Appendix D

Evaluation Report

City of Ottawa

Evaluation Report
Eastern Light Rail Transit (Blair Station to Trim Road) integrated with Highway 174 Widening (Highway 417 to Trim Road)

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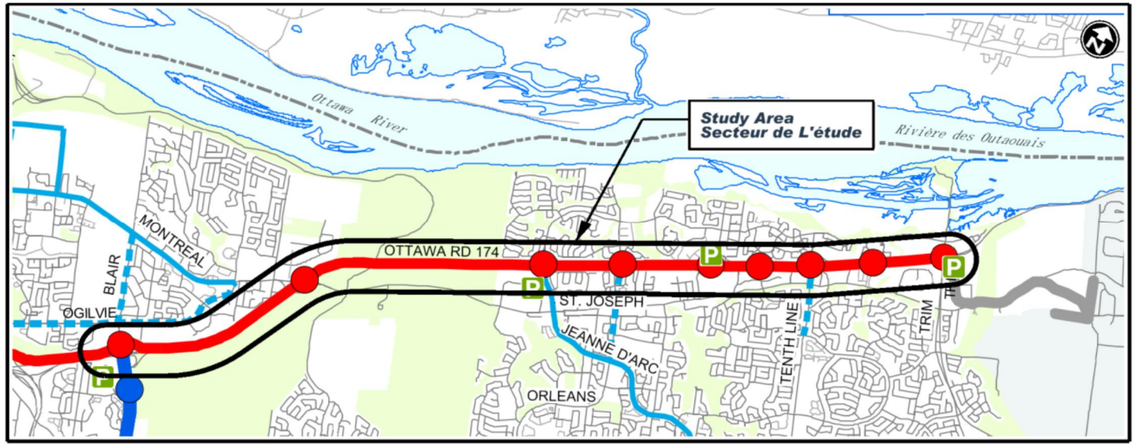
1 INTRODUCTION

The following Evaluation Report is part of the Planning and Environmental Assessment Study for the Eastern Light Rail Transit (LRT), extending from Blair Station to Trim Road (Figure 1-1). It considers the widening of Highway 174 in the assessment and evaluation process as the LRT and highway widening alternatives were integrated as noted throughout this report.

Figure 1-1: Study Area



On November 26, 2013, Council approved the 2013 Transportation Master Plan (TMP) that identifies the Stage 2 proposal to extend the Light Rail Confederation Line further east to Orléans, known as the Confederation Line East Light Rail Transit (LRT) extension. The 2013 TMP envisions the East LRT facility along the Highway 174 (HWY 174) road corridor. Accordingly, co-locating the East LRT with the HWY 174 road corridor will have ramifications on the HWY 174 widening options and both projects need to be coordinated and considered in an integrated manner.

The objective of this report is to assess the potential impacts of each alternative alignment on the environment in order to identify a preliminary preferred alternative. This report documents the results of the Impact Assessment and Evaluation and presents the Preliminary Preferred Alternative Alignment for review.

1.1 Methodology

The evaluation of the alternative alignments was undertaken using the Concordance Method. This method involves ranking alternatives according to defined indicators and measurements, weighting the indicators and measurements, calculating scores and adding the scores in a matrix. The evaluation process consisted of the following steps:

Step 1: Describe Existing Conditions

Step 2: Identify Alternatives

Step 3: Identify Evaluation Criteria Groups, Indicators and Measurements

Step 4: Assign Weights

Step 5: Analyze Impacts of each Alternative Alignment

Step 6: Apply Evaluation Method (including carrying out Sensitivity Analyses)

Step 7: Review Evaluation Results and Select Preliminary Preferred Alternative

This report focuses on *Step 5: Analyze Impacts of Each Alternative Alignment*, *Step 6: Apply Evaluation Method*, and *Step 7: Review Evaluation Results and Select Preliminary Preferred Alternative* based on the Concordance Methodology performed for the East LRT Planning and Environmental Assessment Study. A brief synopsis of Steps 1 to 4 is provided in Section 2, Previous Steps.

2 PREVIOUS STEPS

Steps leading up to the assessment and evaluation of the alternative solutions are briefly summarized in this section for the purpose of continuity. An existing conditions report was completed and a preliminary list of evaluation criteria was drafted. The information already obtained for the HWY 174/CR17 EA study was used to inform the decision-making process within the East LRT study.

2.1 Step 1: Existing Conditions

A description of the environmental conditions was previously documented in "*Existing Conditions Report, Eastern Light Rail Transit (Blair Station to Trim Road)*". The Existing Conditions Report describes the studies and investigations undertaken to document the existing social, transportation, physical, economic and biological conditions of the study area. It is intended to represent the baseline conditions for the Study Area against which the potential environmental effects of the project will be assessed. Overall, the baseline data was collected and analyzed for key environmental parameters in order to:

- Provide an understanding of existing conditions;
- Allow for future predictions of how the proposed project may cause these environmental conditions to change;
- Allow for future predictions of how adverse effects can be mitigated and beneficial effects enhanced; and
- Provide a basis for designing monitoring programs.

2.2 Step 2: Identify Alternatives

Three separate alternatives were developed that included both the LRT and highway widening.

- Alternative 1: North side LRT with highway widening to the median where width exists, otherwise widening to the outside;
- Alternative 2: South side LRT with highway widening to the median where width exists, otherwise widening to the outside; and
- Alternative 3: Median LRT with highway widening into the median where there is space still available, and to the outside in other areas (all widening is to the outside in areas where the median is insufficient to accommodate the LRT).

The integrated alternatives all include:

- Roadway cross section that incorporates:
  - 3 lanes in each direction;
  - Paved shoulders and concrete median barrier;
  - A buffer between lanes to allow designation of the median lane for high occupancy vehicles; and
  - A continuous concrete barrier between HWY 174 and the ELRT.

- LRT cross section includes:
  - Two LRT tracks;
  - Space for overhead catenary poles (generally between the two tracks); and
  - Platforms at stations, including track transitions where centre platforms are used.

Each LRT alternative is illustrated in Figures 2-1 through 2-4. Typical cross-sections of each alternative, also showing the highway widening are shown in Figures 2-5 and 2-6.

2.3 Step 3: Evaluation Criteria

The following six groups of evaluation criteria were developed to evaluate the relative preference of each alternative solution. Many of these criteria were developed during the HWY 174/CR17 EA study with input from the public.

- Social Criteria;
- Transportation Criteria;
- Infrastructure Criteria;
- Cost Criteria;
- Biological Criteria; and
- Physical Criteria.

Within these groups, indicators and measurements were identified and selected to assess the characteristics of each alternative. These evaluation criteria, along with the alternative alignments, were reviewed and developed with the Project Management Team.

It is important to note that only criteria groups/indicators/measurements that had an expected result of a measurable difference between the alternatives were selected for the evaluation.

Table 2-1 lists the criteria groups and indicators, the measurements developed for each indicator and the data sources used to perform the analysis.

2.4 Step 4: Weights

In accordance with Step 4 of the evaluation process, members of the Study Team were asked to assign weights to each of the identified criteria groups, indicators and measurements. A workbook was prepared and distributed, which lead the evaluators through a series of steps in which they assigned weights to reflect their community values, policies and area of expertise. A total of 100 points were available to apply to the various indicators and measurements.

The weightings were averaged to provide an overall weight for each criteria group. The results are shown in Figure 2-7. The blended weights were used as one scenario during the application of the concordance methodology.

Figure 2-1: LRT Alignment Alternatives (Blair to Montreal Road)

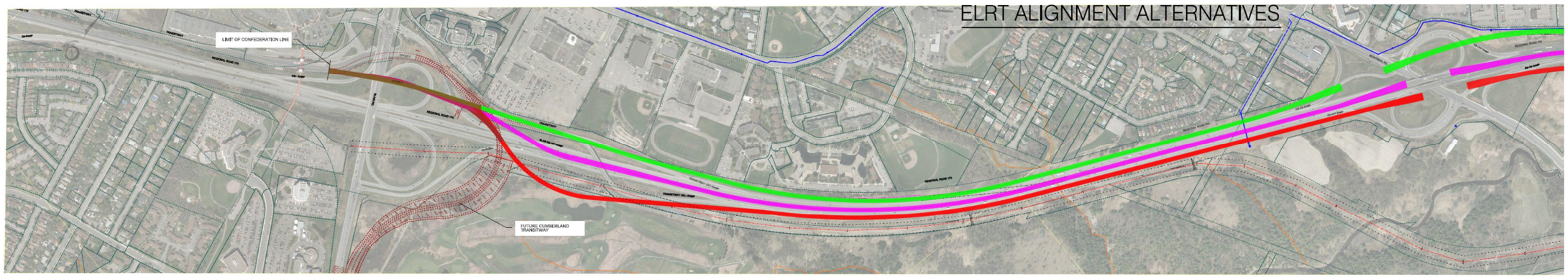


Figure 2-2: LRT Alignment Alternatives (Montreal Road through Greenbelt)

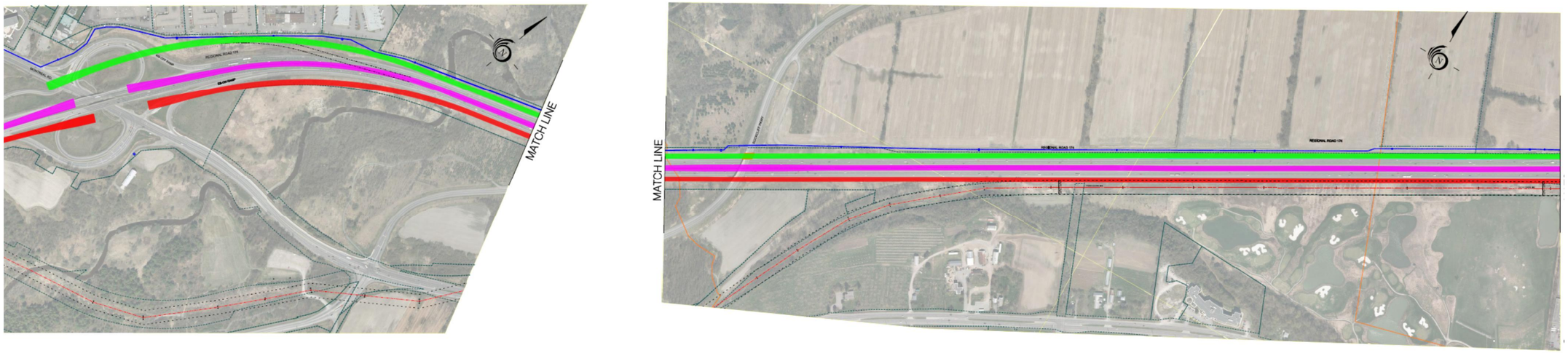


Figure 2-3: LRT Alignment Alternatives (Greenbelt to Orléans Boulevard)

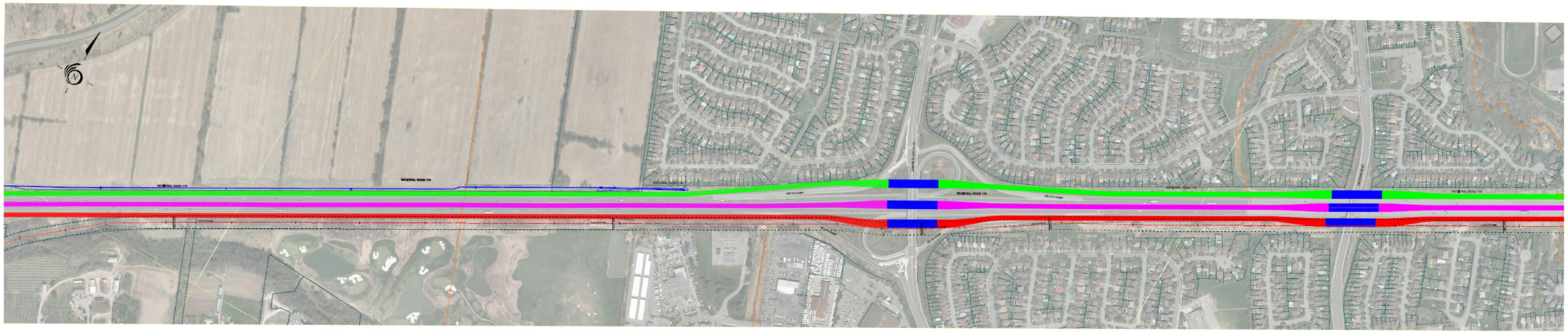


Figure 2-4: LRT Alignment Alternatives (Orléans Boulevard to Trim Road)

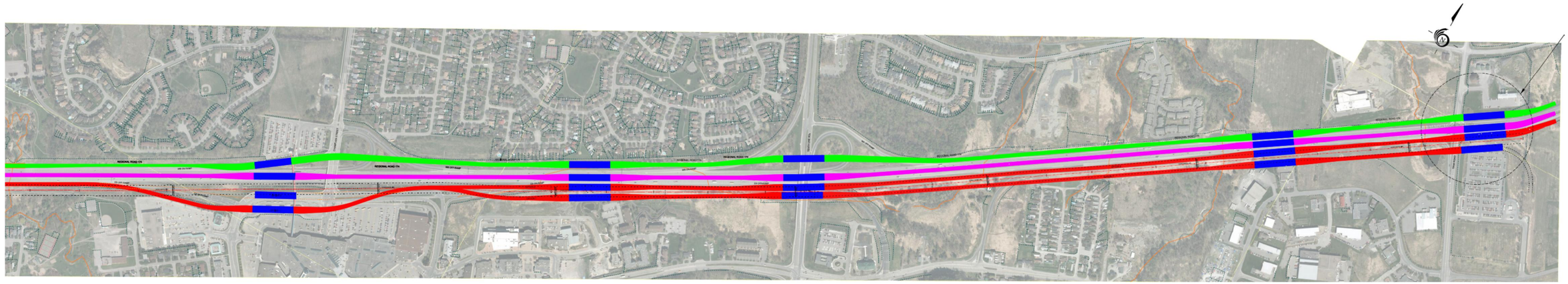


Figure 2-5: North/South Alignment & Station Cross Section

The alternatives west of Trim Road include both a 6-lane freeway and an LRT within the HWY 174 corridor. The freeway width is sufficient to allow for the introduction of High Occupancy Vehicle (HOV) lanes. There will be a concrete barrier between the two directions of travel and between freeway traffic and LRT traffic. The LRT corridor will consist of two tracks. Catenary poles are required to supply power to the trains. Additional width is required at stations as illustrated below.

