Transportation Needs Assessment and Alternative Development Report

FINAL

Vaughan Transportation Plan

July 27, 2023

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Contents

1 Introduction

One of the key objectives of the Vaughan Transportation Plan (VTP) is to accelerate the change towards more sustainable travel. People and cities cannot change overnight. Progress towards a more sustainable Vaughan as set out in the 2012 Transportation Master Plan (TMP) and the VTP requires a new set of evaluation tools that properly measures the benefits of all modes of travel. In order to do so, the identification and prioritization of opportunities in the network (or "gaps" as they will be referred to in this document), as well as the identification and evaluation of transportation infrastructure improvements, must explicitly consider all modes of transportation: autos, transit, bicycles, and pedestrians.

This report provides an overview of the transportation needs assessment and alternative development process. It includes the following steps: existing gap identification and prioritization, future gap identification and prioritization, alternative development, alternative evaluation, and ultimately the selection of a draft preferred alternative. A flow chart of the process can be found in **Figure 1-1**. The framework is further explained in **Section 2**.

Figure 1-1: Gap Analysis, Identification, and Prioritization Process

2 Needs Assessment and Alternative Development Framework

The Vision of the VTP is to create a transportation system that provides high-quality, attractive, competitive, and sustainable mobility choices. It is therefore essential to invest effort in identifying issues not only for the road and transit network but also for the walking and cycling network. This will ensure that the available infrastructure is well connected, comfortable, safe, and accessible which in turn will encourage Vaughan residents and visitors to make more sustainable travel choices.

The overall process from gap identification to the preferred alternative recommendations is presented in **Figure 2-1**, starting with data collection and followed by five steps:

- **Data Collection:** To develop the spatial analyses presented in the following sections, existing networks for all modes needed to be established. Road, transit, sidewalk, and cycling networks were provided by the City of Vaughan or York Region. Additional work was completed to refine the bicycle network through a lens of accessibility, comfort, and equity using an "All Ages and Abilities" (AAA) framework as adapted from the National

Association of City Transportation Officials (NACTO). The AAA framework reflects the current minimum standard for cycling facilities in the City as required by the Pedestrian and Bicycle Master Plan (2020). The details of the AAA bicycle network development are provided in ***Appendix A: Process for developing Vaughan's All Ages & Abilities (AAA) Bike Network in GIS*** and the AAA network is shown in ***Appendix B: All Ages and Abilities (AAA) Bike Network***.

- **Step 1, Existing Gap Identification:** The first step of the process was to identify gaps in the existing multimodal networks from a system perspective. This perspective is vital to ensure that transportation improvements are not limited to addressing localized capacity constraints, but rather that they address the lack of choice – either choice of travel mode or choice of route – that contributes to demand exceeding capacity. The gap identification analysis was completed using GIS and spatial analyses, resulting in a long list of gaps in the walking, cycling, transit, and road network. The results are presented in **Section 3** of this report.
- **Step 2, Existing Gap Prioritization:** The second step of the process, existing gap prioritization, evaluates the importance of the identified long list of gaps and assigns priority. The prioritization is broadly based on four categories: transportation, land use, social equity, and safety, which are then quantified using metrics within each category. The output of this step is a priority list of gaps, organized from the highest priority in terms of needing improvement (from the categories evaluated) to the lowest priority. The results for this step are presented in **Section 4.**
- **Step 3, Future Gaps Identification and Prioritization:** The third step of the process involves leveraging Vaughan Travel Demand Model outputs for two main purposes: to further prioritize existing gaps identified in the previous step, and to highlight new gaps that may need to be addressed in the future. Future growth indicators that were considered include qualitative and quantitative aspects for all travel modes captured in travel demand modelling. The results from this step are presented in **Section 5**.
- **Step 4, Developing Future Alternatives:** The fourth step of this process involves building sets of alternatives to address gaps. These comprise packages of recommended improvements to evaluate, primarily using the Vaughan Travel Demand Model. Recognizing that addressing road network gaps through road widenings or extensions will likely result in induced vehicular demand, transit, and active transportation-focused improvements were considered first. Thus, gaps in the road network do not necessarily trigger road improvements, which is consistent with the City's vision to provide high-quality, attractive, competitive, and sustainable mobility choices. The alternatives developed for this step are presented in **Section 7**.
- **Step 5, Alternative Evaluation**: The last step of this process is the evaluation of alternatives using qualitative and quantitative measures to compare their impacts on the overall transportation system in Vaughan and determine the effectiveness of the gap identification and prioritization steps in terms of achieving the objectives of the VTP. Evaluation metrics were developed with indicators that relate directly to the greater objectives of the VTP to ensure that the outcomes of this process align well with the overall plan. The evaluation methodology and results are presented in **Section 8**.

A summary of these steps is visualized in **Figure 2-1** on the following page.

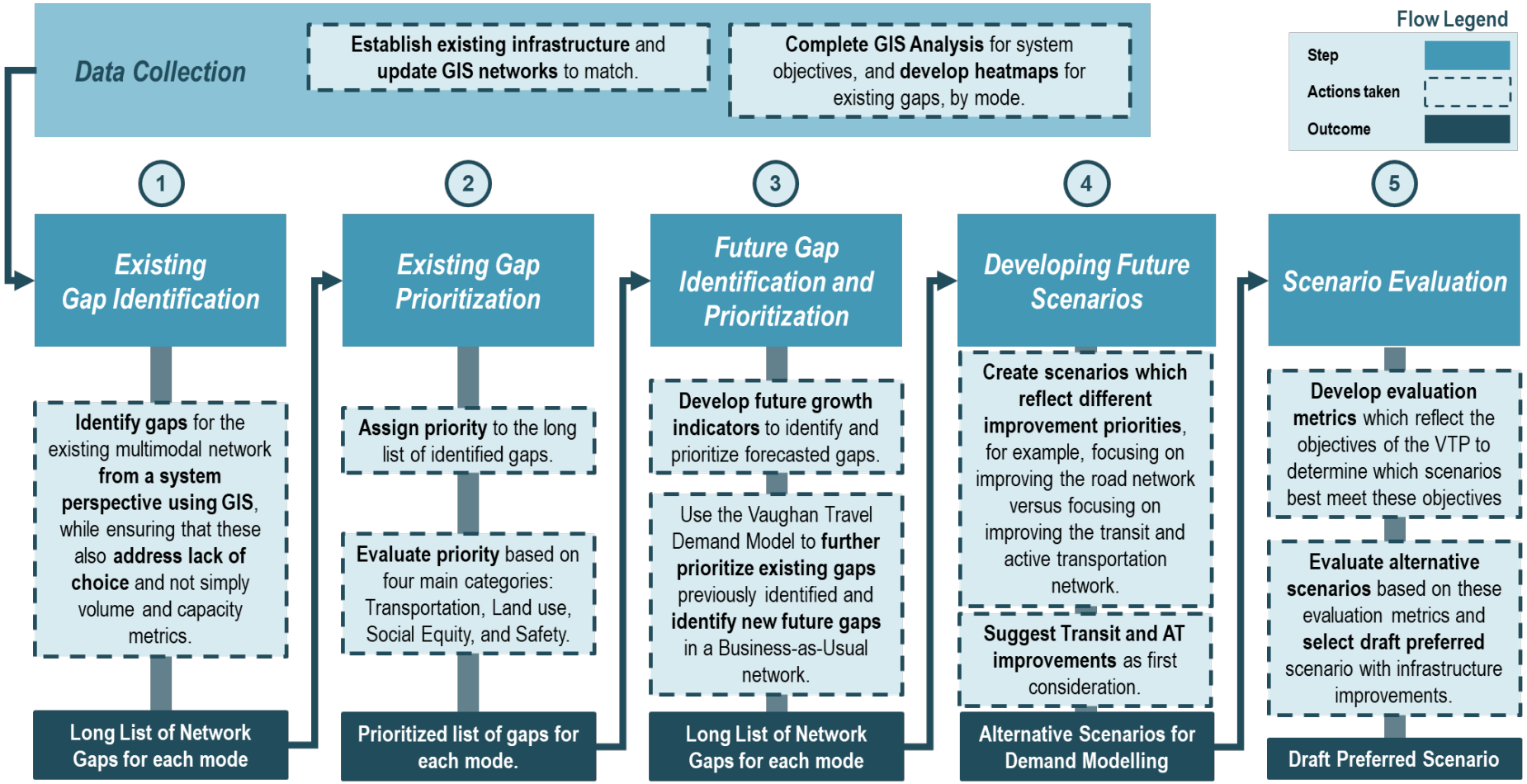


Figure 2-1: Process for identifying gaps and proposing infrastructure improvements

3 Existing Gap Identification

The objectives of the gap analysis and prioritization phases were to:

- Determine the need and justification for new infrastructure;
- Consider gaps for all modes equally;
- Prioritize areas of greatest need;
- Accommodate future growth; and
- Create an adaptable and repeatable framework.

Gaps were identified from a system perspective. Many of the problems, as well as opportunities, in the transportation system originate from missing connections such as disconnected biking infrastructure, sidewalk gaps or a lack of direct walking routes, circuitous roads, long blocks, an urban form built to the scale of vehicles instead of people, and few crossings of major barriers. This results in a lack of mobility and route choice, which ultimately forces an over-reliance on autos to complete trips. By providing more choice in the system, it becomes more reliable and efficient by virtue of having more options. In order to identify these gaps, a series of spatial analyses were completed using primarily GIS tools. This analysis identified “hot spots”, or gaps that require improvement.

3.1 Methodology

Connectivity and safety indicators were used during the gap analysis to help identify issues in the existing road, transit, walking, and biking network as shown in **Figure 3-1**, below.

Appendix C: Existing Gap Identification Measures provides a full description of the indicators, including specific data requirements, and descriptions of how gaps for each indicator could appear.

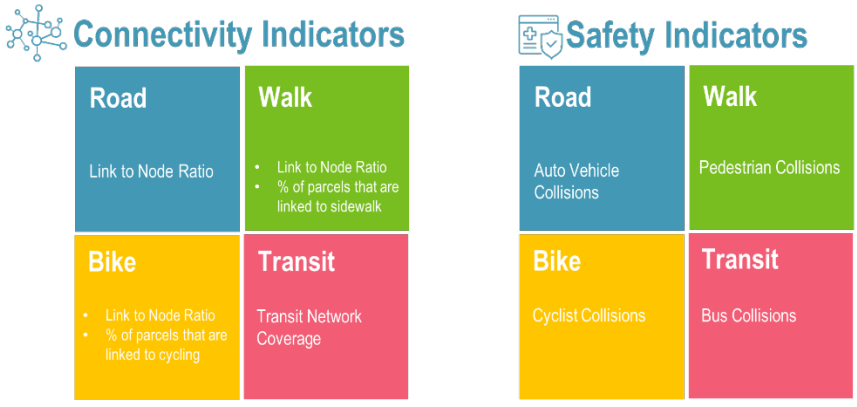


Figure 3-1: Objectives and measures used for identifying network gaps

The types of gaps identified can be found in **Figure 3-2**.

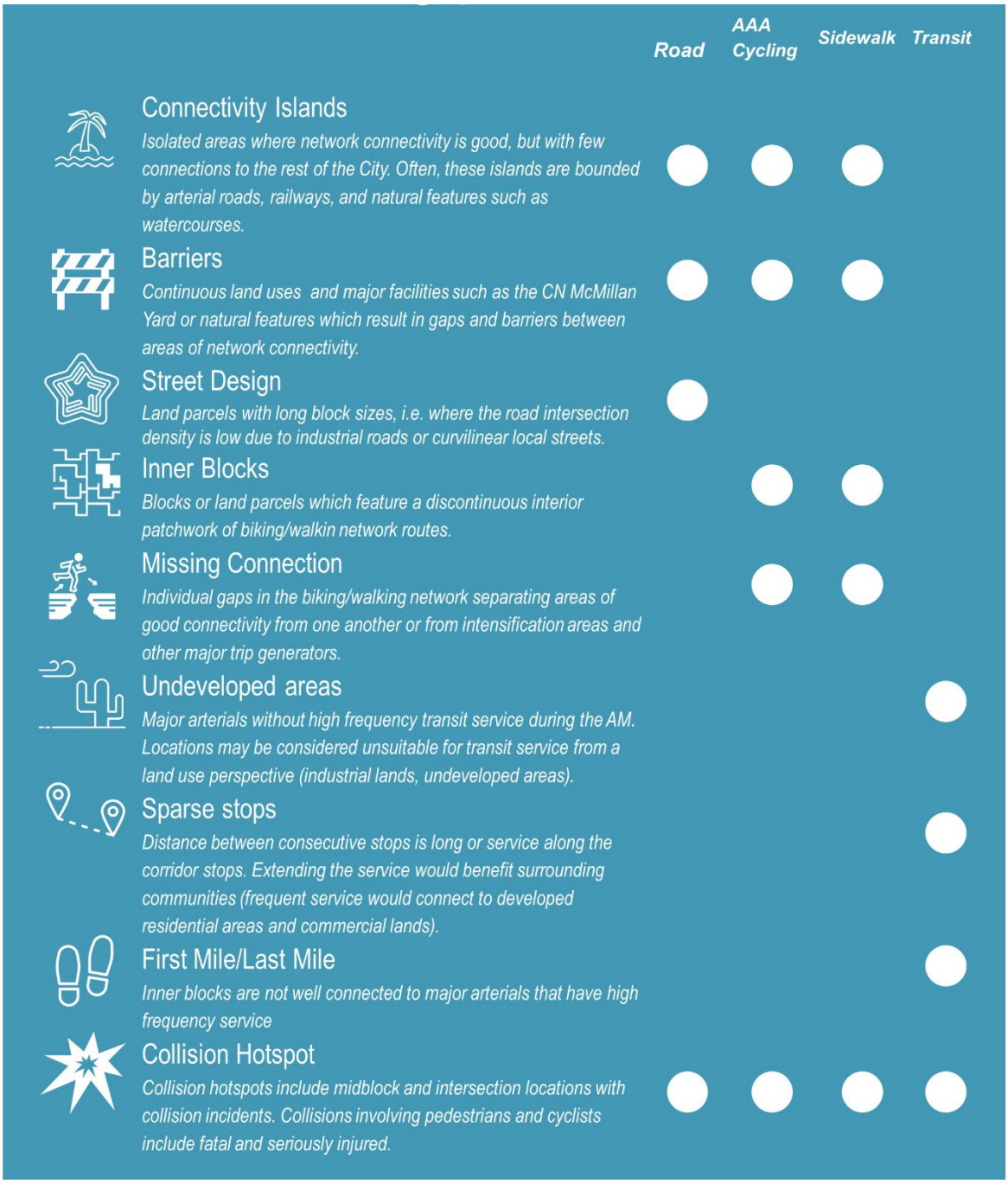


Figure 3-2: Types of Existing Gaps

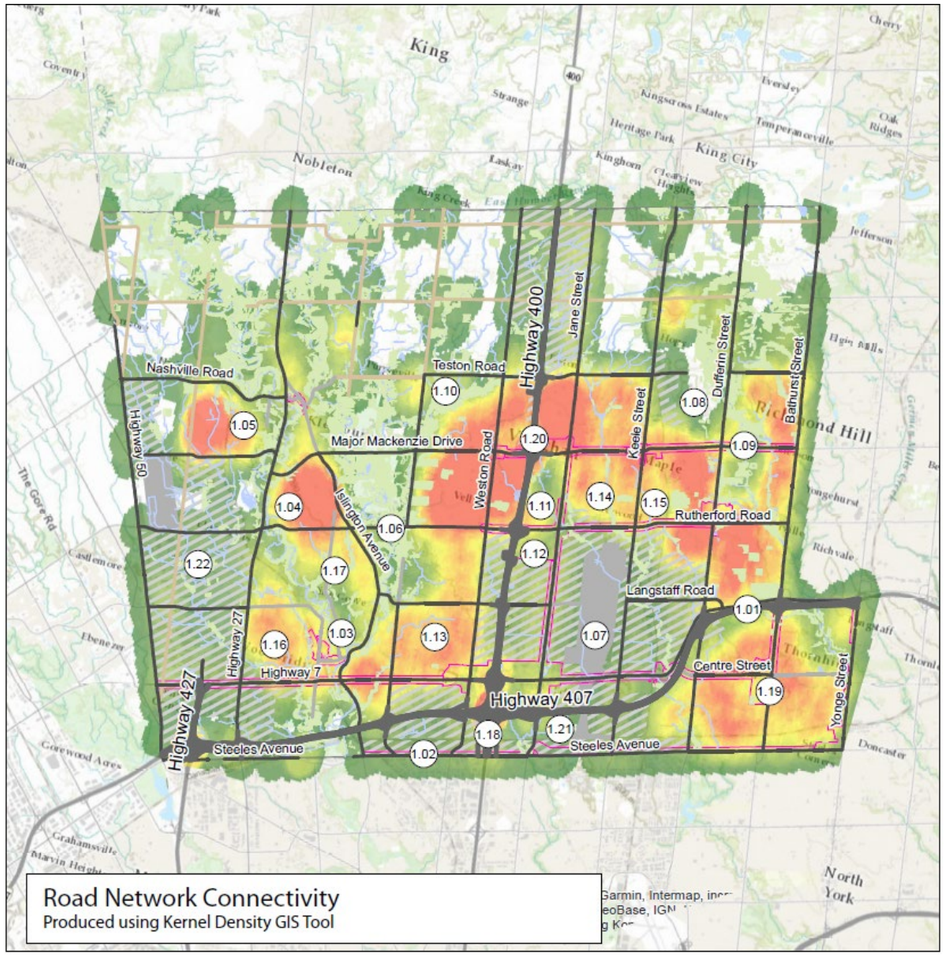
3.2 Long List of Gaps

Overall, the gap analysis resulted in over 200 locations and corridors that require some form of improvement, which are referred to as the long list of gaps. Gaps have been categorized into groups and help during the development of alternative solutions, as different gaps will require a difference in approach to address.

Sections **3.2.1** to **3.2.5** provide a few examples of the long list of gaps: road network connectivity, AAA cycling network connectivity, sidewalk network accessibility, transit accessibility, and mid-block cycling and pedestrian-involved collisions. The full list can be found in ***Appendix D: Long List of Existing Gaps***.

3.2.1 Road Network Connectivity

A colour gradient of dark green to dark red indicates areas with low to high road intersection density, respectively.



Long List of Gaps

Connectivity Islands

Isolated areas where road connectivity is good, but with few connections to the rest of the City. Often, these islands are bounded by arterial roads, railways, and natural features such as watercourses.

- **1.02 – Steeles Ave W:** Poor connectivity. Islands of connectivity surrounding the intersections with Hwy 427, Hwy 27 and Kipling Avenue, and Hwy 400.
- **1.03 – Woodbridge Centre**: Connectivity island separated from the majority of the City; bounded by Hwy 27, Hwy7, and the Humber River valley.
- **1.04 – Napa Valley Community:** Connectivity island separated from the majority of the City; bounded by Hwy 27, Major Mackenzie Diver, Islington Avenue, and the Humber River valley. Langstaff Road is discontinuous across the Humber River valley
- **1.05 – Block 61 West:** Connectivity island separated from the majority of the City; bounded by Huntington Road, Nashville Road, Hwy 27, and Major Mackenzie Drive.
- **1.18 – Highway 400/Highway 407 Interchange:** Connectivity islands separated by the highway interchange.

Street Design

Land parcels with long block sizes, i.e. where the road intersection density is low due to industrial roads or curvilinear local streets.

