The Terrapin Transporters' Analysis of University Park's Public Transportation System

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Executive Summary

The Town of University Park, located between the Prince George's Plaza station and the College Park station on Washington D.C. Metro's Green Line, has requested that their current town public transportation systems be analyzed. They have assigned the Terrapin Transporters, our team of six University of Maryland (UMD) students, with the task of evaluating these systems, their efficiency and effectiveness. We are working on this project for our senior capstone project.

University Park (UP) is a town with ready access to public transportation, with a town shuttle and connections to Washington Metropolitan Area Transit Authority (WMATA), TheBus of Prince George's (PG) County (Route1Ride), and Shuttle-UM of UMD. Although this town has ample transit access, the UP government is always aiming to improve the standard of living for their residents, increase ridership on the provided transit services, and in this way provide the best bus services possible. In designing an optimal public transit system, sustainability is a primary focus for both PG County and the town of UP. PG County developed a Sustainable Energy Program, and among its goals is to reduce county-wide greenhouse gas (GHG) emissions by 80% below 2008 levels by 2050. UP has their own Sustainability Action Plan, and with regards to public transportation, it has a paramount goal of reducing operating costs while also lowering its environmental footprint. The Terrapin Transporters have made it their mission to help UP's residents take advantage of the community's many public transit networks, and to suggest alternative or improvements that may increase said network's efficiency and accessibility. The project goal is to evaluate the current public transportation system and determine which aspects could be improved in order to increase ridership among residents. Moreover, we will research the possible development and integration of more sustainable system alternatives. This project has three main objectives: design and implement a ridership survey, analyze UP's transportation using GIS technology and cost benefit analysis, and the explore the transit connection between UP and UMD.

The following report is our synthesis of these three objectives.

Introduction

The Town of University Park, located between the Prince George's Plaza station and the College Park station on Washington D.C. Metro's Green Line, has requested that their current town public transportation systems be analyzed. They have assigned the Terrapin Transporters, our team of six University of Maryland (UMD) students, with the task of evaluating these systems, their efficiency and effectiveness. We are working on this project for our senior capstone project.

University Park (UP) is a town with ready access to public transportation, with a town shuttle and connections to Washington Metropolitan Area Transit Authority (WMATA), TheBus of Prince George's (PG) County (Route1Ride), and Shuttle-UM of UMD. Although this town has ample transit access, the UP government is always aiming to improve the standard of living for their residents, increase ridership on the provided transit services, and in this way provide the best bus services possible. In designing an optimal public transit system, sustainability is a primary focus for both PG County and the town of UP. PG County developed a Sustainable Energy Program, and among its goals is to reduce county-wide greenhouse gas (GHG) emissions by 80% below 2008 levels by 2050. UP has their own Sustainability Action Plan, and with regards to public transportation, it has a paramount goal of reducing operating costs while also lowering its environmental footprint.

Current Public Transit System in University Park

There are three public buses that operate along the perimeter of UP, which are MetroBus, TheBus, and Shuttle-UM. All three have routes that connect the town to the MetroRail on the Green Line. The Town Bus service that connects UP and Prince George's Plaza Metro stop in Hyattsville provides UP residents with free weekday transportation to the Metro Green Line. The

route also provides residents with access to The Mall at Prince Georges for their shopping needs, which is 0.3 miles away from PG Plaza. Also in the vicinity is the University Town Center, which includes the National Center for Health Statistics Headquarters and other federal offices, and is 0.4 miles away from PG Plaza. Additionally, there are two UMD mBike bike share stations within UP available for use to residents at no cost.

After completion of construction of the Purple Line in 2020, this 16-mile light rail line will connect the Maryland suburbs of Bethesda, Silver Spring, Takoma/Langley Park, College Park, and New Carrolton. Much of UP is within a reasonable walk or very short bike ride to the M Square station, the Riverdale station, and the College Park station. Its introduction will be a dramatic enhancement of public transportation options in this part of the metro area. An emerging concern for the UP government is if and how the residents plan on using the Purple Line, and what it might mean for other parts of the local transportation infrastructure, for example if there need to be additional sidewalks built to facilitate UP residents walking to a Purple Line station.

Public Transit in America

Outside of the United States, a rural Canadian municipality has employed Uber to handle its public transportation needs. By paying a yearly flat fee, the town of Innisfil has found that subsidizing a private entity is actually less costly than developing a public transportation system themselves. The service is utilized by 77% of the town's population, contributing to over 25,000 rides between May 2017 and January 2018 (Lindeman, 2018). Critics question the risks associated with the arrangement. The rideshare-as-public-transportation enterprise remains largely unproven, even at small scales. Moreover, Uber has monetary motivations, leading some residents to believe that the company will raise subsidy fees once Innisfil becomes dependent upon the service.

In comparison to Innisfil, UP is a much smaller municipality. According to recent surveys, UP has a population of 2,654 people dispersed over 0.50 square miles, whereas Innisfil has a population of roughly 36,000 people across an area of 101 square miles. This sheer lack of size damages the case for a privatized public rideshare system, because most citizens of UP use public transportation to travel to locations outside of the community. In a long-term scenario, the use of a privatized rideshare entity may also lead to greater carbon emissions and increased local traffic in comparison to current public transportation.

Environmental Impact of Transportation

Transportation has a major impact on the environment. Some of the negative environmental impacts associated with transportation include greenhouse gas emissions, environmental damage, traffic congestion, road damage, and accidents. Public transportation, however, can provide environmental benefits such as emissions reductions. These environmental costs and benefits are often difficult to quantify in monetary terms and their dollar values are not universally-agreed upon.

This report will focus on carbon dioxide emissions alone. A cost-benefit analysis for the UP town shuttle bus and Shuttle-UM bus was conducted in order to evaluate their environmental impacts and present the town with recommendations in improving public transit for the town.

Goals and Objectives

Objective 1: Ridership Survey

A ridership survey was essential to this project for both the analysis of the current UP public transit system and for developing informed and sound suggestions that aim to help improve the system's efficiency. By engaging directly with the population of UP, we were able to gather information on the opinions, satisfaction, and ridership of the transit system. The UP resident's personal assessments and ridership of UP public transit directed our project proposals for improvement.

Findings from this survey helped our team decide whether a proposed ArcGIS map of alternate routes in Objective two was necessary. For instance, the residential responses about the Town Bus' accessibility told us what changes may be made to bus routes or schedules to make the bus more convenient to use. Survey findings were also used when gauging the public's awareness of and desire for additions or alterations to the UP and UMD connections in Objective three. We were also able to quantify the need of the UP and UMD connecting route via respondent commuting frequency to UMD, and learned what the most common commuting methods are for UMD commuters. Lastly, the cost-benefit analysis relied heavily on the information gathered from the survey to evaluate the efficiency of the Town Bus routes and schedules in accordance with its ridership.

Objective 2: GIS and Cost-Benefit Analysis

The second objective was to evaluate UP transportation using a combination of GIS applications and cost-benefit analysis. Within this objective, the first goal was to assess the

accessibility of the WMATA metro, WMATA bus, and Town Shuttle Bus stops to UP residents. The

second goal was to quantitatively determine whether or not the Town Bus is environmentally

efficient. Our client was specifically interested to see the direct and indirect costs of the Town Bus,

and if an alternative route would be more cost-effective. Through these analyses, our group

became more informed about the efficiency of the current Town Bus route, and the accessibility of

WMATA metro, WMATA bus, and Town Bus stops. Our final recommendation relied on the cost-

benefit ratio of the shuttle, and accessibility data gathered in this objective.

Objective 3: Connections Between UMD and University Park

The third objective was to investigate the existing transportation connections between

UMD and UP. This consisted of exploring the UMD bus routes that connect with UP, their locations,

frequency, and ridership. A cost-benefit analysis was also conducted to address the environmental

impacts of the two Shuttle-UM routes that connect UP and UMD. Our client emphasized the

importance of this objective because he believes there are many UP residents that either work or

study at the university. By conducting research for this objective, our group better grasped the

adequacy of UMD's connection to UP, in order to recommend improvements.

Methodology and Research Approach

Objective 1: Ridership Survey

In order to assess the knowledge and interest of UP's residents in the public transportation system, we designed and implemented an online survey for distribution to the town residents. We used the online platform of Google Forms, and asked questions about residential demographics, awareness and opinion of UP public transit options, ridership frequency, commuting patterns, the Purple Line, and the desire for additions or alterations to UP-UMD connecting routes. The majority of the questions were multiple choice quantitative questions, with a few qualitative open-ended questions.

Our client Joe Schultz, a Ward 2 Councilmember, and the UP Mayor, Lenford Carey, distributed the survey via the town listserv (a Google group list) and the Mayor's resident email list. Quantitative and qualitative analysis were conducted in Microsoft Excel.

Objective 2: GIS and Cost Benefit Analysis of UP

GIS Analysis

UP census boundary data were downloaded from the United States Census Bureau ("Census Profile: University Park, MD"). Prince George's County road data was downloaded from the Prince George's County planning department ("GIS Open Data"). Washington Metropolitan Area Transit Authority (WMATA) bus lines, bus stops, metro lines, and metro stops were downloaded from the open source data available on dc.gov ("Metro Bus Stops"and "Maryland Transit - WMATA Metro Station Entrances"). The boundary of UP was put into ArcGIS Pro 2.0, and then one of the data layers that needed to be focused was overlaid. Using the select tool, one can select the features

from the data layer in question, either the bus stops, metro stops, or PG County roads, that are found within the boundary layer of UP. Once the data within UP is selected, you can export this selected data into a new layer, producing a new data layer containing only the data within UP.

This method worked for the roads of PG County, but not for the Washington D.C. bus and metro stops due to their geographic locations. Officially, the WMATA stops fell outside the boundary of UP, but were just across the streets that discern the boundary: Baltimore Avenue, Adelphi Road, and the East-West Highway. For these layers, the process began the same way, but when you select the data that you want to export from the WMATA bus stops, you have to choose stops within a certain distance of the UP boundary. This issue arises because technically, there are no bus stops within the municipal limits themselves. In our selection, we selected WMATA bus stops within 0.2 kilometers of the city boundary. After exporting and creating this data layer, we repeated the same initial steps for the metro stops layer. When selecting the Metro stops, we knew the only two relevant metro stops were Prince George's Plaza and College Park-UMD. Knowing this, we were able to select these two Metro stops by name, export and create the data layer.

Once all the layers were organized to only show the areas around UP, we wanted to see how the WMATA system served UP. To do this, using the buffer tool, a 0.5 kilometer buffer radius was created around each of the WMATA bus stops. According to transit planning consultant, Jarrett Walker, people are usually willing to walk 400-500 meters to get to public transit (Walker).

The next step was to add the desired layers, in our case the focused roads, Metro stops, bus stops, and bus stop buffer, along with other important aspects of a map including a scale bar and north arrow to a map document in ArcGIS Pro 2.0. This created a visualization of some of the transportation options available for use by UP residents.

In order to evaluate the coverage of the UP shuttle route, similar methodology was used as the methodology above. These new maps used the UP roads layer as well as the UP shuttle route and stops provided by Councilmember Ms. Martha Wells. The shuttle route and stops were overlaid onto the UP roads layer that we previously made. Once this was completed, the same buffer as was added in the previous map: 0.5 kilometers. The entirety of UP was covered by this 0.5 kilometer buffer so another map was created using a 0.2 kilometer buffer to see where coverage may lack.

Cost-Benefit Analysis of University Park Shuttle

While listing the direct costs of an activity (e.g., operating a town shuttle) is relatively straightforward, quantifying the indirect costs and benefits associated with an activity (e.g., carbon emissions from driving) presents many challenges. Assumptions must be made in a cost-benefit analysis, as not every possible cost or benefit can be quantified easily. For this analysis, we looked at emissions savings, while excluding capital expenses and cost of congestion. Vehicle cost savings and operational expenses were also calculated. Given our project's parameters, we felt that these types of costs and benefits were appropriate and fair in evaluating UP's transportation system. See Recommendations for further discussion on results and decision-making.

Calculating Operating and Carbon Cost of University Park Shuttle

The social cost of carbon (SCC) is defined as the economic cost associated with the marginal impacts of climate change that result from an additional ton of carbon dioxide (tCO_2) emitted into the atmosphere (US EPA 2019). The figure can also represent the value of damages avoided due to a reduction in carbon emissions. There is no agreement in the literature on the correct quantification of SCC. In this analysis, we used the social cost of carbon estimated by the EPA. The

EPA's latest figure equates the average SSC to $42 per tCO_2 with a 3% discount rate (US EPA 2019)
(Table 1).

