

# **Catmobile**

May 2, 2013

Environmental Science II

Investigators: Kvochak, Lewis, McIntyre, Radomile

Affiliation: Dept. of Geography & the Environment,  
Villanova University, 800 Lancaster Ave., Villanova, PA 19085

**Abstract**

Gavin Lewis

In 2004, Villanova University officially implemented the Campus Environmental Sustainability Policy, pledging to make the university more sustainable. Reducing the campus' emissions of greenhouse gases in particular, is one significant way to achieve this goal. The purpose of our research was to address the issue of CO<sub>2</sub> emissions by student commuters. We specifically studied the possible environmental benefits of an off-campus shuttle as a way to decrease the number of students who drive to campus. To do this, we initially surveyed a sample of students to evaluate the likelihood of use of the proposed shuttle and then designed a concept route and schedule. To determine whether our shuttle would be beneficial from an environmental standpoint, we compared the amount of CO<sub>2</sub> emitted by a single student's daily commute to the amount of CO<sub>2</sub> emitted by the daily commute of our proposed shuttle. Our study revealed that over 90% of the surveyed students would take an off-campus shuttle to Villanova University if it was available. Through this study, we also found that the majority of the students living off-campus live nearby one another and in close proximity to the University. Therefore, a shuttle taking off-campus students to and from campus would not only be helpful to the student body, but would also decrease CO<sub>2</sub> emissions, helping to achieve the campus' goal of lessening our environmental footprint and making Villanova University a more sustainable campus.

## **Introduction**

Evan McIntyre

The availability of public transportation in suburban areas has always been a problem. In a city like Philadelphia, it is fairly easy to navigate to any particular point due to the abundance of public transportation. In more suburban areas, generally, this is not the case. According to the Chicago Tribune, experts say that suburbia works against public transportation due to its limited road network, widely dispersed population, and its obsession with and reliance on motor vehicles (Arndt, 1986). If one lives in a suburban town, it is probable that he or she owns a car because public transportation can be difficult to access.

It is usually not difficult to use public transportation to go into the city; however, if students need to commute to school from nearby suburban towns, the availability of cheap and easily accessible public transportation is limited. Currently, access to the various towns surrounding Villanova University can be expensive and time-consuming, unless one has a personal vehicle. Train tickets through the Southeastern Pennsylvania Transportation Authority, from Villanova to Philadelphia, are typically six dollars one-way. Travelling from campus to locations other than the city usually requires multiple train and bus transfers, which can be time-consuming. For example, a trip from Villanova to the King of Prussia Mall would require waiting for a train, then transferring and waiting for a bus, which increases the trip time from 10 minutes by car to 42 minutes via SEPTA. People are often deterred by the cost and time required to use public transportation, therefore, they are more likely to drive their own personal vehicles.

At Villanova University, parking lots are filled to capacity with the vehicles of students who largely commute within a five to ten mile radius of the school. According to a 2011 study conducted by the Environmental Protection Agency, the average car emits about 5.1 metric tons of carbon dioxide annually (EPA, 2011). Research also shows that a heavy-duty transit bus is

more efficient than a personal vehicle if used by at least eleven people (Lowe et al., 2009). Therefore, students who commute from off-campus residencies would emit lower levels of CO<sub>2</sub> if they were to utilize public transportation. We would like to establish an alternative that is environmentally friendly, reliable, free to students and easier to use.

Off-campus shuttles are a common mode of transportation at a variety of universities. Schools like Towson, Hartford, Fairfield, Ramapo, and many others offer off-campus shuttles that allow students to have easy access to the surrounding communities<sup>1,2,3,4</sup>. According to the coach bus company, Krapf's Coaches, a 55-passenger coach bus is 475% more fuel efficient than a hybrid car (Go Green). If Villanova also incorporates a similar shuttle service as these various universities have, its carbon footprint as a school could be dramatically reduced.

