Hamilton Bus Service Research Report

1. Context

Reason for choosing the topic:

As an international student, when I first came to a new place, I relied a lot on public transport for my daily travel. If there were only a few buses or no bus routes between my home and the university, it would be very inconvenient. So I wanted to find out which areas in Hamilton City are covered by existing bus services and show them on a map. This way, I can clearly see where the bus service areas are. It will also help me and other international students find places to live that have good bus access. That's why I chose "Hamilton Bus Service Research" as the topic of my project, and I focused on the current residential areas.

Reason for choosing tools:

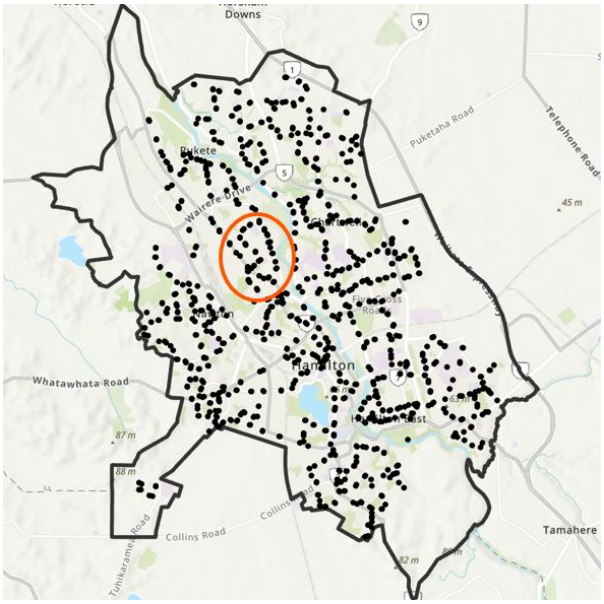
To achieve my research goal, I downloaded the needed data from official websites. These include data for "Existing Bus Stops", "Existing Bus Routes", and the "Boundary of Hamilton City".

When I looked at the data, I noticed that most of it was shown in tables. This made the information hard to understand and not easy to see directly. For example, the Existing Bus Stops table below is not easy to understand.

	OBJECTID *	Shape *	ROUTE_ID	STOP_ID	ROUTE_NAME	STOP_NAME
1	1	Point	4622	14001000	Pukete	20 Tupelo St
2	2	Point	3771	14001013	Orbiter	126 Ellicot Rd
3	3	Point	19537	14001013	Meteor	126 Ellicot Rd
4	4	Point	4620	14001015	Te Rapa	202 Sandwich Rd
5	5	Point	4622	14001015	Pukete	202 Sandwich Rd
6	6	Point	4622	14001017	Pukete	86 Sandwich Rd
7	7	Point	4622	14001020	Pukete	12 Braid Rd
8	8	Point	4622	14001028	Pukete	1340 Victoria St (Trevell...
9	9	Point	4612	14001029	Claudelands	18 Fifth Ave
10	10	Point	4606	14001036	Fairfield	611 Victoria St

Table 1: Part of the existing bus stop data

Therefore, I thought that if I could visualize the data all the time, for example, visualize the "existing bus stops" data on map could make me identify the areas without bus stops easily, so I think it would help me work more efficiently and effectively. In addition, it could also inspire me to determine the research direction and set up research methods.



Picture 1: Visualization of existing bus stop data in ArcGIS application
(Note：The black dots in the picture are bus stops)

And the ArcGIS application could realize my requirement, so as a result, I decided to use the **ArcGIS application** for my project, as it allows me to visualize and analyze the data throughout the entire process.

2. Research and Analysis Logic of the Project

2.1 Start with the existing bus stop data. For each bus stop, create a circle with a fixed radius to show its service area.

2.2 Inside the Hamilton City boundary, remove all the bus service areas to get the places without bus stop coverage.

2.3 Use the same method to focus on key areas (such as residential zones). Subtract the bus service area from the total area of the key zones to find which parts have no bus stop coverage.

2.4 Take out water bodies and protected areas from the uncovered areas to get a more accurate result of where there is truly no bus coverage.