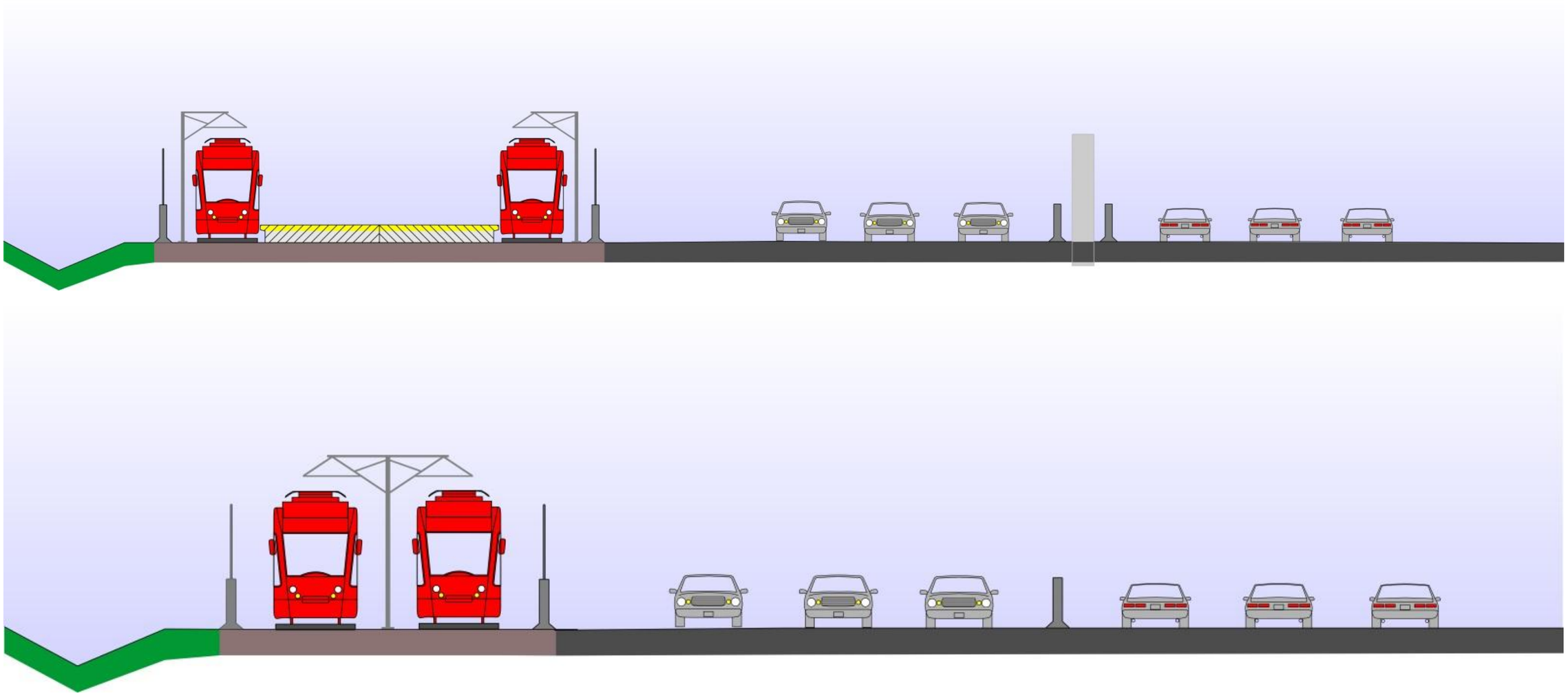


Figure 2-6: Median Alignment & Station Cross Section

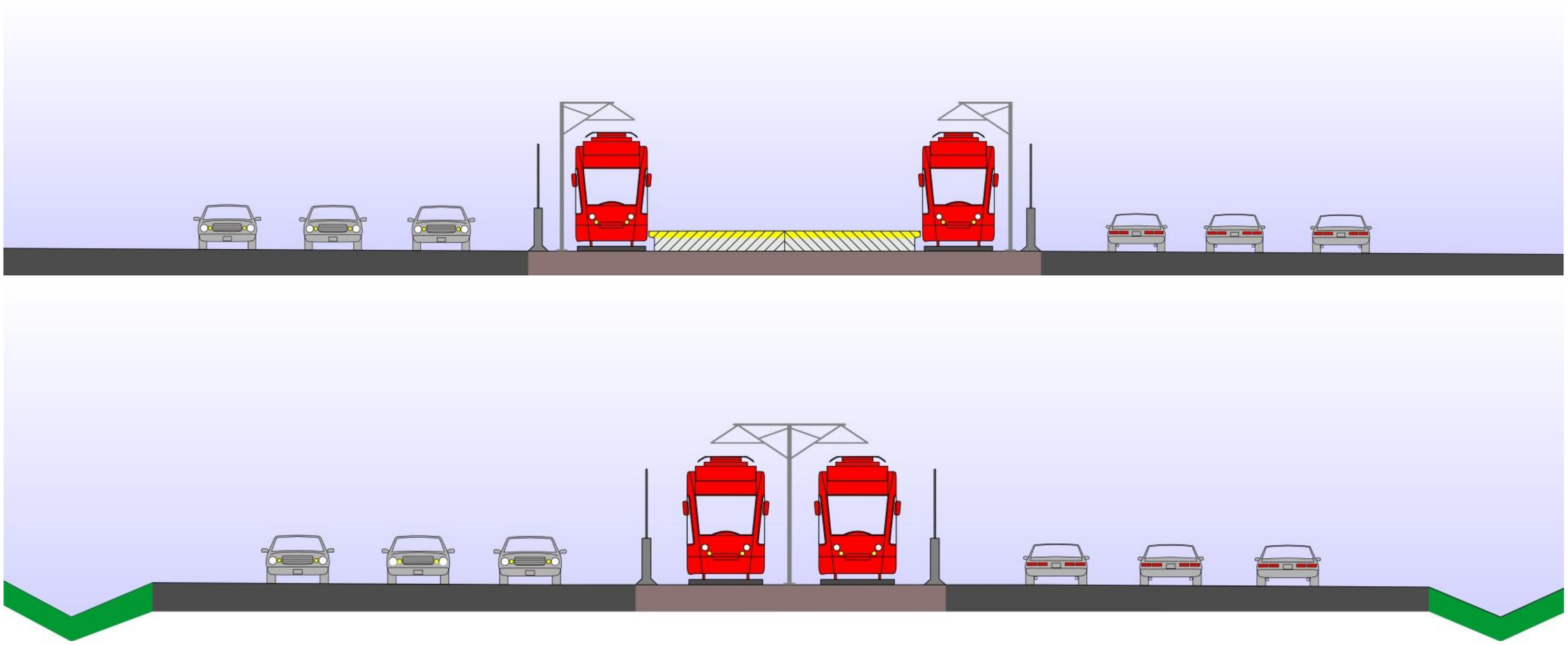


Figure 2-7: East LRT Criteria Group Weights

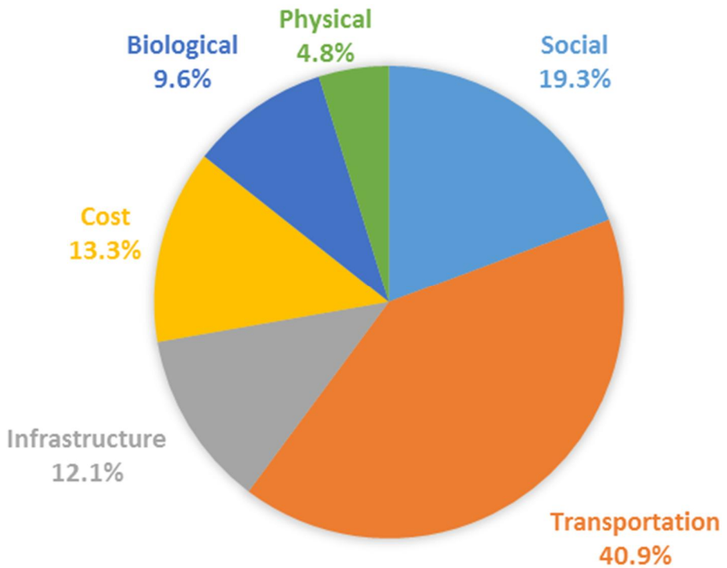


Table 2-1: Criteria and Measurements

Criteria Group	Indicator	Measurement	Data – Source & Type
Social	Archaeological resources	Extent of disruption to areas identified as having archaeological potential (ha)	Ottawa GIS Mapping, Golder Stage 1 mapping, QUANTITATIVE
	Noise	Increase in number of noise sensitive receivers with a noise level of > 60 dBA (#)	Noise modeling using traffic forecasts and mapping with 2011 aerial photography, QUANTITATIVE
	Property Impacts	Number of properties impacted (#) (does not include Hydro One/ provincial lands)	GIS Mapping, Ottawa property fabric mapping. QUANTITATIVE
		Amount of property required (hectare)	GIS Mapping, Ottawa property fabric mapping, QUANTITATIVE
	Compatibility with Adjacent Communities	Integration of LRT with community (comparative)	Mapping and air photo interpretation, QUALITATIVE
		Protection and encouragement of property and business investment (comparative)	Mapping and air photo interpretation, QUALITATIVE
	Views and Vistas	Effects on views within the Greenbelt (comparative)	Mapping and air photo interpretation; Planning documents. QUALITATIVE
		Effects on views, Capital Parkways, Capital Views, scenic entry points outside of the Greenbelt (comparative)	Mapping and air photo interpretation; Planning documents, QUALITATIVE
	Smart Growth	Supports City policies regarding intensification and community planning (comparative)	Professional Judgment, QUALITATIVE
		Motivate sustainable travel choices (comparative)	Professional Judgment, QUALITATIVE
		Opportunities to encourage Transit Oriented Development (comparative)	Professional Judgment, QUALITATIVE
Transportation	Safety	Transit Infrastructure/Personal safety (comparative)	Professional Judgment, QUALITATIVE
	Transit Network Function	Compatibility with future network (2031 rapid transit and transit priority network concept) (comparative)	Mapping, Transportation planning documents, Professional Judgment, QUALITATIVE
		Rider comfort and service quality (comparative)	Professional Judgment, QUALITATIVE
	Transit Ridership	Ability to connect all-day trip generators (comparative)	Professional Judgment, QUALITATIVE
	Transit Stations	Location and spacing (comparative)	Mapping, Transportation planning documents, Professional Judgment, QUALITATIVE
		Potential for multi-modal connections (walk, cycle, transit) (comparative)	Mapping, Transportation planning documents Professional Judgment, QUALITATIVE
	Pedestrian and Cyclists	Multi-use pathway opportunities (comparative)	Mapping, Transportation planning documents, Professional Judgment QUALITATIVE
	Road Network Function	Compatibility with existing network (changes required to existing road network) (comparative)	Mapping, Professional Judgment, QUALITATIVE

Table 2-1: Criteria and Measurements

Criteria Group	Indicator	Measurement	Data – Source & Type
Infrastructure	Major Municipal Infrastructure	Number of conflicts of major Infrastructure (watermains, sewers) (#)	GIS Mapping of municipal services QUANTITATIVE
	Utilities	Number of crossings of major utility corridors such as pipelines (#)	GIS Mapping of utilities QUANTITATIVE
		Number of conflicts with Hydro One transmission line (#)	Length of LRT corridor within 15m of transmission line centreline, Number of transit stations under transmission line; Number of crossings of transmission line. QUANTITATIVE
	Major Structures	Number of changes to existing structures and interchanges including new structures required (#)	GIS Mapping of municipal services QUANTITATIVE
Cost	Capital costs	Relative costs (comparative)	Concept plans, SEMI-QUANTITATIVE
	Operating costs	Operation and maintenance costs (comparative)	Concept plans, SEMI-QUANTITATIVE
Biological	Natural Heritage features	Proximity to or fragmentation of ANSI (ha)	GIS mapping, field visit data, QUANTITATIVE
	Aquatic	Number of watercourse crossings containing known fish habitat (# and low, moderate and high sensitivity)	GIS mapping, field visit data, QUANTITATIVE
	Wildlife	Loss of woodland area (m^2)	GIS mapping, field visit data, QUANTITATIVE
		Potential disruption to significant wildlife habitat (m^2)	GIS mapping, field visit data, QUANTITATIVE
	Species at Risk	Potential disruption of Species at Risk habitat (# and ha)	GIS mapping, field visit data, Professional Judgment , SEMI-QUALITATIVE
Physical	Slopes and ravines	Length of construction within areas of unstable slopes (m)	GIS Mapping of geologic conditions, QUANTITATIVE

3 IMPACT ANALYSIS OF THE ALTERNATIVES

The Impact Analysis (Step 5) involves ranking each alternative solution, from highest to lowest, for each of the measurements. This ranking was done independently by specialists on the Study Team responsible for the various social, transportation, economic, biological and physical aspects of the study. Environmental effects were predicted considering the interaction of all phases of the alternative solutions (planning design/pre-construction, construction, operation) with the existing environment.

The following is a brief description of typical activities that occur during the various phases of a project's evolution. The project may involve development of the East LRT with no highway widening as an interim phase. Highway widening would then proceed as a separate phase.

Planning Design/Pre Construction
Following completion of the Environmental Project Report, the City of Ottawa will ultimately proceed with implementation and construction, which includes the pre-construction activities and design. Project-related environmental effects will be defined in more detail during the planning/pre-construction phase. These activities for LRT and later highway implementation will likely include:

- Site surveying;
- Detailed site investigations;
- Completion of detailed design and contract drawings; and
- Acquisition of land for the required right-of-way and supporting infrastructure.

Construction
Physical construction activities could include:

- Set-up of construction site to house construction trailers, worker parking, material and equipment storage;
- Set-up of road detour(s) including erection of traffic control signs, temporary concrete barriers, barricades, temporary pavement markings, hoarding, and fencing;
- Clearing and grubbing of trees and vegetation within the right-of-way for construction of the project;
- Stripping of topsoil within the right-of-way;
- Excavation of earth overburden and bedrock for structure foundations;
- Trenching and installation of storm sewers, watermains, and other buried services and utilities;
- Grading of the right-of-way, including cutting and filling;
- Realignment of roadways and/or interchanges, construction of new elevated LRT segments, tunnels, and/or retaining walls;
- Laying of granular materials, LRT tracks and other associated infrastructure (e.g. catenary wires and poles) along the right-of-way;
- Construction of pedestrian bridges, stairwells, elevators, platforms and other station components;
- Drainage ditches, new culverts, modify existing culverts, and stormwater treatment facilities;
- Modifications to existing and construction of new vehicle overpass bridge structures;
- Right-of-way barriers and fencing;
- LRT Tracks to include sub ballast, ballast, wood ties, concrete ties/plinths, signage, turnouts, rail and other track materials; and
- Installation of landscaping features such as sodding, seeding, tree and shrub plantings, paving stones, station furniture and lighting fixtures.

Operation
During the operation phase, the LRT corridor would provide facilities for the movement of light rail vehicles including:

- Daily operation of light rail vehicles;
- Daily operation of station facilities;
- Inspection, maintenance and replacement of building infrastructure, including stations, tunnels, bridges, culverts, rails, signalling, and electrical supply;
- Inspection, maintenance and replacement of landscaping, fencing, lighting and security and communications systems;
- Daily maintenance of light rail vehicles, including inspection, exterior/interior cleaning and washing;
- Winter snow clearance and salting of access roadways and sidewalks; and
- Storm drainage system repairs, drainage structure maintenance and clean-out.

The assessment and evaluation of alternative solutions focuses primarily on the physical impacts that could occur during construction and operation of the transportation corridor.

Measurements with a quantitative assessment were assigned a measurement unit as previously indicated in Table 2-1. This unit was an area or another number quantifying a specific characteristic of the alternative. For each quantitative measurement, quantities were calculated and used for comparing the alternatives.

For those measurements requiring a qualitative assessment, specific terms were used to reflect the qualitative judgment of the impacts for each alternative. These terms, as described below in Table 3-1, relate to the degree of impact or the benefit related to the indicator/measurement.

Table 3-1: Vocabulary Used for Qualitative Assessments

Terms used to describe:		Definition:
Negative Impacts	Positive Impacts	
None/No	None/No or Least	The impact is judged to be either completely non-existent, or has the least impact compared to all the alternatives in the table.
Negligible	Limited	The impact exists, but is of a magnitude small enough that it has little effect, or is of limited benefit.
Slight / Moderate	Reasonable	The impact exists and is of relatively low magnitude, but enough to have a measurable effect or contribution.
Some	Good	The impact exists and has an effect that is of a moderate magnitude, or provides a moderate contribution.
Significant	Best	The impact exists and has an effect that is relatively large, or has the most impact when compared to other alternatives in the table.

Once the quantitative and qualitative assessments were complete, the alternatives were ranked. The extent of the potential impact determined the rank assigned to the alternative. The ranking process used was "competition ranking". Alternatives assessed as equal received the same ranking number, and then a gap was left in the ranking numbers. For example if A ranks ahead of B and C (which compare equal) and B and C are both ranked ahead of D, then A gets ranking number 1 ("first"), B gets ranking number 2 ("joint second"), C also gets ranking number 2 ("joint second") and D gets ranking number 4 ("fourth"). Similarly if A, B and C compare as equal and are all ahead of D, then A, B and C get ranking number 1 ("joint first"), and D gets ranking number 4 ("fourth").

The following sections describe the impact assessment for the alternative alignments within the context of the six evaluation criteria groups. For each indicator, one or more measurements were assigned to assess the impacts of each alternative alignment. A description of the data sources consulted to evaluate the alternatives is provided. The rationale for the ranking each of alternatives is also discussed.

Note that alternatives were ranked for each measurement individually. Rankings were **not** blended within the indicator to create an overall indicator rank.

3.1 Social Criteria Evaluation

The social indicators and measurements form the basis for determining the degree to which the alternative alignments impact the social environment. The assessment of the social measurements was performed by several specialists, each with a particular area of expertise. GIS mapping was used to calculate several of the measurements, whereas professional judgment was used to evaluate those measurements that were qualitative in nature. A total of eleven (11) measurements were used to evaluate the potential impacts of the alternative alignments on the social environment. The mapping data for the alternative alignments included the associated highway widening.

3.1.1 Archaeological Resources

The assessment of the impacts on archaeological resources was carried out by using the following measurement: extent of disruption to areas identified as having archaeological potential (expressed in hectares). The Golder Stage 1 Archaeological Assessment report was prepared as part of the HWY 174-CR 17 EA Study (Appendix A).