Table 1 Social Cost of Carbon at various discount rates (US EPA 2019)

Social Cost of CO_2, 2015-2050 [a] (in 2007 dollars per metric ton CO_2)
Source: Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory
Impact Analysis Under Executive Order 12866 (May 2013, Revised August 2016)

Year	Discount Rate and Statistic			
	5% Average	3% Average	2.5% Average	High Impact (95th pct at 3%)
2015	$11	**$36**	$56	$105
2020	$12	**$42**	$62	$123

In order to calculate the annual cost of the University Park town shuttle, we first added up
the sum of operation expenses. Next, we calculated the cost of emissions by finding the fuel
economy of the vehicle model. The total amount of gasoline was calculated using the route's
distance and fuel economy. Using the U.S. EPA 's (2019) listed amount of carbon dioxide (CO_2)
emitted per gallon of gasoline (19.64 lbs), we found the total pounds of CO_2 emitted annually
before converting to metric tons. This was then multiplied by the social cost of carbon according to
the EPA. This annual cost of the shuttle's emissions was then added to the operational cost of the
shuttle, resulting in a complete cost of one year of running the shuttle bus.

According to the Town Clerk of UP, Andrea D. Marcavitch, the primary bus model for the
Town Shuttle Buses is a 2015 Chevrolet, 4500 Express (CG33803) (A. Marcavitch, personal
communication, March 6, 2019). The fuel economy is 14.0 mpg. Once again, using 19.64 lbs of
carbon emitted (US EPA 2019), we found the total pounds of CO_2 emitted annually before
converting to metric tons. According to the town ridership data from 2019, we calculated the

average daily and annual mileage of the town bus drivers. Then, we computed the annual CO_2

emissions of the bus in metric tons. To obtain the total annual carbon cost of the bus, we multiplied

the emissions by the social cost of carbon, $42, at a 3% discount rate. To obtain a range, we also

computed the value using $12 and $62, the social cost of carbon with a 5% and 2.5% discount rate

respectively.

Calculating Vehicle Cost Savings

To calculate the vehicle cost savings, we used a figure of 20 cents per mile (Litman 2015).

This figure incorporates car ownership costs. We simulated a town citizen driving the same distance

as the town shuttle daily. The daily distance is 11 miles per day since the shuttle route is

approximately 5.5 miles one way (i.e., a morning and evening commute). This daily distance was

used to calculate the annual driving distance, assuming a five day workweek and no holidays. This

was then multiplied by the vehicle cost savings figure of 20 cents per mile.

Weighing Costs Versus Benefits

We calculated the cost of emissions per vehicle, using the same method we used for the

Town shuttle. We assumed that the average vehicle has a fuel economy of 24.9 miles/gallon (US

EPA 2019), and obtained the yearly carbon cost per car using EPA's social cost of carbon.

To evaluate whether the environmental benefits of the shuttle outweigh its costs, we

created a ratio of the shuttle emissions cost divided by the emissions cost of an average vehicle.

This gives the number of town citizens needed to ride the shuttle daily to make the emissions cost

of the shuttle less than if the citizens drove.

Objective 3: Connection Between UMD and University Park

Our third objective initially was to "Investigate and propose possible transportation connections between UP and the UMD campus." This objective was formed under the assumption that UMD lacked a public transit route through UP. However, upon more research we found that there were two connecting bus routes to the town provided by the university. These are the Shuttle-UM Routes 113: Hyattsville and 126: New Carrollton. We then modified our objective to: "better understand these connections and assess their adequacy on a critical level."

The methodology used for this objective has been to search for information on the UMD DOTS website to find bus routes, times and headways (the time it takes for the bus to drive the entire route) (UMD DOTS). After finding this information we contacted Cara Fleck, Assistant Director for Marketing & Communications for DOTS, to find information on bus models and ridership on routes 113: Hyattsville and 126: New Carrollton. We then used this information along with the opinions of the UP residents collected through our survey to determine whether the Shuttle-UM bus routes satisfy the needs of this community.

Methodology of Cost-Benefit Analysis of Shuttle-UM

Calculating Carbon Cost of Buses

We calculated the carbon dioxide emissions using the same methodology as the cost-benefit analysis for the UP Town Shuttle (see Objective 2 Cost-Benefit Analysis Methodology above) for each of the two Shuttle-UM routes that service the perimeter of UP using the average fuel economy for Shuttle-UM buses: 4.05 mpg (C. Fleck, personal communication, March 7, 2019). The

mileage of each Shuttle-UM route was calculated from the central UP stop to Stamp Student Union, an approximate center of the UMD campus. These route distances were multiplied by the number of times the route is run daily to get a daily total distance; this figure was subsequently converted to an annual total, assuming five day a week operation and no holidays. From here, the distance was multiplied by the fuel economy and then the annual carbon emissions were found and converted to an annual carbon cost of each bus route.

Calculating Vehicle Cost Savings and Vehicle Emissions Cost

Using a figure of 20 cents per mile (Litman 2015), the annual vehicle cost savings were calculated by simulating the Shuttle-UM routes as if a citizen drove a vehicle instead of riding the shuttle. We also calculated the annual emissions cost of driving this simulated route.

Weighing Costs and Benefits

To quantify the environmental impact, we created a ratio of the and shuttle emissions cost divided by the annual vehicle emissions cost. The ratio yields the number of citizens needed to make the shuttle environmentally beneficial.

Findings

Objective 1: Survey

General Questions

Our online survey circulated for three weeks and received 158 responses. This is roughly 13.7% of the 2,169 residents ("Census Profile: University Park, MD"). The age of the respondents varied relatively equitably across the delineated ranges between 21 - 65+ years, with the largest representation of 31% falling between 41 - 55 years, the second largest of 29.1% falling between 65 years and above, and the smallest representation of only 0.6% falling between 21 - 24 years. Ninety-eight percent of the respondents own a personal vehicle, and only 2.5% of them answered that they experience difficulty traveling for errands or personal business, indicating that the vast majority of our sample is not reliant on public transportation and use their personal vehicles for commuting needs. Of the respondents, 37.8% commute 5-7 days a week, 36.5% commute 3-5 days a week, and 20.5% do not commute to work or school.

Forty-three percent of our sample commute to D.C. most frequently. The second most frequent commuting destination is UMD (17.9%). The rest of the respondents (39.2%) used the fill-in-the-blank "other" option to write in their commute destination. Answers were further consolidated for simplicity and ease of analysis, including grouping municipalities like Suitland and Greenbelt into a "Within PG County" group (Figure 2).

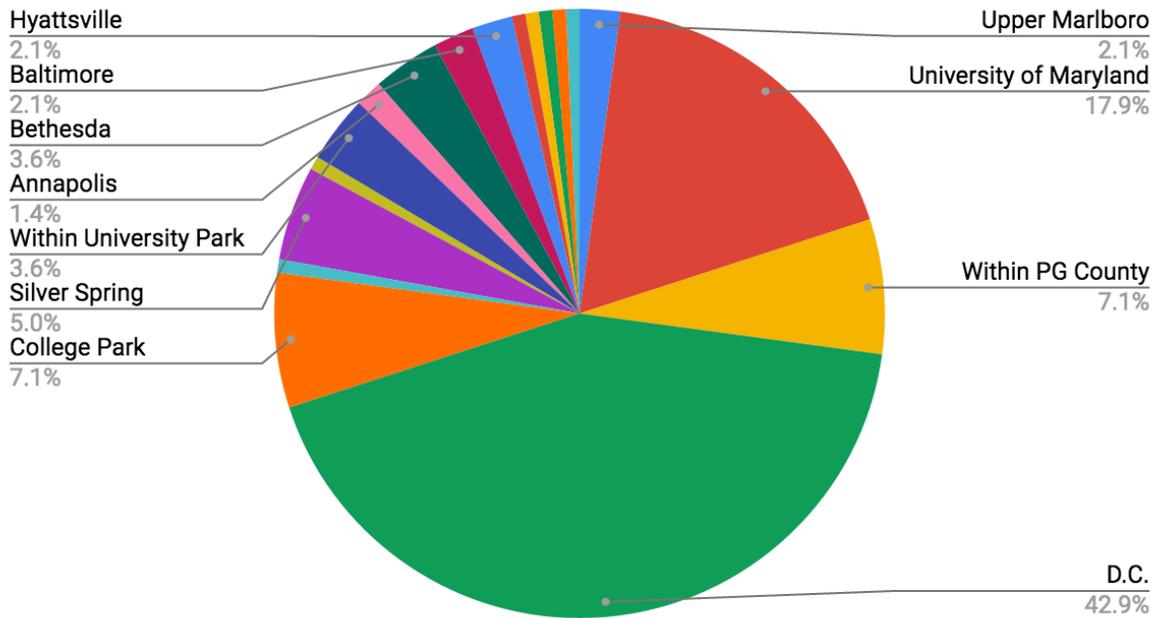## 5. Where do you commute to most frequently?

Location	Percentage
Hyattsville	2.1%
Baltimore	2.1%
Bethesda	3.6%
Annapolis	1.4%
Within University Park	3.6%
Silver Spring	5.0%
College Park	7.1%
Upper Marlboro	2.1%
University of Maryland	17.9%
Within PG County	7.1%
D.C.	42.9%

Figure 1 "Where do you commute to most frequently?"

Ridership Questions

This section assesses the residents' ridership of the UP Town Bus, Bikeshare, the Metro Bus, and TheBus. The largest percentage (31.6%) of residents stated that they use the Town Bus occasionally for their work commute, and the next largest percentage (31%) answered that they never use the Town Bus for their work commute (Figure 3). While this finding is significant, we must remember that the 31% that never use the Town Bus for their work commute may not do so simply because their work location is not near Prince George's Plaza, or because the Town Bus does not connect to the Metro Green Line. These responses also include the 20.5% of respondents that reported that they do not commute for work or school. This lack of ridership does not indicate a major inadequacy in the Town Bus, but simply that it is not useful for some, and for others it just does not satisfy their personal work commute needs.

7. Do you ever use the town bus to Prince George's Plaza Metro station for your work commute?

158 responses
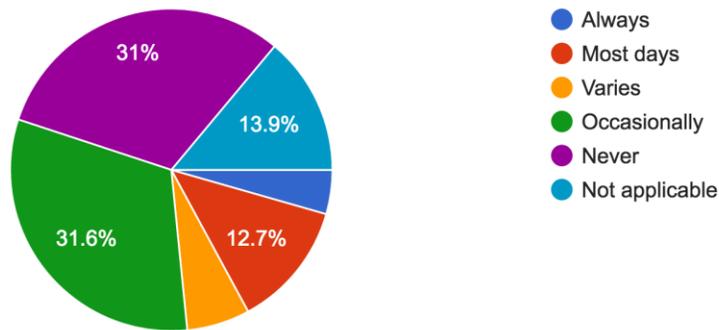
Figure 2 "Do you ever use the town bus to PG Plaza Metro station for your work commute?"

Among the different transit options in UP ridership was highest for the Town Bus, and largely infrequent for the Bikeshare, the MetroBus, and TheBus. However, it's important to note that ridership was low across all options. Most respondents answered that they rode the Town Bus only a few times a year, while the most popular answer for the ridership of Bikeshare, MetroBus, and TheBus was never (Figure 4).

8. How often do you use any of these public transportation options readily available to University Park residents?
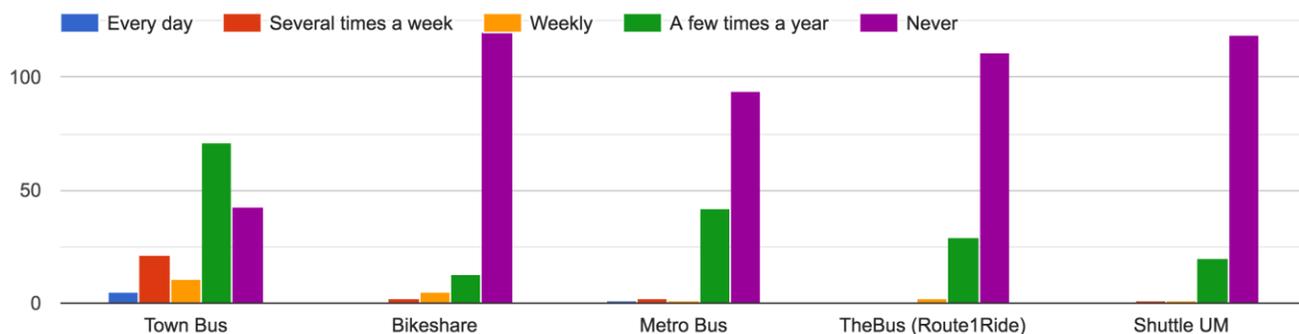
Figure 3 "How often do you use these public transit options?"

Lack of knowledge of the Town Bus does not seem to be the main reason for low ridership. To gauge residents' awareness of their proximity to the Town Bus, the survey asked participants if they are aware of the location of the Town Bus stops within UP. Seventy-three percent of the respondents answered that they are aware of the stop's locations, 21.5% answered that they're somewhat aware, and only 5.7% answered that they are not at all aware (Figure 5). This is important when determining what areas of UP public transit are in need of improvement, because if the survey indicated that residents were predominately uninformed on the locations of the Town Bus stops, increased outreach efforts to spread awareness of the Town Bus accessibility and services would recommended.

