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# Greenhouse Gas Inventory of Transportation and Driving Habits at Gettysburg College

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# Greenhouse Gas Inventory of Transportation and Driving Habits at Gettysburg College


## Abstract

By tracking the overall emissions put out by a college campus, mitigation strategies can be researched to lower total emissions. This study utilized a survey for both the student body and faculty and staff members at Gettysburg College in Gettysburg, Pennsylvania. This survey allowed this study to answer three research questions; what is the total number of Scope 3 emissions at Gettysburg College, how do these findings compare to findings from 2009 and the 2016 STARS report for Gettysburg College, and if any potential mitigation strategies are welcomed by the campus community. This study examined five major driving related emission totals in order to come to the overall emissions number. These five groups include: the daily commutes of faculty and staff, faculty and staff travel related to Gettysburg College official business, student commutes to and from home, daily commutes of students while on campus and the total amount of carbon emissions related to abroad travel for both the Fall and Spring worldwide programs in 2021. The total of Gettysburg Colleges Scope 3 emissions that are related to commutes and travel is estimated to be 1,219 tons. These findings were compared to a report from 2009 by Gettysburg College students about emissions from several overlapping categories in 2007 and 2008. It was found that staff and faculty now travel less of a distance from work to home and also make fewer trips to campus than they did in the previous decade and emissions are significantly less regarding study abroad air travel. Additionally, for the 2020-2021 academic year, the largest category of Scope 3 emissions comes from students going abroad. The 2021 study also investigated which mitigation strategies would be supported by faculty and staff and students. Proposed strategies included increasing or instituting parking permit fees, receiving a stipend for alternative transportation options, creating a bike share program, and creating a carpool matching system. We found that students are more open minded to such mitigation strategies than are faculty and staff. Future studies should further investigate these strategies alongside additional Scope 3 emission categories.



## Keywords

Transportation, carbon emissions, mitigation strategies, Scope 3 emissions, STARS (The Sustainability Tracking, Assessment & Rating System)

## Disciplines

Environmental Studies | Sustainability | Transportation

## Comments

Written for ES 400: Senior Seminar

# Greenhouse Gas Inventory of Transportation and Driving Habits at Gettysburg College

Megan Wojnar and Flavia Scotto d'Antuono

Rutherford Platt

ES400: Senior Seminar

December 16th, 2021

I affirm that I will uphold the highest principles of honesty and integrity in all my endeavors at Gettysburg College and foster an atmosphere of mutual respect within and beyond the classroom.

## Abstract

By tracking the overall emissions put out by a college campus, mitigation strategies can be researched to lower total emissions. This study utilized a survey for both the student body and faculty and staff members at Gettysburg College in Gettysburg, Pennsylvania. This survey allowed this study to answer three research questions; what is the total number of Scope 3 emissions at Gettysburg College, how do these findings compare to findings from 2009 and the 2016 STARS report for Gettysburg College, and if any potential mitigation strategies are welcomed by the campus community. This study examined five major driving related emission totals in order to come to the overall emissions number. These five groups include: the daily commutes of faculty and staff, faculty and staff travel related to Gettysburg College official business, student commutes to and from home, daily commutes of students while on campus and the total amount of carbon emissions related to abroad travel for both the Fall and Spring worldwide programs in 2021. The total of Gettysburg Colleges Scope 3 emissions that are related to commutes and travel is estimated to be 1,219 tons. These findings were compared to a report from 2009 by Gettysburg College students about emissions from several overlapping categories in 2007 and 2008. It was found that staff and faculty now travel less of a distance from work to home and also make fewer trips to campus than they did in the previous decade and emissions are significantly less regarding study abroad air travel. Additionally, for the 2020-2021 academic year, the largest category of Scope 3 emissions comes from students going abroad. The 2021 study also investigated which mitigation strategies would be supported by faculty and staff and students. Proposed strategies included increasing or instituting parking permit fees, receiving a stipend for alternative transportation options, creating a bike share program, and creating a carpool matching system. We found that studies are more open minded to such mitigation strategies than are faculty and staff. Future studies should further investigate these strategies alongside additional Scope 3 emission categories.



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## I. Introduction

Many in the United States are beginning to recognize climate change as a critical challenge, aggravated by a culture over-dependent on the automobile. The Environmental Protection Agency estimates that 62% of transportation sector emissions come from passenger cars or light-duty vehicles (Lewis et al, 2017). The transportation sector accounts for one-third of all greenhouse gases (GHG) linked to climate change, highlighting how integral solutions to limiting car emissions are to this problem (Lewis et al, 2017). College campuses can be a driving force in implementing sustainability plans related to emissions on a larger-scale given their ability to serve as role models to society (Adenle and Alshuwaikhat, 2017).

Transportation of faculty and students to and from campus has been identified as a main contributor to greenhouse gas emissions (Yanez et al, 2019). Researchers therefore study transportation habits to reduce GHG emissions on college campuses (Yanez et al, 2019). James Madison University recently surveyed ten percent of their staff and student body to evaluate their driving habits (Yanez et al, 2019). Dickinson College recently conducted a Greenhouse Gas Emissions report, comparing the years 2008 to 2019 (Dickinson College, 2020). The findings from the Dickinson study reveal that transportation accounted for 25.7% of GHG emissions in 2019, a decrease of 7.5% from 2008 numbers (Dickinson College, 2020).

Gettysburg College also conducted a study on GHG emissions. The 2009 study showed that 26.4% of faculty do not drive to campus, 7.2% carpool to and from, and 66.4% drive alone in a personal vehicle (Boamah et al, 2009). The numbers differ for staff: 8.9% walk or bike to campus, 8.9% carpool both ways, and over 80% drive to campus in their individual vehicle (Boamah et al, 2009). Based on the 2009 calculations, there was an estimated 1,284.0 metric tons of carbon released, accounting for 6% of the total emissions for 2008-2009. One of the

suggestions from a 2009 Gettysburg College study was that the technology department could develop a database to match individuals by specific criteria for carpooling (Boamah et al, 2009). Despite the study not identifying what incentives would prompt faculty and staff to enroll in this program, there has been much research to suggest the effectiveness of a carpooling program.