Table 3-2: Measurement of Impacts on Archaeological Resources

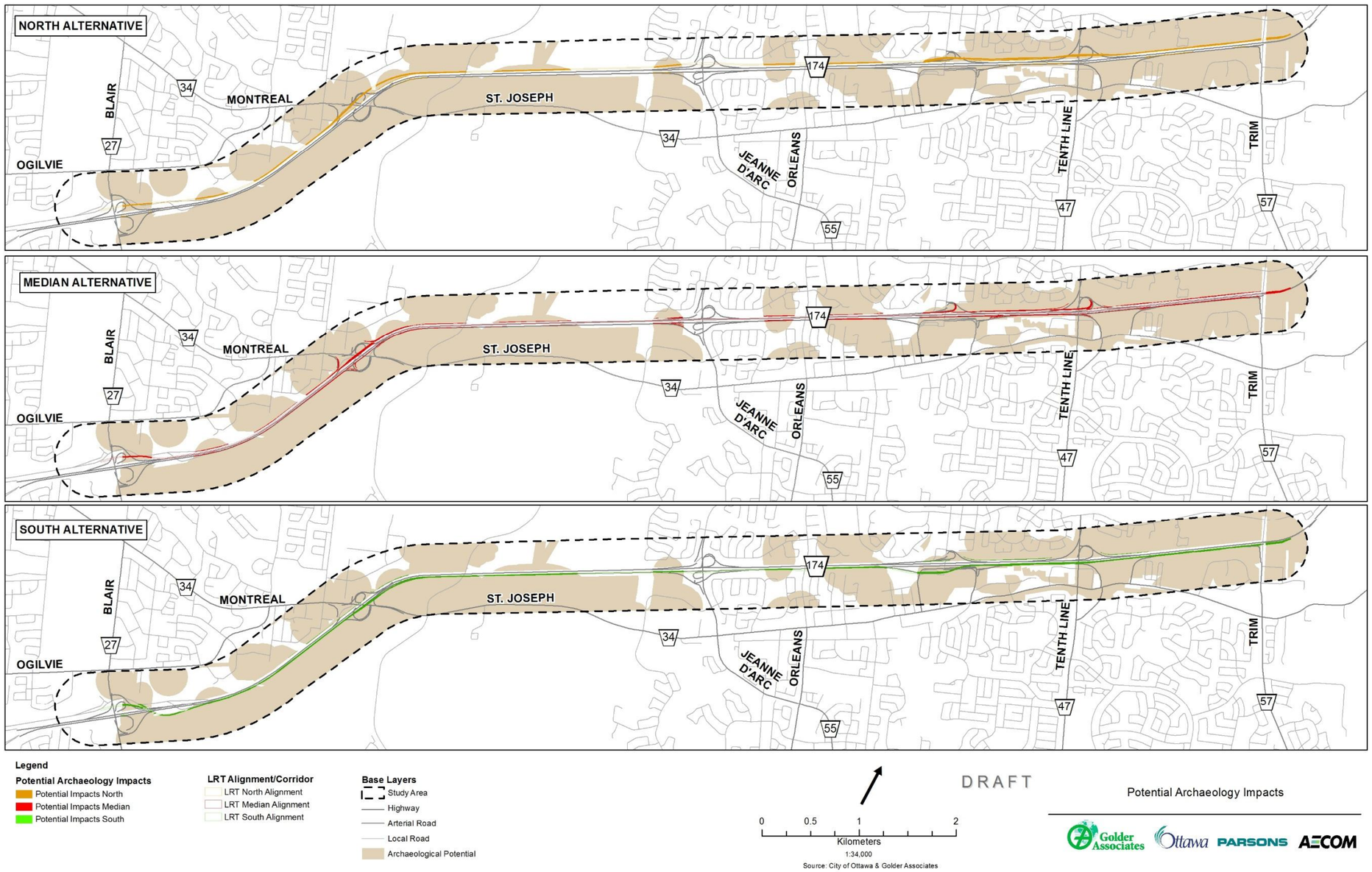
Indicator	Measurement	Data – Source & Type
Impact on archaeological resources	Extent of disruption to areas identified as having archaeological potential (ha)	Ottawa GIS Mapping Golder Stage 1 mapping QUANTITATIVE

The extent of disruption to areas identified as having archaeological potential was determined using the City of Ottawa Archaeological Master Plan (archaeological potential mapping) combined with the Ontario Ministry of Tourism, Culture and Sport checklist for determining archaeological potential as identified in Golder Associates Stage 1 report. Using GIS, each alternative was overlaid with the archaeological potential layers and the areas of disruption were calculated (Figure 3-1). The extent of disruption was determined by the overlap between these two (2) GIS layers. The North Alternative was found to overlap with 7.0 ha with archaeological potential, the South Alternative with 6.3 ha, and then Median Alternative with 5.3 ha. The rankings are summarized below in Table 3-3.

Table 3-3: Ranking for Archaeological Resources

Measurement	Alternative		
	North	South	Median
Extent of disruption to areas identified as having archaeological potential (ha)	7.0 ha	6.3 ha	5.4 ha
Rank	3	2	1

Figure 3-1: Impact on Archaeological Resources



3.1.2 Noise

The City of Ottawa noise impact assessment methodology is set out in the City of Ottawa Environmental Noise Control Guidelines (Ottawa Guideline) dated May 10, 2006. For capital works projects such as this project, the Ottawa Guideline identifies the importance of overall sound level limits and the relative change in noise levels due to Light Rail Transit systems. City of Ottawa noise guidelines note that noise mitigation investigations are required where there is:

- A noise impact of 5 dB or greater, and an overall noise level of 55 to 60 dBA; or
- An overall noise level of more than 60 dBA.

Noise predictions investigated both of these requirements. However, no noise sensitive receivers were found to experience an increase in noise levels above 5 dBA. Since this measurement does not distinguish between alternatives, only the measurement that investigated the increase in number of noise sensitive receivers with a noise level of greater than 60 dBA is discussed. On-site noise measurements to assess existing noise levels were not undertaken as part of this assessment. This assessment compares predicted future noise levels, which are not measureable. The proposed metric to assess future noise levels is summarized in Table 3-4.

Table 3-4: Measurement of Impacts on Noise

Indicator	Measurement	Data – Source & Type
Noise	Increase in number of noise sensitive receivers with a noise level of > 60 dBA (#)	Noise modeling using traffic forecasts and mapping with 2011 aerial photography QUANTITATIVE

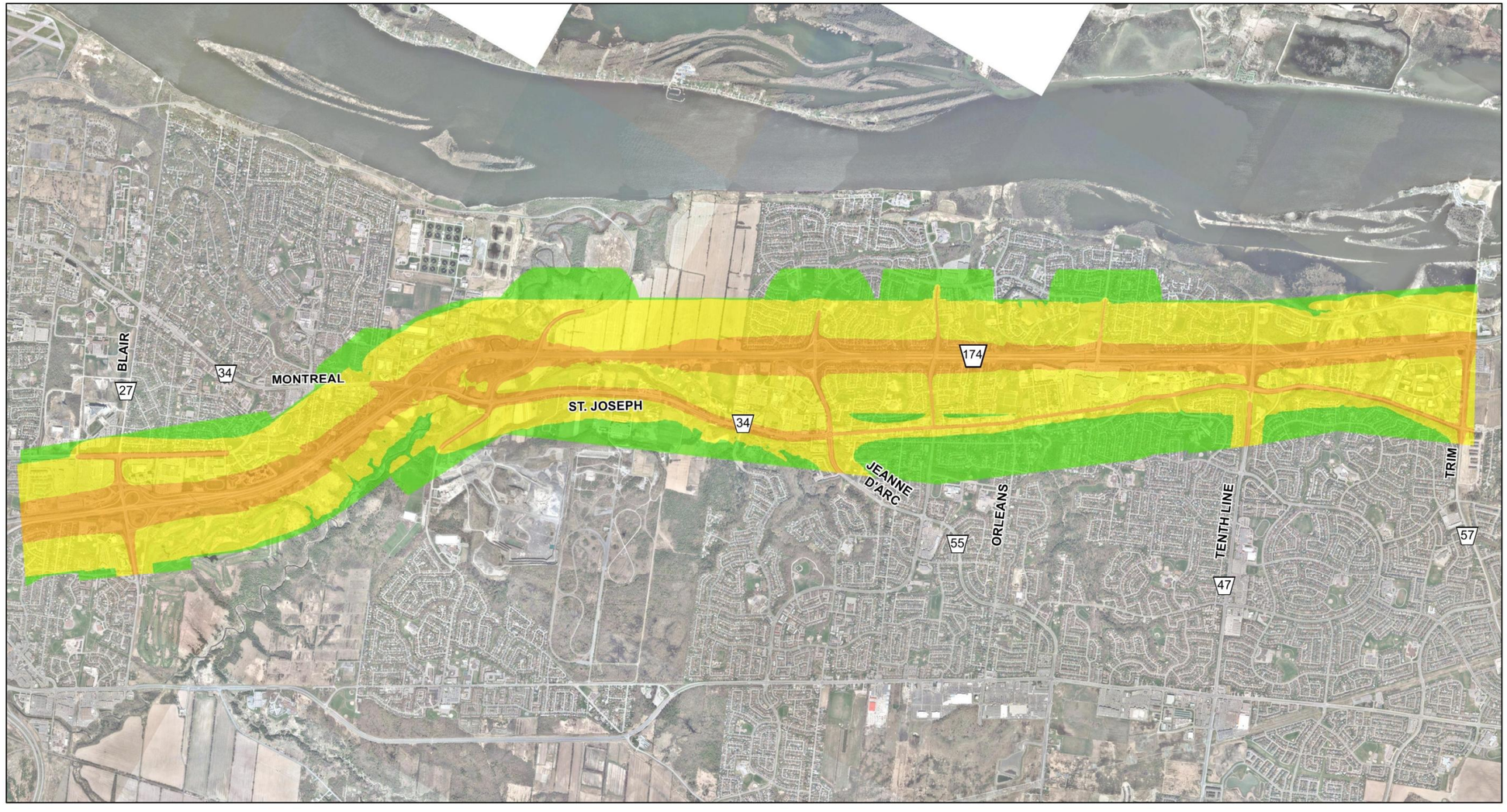
As required by the Ottawa noise guidelines, traffic and LRT noise predictions are required to be completed in accordance with the Ontario Road Noise Analysis Method for Environment and Transportation (ORNAMENT) prediction algorithm implemented in the Ministry of the Environment and Climate Change (MOECC) program STAMSON. ORNAMENT/ STAMSON is a receptor based prediction algorithm that requires a separate calculation for each receptor location. This is impractical to implement when quickly reviewing a large number of receptors. Therefore a graphical noise prediction software (Cadna/A) was calibrated to approximate the noise results from ORNAMENT. As this is an approximation, it is suitable for comparison purposes of different alternatives, but there will be some anomalies (differences from ORNAMENT) near topographical features, such as overpasses. Only noise sensitive receivers with direct exposure (no intervening rows of housing) were considered in this analysis. Locations further removed from the project will have similar changes in noise level but lower noise exposures. Existing noise barriers were not included in this analysis. Further detailed analysis using the mandated ORNAMENT prediction methodology and STAMSON software will be completed for the analysis of the preferred alternative.

The results of the overall noise level assessment show that without the LRT project, noise levels with 2031 traffic are close to or exceed the City of Ottawa threshold of 60 dBA for noise mitigation investigation (see Figure 3-2). This includes most residential sections located along the HWY 174 corridor. To investigate the relative impacts of the alternatives, the increase in number of sensitive receivers (compared to the scenario without the LRT project) requiring noise mitigation investigation was used as the basis of assessment. Note that the primary noise source along the corridor is the vehicular traffic on HWY 174. For the North and South Alternatives, HWY 174 is in the same configuration and hence these two alternatives will have the same noise assessment and ranking. Noise level contour maps for the alternative LRT alignments and associated highway widening are presented in Figure 3-3. According to the assessment, 100 additional noise sensitive receivers will experience a noise level of greater than 60 dBA as a result of the construction of the North or the South Alternative. For the Median Alternative, 92 additional noise sensitive receivers will experience a noise level of greater than 60 dBA. The results of the alternatives comparison, with respect to noise, are summarized below in Table 3-5.

Table 3-5: Ranking for Noise

Measurement	Alternative		
	North	South	Median
Increase in number of noise sensitive receivers with a noise level of > 60 dBA (#)	100	100	92
Rank	2	2	1

Figure 3-2: Noise Levels without the LRT Project



Legend

Predicted Noise Levels

- <55 dBA
- 55 - 60 dBA
- >60 dBA

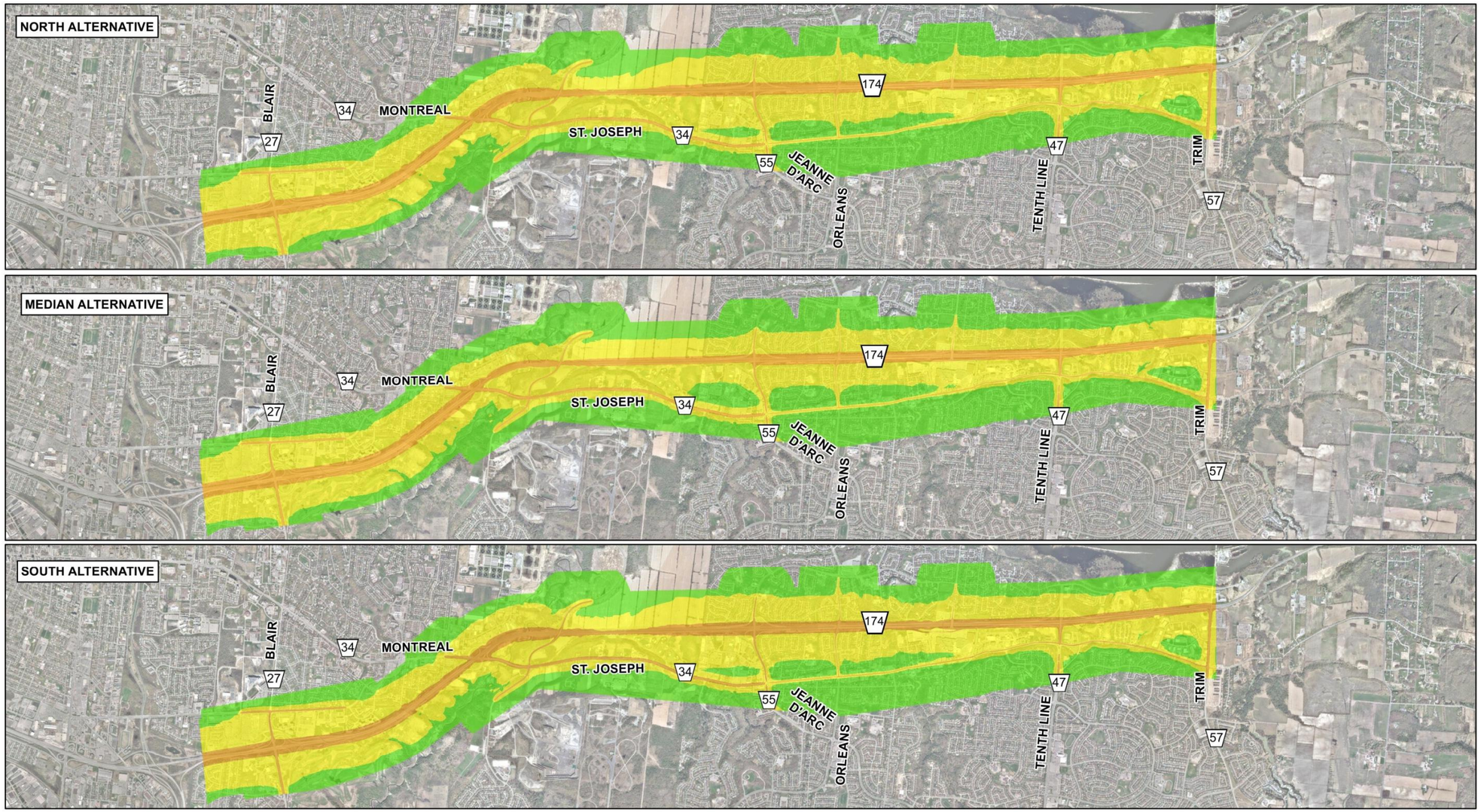
0 0.5 1 2
Kilometers

1:32,000

Source: City of Ottawa

DRAFT

Figure 3-3: Noise Level Maps for Alternatives



3.1.3 Property Impacts

The assessment of property impacts was carried out using two (2) measurements; one that examines the number of properties impacted, and another that takes into account the area (in hectares) of property that would be required for each of the alternatives. The data sources for these measurements are summarized in Table 3-6 below.