In this study, our goal is to quantify the popularity and usefulness of an off-campus shuttle, as well as identify the environmental benefits of opting to use a shuttle rather than a car when commuting to school. Due to a lack of convenient public transportation, many off-campus commuters are driving their cars to and from campus every day. The abundance of student motor vehicle traffic contributes to the high levels of CO<sub>2</sub> being emitted into the atmosphere. As a group, we would like to implement a free off-campus shuttle that would give off-campus residents an environmentally friendly alternative for their daily commute. Our proposed off-campus shuttle would make stops near most of the major housing locations in the area and provide the students of Villanova with the opportunity to save money, as well as help the university attain its goal of becoming a more sustainable campus. We hypothesize that if an environmentally friendly off-campus shuttle were available; students would be more inclined to use this cheaper method of transportation rather than their personal automobiles.

**Methods**

Danielle Radomile

We created a comprehensive survey through the use of SurveyMonkey®, a free online survey and software tool, to collect information from 418 Villanova students. The survey included questions concerning the survey-taker's class, college living arrangements, class schedule, and potential interest in utilizing the shuttle. Some questions could be skipped while others could be completed with multiple answers. A more detailed example of our survey can be seen below. The link to our survey was then sent via email to Villanova University professors and student organizations who then distributed the survey to their students through email. To avoid bias, we selected professors who teach students of different majors. After two weeks, the results of the survey were collected and compiled. Based on the answers collected from the survey question inquiring where students live, we created a proposed route and schedule. We met with representatives from the department of public safety, the admissions office, residence life, and the office of student enrollment and asked the following questions: how many upperclassmen live off-campus; how many parking spots are available to these commuters; and where are the majority of upperclassmen houses located? We also contacted Krapf's Coaches to determine the fuel efficiency of a 20-passenger shuttle bus. Using these data, as well as data acquired through internet sources, we estimated the amount of CO<sub>2</sub> emitted by a single-passenger car commuting to and from Bryn Mawr and by our proposed off-campus shuttle.

**Off-Campus Shuttle**

1. What year do you graduate in?

- 2013
- 2014
- 2015
- 2016

\*2. Where do you live?

- South campus
- Main campus
- West campus
- The Courts
- Home properties
- Commuter
- Other Off-Campus Housing (please specify)

\*3. If you commute from off campus, what is your current means of transportation?

- Car (single person)
- Carpool with friends
- Train
- Bus
- Bike
- Walk
- Other (please specify)

4. If you don't already live off-campus, are you planning on living off-campus in the future?

- Yes
- No
- I already live off campus

\*5. If a shuttle was available to and from areas near off campus housing would you use it? (Only answer if you live off campus)

- Yes
- No (please specify)

6. What time of the day do you usually depart from home (for off campus commuters only)?

- |                                 |                                    |
|---------------------------------|------------------------------------|
| <input type="checkbox"/> 6-7am  | <input type="checkbox"/> 10-11am   |
| <input type="checkbox"/> 7-8am  | <input type="checkbox"/> 11am-12pm |
| <input type="checkbox"/> 8-9am  | <input type="checkbox"/> Past 12pm |
| <input type="checkbox"/> 9-10am |                                    |

7. What time of the day do you usually depart from campus (for off campus commuters only)?

- |                                    |                                    |
|------------------------------------|------------------------------------|
| <input type="checkbox"/> 11am-12pm | <input type="checkbox"/> 3-4pm     |
| <input type="checkbox"/> 12-1pm    | <input type="checkbox"/> 4-5pm     |
| <input type="checkbox"/> 1-2pm     | <input type="checkbox"/> 5-6pm     |
| <input type="checkbox"/> 2-3pm     | <input type="checkbox"/> After 6pm |

8. How do you acquire the current ON-campus shuttle schedule?

- Villanova website
- Friends
- Experience
- Just wait

9. Do you think it's effective? If not, how do you want to be informed of shuttle schedules?

- Yes, I think it is effective
- no, Phone
- no, Twitter
- no, Facebook
- no, Villanova app
- no, Email

Done

**Results**

Natalie Kvochak

Table 1. Departure time from home of students living off-campus.