9. Are you aware of where the Town Bus stops are located in your community?

158 responses
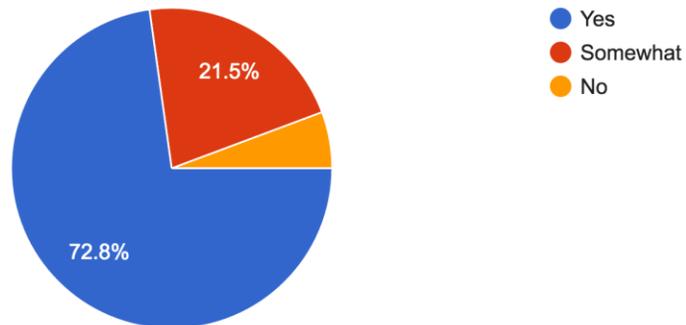
Figure 4 "Are you aware of where the Town Bus stops are located in your community?"

UP/UMD Connection Questions

The third section of the ridership survey gathered information on awareness of the two existing Shuttle-UM routes connecting UP and UMD, and also on participants' need for the connecting routes for commuting purposes. Most of the respondents (79.6%) do not commute to UMD campus for classes or for work. Hence, approximately 20% of the resident sample could benefit from a UP-UMD public transit route connection (Figure 6).

10. Do you commute to the UMD campus for classes or work? (If yes, please answer question 11)

157 responses
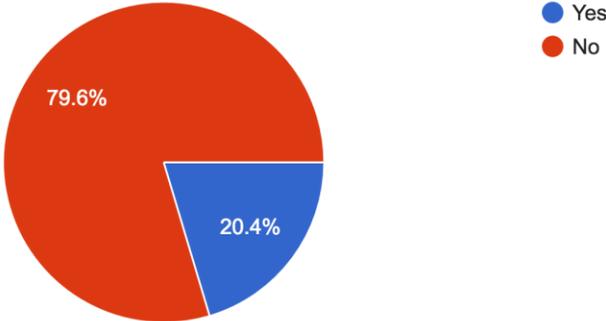
Figure 5 "Are you aware of where the Town Bus stops are located in your community?"

Among those respondents that do commute to campus, we then asked about their most common method of travel. Most popular was by car, next was by foot, third was by bike, and the least popular method to commute to UMD campus was by bus (Figure 7). This low bus ridership may indicate that either there are gaps within the two existing UP-UMD bus services making them inconvenient or inaccessible, or that residents are not sufficiently aware enough about the existing UP-UMD routes.

11. How do you commute to campus?
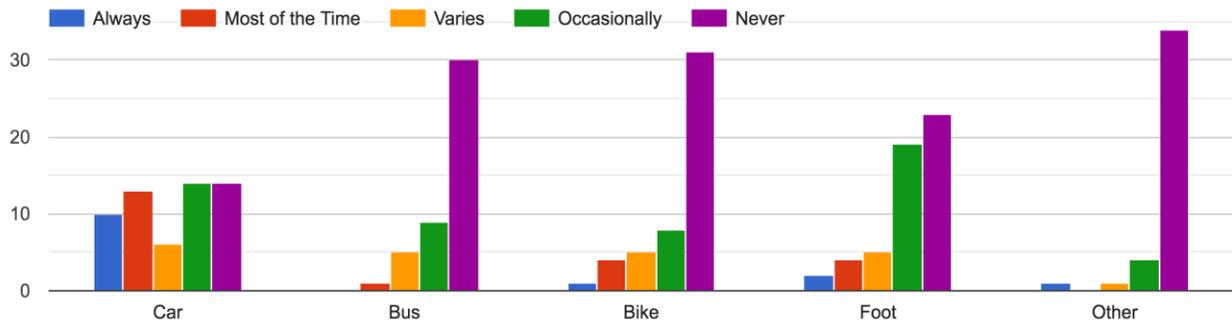
Figure 6 "How do you commute to campus?"

To address whether lack of information is the reason for the low UP-UMD bus route ridership, the survey asked if the respondents were aware that there are two existing routes connecting UP and UMD campus. A majority (76%) answered that they were not aware of the routes. This finding is incredibly significant to the recommendations for improvement in Objective three. Shuttle-UM ridership on UP connecting routes could increase if the town simply reached out to UP residents via a pamphlet or an email and letting them know about this service (Figure 8). Respondents were also asked how accessible they find Shuttle-UM, and the majority (66.3%) said they are unsure. This is indicative of a clear lack of knowledge of the Shuttle-UM services offered to them, and also supports the notion for public outreach efforts to increase public transit service awareness.

12. Are you aware that ShuttleUM offers two connecting routes between UP and UMD campus?

154 responses
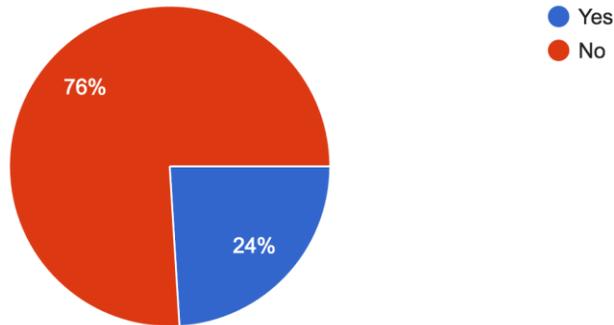
Figure 7 "Are you aware that Shuttle-UM offers two connecting routes between UP & UMD?"

To better understand residents' motives, in the survey we asked why those UMD commuters that travel by car do so rather than by public transit or walking/biking. The majority (65.2%) of the sample said it was because of convenience. This is a relatively broad answer with lots of possible implications. Our general take from this answer was that with all things considered, convenience and ease of use is the paramount factor in determining whether a person uses public transit services. The next most popular answer (16.7%) said the reason was because they need continued access to a personal vehicle during the day. To make the data readable, some responses from those that used the "other" option were consolidated into more general groups (Figure 9).

13. If you drive to campus, instead of using public transport or walking/biking, why?
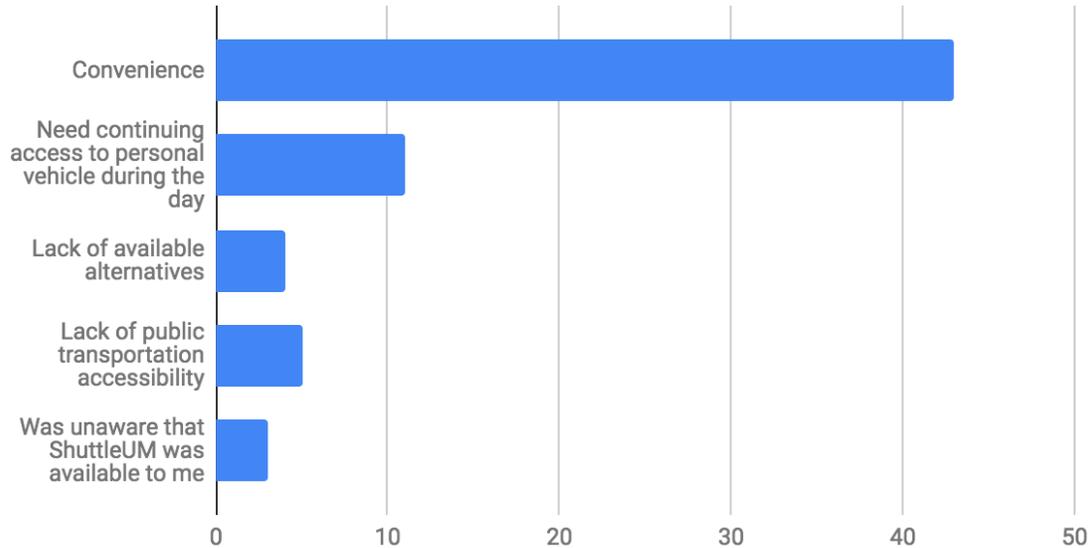
Figure 8 "If you drive to campus instead of using public transport or walking/biking, why?"

Purple Line Questions

Understanding how UP residents foresee using the Purple Line is an important step in making it most efficient and accessible to the community. When asked if they anticipate using the Purple Line Light Rail, 50.3% of respondents answered yes, 40.8% answered maybe, and only 8.9% answered no (Figure 10). This indicates that the Purple Line will be used substantially by UP residents, and that it should be a major point of consideration for the UP government after its construction.

15. Do you anticipate using the Purple Line? (If yes, please answer question 16)

157 responses
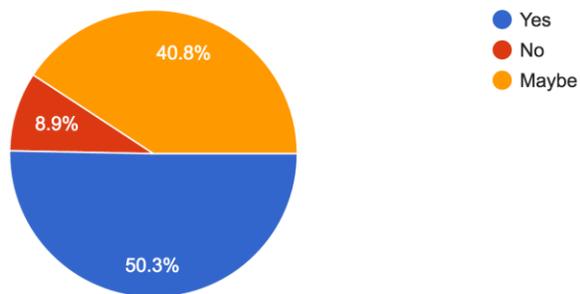
Figure 9 "Do you anticipate using the Purple Line?"

Respondents were then asked which of the listed proposed Purple Line stations near UP they intend to use. Seventy-four percent answered the College Park station, 55.7% answered the Riverdale station, 22.1% answered the M Square station, and 3.8% answered the Takoma/Langley Park station (Figure 11). It is advisable for the UP government to ensure that there are walking/biking routes between UP and the three highest use Purple Line stations. Construction of sidewalks and landscaping efforts will help to make these travel routes accessible.

16. If so, which of the following proposed Purple Line stations near University Park will you use?

131 responses
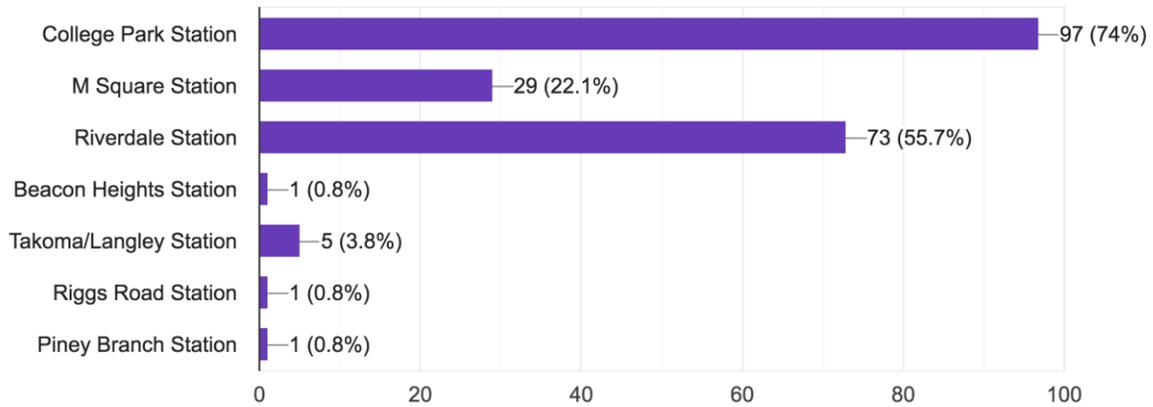
Figure 10 "Which of the following Purple Line stations will you use?"

Opinion Questions

In this section of the survey, we asked respondents about their opinion on UP public transit in order to tailor our suggestions and proposals for improvements to the specific desires of the residents. First, respondents were asked if they would like to see the town pay to install amenities at the Town Bus stops. Forty-five percent said that they did not wish to see any new amenities installed. Some respondents also wrote that they did not feel that adding amenities to bus stops were an unnecessary use of taxpayer money. The second most common answer (21%) said they would like to see signs installed (Figure 12). This would be a relatively inexpensive and achievable addition that would make the locations of Town Bus stops more apparent to residents. Signs that include pickup times would be even more informative.