Table 3-6: Measurement of Property Impacts

Indicator	Measurement	Data – Source & Type
Property Impacts	Number of properties impacted (#) (does not include Hydro One/ provincial lands)	GIS Mapping Ottawa property fabric mapping QUANTITATIVE
	Amount of property required (hectare)	GIS Mapping Ottawa property fabric mapping QUANTITATIVE

The determination of the number of properties impacted and the amount of property required was undertaken using GIS analysis of the right-of-way requirements of the various alternatives. For the number of properties impacted, all properties were counted regardless of the extent of the impact. In both cases, the South Alternative is the only alternative with any property impacts. These property impacts are at the Pineview Golf Course, at Place D'Orléans and Trim Road. Three (3) private properties and one (1) property owned by the National Capital Commission are required (Figure 3-4). The total area impacted is approximately 3.4 ha. The North Alternative and Median Alternative are not expected to have property impacts. Table 3-7 summarizes the potential impacts to property. Note that the area of property refers to the area affected by the preliminary right-of-way limits. The actual right-of-way requirements will be assessed during the detailed design.

Table 3-7: Ranking for Property Impacts

Measurement	Alternative		
	North	South	Median
Number of properties impacted (#)	0	3 private properties 1 NCC property	0
Rank	1	3	1
Amount of property required (ha)	0	3.4 ha	0
Rank	1	3	1

3.1.4 Compatibility with Adjacent Communities

Assessing the compatibility of each alternative with adjacent communities involves looking at how each of the LRT alternatives would function in the context of the community. Two (2) measurements were selected: integration of LRT with adjacent communities, and protection and encouragement of property and business investment. The data sources for these measurements can be found below in Table 3-8.

Table 3-8: Measurement of Compatibility with Adjacent Communities

Indicator	Measurement	Data – Source & Type
Compatibility with Adjacent Communities	Integration of LRT with community (comparative)	Mapping and air photo interpretation QUALITATIVE
	Protection and encouragement of property and business investment (access)	Mapping and air photo interpretation QUALITATIVE

With respect to LRT integration with adjacent communities, consideration was given to impacts such as: consistency with adjacent land use designations; barriers to movement; and improved walkability and accessibility to transit and active transportation corridors. All alternatives are perceived to not create additional barriers between communities since they are adjacent to or within an existing highway corridor that forms a barrier for community connections between the north and south sides of the corridor. In the segment between Blair Station and Montreal Road, the North Alternative would provide for good integration with adjacent communities on the north side between Blair Road and Montreal Road and the proposed station at Montreal Road/ St. Joseph Boulevard could be integrated with adjacent community facilities and would not require crossing of the HWY 174 corridor to access the station.

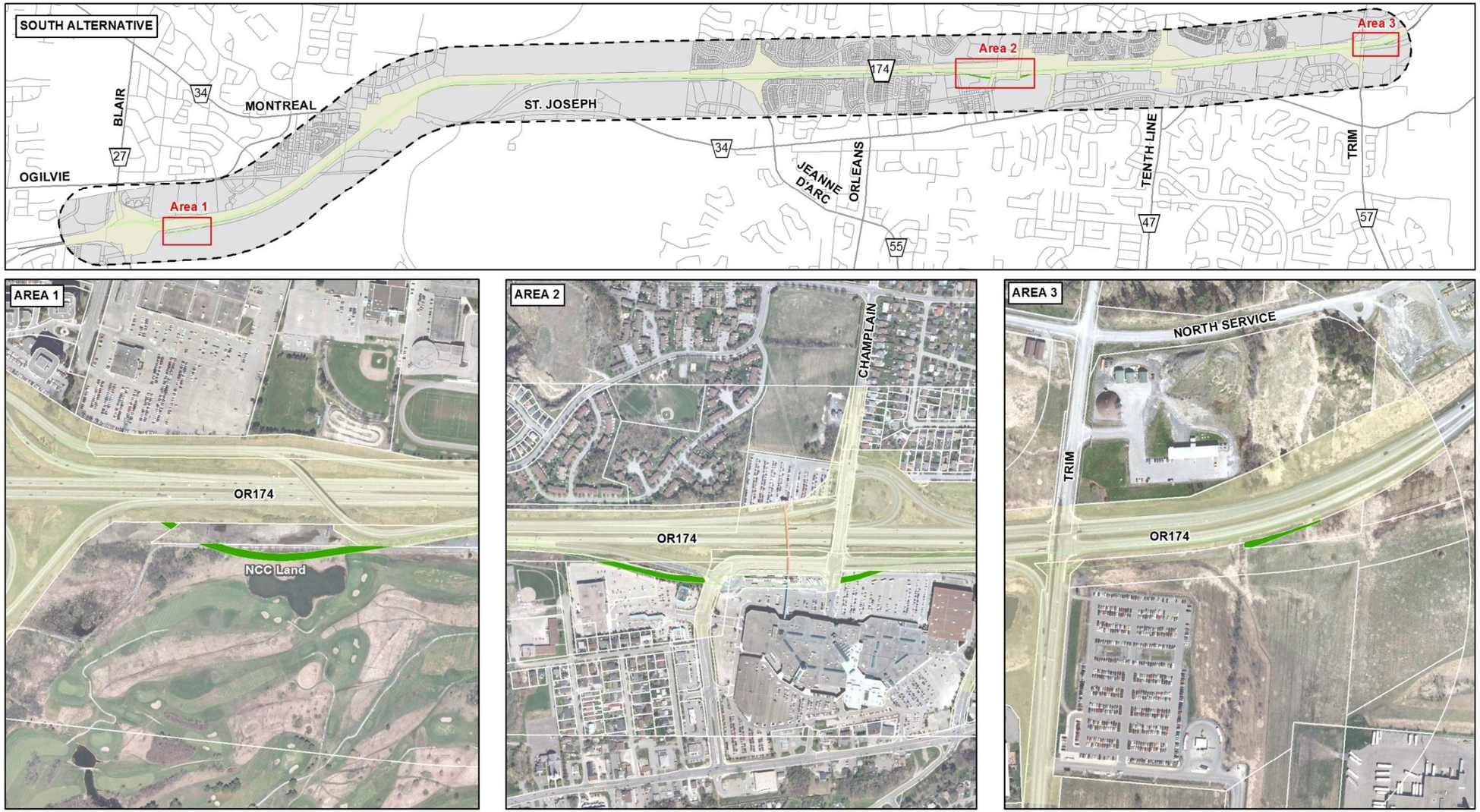
Moderate impacts are expected on existing established residential communities in areas where the North Alternative would be located in close proximity, and while stations would be located in closer proximity to communities along the north side of the HWY 174 corridor, the footprint required could make integration difficult without commiserate increases in community impacts such as noise and light pollution due to proximity of the stations to adjacent low-density residential properties.

The Median Alternative can support good integration with communities to the north and south via new and/or improved crossing opportunities along the HWY 174 corridor, and has the least impact on existing communities. The South Alternative provides the least opportunities for integration with existing communities since there are no communities present to the south between Blair Road and the Youville Drive Business Park, and the proposed station at Montreal Road/St. Joseph Boulevard would be located on the far side of the HWY 174 corridor.

Similar to the north side alternative, the south alignment alternative would provide for stations in closer proximity to established communities along the south side of HWY 174, however the footprint required for station facilities could be make integration difficult without commiserate increases in community impacts such as noise and light pollution due to proximity of the stations to adjacent low-density residential properties. There is also an additional barrier on the south side of HWY 174 in the form of the Hydro One transmission line. The South side alignment alternative would create additional impacts on existing communities along the south side of HWY 174 due to the required relocation of the Hydro One transmission line closer to established residential communities to provide space for an LRT alignment and stations.

With respect to the protection and encouragement of property and business investment, the North Alternative may have some impact on existing functional use of properties in several locations, due to the anticipated requirement for retaining walls located in close proximity to residential properties in Orléans, which may impact use and enjoyment. The North Alternative provides the least opportunity for encouragement of property investment due to the large lengths of the alignment located close to purely low-density residential uses.
The Median Alternative fairs better than the North Alternative since it provides for the protection of existing functional uses of properties located adjacent to the alignment and requires no displacement of existing uses. Furthermore, it provides a good opportunity to encourage property investment due its closer proximity to commercial areas (St. Joseph Boulevard mainstreet), mixed-use and employment nodes.

Figure 3-4: Property Analysis



The South Alternative provides good opportunity for protection of existing functional use of properties, although relocation of the Hydro One transmission lines along the corridor can be seen as a disincentive to investment for affected properties. This Alternative would require the displacement of one commercial building on a large lot near Place D'Orléans station. However, overall it provides the best opportunity for encouragement of property and business investment because it is the closest in proximity to existing commercial development (St. Joseph Boulevard mainstreet), mixed-use and employment nodes, which are designated growth areas. A south side alignment would stimulate greater investment in those key areas due to closer proximity of stations and the potential ability to integrate new development and investment opportunities with LRT stations. The rankings for compatibility with adjacent communities are summarized below in Table 3-9.

Table 3-9: Ranking for Compatibility with Adjacent Communities

Measurement	Alternative		
	North	South	Median
Integration of LRT with community (comparative)	Good integration since communities are only located on north side between Blair Road and Montreal Road.	Least integration since there are no communities to the south between Blair Road and Youville Drive Business Park. Would also require displacement of Hydro One transmission lines closer to established residential communities.	Good integration with communities to the north and south via new and/or improved crossing opportunities
Rank	1	3	1
Protection and encouragement of property and business investment (access)	Least opportunity for encouragement of property investment due to large lengths of alignment in proximity to residential use.	Best opportunity for encouragement of property investment due to proximity to St. Joseph Boulevard mainstreet, mixed-use and employment nodes.	Good opportunity for encouragement of property investment due to proximity to St. Joseph Blvd mainstreet, mixed-use and employment nodes.
Rank	3	1	2

3.1.5 Views and Vistas

Views and vistas are aesthetic elements that enhance or detract from a space depending on the quality of the scenery. They can transform a space from boring or uninspired to dynamic and interesting depending on their juxtaposition, nature, and composition. The more variation in the scenery, the more engaging it becomes and therefore the more enhanced the experience. Views and vistas must be assessed from the vantage points of both the passenger and the surrounding landowners/residents and must consider how they are influenced by the proposed alignment. Table 3-10, below, describes the measurements for the Views and Vistas indicator.

Table 3-10: Measurement of Impacts on Views and Vistas

Indicator	Measurement	Data – Source & Type
Views and Vistas	Effects on views within the Greenbelt (comparative)	Mapping and air photo interpretation; Planning documents QUALITATIVE
	Effects on views, Capital Parkways, Capital Views, scenic entry points outside of the Greenbelt (comparative)	Mapping and air photo interpretation; Planning documents QUALITATIVE

This indicator has been broken down into two measurements to reflect the importance to views and vistas of the NCC-owned Greenbelt land. The LRT/HWY 174 corridor is located adjacent to the Greenbelt from Blair Road to Montreal Road and then crosses the Greenbelt from Montreal Road to west of Jeanne d'Arc Boulevard.

The LRT is powered by electricity provided through catenary wires and poles, which will be erected along the entirety of the alignment. In addition, concrete barriers will be placed between the HWY 174 and the LRT alignment and in the median of HWY 174 to act as a collision barrier. Regardless of the location of the LRT alignment, both catenary wires and poles and concrete barriers will be required between the LRT and the highway. These structures will impact on the views and vistas both from the HWY 174 corridor as well as from adjacent land uses. The catenary wires have a greater impact on distant views, which are smaller by proportion in the field of vision, than on close views.

The corridor from Blair Road to Montreal Road is adjacent to urbanized development to the north, including commercial and residential land uses. There is an existing Hydro One transmission line along the south side of the corridor that currently impacts on existing views. Catenary wires and poles will be lower in height than the transmission line. The lower-density residential land uses that back onto the corridor generally have a noise wall separating them from the highway corridor, minimizing the existing views available and subsequently the impact that the LRT will have on views of the Greenbelt for some adjacent landowners. For this section, the South Alternative will have the greatest impact on views to and from the Greenbelt, affecting travellers in both directions and some apartment residents. This impact is muted by the existing presence of the transmission line in the view. The North Alternative will be on the developed side of the corridor and the Median Alternative will generally affect westbound but not eastbound travellers.

The corridor from Montreal Road to west of Jeanne d'Arc Boulevard includes close views of the Green's Creek valley on both sides. East of the structure carrying the Sir George-Etienne Cartier (GEC) Parkway over HWY 174, there are also expansive distant views of agricultural lands to the north and closer views of rural lands and treed escarpment to the south. Hedgerows are present at a number of locations along the corridor, breaking up the more distant views. The Hydro One transmission line is located along the south side of the corridor beginning east of GEC Parkway. For this section the North Alternative, with its predominantly distant vistas, will have the greatest impact on views to and from the Greenbelt. The South Alternative with its closer views, and the existing impact of the transmission lines on views, will have somewhat less of an impact. Views from the White Sands Golf Course on the south of HWY 174 are already impacted by the transmission line and the freeway. For the Median Alternative, both directions of travel on the HWY 174 will have unimpeded views to the outside, and no roadside barriers are anticipated.

Outside of the Greenbelt in Orléans, views are generally closer due to the built environment being located adjacent to the right-of-way and vegetation along the right-of-way. Residential land uses backing onto the corridor generally have berms, vegetation and/or noise walls located along the right-of-way, obscuring existing views. For both the North and the South Alternatives, views to the north and south will be partially obscured and visually impacted by the catenary poles and concrete barriers that would need to be installed between the road and the LRT. The Median Alternative will allow both directions of travel on the HWY 174 to have unimpeded views to the outside, with no roadside barriers anticipated. Both the South Alternative and North Alternative have greater impacts on views outside of the Greenbelt than the Median Alternative.

HWY 174 is a scenic entry point to downtown Ottawa as defined by the Ottawa Official Plan and the NCC. The Median and South Alternatives provide the best opportunity for the placement of gateway features and signage on the right hand side of HWY 174 for westbound travellers entering the Greenbelt from Orléans.

The rankings for views and vistas are summarized in Table 3-11.

Table 3-11: Ranking for Views and Vistas

Measurement	Alternative		
	North	South	Median
Effects on views within the Greenbelt (comparative)	Significant impact since there are more distant views to the north than to the south, and therefore visual impacts from catenary poles are greater.	Significant impact, although less so than the north alternative, since views to the south are generally closer than to the north and there are power transmission lines affecting the quality of existing views.	Some impact since only views to the inside of the corridor will be impeded.
Rank	3	2	1
Effects on views, Capital Parkways, Capital Views, scenic entry points outside of the Greenbelt (comparative)	Significant impact since views outside the Greenbelt are generally closer. Views will be partially obscured and visually impacted by catenary poles and concrete barriers between the road and LRT. Parkway structure to be replaced.	Significant impact since views outside the Greenbelt are generally closer. Views will be partially obscured and visually impacted by catenary poles and concrete barriers between the road and LRT. Opportunity to provide gateway feature westbound. Parkway structure to be replaced.	Significant impact since views outside the Greenbelt are generally closer. Only views to the inside of the corridor will be impeded. Opportunity to provide gateway feature westbound. Parkway structure to be replaced.
Rank	2	2	1

3.1.6 Smart Growth

Smart growth is an urban planning and transportation theory that concentrates growth in compact, walkable urban centres in order to avoid urban sprawl. Smart growth encourages transit-oriented, walkable, and bicycle-friendly land uses, including complete streets, as well as mixed use development with a range of housing choices. These principles are reflected in both the City of Ottawa's Official Plan (OP) and its Transportation Master Plan. Table 3-12 summarizes the measurements used to assess each of the alternatives contributions to smart growth.

Table 3-12: Measurement of Impacts on Smart Growth

Indicator	Measurement	Data – Source & Type
Smart Growth	Supports City policies regarding intensification and community planning (comparative)	Professional Judgment QUALITATIVE
	Motivate sustainable travel choices (comparative)	Professional Judgment QUALITATIVE
	Opportunities to encourage Transit-Oriented Development (comparative)	Professional Judgment QUALITATIVE

The first measurement involves examining the alternatives from the perspective of how they support City of Ottawa policies regarding intensification and community planning. The City has policies to direct growth and development to mixed-use centres, mainstreets and employment designated areas. The North Alternative is moderately supportive of City policies on growth and intensification due to its proximity throughout Orléans to residential areas, and by providing good connections to Canotek and Taylor Creek Business Parks, as well as lands designated for future development north of HWY 174 at Place D'Orléans/Champlain. The Median Alternative is somewhat supportive of City polices due to the median station locations being relatively close to areas both north and south of HWY 174, but it does not allow for direct connections from adjacent development. The South Alternative is the most supportive of these policies due to its stronger association with designated growth areas on the south side of HWY 174 including Youville Drive Business Park, St. Joseph Boulevard Mainstreet, Place D'Orléans, and the Taylor Creek Business Park.

