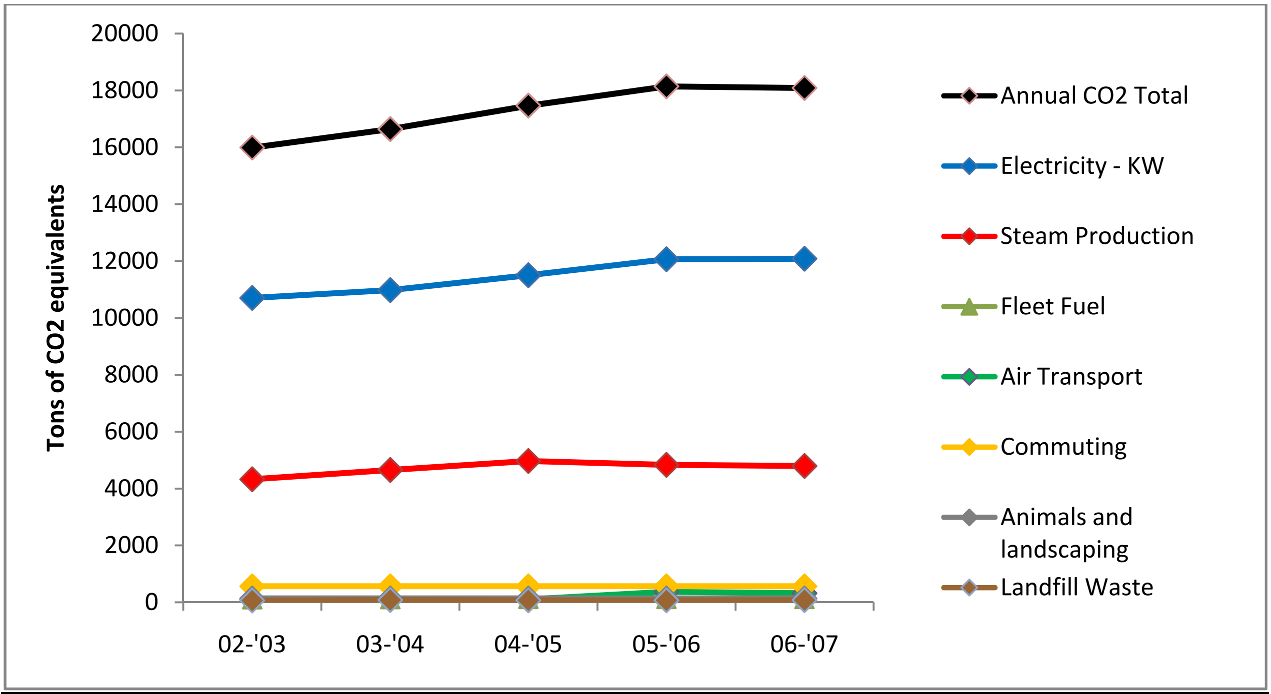

Fig 1: Tons of carbon dioxide equivalent emissions (TCDE) produced by Hollins from 02/03 – 06/07