2.5 Combine the updated layers to get the final result. This includes:

1> The total area in Hamilton City without bus service

2> The priority areas where new bus stops should be added

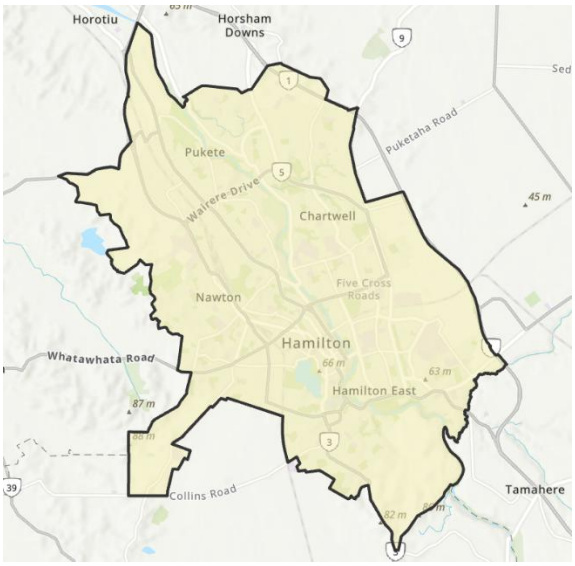
3. Dataset Collection and Preprocessing

Data Collection:

For this research, I downloaded data such as the Hamilton City boundary, bus stops and routes, water bodies (rivers and lakes), reserve areas, and land use areas like residential, school, hospital, and commercial zones from official government websites.

For a full list of the original data and their purposes, please see Appendix 1: Data Details and Sources.

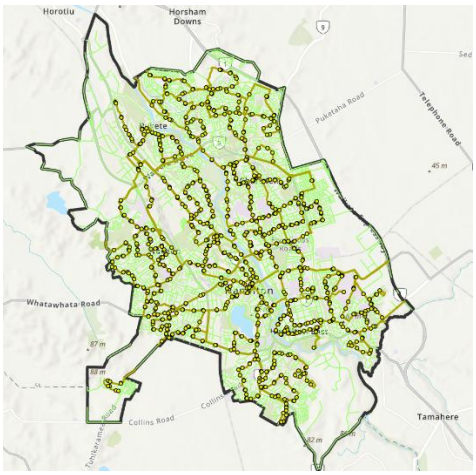
In the data preprocessing step, I first clipped all the data using the Hamilton City boundary. This means the analysis was limited to the area within the city.



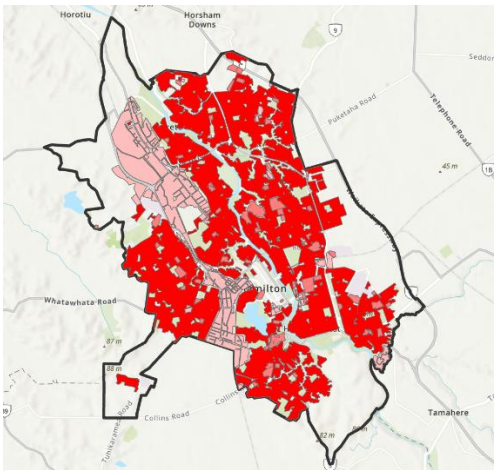
Picture 2: Visualization of Hamilton City Boundary

Then, I created a 30-meter buffer around all water body data (including river centerlines, river polygons, and lakes) to better represent the true size of water bodies — because bus stops should not be placed too close to water.

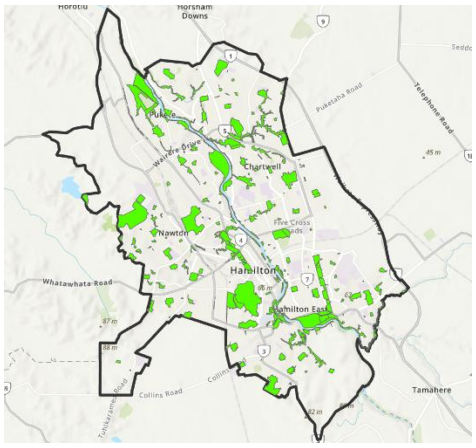
The following is a visualization of the relevant data after preprocessing.