Another component of smart growth is sustainable travel choices. This measurement compares each alternative in the context of how they motivate sustainable travel choices. Both the North and South Alternatives require trip generators located on opposing sides of the HWY 174 to cross the corridor to access the LRT station. Although both alternatives have the ability to increase walking and cycling trips to access transit, the majority of all-day trip generators are located on the south side of the HWY 174, making the South Alternative more favourable than the North Alternative. The Median Alternative presents the best opportunity to motivate sustainable travel choices since the stations have the best potential to be designed to improve both pedestrian and cycling connections across the HWY 174 corridor and to reduce its barrier effect on adjacent communities. However, the Median Alternative will require more consideration to design connections in order to reduce the perception of isolation that may be associated with travel choices to median stations.

Transit-oriented development (TOD) is another component of smart growth. The North Alternative has good opportunities to encourage TOD at Place D'Orléans and between Tenth Line and Trim Road. The Median Alternative has moderate ability to encourage TOD, but the walking distance between potential development and stations is further and connections are less direct. However the longer walk is balanced by the proximity of more land on both sides of HWY 174, which are within the TOD catchment zone. The South Alternative has the best opportunities for TOD since stations will be closer to development opportunities around Jeanne D'Arc, Place D'Orléans, Orléans Town Centre and Trim Road. The rankings for smart growth can be found in Table 3-13.

Table 3-13: Ranking for Smart Growth

Measurement	Alternative		
	North	South	Median
Supports City policies regarding intensification and community planning (comparative)	Moderately supportive of City policies due to proximity to residential areas in Orléans, two business parks and designated growth areas north of HWY 174.	Most supportive of City policies due to proximity with several designated growth areas on the south side of HWY 174.	Somewhat supportive of City policies due to proximity to areas both north and south of HWY 174. However, it does not allow for direct connections to adjacent development.
Rank	2	1	3
Motivate sustainable travel choices (comparative)	Reasonable opportunities to motivate sustainable travel choices, but will require trip generators located on the south side to cross the entire HWY 174 corridor.	Good opportunities to motivate sustainable travel choices, but will require trip generators located on the north side to cross the entire HWY 174 corridor. A greater number of trip generators are located on the south side of the HWY 174.	Best opportunity to motivate sustainable travel choices since stations locations will reduce barrier effect on adjacent communities.
Rank	3	2	1
Opportunities to encourage transit-oriented development (comparative)	Good opportunities to encourage TOD at Place D'Orléans and between Tenth Line and Trim Road.	Best opportunities to encourage TOD since stations will be closer to development at Jeanne D'Arc, Place D'Orléans, Orléans Town Centre and Trim Road.	Reasonable opportunities to encourage TOD since walking distance between potential development and stations is further.
Rank	2	1	3

3.2 Transportation Criteria Evaluation

The City of Ottawa's 2013 Transportation Master Plan establishes the goals to transform Ottawa's transit system. The East LRT project is identified as one of the major projects outlined in the 2031 Affordable Rapid Transit and Transit Priority (RTTP) network. The widening of Highway 174 is identified on Map 9 Road Network – Network Concept from the 2013 TMP. The following sections present the indicators and measurements that were used to compare the alternatives from the perspective of transportation including their ability to satisfy the objectives of the 2013 TMP.

3.2.1 Safety

Safety was assessed using one measurement, which combines an evaluation of both transit infrastructure and personal safety. As described below in Table 3-14, professional judgment guided the evaluation of the alternatives with respect to safety.

Table 3-14: Measurement of Impacts on Safety

Indicator	Measurement	Data – Source & Type
Safety	Transit Infrastructure/Personal safety (comparative)	Professional Judgment QUALITATIVE

Transportation infrastructure and Stations will be designed to be safe in accordance with existing specifications. Transit infrastructure and stations will adhere to Crime Prevention Through Environmental Design (CPTED) principles and OC Transpo facility guidelines. In general, the following principles has been recognized and considered inherent in the designs:

- Safety of the infrastructure – segregated, protected from intrusion. Exit routes and walkways to clear passengers away from an incident;
- Safety of passengers – National Fire Protection Association's *Standard for Fixed Guideway Transit and Passenger;*
- Personal safety – clear sight lines, no blind spots or hidden areas, passive surveillance, clearly signed routes and services, access to staff at designated areas. Accessible redundancy for high service standard.

In all of the alternatives, perceptions of personal safety can still exist and be mitigated through design. The proximity to and conflicts of the South Alternative with the existing Hydro One corridor represent some risk to transit infrastructure. For both the North Alternative and South Alternatives, stations will also be less visible due to the need to be one level below highway grade to accommodate ramp connections at interchanges. The Median Alternative is the preferred option because stations will be more visible, despite the station location in the middle of HWY 174 corridor potentially increasing perceptions of isolation and risks to personal safety. The ranking for safety can be found below in Table 3-15.

Table 3-15: Ranking for Safety

Measurement	Alternative		
	North	South	Median
Transit Infrastructure/Personal safety (comparative)	Moderate impact since stations will be less visible due to need to be one level below highway grade to accommodate ramp connections at interchanges.	Some impact since proximity to and conflicts with hydro corridor represent some risk to transit infrastructure. Stations will be less visible due to need to be one level below highway grade to accommodate ramp connections at interchanges.	Negligible impact since stations will be more visible. However, locating station in the middle of highway may increase perception of isolation and personal safety risk.
Rank	2	3	1

3.2.2 Transit Network Function

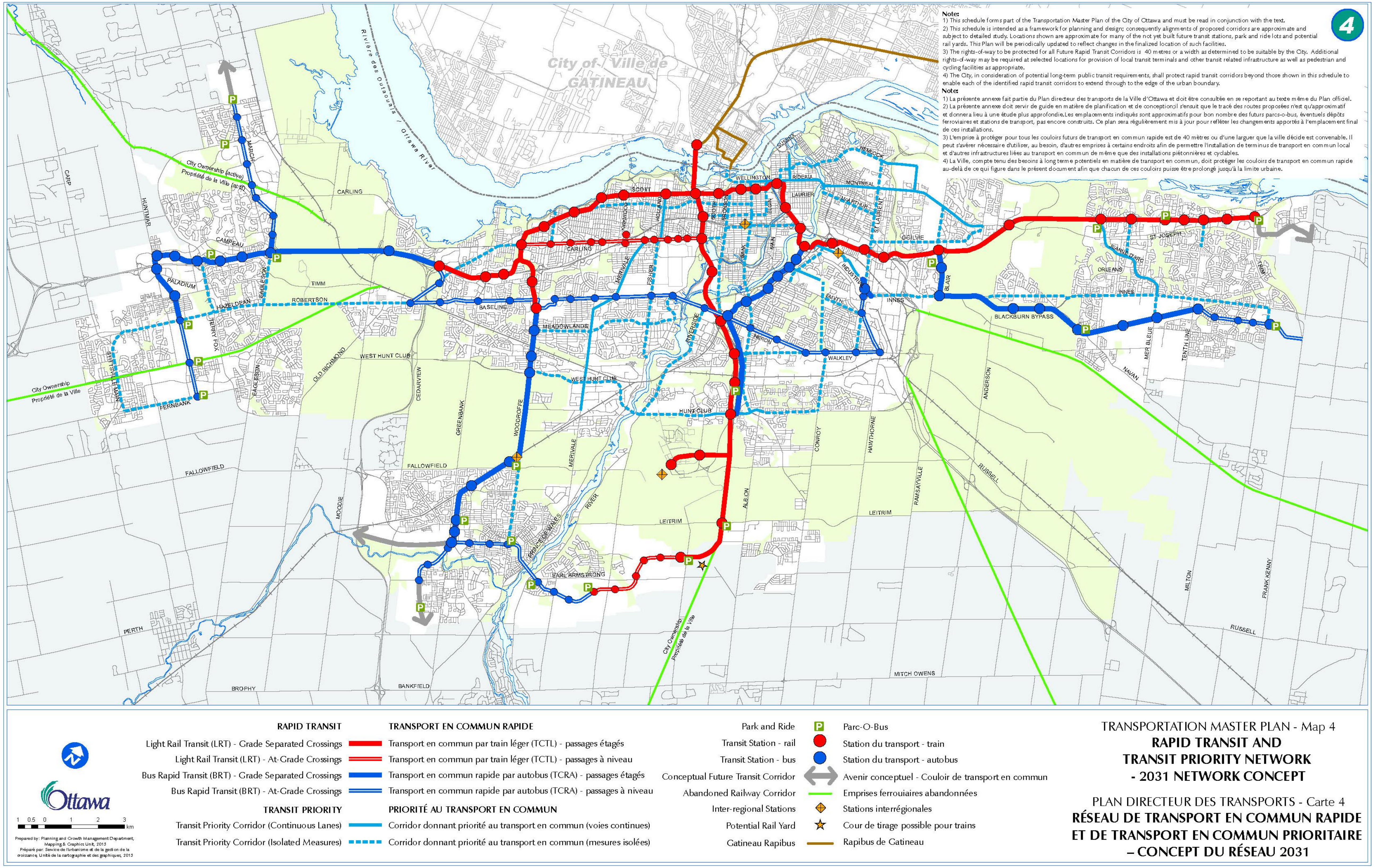
Since the LRT will work as a key part of the City of Ottawa's transit network, it is important that it enhances the function of the network. Table 3-16 summarizes the measurements used to assess the impacts of the alternatives. The future network mentioned in the measurement refers to the 2031 Rapid Transit and Transit Priority (RTTP) Network Concept outlined in the City of Ottawa's Transportation Master Plan (2013). Rapid transit includes both light rail transit and bus rapid transit. Transit priority refers to measures put in place (e.g. dedicated bus lanes, bus queue jumps) to eliminate delay to transit services caused by congestion and to minimize delay caused by traffic signals.

Table 3-16: Measurement of Impacts on Transit Network Function

Indicator	Measurement	Data – Source & Type
Transit Network Function	Compatibility with future network (2031 rapid transit and transit priority network concept) (comparative)	Mapping Transportation planning documents Professional Judgment QUALITATIVE
	Rider comfort and service quality (comparative)	Professional Judgment QUALITATIVE

The first measurement evaluated how each of the alternatives perform in the context of the future network outlined in the City of Ottawa's 2013 Transportation Master Plan. All identified future rapid transit and transit priority links extend south from the HWY 174 corridor, as can be seen in Figure 3-5. The South Alternative therefore provides the best compatibility since it is the closest in proximity and would facilitate linkages with the future network. Both the North and the Median Alternatives can have their stations designed such that they are compatible with future transit priority corridor links. However, in both alternatives, future extension of rapid transit east of Trim Road to serve Cardinal Creek would require a crossing of HWY 174.

Figure 3-5: Rapid Transit and Transit Priority Network - 2031 Network Concept



Rider comfort and service quality are greatly influenced by components of the alignment design such as curves and grade changes that may impact the experience of transit users. The South Alternative has the greatest impact on rider comfort and service quality because this alignment must cross over or under the highway from Blair Station to reach the south side of the HWY 174 corridor. Additional curves and grades will also be required at station locations in order to integrate with highway interchanges ramps. The North Alternative performs better than the South Alternative since no crossing over or under the highway is required after Blair Station. However, curves and grades will still be required at station locations to integrate with highway interchange ramps. The Median Alternative will also require a crossing over or under the westbound lanes of the HWY 174 to reach the median. However, since this alignment will follow the existing grade and will be straight, the Median Alternative will result in the best ride comfort and service quality. The ranking for transit network function can be found below in Table 3-17.

Table 3-17: Ranking for Transit Network Function

Measurement	Alternative		
	North	South	Median
Compatibility with future network (2031 rapid transit and transit priority network concept) (comparative)	Least compatibility since future extension of rapid transit to serve Cardinal Creek would require crossing of HWY 174. Furthest from future rapid transit and transit priority links.	Best compatibility since closest in proximity to identified future rapid transit and transit priority links.	Good compatibility since future extension of rapid transit to serve Cardinal Creek would require crossing of HWY 174.
Rank	3	1	2
Rider comfort and service quality (comparative)	Good rider comfort since no crossing of HWY 174 corridor required. Additional curves and grades at station locations required to integrate with interchange ramps.	Reasonable rider comfort although crossing of HWY 174 corridor required. Additional curves and grades at station locations required to integrate with interchange ramps.	Best rider comfort and service quality although crossing of HWY 174 corridor required. Alignment will be at existing grade and will be straight.
Rank	2	3	1

3.2.3 Transit Ridership

According to the 2013 TMP, OC Transpo's share of travel in the morning peak period was just over 22% in 2011, and the TMP aims to increase that mode share to 26% by 2031. The City is required to make transit a more attractive option than automobile use for a greater number of residents in order to reach this increased modal share. Therefore, it is important to assess the impact of each of the LRT alternatives on transit ridership. The measurement used to evaluate transit ridership can be found in Table 3-18.

Table 3-18: Measurement of Impacts on Transit Ridership

Indicator	Measurement	Data – Source & Type
Transit Ridership	Ability to connect all-day trip generators (comparative)	Professional Judgment QUALITATIVE

Within the study area, the majority of all-day trip generators are located on the south side of the HWY 174 corridor, with the exception of La Cité collégiale. The ability to connect all-day trip generators is largely influenced by the proximity and accessibility of the alignments with respect to the location of trip generators. Since the North Alternative is located furthest from the majority of all-day trip generators, this alternative enhances transit ridership the least. Although direct connections to the Median Alternative are not possible, this alternative offers shorter walking distances to major opportunities than the North Alternative. The South Alternative provides the best connection to all-day trip generators due to its close proximity to the majority of all-day trip generators located to the south of the HWY 174 corridor. The ranking for transit ridership can be found below in Table 3-19.

Table 3-19: Ranking for Transit Ridership

Measurement	Alternative		
	North	South	Median
Ability to connect all-day trip generators (comparative)	Fewest opportunities for direct connections due to distance from majority of all-day trip generators.	Best opportunity for direct connection due to proximity to majority of all-day trip generators.	No direct connections possible but offers shorter walking distance to major opportunities than North Alternative.
Rank	3	1	2

3.2.4 Transit Stations

The 2013 TMP identified several transit stations along the proposed LRT corridor. Two (2) measurements were selected to assess the ability of each of the alternatives to accommodate the transit stations outlined in the TMP. These measurements are summarized below in Table 3-20.

Table 3-20: Measurement of Impacts on Transit Stations

Indicator	Measurement	Data – Source & Type
Transit Stations	Location and spacing (comparative)	Mapping Transportation planning documents Professional Judgment QUALITATIVE
	Potential for multi-modal connections (walk, cycle, transit) (comparative)	Mapping Transportation planning documents Professional Judgment QUALITATIVE

With respect to the location and spacing of transit stations, all alternatives can accommodate the stations identified in the TMP. However, due to the presence of the HWY 174 corridor as a pre-existing division between north and south communities, the location of the alternatives will influence the accessibility of the stations to adjacent communities. The North Alternative will provide for good station locations serving communities on the north side only, whereas the South Alternative will provide for good station locations serving communities on the south side only. The Median Alternative performs the best because this alignment would be equidistant from both communities to the north and south, reducing or eliminating the barrier effect of HWY 174.

According to the TMP, rapid transit stations should serve as multimodal hubs that are integrated with surrounding communities. Therefore, it is important to examine the potential for multi-modal connections to the LRT, including walking, cycling, and other transit. The North Alternative provides the best ability to provide multi-modal connections on the north side of the corridor, but requires all users accessing from the south side to cross the highway corridor. Station placement provides limited ability to provide for additional connections across the highway. The inverse applies to the South Alternative due to its location on the south side of the corridor. The Median Alternative provides for reasonable multi-modal connections to both the north and the south sides of the corridor, but requires the crossing of half of the highway. In this alternative, the station placement permits the best ability to provide additional connections across the highway.

The ranking for transit stations can be found in Table 3-21.

Table 3-21: Ranking for Transit Stations

Measurement	Alternative		
	North	South	Median
Location and spacing (comparative)	Provides good station locations serving communities on the north side of the corridor only.	Provides good station locations serving communities on the south side of the corridor only.	Station locations would be equidistant from communities both on the north and south side of the corridor.
Rank	2	2	1
Potential for multi-modal connections (walk, cycle, transit) (comparative)	Provides best ability for multi-modal connections on north side of the corridor but requires all users accessing from the south to cross the highway corridor. Station placement provides limited ability to provide for additional connections across the highway.	Provides best ability for multi-modal connections on south side of the corridor but requires all users accessing from the north to cross the highway corridor. Station placement provides limited ability to provide for additional connections across the highway.	Provides for reasonable multi-modal connections to both north and south sides of the corridor but requires crossing of half the highway to access. Station placement permits best ability to provide additional connections across the highway.
Rank	2	2	1

3.2.5 Pedestrians and Cyclists

Maximizing walkability and developing a great cycling city are central to the City of Ottawa's TMP. The provision of multi-use pathways is one way to progress in these areas. Table 3-22, below, summarizes the data sources used to assess the impacts of each of the alternatives on multi-use pathway opportunities.