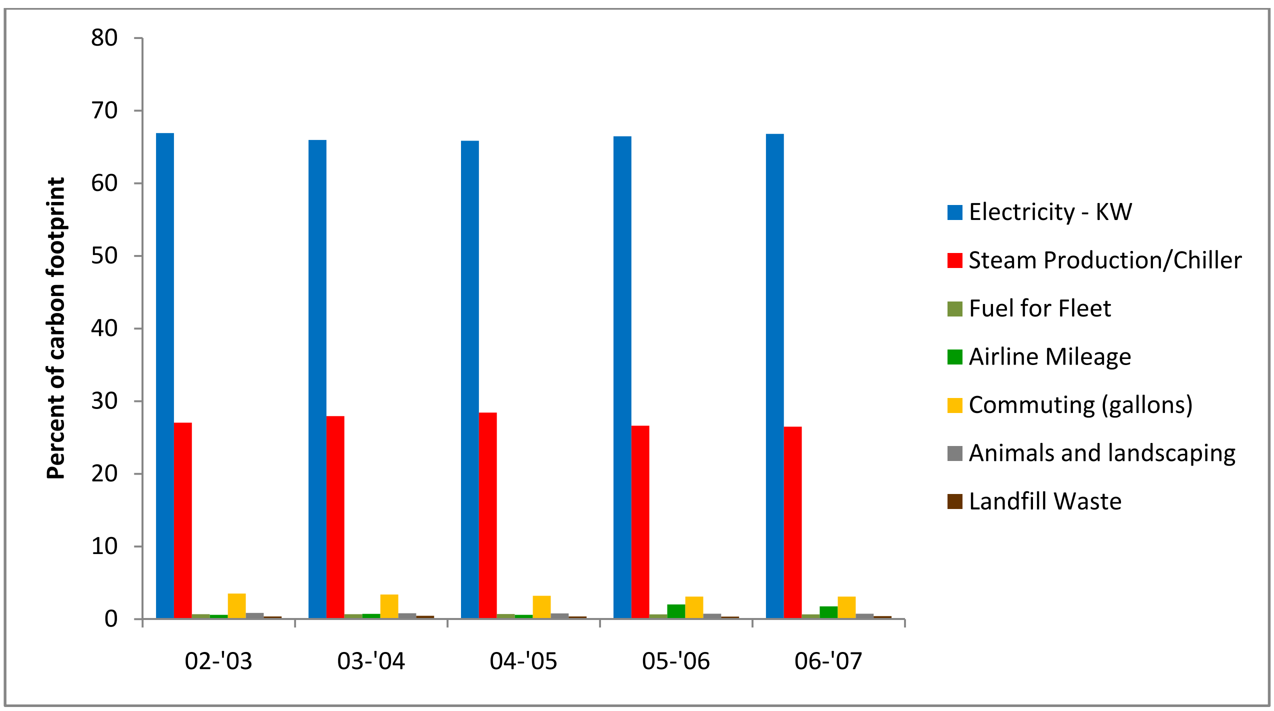

Fig 2: Percent contribution of each factor to the carbon footprint of Hollins from 02/03-06/07.

Electricity Consumption

Our electricity is purchased from Appalachian Electric Power and is generated primarily by the burning of coal (88.3%). The remaining sources for generation of electricity for our region are nuclear (10.9%) and water (0.8%). Unfortunately, electricity generation from coal produces the highest levels of greenhouse gases per KWH. Our particular mix for electricity results in 1.85 lbs of CO_2/KWH. As such, a large percentage of our carbon footprint results from our consumption of electricity.

In the past 5 years, our consumption of electricity has grown (Table 1). For each year, except 06/07, we experienced a large annual increase (2.6-4.9%) in our consumption of electricity. The VAC came on line in 2004 and may account for some of the increase. In addition, an increase in use of electronics, including computers and cell phone chargers, may also account for some of the increase. During the 06/07 academic year, efforts were made to reduce electricity consumption on campus, including placement of "lights out" signs above light switches. Perhaps, as a result of that effort, we had a much smaller rate of increase (0.16%) in electricity usage.

Table 1: Electricity consumption and our carbon footprint

Academic Year	Purchased KWH	TCDE	% of Carbon Footprint
2002- 2003	11,569,875	10702.13	66.92
2003- 2004	11,868,194	10978.08	65.96
2004- 2005	12,433,918	11501.37	65.85
2005-2006	13,039,940	12061.94	66.48
2006-2007	13,060,507	12080.97	66.79

Generation of steam and chilled water

We primarily use natural gas for the generation of steam and chilled water on campus. We supplement this fuel source with both oil and propane when availability of natural gas becomes limited. Natural gas produces 117 lbs CO_2/mmBtu while fuel oil and propane generate 22.384 lbs CO_2/gal and 12.805 lbs CO_2/gal, respectively.

Our production of greenhouse gases from this source has ranged from 3922 to 4502 TCDE (Table 2). Unlike our consumption of electricity, there does not appear to be either an increase or decrease in our use of these fossil fuels for on-campus generation over the last 5 years. With the addition of the small energy efficient boilers which were installed in 2007, we anticipate that this component of our carbon footprint will decrease in the future.

Table 2: Generation of steam/chilled water and our carbon footprint

Academic Year	Nat Gas (MMBTU)	Oil (gal)	Propane (gal)	TCDE	% of Carbon Footprint
2002-2003	72474	5079	4461	4325.13	27.04
2003-2004	76413	11969	7452	4651.82	27.95
2004-2005	83583	4497	4298	4967.45	28.44
2005-2006	78576	18895	3419	4830.06	26.62
2006-2007	80747	4392	3149	4793.02	26.50

Commuting to Work and School

We utilized data from the 06/07 academic year in order to estimate the fossil fuel consumption used in the commutes of off-campus students, faculty and staff to Hollins. One-way mileage was calculated for each of the 98 commuting students, 86 faculty members, and 171 staff members by calculating the average driving distance between the origin zip code and the Hollins zip code (24020) for each individual. We assumed that each student made 3 round trips per week during both semesters for a total of 78 round trips/student/academic year. We assumed that faculty members commuted to the campus 175 days/year while the staff members were assumed to commute 240 days/year. For all commuters, we assumed that they drove alone and made only one trip per day. We also used an average of 24.4 miles per gallon for each commuter and assumed for each gallon of gas 20 lbs of CO_2 was released

Annually Hollins commuters travel over 1.3 million miles to and from our campus (Table 3). This results in the release of 563.24 tons of carbon and accounts for 3.1% of our carbon footprint.