17. Would you like to see the town pay to install any of the following amenities at town shuttle bus stops?
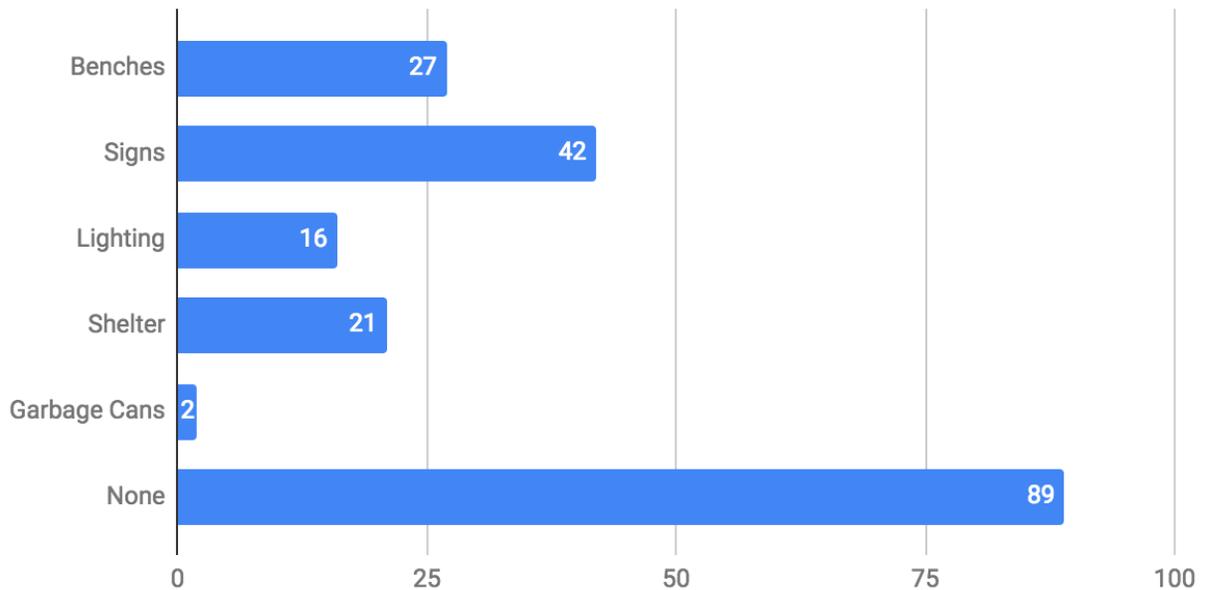

Figure 11 "Would you like the town to install any of the following amenities at town shuttle bus stops?"

When asked which changes would cause the respondent to use the Town Bus for commuting more often, 46.2%, answered nothing, 24.8% answered more frequent service, and 17.2% answered a connection to College Park Metro Station. Five respondents indicated that a phone application that tracked the shuttle would be useful. Giving residents the ability to track the location and updated times of departures and arrivals of the Town Bus shuttle via their mobile devices would make it drastically easier for residents to plan their commuting schedule (Figure 13).

18. Which of the following changes, if any, might cause you to use the town shuttle bus for commuting more often?
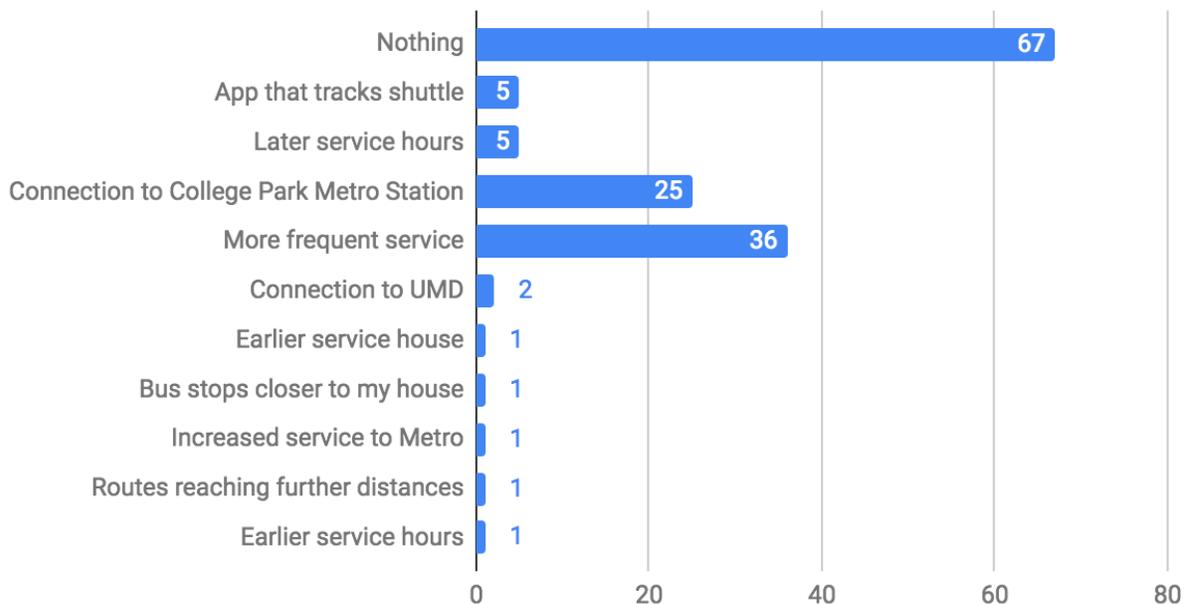

Figure 12 "Which changes might cause you to use the town shuttle bus more often?"

The last question of the survey was an open-ended one. It asks if there is anything the town can do to increase the respondents' use of public transit. Some notable responses include increased hours for the Town Bus particularly for early morning and evening trips, making Shuttle-UM rideable to all UP residents even without a school-issued ID, a better, more direct bike path to UMD, more frequent Town Bus trips from PG Plaza Metro to UP, among others.

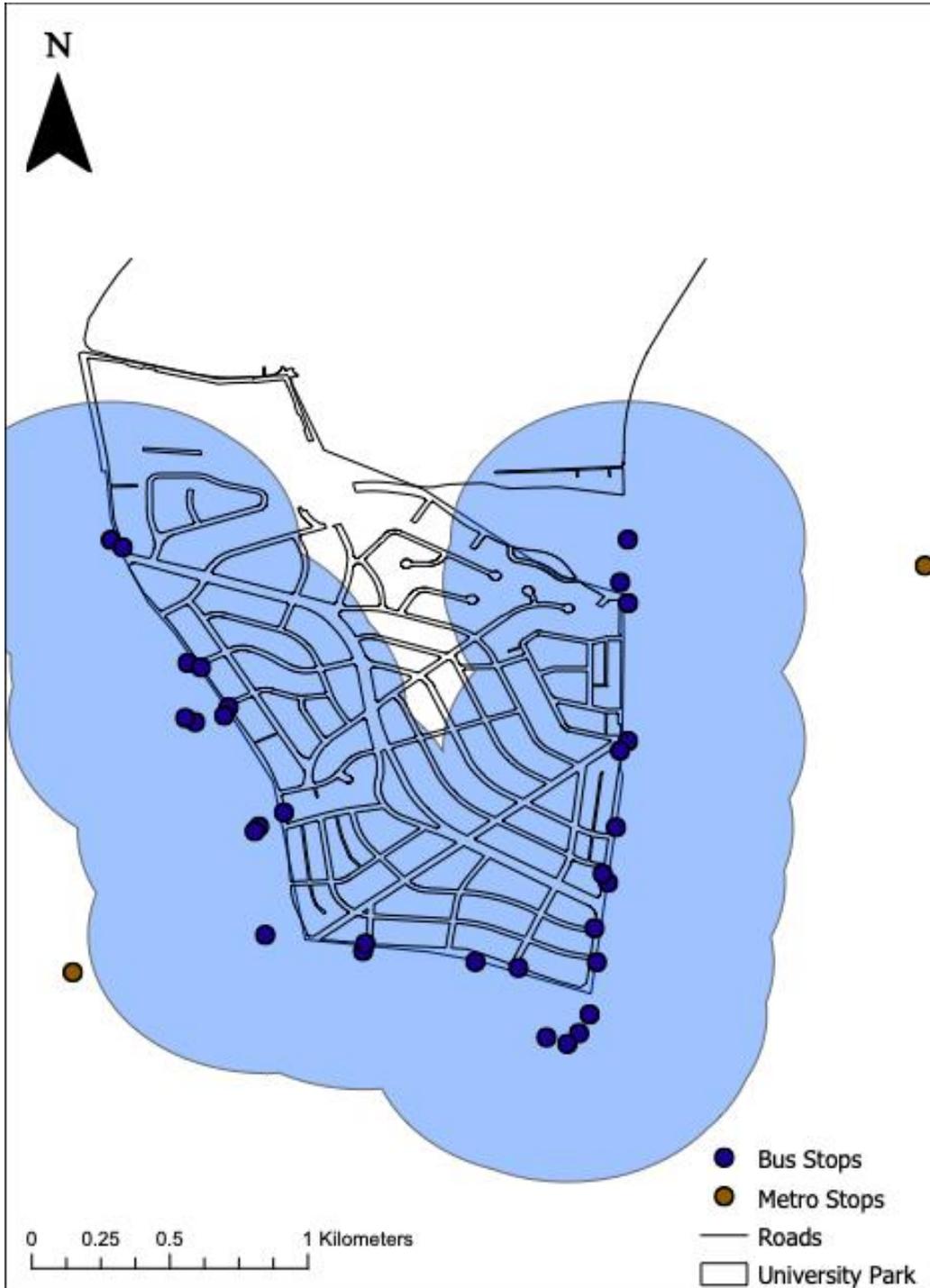## *Objective 2: GIS and Cost Benefit Analysis*

GIS Mapping

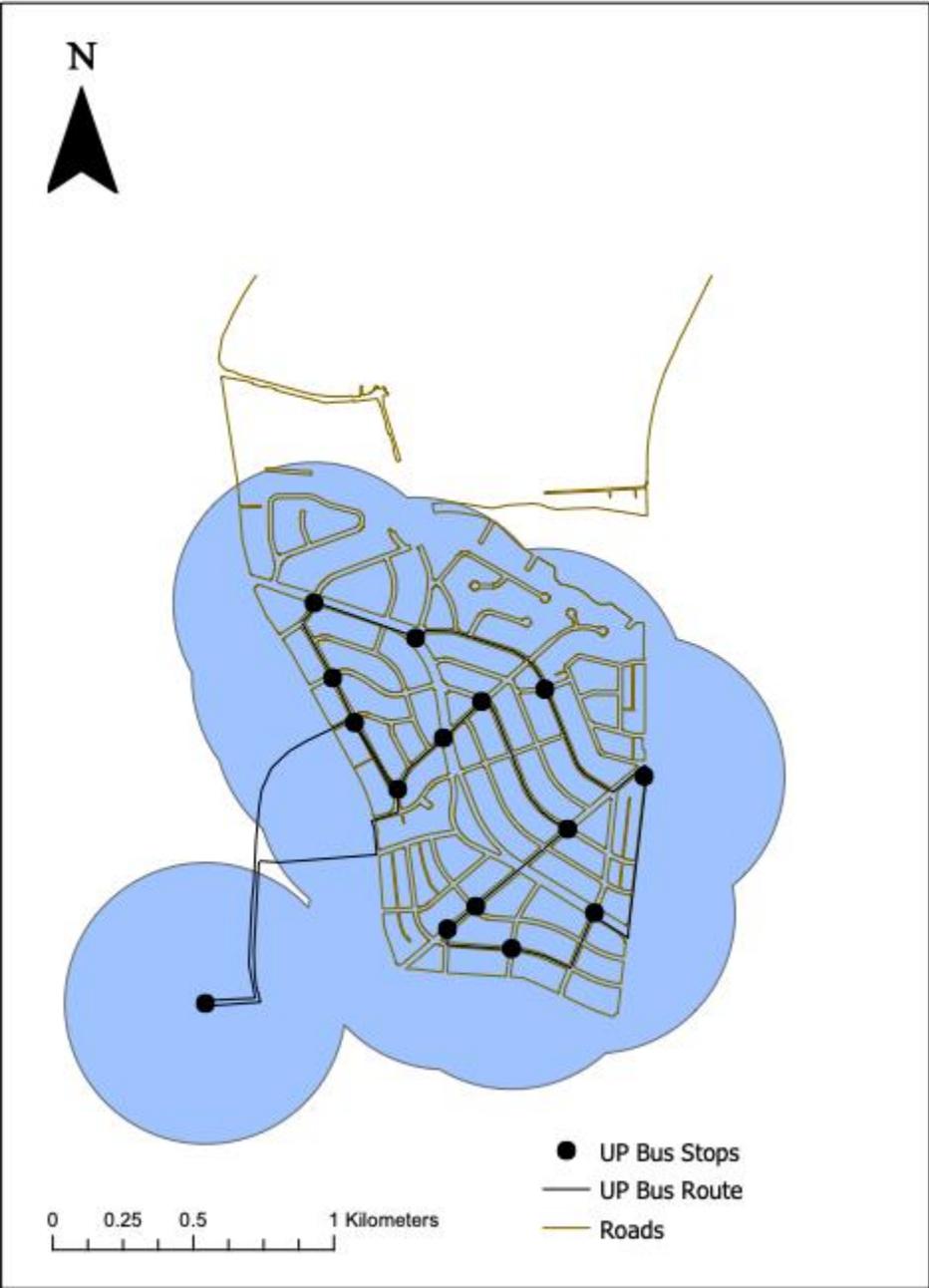*Figure 13 UP with WMATA bus and rail stops and a 0.5km buffer*