Colleges have realized how impactful their role in alleviating climate change can be. Many universities across the nation have made climate commitments and efforts to track GHG emissions, especially as it pertains to transportation. Transportation emissions are considered Scope 3 emissions, meaning they are indirect emissions from the activities or assets not owned or controlled by the reporting organization (Hertwich and Wood, 2018). Between 1995 and 2015, Scope 3 emissions grew by 84% globally (Hertwich and Wood, 2018). The Sustainability Tracking Assessment and Rating System, otherwise known as STARS, has gained popularity as a useful tool to combat these emissions. This is especially true as the program focuses on bike access and vehicles with inputs other than gasoline or other alternative modes of transportation. It is also notable for its ability to engage the community and its focus on all sectors of sustainability (Barrella et al, 2014). STARS has proven integral to many universities' advancement for sustainable solutions and by abiding by its guidelines (Barrella et al, 2014).

This project will investigate the overall vehicle emissions at Gettysburg College, incorporating data from both the faculty and staff members' personal driving habits and the students' personal driving habits. By compiling data from various offices, one can create a profile of what the college-owned fleet looks like and the emissions it produces. The study will also revitalize the STARS program that expired in 2019 by compiling data for transportation-related entries in order to better understand the differences between emissions from the year 2009 to present. It will provide an update to Gettysburg College to inform the

administration of any necessary changes that must be made to reduce emissions. Other universities will be able to look to Gettysburg College as a model for its goals and its mitigation strategies widely accepted by the stakeholders. Finally, the study will build on the 2009 report by analyzing attitudes towards the following strategies to subdue car usage: implementing stipends, increasing or imposing parking permits, and creating a bike share program. In essence, our study seeks to answer the following three questions:

1. What are the total emissions of transportation from faculty and staff and students in their travel to conduct academic and extracurricular activities?
2. How do the findings compare to the previous report completed in 2009 and the STARS report from 2016?
3. What mitigation strategies to reduce emissions would be supported by students, faculty, and staff?

The first hypothesis is that many more individuals are also interested in sustainable options now than ever before and could possibly opt for a bike over a car. Additionally, the pandemic has likely changed many habits. Students may still be fearful of COVID or fragile health systems in other countries and may choose not to study abroad. Faculty and staff who saved money during the pandemic by being remote may try to implement alternative travel methods in their day to day life. The second hypothesis focuses on the second and third research questions and states that emissions have decreased since 2009, given the college's Climate Action Plan that established 2032 as the date to reach carbon neutrality (Climate Action Plan).

## III. Methods

Data for this research project came from voluntary surveys sent out to both faculty members, staff members, and the student body of Gettysburg College. Within these surveys, a multitude of questions were asked to help calculate the total amount of Scope 3 emissions at Gettysburg College (Figure 6 & 7). This study looked into a past study from 2009, and many of the questions found in the surveys came from the previous study. By having these questions mirror each other, the study was able to take an in depth look and compare the years included in the past study along with the current years included in this study. Surveys were created and distributed via Google Forms, and all survey data began being collected on October 25th and stopped being collected on October 31st. Both surveys were distributed to faculty, staff and students via a mass email from Provost Christopher Zappe.

To answer research question #1, this study looked at the total emissions of transportation from faculty, staff and students in their travel to conduct academic and extracurricular activities. Averages and estimations were taken of the following: the daily commutes of faculty and staff, faculty and staff travel related to Gettysburg College official business, student commutes to and from home, daily commutes of students while on campus and the total amount of carbon emissions related to abroad travel for both the Fall and Spring worldwide programs in 2021. This study also obtained information on certain statistics related to transportation from various offices around campus. These offices include the Office of Transportation and the Center for Global Education. From the Office of Transportation, the study gained knowledge on how many school vehicles there are, how the school tracks gas purchasing and mileage counting for the college fleet, how many personal shuttles/charters occur each school year, along with further information on Gettysburg Colleges Rabbit Transit system. From the Center for Global Education, the study

gained access to the amount of students studying globally for the 2021-2022 school year and where those students were traveling. This aided in the calculations of Gettysburg's global carbon footprint. When looking into this data, Google Flights was used to determine the total emissions for each student based on their study abroad location. A neutral airport, Newark International Airport in Newark, New Jersey, was selected to use for the starting point of all trips, as the Center for Global Education was unable to supply the study with initial flight information. Numbers may continue to fluctuate for the Spring of 2022, as students may choose to enroll in abroad programs or withdraw their applications. However, the Center for Global Education does not anticipate these numbers will fluctuate greatly.

In order to compare the data to the data from the 2009 study of the same nature and answer research question #2, how do the findings compare to the previous report completed in 2009 and the STARS report from 2016, the surveys posed the same questions when applicable to the 2021 pool of respondents. In the survey sent to faculty and staff members, questions that stayed the same included if the individual is a faculty or staff member, how many times per week does the individual drive round trip to and from campus, and approximately how far does the individual drive to and from campus per day. In the student survey, all questions posed were unique to the 2021 pool of respondents as no survey for students was utilized in the original 2009 study. Questions that were asked include how the student plans to travel to and from campus for the school year and how many miles it is, if they have a registered car on campus, or if they have an unregistered car at an off-campus location, how many miles they drive their car per week and why they do not choose to use public transportation. The students were also asked if they reside off-campus and how far their off-campus residence is, and what their primary mode of transportation is while living off campus to and within campus. This data was analyzed using an

excel sheet to fully calculate all responses. By taking data points from the 2009 survey and matching them up with data points stemming from the questions posed in this survey, this study was able to make a full comparison of questions that mirrored each other. By obtaining all of this information, this study hopes to update the information from the 2016 STARS report and provide Gettysburg College with an updated analysis of the numbers associated with the emissions from transportation modes. Once this data is manipulated and put into the format of the STARS report, this study should allow future studies to finish the entirety of the STARS report to complete an updated certification.

To answer research question #3, the study looked at what mitigation strategies to reduce emissions would be supported by students, faculty, and staff. The study gave three options to gauge interest on both surveys. In question #11 in the student survey and question #7 in the faculty and staff survey, options included Gettysburg College creating a bike share program, Gettysburg College providing individuals with a stipend to use a different form of transportation, Gettysburg College imposing or increasing a fee for parking permits (Figure 6 & 7). On the survey sent to faculty and staff, a unique question was posed to gauge interest if faculty and staff would be interested in Gettysburg College creating a system to identify faculty or staff to carpool with to desired locations. After data collection was complete, all answers to the mitigation strategy questions were analyzed numerically to see if there was any overall interest in options provided. This study also used a comment section, seen as question #12 and question #8, to allow respondents a chance to offer any comments. Respondents, primarily faculty and staff, utilized this section to offer their own ideas on mitigation at Gettysburg College. The majority of comments on this survey offered ideas on working from home and a transition to a four day work week to mitigate carbon emissions.