- **1.13 – Highway 7/Weston/Rutherford/Islington Parcels:** Poor connectivity due to curvilinear suburban street network
- **1.14 – Rutherford/Keele/Major Mackenzie/Jane Parcels:** Poor connectivity due to curvilinear suburban street network.
- **1.15 – Rutherford/Barrie GO Line/Major Mackenzie/Keele Parcels:** Poor connectivity due to curvilinear suburban street network
- **1.16 – Highway 7/Kipling/Langstaff/Highway 27 Parcels:** Poor connectivity due to curvilinear suburban street network.
- **1.17 – Humber River/Islington/Rutherford Parcels:** Poor connectivity due to curvilinear suburban street network.
- **1.19 – Thornhill:** Areas of poor connectivity due to the curvilinear suburban street network.

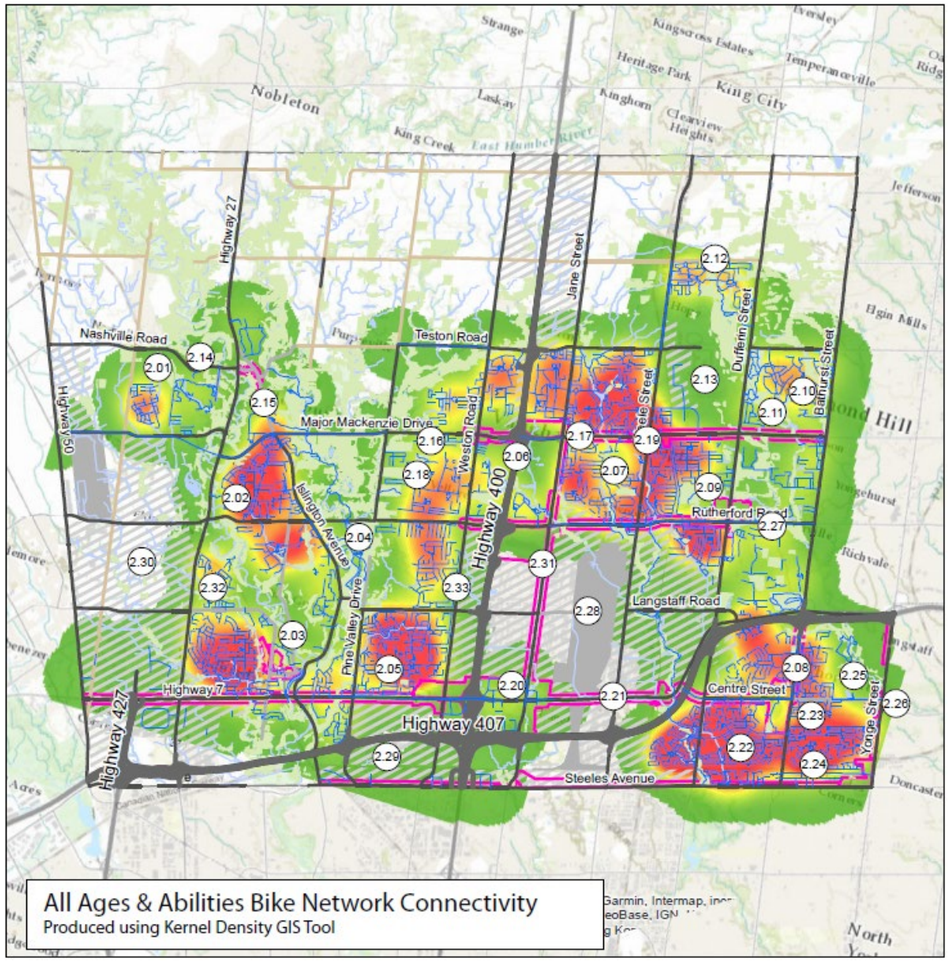
Barriers

Continuous land uses and major facilities such as the CN McMillan Yard or natural features which result in gaps and barriers between areas of road network connectivity.

- **1.01 – Highway 407:** Forms a barrier between well-connected communities to the north and south, from Bathurst to Dufferin Streets.
- **1.06 – Kortright & Boyd Conservation Areas**: Conservation area forms barriers to east-west travel between Woodbridge and the rest of the City. Pine Valley Drive is discontinuous across the conservation areas.
- **1.07 – CN MacMillan Yard & Employment Areas:** Rail infrastructure and associated industrial employment areas form a significant barrier to east-west connectivity north of Steeles Avenue and south of Rutherford Road.
- **1.08 – Keele Valley Landfill:** Closed landfill forms a barrier to east-west connectivity from Keele Street to Dufferin Street north of Major Mackenzie Drive. Teston Road is discontinuous across the landfill.
- **1.09 – Dufferin/Major Mackenzie Intersection:** Maple Nature Reserve forms a barrier to east-west connectivity in northeast and southeast quadrants.
- **1.10 – Pine Valley/Teston Intersection**: Undeveloped green space forms a barrier to north-south and east-west connectivity.
- **1.11 – Canada's Wonderland:** Amusement Park forms a barrier to east-west connectivity.
- **1.12 – Vaughan Mills:** Large shopping mall forms a barrier to north-south and east-west connectivity.
- **1.20 – Highway 400 Corridor:** Highway infrastructure forms a significant barrier to east-west connectivity. Only one mid-block crossing exists (Portage Parkway), funneling east-west traffic to major arterial roads.
- **1.21 – South Vaughan Employment Areas:** Industrial employment areas south of Hwy 407 and west of Dufferin Street form barriers to north-south and east-west connectivity, funneling traffic to major arterial roads.
- **1.22 – West Vaughan Employment Areas:** Existing and future employment areas in Blocks 50, 57-60, and 64-66 form barriers to north-south and east-west connectivity, funneling traffic to major arterial roads only.

3.2.2 All Ages & Abilities (AAA) Cycling Network Connectivity

A colour gradient of dark green to dark red indicates areas with low to high AAA bike network density, respectively.



Long List of Gaps

Connectivity Islands

Isolated areas where road connectivity is good, but with few connections to the rest of the City. Often, these islands are bounded by arterial roads, railways, and natural features such as watercourses.

- **2.01 – Block 61 West**
- **2.02 – Napa Valley Community** (Block 53)
- **2.03 – Woodbridge Centre** (Blocks 51 & 44)
- **2.05 – Block 37:** New Highway 7 multi-use path is the only current AAA connection to this block
- **2.08 – Thornhill:** Internal discontinuity in AAA network also evident around Promenade Mall
- **2.10 – Block 12 Northeast**
- **2.12 – Historic Community of Hope**
- **2.32 – Block 52 Southwest**

Barriers

Continuous land uses and major facilities such as the CN McMillan Yard or natural features which result in gaps and barriers between areas of road network connectivity.

- **2.04 – Kortright & Boyd Conservation Areas:** Conservation area forms barriers to east-west travel between Woodbridge and the rest of the City.
- **2.06 – Highway 400/Canada's Wonderland:** Barrier separating dense areas of AAA network connectivity to the east and west, with no mid-block crossings featuring AAA infrastructure.
- **2.13 – Keele Valley Landfill:** Closed landfill forms a barrier to east-west connectivity from Keele Street to Dufferin Street.
- **2.24 – CN York Subdivision** (Yonge-Steeles Intensification Area): Rail corridor forms a significant barrier to accessing the intensification area from denser areas of Thornhill to the northwest.
- **2.25 – Block 2:** Golf and country clubs form barriers between central Thornhill and the Langstaff intensification area.
- **2.28 – CN MacMillan Yard & Employment Areas:** Rail infrastructure and associated industrial employment areas form a significant barrier to east-west AAA connectivity north of Steeles Avenue and south of Rutherford Road.
- **2.29 – South Vaughan Employment Areas:** Industrial employment areas south of Hwy 407 and west of Dufferin Street form barriers to north-south and east-west connectivity. No continuous AAA facilities in these areas.
- **2.30 – West Vaughan Employment Areas:** Existing and future employment areas in Blocks 50, 57-60, and 64-66 form barriers to north-south and east-west connectivity. No continuous AAA facilities in these areas.

Inner Blocks

Blocks or land parcels which feature a discontinuous interior patchwork of AAA/sidewalk network routes.

- **2.07 – Historic Maple Village** (Southwest quadrant of Keele/Major Mackenzie Intersection): Discontinuity due to rural-profile roads.
- **2.09 – Dufferin/Rutherford Intersection**: Undeveloped greenspace and collector roads in the northwest quadrant form internal barriers to north-south and east-west connectivity.
- **2.18 – Block 39**
- **2.27 – Blocks 10 & 11**

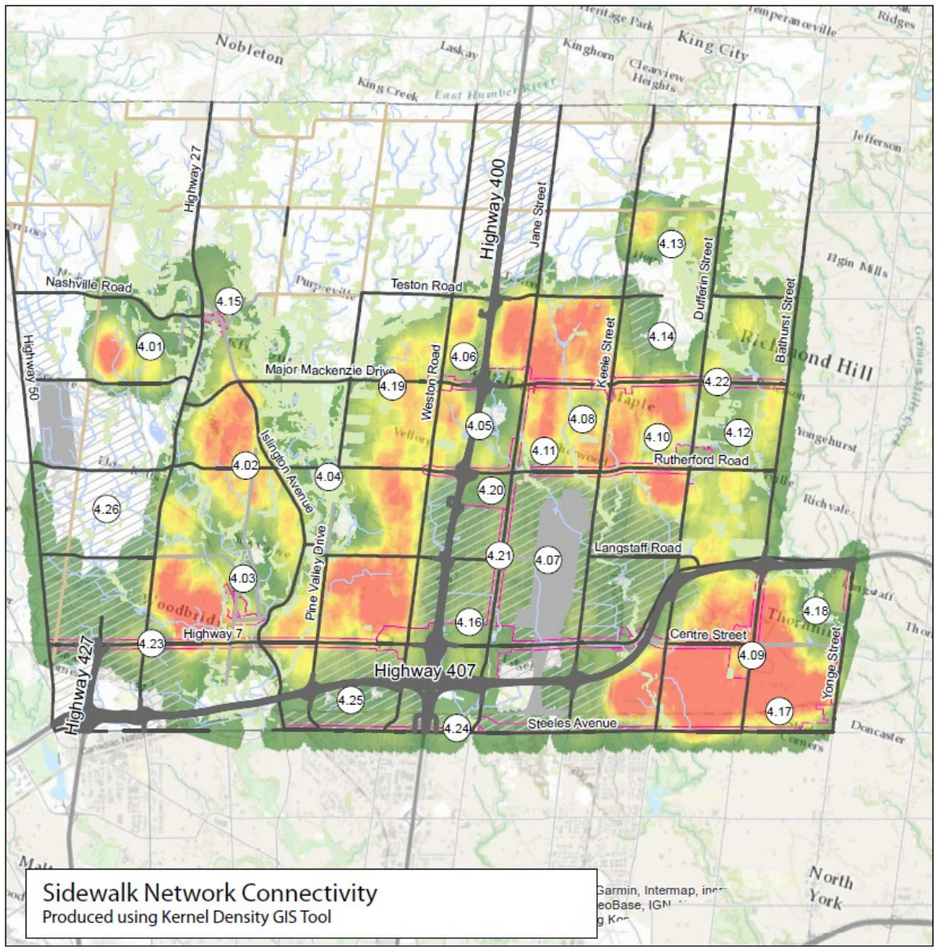
Missing Connection

Individual gaps in the AAA/sidewalk network separating areas of good connectivity from one another or from intensification areas and other major trip generators.

- **2.11 – Dufferin/Major Mackenzie Intersection:** Missing AAA connection in northeast quadrant to Major Mackenzie Intensification Area due to Maple Nature Reserve barrier.
- **2.14 – Kleinburg Intensification Area:** Missing connection to Block 61 West along Nashville Road.
- **2.15 – Kleinburg Intensification Area:** Missing connection to Napa Valley Community along Islington Avenue.
- **2.16 – Jane/Major Mackenzie Intensification Area:** Missing connection from the west along Major Mackenzie Drive from Pine Valley Drive to Highway 400.
- **2.17 – Jane/Major Mackenzie Intensification Area:** Missing connection from north and south along Jane Street and east along Major Mackenzie Drive.
- **2.19 – Keele/Major Mackenzie Intensification Area**: Missing connection from all directions along Keele Street and Major Mackenzie Drive.
- **2.20 – Vaughan Metropolitan Centre Intensification Area:** Missing connection along Hwy 7 from Edgeley Blvd to Jane Street.
- **2.21 – Highway 7 Corridor:** Major arterial corridor without continuous AAA network infrastructure.
- **2.22 – Bathurst/Centre Intensification Area:** Missing north-south connections along Dufferin and Bathurst Streets.
- **2.23 – Bathurst/Centre Intensification Area:** Missing east-west connection along Centre Street.
- **2.26 – Yonge Street Corridor:** Missing north-south connections between Langstaff, Bathurst/Centre, and Yonge/Steeles intensification areas.
- **2.31 – Jane Street Corridor:** Major arterial corridor without continuous AAA network infrastructure.
- **2.33 – Weston Road Corridor:** Major arterial corridor without continuous AAA network infrastructure.

3.2.3 Sidewalk Network Connectivity

A colour gradient of dark green to dark red indicates areas with low to high sidewalk network density, respectively.



Long List of Gaps

Connectivity Islands

Isolated areas where network connectivity is good, but with few connections to the rest of the City. Often, these islands are bounded by arterial roads, railways, and natural features such as watercourses.

- **4.01** – **Block 61 West**
- **4.02 – Napa Valley Community** (Block 53)
- **4.03 – Woodbridge Centre** (Blocks 51 & 44)
- **4.09 – Thornhill**
- **4.13 – Historic Community of Hope**

Barriers

Continuous land uses and major facilities such as the CN McMillan Yard or natural features which result in gaps and barriers between areas of road network connectivity.

- **4.04 – Kortright & Boyd Conservation Areas:** Conservation area forms barriers to east-west travel between Woodbridge and the rest of the City.
- **4.05 – Highway 400/Canada's Wonderland:** Barrier separating dense areas of sidewalk connectivity to the east and west.
- **4.07 – CN MacMillan Yard & Employment Areas:** Rail infrastructure and associated industrial employment areas form a significant barrier to east-west connectivity north of Steeles Avenue and south of Rutherford Road.
- **4.14 – Keele Valley Landfill:** Closed landfill forms a barrier to east-west connectivity from Keele Street to Dufferin Street.
- **4.17 – CN York Subdivision** (Yonge-Steeles Intensification Area): Rail corridor forms a significant barrier to accessing the intensification area from denser areas of Thornhill to the northwest.
- **4.18 – Block 2:** Golf and country clubs form barriers between central Thornhill and the Langstaff intensification area.
- **4.25 – South Vaughan Employment Areas:** Industrial employment areas south of Hwy 407 and west of Dufferin Street form barriers to north-south and east-west connectivity. No significant sidewalk density in these areas.
- **4.26 – West Vaughan Employment Areas:** Existing and future employment areas in Blocks 50, 57-60, and 64-66 form barriers to north-south and east-west connectivity. No significant sidewalk density in these areas.

Inner Blocks

Blocks or land parcels which feature a discontinuous interior patchwork of AAA/sidewalk network routes.

- **4.06 – Highway 400/Major Mackenzie Interchange:** Commercial area in the northwest quadrant forms a gap in sidewalk connectivity.
- **4.08 – Historic Maple Village** (Southwest quadrant of Keele/Major Mackenzie Intersection): Discontinuity due to rural-profile roads.
- **4.10 – Dufferin/Rutherford Intensification Area:** Undeveloped greenspace and collector roads form barriers to connectivity.
- **4.11 – Jane/Rutherford Intersection:** Parkland, Vaughan Operations Centre, and CN rail tracks form barriers to connectivity.
- **4.12 – Blocks 10-12:** Patchwork of internal connectivity, with undeveloped greenspace and parkland forming internal barriers.
- **4.19 – Blocks 39 & 40:** Poor connectivity to west and north of blocks.

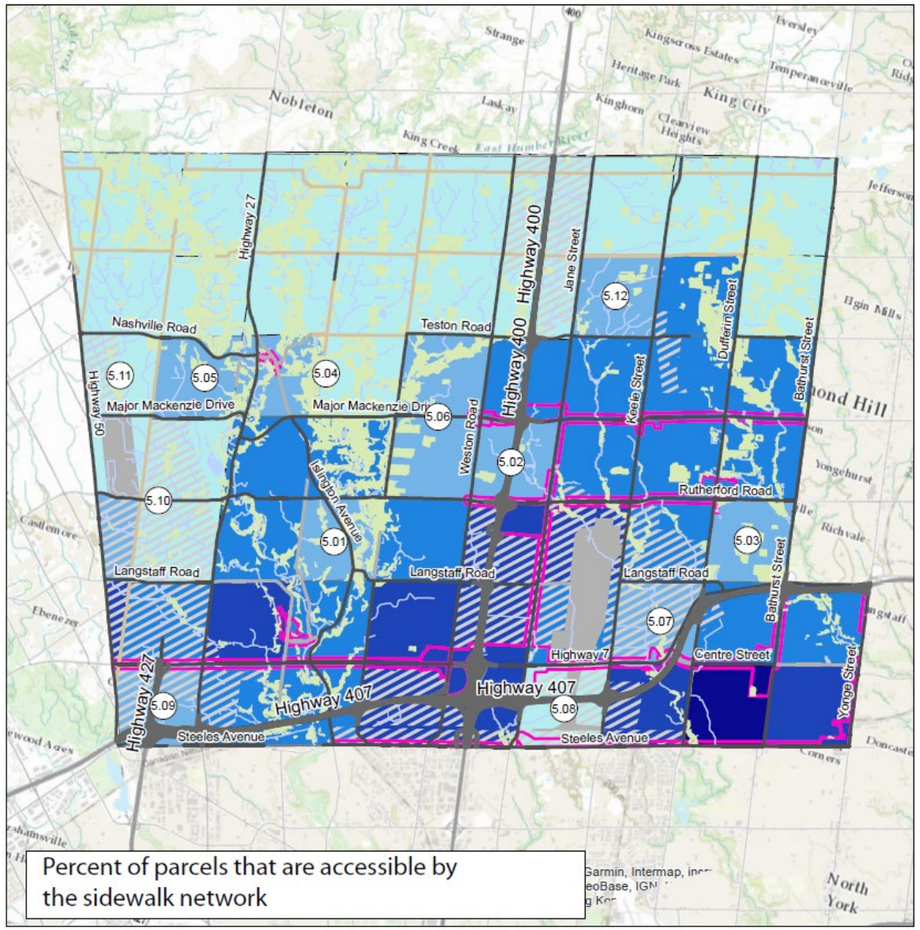
Missing Connection

Individual gaps in the AAA/sidewalk network separating areas of good connectivity from one another or from intensification areas and other major trip generators.

- **4.15 – Kleinburg Intensification Area:** Missing connections to Kleinburg from other areas of the City.
- **4.16 – Vaughan Metropolitan Centre Intensification Area:** Missing connections to VMC area from nearby dense areas of the City, especially Thornhill and Woodbridge.
- **4.20 – Vaughan Mills Intensification Area:** Continuous intensification corridor without significant sidewalk infrastructure.
- **4.21 – Jane Street Intensification Area:** Continuous intensification corridor without significant sidewalk infrastructure, from VMC north to Major Mackenzie.
- **4.22 – Major Mackenzie Drive Intensification Area:** Continuous intensification corridor without significant sidewalk infrastructure, from Keele east to Bathurst.
- **4.23 – Highway 7 Intensification Area:** Continuous intensification corridor without significant sidewalk infrastructure, from Islington west to Highway 50, with some sidewalk density around Woodbridge Centre.
- **4.24 – Steeles Avenue Intensification Area:** Continuous intensification corridor without significant sidewalk infrastructure, from Dufferin west to Islington.