Time of Departure from Home	Number of Students	Percent %
6-7 am	4	2.353
7-8 am	24	14.12
8-9 am	32	18.82
9-10 am	50	29.41
10-11 am	33	19.41
11-12 pm	16	9.411
Past 12 pm	11	6.471
<b>Total</b>	<b>170</b>	<b>100.0</b>

Table 2. Departure time from campus of students living off-campus.

Time of Departure from Campus	Number of Student	Percent %
12-1 pm	5	2.688
1-2 pm	7	3.763
2-3 pm	19	10.22
3-4 pm	25	13.44
4-5 pm	37	19.89
5-6 pm	36	19.35
After 6 pm	57	30.65
<b>Total</b>	<b>186</b>	<b>100.0</b>

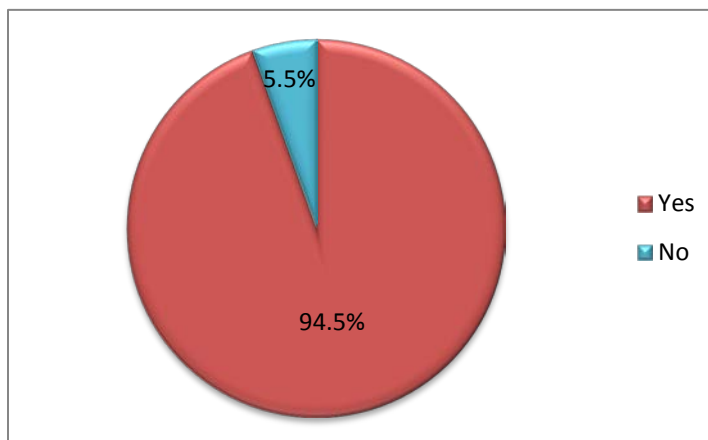
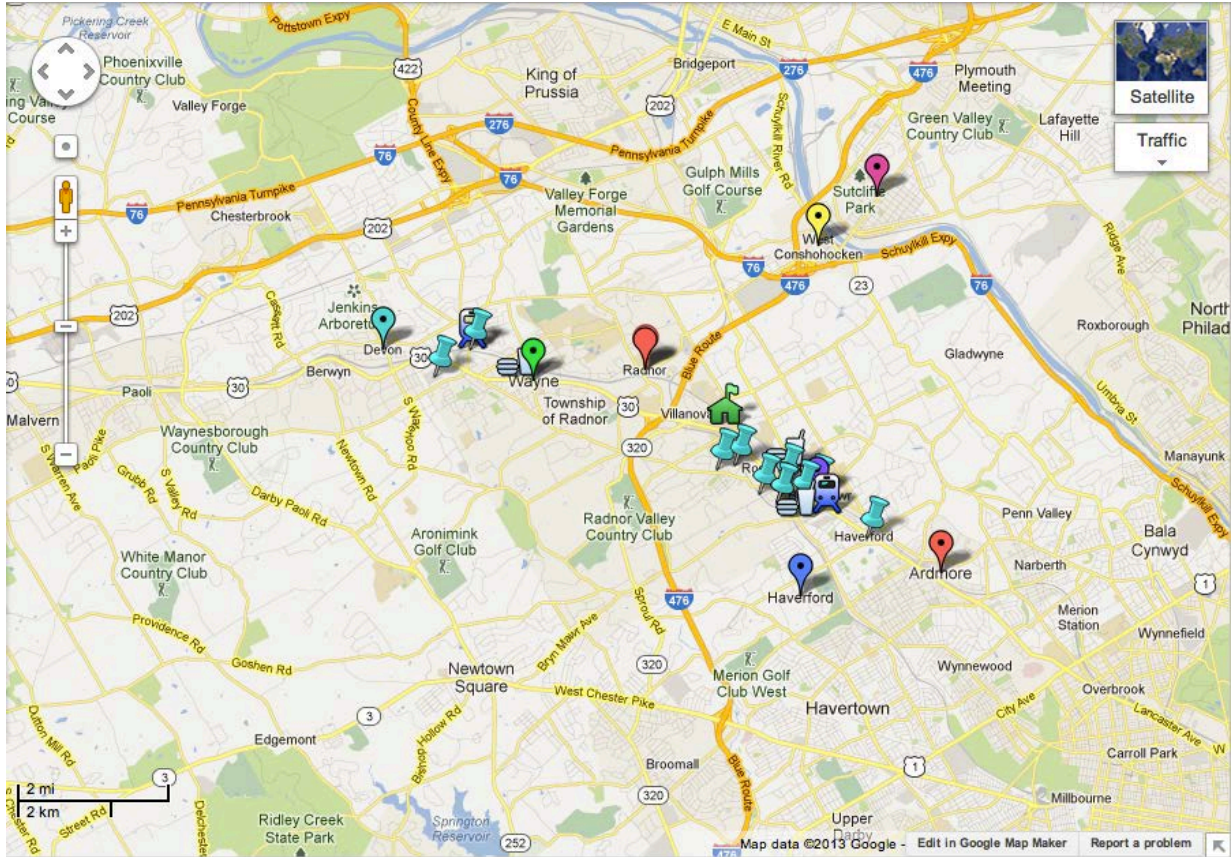