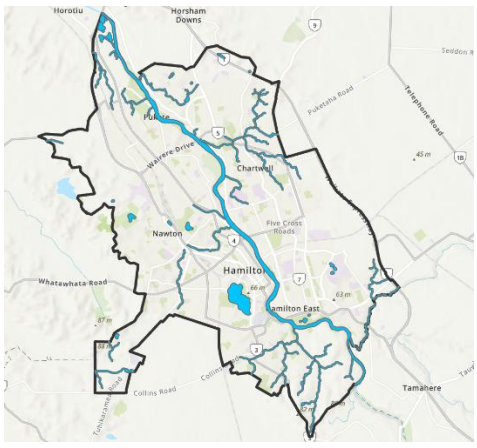
Bus stops, routes, roads data combination



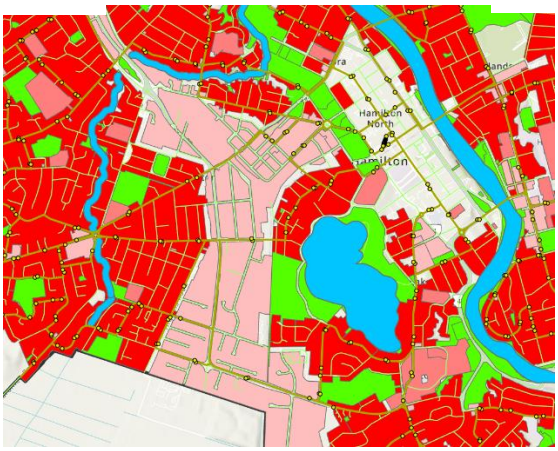
Key zones (including: school, hospital, Industrial, business, residential)



Reserve area



Water body



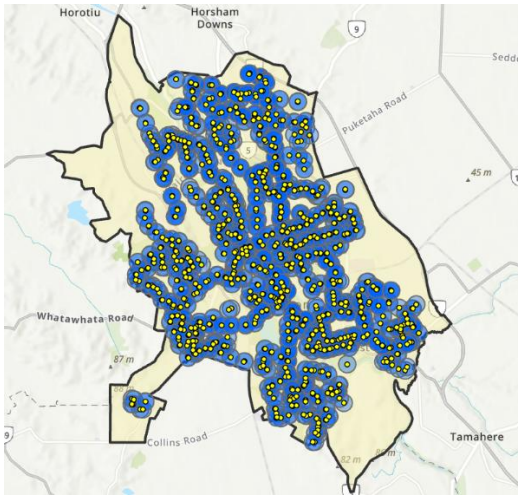
Combination of data

Picture 3: collection of visual displays of preprocessed data

3. Analysis Workflow

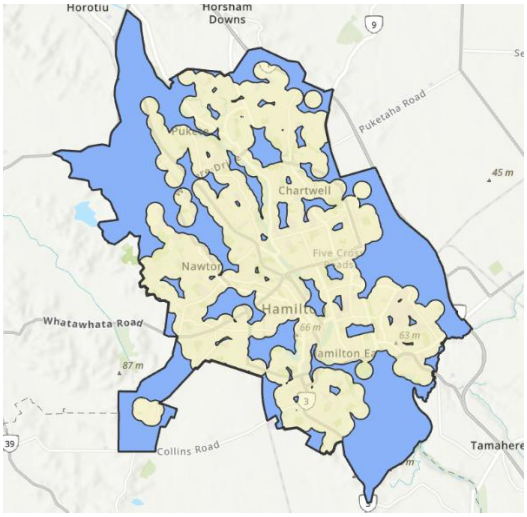
Next, I started the formal analysis in ArcGIS

1> Create a 300m buffer around each bus stop to show the bus service area.



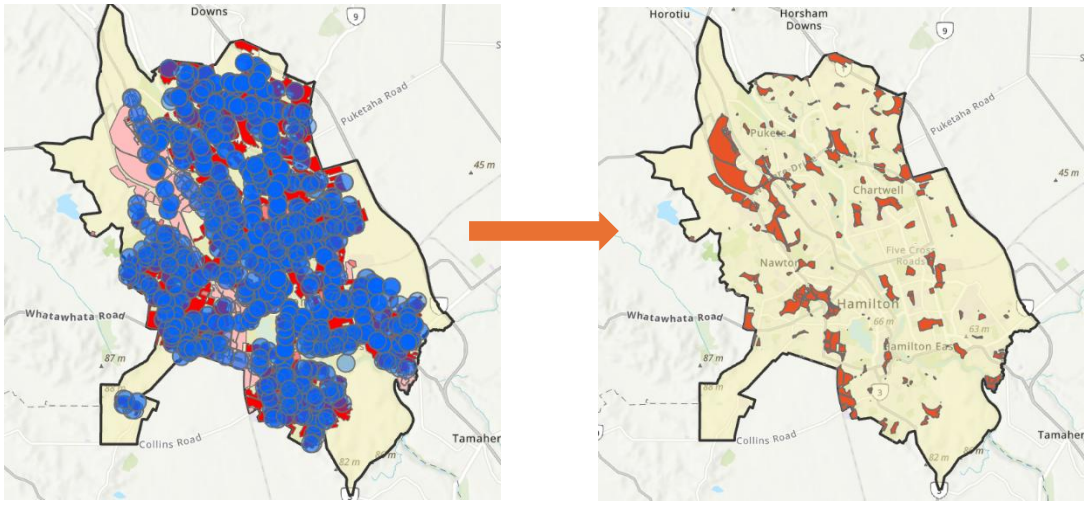
Picture 4: 300-meter buffer zones of bus stops