## III. Results

*What are the total emissions of transportation from faculty and staff and students in their travel to conduct academic and extracurricular activities?*

The total Scope 3 emissions related to commutes and travel based upon the survey results is 1,219.9 tons (Table 3).

### *Faculty and Staff Daily Commutes*

There were 227 responses to the survey for faculty and staff at Gettysburg College. Staff members had the highest response rate of 59.2% percent, while 35% of faculty members chose to participate (Table 1). Regarding primary means of transportation to and from campus, 78% of faculty and staff use a personal vehicle with themselves as the sole passenger (Figure 1). The second most popular mode was walking at nearly 15% percent (Figure 1). Both groups were combined to estimate the number of times per week that employees commuted to campus and the large majority exhibit patterns typical of the universal five-day work week. Using the standard number of .44 kilograms (kg) of carbon emitted per mile by car, it is estimated that Gettysburg College employees emit 69.4 tons of carbon during the academic calendar year for their commutes (Table 3). It is estimated that Gettysburg College employs 1,120 individuals which was also important to this calculation.

### *Faculty and Staff Extracurricular/College-Related Business*

This category refers to any extracurricular activity that is college-related. It was intended to account for conferences, field trips, or athletic events. The total amount of emissions for this category was 254.8 tons of carbon (Table 3). Regarding summary statistics, the minimum

distance traveled in the 2021-2022 academic year was 0 miles, which was also the most frequently occurring, while the maximum was 10,000 miles. Of the 206 respondents to the question, the average is 534.6 additional miles traveled. Calculations were also done using the standard number of .44 kg emitted per mile in an automobile.

*Student Commute To and From Home*

Approximately 13% of students chose to participate in the survey (Table 1). Regarding the distance from home, there are several students who live in Gettysburg, Pennsylvania. There is a student who lives 8,982 miles away, representing the maximum distance (Table 4). The average student travels 449.6 miles to get to campus from their home (Table 4). The median is 180 miles (Table 4). The survey also found that 82% percent of students travel by car, while more than 7% percent use a plane. Of the students who travel by car to get to campus, 54.5% percent of students have registered their vehicle with the Department of Public Safety (DPS) (Table 4). Of the 45.5% of students who responded with "No," 23% of students answered that they do have a vehicle located at their off-campus house that is not registered with the college (Table 4).

*Student Commutes While On Campus*

Students emit approximately 76.7 tons of carbon during the academic calendar year (Table 3). This includes students who primarily travel from their off-campus house to get to campus by vehicle and students who typically use their car to travel between buildings during the day. It also includes the trips that students make while at Gettysburg College according to their responses.

*Study Abroad*

Emissions from study abroad account for 36.1% of emissions, at 441.2 tons (Table 3). For the Fall of 2021, approximately 98.8 tons of carbon were emitted, while it is slightly higher for the Spring 2022 estimate, at 121.8 tons (Table 5).

*How do the findings compare to the previous report completed in 2009 and the STARS report from 2016?*

Faculty members lived an average of 15.08 miles from campus, a decrease of more than four miles from the 2009 estimate (Table 2). Staff members typically live closer to campus than faculty members do, with an average distance of 12.74 miles away (Table 2). This distance is over four miles closer than the 2009 estimate regarding staff members (Table 2). The 2009 study estimated that faculty and staff commute to campus thirty-five weeks of the year, which is the same number used in these calculations (Boameh et al, 2009).

Furthermore, approximately 95% percent of students choose to walk to travel between campus buildings during the day (Figure 2). Significantly less choose to use a personal vehicle, while even fewer choose to use a bicycle (Figure 2). The 2016 STARS report said that 85% percent of students choose to either bike or walk, while the other 15% percent opted for less sustainable transportation options to navigate campus (Gettysburg College STARS Report).

*What mitigation strategies to reduce emissions would be supported by students, faculty, and staff?*

Overall, Gettysburg College faculty and staff were not widely receptive to any mitigation strategy proposed in the survey (Figure 3). “Not at all likely” was the most popular category for

all four options (Figure 3). Of the four mitigation strategies, employees seem most receptive to the idea of GBC providing a stipend for a different transportation option and if there was a system to identify individuals to share rides with (Figure 3). Overall, students were more interested in the three proposed strategies (Figure 4). The categories of "Very likely" and "Extremely likely" combined were competitive with the sums for other categories (Figure 4). Additionally, more students suggested they were "Somewhat likely" to leave their vehicle at home if GBC provided each individual with a stipend for a different transportation option (Figure 4). Regarding attitudes towards Rabbit Transit (an alternative option to the personal vehicle), nearly 30% of students selected a preference for a personal vehicle, while nearly a quarter expressed uncertainty in its usage (Figure 5).

## IV. Discussion

To answer the first research question regarding employee and student transportation habits and total emissions, it is important to address a limitation. For this study, all numbers are estimates and averages of all data entries collected. The demographic data used to perform our calculations are also subject to change as the respondents involved may choose to transfer or withdraw their position at Gettysburg College, whether they are a student, faculty member or staff member. With this in mind, there are also several differences between the current study and the 2009 Gettysburg study which can be explained by a difference in methodology, advances in technology, and choice of Scope 3 emissions to analyze. For example, the categories differed from those presented in this study and formerly included solid waste and carbon offsets as additional categories (Boamah et al, 2009). Meanwhile, this study chose to investigate the student commute as one can easily assume their transportation to and from campus widely

contributes to Scope 3 emissions. Overall, it was found that Gettysburg College emitted 1,219 tons of carbon across the Scope 3 categories chosen (Table 3). To compare, the 2009 Gettysburg College report calculated that in 2007, Scope 3 emissions accounted for 5,813.7 tons, while in 2008, it increased to 6,153.5 tons (Boamah et al, 2009).

Study abroad was one of the largest polluting categories for both studies. It accounted for 441.2 tons of carbon emitted from study abroad programs for the 2021-2022 academic year. There is a drastic difference between this number and that of previous research. To reflect back to the second research question, study abroad accounted for approximately 10.1% of total emissions, at 2,061.1 in 2007 tons and 2,407.2 tons in 2008 (Climate Action Plan). This number is lower than in years past. While not specified, estimates from 2009 could have been based on the carbon emissions of the entire flight. This could explain the disparity between the numbers, as this study utilized Google flights which go by individual flight passengers. Given that study abroad programs are very integral to Gettysburg College's appeal, it is also possible that many more students chose to participate in this program in years past than in the current one where many countries are still mitigating the impacts of the COVID-19 pandemic. This is partially informed by Dickinson College's 2019 GHG Report. They estimated that they typically send 364 and 447 students to study abroad annually, with a grand total of 1,817 tons of carbon emitted in 2019 (Dickinson College, 2019). This is a greater number than the 254 students expected to study abroad this year and as the report says, carbon intensity of commercial air travel increasingly improves each year (Dickinson College, 2019).