Figure 1. Percent of Villanova Students (n=416) who would use an off-campus shuttle currently or once they live off-campus.



Key:














-  = Villanova University
  = Devon, PA
  = Wayne, PA.
  = Radnor, PA.
-  = Bryn Mawr, PA
  = Haverford, PA
  = Ardmore, PA.
  = West
-  = Conshohocken, PA
  = Conshohocken, PA
  = Specialties food/ market/ other service
-  = Train station
  = Apartment complex or house students reported living in.

Figure 2: Areas and specific apartments that Villanova Students reported to live in or around.



Table 3. Locations off-campus residing students reported living in (n=56).

Town	Residing Students	Percent of Students
<b>Devon</b>	1	1.64%
<b>Wayne</b>	5	8.20%
<b>Radnor</b>	5	8.20%
<b>Bryn Mawr</b>	45	73.77%
<b>Haverford</b>	1	1.64%
<b>Ardmore</b>	2	3.28%
<b>West Conshohocken</b>	1	1.64%
<b>Conshohocken</b>	1	1.64%
<b>Total</b>	61	100%

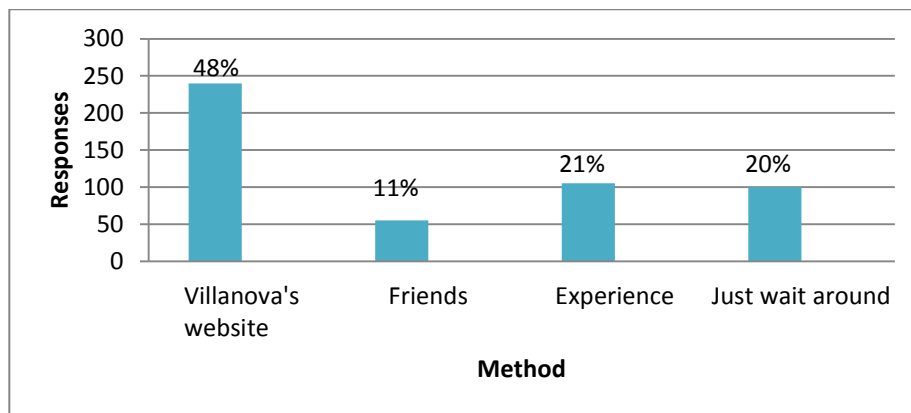


Figure 3. Number of responses for (n= 500) and percentages of how Villanova students currently inform themselves about the shuttle route and schedule. 91.7% of students find means of accessing shuttle information ineffective.