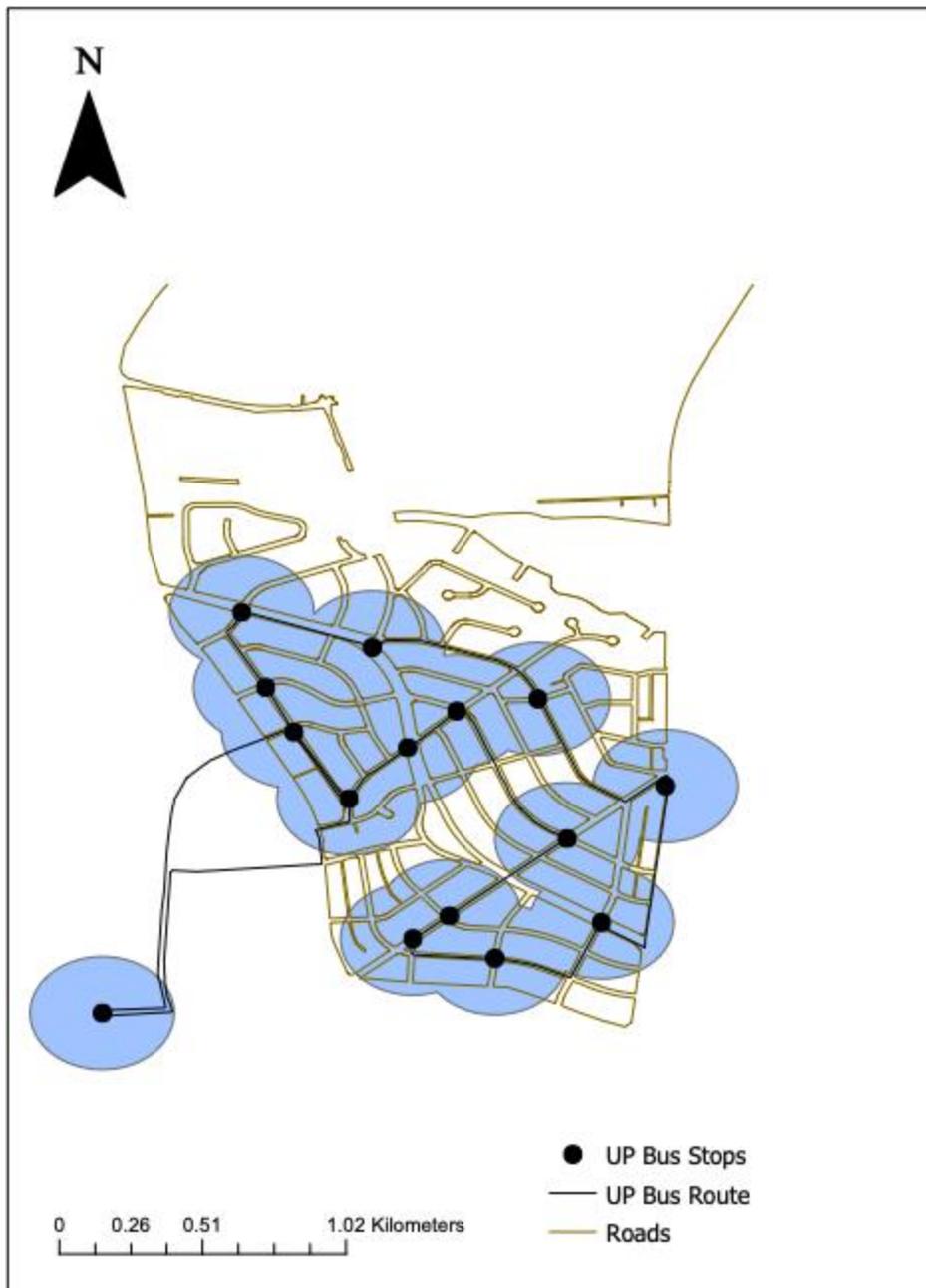*Figure 14 UP shuttle stops, route, and 0.5km buffer*

Figure 15 UP shuttle stops, route, and 0.2km buffer

Figures 14 and 16 use 0.5 and 0.2 kilometer buffers, respectively, to demonstrate the

accessibility of WMATA bus stops to UP homes. Figure 15 uses a 0.5 kilometer buffer to highlight the

accessibility of the Town Shuttle Bus to UP homes. Based on pedestrian walking speed analysis by

Knoblauch, Pietrucha, and Nitzburg, a 0.5 kilometer walk will take approximately 6-9 minutes in a typical

suburban setting (Knoblauch et al. 27-38). The same study suggests that a 0.2 kilometer walk would take roughly 2-5 minutes. Although the town of UP is small enough that most of the WMATA bus stops seem to be within walking distance of most homes, the reportedly low ridership suggests that the absence of sidewalks in most locations does not make it easy to walk to the stops (Figure 16).

Following our analysis of the WMATA metro and bus connection, we conducted similar analyses on the shuttle. The entirety of UP is located within a 0.5 kilometer radius of any one shuttle stop, and approximately 70% of homes lie within 0.2 kilometer distance from at least one stop (Figure 15, Figure 16). The commuter shuttle bus stops are interspersed at relatively even intervals throughout UP, and not located solely on the town border, which makes these stops accessible. Despite this, only 25% of survey respondents ride the shuttle at a weekly frequency or greater (Figure 3). From these results, it appears that lengthy headways may negatively impact shuttle bus ridership.

Based on our radii analysis, both the WMATA transportation system and Town shuttle bus have widespread accessibility in UP, yet the commuter shuttle has comparatively higher ridership. Reportedly low WMATA bus ridership is likely the result of cost for a bus pass leading to a general lack of interest in the service. The free cost of the UP shuttle, in conjunction with stop locations on the interior of town, likely explain the higher ridership rates.

Cost-Benefit Analysis of University Park Shuttle

Costs for the Shuttle Bus

In fiscal year 2018, the Town spent $15,722.26 on operating costs for the town shuttles. This included gas, parts, maintenance costs, and driver training, supplies, and uniforms. An additional $57,527.12 was spent on bus driver salaries (Marcavitch). The annual amounts of emissions in

operating the town shuttle is 11.59158 tons of CO_2. The cost of this CO_2 is $139.10 - $718.68, depending on the discount rate (5% and 2.5% respectively). Using the EPA's 3% discount rate standard benchmark of $42 per ton of CO_2, the overall carbon cost of operating the shuttle is $486.84 annually. These combined with the annual carbon cost for the shuttle ($486.84) bring the total cost of the shuttle to $73,736.22.

Costs for a Personal Vehicle

Each vehicle costs $572 to operate annually, when driven the same daily distance as the shuttle route. This results in a carbon cost for each vehicle of $43.01 annually at a 3% discount rate. As the sum of the vehicle cost and carbon cost, each vehicle costs $615.01 annually.

Weighing Costs and Benefits

Table 2 Summary of calculations of cost-benefit analysis of UP Town Shuttle

Carbon Cost of Town Bus	$486.84
Carbon Cost of a Vehicle	$43.01
Ratio of shuttle carbon cost to vehicle carbon cost	11.32

To make the shuttle worthwhile environmentally, the cost of carbon for the shuttle must be less than that of if each of the riders drove vehicles instead. Dividing the cost of carbon for the shuttle by the cost of carbon for a single vehicle produced a threshold of number of riders of 11.32. This means that 12 people must take the shuttle daily instead of driving individually (i.e., one person per vehicle). According to ridership data, the lowest daily ridership was 13 citizens followed by 17 citizens as second lowest (Marcavitch). This illustrates that ridership exceeds the threshold of 12 riders, meaning that the shuttle is worth the costs environmentally.

Objective 3: Connection between UMD and UP

Currently, UMD has two bus routes that connect to UP. The first is the 113: Hyattsville bus connection. This line travels through three stops along the western border of UP on Adelphi Road. Another route provided to UP from UMD is the 126: New Carrollton route. This route runs along the eastern border of UP on Baltimore Avenue. The 113: Hyattsville bus has a headway of one hour. It takes less than 15 minutes to take this Shuttle-UM bus from its inbound stops along UP to the main UMD bus stop. However, the outbound stops across from UP would take nearly the entire headway to arrive at UMD. Similarly, the 126: New Carrollton bus has a headway of 70 minutes. On this bus the UP stops are the first few on the route with no difference between inbound and outbound, therefore it takes near an hour to get to the UMD Stamp Student Union from any of the UP stops; however, each of these UP stops has a different stop across route one that is not labeled as "inbound" but would provide a shorter riding time on the bus (UMD DOTS).

Our group anticipated these headways to be too infrequent for UP residents who live so close to UMD, which is only an average-six-minute car ride. We asked residents about this issue on our survey. The first question gives us an idea of how many UP residents commute to UMD for class or work. The results were 20.4% out of the 158 responses received. This percentage is less than we anticipated. However, the results for how they choose to commute shows that most residents commute via personal vehicles, many walk occasionally and fewer bike or bus. Twenty-four percent of UP residents are aware of the Shuttle-UM connection to UMD. This is a higher percentage than the 20.4% that said they commute to UMD. Additionally, 66.2% stated that they drive to campus, rather than other modes of transportation, for convenience purposes. However, only 15.3% stated that they believed the bus route to be inadequate and 66.3% of residents stated that they were unsure of the accessibility of the Shuttle-UM.

To further determine the adequacy of these routes we collected ridership data from the UMD Department of Transportation and found surprisingly low ridership for both routes (Fleck). The 113: Hyattsville bus route receives a weekly total of 286 riders for all of the UP stops (inbound and outbound), and the 126: New Carrollton bus receives a weekly total of 112 riders for all of the UP stops.

Table 3 Shuttle-UM ridership numbers

126 New Carrollton			113 Hyattsville	
Stop name	Weekly psgrs		Stop name	Weekly psgrs
Balt. Ave. @ Univ Pk Town H	38		Wells Pkwy (outbound)	57
Balt. Ave. @ Van Buren	23		Northwestern HS	42
Balt. Ave. @ Underwood	17		Toledo/Adelphi	50
Balt. Ave. @ Sheridan	34		Adelphi/Toledo	34
Total	112		Van Buren	38
			Wells Pkwy (inbound)	65
			Total	286

This information shows that many of the UP residents do not utilize the Shuttle-UM connection. As the survey results show, of the 20.4% of residents that commute to UMD a large portion of those residents, 24%, are aware of the UMD connection, yet 66.2% percent of them choose not to commute for convenience purposes. We see this reflected in the low ridership data of the Shuttle-UM bus stops through UP. Therefore, the routes are not adequate to meet the needs of UP residents who commute to UMD due to convenience issues. Since the bus stops along the perimeter of the town provide an accessible distance from many places within the town according to our GIS findings, the issue that likely causes residents to perceive Shuttle-UM to be inconvenient is headways.

Results of Cost-Benefit Analysis of Shuttle-UM

Carbon Cost of the Shuttle-UM Buses

The results from our analysis show that the 113: Hyattsville bus route has an annual carbon cost of $325.32 - $1680.82. Using the EPA 3% discount rate benchmark, the cost is $1138.62. For the 126 route, the range is $210.72 - $1088.72, with a 3% benchmark of $737.52.

Costs for a Personal Vehicle

The annual vehicle cost of a citizen driving the Shuttle-UM route in an average vehicle is $332.80 for the 113: Hyattsville route and $270.40 for the 126: New Carrollton route. The annual carbon cost of a vehicle driving the 113 route is $25.03 and $20.33 for the 126 route at a 3% discount rate.

Table 4 Cost-benefit analysis of Shuttle-UM routes

Shuttle-UM Route	Annual carbon cost (3% discount rate)	Ratio of shuttle carbon cost to vehicle carbon cost
113: Hyattsville	$1138.62	$737.52
126: New Carrollton	45.49	36.28

Weighing Costs and Benefits

The ratio of the Shuttle-UM carbon cost to vehicle carbon cost is 45.49 for the 113: Hyattsville route and 36.28 for the 126: New Carrollton route. This means that at least 46 UP residents must ride the 113: Hyattsville route and 37 UP residents must ride the 126: Hyattsville route for the shuttles to be environmentally worthwhile.

Based on UMD Department of Transportation ridership data for the stops that service the perimeter of UP, the average total daily ridership for all the UP stops is 36.6 for the 113: Hyattsville

route and 22.4 for the 126: New Carrollton. Both of these figures are lower than their respective

environmental thresholds. Moreover, the ridership data includes both UP residents and non-

residents. Therefore, operating the shuttles to the perimeter of UP is not environmentally

beneficial, and even more UP residents must ride the shuttles for a net environmental benefit.

Conclusions

Recommendations

With current ridership, the town shuttle bus emits less carbon than if riders were to drive individually. Because of this, we recommend that the shuttle continues to operate. Increasing ridership would benefit the Town by further reducing emissions.

For Shuttle-UM Buses, the current ridership is lower than than the threshold number of riders to make the Shuttle-UM Buses more environmentally efficient than driving. Therefore, measures should be taken to increase ridership for the town, in order to minimize environmental impact.