2> Remove the buffer area to get the "no bus service" area.



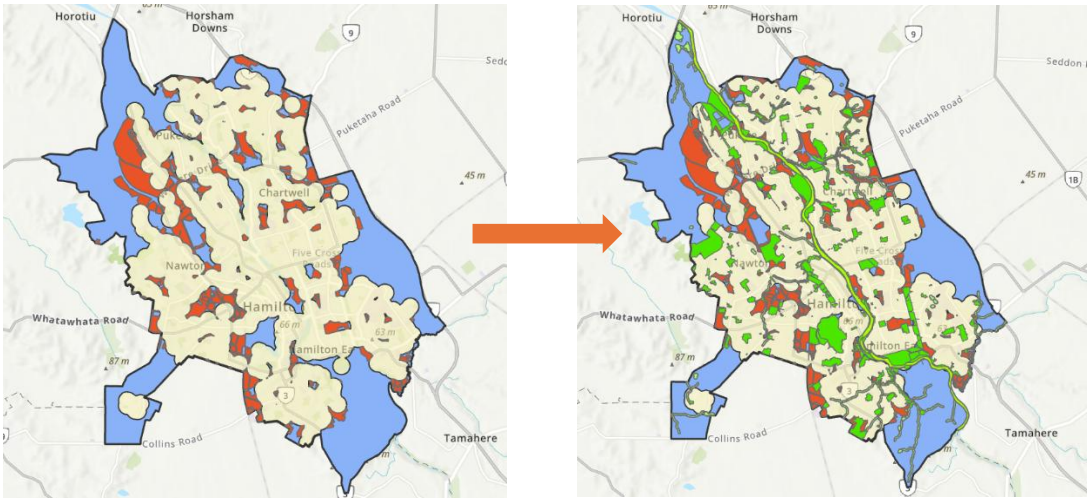
Picture 5: Areas without bus service

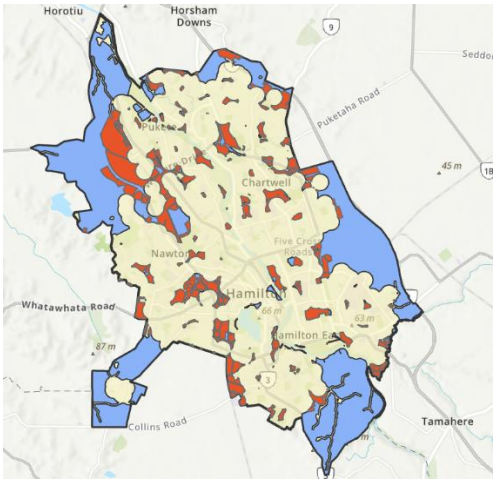
3> From this, select the "no service" areas inside key zones (like residential, schools, etc.).