This study estimates emissions for outsourced travel for the year at approximately 254.8 tons (Table 3). Directly outsourced travel resulted in a release of 1216.9 metric tons of carbon in 2007, which was 5.4% of total 2007 emissions (Climate Action Plan). It is difficult to compare

outsourced travel, referred to as “extracurricular” or “college-related business” interchangeably, between the two reports. Part of this problem can stem from definitions. For this study, the terms were left ambiguous, with only “college-related business paid for by GBC to attend events such as conferences, athletic competitions, field trips, and other school sponsored trips” being indicators of what the question asked. The 2009 report asks for “the number of miles per year that the college has spent on air travel, rental cars, taxis, trains, buses, and gas” and worked closely with the Transportation Office to calculate these numbers (Boamah et al, 2009). However, the data collected for faculty and staff outside travel, while all calculated in miles, did not account for travel being by car or by plane. Greenhouse gas emissions differ greatly when coming from a car or a plane, so this limitation impacted our data greatly. To continue on with the study, an average estimate of .44 kg of carbon emissions per mile driven in a car was used for all data regarding faculty and staff outside business travel paid for by Gettysburg College. Therefore, the reported numbers from faculty and staff regarding how many miles traveled for this category were assumed to be from car travel for ease, using the standard .44 kg per mile.

As for their own personal transportation to and from work, the results of this study's survey show that 78% percent of faculty and staff members commute in a personal vehicle, less than 1% percent carpool, 5% percent ride a bicycle, and 15% percent walk to work. This is relatively consistent with other colleges. Dickinson College, located forty-five minutes away from Gettysburg College, is a similar-sized, residential, liberal arts college. A Dickinson survey from 2017 reveals that 75% percent of all employees drive in a single-occupant motor vehicle, while 2% percent carpool, 4% percent ride a bicycle, and 19% percent walk (Dickinson College, 2019).

However, there is much room for improvement in prompting faculty and staff to choose more sustainable options. Other universities excel in this area, with one example being the University of Cape Town. A 2011 study combined employee and student commutes (as it is not a residential college) to find that 16% percent walk or bike, 33% percent use a shuttle, 42% percent use a personal vehicle, and the other 9% percent use a motorbike, train, taxi, or bus (Letete et al, 2011). It helps that Cape Town is a major city and likely has accommodations for those seeking carbon-free transportation options that are more difficult to find in a more rural setting such as Gettysburg (Letete et al, 2011). However, the student commute to home accounts for 377.8 tons of carbon emitted (Table 3). Only 4% took options such as the train or bus, while everyone else indicated that they either drive or fly.

Finally, Gettysburg College has localized their staff in recent years or many have chosen to relocate closer to the campus. Recall that the second research question asks for comparisons, and via the two studies, one can see that staff members take about the same amount of trips to campus, however, faculty now make about one less trip than in years past (Table 2). The average number of trips to campus per week and the average distance of these trips has changed between 2009 and 2021. Staff especially now live an average of 12.7 miles away, which is about half the distance from 2009 (Boamah et al, 2009). There are several reasons why staff may live closer now. For example, Gettysburg and the local area could have been subjected to new housing projects or it may have become cheaper to move here. Perhaps long-time staff members have chosen to relocate after years of enduring a longer commute. As for faculty, it is possible that the ongoing COVID-19 pandemic has enabled many opportunities for work, learning, or extracurricular events to be made possible over virtual platforms such as Zoom. Weariness about

the continuing pandemic could make faculty and staff less inclined to be a part of events they would have otherwise participated in.

As for students, most students walk between campus buildings and a large majority of students use a personal vehicle to travel to various locations in and around Gettysburg College. In 2009, the College contracted with Freedom Transit, now Rabbit Transit, to provide a public transportation option that would allow students to shuttle between popular locations such as Walmart and the Outlets Shoppes at Gettysburg (Climate Action Plan). In the fall of 2019, the shuttle transported 1,166 riders, 934 students across the spring and fall semesters in 2020, and 152 riders in the spring of 2021 (Biesecker, 2021). While the stark decline in ridership can be attributed to the ongoing pandemic, the survey has highlighted that there is also room for improvement in terms of promoting the service. Nearly a quarter of respondents suggested that they are unsure how to use the service (Figure 5). The surveys also showed that a number of students say that Rabbit Transit is too expensive, although it is a free service to any student at Gettysburg College. It could be beneficial to educate students, possibly during First Year Orientation, on the shuttle's schedule, where it stops, and at what times. Emphasizing this public transportation option can also be a powerful mitigation tool if done correctly. This would likely not apply to staff and faculty as much as no respondent indicated that they use public transit (Figure 1).

When looking to answer the third research question on mitigation, the majority of the 227 faculty and staff respondents reported that it was not at all likely that they would opt for any of the mitigation strategies given. These mitigation strategies included Gettysburg College creating a bike share program, providing a stipend to use alternative modes of transportation, and increasing or establishing parking fees. A mitigation strategy that was unique to the faculty and

staff survey was Gettysburg College creating a carpool system for faculty and staff. When looking at the data from all four questions, 49% to 71% of all faculty and staff said they would not be at all likely to participate in any mitigation strategy. Data from the student survey shows that the student body of Gettysburg College may feel differently towards the mitigation strategies. Only 22% to 39% felt that they would be not at all likely to choose any of the three mitigation strategies listed.

*Bike Share Program*

If Gettysburg College is able to promote a bike share program, 135 of 345 student respondents are already at least somewhat likely to join the program. Gettysburg Colleges Student Senate has recently begun discussion on bringing a scooter share program to campus, but there are many environmental factors that come into play with scooters. Putting energy towards a bike share program could enhance campus culture while also continuing to lower Gettysburg Colleges campus wide emissions. To aid in the creation of a bikeshare program, the college can utilize GIS tools to map out where these bikeshare locations should be placed. A university in Saudi Arabia was able to utilize GIS software to aid in programs like this (Adenle and Alshuwaikhat, 2017).