3.2.4 Percentage of Parcels Accessible by the Sidewalk Network

Darker shades of blue indicate that a higher percentage of parcels within a given city block are accessible by the sidewalk network (defined as within 25 metres of a sidewalk). A gap was identified as a parcel or block less than 40% accessible by the sidewalk network. In some cases, multiple blocks were added together as a gap. North of the gaps that are shown and listed are remaining rural blocks that have less than 20% accessibility, which were not added to the list.



Legend

- Intensification Areas
- Rail Facilities
- Employment Areas

City Blocks- Parcels that are accessible by sidewalk

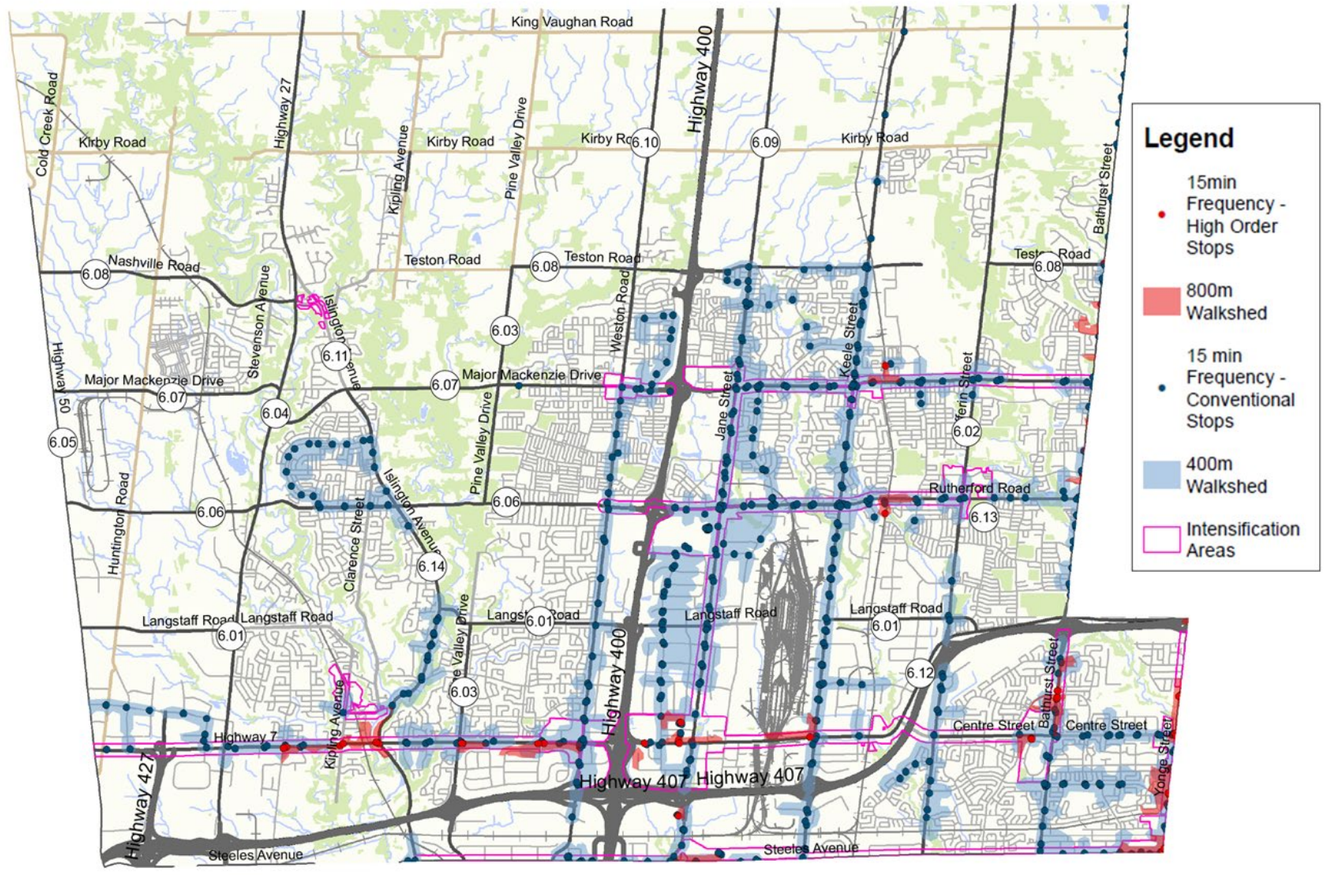
- 0% - 20%
- 20.1% - 40%
- 40.1% - 60%
- 60.1% - 80%
- 80.1% - 100%

Long List of Gaps

	Gap	Land Uses within Parcels							
		Residential	Commercial	Industrial	Parkland	Recreational	Highway	Railway	Open Space
5.01	Block 45	✓			✓	✓			
5.02	Block 32	✓				✓	✓		
5.03	Block 10	✓			✓				
5.04	Blocks 47 & 54	✓			✓				✓
5.05	Block 61	✓							
5.06	Blocks 39 & 40	✓			✓				✓
5.07	Block 16			✓			✓		
5.08	Block 22			✓				✓	✓
5.09	Block 57			✓			✓		✓
5.10	Blocks 59, 60, 64, & 65			✓				✓	✓
5.11	Block 66								✓
5.12	Block 27								✓

3.2.5 AM Peak Transit Accessibility

Red and blue points indicate bus stops served by 15-minute frequency higher-order and conventional transit services, respectively. Red and blue highlighted areas indicate the walkshed for such stops (800 metres for higher-order and 400 metres for conventional transit services).



AM Peak Transit Accessibility

Walksheds created based on the sidewalk network around high order* and conventional bus stops that have 15 min service between 7-8am on a typical weekday
Transit service based on January 2020 GTFS data

*Many high order stops are served by non-VIVA routes and as such high frequent service doesn't indicate 15 min VIVA service.

Long List of Gaps

Undeveloped areas

Major arterials without high frequency transit service during the AM. Locations may be considered unsuitable for transit service from a land use perspective (industrial lands, undeveloped areas).

- **6.03 – Pine Valley Drive:** From south City limits to north City limits, including one major discontinuity
- **6.04 – Highway 27:** From south City limits to north City limits
- **6.05 – Highway 50:** From south City limits to north City limits
- **6.10 – Weston Road:** From Major Mackenzie Drive to north City limits
- **6.08 – Teston Road/Nashville Road:** From east City limits to west City limits, excluding five stops from Keele Street to Highway 400
- **6.09 – Jane Street:** From Teston Road to north City limits

Sparse stops

Distance between consecutive stops is long or service along the corridor stops. Extending the service would benefit surrounding communities (frequent service would connect to developed residential areas and commercial lands).

- **6.01 – Langstaff Road:** From Dufferin Street to west City limits, including two major discontinuities in Langstaff
- **6.02 – Dufferin Street:** From Langstaff Road to north City limits, excluding two stops north of Langstaff and south of Major Mackenzie
- **6.06 – Rutherford Road:** From Weston Road to west City limits, excluding four stops west of Islington Avenue
- **6.07 – Major Mackenzie Drive:** From Weston Road to west City limits
- **6.11 – Islington Avenue:** From Napa Valley Avenue to Highway 27
- **6.12 – Highway 7:** From Keele Street to Bathurst Street; long stop spacing/discontinuities in walkshed
- **6.13 – Rutherford Road:** From Dufferin Street to Bathurst Street; long stop spacing/discontinuities in walkshed
- **6.14 – Islington Avenue:** From Langstaff Road to Rutherford Road; long stop spacing/discontinuities in walkshed

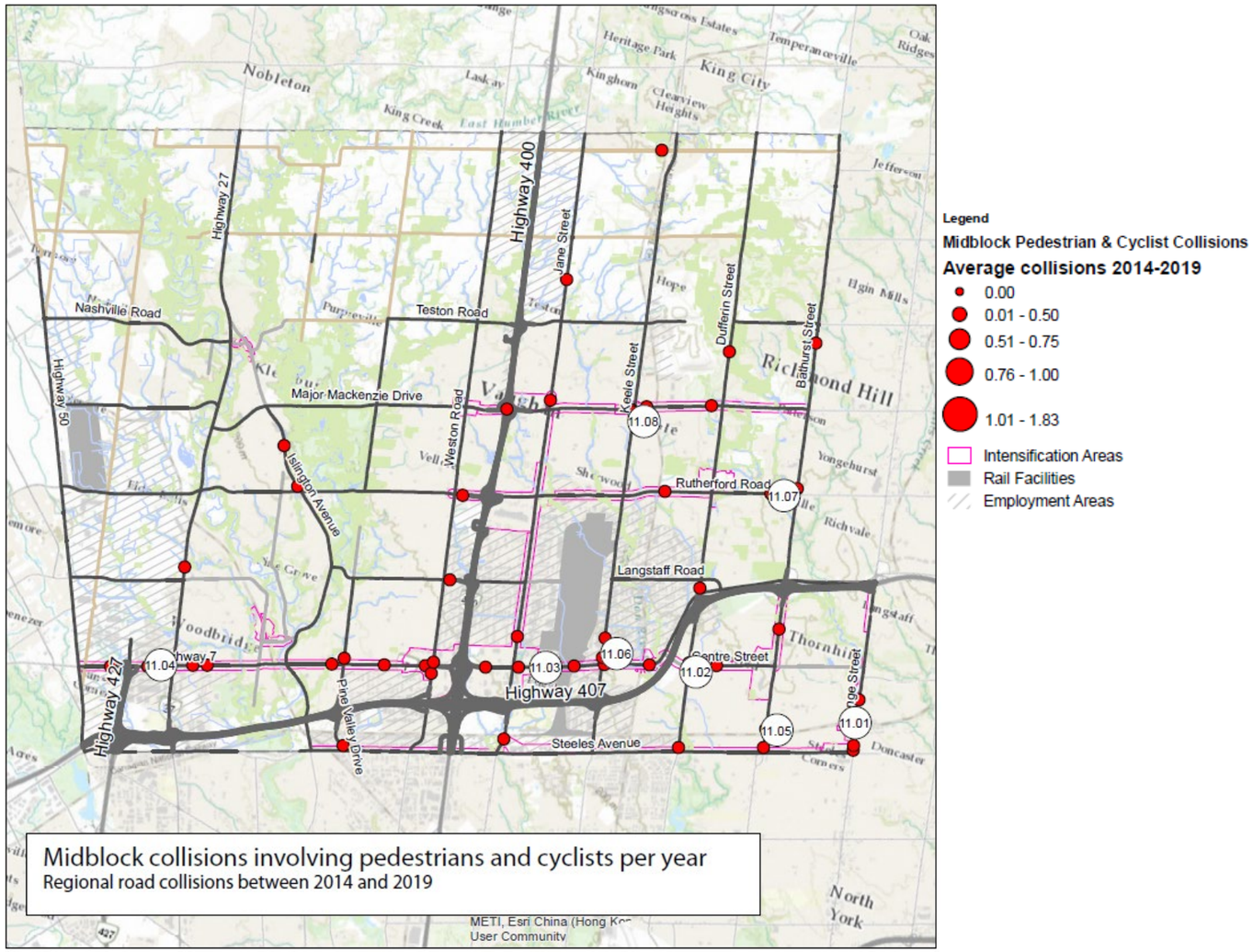
First Mile/Last Mile

Inner blocks are not well connected to major arterials that have high frequency service

The majority of inner blocks are not within walking distance of high-frequency transit stops. More specifically, 23% of people and 28% of jobs are within walking distance of high-frequency stops during the AM peak, and only 4% of people and 5% of jobs in the off-peak.

3.2.6 Midblock Cyclist and Pedestrian-Involved Collision Rate

Red dots are sized proportionately to the average cyclist and pedestrian-involved collision rate at the corresponding midblock segment. Collision location and frequency are recorded as per available collision data from York Region only.



Long List of Collision Hotspots

Collision Hotspot

Collision hotspots include midblock and intersection locations with collision incidents. Collisions involving pedestrians and cyclists include fatal or seriously injured.

- **11.01 - Yonge Street:** From Steeles Avenue to South of Centre Street
- **11.02 - Centre Street:** From West of Dufferin Street to East of Dufferin Street
- **11.03 - Highway 7:** From West of Pine Valley Drive to West of Centre Street
- **11.04 - Highway 7:** From West of Highway 427 to East of Highway 27
- **11.05 - Dufferin Street:** From Steeles Avenue to North of Steeles Avenue
- **11.06 - Keele Street:** From Highway 7 to North of Highway 7
- **11.07 - Rutherford Road:** From Bathurst Street to West of Bathurst Street
- **11.08 - Major Mackenzie Drive:** From Keele Street to East of Keele Street

4 Existing Gap Prioritization

After the long list of gaps has been identified as discussed in **Section 3**, they were prioritized based on a series of indicators to form a short list of gaps. The methodology and results are discussed in this section.

4.1 Methodology

To prioritize gaps within each mode according to the objectives of the VTP, a series of prioritization indicators – quantitative measures which can be calculated using GIS software for each gap identified in the long list – were developed. The indicators are not dependent on mode, which allows for a direct comparison of the priority score across all modes. Simply put, the higher the gap score, the higher it should be prioritized (all else being equal). The calculation of scores is described in greater detail below.

The data on which the indicators are based were taken from a variety of data sources, including the 2016 Transportation Tomorrow Survey (TTS), Statistics Canada Census, and Google Maps Distance Matrix API. The indicators used in the prioritization process are listed in the following table (**Table 4-1)**, along with data sources and descriptions where necessary. Note that collision hotspot data from the long list was used as an input to the safety prioritization indicators, rather than as a category of gaps on its own.

Table 4-1: Gap Prioritization Indicators

Category	Description of Indicators	Data Source(s)
Transportation Indicators	• **Mode-Specific Average Travel Time**: Average travel time from the gap to the nearest Primary Centre, Local Centre, or VMC, by mode. • **Mode-Specific On-Road to Straight-Line Distance Ratio:** Ratio of on-road distance divided by straight-line distance, from the gap to nearest Primary Centre, Local Centre, or VMC, by mode. • **Presence of a 15-Minute Frequency Transit Stop:** Whether a transit stop with a 15-minute frequency exists within 400 metres of the gap.	• Google Maps Distance Matrix API • GIS data provided by York Region Transit
Land Use Indicators	• Population Density • Presence of Employment Area • Presence of Intensification Area	• Transportation Tomorrow Survey (TTS) • GIS Data (Official Plan)
Social/Equity Indicators	• Percentage of Low-Income Households • Percentage of Seniors • Percentage of Immigrant Residents • Percentage of Zero-Car Households	• Statistics Canada Census • TTS Data
Safety Indicators	• Presence of a School Zone • Presence of a Senior Care Centre • Severity of Mode-Specific Collision Hotspots	• GIS data provided by the City • Collision data provided by York Region

To rank and compare the long list of gaps, and in particular, to give equal weighting to all categories of indicators, a normalized scoring system was developed. The indicator scoring system allowed for a weighted average score to be developed, considering the relative value of all indicators, for each gap, giving a normalized measure of how great the "need" of addressing that gap may be. The scoring system was developed as follows, with a higher score corresponding to greater need and therefore higher priority:

- For "discrete" indicators (i.e. those answerable with a "yes or no", such as the presence of a school zone within 500 metres of the gap), a score of 1 or 3 was assigned, with a score of 3 being assigned to whichever answer demonstrated greater need (ex. the presence of a school zone, or the lack of presence of a frequent transit stop) and a 1 being assigned to whichever answer demonstrated lesser need;
- For "continuous" indicators (i.e. those which have a calculated absolute value relative to other gaps, such as population density in persons per square kilometre, or percentage of low-income households in the associated Census dissemination area), a score between 1 and 4 was assigned depending upon the relative value of the indicator for the gap as compared to the average and standard deviation of that same indicator when calculated across all geographies (either Census dissemination areas or TTS traffic zones) in the City of Vaughan:
    - A score of 1 – Indicator value for the gap is less than $(Avg - StDev)$;
    - A score of 2 – Indicator value for the gap is between $(Avg - StDev)$ and Avg;
    - A score of 3 – Indicator value for the gap is between Avg and $(Avg + StDev)$;
    - A score of 4 – Indicator value for the gap is greater than $(Avg + StDev)$.

A calculation example for Gap 2.08 from the long list (internal discontinuities in the AAA cycling network in Thornhill) is given below in **Table 4-2**, demonstrating how scores are assigned to each indicator. Each indicator score is averaged to obtain a category score, and each category score is averaged to an overall weighted average score for the gap.

Table 4-2: Gap prioritization example scoring calculation

Category	Indicator	Indicator Score	Category Average Score
Transportation Indicators	• Mode-Specific Average Travel Time	4	**3.0**
	• Mode-Specific On-Road to Straight-Line Distance Ratio	2	
	• Presence of a 15-Minute Frequency Transit Stop	3	
Land Use Indicators	• Population Density	2	**2.0**
	• Presence of Employment Area	1	
	• Presence of Intensification Area	3	
Social/Equity Indicators	• Percentage of Low-Income Households	2	**2.0**
	• Percentage of Seniors	2	
	• Percentage of Immigrant Residents	2	
	• Percentage of Zero-Car Households	2	
Safety Indicators	• Presence of a School Zone	3	**3.0**
	• Presence of a Senior Care Centre	3	
	• Severity of Mode-Specific Collision Hotspots	3	

Averaging the category scores gives an overall score of **2.50** for this gap.

4.2 Short List of Gaps

Having completed the calculation of an overall average score for each gap, the long list of gaps can be organized in descending order into a prioritized shortlist for each mode. Please note that all categories were given the same weight in calculating the average. The results of the existing gap prioritization are discussed in the following sections.

4.2.1 Pedestrian Network Gaps

Scores were calculated for the long list of sidewalk network gaps, resulting in the shortlist of gaps presented in **Table 4-3**.

Table 4-3: Short List of Sidewalk Network Gaps

Gap	Description	Average Score	Transportation Score	Land Use Score	Social Equity Score	Safety Score
4.09	Thornhill	2.94	3.0	3.3	3.8	1.7
4.21	Jane Street Intensification Area	2.79	3.0	3.0	3.5	1.7
4.03	Woodbridge Centre	2.75	3.3	2.0	3.0	2.7
4.24	Steeles Avenue Intensification Area	2.54	3.7	2.3	2.5	1.7
4.17	CN York Subdivision	2.44	1.7	1.7	3.8	2.7
4.20	Vaughan Mills Intensification Area	2.38	3.0	1.7	2.5	2.3
5.08	Block 22	2.38	3.7	1.7	2.5	1.7
4.25	South Vaughan Intensification Area	2.33	3.0	1.7	3.0	1.7
4.11	Jane/Rutherford Intersection	2.33	2.3	1.7	3.0	2.3

The southeast Vaughan area of Thornhill had the highest scores in the prioritization of sidewalk gaps. In general, the area has good sidewalk density within the gap area itself, but connecting to the rest of Vaughan for pedestrians is difficult given that it is bound by several key roadways including Hwy 407, Steeles Ave., and Keele St.

4.2.2 Cycling Network Gaps

The same process was undertaken for the long list of cycling network gaps, the results of which are presented in **Table 4-4**.