Table 3-22: Measurement of Impacts on Pedestrians and Cyclists

Indicator	Measurement	Data – Source & Type
Pedestrian and Cyclists	Multi-use pathway opportunities (comparative)	Mapping Transportation planning documents Professional Judgment QUALITATIVE

When examining the potential of each of the alternatives to provide multi-use pathway opportunities, the ability of the North Alternative to provide a parallel multi-use pathway is limited, but connections to facilities on the north side of the corridor do not require crossing of the highway. There are also fewer locations for a multi-use pathway connection to the north of the HWY 174 corridor than to the south because limited space was left between houses to accommodate pathway connections. The ability of the South Alternative is also limited, but connections to facilities on the south side of the corridor do not require crossing of the highway. The existing pathway along a portion of the South Alternative would need to be relocated in the remaining space south of the LRT. The Median Alternative provides the greatest ability to provide a parallel multi-use pathway, but connections to other facilities will require highway crossings. However, these crossings can be integrated into station designs. The ranking for pedestrians and cyclists can be found in Table 3-23.

Table 3-23: Ranking for Pedestrian and Cyclists

Measurement	Alternative		
	North	South	Median
Multi-use pathway opportunities (comparative)	Limited ability to provide parallel pathway facility, but connections on the north side of HWY 174 do not require crossing of the highway. Fewer pathway connections to the north of HWY 174 than to the south.	Limited ability to provide parallel pathway facility, but connections on the south side of HWY 174 do not require crossing of the highway. Existing pathways would need to be modified.	Provides the best flexibility in providing parallel pathway opportunities but connections to other facilities will require highway crossings. Crossings can be integrated into station design.
Rank	2	2	1

3.2.6 Road Network Function

The LRT is proposed to be constructed in an area that already has an existing road network. To decrease costs and improve efficiency, the ideal LRT alignment should have minimal impact on the existing road network function. The measurement used to evaluate this indicator can be found in Table 3-24.

Table 3-24: Measurement of Impacts on Road Network Function

Indicator	Measurement	Data – Source & Type
Road Network Function	Compatibility with existing network (changes required to existing road network) (comparative)	Mapping Professional Judgment QUALITATIVE

Compatibility with the existing road network was used to assess the impact of each alternative on the function of the road network. Compatibility was comparatively measured by examining the changes that would be required to the existing road network as a result of each of the alternatives. Both the North Alternative and the South Alternative have significant potential impacts on ramp geometry at interchanges to accommodate both the LRT alignment itself as well as LRT stations. For the North Alternative, the south to westbound on-ramp at Champlain Street would need to be entirely removed to accommodate a station serving Place D'Orléans. For the South Alternative, the eastbound off-ramp at Tenth Line would require significant alteration or complete removal to accommodate the LRT. The South Alternative is considered to have a greater impact on road network function than the North Alternative. The Median Alternative would only have slight potential impacts on road and ramp geometry at interchanges, since the majority of the HWY 174 corridor can already accommodate a median LRT without structural changes to interchanges. However, the westbound lanes at Montreal Road and St. Joseph would need to be shifted to accommodate the LRT.

Table 3-25: Ranking for Road Network Function

Measurement	Alternative		
	North	South	Median
Compatibility with existing network (changes required to existing road network) (comparative)	Significant potential impacts on ramp geometry at interchanges. Removal of ramp required.	Significant potential impacts on ramp geometry at interchanges. Significant alteration or removal of ramp required.	Slight potential impacts on road and ramp geometry at interchanges. Shifting of some lanes required.
Rank	2	3	1

3.3 Infrastructure Criteria Evaluation

This criteria group reflects the desire to minimize operational and maintenance difficulties to infrastructure, avoid construction difficulties and associated cost implications. Several key infrastructure components were identified for assessment.

3.3.1 Major Municipal Infrastructure

The LRT is proposed to be located in a pre-existing highway corridor that is largely flanked by development to the north and the south. This development requires major municipal infrastructure such as watermains and sewers. The major municipal infrastructure was selected as an indicator because conflicts with this infrastructure would complicate construction and would have significant cost implications. The measurement used to assess impacts on major municipal infrastructure is summarized below in Table 3-26.

Table 3-26: Measurement of Impacts on Major Municipal Infrastructure

Indicator	Measurement	Data – Source & Type
Major Municipal Infrastructure	Number of conflicts of major Infrastructure (watermains, sewers) (#)	GIS Mapping of municipal services QUANTITATIVE

The number of potential conflicts with major infrastructure was used as the measurement to assess impacts on major municipal infrastructure. The types of infrastructure that were included in this evaluation are the following: watermains, sanitary sewers, storm sewers and creek culverts. GIS was used to count the number of conflicts, which are considered as locations where the proposed alignments intersect with any of these infrastructure types (Figure 3-6). Both the North Alternative and the Median Alternative had a total of thirty (30) conflicts, which include 8 watermains, 11 sanitary sewers, 5 storm sewers, and 6 creek culverts. The South Alternative had a total of thirty-three (33) conflicts which includes 10 watermains, 12 sanitary sewers, 5 storm sewers and 6 creek culverts. The North and Median Alternatives therefore had the least impact with respect to major municipal infrastructure. The rankings for major municipal infrastructure are summarized below in Table 3-27.

Table 3-27: Ranking for Major Municipal Infrastructure

Measurement	Alternative		
	North	South	Median
Number of conflicts of major Infrastructure (watermains, sewers) (#)	30 conflicts (8 watermains; 11 sanitary sewers; 5 storm sewers; 6 creek culverts)	33 conflicts (10 watermains; 12 sanitary sewers; 5 storm sewers; 6 creek culverts)	30 conflicts (8 watermains; 11 sanitary sewers; 5 storm sewers; 6 creek culverts)
Rank	1	3	1

3.3.2 Utilities

Utilities were also selected as an indicator because utilities *are* not owned or managed by the municipal government. Table 3-28, below, summarizes the two (2) measurements used to evaluate the impacts on utilities.

Table 3-28: Measurement of Impacts on Utilities

Indicator	Measurement	Data – Source & Type
Utilities	Number of crossings of major utility corridors such as pipelines (#)	GIS Mapping of utilities QUANTITATIVE
	Number of conflicts with Hydro One transmission line (#)	Length of LRT corridor within 15m of transmission line centreline Number of transit stations under transmission line Number of crossings of transmission line QUANTITATIVE

The number of crossings of major utility corridors (e.g. pipelines) was used as one measurement of impacts on utilities (Figure 3-7). All of the alternatives were found to have the following potential conflicts: five (5) crossings of gas mains with 150-500mm diameter and a 350m section near a 500mm diameter gas main along the westbound lanes within the Greenbelt. In addition to these potential conflicts, the North Alternative also conflicts with a gas main along the westbound off-ramp located at Champlain Street. As a result of this additional intersection with a gas main, the North Alternative has the greatest impact on utilities of the alternatives considered.

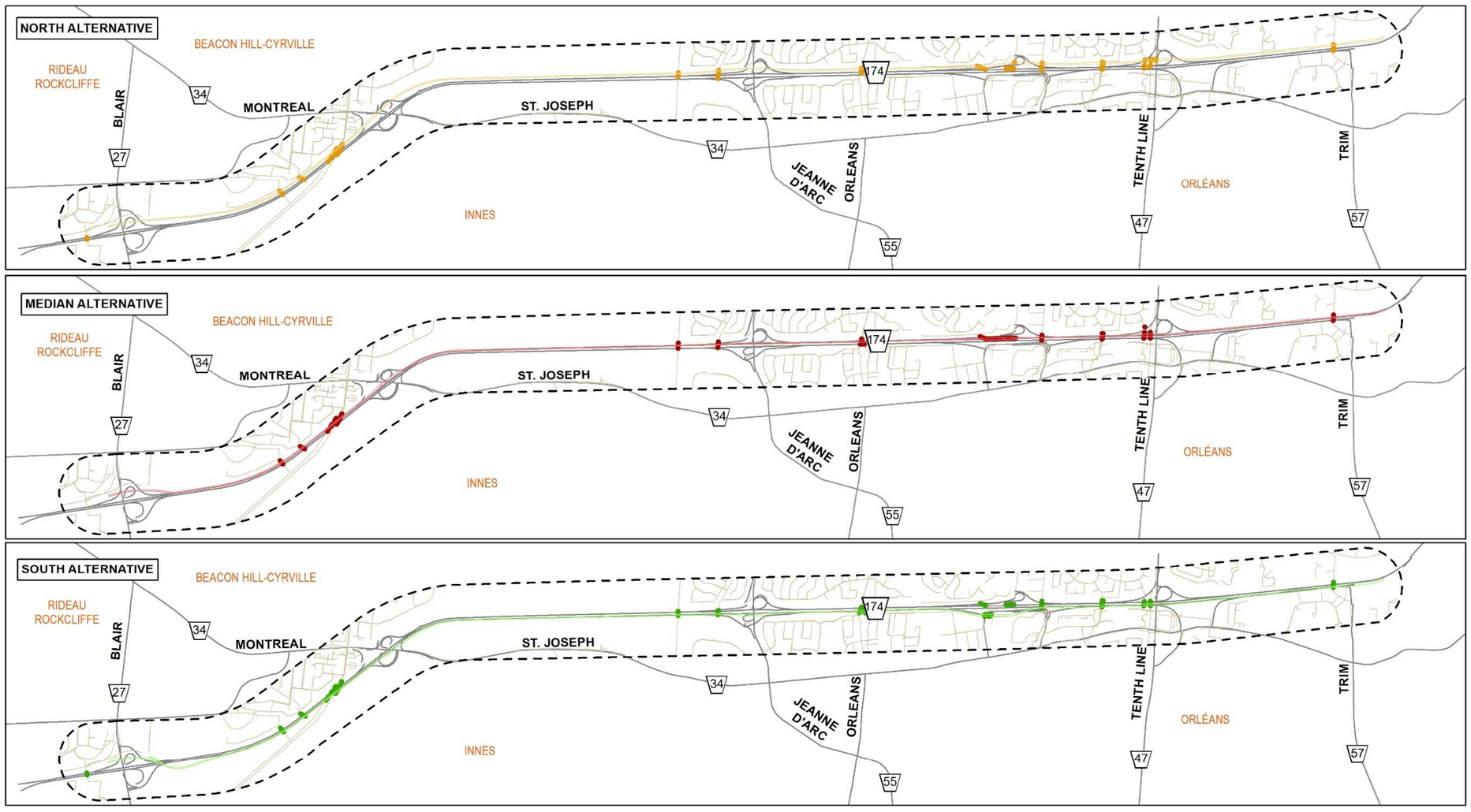
Another measurement selected for this indicator was the number of conflicts with Hydro One transmission lines. Transmission lines owned and operated by Hydro One are located along the south side of the HWY 174. Due to the LRT being powered by electricity that is supplied through catenary poles and lines, there is the potential for there to be electrical interference between the transmission line and the LRT catenary lines. A minimum setback distance of 15m from the transmission line centreline is required for maintenance access.

To assess conflicts with the existing Hydro One transmission line, the following items were considered: the number of times the alignment crossed under the transmission line, the number of interchange ramps that pass under the transmission line and would need to be modified, the number of transit stations shown under the transmission line and the length of the LRT corridor within 15m (minimum setback) of the transmission line centreline. The South Alternative has the greatest impact because it is located within close proximity to the existing Hydro One transmission line. The South Alternative is located within 15m of the centreline of the transmission line for over 7km, requires 2 crossings of the transmission line, has 6 transit stations located under the transmission line and requires 7 ramps under the transmission line to be modified. This is compared to the Median Alternative, which has less than 2km of road widening and ramps within 15m of the transmission centreline and requires 7 ramps under the transmission line to be modified. The North Alternative has the least impact since it only requires 1 ramp under the transmission line to be modified and 200m of ramp within 15m of the transmission line. The rankings for utilities can be found below in Table 3-29.

Table 3-29: Ranking for Utilities

Measurement	Alternative		
	North	South	Median
Number of crossings of major utility corridors such as pipelines (#)	5 crossings of gas mains 150-500 mm; 350m section of 500mm gas main along westbound lanes in Greenbelt; Gas main along westbound off-ramp at Champlain.	5 crossings of gas mains 150-500 mm; 350m section of 500mm gas main along westbound lanes in Greenbelt.	5 crossings of gas mains 150-500 mm; 350m section of 500mm gas main along westbound lanes in Greenbelt.
Rank	3	1	1
Number of conflicts with Hydro One transmission line (#)	Requires 1 ramp under the transmission line at an interchange to be modified; 200m of eastbound ramp to Place d'Orléans will be within 15m of transmission lines. No crossings of the transmission line are required and no stations are located under the line	Requires 2 crossings of the transmission line; Requires 7 ramps under transmission line at interchanges to be modified; 7.14km of the LRT corridor is within 15m of the centerline of the line; 6 stations are located under the transmission line	Requires 7 ramps under transmission lines at interchanges to be modified; Sections within 15m of transmission lines are 0.8km of HWY 174 widening near Place d'Orléans; 0.75km of auxiliary lanes between Place d'Orléans and Tenth Line and 0.39km eastbound right turn lane at Trim Road. No crossings of the transmission line are required and no stations are located under the line
Rank	1	3	2

Figure 3-6: Major Infrastructure Impacts



3.3.3 Major Structures

Since the LRT is proposed to be located in a corridor that has already been used as a major highway, there are a number of existing structures that would require alterations to accommodate the LRT. There is also the potential that new structures would need to be built to accommodate the LRT. The measurement used to assess impacts to major structures is provided below in Table 3-30.

Table 3-30: Measurement of Impacts on Major Structures

Indicator	Measurement	Data – Source & Type
Major Structures	Number of changes to existing structures and interchanges including new structures required (#)	Mapping of municipal services QUANTITATIVE

Alterations to existing interchanges are considered as major structural interventions due to the requirement for a reconfiguration of the on and off ramps to accommodate the LRT. Changes or additions to culverts and pedestrian bridges are considered as minor in comparison. Several interventions, such as the creation of a tunnel to connect the LRT underground to Place D'Orléans (as would be required in the South Alternative), are considered very complex structural interventions that would require substantial costs to design and construct. When evaluating the alternatives, the Median Alternative requires considerably fewer alterations and additions because it would not interfere with the existing HWY 174 interchanges. Much of the corridor is able to accommodate the additional space that would be required for the Median Alternative without structural alterations. Although the North Alternative requires 20 major structural interventions compared to 14 major for the South Alternative, the requirement to alter or create new very complex structures makes the South Alternative the least feasible. The ranking for major structures is summarized in Table 3-31.

Table 3-31: Ranking for Major Structures

Measurement	Alternative		
	North	South	Median
Number of changes to existing structures and interchanges including new structures required (#)	20 major structural interventions; 5 minor structural interventions.	2 very complex structural interventions; 14 major structural interventions; 4 minor structural interventions.	7 major structural interventions; 6 minor structural interventions.
Rank	2	3	1

Figure 3-7: Utility Impacts

3.4 Cost Criteria Evaluation

The cost impacts of the alternatives were evaluated from two perspectives: the capital costs of the LRT and the highway widening; and the costs associated with the operation and maintenance of the LRT.

3.4.1 Capital Costs

The capital cost indicator provides a value of the preliminary capital construction costs and engineering design costs to compare the alternative integrated alignments (Table 3-32). Typically, a conceptual design does not provide detailed construction costing. The costs estimates are therefore preliminary in nature and are presented qualitatively for comparison purposes. More detailed costing will be undertaken at the future design stages of the project.

Table 3-32: Measurement of Impacts on Capital Costs

Indicator	Measurement	Data – Source & Type
Capital costs	Relative costs (comparative)	Concept plans SEMI-QUANTITATIVE

To determine the costs, the alternatives were examined from the perspective of roadways and structural alterations. The LRT technology to be used has already been selected, and therefore the costs associated with the technology remain the same for all the alternative alignments. For each of these project activities (roadway and structures), the major components that would influence cost were determined.

For roadways, factors that influenced the evaluation include: staging, grading, paving, granular material, and drainage. From a roadways perspective, both the North Alternative and the South Alternative are considerably more expensive than the Median Alternative because of the requirements to significantly alter existing interchange ramp geometry to accommodate the LRT and its stations. Since the surface area to be graded and paved is larger due to the requirements to alter interchange ramps, the costs increase substantially. The drainage infrastructure for the North and South Alternative is also more expensive as an additional storm sewer between the highway and LRT is needed to drain the HWY 174 compared to the Median Alternative.