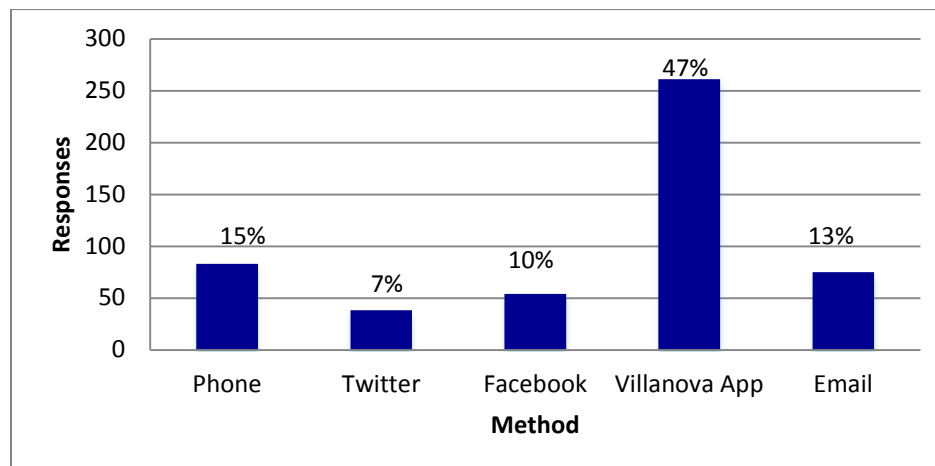
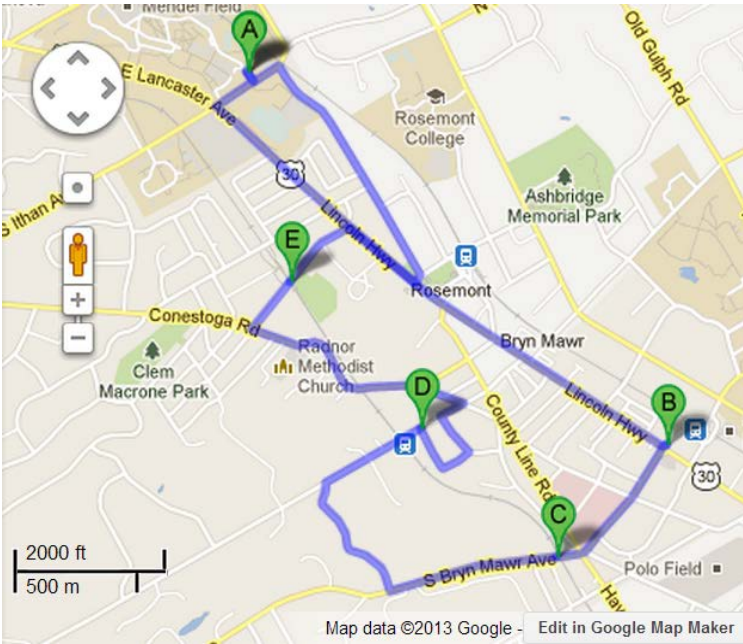


Figure 4. Number of responses for (n=557) and percentages of how Villanova students would like to be informed about the shuttle route and schedule.

Our data shows that, out of 418 Villanova students surveyed from the freshmen class to the senior class, the vast majority of students, 94.5%, would take an off-campus shuttle to and from campus if available (Figure 1). We asked upperclassmen, via our survey, to identify where they currently reside off-campus. Most students reported to live within 6 miles of Villanova. A majority live along or near Lancaster Avenue, in either Devon, Wayne, Radnor, Bryn Mawr, or Ardmore (Figure 2). The majority of our surveyed students, 74%, live in Bryn Mawr, PA. A maximum of 8% and a minimum of 1% of students reported living in other towns, making Bryn Mawr the most popular location (Figure 2 and Table 3). Most students who live off-campus leave their residencies for campus between 7 am and 12 pm (Table 1). The majority of students reported to leave campus for their residencies after 6 pm (Table 2). However, a significant amount of students, 117, reported leaving between 2 pm and 6pm. In 500 student responses, a preponderant amount reported to use the Villanova website for information on the shuttle and schedule, followed by experience, just waiting, and friends respectively (Figure 3). A sizable number of 551 out of 557 student responses, 91.7%, reported the current means of accessing shuttle information to be ineffective. Other possible ways students would like to be informed of an off-campus shuttle, in order of most desired to least desired, include the Villanova app, phone, email, Facebook, and twitter. The Villanova app was significantly the most popular response among students (Figure 4).