Given that Gettysburg College is a residential college with short distances between buildings, it is no surprise that students would be more interested in bike share programs as opposed to a larger campus. For example, a study in 2009 at the University of Maryland showed that only 5% of students chose to use bikes as part of a bike share program for commuting (Sanaz, 2019). However, since then, the University of Maryland has put time and effort into promoting the benefits of bike share programs, and the percentage of students commuting with

bikes rose from 5% to 15% percent by 2019 (Sanaz, 2019). Once bikes are installed on campus, it would be critical to promote their use through campaigns and advertisements.

*Stipend provided by Gettysburg College*

The mitigation strategy to provide a stipend to faculty, staff and students to leave their vehicle at home and opt for a different mode of transportation (walking, biking, public transit, etc) was favored more than the bike share program. While there was still a clear dissatisfaction with the strategy in general, more respondents, especially from the student survey, seemed to be open to the idea. However, this mitigation strategy has some setbacks. While the college makes a profit off of students paying for a parking permit, they would inevitably be losing money if that profit ceased and payment had to be made to those not purchasing a parking permit. There is also the possibility that faculty, staff and students would decide to not purchase a parking permit and take the stipend but still use and park their car elsewhere. There are few ways to ensure this mitigation strategy is followed unless it becomes necessary for all parties to have a parking permit to park in all parking spaces on and around campus.

*Increased or Established Parking Fees by Gettysburg College*

While the student body must already pay to park on campus, all faculty and staff members are able to park on college grounds without any form of payment. The majority of faculty and staff said that they would not reduce their car usage if a parking fee or permit is *imposed* on them, while a good number of students did say they would think again about their car usage if the school *increased* the parking fee. However, the comments on the surveys regarding a potential increase or imposition were large in number. All parties felt that any change in parking

permits both students and faculty and staff members would be inappropriate on the college's end. Faculty and staff stated the need for their cars close by for personal reasons, along with other reasons such as safety, work needs and convenience. Many students stated that they needed their cars for medical reasons, school commitments and sports. All of these reasons deterred these respondents from saying they would reduce their car usage if there was a change to the parking fee structure, so this mitigation strategy is not feasible in the near future for Gettysburg College, along with the added animosity it would add to the atmosphere of the college.

*Carpool System for Faculty and Staff*

Unique to the faculty and staff survey, respondents were asked if they would be interested in participating in a system to identify faculty or staff to carpool with created by Gettysburg College. Around 70% of respondents said they would not at all be likely or not be very likely to participate in a program like this. Carpooling to and from work is one of the best ways to mitigate emissions as it allows individuals the comfort of the personal vehicle structure while also transporting more than just one individual. Some benefits of carpooling include a reduction in vehicle miles traveled, reduced fuel consumption and most importantly, reduced greenhouse gas emissions (Shaheen et al, 2018). All of these factors benefit not only the individual, but they are also factors that can directly aid in lowering the total emissions put out by the college. There are also a multitude of ways the college can incentivize carpooling with other faculty and staff members. Some of these ways include financial support and preferred parking for those who participate (Shaheen et al, 2018). Many faculty and staff reported concerns with carpooling due to the distance they live from campus. In many communities, carpooling is difficult if individuals live alone or far from others (Zhou, 2012). Studies have shown that people that live closer

together in tight knit communities have an easier time communicating about carpooling (Zhou, 2012). If Gettysburg College created a system for faculty and staff to have a platform to communicate about carpooling, the campus would be able to utilize carpooling as a feasible mode of transportation during the work day. In 2007, a carpooling system for Universities was looked into by mobility managers of the State University of Milan and the Polytechnic University of Milan. The program utilized services like suggesting preferred matches to users, specific destination selection and delay information of rides (Lue et al, 2009). The program uses an algorithm to match drivers and riders that are good matches, and this allowed for carpooling at each university to increase (Lue et al, 2009). By seeing how this works at universities elsewhere, Gettysburg College can take this model and use it to create a system that benefits the community of the college.

*Additional Mitigation Strategies*

Additionally, our studies survey opted to include a comments section in order for respondents to voice their opinions on different mitigation strategies. Many respondents from the faculty and staff survey expressed interest in a four day or a hybrid work week, which would decrease the overall number of trips to campus. Four day or hybrid work weeks have been beneficial in a multitude of areas, including reducing environmental impacts from carbon emissions (Knight et al, 2012). By reducing annual and lifetime commutes to work, carbon emissions associated with the college will drastically reduce. The same survey registered a lot of responses regarding increasing public transit stops for faculty and staff that live outside of the Gettysburg area. While this may not be directly feasible as local government dictates a lot of public transit criteria, there is always room for improvement and suggestions when it comes to

serving the people of your community. Many respondents also were interested in seeing an increase in covered bike racks and better conditions of biking paths throughout campus and the Gettysburg area. This is a mitigation idea that could hold traction if brought to the right people.

## V. Conclusion

There are a few main takeaways one can get from this study. First, faculty and staff live closer to campus and come to campus fewer times when comparing today's data to the 2009 study. Gettysburg College faculty and staff have localized, although for reasons unknown. With remote work on the rise, and possible limitations due to the ongoing COVID-19 pandemic, these findings are not surprising. Second, student commuting while on campus is overall very sustainable. With close to 95% of the student body walking on campus everyday, in addition to the population of students that bike, we are looking at a student body that is close to using 100% of sustainable commuting options during the day. Our residential campus plays a large role in this, as students can walk to almost every place on campus in ten minutes or less. By already seeing that the student body prefers sustainable modes of daily commuting, the third major finding is no surprise. Students at Gettysburg College are more open to mitigation strategies than the faculty and staff. There is reason to believe that living on a residential campus plays a major role in the discrepancies between the student survey answers and the faculty and staff survey answers. However, it is still a positive sign to see the student body so interested in utilizing different mitigation strategies.

This study, after all data analysis was complete, was able to form recommendations in order to move forward with lowering Gettysburg College's overall emissions from transportation. The first recommendation stems from the faculty and staff comments given on the

survey. Remote working options and a transition to a four day work week where applicable were very prevalent in these responses. If the college is able to accommodate faculty and staff that can easily and effectively work with a four day or remote work schedule, it can decrease transportation emissions. There was also a large number of survey responses that expressed the troubles they have had with finding housing in and around Gettysburg. If the college was able to form a committee for locating housing for faculty and staff, commutes of these groups would lessen and therefore decrease overall carbon emissions. Finally, another finding from this study was the lack of knowledge pertaining to Rabbit Transit, the public transportation option at Gettysburg College. With further education on this service, possibly at First Year Orientation Programs, students could reduce their emissions when traveling off-campus. Introducing first-year students to Rabbit Transit will allow them to become both familiar and comfortable with the service, hopefully sustaining their interest across their four years' time at the college.