Construction staging is influenced by the level of service to be maintained during construction and the location and access to the construction site. For the purposes of evaluation, we have assumed that the existing number of lanes (including the shoulder bus lane) will have to be maintained and that ramps will also need to remain open for the majority of the construction period. For the North Alternative and the South Alternative there will be substantial staging cost to redirect traffic around ramp and station construction zones, and a portion of the highway shoulder will be required to buffer the construction zone from adjacent traffic. This may require widening of the roadway to shift active lanes away from the construction, while maintaining the existing number of lanes. The Median Alternative will require a construction zone down the centre of the highway and access points to and from the site at strategic locations along the corridor. The buffer and access requirements will likely occupy the inner shoulder and inner lane, requiring that an additional temporary or permanent lane be added to the outside of the existing highway. Staging costs are somewhat similar for all three alternatives, but will impact both directions of highway travel for the Median Alternative.

Several factors influence the costs associated with engineering of major structures, including: the number of alterations to existing structures (e.g. interchanges, culverts, and pedestrian bridges), the number of new structures required, and the complexity of those structures. The South Alternative is the most expensive from a structural perspective because of the numerous alterations required to existing interchanges, as well as the construction of a complex underground tunnel and underground station to accommodate the LRT at the Place D'Orléans station. Although the North Alternative also requires changes to existing interchanges and several new structures, it does not require a tunnel or an underground station. Both the North and South Alternatives would also require the installation of retaining walls along the outside of the LRT corridor. The Median Alternative has the lowest costs because the majority of the HWY 174 corridor can accommodate the LRT in the median without major structural changes at the interchange. Overall, the Median Alternative was found to be the least expensive alternative. The ranking for capital costs is summarized below in Table 3-33.

Table 3-33: Ranking for Capital Costs

Measurement	Alternative		
	North	South	Median
Relative costs (comparative)	Mid-range	Highest	Lowest
Rank	2	3	1

3.4.2 Operating Costs

Another important component of the cost criteria is the cost to operate the LRT. Within this indicator, both operating costs and maintenance costs are taken into account (Table 3-34). These costs are once again comparative since operational requirements may change compared to the conceptual design.

Table 3-34: Measurement of Impacts on Operating Costs

Indicator	Measurement	Data – Source & Type
Operating costs	Operation and maintenance costs (comparative)	Concept plans SEMI-QUANTITATIVE

Factors related to the costs of operation and maintenance of the LRT would remain the same for all alternatives. However, factors related to the design of the alignment, such as grade separations, curves, and station construction will influence the costs associated with operation and maintenance. Accessibility for maintenance between stations will also influence costs. The North and South Alternatives both have an increased number of grades and curves, along with deeper and more complex station facilities than that of the Median Alternative. This is due to the fact that the North and South Alternatives will need to be integrated with the pre-existing interchanges for the HWY 174. In contrast, the Median Alternative is located along a relatively straight corridor located at-grade with the HWY 174, which would drastically reduce operating costs. However, accessibility of locations along the alignment between stations will be more difficult for the Median Alternative because access would require the blocking of highway lanes. Despite the increased costs associated with the staging required for maintenance of the Median Alternative, it is still the least expensive when compared with the substantial operating costs required as a result of the numerous number of grades, curves, and complex station facilities required of the North and South Alternatives. The ranking for operation and maintenance costs is summarized in Table 3-35.

Table 3-35: Ranking for Operating Costs

Measurement	Alternative		
	North	South	Median
Operation and maintenance costs (comparative)	Mid-range	Mid-range	Lowest
Rank	2	2	1

3.5 Biological Criteria Evaluation

The biological indicators used for this evaluation include: Natural Heritage Features, Aquatic Environment, Wildlife, and Species at Risk. A discussion of each of these indicators and the measurements used to compare and evaluate the alternative alignments is provided in the following sections. As with other indicators, the potential impacts of the LRT and highway widening were considered.

3.5.1 Natural Heritage Features

Proximity to or fragmentation of Areas of Natural and Scientific Interest (ANSIs) was used as the measurement to assess impacts of the alternatives on natural heritage features. Table 3-36, below, summarizes the data sources that formed the basis of the evaluation of impacts on ANSIs.

Table 3-36: Measurement of Impacts on Natural Heritage Features

Indicator	Measurement	Data – Source & Type
Natural Heritage features	Proximity to or fragmentation of ANSI (m/ha)	GIS mapping, field visit data QUANTITATIVE

Green's Creek provincially significant ANSI was identified within the study area. GIS layers were retrieved from the Natural Heritage Information Centre database, the City of Ottawa, as well as from the Ontario Ministry of Natural Resources and Forestry. To determine the extent of impact on the Green's Creek ANSI, each of the LRT alignments were overlaid on top of the Green's Creek GIS file to determine the extent of overlap (Figure 3-8). In the North and South Alternatives, the edge of Green's Creek ANSI will likely be affected as a culvert extension or a new structure is anticipated in order to accommodate the additional LRT infrastructure. However the median structure may be able to make use of the existing culverts and could reduce the work done within the Green's Creek ANSI. With respect to the area affected by these upgrades, 0.64 ha will be affected in the South Alternative, 0.57 ha will be affected in the North Alternative, and 0.44 ha will be affected in the Median Alternative. The Median Alternative therefore has the least impact on the Green's Creek ANSI. The rankings for natural heritage features are summarizes below in Table 3-37.

Table 3-37: Ranking for Natural Heritage Features

Measurement	Alternative		
	North	South	Median
Proximity to or fragmentation of ANSI (ha)	0.57 ha	0.64 ha	0.44 ha
Rank	2	3	1

3.5.2 Aquatic Environment

Several watercourses have been identified within the study area that have the potential to be affected by the proposed alternatives. Impacts to the aquatic environment were measured by counting the number of watercourse crossings containing known fish habitat. The data sources for this evaluation are summarized in Table 3-38, below.

Table 3-38: Measurement of Impacts on Aquatic Environment

Indicator	Measurement	Data – Source & Type
Aquatic Environment	Number of watercourse crossings containing known fish habitat (number of low, moderate and high sensitivity)	GIS mapping, field visit data QUANTITATIVE

To determine the watercourses that contain known fish habitat in the study area, fish records were summarized by reviewing available background information and secondary-source reports on the four (4) sub watersheds located in the study area. The 4 sub watersheds are Taylor Creek, Bilberry Creek, Green's Creek and Voyager Creek. The total number of watercourse crossings was determined through a combination of a review of secondary source documents, fieldwork and interpretation of aerial photography. For each alternative alignment, aquatic habitat assessments were conducted at each watercourse crossing that could be accessed through roadside surveys. The assessments were carried out to classify discharge characteristics, stream permanence, and sensitivity, among other characteristics.

Where watercourse crossings were located on private property, the closest upstream and/or downstream road crossing was visited to survey the same reach of the watercourse.

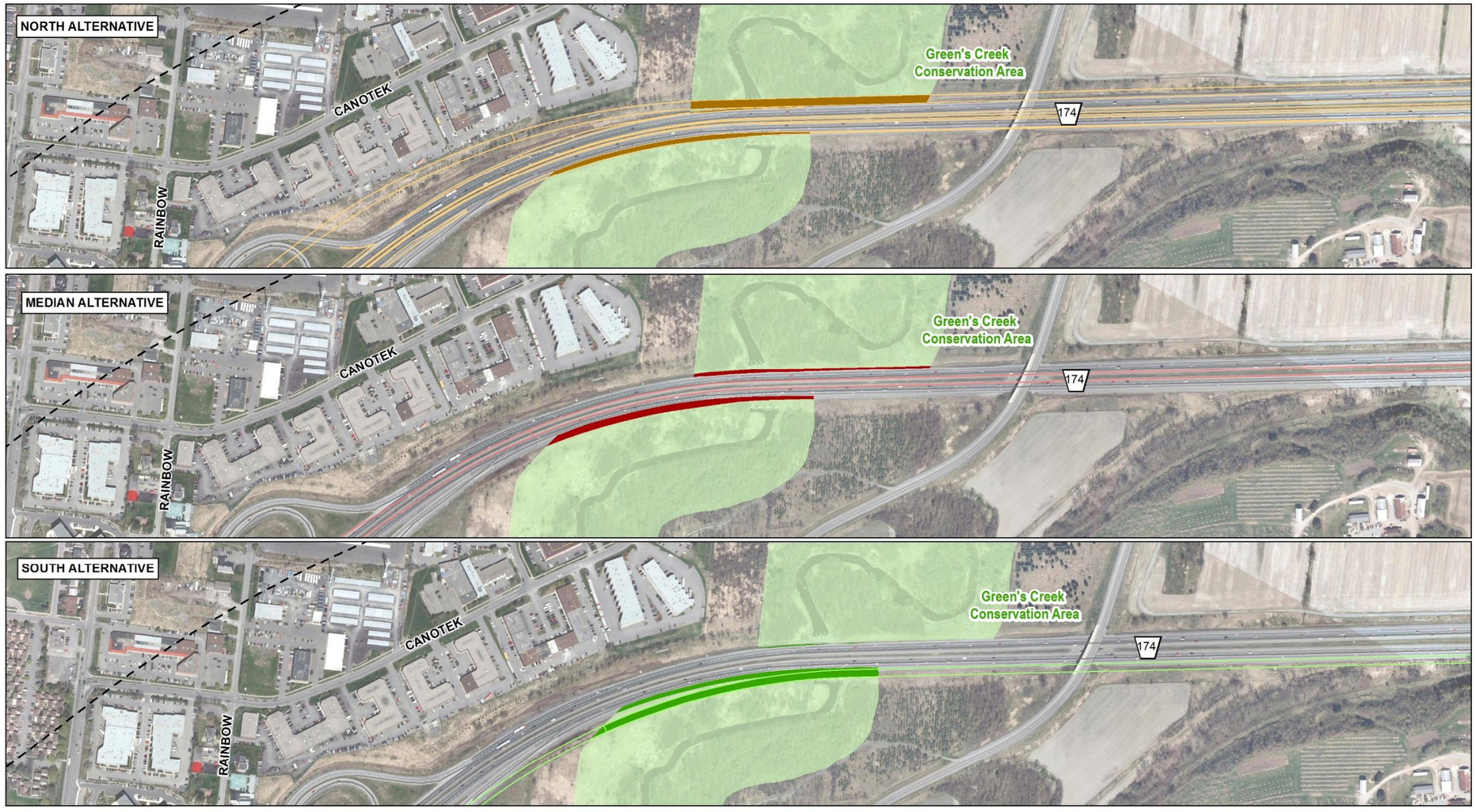
Otherwise, watercourses were identified through a combination of aerial photographic interpretation and use of the City's base layer for watercourses. For the purposes of this evaluation, watercourses were defined as waterbodies containing or contributing to fish habitat.

Table 3-39 provides the parameters under which each watercourse was defined as high, moderate or low sensitivity.

Table 3-39: Sensitivity Ranking of Aquatic Habitats

High Sensitivity	Moderate Sensitivity	Low Sensitivity
Cool/cold water thermal regime Headwater area Permanent flow Natural channel Natural stream process observed (e.g., riffle/run/pool sequence and meanders) Located in natural area (e.g., woodland, wetland) Groundwater seepage indicators present High quality and quantity fish habitat No fish barriers Water quality appears good (e.g., clear, no obvious agricultural runoff, no algae)	Cool/warm water thermal regime Permanent or intermittent flow Natural or channelized channel Natural stream process observed (e.g., riffle/run/pool sequence and meanders) In natural or impacted areas Groundwater seepage indicators present Overall moderate quality and quantity fish habitat No fish barriers Some concern for water quality (e.g., suspended solids or algae growth)	Warm water thermal regime Permanent or intermittent flow Channelized channel Uncontrolled stream processes (e.g., erosion, unstable banks) Within highly impacted areas No groundwater indicators present Low quality and quantity fish habitat Fish barriers Concern for water quality (e.g., turbid water, high suspended solids or uncontrolled algae growth)
System is generally considered not to be resilient to environmental perturbations and cannot easily buffer change.	**System is somewhat stable and should be resilient to change and perturbation**	**System is quite stable and resilient to change and perturbation.**

Figure 3-8: Impact on Areas of Natural and Scientific Interest



Along the HWY 174, a total of thirteen (13) existing water crossings were identified within the study area. For each of the water crossings, a habitat assessment was carried out upstream and downstream of the existing crossing of the HWY 174, for a total of twenty-six (26) habitat assessments. Using the location of each of the alternative alignments, the impacts both upstream and downstream of all water crossings were assessed. The North Alternatives was found to impact fifteen (15) of the twenty-six (26) habitats assessed. Of these, thirteen (13) were considered low sensitivity and two (2) were considered high sensitivity. The South Alternative was found to impact fourteen (14) habitats, with eleven (11) of them being low, two (2) being moderate, and one (1) being high sensitivity. Both the North and South Alternatives were considered to have some impacts on the aquatic environment. Since the majority of the watercourses located within the median of HWY 174 are already enclosed, only slight impacts as a result of the Median Alternative are anticipated. The rankings for the aquatic environment can be found below in Table 3-40.

Table 3-40: Ranking for Aquatic Environment

Measurement	Alternative		
	North	South	Median
Number of watercourse crossings containing known fish habitat (# and low, moderate and high sensitivity)	15 habitats impacted: 13 low and 2 high sensitivity	14 habitats impacted: 11 low, 2 moderate and 1 high sensitivity	Work occurring in median or along outside of existing shoulder will take place where crossings are already enclosed.
Rank	2	2	1

3.5.3 Wildlife

Impacts to wildlife were identified using two (2) measurements: loss of significant woodland area (in m^2) and potential disruption to significant wildlife habitat (in m^2). Both of these measurements were analyzed using GIS mapping as noted in Table 3-41.

Table 3-41: Measurement of Impacts on Wildlife

Indicator	Measurement	Data – Source & Type
Wildlife	Loss of woodland area (m^2)	GIS mapping, field visit data QUANTITATIVE
	Potential disruption to significant wildlife habitat (m^2)	GIS mapping, field visit data QUANTITATIVE

A 'significant woodland' (Provincial Policy Statement, 2014) is an "area which is ecologically important in terms of features such as species composition, age of trees and stand history; functionally important due to its contribution to the broader landscape because of its location, size or due to the amount of forest cover in the planning area; or economically important due to site quality, species composition, or past management history." Significant woodlands were identified by the City of Ottawa. Field studies used this mapping to confirm or review woodland boundaries along the roadside. To determine the impact on woodland area, each of the alignments was overlaid with the significant woodlands GIS file (Figure 3-9). The South Alternative impacts approximately 1230 m^2 of significant woodland, whereas the North Alternative impacts 334 m^2. Since the median between HWY 174 has been previously cleared of trees, no significant woodlands are located within this area and no significant woodlands will be impacted a result of the Median Alternative.

Biologists conducted field investigations in the study area and performed preliminary evaluations of significant wildlife habitat, as defined by the Ministry of Natural Resources and Forestry (MNRF) technical guide on significant wildlife habitat. Significant wildlife habitat is divided into the following four components: seasonal concentrations of animals, rare vegetation communities or specialized habitats for wildlife, habitats of species of conservation concern, and wildlife movement corridors. Table 3-42 summarizes the significant wildlife habitat identified in the study area. Since these habitats were determined through a cursory review, more detailed studies will be conducted to evaluate the potential significant wildlife habitat.

Table 3-42: Potential Significant Wildlife Habitat Located in the Study Area

Significant Wildlife Habitat	Candidate Habitat Located in the Study Area
Seasonal Concentration Areas of Animals	
Waterfowl Stopover and Staging Areas (Terrestrial)	Candidate habitat may be present in agricultural lands east of Sir George Etienne Cartier Parkway.
Waterfowl Stopover and Staging Areas (Aquatic)	Candidate habitat may be present along vegetation communities along Green's Creek.
Shorebird Migratory Stopover Area	Candidate habitat may be present along vegetation communities along Green's Creek.
Raptor Wintering Area	Candidate habitat may be present along vegetation communities along Green's Creek.
Bat Maternity Colonies	Candidate habitat may be present within all FOD, FOM, FOC, SWD, SWM, and SWC vegetation communities identified through the Ecological Land Classification.
Turtle Wintering Areas	Candidate habitat may be present within vegetation communities associated with Green's Creek, Taylor Creek and Bilberry Creek.
Reptile Hibernaculum	Candidate habitat may be present along Green's Creek. A confirmed Milksnake was observed in this location.
Colonially-Nesting Bird Breeding Habitat (Trees and Shrubs)	Candidate habitat may be present within the identified Swamp communities along Green's Creek.
Colonially-Nesting Bird Breeding Habitat (Ground)	Candidate habitat for Brewers Blackbird may be present within the areas along Green's Creek.
Deer Yarding Areas	Candidate habitat may be present within vegetation communities along Green's Creek.
Deer Winter Congregation Areas	Candidate habitat may be present within the areas along Green's Creek. This woodland is over 100 hectares in size.
Specialized Habitat for Wildlife	
Bald Eagle and Osprey Nesting Foraging and Perching Habitat	Candidate habitat may be present within the study area given its proximity to the Ottawa River. Species can be found nesting several kilometers away from the river.
Turtle Nesting Areas	Candidate habitat may present along vegetation communities found along Green's Creek, Taylor Creek and Bilberry Creek.
Amphibian Breeding Habitat (Woodland)	Candidate habitat may be present within the vegetation communities found along Green's Creek, Taylor Creek and Bilberry Creek.
Amphibian Breeding Habitat (Wetlands)	Candidate habitat may be present within the vegetation communities found along Green's Creek, Taylor Creek and Bilberry Creek.