Table 3: Mileage, gasoline use, and the associated carbon footprint from commuting by Horizon students, faculty and staff

	Avg round trip	Total Round trip Mileage (# days)	Total Miles	Gallons Used (avg. 24.5 mpg)	TCDE	% of Carbon Footprint
Students	31.2	3060 (78 days)	238,680	9742	563.24	~3.1%
Faculty	16.6	1428 (175 days)	249,900	10200		
Staff	21.7	3714 (240 days)	891,360	36382		

University Air Travel

We included air travel for short term trips as well as air travel from the president's office, development, admissions, and faculty travel/research grants in the calculation of university air travel. For each short term course that involved air travel, we calculated the number of air miles between the Roanoke airport and the airport of destination for each academic year between 02/03 and 06/07. We then generated total air mileage for each short term course based on enrollment. However, we were only able to collect accurate data on air travel from the President's Office, Development, and Admissions for the 05/06 academic year. Similarly, we were only able to collect accurate air travel data from faculty travel grants during the 06/07 academic year.

Calculating carbon output from air travel is difficult as output depends on age of aircraft, load, windspeed and direction, as well as other factors. We assumed 1.04 lbs CO_2/passenger mile based on variables described in the appendix. Other models and carbon offset organizations use values from (0.45-1.8 lbs CO_2/passenger).

As noted in Table 4, we have increased the number of short term trips that involve air travel in the last 5 years. As a result, our carbon footprint for air travel has grown. Overall air travel comprises 0.6-2% of our carbon footprint.

Table 4: University Air Travel and our carbon footprint

Academic Year	# Short term trips w/ air travel	Total short term air miles	Presidents Office, Development, and Admissions (air travel only)	Faculty Travel and Research (air travel only)	TCDE	% of Carbon Footprint
2002-2003	2	55860	70,423	50,836	93.61	0.59
2003-2004	5	105520	70,423	50,836	119.43	0.72
2004-2005	3	78240	70,423	50,836	105.77	0.61
2005-2006	7	579920	**70,423**[a]	50,836	366.12	2.02
2006-2007	5	486840	70,423	**50,836**[b]	317.72	1.76

a –data from 05/06 was used to calculate air travel from Presidents Office, Development and Admissions
b- data from 06/07 was used to calculate air travel from faculty travel and research grants

University Fleet

Our consumption of fossil fuel to power our university fleet has not substantially changed in the last 5 years. One gallon of gasoline generates 20 lbs of CO_2 while one gallon of diesel fuel generates 22 lbs of CO_2. On average fleet fuel contributes 110-120 tons of CO_2 annually and accounts for 0.65-0.7% of our carbon footprint (Table 5).

Table 5: Fuel consumption for the university fleet and our carbon footprint

Academic Year	Gas (gallons)	Diesel (gallons)	MTCDE	% of Carbon Footprint
2002-2003	9942	1012	110.552	0.69
2003-2004	10640	645	113.495	0.68
2004-2005	10969	1271	123.671	0.71
2005-2006	10230	1649	120.439	0.66
2006-2007	10031	1745	119.505	0.66

Animal agriculture and landscaping

Livestock (primarily cattle) produce methane, a potent greenhouse gas (21X the global warming potential of carbon). Values vary for the total greenhouse gas by beef cattle. We used a value of 2,283 lbs/head/yr for cattle which are grazed on our acreage north of I-81 and 1,165 lbs/head/yr for horses in our riding program. In addition we use nitrogen fertilizer on our lawns which releases N_xO, a potent greenhouse gas (310X the global warming potential of carbon). We have 81 beef cows, 32 horses and use 50,150 lbs of fertilizer (10%N) annually (Table 6).