Information gathered from our survey helped steer us toward our proposed recommendations. To make the Town Bus more convenient to residents and thus increase ridership, our team recommends a partnership with NextBus, an app service that uses GPS software to track shuttle buses in real time. This shuttle tracking app will make the arrivals, departures, and bus stop locations viewable to riders in real-time and readily available on their mobile device. While UP residents are generally aware of the Town Bus services, the vast majority of respondents did not know that there are the two existing Shuttle-UM routes between UP and UMD. To increase Shuttle-UM ridership, our team created an informational pamphlet designed to raise awareness about these public transit options available to them. The majority of the commuting UP residents travel most frequently to D.C., thus ensuring that the town is sufficiently connected with metro rail lines is a huge priority. The Purple Line will appreciably expand this connection, so long as travel to the stations is convenient. Our team proposes that sidewalks be implemented that directly connect UP and College Park station, Riverdale station, and M Square station. Three specific requests made by residents that our team feels should be taken into serious consideration by the UP government is

that the hours for the Town Bus be extended further into the morning, midday, and the evening, that trips be made more frequent, and that the Shuttle-UM service be made accessible to all UP residents without requiring a school ID.

Limitations

The ability of UP to implement our proposed changes is limited by a variety of factors. With regards to a partnership with NextBus, the costs associated with both installation of the GPS technologies and the service fee required by the company may deter the PG county from approving the partnership.

Extending the service hours and increasing frequency of trips for the Town Bus has a significant cost associated with it as well. Labor costs including paying drivers, operational costs including increased gasoline intake and more frequent vehicle maintenance services, and the social costs associated with an increased carbon footprint must all be factored in. Considering the fact that UP already dedicates a notably large sum of their budget to their existing transit system, extending service hours and trip frequency may exceed what UP government wishes to spend. Raising taxes for residents would supply some of this needed funding, but may not be in the best wishes of the residents, especially given the survey results where respondents stated that they do not wish to supply additional taxpayer money toward the UP transit system.

The willingness of UMD to form a partnership with UP so that UP residents can ride Shuttle-UM without a student-ID, and instead with some other form of identification or fee, is the main limiting factor for objective three. Because Shuttle-UM is largely funded by undergraduate tuition fees, UMD DOTS may be hesitant to accept this proposal if they do not see it as fair. Suggesting a

small, once-a-year fee for UP residents to pay to allow them to ride Shuttle-UM would be an advisable solution.

Building additional sidewalks that provide a direct path to Purple Line metro stops to increase walkability and bikeability has the largest cost associated with it. Sidewalk construction has a myriad of associated costs, including contracting fees, labor costs, material costs, and requires shutting down areas for construction. However, based on the survey's results that the majority of UP residents do plan on using the Purple Line, we believe this action will greatly aid the UP residents in using the Purple Line.

Future Work

Our research entailed an in-depth cost-benefit analysis of the Town Bus and Shuttle-UM with emphasis on environmental costs of carbon, a GIS analysis of existing Town Bus and Shuttle-UM routes, development and distribution of a ridership survey, and an analysis of the existing and possible future connection. We recommend that the UP government actively works to increase their residents' awareness of all the public transit options offered to them. This can be accomplished first by distributing the informational pamphlet we created that details the runtimes, stop locations, and usership costs for the resident for the Town Bus, Shuttle-UM, and the Metro Bus.

We also advise that the UP government focuses on increasing the accessibility of their residents to the Purple Line by increasing walkability and bikeability, and to inform residents on where the stops will be, and how they can be accessed.

Increasing ridership of the public transit options available to UP residents will aid UP in achieving the sustainability goals outlined in PG County's Sustainable Energy Program as well as in

UP's Sustainability Action Plan. Additional outreach programs that inform the residents on the importance of reducing the town's carbon footprint by using public transit will also help push the town's agenda for sustainability. Residents will likely be more ept to support a comprehensive public transit system despite the large sum of costs associated to taxpayers if they understand the importance of reducing their carbon footprint and being environmentally conscious in their commuting routine.

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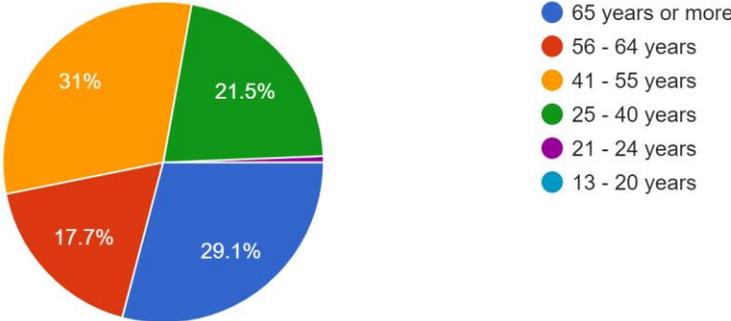data.imap.maryland.gov/datasets/ffddcef118ad4421870a355e8c7ac625_22.

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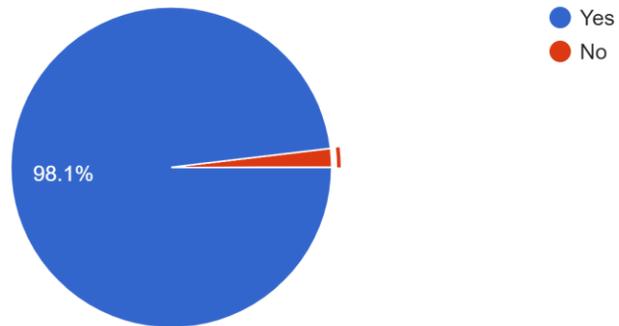# Appendices

Appendix A: Survey Questions
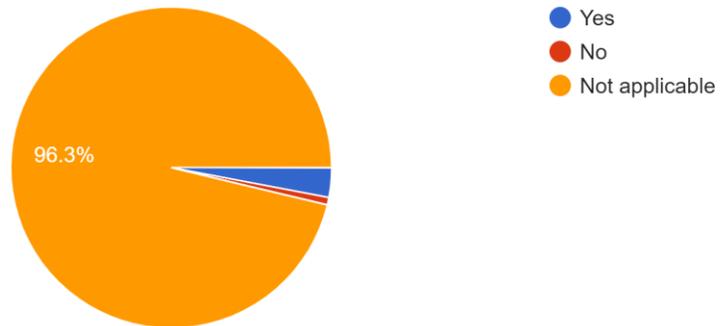
1. What is your age?
158 responses

Legend:
- 65 years or more
- 56 - 64 years
- 41 - 55 years
- 25 - 40 years
- 21 - 24 years
- 13 - 20 years

31%   21.5%   17.7%   29.1%

2. Do you own a personal vehicle (car or truck)?

158 responses

- Yes
- No

98.1%

3. If you don't own a car or truck, do you have ready access to one - meaning, you can use it at short or no notice?

134 responses

- Yes
- No
- Not applicable

96.3%

4. Do you commute regularly to work or school?
156 responses

- 5-7 days/week
- 3-5 days/week

5. Where do you commute to most frequently?
149 responses

- Within University Park
- University of Maryland
- D.C.
- Annapolis
- Baltimore
- Silver Spring
- Bethesda
- Greenbelt

1/7

40.3%

16.8%
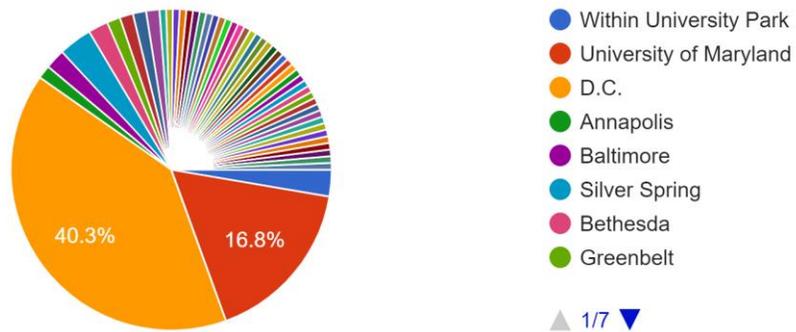
6. Do you have difficulty traveling for errands or for personal business, such as visiting doctor's offices or shopping?

158 responses
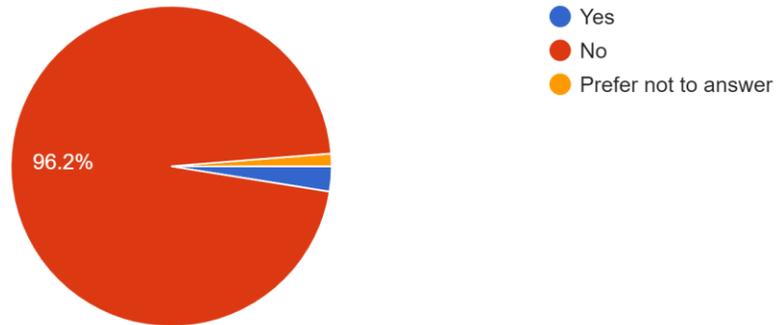
- ● Yes
- ● No
- ● Prefer not to answer

96.2%

7. Do you ever use the town bus to Prince George's Plaza Metro station for your work commute?

158 responses

- ● Always
- ● Most days
- ● Varies
- ● Occasionally
- ● Never
- ● Not applicable

31%
13.9%
31.6%
12.7%
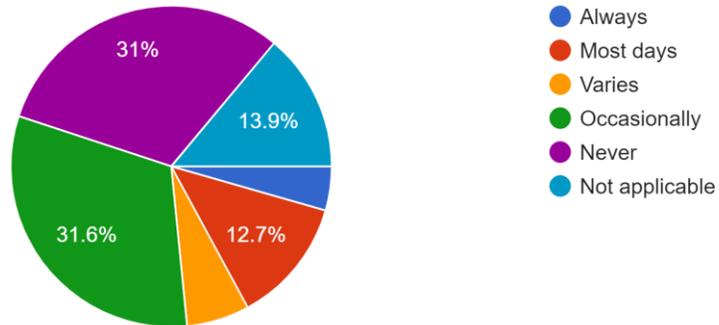
8. How often do you use any of these public transportation options readily available to University Park residents?
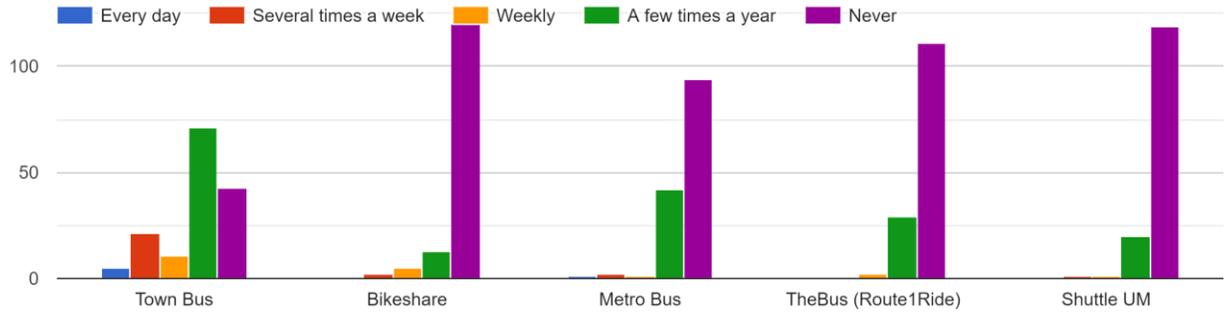
9. Are you aware of where the Town Bus stops are located in your community?
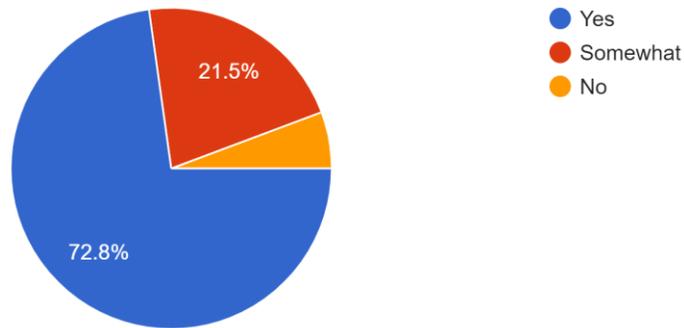
158 responses