V. Tables, Figures, and Appendices

**Table 1.** A table highlighting the percentage of each population that participated in the survey. Students had the lowest participation rate, while staff had the highest.

| How many miles to get from your hometown to GBC? (mi) | | |
|---|---|---|
| Min, Max | Median | Average |
| 0, 8982 | 180 | 449.6 |
| Do you have a car registered on campus for the fall semester of 2021? | | |
| Yes | No | |
| 54.5% | 45.50% | |
| 157 respondents | 188 respondents | |
| If not, do you have a vehicle that is not registered with the school? | | |
| Yes | No | |
| 22.9% | 77.10% | |
| 47 respondents | 158 respondents | |

**Table 2.** A comparison of faculty and staff commutes between 2009 and 2021 (Boamah et al, 2009). The table suggests that faculty and staff have shorter commutes and make fewer trips to campus in 2021.

| 2021 | Faculty | Staff |
|---|---|---|
| Average Number of Trips to Campus per week | 3.29 | 4.20 |
| Average Distance of Trip to Campus (miles) | 15.08 | 12.74 |

| 2009 | Faculty | Staff |
|---|---|---|
| Average Number of Trips to Campus per week | 4.33 | 4.41 |
| Average Distance of Trip to Campus (miles) | 19.72 | 26.01 |

**Table 3.** A breakdown of Scope 3 emissions for the 2020-2021 academic year by percentage. Nearly all emissions come from the students' commutes to campus and back home four times a calendar year.

| Category | Percent of Total | Amount (tons) |
|---|---|---|
| Faculty and Staff Commute | 5.6% | 69.4 |
| Faculty Outsourced Business | 20.8% | 254.8 |
| Student Commute to Home | 31.0% | 377.8 |
| Student Commute on Campus | 6.2% | 76.7 |
| Fall and Spring Abroad* | 36.1% | 441.2 |
| **Total:** | **100%** | **1,219.9** |

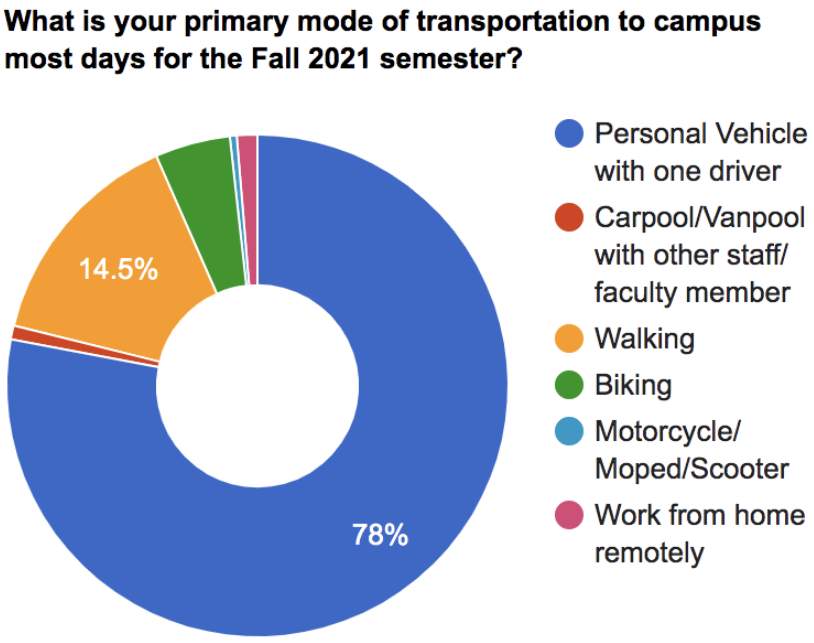


**Figure 1.** A pie chart depicting how faculty and staff members normally commute to campus. An overwhelming majority use a personal vehicle with a single passenger, while the second largest category is those who walk at nearly 15% percent.

**Table 4.** Additional statistics on how far students travel to get to GBC and if they have a car on campus, and whether or not it is registered with the school.

| How many miles to get from your hometown to GBC? (mi) | | |
|---|---|---|
| Min, Max | Median | Average |
| 0, 8982 | 180 | 449.6 |
| Do you have a car registered on campus for the fall semester of 2021? | | |
| Yes | No | |
| 54.5% | 45.50% | |
| 157 respondents | 188 respondents | |
| If not, do you have a vehicle that is not registered with the school? | | |
| Yes | No | |
| 22.9% | 77.10% | |
| 47 respondents | 158 respondents | |

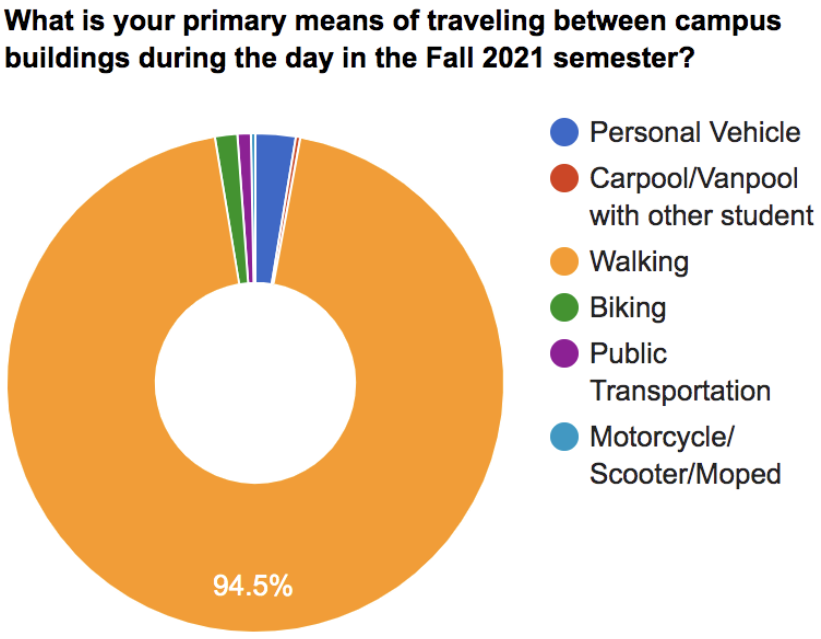


**Figure 2.** Highlights how students travel between classes and activities during the day. Nearly 95% of students walk primarily while others drive or bike.