Table 4-4: Short List of AAA Network Gaps

Gap	Description	Average Score	Transportation Score	Land Use Score	Social Equity Score	Safety Score
2.22	Bathurst/Centre Intensification Area	3.27	3.7	2.7	3.8	3.0
2.03	Woodbridge Centre	2.75	3.3	2.0	3.0	2.7
2.08	Thornhill	2.50	3.0	2.0	2.0	3.0
2.23	Bathurst/Centre Intensification Area	2.50	3.0	1.7	3.0	2.3
3.01	Block 30	2.50	2.7	2.0	3.0	2.3
2.24	CN York Subdivision	2.44	1.7	1.7	3.8	2.7
3.08	Block 31	2.44	3.0	2.3	2.8	1.7
2.19	Keele/Major Mackenzie Intensification Area	2.38	2.3	1.7	2.5	3.0

Scores from the shortlisted cycling network gaps have significant variability between the highest and lowest scoring gaps. The Bathurst/Centre intensification Area scored highest and appears as the first and fourth priority. For this corridor, there are missing north-south connections along Dufferin and Bathurst Streets (which is the highest scoring gap), and a missing east-west connection along Centre Street.

4.2.3 Transit Network Gaps

The long list of transit network gaps was also subject to the same process, resulting in the shortlist of gaps presented in **Table 4-5.**

Table 4-5: Short List of AM Transit Network Gaps

Gap	Description	Average Score	Transportation Score	Land Use Score	Social Equity Score	Safety Score
6.02	Dufferin	3.04	2.7	3.3	3.5	2.7
6.01	Langstaff	2.92	3.7	2.3	3.0	2.7
6.03	Pine Valley	2.85	3.7	2.3	2.8	2.7
6.13	Rutherford	2.85	2.7	3.3	2.8	2.7
6.07	Major Mackenzie	2.58	3.3	2.3	2.0	2.7
6.11	Islington	2.58	2.7	3.0	2.0	2.7
6.14	Islington	2.56	3.7	2.3	2.3	2.0

In general, transit network gaps were observed along corridors. Islington was noted to appear twice in the list, which represents sections north and south of Rutherford Road.

4.2.4 Road Network Gaps

Similarly, the scoring process was undertaken for the road network. **Table 4-6** presents the shortlist of road network gaps.

Table 4-6: Short List of Road Network Gaps

Gap	Description	Average Score	Transportation Score	Land Use Score	Social Equity Score	Safety Score
1.02	Steeles Ave W	2.75	3.5	2.7	3.5	1.3
1.19	Thornhill	2.63	3.0	2.0	3.5	2.0
1.21	South Vaughan Employment Area	2.58	4.0	1.7	3.0	1.7
1.03	Woodbridge Centre	2.44	3.0	1.3	2.8	2.7
1.16	Block 51	2.44	3.0	1.3	2.8	2.7
1.13	Blocks 37 & 38	2.38	3.0	1.3	2.5	2.7
1.12	Vaughan Mills	2.38	3.0	1.7	2.5	2.3
1.14	Block 25	2.35	3.5	1.7	2.3	2.0

The highest scoring gap for the road network was at Steeles Ave W, which has poor connectivity as the road forms significant key intersections with Hwy 427, Hwy 27, Kipling Ave, and Hwy 400. This leads to several islands of connectivity in the gap area. Additionally, it can be noted that the South Vaughan Employment Area gap also covers Steeles Ave, west of Highway 400.

ROAD GAPS FEASIBILITY FILTER

In addition to the prioritization indicators methodology, road network gaps only were subject to an additional step of prioritization in the form of a “feasibility filter” – a desktop review was conducted to determine the feasibility of road widening or new road infrastructure. Priority is given to road network gaps in areas of high feasibility. Feasibility filter categories are given below in **Table 4-7**, along with land use considerations and examples of city blocks matching each description.

By contrast, improvements to active transportation and public transit infrastructure are typically much more easily accommodated within existing public rights-of-way, and therefore were not subject to the same feasibility filter.

Table 4-7: Land use feasibility filter considerations

Land Use Considerations	Feasibility Filter	City Block Example
Stable, developed residential neighbourhood or significant natural/built barriers	**Low** – Road improvements are infeasible	Block 37
Developed neighbourhood with some right-of-way or open space for road improvements	**Medium** – Road improvements possible but unlikely	Block 39
Neighbourhood intensifying/in transition	**Medium** – Significant possibility for road improvements	Block 11
Undeveloped neighbourhood or open space	**High** – Freedom for road improvements	Block 59

4.3 Prioritized Gap Locations/Corridors

The prioritization process yielded the shortlists presented in **Section 4.2**, which are organized solely based on priority. Plotting the high-priority shortlists of each category of gap on a map of Vaughan allows for grouping of these transportation network gaps based on geography. These prioritized locations/corridors allow for solution development and the planning of infrastructure in future alternatives.

The prioritized sidewalk network gaps are listed in **Table 4-8** and presented in **Figure 4-1**. The prioritized corridors or areas include Thornhill, Woodbridge Centre, Jane Street, and Steeles Avenue West.

Table 4-8: Prioritized Sidewalk Network Gaps

Prioritized Sidewalk Network Gaps Location/Corridor	Gaps	Score
Thornhill	**4.09** – Thornhill	2.94
	4.17 – CN York Subdivision	2.44
Woodbridge Centre	**4.03** – Woodbridge Centre (Blocks 51 & 44)	2.75
Jane, from Highway 7 to north of Rutherford	**4.21** – Jane Street Intensification Area	2.79
	4.20 – Vaughan Mills Intensification Area	2.38
	4.11 – Jane/Rutherford Intersection	2.33
Steeles Avenue West	**4.24** – Steeles Avenue Intensification Area	2.54
	4.25 – South Vaughan Employment Area	2.33
	5.08 – Block 22	2.38

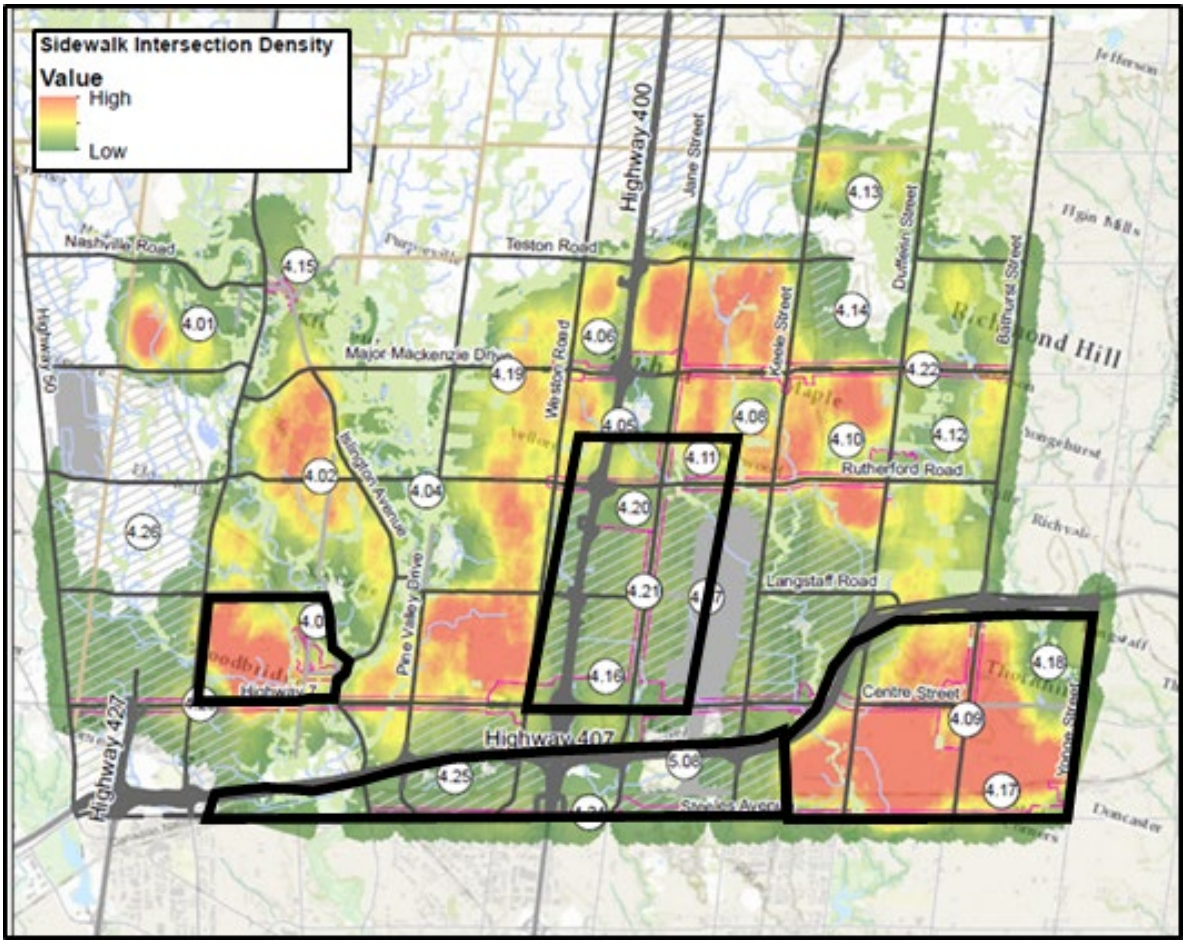


Figure 4-1: Prioritized Sidewalk Network Gap Locations

The prioritized AAA cycling network gaps are listed in **Table 4-9** and presented in **Figure 4-2**. The prioritized corridors or areas include Thornhill, Woodbridge Centre, the area bounded by Jane, Weston, Highway 7, and Rutherford, and Keele and Major Mackenzie.

Table 4-9: Prioritized AAA Cycling Network Gaps

Prioritized AAA Cycling Network Gaps Location/Corridor	Gaps	Score
Thornhill	**2.22** – Bathurst/Centre Intensification Area	3.27
	2.08 – Thornhill	2.50
	2.23 – Bathurst/Centre Intensification Area	2.50
	2.24 – CN York Subdivision	2.44
Woodbridge Centre	**2.03** – Woodbridge Centre (Blocks 51 & 44)	2.75
Between Jane and Weston, Highway 7 to Rutherford	**3.01** – Block 30	2.50
	3.08 – Block 31	2.44
Keele & Major Mackenzie	**2.19** – Keele/Major Mackenzie Intensification Area	2.38

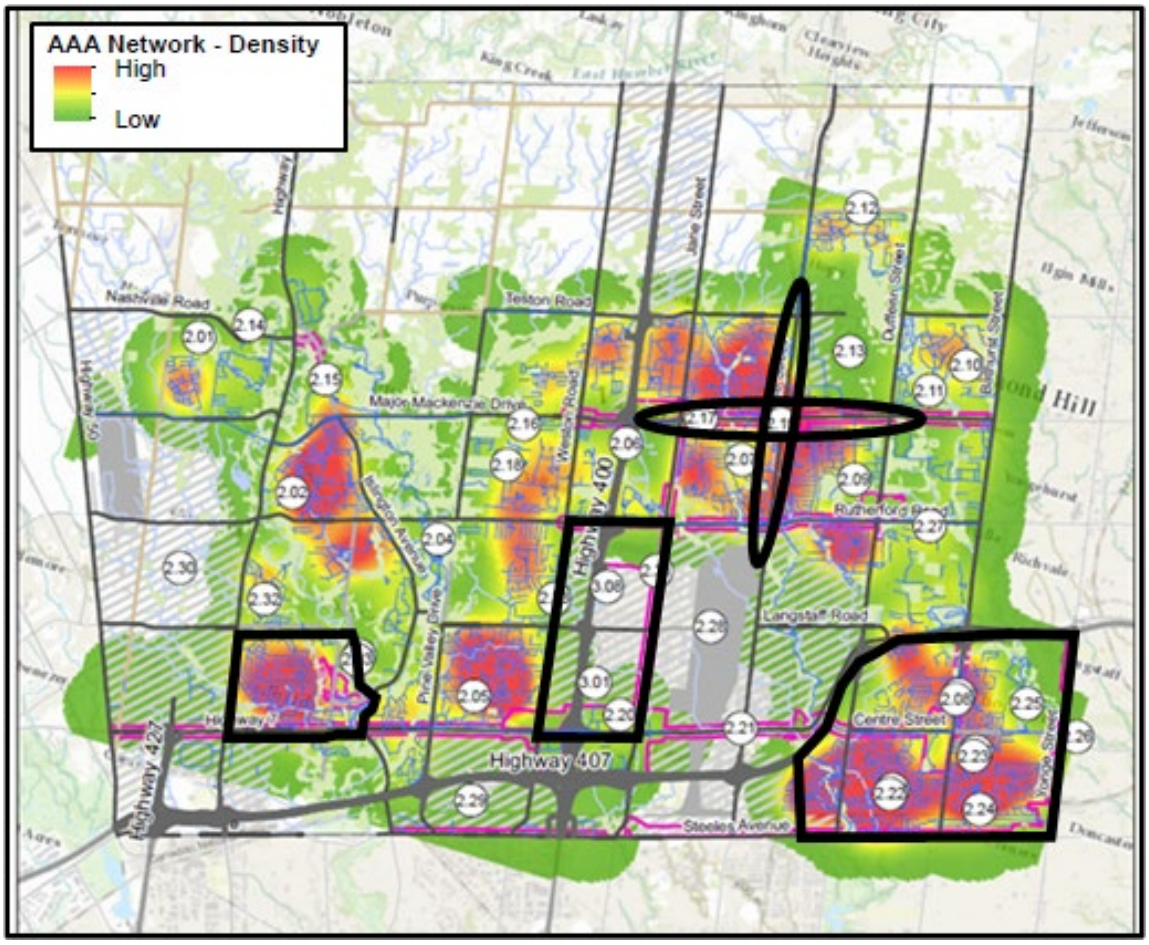


Figure 4-2: Prioritized AAA Cycling Network Gap Locations

Prioritized gap areas in the AAA Cycling Network have some overlap with both the sidewalk (**Figure 4-1**) and road network gaps (shown in **Figure 4-4**), particularly in the Hwy 400 area. Additionally, the Thornhill area appears as the highest priority gap, primarily due to being bounded by highways and intersections, lacking access to the remainder of Vaughan.

The prioritized transit network gaps are listed in **Table 4-10** and presented in **Figure 4-3**.

Table 4-10: Prioritized AM Transit Network Gaps

Prioritized AM Transit Network Gaps Location/Corridor	Gaps	Score
Dufferin, from Langstaff to north City limits	**6.02** – Major corridor without frequent transit service	3.04
Langstaff, from Dufferin to west City limits	**6.01** – Major corridor without frequent transit service	2.92
Pine Valley, from south to north City limits	**6.03** – Major corridor without frequent transit service	2.85
Rutherford, from Dufferin to Bathurst	**6.13** – Sparse stops	2.85
Major Mackenzie, from Weston to west City limits	**6.07** – Major corridor without frequent transit service	2.58
Islington	**6.11** – Major corridor without frequent transit service	2.58
	6.14 – Sparse stops	2.56

Figure 4-3: Prioritized AM Transit Network Gap Locations

The Dufferin corridor was identified as the highest priority transit gap area, where service improvements could be beneficial. Other corridors, such as Langstaff, Pine Valley, and Rutherford, are also identified that could benefit from frequent transit service or changes in stop spacing. It is, however, acknowledged that this analysis is primarily to inform, and does not include other constraints or considerations such as budget and scheduling conflicts.

The prioritized road network gaps are listed in **Table 4-11** and presented in **Figure 4-4**. These show groupings of gaps, along with their feasibility filter level, which represents how feasible road improvements are in this area.

Table 4-11: Prioritized Road Network Gaps

Prioritized Road Network Gaps Location/Corridor	Gaps	Score	Feasibility
Steeles Avenue West/South Vaughan Employment Area	**1.02** – Steeles Ave W **1.21** – South Vaughan Employment Area **1.18** – Highway 400/Highway 407 Interchange	2.8 2.6 2.1	High
West Vaughan Employment Area	**1.22** – West Vaughan Employment Areas	2.1	High
Highway 400 Corridor	**1.20** – Highway 400 Corridor **1.18** – Highway 400/Highway 407 Interchange	2.3 2.1	Medium
Northeastern Vaughan	**1.15 –** Block 18 Street Design **1.09 –** Dufferin / Major MacKenzie Intersection **1.10 –** Pine Valley / Teston Intersection **1.08 –** Keele Valley Landfill	2.0 1.7 1.7 1.6	Medium

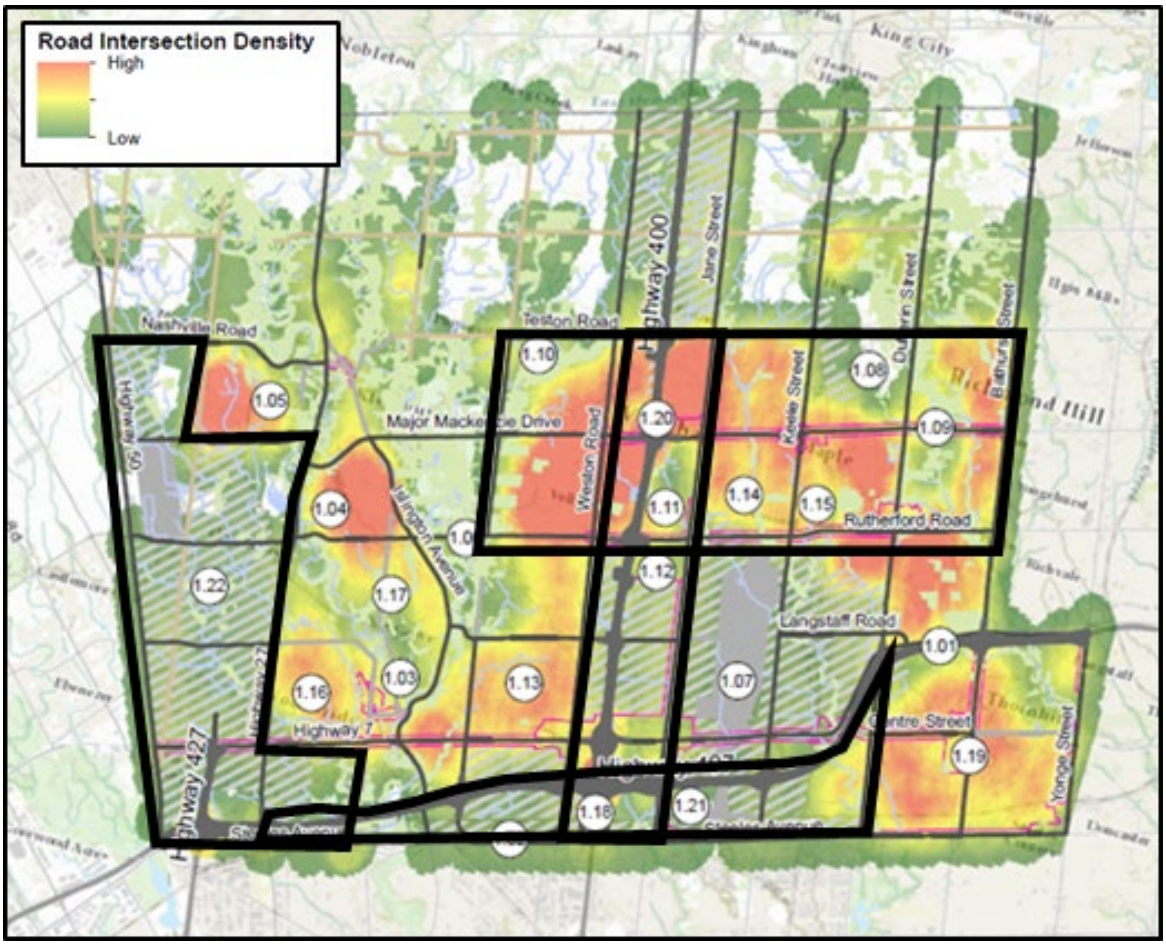


Figure 4-4: Prioritized Road Network Gap Locations

In general, the prioritized road network gap locations are adjacent to major highways, such as Highway 427 / Highway 50 (West Vaughan Employment Areas), Highway 400, and Highway 407. The Steeles Ave, South Vaughan Employment Area, and West Vaughan employment areas have the highest priority.