10. Do you commute to the UMD campus for classes or work? (If yes, please answer question 11)
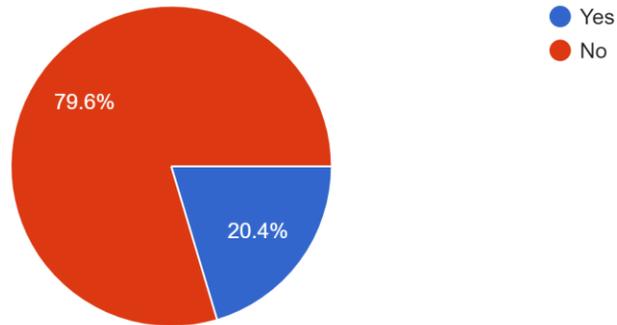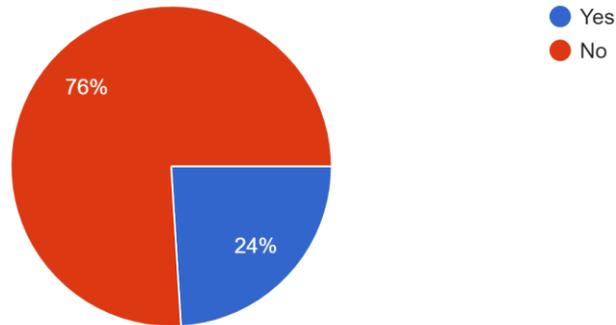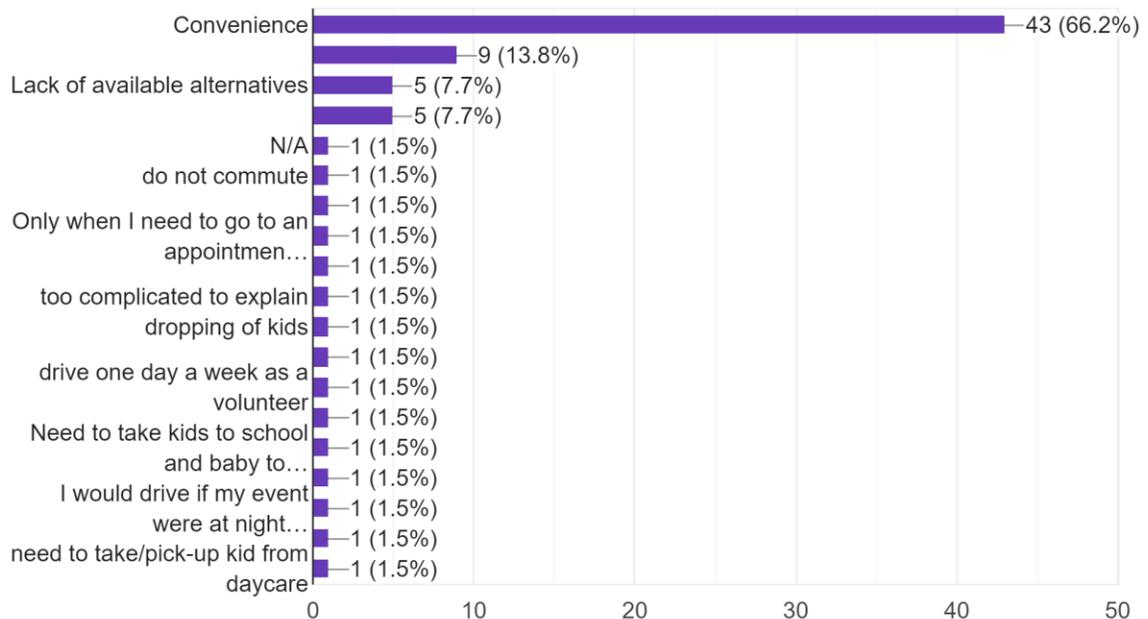
157 responses

11. How do you commute to campus?
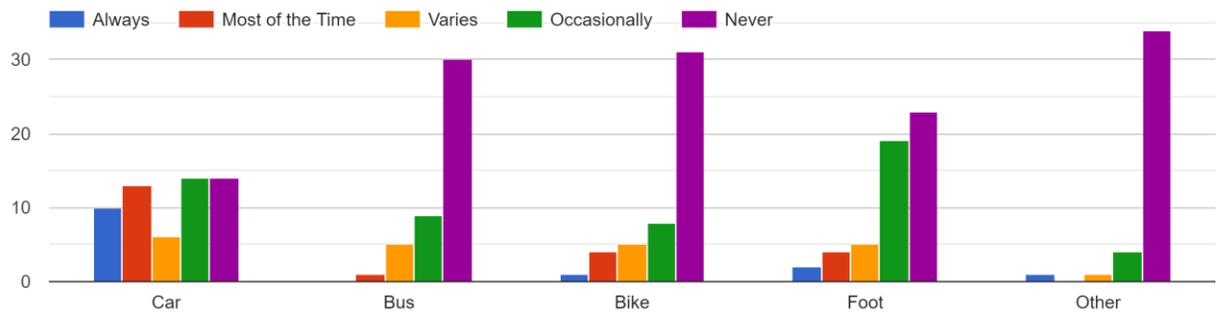
12. Are you aware that ShuttleUM offers two connecting routes between UP and UMD campus?
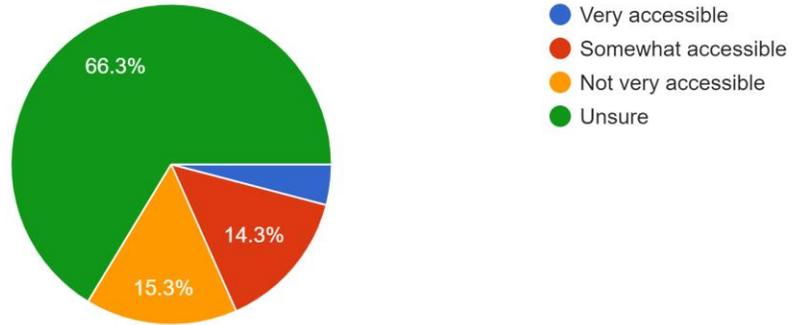
154 responses

- Yes
- No

76%

24%

## 13. If you drive to campus, instead of using public transport or walking/biking, why?

65 responses

Convenience	43 (66.2%)
	9 (13.8%)
Lack of available alternatives	5 (7.7%)
	5 (7.7%)
N/A	1 (1.5%)
do not commute	1 (1.5%)
	1 (1.5%)
Only when I need to go to an appointmen…	1 (1.5%)
	1 (1.5%)
too complicated to explain	1 (1.5%)
dropping of kids	1 (1.5%)
	1 (1.5%)
drive one day a week as a volunteer	1 (1.5%)
	1 (1.5%)
Need to take kids to school and baby to…	1 (1.5%)
	1 (1.5%)
I would drive if my event were at night…	1 (1.5%)
	1 (1.5%)
need to take/pick-up kid from daycare	1 (1.5%)

14. How accessible do you find ShuttleUM?
98 responses

- ● Very accessible
- ● Somewhat accessible
- ● Not very accessible
- ● Unsure

66.3%
14.3%
15.3%

15. Do you anticipate using the Purple Line? (If yes, please answer question 16)
157 responses
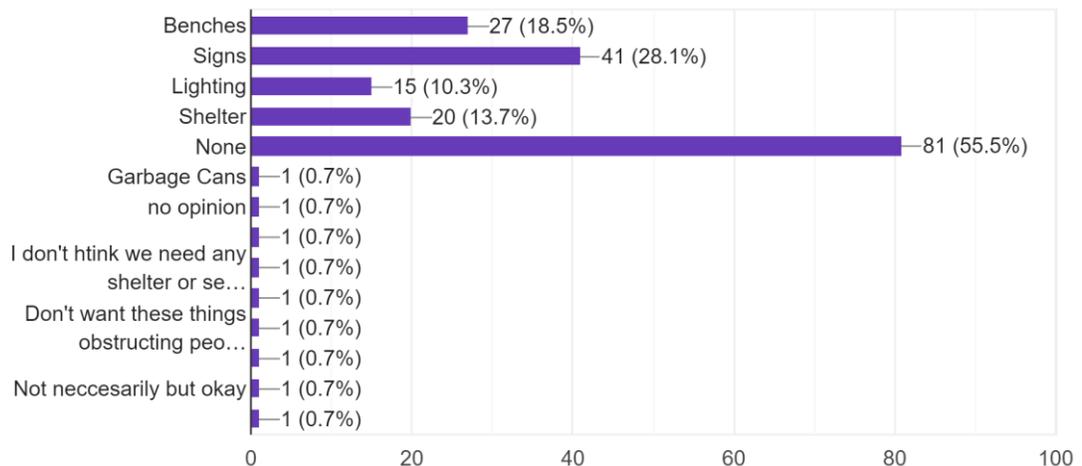

- ● Yes
- ● No
- ● Maybe

40.8%
8.9%
50.3%
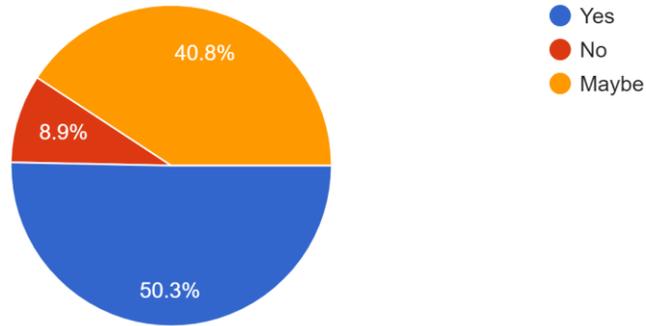
16. If so, which of the following proposed Purple Line stations near University Park will you use?
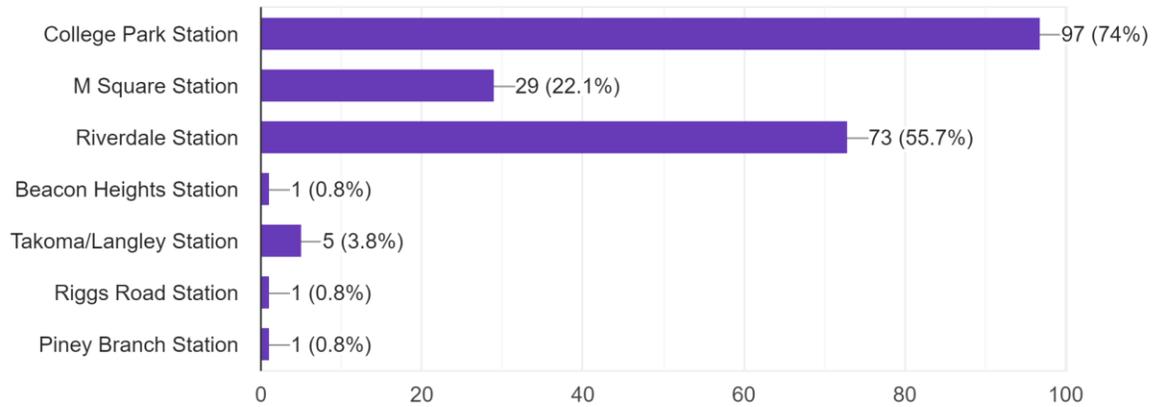
131 responses

17. Would you like to see the town pay to install any of the following amenities at town shuttle bus stops?

146 responses

18. Which of the following changes, if any, might cause you to use the town shuttle bus for commuting more often?

148 responses

- ● More frequent service
- ● Bus stops closer to my house
- ● More amenities at bus stops
- ● Connection to College Park Metro S…
- ● Nothing
- ● Improved awareness of services
- ● Shorter, more direct route to the sh…
- ● designated stops in town during eve…

△ 1/4 ▽

41.9%
22.3%
16.9%

19. What, if anything, could the town do that would make it easier and more practical for you to use public transportation to commute to work, school, or for personal business and pleasure?