**Table 5.** A table to show the breakdown of emissions between fall and spring semesters for the 2021-2022 academic year.

| Abroad | | | | |
|---|---|---|---|---|
| Semester | Number of Students | Total distance (miles) | Emissions to (tons) | Amount roundtrip (tons) |
| Fall 2021 | 116 | 113737 | 98.8 | 197.6 |
| Spring 2022 | 138 | 104256 | 121.8 | 243.6 |
| | | | **Total:** | 441.2 |

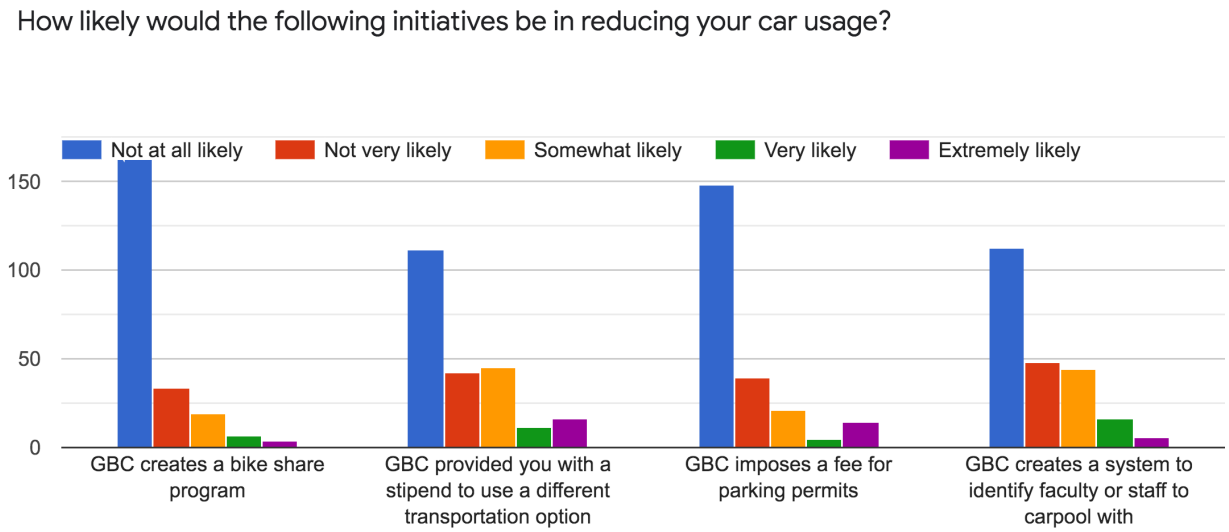


**Figure 3.** Each mitigation strategy proposed in the survey is presented here. Overall, faculty and staff seem much more interested in an opportunity to carpool or receive a stipend for another transportation strategy than using a bike or having to pay a fee.

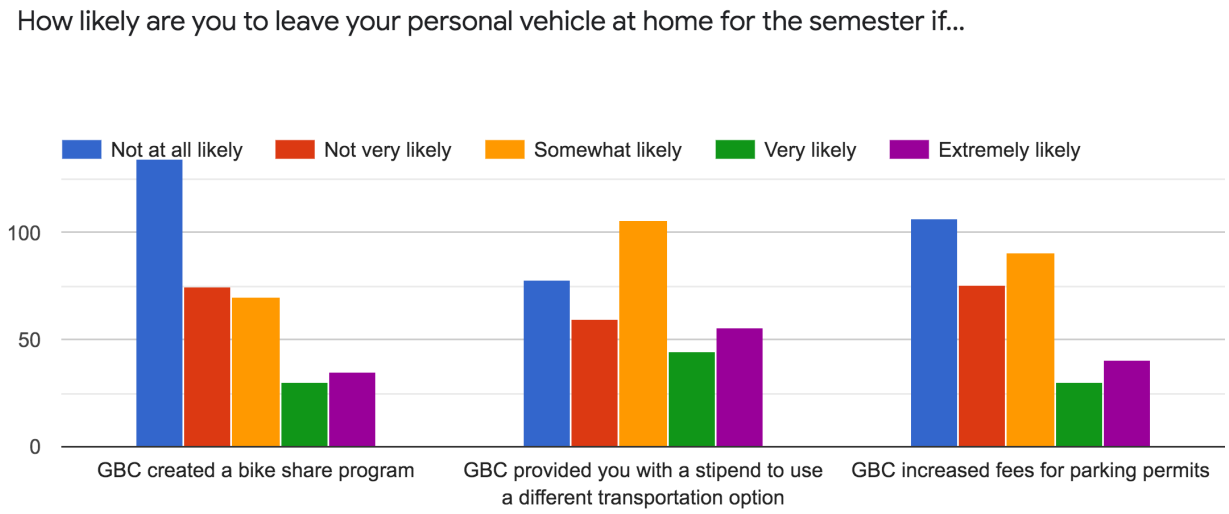


**Figure 4.** The poll sought students' opinions on a bike share program in lieu of bringing their car to campus. The majority of students would not leave their car at home even if Gettysburg College provided a bike.

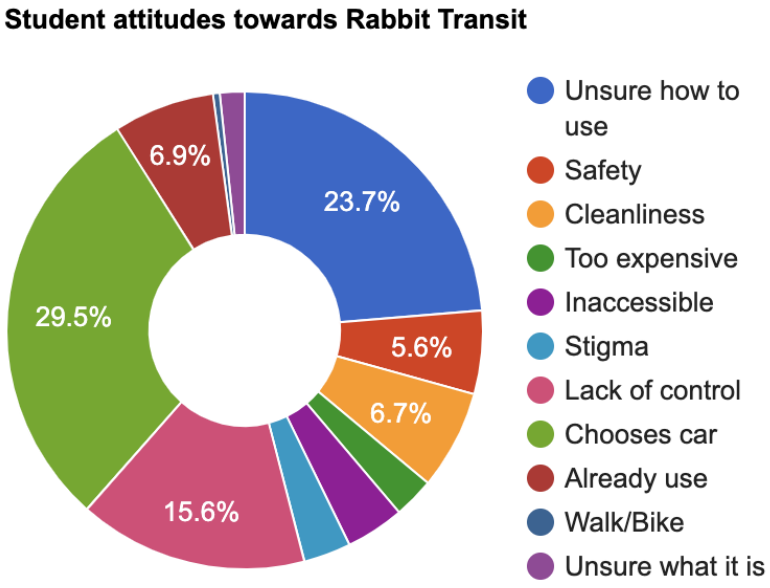


**Figure 5.** The reasons why students choose not to use Rabbit Transit vary. While nearly 30% of students prefer to use a personal vehicle, almost 24% do not know how to use Rabbit Transit which can be an opportunity for improvement in the school's sustainability initiatives.