Across all categories of gaps, certain corridors and areas of the City of Vaughan appear commonly as prioritized gap locations. These include the Highway 400 corridor, Thornhill, Woodbridge Centre, northeastern Vaughan, and the South Vaughan Employment Area. This indicates that infrastructure improvements in these areas of the city have the greatest potential to positively address gaps in multiple facets of Vaughan's transportation network. For instance, developing a finer-grained street network in the vicinity of Highway 400 and implementing further midblock crossings of the highway could increase active transportation network density in these areas, resolving gaps in the road, cycling, and sidewalk networks simultaneously.

5 Future Gaps Identification and Prioritization

5.1 Methodology

To accommodate the effects of future growth, gaps were identified and prioritized for future conditions using the results of the Vaughan Travel Demand Forecasting model under the 2051 "Business-as-Usual" (BAU) scenario. Details on this scenario are further discussed in **Section 7.1**. The results either help to further prioritize existing gaps previously identified in the existing gaps prioritization step or to highlight new gaps which may also merit the inclusion of infrastructure to address.

Since the prioritization indicators which underlie the existing gap prioritization process cannot be calculated under future conditions with current analytical tools, a different set of indicators were developed for each mode to identify and give priority to future gaps. The indicators include:

- **Cycling gaps:** based on conversion potential from auto trips
- **Transit gaps:** based on crowding on transit lines and population and employment accessibility
- **Road gaps:** based on travel time index

Detailed methodology and results are discussed in the following sections.

5.2 Future Cycling Network Focus Areas

The Vaughan Travel Demand Forecasting Model does not model individual cycling network links or volumes. Specifically, this model is disaggregated only to a traffic zone level and does not feature local street networks, cycling facilities, or trails. Since it is difficult to accurately model cycling trips or volumes using this level of aggregation, future cycling network gaps were identified at the traffic zone level.

Cycling network gaps were identified by filtering plotting the average travel speed of short (i.e., trips under 5 kilometres in length) auto trips originating from each traffic zone, as output by the model. Short auto trips with a low average travel speed were considered indicative of a high latent potential to convert auto trips to cycling trips, as cycling speeds can approach vehicle speeds in these areas.

Table 5-1 lists future cycling network focus areas in Vaughan and **Figure 5-1** presents them geographically. Results are clustered in three areas of the City, all of which feature a high proportion of short, slower auto trips in the future: Thornhill near Promenade Mall and Dufferin Street, Northeastern Vaughan near Rutherford and Maple GO stations, and the Vellore neighbourhood west of Highway 400. Prioritizing cycling infrastructure improvements in these neighbourhoods could have the greatest investment potential.

It was noted that the City has recently completed the Pedestrian and Bicycle Master Plan (PBMP) in 2020 which defines a primary cycling network that aligns with roadways and a network of multi-use recreational trails. The identification of focus areas builds on the recommendations in the PBMP and identifies areas to prioritize cycling and walking

infrastructure improvements since these areas have the highest potential for benefit from a demand perspective (i.e., future low-speed and short-distance auto trips can more easily be converted to active mode).

Table 5-1: Prioritized Future Cycling Network Gaps

Prioritized Future Cycling Network Gaps Location/Corridor	Description	Existing or New Gaps?
Vellore Neighbourhood	Dense residential neighbourhood with low average travel speed.	Existing (further prioritized 2.16, 2.18, 3.03, 3.04)
Northeastern Vaughan	Residential neighbourhoods with low average travel speed and high existing transit access.	Existing (further prioritized 2.07, 2.09, 2.17, 2.19, 3.05)
Southwestern Thornhill	Residential neighbourhoods with low average travel speed and high existing transit access.	Existing (further prioritized 2.22)

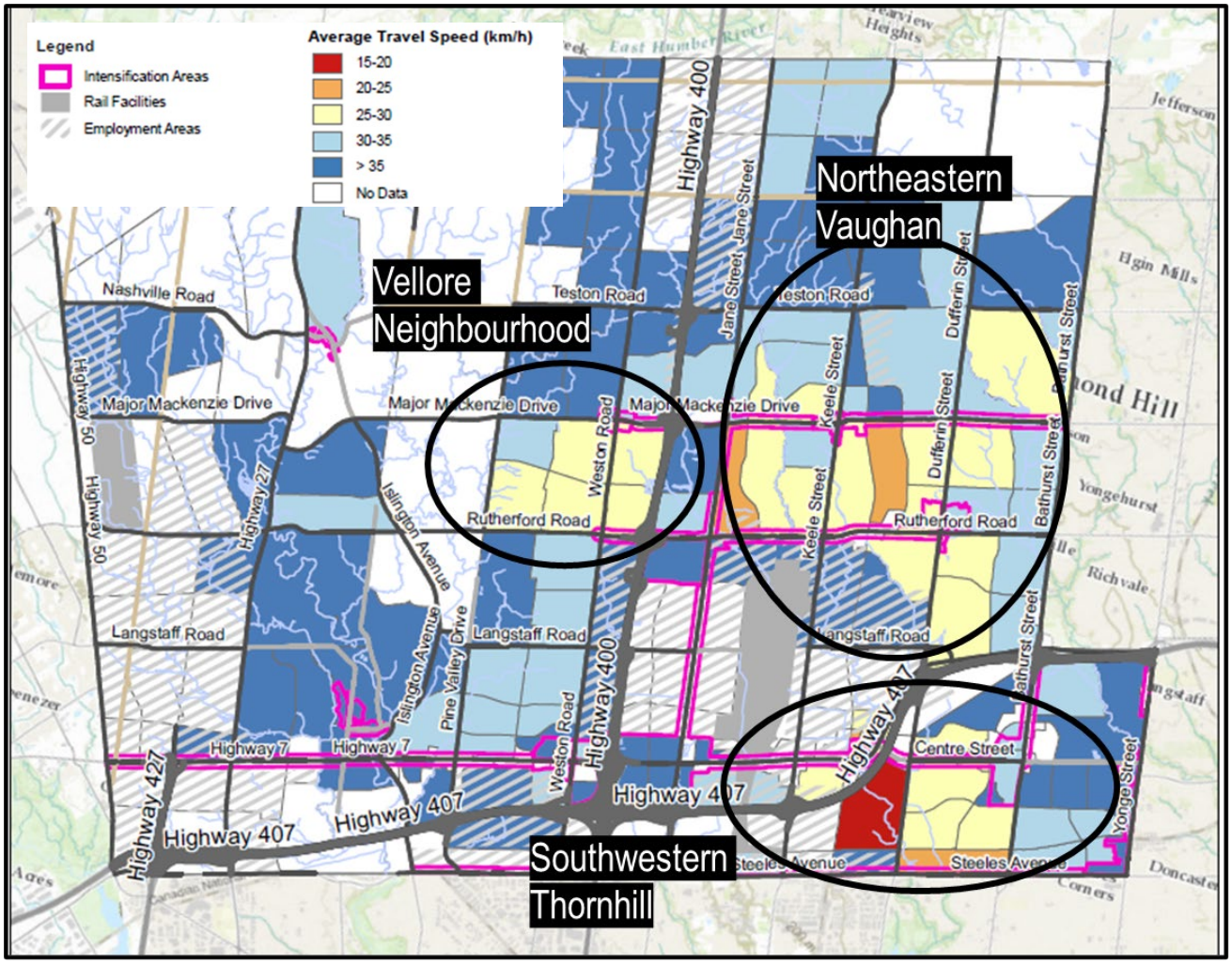


Figure 5-1: Future Cycling Network Focus Area Identification

5.3 Future Transit Network Priority Areas

Transit network gaps under 2051 BAU conditions were considered both from a user perspective and a network perspective. A plot of high-demand or "capacity-constrained" surface transit corridors was produced, as well as plots of coverage gaps – mapping the total number of jobs across the model area accessible by transit *from* a given Vaughan zone within 45 minutes, or the total population across the model area accessible *to* a given Vaughan zone within 45 minutes. The coverage gap maps were overlayed with community/new community areas or employment areas (respectively) using GIS data from the City of Vaughan; community areas that can access few jobs by transit within 45 minutes, or employment areas accessible to a low population by transit within 45 minutes, represent transit gaps.

Table 5-2 lists the prioritized future transit network gaps based on capacity constraints, and **Figure 5-2** summarizes transit network gaps. Although the population and employment coverage gap maps largely further prioritize existing priority areas, the capacity-constrained corridor map identifies new transit network gaps to be considered in alternative development.

Table 5-2: Prioritized Future Transit Network Gaps based on Capacity Constraints

Prioritized Future Transit Network Gaps Location/Corridor	Description	Existing or New Gaps?
Highway 7	Capacity-constrained areas primarily in the eastbound direction from Highway 50 to Jane, both directions between Jane and Weston.	New
Jane Street	Capacity-constrained for both directions between Highway 7 and Rutherford.	New
Northeastern Vaughan	Capacity-constrained, primarily in the eastbound direction, largely between Keele and Yonge.	New

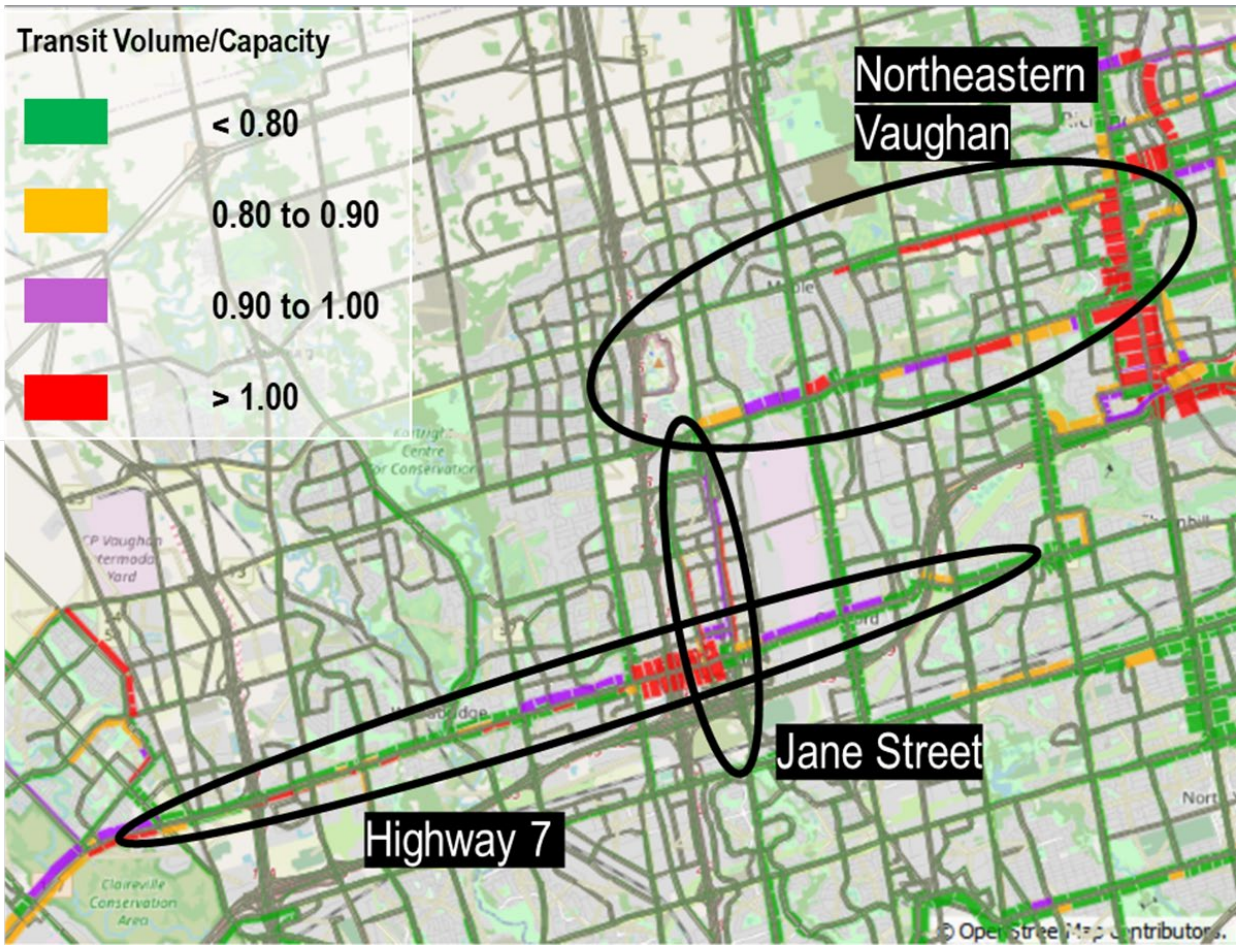


Figure 5-2: Future Transit Network Capacity-Constrained Corridor Gaps

Table 5-3 lists the prioritized future transit network gaps based on residents' access to employment within 45 minutes by transit, and **Figure 5-3** presents them geographically. For this gap, residential / community (shown in the hatched area) and intensification areas (pink area) are considered. These generally correspond to priority areas already identified through the existing gap prioritization process.

Table 5-3: Prioritized Future Transit Network Gaps based on Accessibility to Employment

Prioritized Future Transit Network Gaps Location/Corridor	Description	Existing or New Gaps?
Kleinburg	Major population centre with poor employment transit accessibility.	Existing (further prioritized 6.04, 6.07, 6.11)
Woodbridge Centre	Major population centre with poor employment transit accessibility.	Existing (further prioritized 6.01, 6.06, 6.11, 6.15)
Northeastern Vaughan	Residential blocks/corridors with poor employment transit accessibility, between Rutherford and Teston.	New

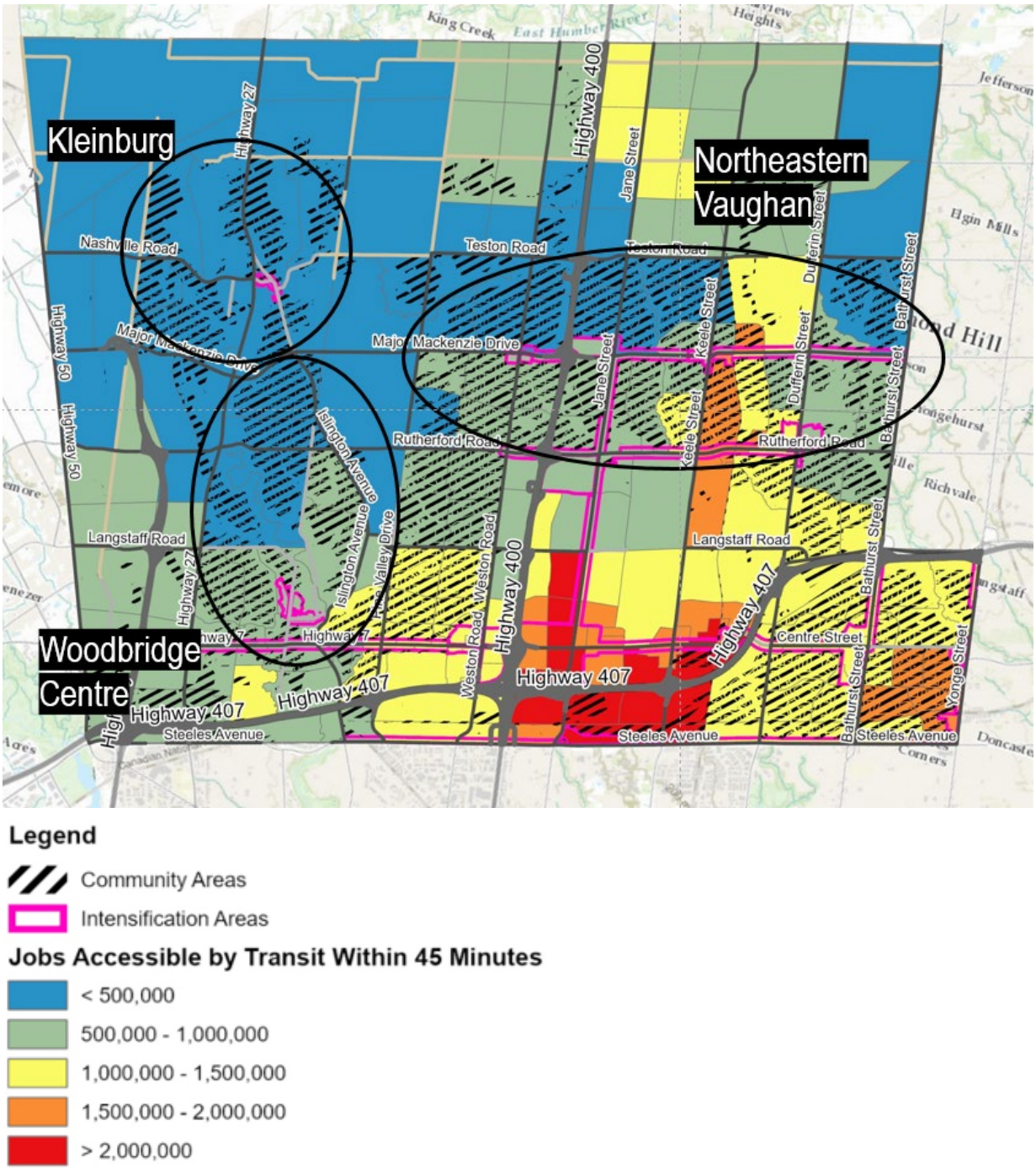


Figure 5-3: Future Transit Network Employment Coverage Gaps

Table 5-4 lists the prioritized future transit network gaps based on access to employment (in the City) by population within 45 minutes by transit, and **Figure 5-4** presents these geographically. Similar to the employment coverage gaps, these generally correspond to priority areas already identified through the existing gap prioritization process. Gaps highlighted in **Figure 5-4** were generally focused on intensification (highlighted in pink) or employment areas (shown as hatched) that have lower accessibility to population.