Appendix B: GIS Maps
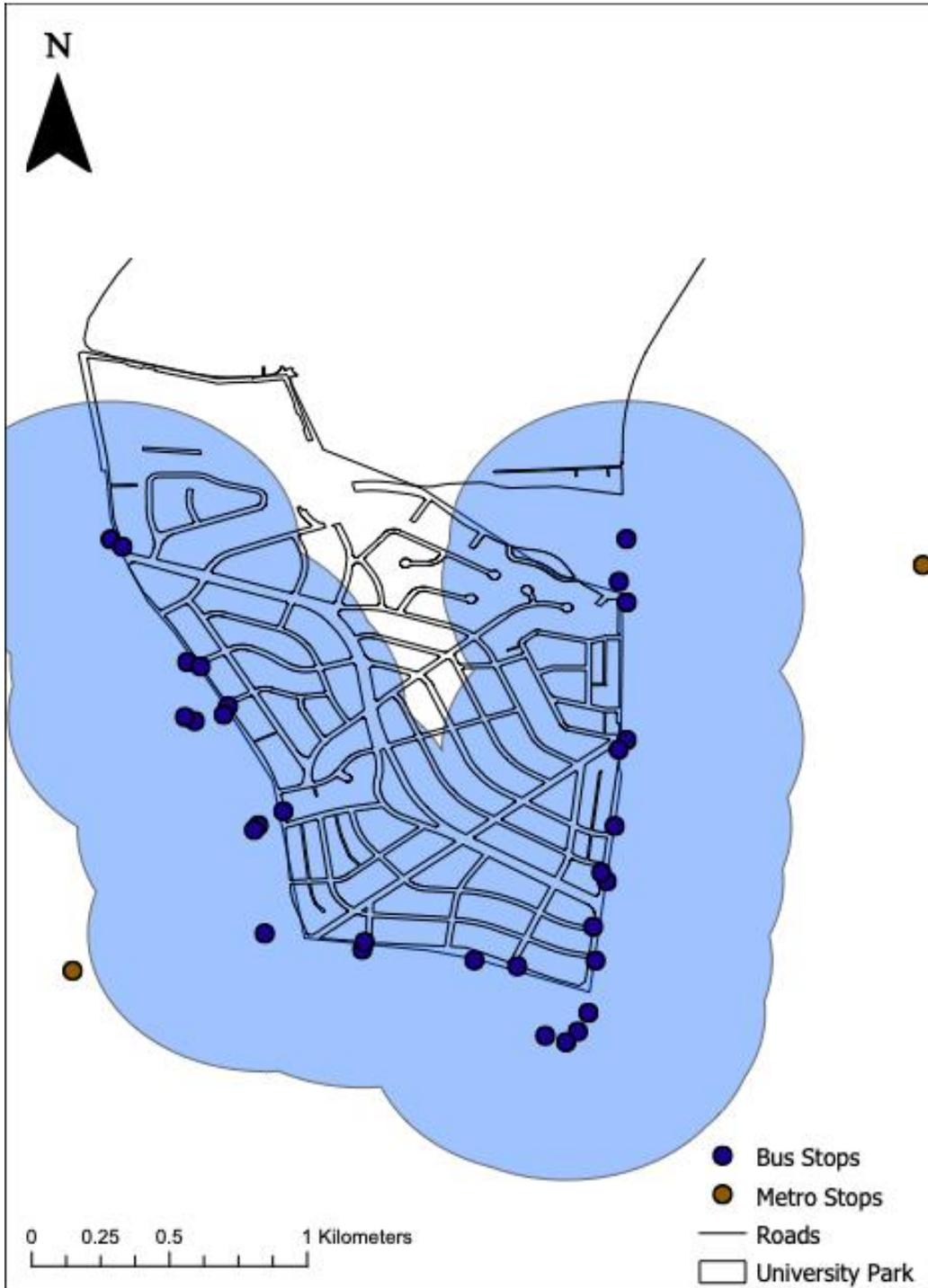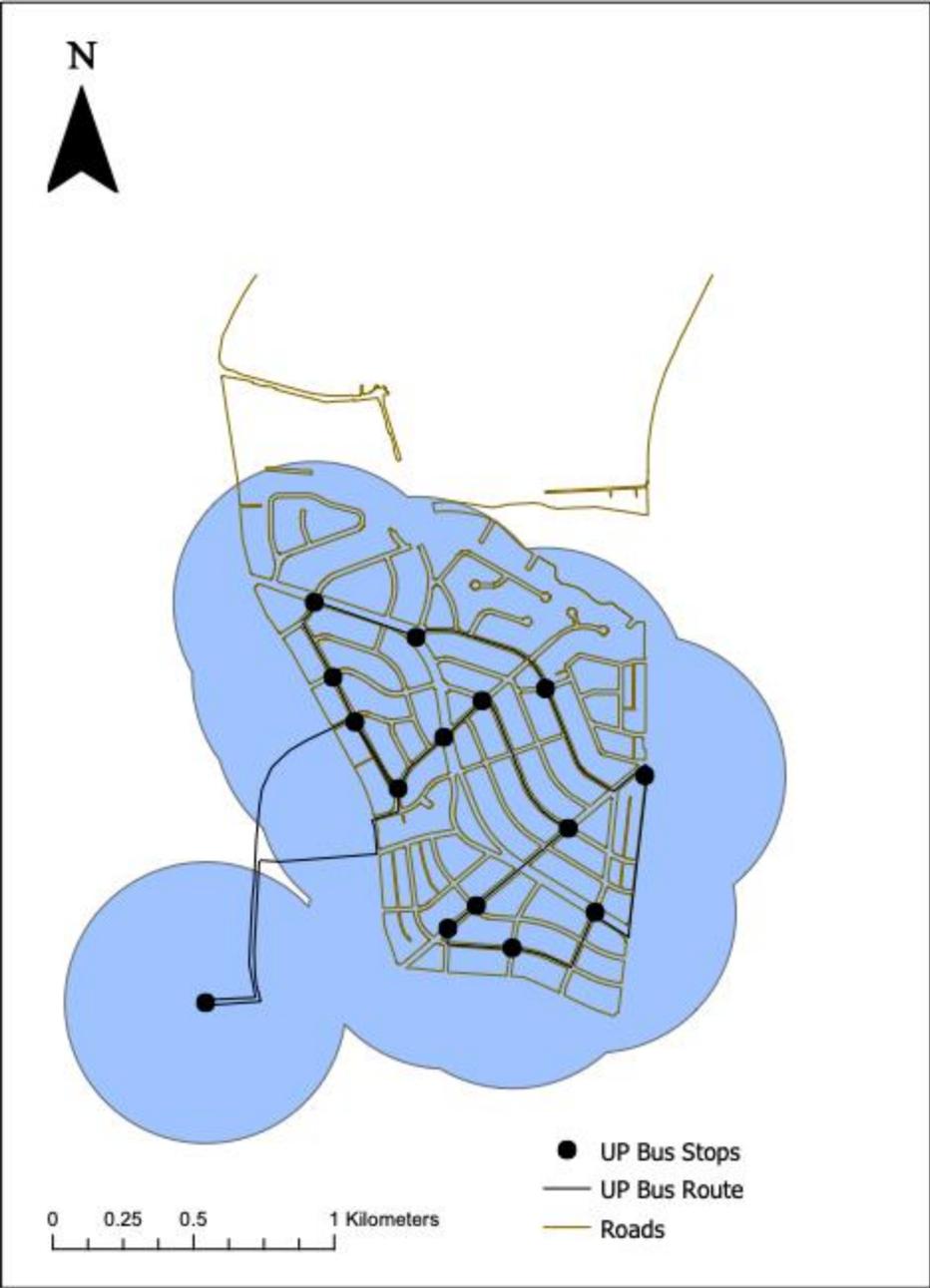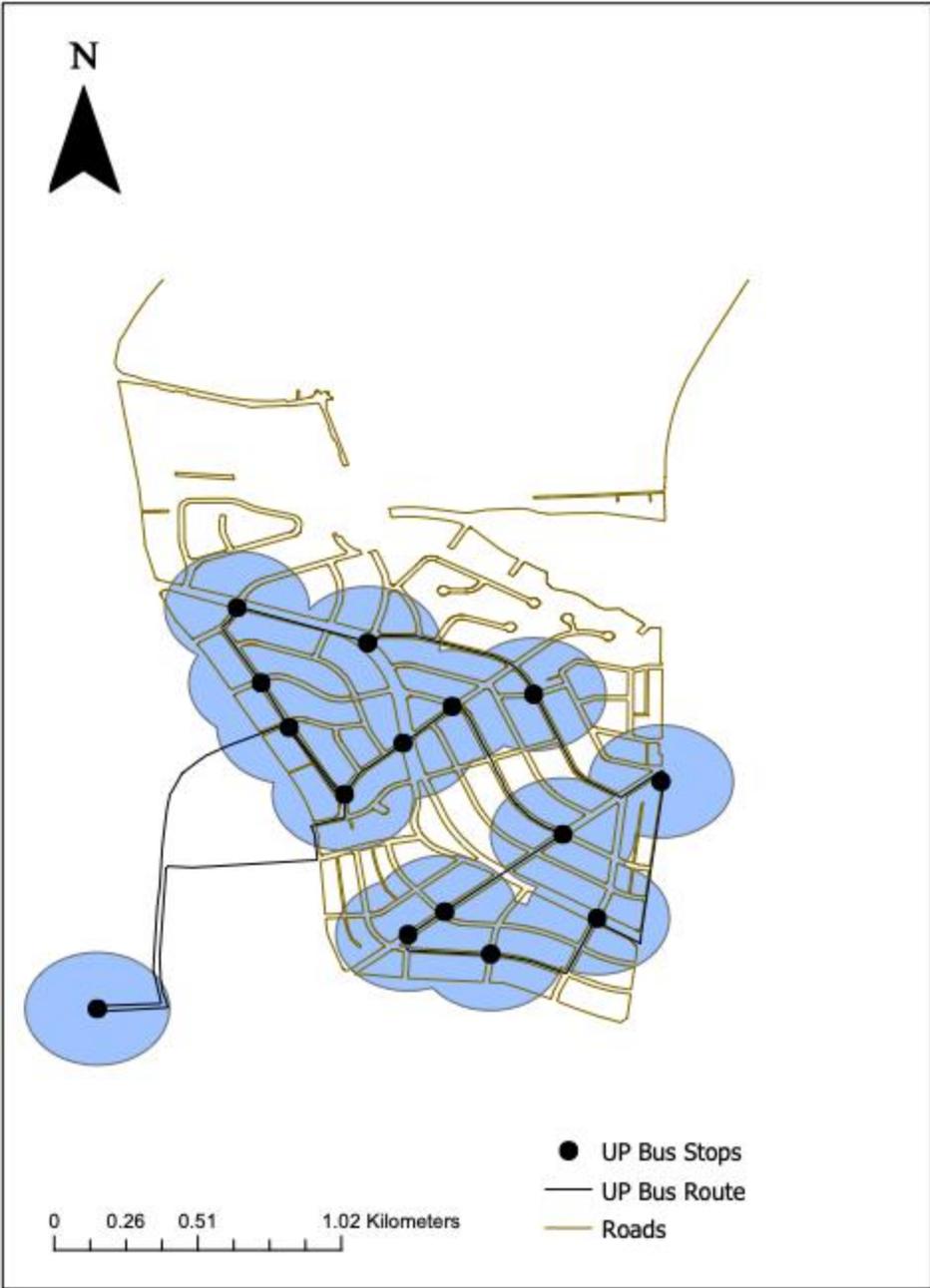
Appendix C: Brochure

Route-1-Ride

Route-1-Ride provides bus service northbound and southbound on route 1, Baltimore Avenue, as well as to the University of Maryland-College Park metro station. The northern stretches of the route go up to IKEA and the southernmost section of the route goes to Mount Rainer. Route-1-Ride runs from 5:30a.m. to 8:05 p.m., Monday through Friday.

Cost: $1.25 per trip
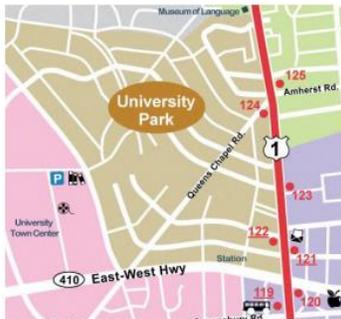
University Park Public Transit Options

This brochure was created by the Terrapin Transporter team for University of Maryland.

University Park Contact:
Joe Shultz, Ward 2 Councilmember
jschultz@upmd.org

WMATA Bus and Metro Lines

The Washington Metropolitan Area Transit Authority has an extensive bus and metro system that stretches from downtown Washington D.C. to various suburbs, including University Park. These forms of transportation can be accessed using a Smart-Trip card. More information about routes and costs can be found on WMATA.com.

Cost: Varies based on destination
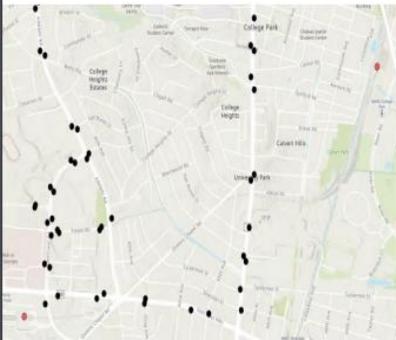
University Park Shuttle Bus

The city of University Park provides a commuter shuttle route in the morning (6 a.m. to 9:30a.m.) and evening hours (4 p.m. to 7:30 p.m.), Monday through Friday. The bus runs every 30 minutes.
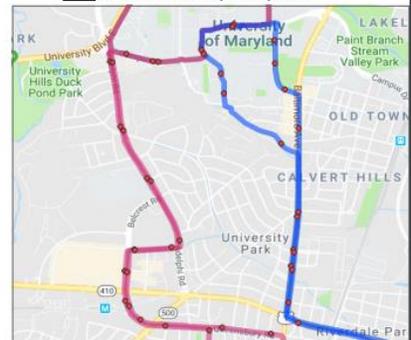
Cost: Free for University Park residents

University of Maryland Shuttles

The UM-Shuttle service has two bus lines that can service University Park, 113 Hyattsville and 126 New Carrollton. The 113 Hyattsville picks up at the intersections of Adelphi and Toledo, Adelphi and Van Buren, and Adelphi and Wells. The 126 New Carrollton picks up at Baltimore and Amherst, Baltimore Ave at Riverdale Park, Baltimore Ave at the National Guard Armory, and Baltimore and Sheridan.

Cost: Free with a University of Maryland ID

https://columbiacollege-ca.libguides.com/mla/interviews