VI. Expanded Reference List


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VII. Instruments

**Figure 6:** Survey distributed to Gettysburg Colleges Student body. The survey was used to collect all necessary data to answer research questions related to study.

## Greenhouse Gas Inventory of Transportation at Gettysburg College

Dear students: We are students from the Environmental Studies Senior Seminar from Fall 2021. We are creating a Greenhouse Gas Inventory for Gettysburg College to help identify if our emissions have reduced in the years since 2009. We are also interested in collecting data on the commuter impact and analyzing attitudes towards different mitigation strategies for the 2021-2022 academic year. In order to estimate this data, we ask if you could please fill out the brief survey below to assist with this assessment. Completion is voluntary and results are anonymous. You may print or download a copy of this text for your records. Thanks for your assistance!

1. Graduation Year

☐ 2025
☐ 2024
☐ 2023
☐ 2022
☐ Other

2. This year, how do you plan to travel from your hometown to Gettysburg College at the beginning and end of the semester?

☐ Plane
☐ Car
☐ Train
☐ Bus
☐ A combination of these

3. How many miles do you have to travel from your hometown to get to Gettysburg College

_____

4. Do you have a car registered on campus for the fall semester of 2021?

☐ Yes
☐ No

5. If no, do you have a vehicle at your off campus house that is not registered with the school?

☐ Yes
☐ No

6. If you live off campus, approximately how many miles do you live from campus?

_____

7. If you live off campus, what is your primary mode of transportation to and from campus for the Fall 2021 semester?

☐ Personal vehicle
☐ Carpool/vanpool with another student
☐ Walking
☐ Biking
☐ Campus shuttle or public transportation
☐ Motorcycle/scooter/moped

8. What is your primary means of traveling between campus buildings during the day in the Fall 2021 semester?

☐ Personal vehicle
☐ Carpool/vanpool with another student
☐ Walking
☐ Biking
☐ Motorcycle/scooter/moped

9. If you have a car on campus, how many miles do you drive on average per week? (This question refers to driving for destinations that are off campus only)

_____

10. If you do not use Rabbit transit, please indicate ALL of the reasons why not.

☐ Unsure how to use
☐ Safety concerns
☐ Cleanliness concerns
☐ Too expensive
☐ Inaccessible from campus
☐ Stigma
☐ Lack of control (lateness, accidents, traffic, etc)
☐ Preference for personal vehicle
☐ I already use Rabbit Transit
☐ Other

11. How likely are you to leave your personal vehicle at home for the semester if….

GBC created a bike share program:

- ☐ Not at all likely
- ☐ Not very likely
- ☐ Somewhat likely
- ☐ Very likely
- ☐ Extremely likely

GBC provided you with a stipend to use a different transportation option:

- ☐ Not at all likely
- ☐ Not very likely
- ☐ Somewhat likely
- ☐ Very likely
- ☐ Extremely likely

GBC increased fees for parking permits:

- ☐ Not at all likely
- ☐ Not very likely
- ☐ Somewhat likely
- ☐ Very likely
- ☐ Extremely likely

12. Do you have any comments/suggestions related to anything with this study?

_____

**Figure 7:** Survey distributed to Gettysburg Colleges Faculty and Staff members. The survey was used to collect all necessary data to answer research questions related to study.

## Greenhouse Gas Inventory of Transportation at Gettysburg College

Dear faculty, administrators, and staff: We are students from the Environmental Studies Senior Seminar from Fall 2021. We are creating a Greenhouse Gas Inventory for Gettysburg College to help identify if our emissions have reduced in the years since 2009. We are also interested in collecting data on the commuter impact and analyzing attitudes towards different mitigation strategies for the 2021-2022 academic year. In order to estimate this data, we ask if you could please fill out the brief survey below to assist with this assessment. Completion is voluntary and results are anonymous. You may print or download a copy of this text for your records. Thanks for your assistance!

1. Are you a faculty or staff member?

☐ Faculty Member
☐ Staff Member

2. What is your primary mode of transportation to campus most days for the Fall 2021 semester?

☐ Personal vehicle with one driver
☐ Carpool/Vanpool with another faculty/staff member
☐ Walking
☐ Biking
☐ Campus shuttle or public transportation
☐ Motorcycle/Scooter/Moped

3. Approximately how far away do you live from campus (miles)?

_____

4. Approximately how many times per week do you drive roundtrip to and from campus in the Fall 2021 semester?

☐ 0
☐ 1
☐ 2
☐ 3
☐ 4
☐ 5
☐ 6
☐ More than 6

5. Please estimate how far you travel off campus (in miles) for college related business, paid for by GBC, in a regular academic year. (Conferences, sports games/meets, field trips, school sponsored trips)

_____

6. If you do not use Rabbit/public transit, please indicate ALL of the reasons why not.

- ☐ Unsure how to use
- ☐ Safety concerns
- ☐ Cleanliness concerns
- ☐ Too expensive
- ☐ Inaccessible where I live
- ☐ Stigma
- ☐ Lack of control (lateness, accidents, traffic, etc)
- ☐ Preference for personal vehicle
- ☐ I already use Rabbit Transit
- ☐ Other

7. How likely would the following initiatives be in reducing your car usage?

GBC created a bike share program:

- ☐ Not at all likely
- ☐ Not very likely
- ☐ Somewhat likely
- ☐ Very likely
- ☐ Extremely likely

GBC provided you with a stipend to use a different transportation option:

- ☐ Not at all likely
- ☐ Not very likely
- ☐ Somewhat likely
- ☐ Very likely
- ☐ Extremely likely

GBC increased fees for parking permits:

- ☐ Not at all likely
- ☐ Not very likely
- ☐ Somewhat likely
- ☐ Very likely
- ☐ Extremely likely

GBC creates a system to identify faculty or staff to carpool with:

- ☐ Not at all likely
- ☐ Not very likely
- ☐ Somewhat likely
- ☐ Very likely
- ☐ Extremely likely

8. Do you have any comments/suggestions related to anything with this study?
   _____