Table 5-4: Prioritized Future Transit Network Gaps based on Accessibility to Population

Prioritized Future Transit Network Gaps Location/Corridor	Description	Existing or New Gaps?
West Vaughan Employment Area	Major employment area with poor population transit accessibility.	Existing (further prioritized 6.01, 6.05, 6.06, 6.07, 6.08)
South Vaughan Employment Area	Major employment area with poor population transit accessibility.	New
Highway 400 Corridor	Employment areas on both sides of Highway 400 with poor population transit accessibility, from Langstaff Road to north City limits.	Existing (further prioritized 6.09, 6.10)

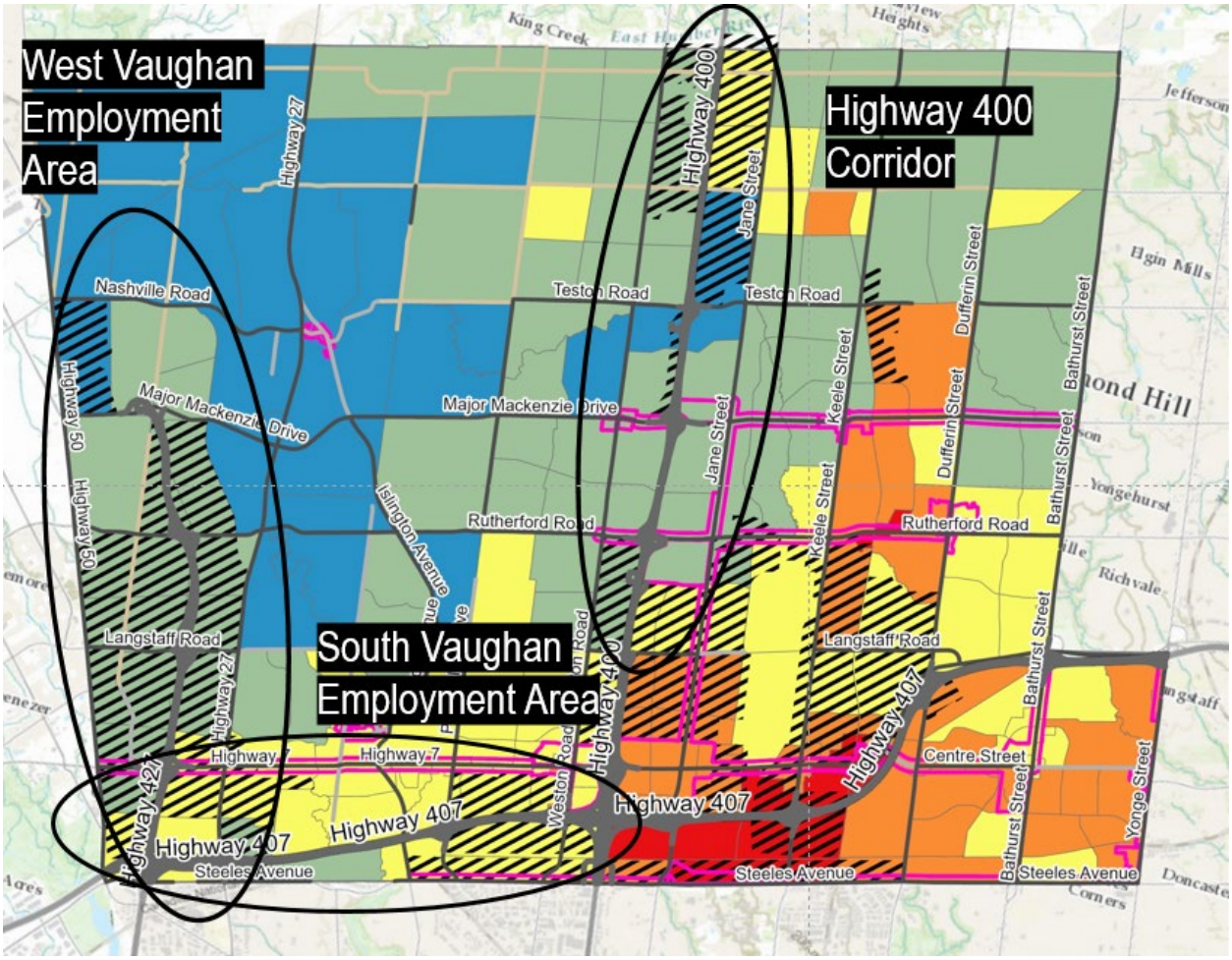


Figure 5-4: Future Transit Network Population Coverage Gaps

5.4 Future Road Network Priority Areas

Road network gaps under 2051 BAU conditions comprise areas of high traffic congestion or "capacity-constrained" auto corridors. Consistent with the VTP objective to analyze the transportation network through the lens of a user, the indicator chosen to prioritize areas of high congestion is a travel time ratio, i.e. the ratio of congested travel time divided by free-flow travel time for each road link in the model results.

Table 5-5 summarizes future road network priority areas in Vaughan, and **Figure 5-5** presents these geographically. Areas of the city that currently feature gaps and therefore have been prioritized through the existing gap analysis process continue to exhibit congestion in the future, including the West Vaughan Employment Area, Highway 400 corridor, and northeastern Vaughan.

Table 5-5: Prioritized Future Road Network Gaps

Prioritized Future Road Network Gaps Location/Corridor	Description	Existing or New Gaps?
West Vaughan Employment Area & Woodbridge	Highway 50, Highway 27, and connecting east-west roads in the West Vaughan Employment Area and Woodbridge continue to experience congestion.	Existing (further prioritized 1.22)
Highway 400 Corridor	East-west and north-south roads near Highway 400 continue to experience congestion.	Existing (further prioritized 1.18, 1.20)
Northeastern Vaughan	East-west and north-south roads east of Highway 400 and north of Highway 7 continue to experience congestion.	Existing (further prioritized 1.09, 1.15)

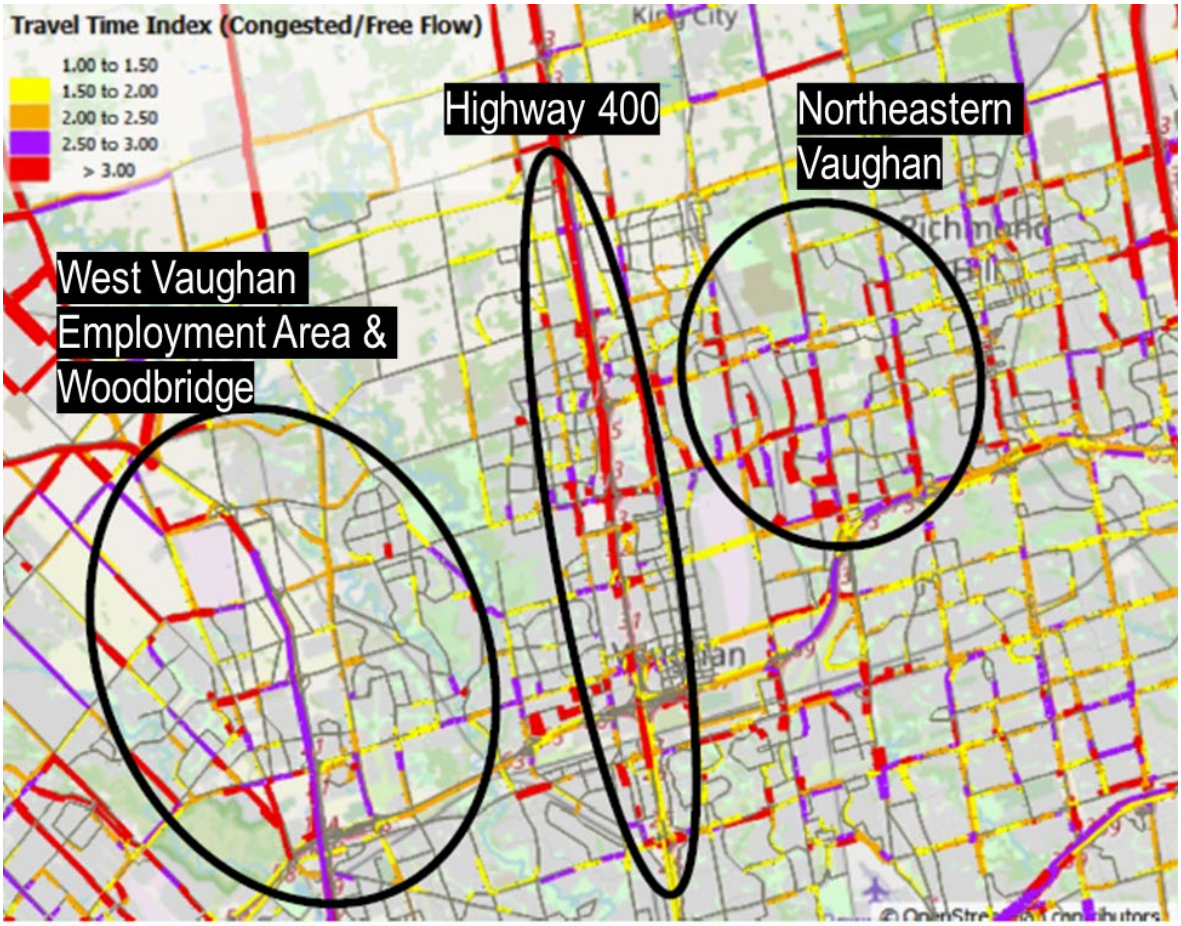


Figure 5-5: Future Road Network Priority Areas

6 Problem and Opportunity

The existing and future gap analysis and prioritization, along with a robust stakeholder and public outreach program to gather input, informed the development of a problem and opportunity statement. This statement defines the key challenges facing the City's transportation system and informs the development of alternative solutions.

6.1 Problem and Opportunity Statement

Vaughan is one of the fastest growing municipalities in Canada. The VTP is a long-term blueprint to move people and goods safely, efficiently, and sustainably, supporting current and future residents, businesses, and visitors.

There are opportunities to improve the city's transportation system. The city has largely been built for the private automobile resulting in large proximity between land uses, reliance on private vehicle travel, and traffic congestion.

As the city intensifies through provincial and regional transit investments, there are opportunities to address the needs for all modes of travel. Special emphasis should be placed on addressing active transportation and transit needs – including the connectivity and safety of active transportation infrastructure and the accessibility and frequency of transit service.

By building the right infrastructure, encouraging a culture change, and thinking forward, the City has an opportunity to provide high-quality, attractive, competitive, and sustainable mobility choices.

7 Developing Future Alternatives

Based on the results from the gap identification and prioritization process and the problem and opportunity statement, transportation improvements and alternatives are proposed. The design of alternatives is discussed in this section. A listing of projects included in each alternative is available in ***Appendix E: Alternative Improvements.***

7.1 Do-Nothing (DN) Alternative

A Do-Nothing (DN) Alternative was included, which did not include additional road or transit projects beyond projects in-progress or that have been recently completed. This alternative serves as the base of comparison against which other future alternatives will be evaluated, and as the base for the Business-As-Usual alternative.

7.2 Business-As-Usual (BAU) Alternative

The Business-As-Usual (BAU) alternative includes road projects identified in previous Vaughan, York Region, and existing Provincial transportation plans. It also includes transit projects from the Metrolinx Regional Transportation Plan that were identified as high priority and would be relevant to the City.

All recommended alternatives in the subsequent sections are built upon the BAU alternative. This alternative is shown in **Figure 7-1**.

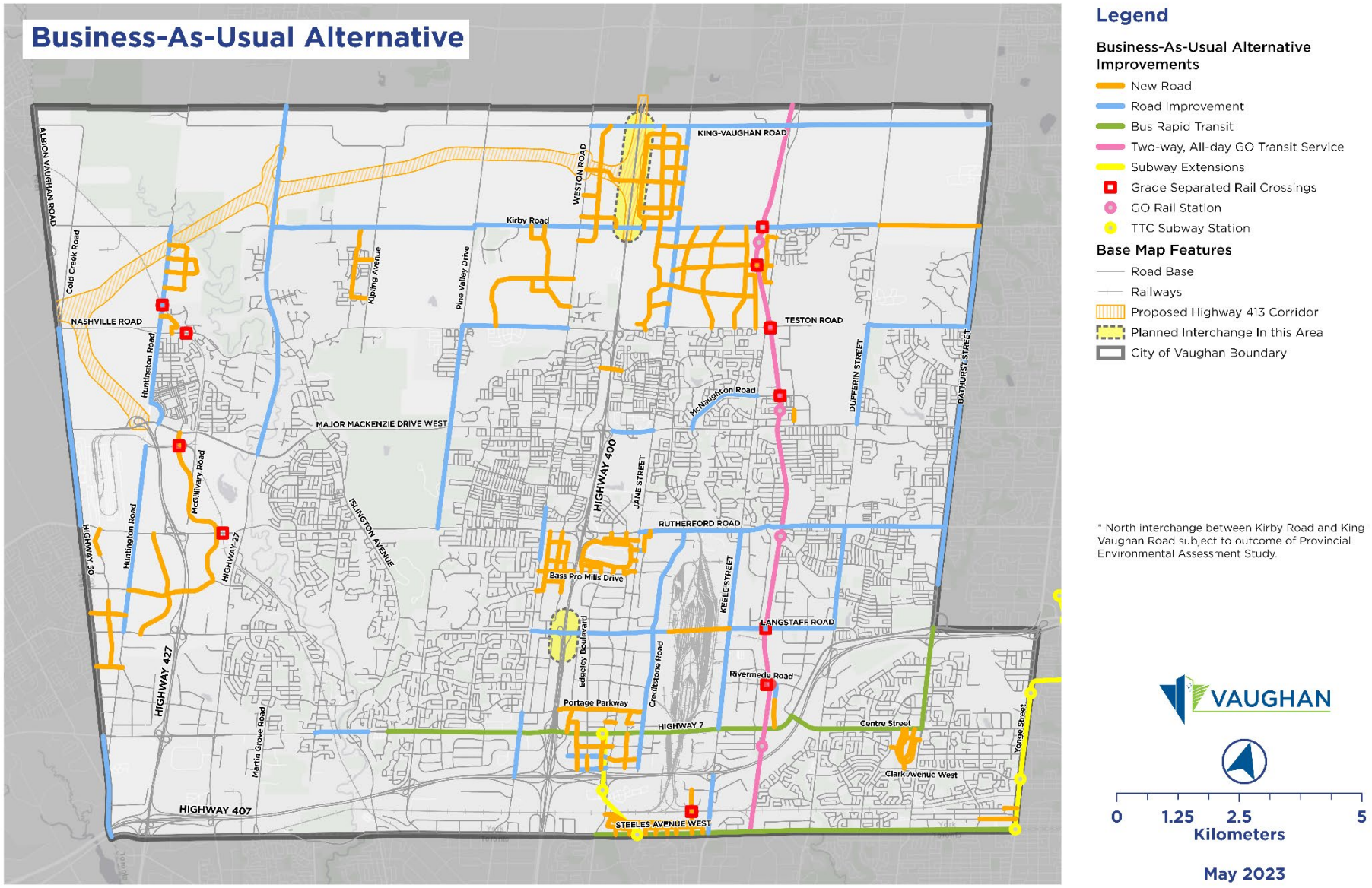


Figure 7-1: Business-as-Usual (BAU) Alternative

7.3 Future Alternative Development

Based on the BAU alternative, three alternatives were developed and evaluated – the "New Roads Alternative", the "Green Alternative", and the "Multi-Modal Alternative". The New Roads Alternative (Alternative 1) seeks to resolve all prioritized gap areas using improvements to the auto network. The Green Alternative (Alternative 2) seeks to resolve all prioritized gap areas using improvements to the transit and active transportation networks. The Multi-Modal Alternative (Alternative 3) uses a combination of improvements to address prioritized gap areas, including all transit and active transportation improvements from the Green Alternative and a subset of the auto improvements from the New Roads Alternative. It is assumed that recommendations in the City's PBMP would be implemented, and these areas were identified based on the methods described in **Section 5.2**.

The future alternatives are summarized in **Figure 7-2**.

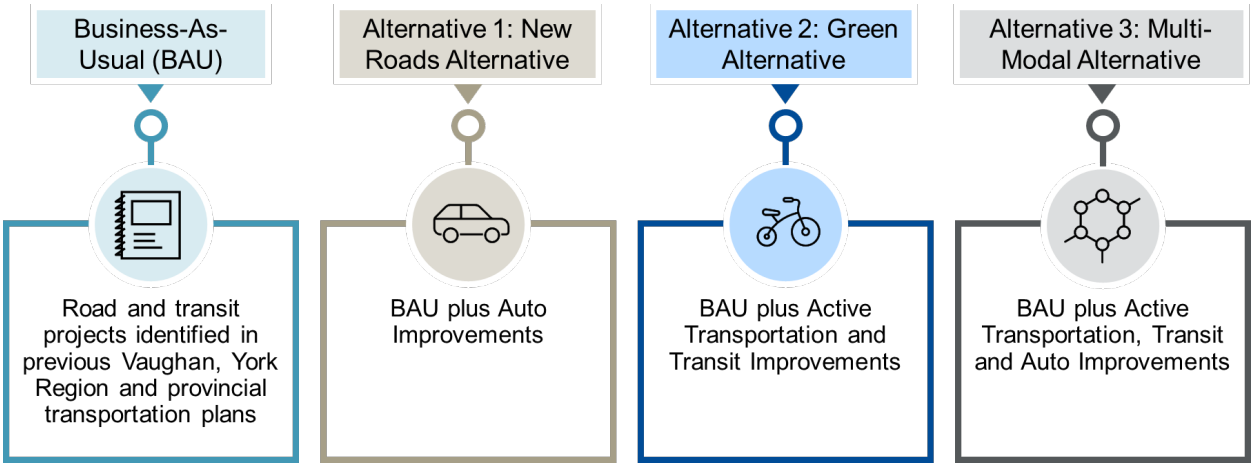


Figure 7-2: Future Alternative Development Process

Section 7.3 to **Section 7.5** provide summaries of the infrastructure improvements included in each alternative and their corresponding maps. Additionally, improvements from the BAU alternative in subsequent mapping are shown in thinner lines, and additional projects for these future alternatives are shown in thicker lines. A detailed list of improvements proposed for each of the three alternatives can be found in ***Appendix E: Alternative Improvements***.

7.4 New Roads Alternative

The New Roads Alternative includes all road and transit projects that were included in the BAU, with additional road improvements identified through the framework described in the previous sections of this report. **Figure 7-3**, below, presents the New Roads alternative. The network mapped below also includes two extensions that are illustrated with dotted lines – these consist of road extensions that were technically justified by analysis, but will not be implemented or have not been approved by Council in the past. BAU improvements are shown with thinner lines to differentiate from alternative-specific improvements in the subsequent mapping of each alternative.