**Discussion**

Danielle Radomile



Key:

- A Villanova University
- B Bryn Mawr Station
- C Wawa
- D Home Properties
- E Garrett Avenue

Figure 5: Proposed off-campus shuttle route. Route is 5.4 miles and takes 30 minutes to complete

Table 4: Example of proposed shuttle schedule for 7:40 loop. In the morning shuttle would leave at 7:40, 8:40 9:40, 10:40, and 11:40 am. In the afternoon, shuttle would resume at 4:30, 5:30, 6:30, 7:30, 8:30, and 9:30 pm.

<b>To</b>		<b>From</b>	
<b>Time</b>	<b>Stop Name</b>	<b>Time</b>	<b>Stop Name</b>
7:40	Villanova University	7:50	Bryn Mawr Station
7:50	Bryn Mawr Station	7:55	Wawa
7:55	Wawa	8:00	Home Properties
8:00	Home Properties	8:05	Garrett Avenue
8:05	Garrett Avenue	8:10	Villanova University

The student responses from our survey indicated positive and enthusiastic feedback for a proposed campus shuttle to off-campus housing. Based off the responses from the survey question inquiring about students' living arrangements, it was determined that 61 out of 416 student responders specified living off-campus in a nearby township. Of those 61 off-campus residents, 48 were seniors. Based off the number of senior responders, and assuming percentages obtained from the survey accurately represent the entire student population, it can be inferred that roughly 75% of seniors live off-campus. It can also be inferred that a little over 70% of off-campus student residents reside in Bryn Mawr, PA. With this data, we concluded that it would be most efficient for the shuttle to stop only in various locations in Bryn Mawr. The route begins at Villanova University and consists of four stops: Bryn Mawr Station, the Bryn Mawr Wawa, Home Properties, and Garrett Avenue (Figure 5). The total route length is 5.4 miles. Without stops, the route takes 19 minutes to complete; with stops, it takes 30 minutes. We also created a proposed shuttle schedule (Table 4). Most students reported leaving their residencies for campus between 7 am and 12 pm and returning to their residencies from 2 pm until after 6 pm. Based off this information, we developed a shuttle schedule that best met students' needs. Morning shuttle rides would be available Monday through Friday starting at 7:40 am and ending at 11:40 am. Afternoon shuttle rides would also be available Monday through Friday starting at 4:30 pm and ending at 9:30 pm.

If such a shuttle were to be implemented, it would significantly improve Villanova University's environmental sustainability by lowering the carbon footprints of commuting students, particularly juniors and seniors (excluding those who commute from family residencies). Of students who drive a car to school, about 65% drive alone and do not car-pool. It can be inferred from our data that an average student living in Bryn Mawr, PA commutes

roughly two miles from Villanova's campus and drives alone to school. To be as accurate as possible, we compared the amount of CO<sub>2</sub> emitted daily by the proposed shuttle's commute to a student's daily commute assuming that this student lives 1.7 miles from campus. This would make the student's total commute 3.4 miles long. On average, a passenger vehicle emits 423 grams of CO<sub>2</sub> per mile (EPA, 2011). Therefore, a student commuting a total of 3.4 miles to campus emits 1,438.2 g of CO<sub>2</sub> in one day. The shuttles currently used by Villanova hold 20 students comfortably and have a fuel efficiency of 8.5 miles per gallon of diesel. On average, burning one gallon of diesel will emit 10,180 grams of CO<sub>2</sub> (EPA, 2011). Therefore, a shuttle with a route of 5.4 miles that is repeated eleven times will emit 71,140.235 grams of CO<sub>2</sub> in one day. In order for the shuttle to be more efficient than a single-passenger student's car, a total of only 50 students would have to ride the shuttle daily.