Table 6: Agriculture/barn and our carbon footprint

Academic Year	# beef cows	# horses	lbs of fertilizer (10%N)	TCDE	% of Carbon Footprint
2006-2007	81	32	50,150	136.73	0.76%

Waste Generation

Waste in landfills is decomposed anaerobically, resulting in the production of methane. The waste we generate on campus is transported to landfills that have methane recovery. The methane that is recovered in these landfills is burned which results in the release of CO_2, a less potent greenhouse gas resulting in 565 lbs of CO_2/ton of waste. While it would be better if we used landfills that used methane recovery to produce electricity, burning the methane is better than allowing it to escape directly into the atmosphere.

Our waste generation varies from year to year with no distinct trends apparent. Overall, waste generation accounts for ~0.35% of our carbon footprint (Table 7).

Table 7: Waste generation and our carbon footprint

Academic Year	Short tons of waste	Equivalent tons of CO2	% of Carbon Footprint
2002-2003	211	59.60	0.37
2003-2004	277	78.25	0.47
2004-2005	238	67.23	0.38
2005-2006	230	64.98	0.36
2006-2007	265	74.86	0.41

CARBON OFFSETS

Forest Preservation

Trees have the ability to absorb and store atmospheric carbon. As such, forests are seen as carbon reservoirs, and can offset greenhouse gas production. Calculations from the Duke Forestry program estimate that 1 acre of forest can absorb 1 metric ton of carbon annually.

Hollins has historically owned ~400 acres. The land south of I-81 contains our campus buildings, groomed lawns and pasture for horses. The land north of I-81 is dominated by pasture which we lease to a cattle farmer. As such, we estimated that only 10 of this original 400 acres is forested. Therefore, prior to 06/07 we were able to offset only 10 metric tons (0.06% of our footprint) of carbon annually. In 06/07 Hollins purchased land on Tinker Mountain and in collaboration with Lee Hartman put 235 acres of forest on Tinker mountain in a conservation easement. Thus, we now have 245 acres of forested land which annually offsets 1.35% of our carbon footprint. If we were to plant more trees on our existing land or acquire more forested acres we would be able to offset a larger portion of our footprint.

Table 8: Forest preservation and carbon footprint offset

Academic Year	# forested acres preserved	TCDE	% of our Carbon Footprint Offset
2002-2003	10	10	-0.06
2003-2004	10	10	-0.06
2004-2005	10	10	-0.06
2005-2006	10	10	-0.05
2006-2007	245	245	-1.35

Recycling

Recycling products reduces our carbon footprint. Recycled materials can replace virgin materials which require substantial energy to harvest and produce. In addition, recycled materials are not landfilled or incinerated, both of which generate greenhouse gases. Using the NERC Environmental Benefits Calculator (http://www.nerc.org/documents/environmental_benefits_calculator.html) we estimated the greenhouse gas reduction for each of the materials that are collected on campus (see appendix). The Calculator derives its values from several lifecycle analysis studies.

In 2005, Hollins initiated a collaborative recycling program with Roanoke County which allowed us to collect aluminum, plastic (#1, #2), and newspaper on campus. Prior to this time, Hollins only recycled mixed paper and steel. In the fall of 2007, Hollins initiated a statewide e-waste recycling event. During this 3-day event, we collected approximately 200 tons of e-waste at the Hollins site alone. Assuming that recycled tonnage in 07/08 is similar to the past two years, we will offset ~1% of our carbon footprint through our recycling program.

Table 9: Recycling and carbon footprint offset

1Ton of product	TCDE	05/06 TCDE	06/07 TCDE	07/08 TCDE
Mixed Paper	1.06	17.1932	16.23337	
Aluminum	4.08	1.01388	2.29908	
Mixed Plastic	0.45	0.4005	0.76275	
Newspaper	0.85	3.196	6.800425	
Steel	0.54	4.8222	4.347	
Computers	0.68			136
Cardboard	0.93			
Food Scraps	0.055			
Scrap Iron	0.54			
TOTAL (% of our carbon footprint)		26.6 (~0.2%)	30.4 (~0.2%)	