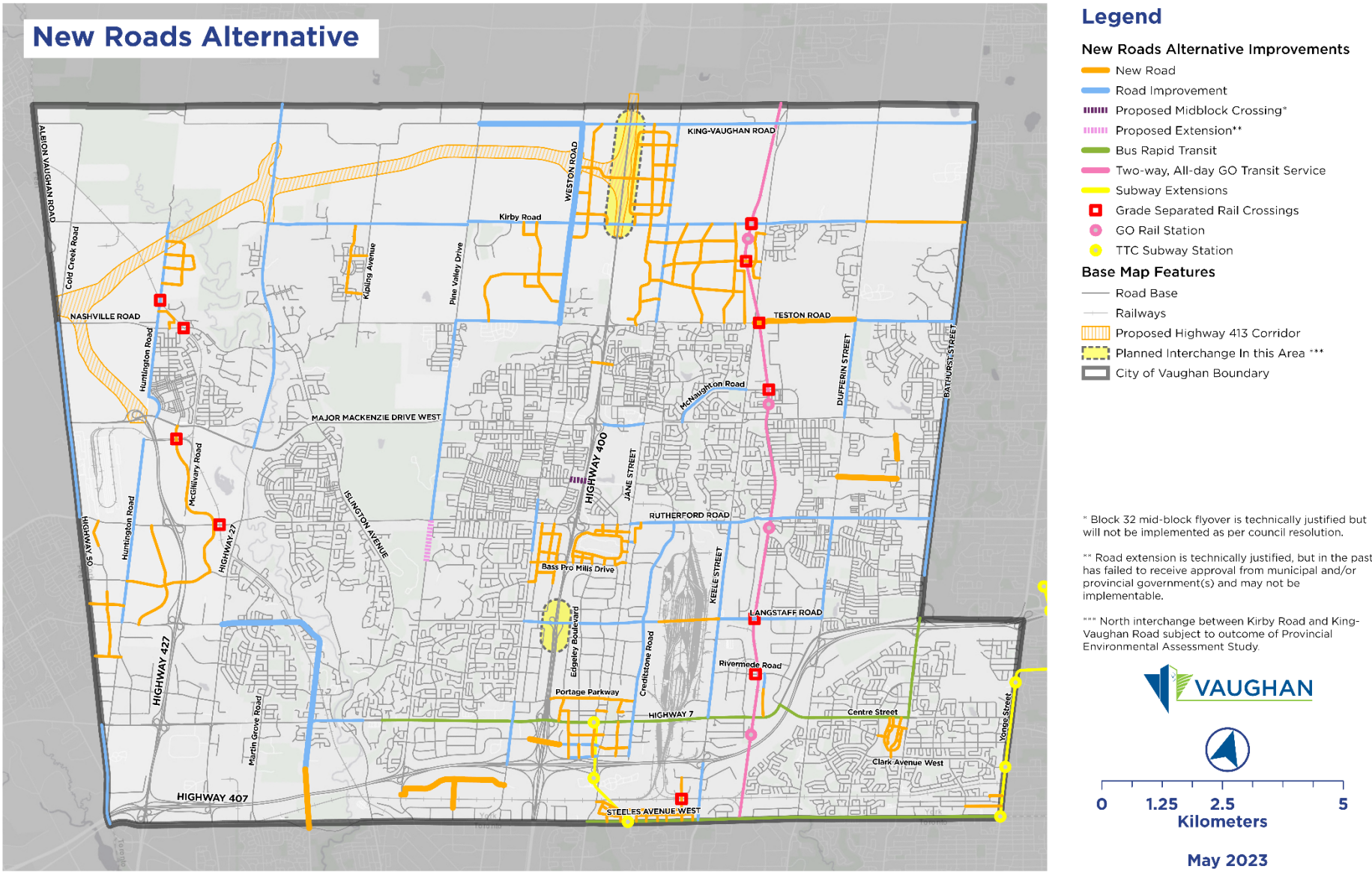


Figure 7-3: New Roads Alternative Map

7.5 Green Alternative

The Green Alternative includes all road and transit projects identified in BAU, with additional above-ground transit and active transportation network improvements identified through the analysis of auto, transit, and active transportation network gaps in Vaughan's transportation network. **Figure 7-4** presents the Green Alternative.

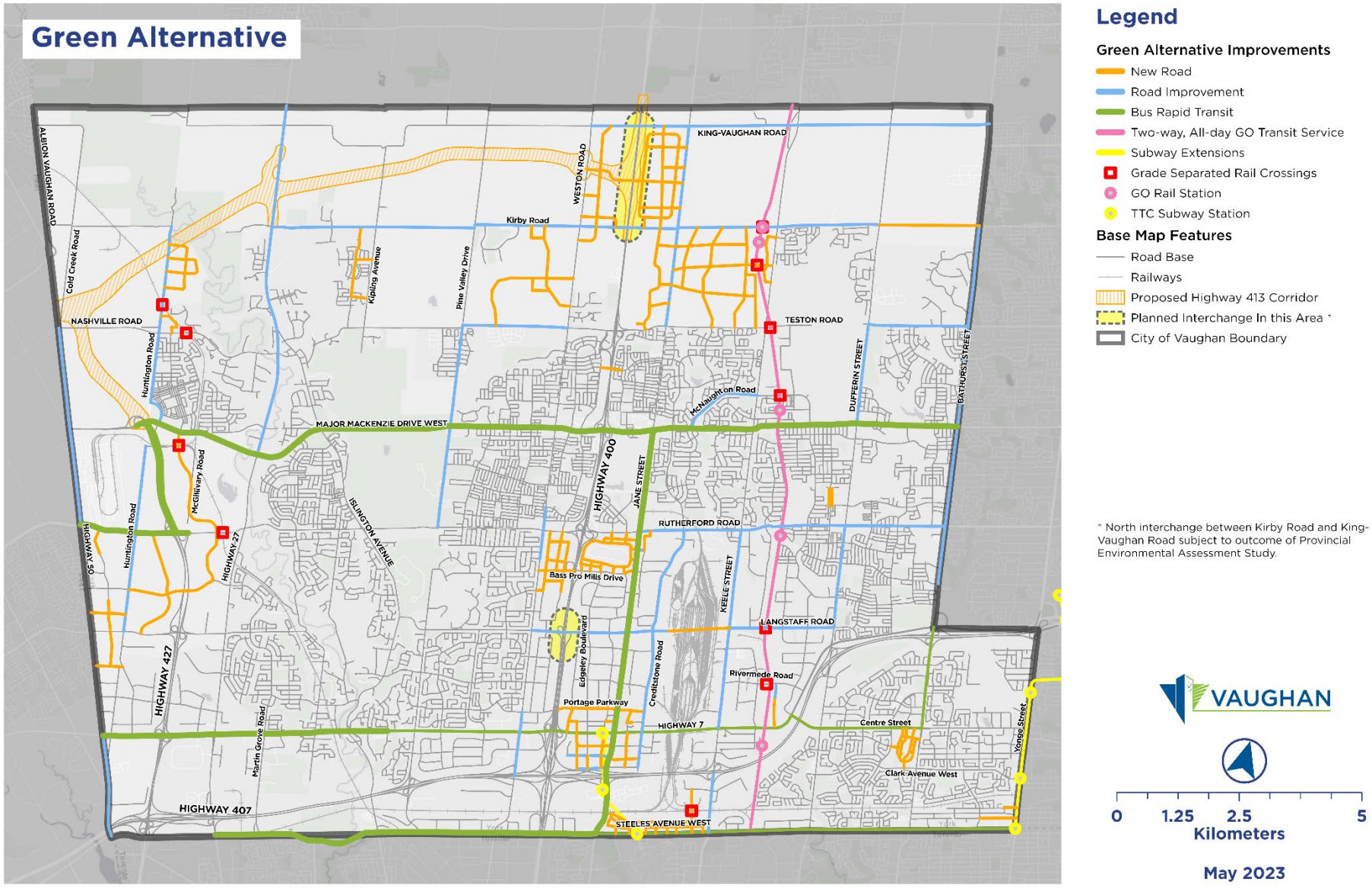


Figure 7-4: Green Alternative Map

7.6 Multi-Modal Alternative

The Multi-Modal Alternative includes all road and transit projects identified in the Green Alternative, with some additional road, above-ground transit, and active transportation network improvements. **Figure 7-5** presents this alternative.

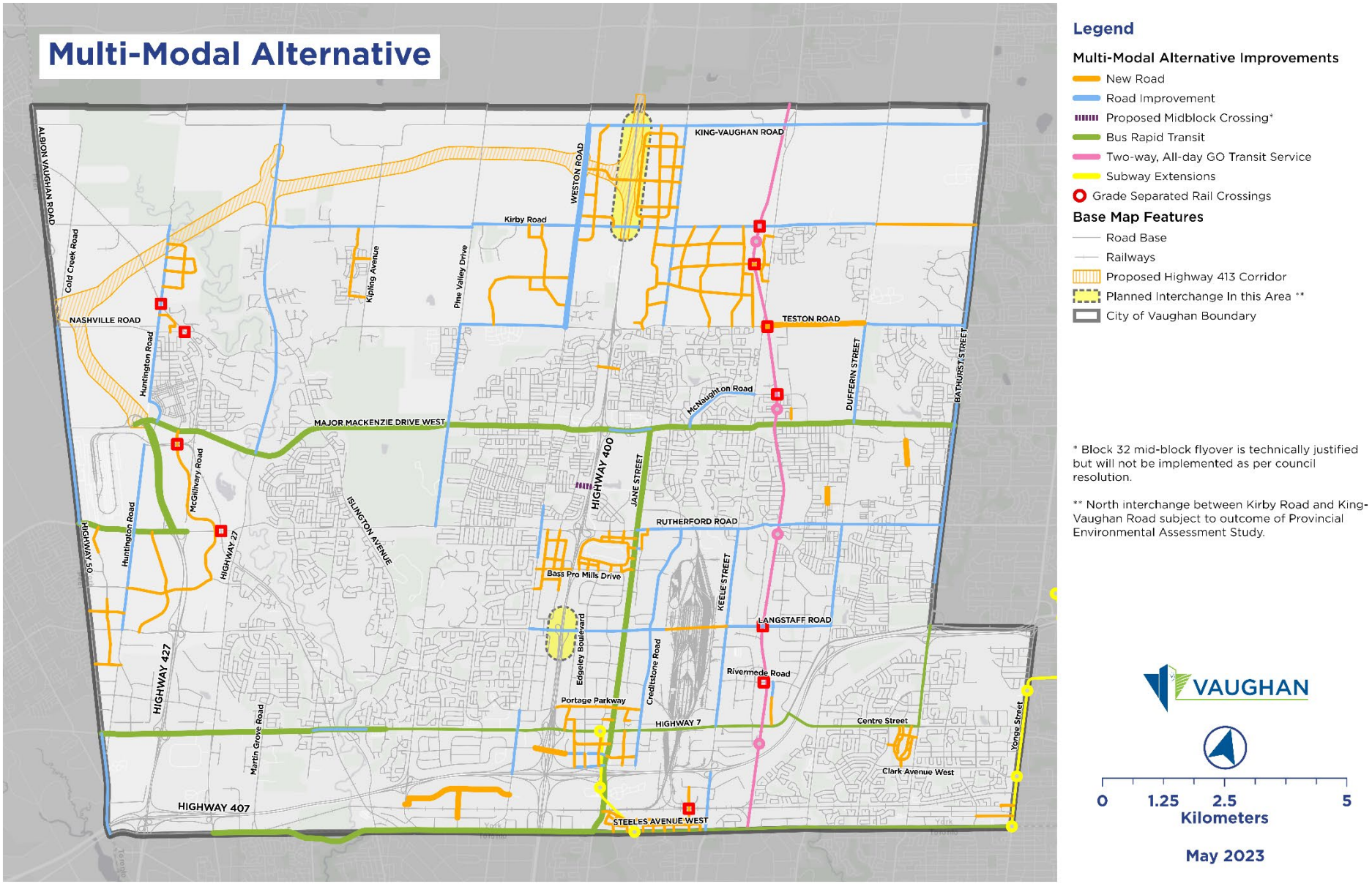


Figure 7-5: Multi-Modal Alternative Map

7.7 Sensitivity Analysis

Sensitivity analysis is a useful tool to consider “what-if” scenarios and build resilience into the planning effort, particularly for transportation networks, where projects can be impacted by changes in policy direction. In addition to the alternatives described above, additional sensitivity analyses were identified to be tested against the draft preferred network, once identified. These consisted of various addition or removal of projects that could have a significant impact on the City’s transport network. In specific, three sensitivity scenarios were identified:

- **Removal of Highway 413.** Highway 413 is a proposed 400-series highway (and potential bus transitway) in the western Greater Toronto Area, currently undergoing planning and analysis by MTO. The project’s eastern end is in Vaughan with interchanges with other major provincial highways at Highway 427 and Highway 400 and provides a connection to municipalities to the east. This project was included in the BAU network. This sensitivity involves removing the planned major provincial highway from the network. This is shown below in **Figure 7-6**.

Figure 7-6: Highway 413 Conceptual Alignment in Vaughan

- **Addition of Bolton/Caledon GO Rail Service**. The Caledon-Vaughan GO rail line is a commuter rail service that would provide a regional link to support significant growth in Caledon and Peel Region. For this sensitivity analysis, the project was coded as a peak-only GO service that would run on the CP MacTier subdivision to Union Station. The line would have a total of 8 stations, Union, Mount Dennis, Weston GO, Emery Station, Woodbridge Station (at Islington, in City limits), Vaughan Station (at Rutherford, in City limits), Kleinburg Station (at Major Mackenzie, in City limits) and terminating at Bolton Station. This project was not included in the BAU network or any alternatives. This sensitivity involves adding the above-described line. The coding of this sensitivity was

based on the ***Commuter Rail Feasibility Study*** of the service, which was completed in 2010[1]. Four options were presented in the study, and Service Option 1 was modelled. The modelled service option is shown below in **Figure 7-7**.

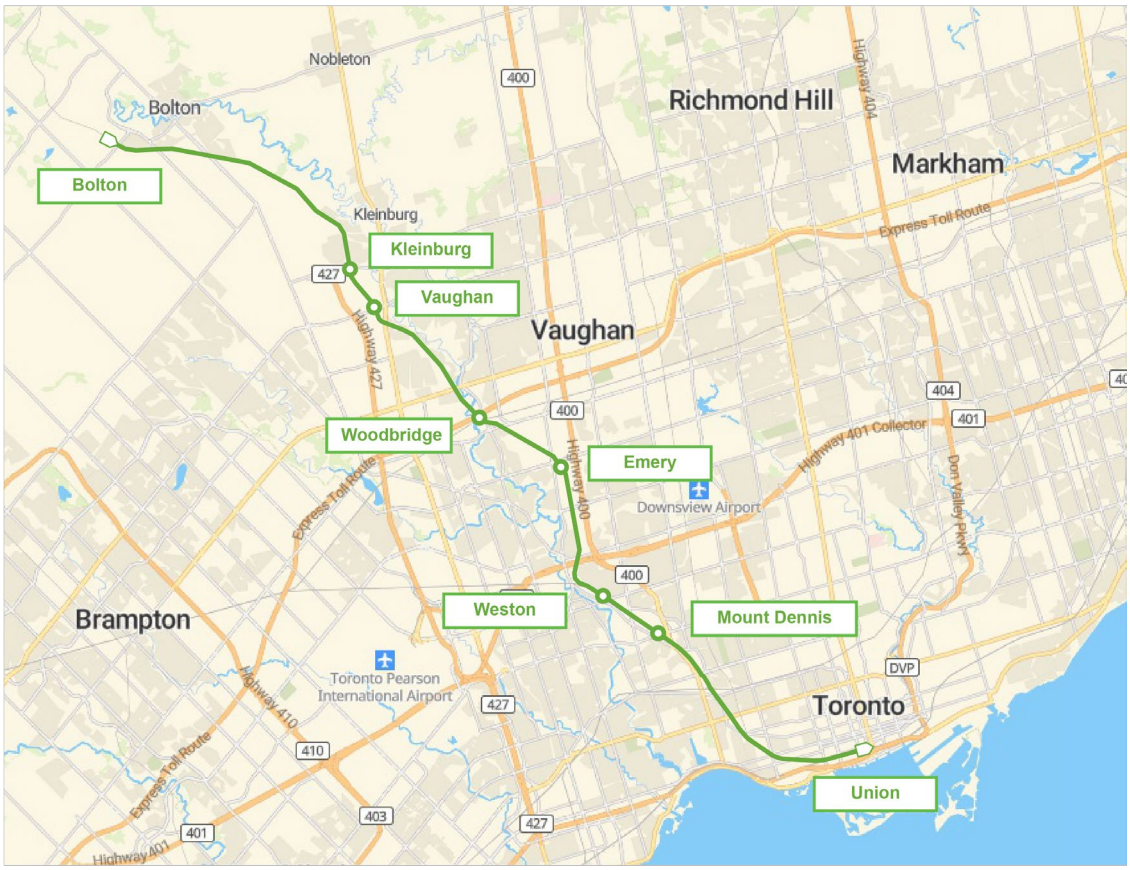


Figure 7-7: Bolton/Caledon GO Service Option 1

- **Removal of Brampton Queen Street BRT.** The Brampton Queen Street BRT is a proposed transit corridor along Queen Street in Brampton and Highway 7 (to Helen Street) in Vaughan, connecting to the existing Highway 7 Rapidway. This project was included in the BAU network. This sensitivity involved converting this rapid transitway from having a dedicated right-of-way to operating in mixed traffic.

These projects were selected as their influence had the potential to impact other projects in Vaughan, either being located within the City itself or acting as services to accommodate demand in and out of the City.

[1] https://transittoronto.ca/archives/reports/Bolton_Commuter_Rail_Feasibility_Study_2010_EN.pdf

8 Alternative Evaluation

8.1 Evaluation Framework

Determining a draft preferred alternative and a set of preferred infrastructure improvements requires the establishment of evaluation criteria and a corresponding framework to compare and evaluate the performance of future alternatives against one another. To develop an evaluation framework, a set of criteria was first developed, presented in **Figure 8-1**.

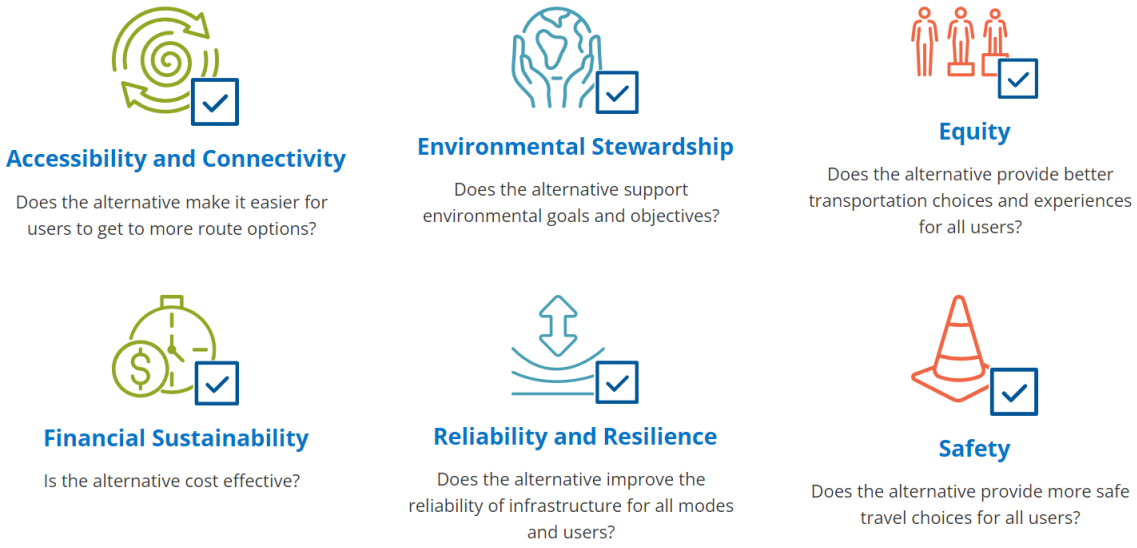


Figure 8-1: Alternative Evaluation Criteria

The above criteria are aligned with the overall vision and objectives of the VTP, and consistent with earlier steps in the problem identification framework. The criteria above were quantified afterward into metrics that could be informed by modelling alternatives analysis. These are presented in **Table 8-1**, on the following page.

Table 8-1: Alternative Evaluation Framework

VTP Objective	Metric	Metric Description
Accessibility & Connectivity	System Reach	# of jobs accessible to Vaughan residents within 45 minutes by auto
		# of jobs accessible to Vaughan residents within 45 minutes by transit
		# of population within 45 minutes of jobs in Vaughan by auto
		# of population within 45 minutes of jobs in Vaughan by transit
Environmental Stewardship	VKT or equivalent GHG emissions	VKT (vehicle-kilometres travelled) for residents and employees of Vaughan.
		Estimated GHG emissions based on VKT for residents and employees of Vaughan.
Equitable	Modal travel time ratio comparison	Average transit/auto travel time ratio for Vaughan zones
		Average transit/auto travel time ratio for Vaughan social-equity seeking zones
Financial Sustainability	Relative cost estimate of alternative	Comparison of cost estimates, relatively, for each alternative (e.g. high, medium, low)
Reliability / Resilience	Delays due to congestion	VHT (vehicle-hours travelled) for all road links
		VHT for congested road links with V/C > 1.00
		Transit rider - hours travelled for all road links
		Transit rider - hours travelled for congested road links
		Lane-km of road links with V/C > 1.00
Safety	Inherent to future designs	New infrastructure will be designed to be safe by design, based on best practices of the day.