Based off our survey question inquiring after students' interest in utilizing an off-campus shuttle, 94.5% responded with interest. This percentage reflects the opinions of students who currently live on-campus as well as students who live off-campus. Hopefully, the overwhelming number of positive responses will give Villanova University more incentive to implement the program. It is our hope that the shuttle will become an integral part of student life and a means of transportation to off-campus housing for all students, regardless of a student's current living arrangement.

Implementing a campus shuttle to off-campus housing would lower the amount of CO<sub>2</sub> emitted per person while commuting to and from campus. Unfortunately, due to the low percentages of students residing in Devon, Wayne, Lower Merion, Haverford, Ardmore, West Conshohocken, and Conshohocken, stops to these towns were not included in the route. Though

meeting every student's need is ideal, proposing a schedule that stops in every town would be inefficient.

Another important consideration, if an off-campus shuttle were to be impended, is cost. It was our hope to create a shuttle that would remain free to all Villanova students. Students who choose to ride the shuttle would save money on gas and would no longer need to buy a parking pass. The American Automobile Association reports that on May 1, 2013, the average price of regular fuel in Pennsylvania was \$3.46 per gallon (Daily Fuel Gauge Report, 2009). According to the EPA, the average passenger vehicle has a fuel efficiency of 21 miles per gallon (EPA, 2011). Based off this data, a student who rides the shuttle would save roughly \$40 a semester on their commute to and from school. This figure is based off a total student commute of 3.4 miles, a vehicle requiring regular fuel, and a 70-day semester. Students would also save a notable amount of money on maintenance and insurance fees. Though economical for students, an off-campus shuttle could come at a considerable cost to the university. The university would be responsible for the initial cost of the shuttle, maintenance fees, insurance fees, salary of the driver, and fuel. The American Automobile Association reports that on May 1, 2013, the average price of diesel fuel in Pennsylvania was \$3.92 per gallon (Daily Fuel Gauge Report, 2009). The fuel for our proposed shuttle, with a total daily route length of 59.4 miles and a fuel efficiency of 8.5 miles per gallon of diesel, would cost roughly \$1,920 per semester. Though beneficial for students, implementing a shuttle to off-campus housing would result in a loss of revenue for Villanova University.

## References

- Arndt, Michael. 1986. Jobs Go To Suburbs, Mass Transit Doesn't. In: Chicago Tribune. Chicago: n. page.
- Daily Fuel Gauge Report. AAA. Oil Price Information Service. (1 May 2013). Retrieved May 1, 2013 from <<http://fuelgaugereport.aaa.com/?redirectto=http://fuelgaugereport.opisnet.com/index.asp>>.
- Going Green. Krapfs Coaches. ( n.d.). Retrieved May 2, 2013 from <<http://www.krapfscoaches.com/going-green/>>.
- Greenhouse Gas Emissions from a Typical Passenger Vehicle. Greenhouse gas emissions from a typical passenger vehicle. (n.d.). From <<http://www.epa.gov/otaq/climate/documents/420f11041.pdf>>.
- Lowe, M., Aytekin, B., & Gereffi, G. 2009, October 26. Manufacturing climate solutions carbon-reducing technologies and U.S. jobs. Retrieved Feb 4, 2013.
- U.S. Environmental Protection Agency, Office of Transportation and Air Quality. (2011). Greenhouse gas emissions from a typical passenger vehicle. Retrieved Feb 4, 2013 from <http://www.epa.gov/otaq/climate/documents/420f11041.pdf>
1. <http://www.towson.edu/adminfinance/auxservices/parking/shuttle/offcampus.asp>
  2. [http://www.hartford.edu/visitingcampus/campus\\_shuttle/](http://www.hartford.edu/visitingcampus/campus_shuttle/)
  3. [http://www.fairfield.edu/documents/student/sl\\_shuttle\\_sched.pdf](http://www.fairfield.edu/documents/student/sl_shuttle_sched.pdf)
  4. <http://www.ramapo.edu/about/shuttlebus/>