Appendix – Factors used in Greenhouse gas calculations and their sources

Activity	Carbon equivalents	Source and calculations
Kilowatts of electricity in Roanoke Valley using AEP electricity	1.85 lbs CO2/KW	ICLEI http://www.iclei.org/ (assuming AEP Roanoke Valley Energy Mix - 88% coal, 10.9% nuclear, 0.8% wind) – Sean McGinnis I confirmed this factor using values from EPA: Direct Emissions from Stationary Combustible Sources (http://www.epa.gov/stateply/documents/resources/stationarycombustionguidance.pdf)
mmBtu (natural gas for steam generation)	117 lbs CO2/mmBtu	EPA: Direct Emissions from Stationary Combustible Sources (http://www.epa.gov/stateply/documents/resources/stationarycombustionguidance.pdf) Carbon-14.47 kgC/mmBtu, 53.06 kg CO2/mmBtu, 116.72 lbs CO2/mmBtu Methane – 4.75 gCH4/mmBtu (methane global warming potential 21) Thus 99.75gCO2/mmBtu = .22lbsCO2/mmBtu N2O – 0.095 g N2O/mmBtu (N2O global warming potential = 310). Thus 29.45 g CO2/mmBtu = 0.065 lbs CO2/mmBtu TOTAL = 117 lbs CO2/ mmBtu
Fuel Oil	22.384 lbs CO2/gal	Energy Information Administration – Voluntary Reporting of Greenhouse Gases. http://www.eia.doe.gov/oiaf/1605/coefficients.html
Propane	12.805 lbs CO2/Gal	Energy Information Administration – Voluntary Reporting of Greenhouse Gases. http://www.eia.doe.gov/oiaf/1605/coefficients.html
Gasoline	20 lbs CO2/gal	EPA: Direct Emissions from Mobil Combustible Sources http://www.epa.gov/stateply/documents/resources/mobilesource_guidance.pdf
Diesel	22 lbs CO2/gal	EPA: Direct Emissions from Mobil Combustible Sources http://www.epa.gov/stateply/documents/resources/mobilesource_guidance.pdf

Air Mileage	1.04 lbs CO_2/passenger mile	Energy Information Administration – Voluntary Reporting of Greenhouse Gases. http://www.eia.doe.gov/oiaf/1605/coefficients.html EPA: Direct Emissions from Mobil Combustible Sources (http://www.epa.gov/stateply/documents/resources/mobilesource_guidance.pdf) 21.095 lbs CO_2/gal; 2.47 gallons/mile = 52.1 lbs CO_2/mile. Assume Industry Average of 50 passengers
Commuting Mileage	0.816 lbs CO_2/mile	Department of Transportation: Summary of Fueld Economy Standards http://www.nhtsa.dot.gov/cars/rules/cafe/docs/Summary-Fuel-Economy-Pref-2004.pdf Average mpg for cars/trucks 2004 24.5; EPA: 20 lbs CO_2/gal
Agriculture	1 Beef cow – 2,283 lbs of CO_2 1 Horse – 1161 lbs of CO_2	EPA: INVENTORY OF U.S. GREENHOUSE GAS EMISSIONS AND SINKS: 1990-2001 http://yosemite.epa.gov/OAR/globalwarming.nsf/content/ResourceCenterPublicationsGHGEmissionsUSEmissionsInventory2003.html Calculations based on Cool Campus Model info derived from EPA source 1 Beef cow – 2,283 lbs of CO_2 46.17 kgCH_4 = 21 x 46.17 = 969.57 kg CO_2 equivalent = 2133 lbs CO_2 0.22 Kg N_2O = 310 x 0.22 = 68.2 kg CO = 150 lbs CO_2 1 Horse – 1161 lbs of CO_2 23.66 kg CH_4 = 1093 lbs CO_2 0.1 kg N_2O = 68.2 lbs CO_2
Fertilizer Applications	9.55 lbs CO_2/lb N	EPA: INVENTORY OF U.S. GREENHOUSE GAS EMISSIONS AND SINKS: 1990-2001 http://yosemite.epa.gov/OAR/globalwarming.nsf/content/ResourceCenterPublicationsGHGEmissionsUSEmissionsInventory2003.html 0.014 kg N_2O/lbN = (310 global warming potential) 9.55 lbs CO_2/lb N
Landfill Waste with CH_4 recovery and flaring	565 lbs CO_2/short ton	EPA: Solid Waste Management and Greenhouse Gas Assessment http://www.epa.gov/climatechange/wycd/waste/downloads/greengas.pdf

Forests	Reduced 2000 lbs/acre	Duke forestry department estimates
Recycling	1Ton of product / Carbon equivalent (TCDE) Aluminum 4.08 Steel Cans 0.54 Newspaper 0.85 Scrap Iron 0.54 Computers 0.68 Mixed Paper 1.06 Mixed Plastic 0.45 Food Scraps 0.055 Cardboard 0.93	Source: Northeast Recycling Center – environmental http://www.nerc.org/documents/environmental_benefits_calculator.html