Picture 6: Process of achieve the Key zones without bus service

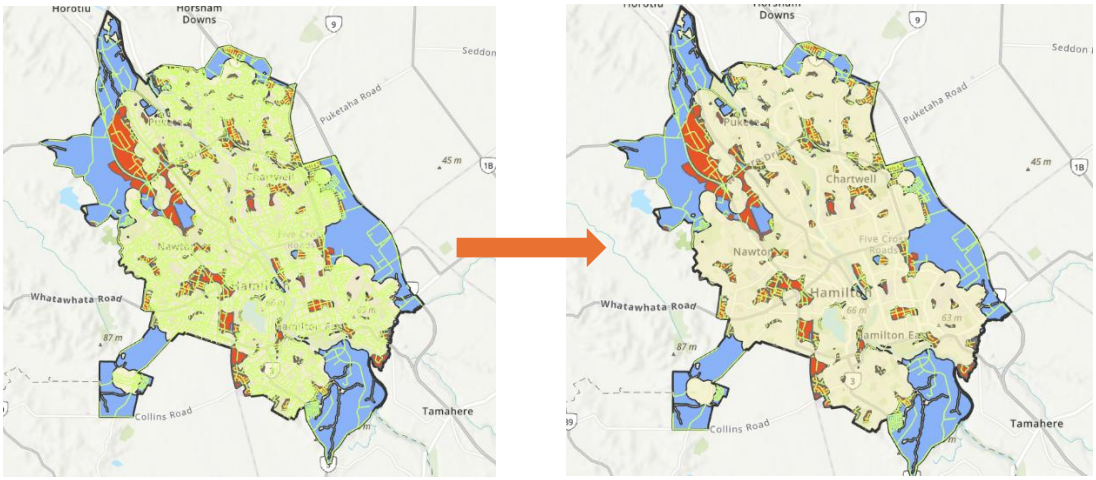
4> Take out the parts that overlap with water bodies and protected areas.





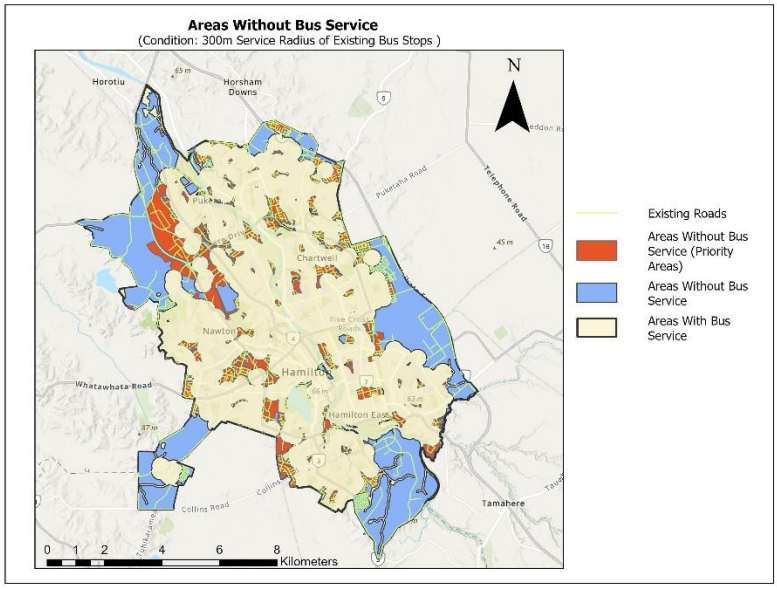
Picture 7: Process of identifying the precise areas without bus service (after removing water bodies and protected areas)

5> Add the road layer and keep only the roads that are accessible.



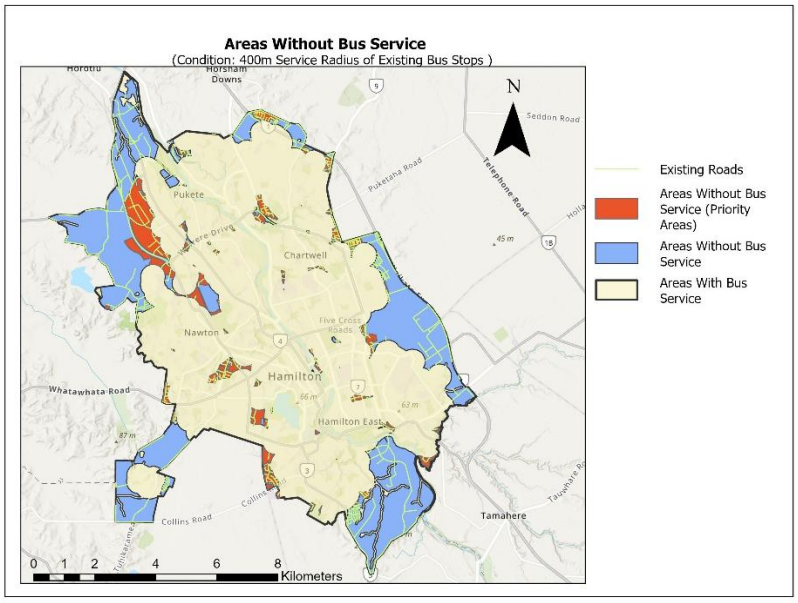
Picture 8: Process of adding existing roads to precise areas without bus service

6> Adding map elements helps make the visualization clearer and easier to understand.