To measure greenhouse gas emissions, factors were used from US Federal Highway Association (FHWA) guidance to relate vehicles' (more specifically passenger auto, light or medium truck, and heavy truck) vehicle-kilometres travelled to kilogram CO^2 equivalent by taking the average speed across modelled links in Vaughan.

There are two qualitative metrics: Financial Sustainability and Safety. The Financial Sustainability metric is based on the cost relative to other options. This is tied to the number of projects in each alternative, and how the total cost of the future alternative compares to the DN alternative. For the Safety metric, which examines the safety of all modes of travel, it is assumed that new infrastructure would be designed to be safe based on best practices. For an alternative that involves only auto improvements (and no AT or transit improvements), the relative safety would be lower.

The remainder of this chapter describes the outcomes of the above framework being applied, first by presenting results in **Section 8.2**, then describing the selection of a draft preferred alternative in **Section 8.3**.

8.2 Alternative Evaluation Results

The evaluation results using the framework discussed in **Section 8.2** can be found in **Table 8-2**. Note that VKT, VHT, and Lane-km are calculated for links in Vaughan only. Results are coloured qualitatively to indicate the relative impact of the evaluation metrics of each alternative. These are calculated relative to the Do-Nothing alternative, which serves as the basis for the comparison of each alternative.

Table 8-2: Evaluation Results

				Compared to Do Nothing			
VTP Objective	**Metric**	**Description**	**Units**	**BAU Alternative**	**New Roads Alternative**	**Green Alternative**	**Multi-Modal Alternative**
Accessibility & Connectivity	System Reach	# of jobs accessible to Vaughan residents within 45 minutes by auto	Jobs	-	9,000	1,000	7,000
		# of jobs accessible to Vaughan residents within 45 minutes by transit	Jobs	36,000	56,000	60,000	87,000
		# of population within 45 minutes of jobs in Vaughan by auto	Population	3,000	48,000	10,000	52,000
		# of population within 45 minutes of jobs in Vaughan by transit	Population	-	27,000	35,000	70,000
Environmental Stewardship	VKT or equivalent GHG emissions	VKT for residents and employees of Vaughan.	veh*km	(2,000)	16,000	(25,000)	(20,000)
		Estimated GHG emissions based on VKT for residents and employees of Vaughan.	kg CO2 equiv	-	3,000	(3,000)	(2,000)
Equitable	Modal travel time ratio comparison	Average transit/auto travel time ratio for Vaughan zones	dimensionless (ratio)	(0.00)	(0.00)	(0.10)	(0.02)
		Average transit/auto travel time ratio for Vaughan social/equity zones	dimensionless (ratio)	(0.01)	(0.00)	(0.03)	0.07
Financial Sustainability	Relative cost estimate of scenario	Comparison of cost estimates, relatively, for each scenario (e.g. high, medium, low)	Qualitative				
Reliability / Resilience	Delays due to congestion	VHT (for all road links)	veh*hr	(100)	(600)	(1,800)	(2,000)
		VHT (for congested road links with V/C > 1.00)	veh*hr	-	(1,700)	(2,100)	(2,800)
		Transit rider - hours travelled (for all road links)	person*hr	500	500	2,300	2,900
		Transit rider - hours travelled (for congested road links)	person*hr	500	300	1,100	1,500
		Lane-km of road links with V/C > 1.00	lane*km	-	(26)	(32)	(44)
Safety	Inherent to future designs	New infrastructure will be designed to be safe by design, based on best practices of the day.	Qualitative				

Worse
Similar
Better

*Note: values in brackets are negative

8.3 Selection of a Draft Preferred Alternative

Selecting a draft preferred alternative involves careful consideration of the performance of the three alternatives evaluated above, not just in comparison to the 2051 BAU alternative as a base case, but also on a relative basis against one another. In particular, trade-offs between disparate categories of evaluation metrics must be taken into account; for instance, increased system reach in the New Roads Alternative being weighed against increased greenhouse gas emissions.

Evaluating alternatives' performance, the **Multi-Modal Alternative** was identified as the draft preferred alternative. This alternative, with its balanced combination of walking, cycling, transit, and auto network improvements, increases system reach by all modes, decreases vehicle hours travelled, and improves transit rider-hours travelled considerably over the other two alternatives. It was noted that one of the metrics, the average transit/auto travel time ratio for Vaughan social/equity zones, increased from DN to the Multi-Modal. From a general perspective, the metric does not capture mode switching, and users switching from auto to transit would make this measure increase (as transit trips are inherently longer). This implies that transit became more attractive for users in equity-seeking zones, which in turn improves the number of travel options available to them. However, it also highlights the disparity between auto and transit trip travel times, which is less than ideal.

Although this alternative's performance in environmental stewardship, equity, and financial sustainability metrics is more modest than the Green Alternative, it still demonstrates a robust improvement in these metrics when compared to the BAU base case or the New Roads Alternative.

8.4 Sensitivity Analysis Results

As described in **Section 7.6**, sensitivity analysis was undertaken on the draft preferred network identified in the previous section, for three scenarios, the removal of Highway 413, the addition of Caledon GO commuter rail service, and the removal of the Brampton Queen Street BRT. The analysis of these sensitivities followed the same evaluation framework described in this chapter. Results are presented in **Table 8-3**, on the following page. Note that network reliability metrics are calculated for users within Vaughan only (i.e. users which start or ended a trip in Vaughan).

The following results were noted from the sensitivity analyses:

- The removal of Highway 413 led to a general increase in VHT and VHT on congested links was noted, along with a decrease in GHG emissions. System reach also decreased.
- The addition of Caledon GO commuter rail generally increased system reach, as new zones could be reached and slightly lower congestion from mode shift likely causing an increase in the auto system reach also. Ridership was noted to be generally low for the line.
- The removal of the Brampton Queen Street BRT led to a decrease in overall ridership for that line, and many opted to use the parallel Major Mackenzie corridor instead. There is

a decrease in population within 45 minutes of jobs in Vaughan, which is this shift in corridor use in Brampton.

Table 8-3: Sensitivity Analysis Evaluation Results

				Compared with Draft Preferred Alternative		
VTP Objective	**Metric**	**Description**	**Units**	**Removal of Highway 413**	**Addition of Caledon GO Rail Service**	**Removal of Queen Street BRT**
Accessibility & Connectivity	System Reach	# of jobs accessible to Vaughan residents within 45 minutes by auto	Jobs	(34,000)	2,000	(2,000)
		# of jobs accessible to Vaughan residents within 45 minutes by transit	Jobs	(11,000)	12,000	(3,000)
		# of population within 45 minutes of jobs in Vaughan by auto	Population	(125,000)	11,000	-
		# of population within 45 minutes of jobs in Vaughan by transit	Population	(30,000)	17,000	(11,000)
Environmental Stewardship	VKT or equivalent GHG emissions	VKT for residents and employees of Vaughan.	veh*km	(82,000)	-	-
		Estimated GHG emissions based on VKT for residents and employees of Vaughan.	kg CO2 equiv	(11,000)	-	-
Equitable	Modal travel time ratio comparison	Average transit/auto travel time ratio for Vaughan zones	dimensionless (ratio)	-	-	-
		Average transit/auto travel time ratio for Vaughan social/equity zones	dimensionless (ratio)	0.01	0.01	0.01
Financial Sustainability	Relative cost estimate of scenario	Comparison of cost estimates, relatively, for each scenario (e.g. high, medium, low)	Qualitative			
Reliability / Resilience	Delays due to congestion	VHT (for all road links)	veh*hr	400	(100)	-
		VHT (for congested road links with V/C > 1.00)	veh*hr	600	(100)	(100)
		Transit rider - hours travelled (for all road links)	person*hr	200	-	-
		Transit rider - hours travelled (for congested road links)	person*hr	(100)	-	-
		Lane-km of road links with V/C > 1.00	lane*km	-	-	-
Safety	Inherent to future designs	New infrastructure will be designed to be safe by design, based on best practices of the day.	Qualitative			

Worse
Similar
Better

9 Preferred Alternative

Based on the transportation needs assessment, alternative development, and evaluation process documented in this report, as well as inputs received from the public during the Virtual Open House, held between November 18 and December 9, 2021, the **Multi-Modal Alternative** is selected as the preferred alternative.

This alternative contains all road and transit improvements included in the “Business-as-Usual” (BAU) alternative, which themselves consisted of plans from current Vaughan, Regional, and provincial transportation plans. It includes all recommendations from Alternative 2: Green Alternative and a subset of road network improvements from Alternative 1: New Road Alternative. This alternative is presented below in **Figure 9-1**. In addition to what is shown in **Figure 7-5,** two additional interchange improvements are also identified per the York Region TMP: an interchange with Highway 413 in the area between Kirby Road and King-Vaughan Road and Highway 400, as well as interchange improvements at Langstaff Road to convert to a full 6-leg interchange.

It can be noted that several other additions to the network were made for the final 2051 Recommended Transportation Network. Some of these projects were not analyzed as part of the Multi-Modal network initially. Among these is the abovementioned proposed Caledon-Vaughan GO service, which was included in the preferred network to maintain consistency with the 2022 York Region TMP rapid transit network. Additionally, several grade separations and road improvements were also included for consistency between the VTP and 2022 York Region TMP. York Region road improvements are highlighted with a green hatch.

A full list of improvements in this alternative is found in ***Appendix E: Alternative Improvements***.

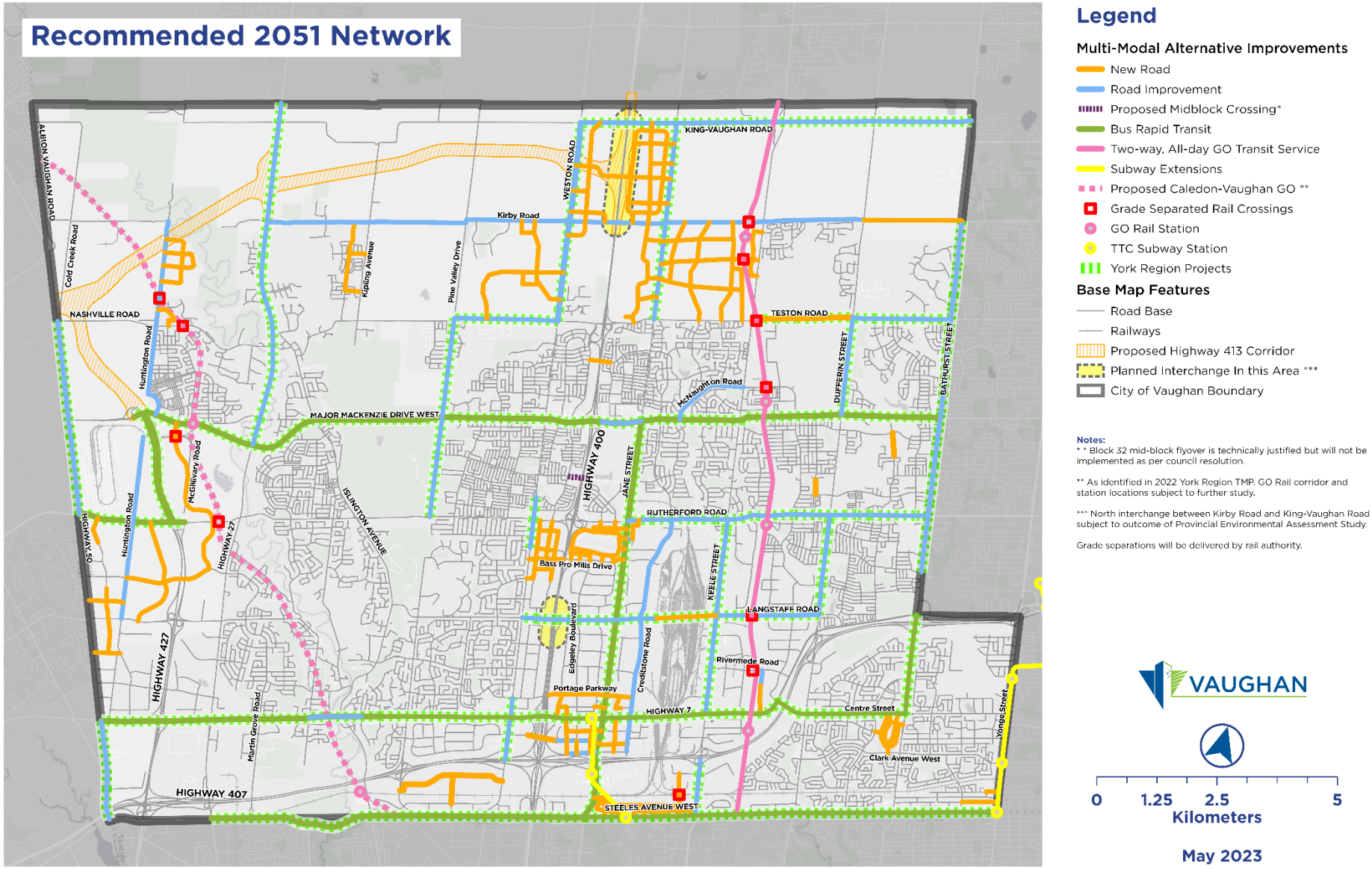


Figure 9-1: Preferred Alternative

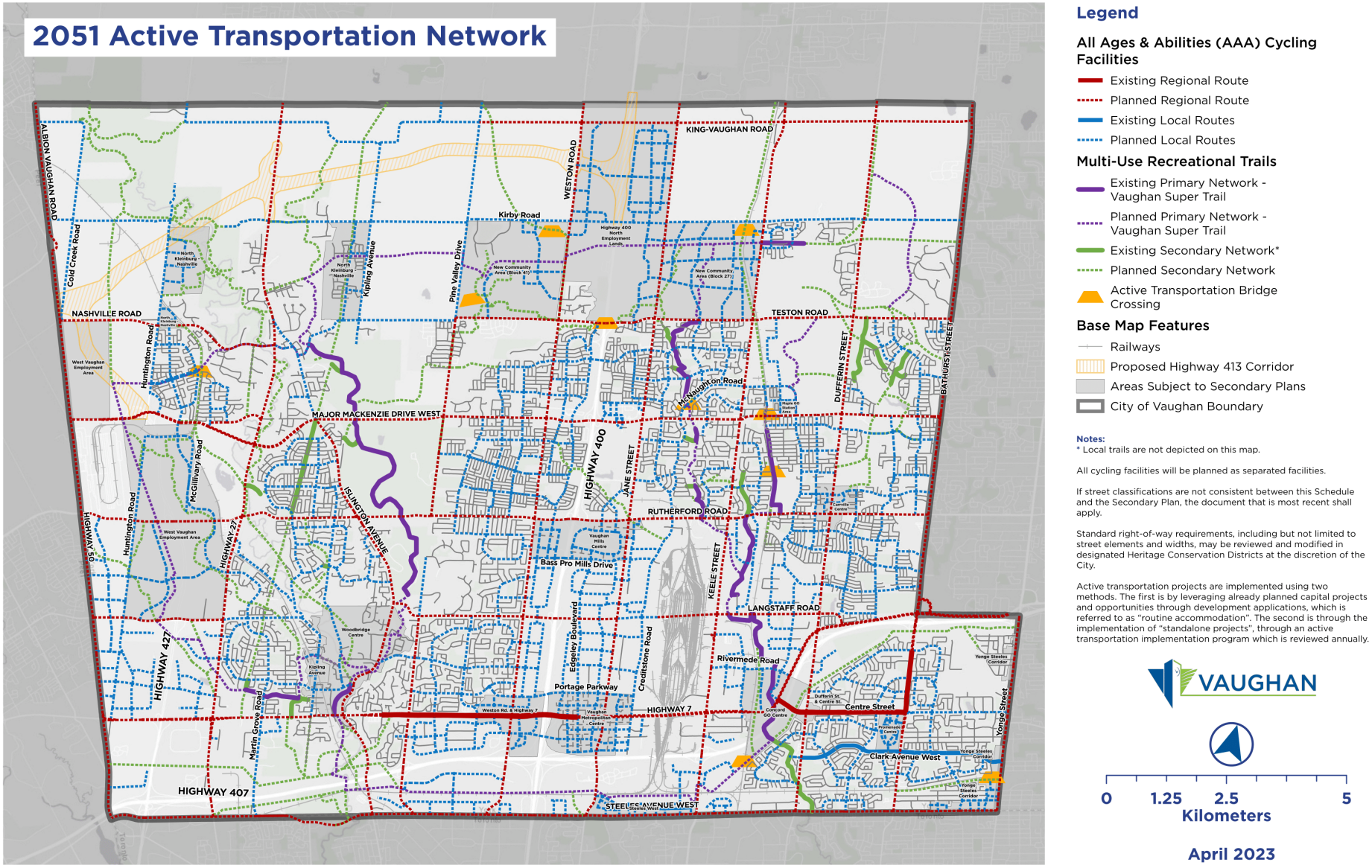


Figure 9-2: 2051 Active Transportation Network

In summary, the Preferred Alternative includes improvements to the City's walking, cycling, transit, and road networks. Appendix E: Alternative ImprovementsTransit network improvements in the preferred alternative consist of rapid transit infrastructure (i.e. dedicated rights-of-way for bus rapid transit) proposed on major arterial corridors in Vaughan, particularly those which are capacity-constrained in the BAU alternative, consistent with bus rapid transit corridors proposed in the York Region Transportation Master Plan.

Road network improvements in the preferred alternative tend towards establishing a finer-grained street network within the City of Vaughan, creating links across barriers identified in the gap analysis process, and filling in missing links to create a more complete street network. These improvements include midblock crossings of Highway 400, two new collector road extensions in the South Vaughan Employment Area, and the "missing link" connection of Teston Road between Keele and Dufferin Streets.

10 Next Steps

Through the process described in this report, an analysis of the City's existing gaps was undertaken, with them being identified and then prioritized based on need. Afterward, an analysis was undertaken of future conditions to determine if more gaps needed to be added, validate existing gaps, and finalize gap priorities. To determine an optimal strategy for implementing network improvements, different types of network improvements were packaged into several alternatives, which were modelled using the Vaughan Travel Demand Model. These alternatives were evaluated to determine how they affected the overall objectives of the VTP using quantitative and qualitative metrics, and the alternative with the most positive overall effect on all objectives was selected as the draft preferred alternative. The next steps after determining the preferred alternative include the following:

- **Consultation with stakeholders and the public.** The preferred alternative is presented to the public in the Spring of 2022. Other key stakeholders and the technical advisory committee will be consulted as well.
- **Finalizing the preferred network** by considering inputs gathered from the stakeholders and general public and applying feasibility lenses to determine if any of the recommended improvements are infeasible and should be removed.
- **Prepare implementation and costing plan.** A high-level geometric cost analysis will be conducted for recommended improvements in the preferred network, and a phasing plan will be developed based on project needs and priority, cost constraints, and potential funding sources. Recommended improvements in the short term will provide input to the City's 10-year capital plan.

Appendix A: Process for developing Vaughan's All Ages & Abilities (AAA) Cycling Network in GIS

Appendix B: All Ages and Abilities (AAA) Cycling Network

Appendix C: Existing Gap Identification Measures

Appendix D: Long List of Existing Gaps

Appendix E: Alternative Improvements