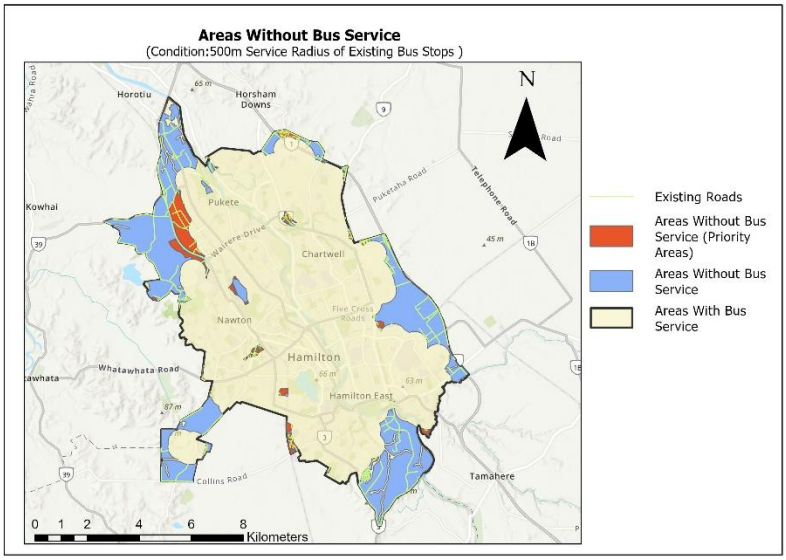


Picture 9: Final result (using a 300-meter buffer)

7> Repeat the steps above for 400m and 500m buffers to get more results.



Picture 10: Final result (using a 400-meter buffer)



Picture 11: Final result (using a 500-meter buffer)

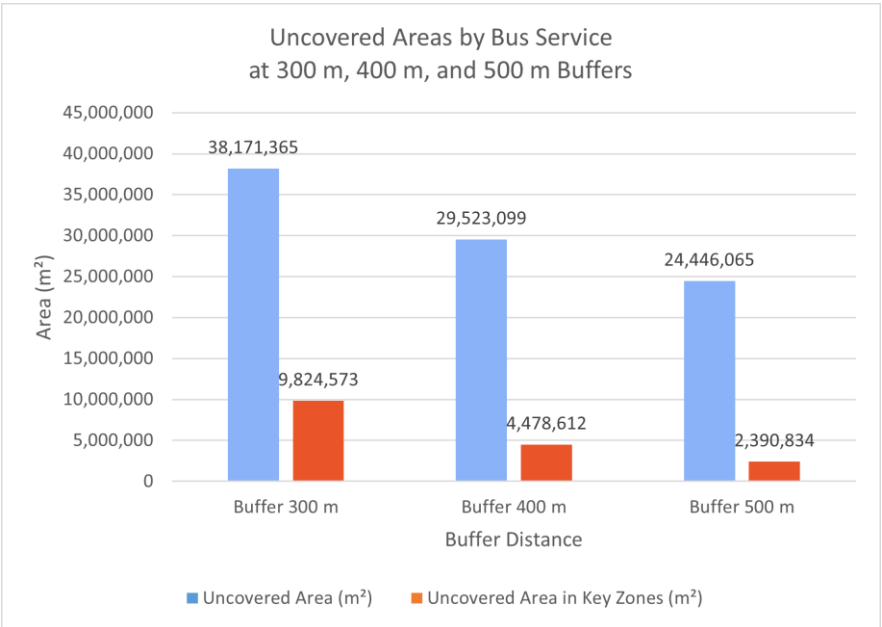
8> Extract the area without bus service coverage

Extract the corresponding area data from the three results obtained

Buffer Distance	Uncovered Area (m²)	Uncovered Area in Key Zones (m²)
Buffer 300 m	38,171,365	9,824,573
Buffer 400 m	29,523,099	4,478,612
Buffer 500 m	24,446,065	2,390,834

Table 2: Uncovered Areas under Different Buffer Distances

The table is then converted into a chart to visually enhance the contrast between the results under different Buffer conditions.



Graph 1: Uncovered Areas by Bus Service at different buffer conditions

5. Conclusion

1> The generated maps clearly highlight areas lacking public transportation services. Blue regions represent general zones without bus coverage, while red regions indicate key areas—such as residential, school, or hospital zones—that are not served. For individuals planning to rent a house and relying on public transportation, these red areas should be avoided.

2> From the table and graph, as the buffer distance increases from 300 m to 500 m, the total uncovered area decreases significantly.

However, the uncovered area within key zones also drops sharply—from 9.82 million m^2 at 300 m to only 2.39 million m^2 at 500 m.

This suggests that expanding the buffer can help reduce service gaps, but it may also reduce the accuracy of identifying priority areas for improvement.

6. Limitations:

Although this project successfully utilized ArcGIS to analyze bus service gaps in Hamilton City, several limitations remain in the workflow:

1> The source data relied on multiple layers with inconsistent resolutions and update frequencies, which may have affected the overall accuracy of the results.

2> The analysis did not incorporate real-world travel behavior or socioeconomic factors, potentially leading to an underestimation of actual service demand.

3> Critical factors such as road connectivity, physical barriers (e.g., rivers and terrain), and population distribution were not considered. Moreover, the buffer-based method oversimplifies real-world accessibility conditions.

7. Future Work:

To improve accuracy, future studies could adopt network-based accessibility analysis, incorporate population datasets, and take into account bus service attributes such as frequency and travel time.

In terms of visualization, enhanced techniques—such as stacked map layers, percentage annotations, combined thematic maps, and interactive dashboards—can provide more intuitive and engaging representations of service coverage. Also consider interactive web maps to let users explore uncovered areas dynamically (e.g., using ArcGIS Online or Leaflet).

In the future, a dedicated software tool can be developed to automate the generation of similar results in batches through coding. An interactive user interface could be integrated to display the results visually. For example, when the mouse hovers over any area, detailed information such as total area, presence of roads, and whether the area is a key zone can be displayed. Additional contextual data, such as the name of the community, can also be included to further enrich the visual experience.

Appendix 1: Data Details and Sources

index	name	Function	source	URL
1	Bus Stops	Provide existing bus stops data	Waikato Open Data Hub	https://data-waikatolass.opendata.arcgis.com/datasets/b143a38c66bb43e6a05ffe0f3bf9a735_0/explore
2	Bus Routes	Provide existing bus routes data	Waikato Open Data Hub	https://data-waikatolass.opendata.arcgis.com/datasets/77468702867 44b7ab77fc44291c34123_0/explore?location=-37.760544%2C175.293198%2C12.40
3	Hamilton City Boundary	As the analysis area	Stats NZ Geographic Data Service	https://datafinder.stats.govt.nz/layer/120963-territorial-authority-2025/
4	Residential Area	As the priority area	LINZ Data Service	https://data.linz.govt.nz/layer/50325-nz-residential-area-polygons-topo-150k/
5	School and Hospital Area	As the priority area	LINZ Data Service	https://data.linz.govt.nz/layer/105588-nz-facilities/
6	Industrial and Business Area	As the priority area	Waikato Open Data Hub	https://data-waikatolass.opendata.arcgis.com/datasets/71fa4223632b424aaab58d39cec5f2a8_0/explore?location=-37.763754%2C175.307244%2C12.05
7	Roads	Provide existing roads data	LINZ Data Service	https://data.linz.govt.nz/layer/53382-nz-roads-addressing/
8	Reverse	To correct the result	Waikato Open Data Hub	https://data-waikatolass.opendata.arcgis.com/datasets/60f870473c8a4b119a71a032f80c848a_0/explore?location=-37.792665%2C175.299834%2C13.53
9	River Centrelines	To correct the result	LINZ Data Service	https://data.linz.govt.nz/layer/50327-nz-river-centrelines-topo-150k/
10	River Polygons	To correct the result	LINZ Data Service	https://data.linz.govt.nz/layer/50328-nz-river-polygons-topo-150k/
11	Lake Polygons	To correct the result	LINZ Data Service	https://data.linz.govt.nz/layer/50293-nz-lake-polygons-topo-150k/