Habitats for Species of Conservation Concern (Not including endangered or threatened species)	
Marsh Breeding Bird Habitat	Candidate habitat may be present within the wetlands communities associated with Green's Creek, Taylor Creek and Bilberry Creek.
Terrestrial Crayfish	Candidate habitat may be present within the wetland communities found along the LRT Route. Field investigations were limited to the areas confined to the watercourses as well as roadside investigations. Wetland communities were not searched for the presence of chimneys or crayfish.
Special Concern and Rare Wildlife Species	Confirmed – A Milksnake was observed along the edge of the road near Green's Creek
Animal Movement Corridors	
Amphibian Movement Corridors	Candidate habitat may exist along Green's Creek, Taylor Creek and Bilberry Creek.
Deer Movement Corridors	Candidate habitat to be confirmed once Deer Wintering Habitat has been confirmed.

To determine the impacts of each of the alternative alignments on significant wildlife habitat, the alignments were overlaid with the GIS file created for significant wildlife habitat (Figure 3-9). The overlapping areas were determined to be disruption to potential significant wildlife habitat. The North Alternative was found to have 5.7 ha affected, the South Alternative had 4.0 ha affected, and the Median Alternative was found to have 1.6 ha affected. From the perspective of significant wildlife habitat, the Median Alternative has the smallest impact. The rankings for wildlife can be found in Table 3-43.

Table 3-43: Ranking for Wildlife

Measurement	Alternative		
	North	South	Median
Loss of woodland area (m^2)	334 m^2	1230 m^2	0
Rank	2	3	1
Potential disruption to significant wildlife habitat (ha)	5.7 ha	4.0 ha	1.6 ha
Rank	3	2	1

3.5.4 Species at Risk

Impacts to species at risk (SAR) were also investigated as part of the evaluation of alternative alignments. Species at risk are protected under Ontario's Endangered Species Act and the federal Species at Risk Act. The measurement used to assess impacts on species at risk is presented below in Table 3-44.

Table 3-44: Measurement of Impacts on Species at Risk

Indicator	Measurement	Data – Source & Type
Species at Risk	Potential disruption of Species at Risk habitat (potential # of species affected)	GIS mapping, field visit data Professional Judgment SEMI-QUALITATIVE

Information on species at risk in the study area was obtained from several data sources including: the MNRF Species at Risk website, additional correspondence with the MNRF, Department of Fisheries and Oceans species at risk mapping, the Atlas of Breeding Birds of Ontario, and the City of Ottawa. Based on background information compiled, a total of 53 SAR were determined to potentially occur within the study area. Field surveys completed in 2013 and 2014 provided input to the assessment of whether species at risk and/or SAR habitat is present in the study area.

The 53 potential species were then screened for available preferred habitat within the study area through the confirmation of existing conditions completed during field investigations. Using the aquatic and terrestrial characterization of the study area, it was determined that 45 species have suitable habitat present in the study area. Of these species, sixteen (16) are listed as Endangered, twelve (12) are listed as Threatened and seventeen (17) are listed as Special Concern. The final list of potential species is based on habitat found along the entire route. The following are the species at risk that have suitable habitat present in the study area:

- American chestnut (*Castanea dentata*);
- American Eel (*Anguilla rostrata*);
- American Ginseng (*Panax quinquefolius*);
- Butternut (*Juglans cinerea*);
- Eastern Prairie Fringed-Orchid (*Platanthera leucophaea*);
- Golden Eagle (*Aquila chrysaetos*);
- Henslow's Sparrow (*Ammodramus henslowii*);
- Hickorynut (*Obovaria olivaria*);
- Little Brown Myotis (*Myotis lucifugus*);
- Loggerhead Shrike (*Lanius ludovicianus*);
- Mountain Lion (*Puma concolor*);
- Northern Myotis (*Myotis septentrionalis*);
- Rapids Clubtail (*Gomphus quadricolor*)
- Rusty-patched Bumble Bee (*Bombus affinis*);
- Spotted Turtle (*Clemmys guttata*);
- Wood Turtle (*Glyptemys insculpta*);
- Barn Swallow (*Hirundo rustica*);
- Blanding's Turtle (*Emydoidea blandingii*);
- Bobolink (*Dolichonyx oryzivorus*);
- Cerulean Warbler (*Dendroica cerulean*);
- Channel Darter (*Percina copelandi*);
- Chimney Swift (*Chaetura pelagica*);
- Eastern Meadowlark (*Sturnella magna*);
- Eastern Musk Turtle (*Sternotherus odoratus*);
- Eastern Whip-poor-will (*Caprimulgus vociferous*);
- Flooded Jellyskin (*Leptogium rivulare*);
- Grey Fox (*Urocyon cinereoargenteus*);
- Least Bittern (*Ixobrychus exilis*);
- Bald Eagle (*Haliaeetus leucocephalus*);
- Black Tern (*Chlidonias niger*);
- Bridle Shiner (*Notropis bifrenatus*);
- Canada Warbler (*Wilsonia canadensis*);
- Common Nighthawk (*Chordeiles minor*);
- Eastern Ribbonsnake (*Thamnophis sauritus*);
- Golden-winged Warbler (*Vermivora chrysoptera*);
- Milksnake (*Lampropeltis triangulum*);
- Monarch (*Danaus plexippus*);
- Northern Brook Lamprey (*Ichthyomyzon fossor*);
- Olive-sided Flycatcher (*Contopus cooperi*);
- Peregrine Falcon (*Falco peregrinus*);
- Red-headed Woodpecker (*Melanerpes erythrocephalus*);
- Short-eared Owl (*Asio flammeus*);
- Snapping Turtle (*Chelydra serpentina*);
- West Virginia White (*Pieris virginiensis*); and
- Yellow Rail (*Coturnicops noveboracensis*).

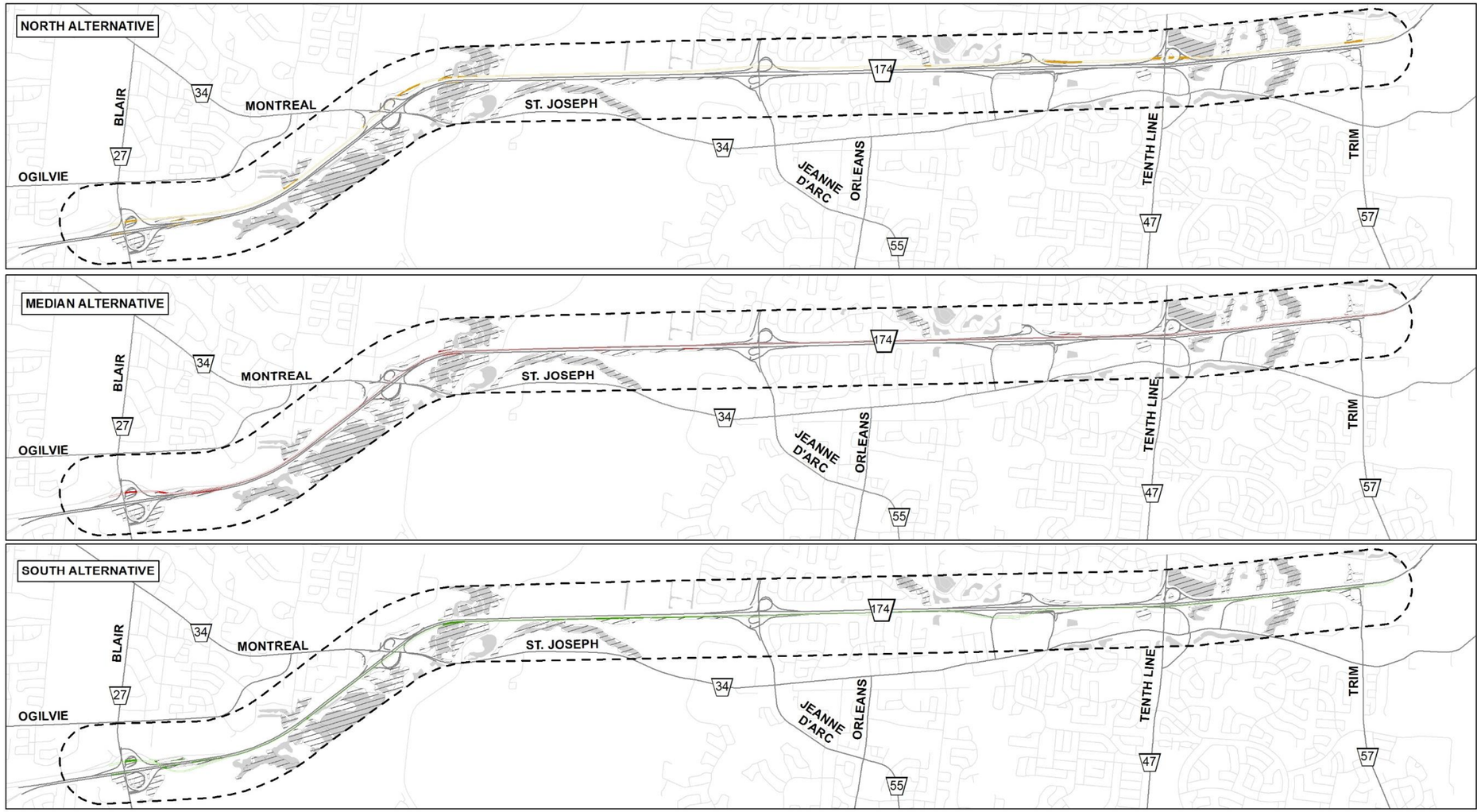
To determine the impacts of each of the alternative alignments on species at risk habitat, a GIS layer of the potential suitable habitat for species at risk was created. The three LRT alignments were overlaid on the potential suitable habitats GIS layer to determine the number of species that could be affected, as well as the area that could be affected by each of the alternative alignments. Habitat for species at risk was included in the representation of significant habitat in Figure 3-9. Both the South and Median Alternatives have the potential to affect potential habitat for 21 threatened and endangered SAR, while the North Alternative has the potential to impact potential habitat for 18 threatened and endangered SAR. The North and South Alternatives have the potential to affect a greater total area of potential habitat. The South Alternative was found to overlap with 10.3 ha of potential species at risk habitat, the North Alternative overlapped with 10.1 ha, and the Median Alternative overlapped with 4.7 ha. The Median Alternative therefore has the least impact on species at risk

and potential habitat for species at risk, due to having a significantly lower total area of potential impact. Additionally, the Median Alternative is within an existing disturbed corridor which further reduces the impact. The ranking for species at risk is summarized in Table 3-45.

Table 3-45: Ranking for Species at Risk

Measurement	Alternative		
	North	South	Median
Potential disruption of Species at Risk habitat (potential # of species affected)	Potential habitat for 18 threatened and endangered SAR. Potential habitat for 14 special concern SAR. Total potential habitat affected 10.1 ha.	Potential habitat for 21 threatened and endangered SAR. Potential habitat for 14 special concern SAR. Total potential habitat affected 10.3 ha.	Potential habitat for 21 threatened and endangered SAR. Potential habitat for 14 special concern SAR. Total potential habitat affected 4.7 ha.
Rank	2	2	1

Figure 3-9: Impact on Significant Woodlands & Habitat



3.6 Physical Criteria Evaluation

The physical indicator and measurement described in the following section forms the basis for determining the degree to which the alternative integrated alignments impact the physical environment. Slopes and ravines were the only physical indicator that was retained. There was no difference between the alternatives with respect to other physical measurements and although impacts may still occur, they do not aid in the selection of a preferred alignment.

3.6.1 Slopes and Ravines

The assessment of impacts on slopes and ravines was carried out by investigating the length of construction that would be required within areas of unstable slopes (Table 3-46). The rationale for the inclusion of this measurement is due to the additional requirements for slope stabilization in areas where there is the potential for slopes to fail.

Table 3-46: Measurement of Impacts of Slopes and Ravines

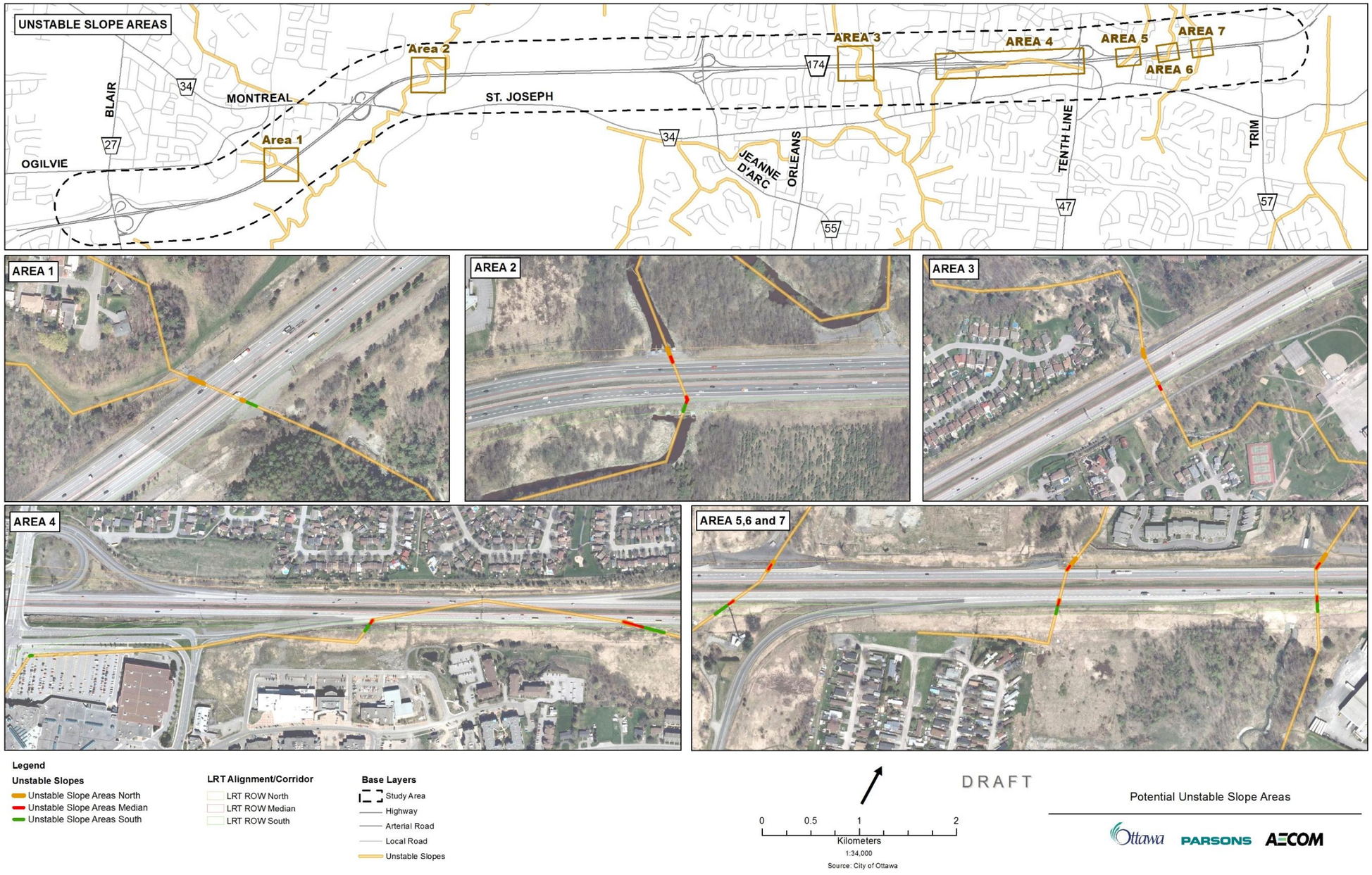
Indicator	Measurement	Data – Source & Type
Slopes and ravines	Length of construction within areas of unstable slopes (m)	GIS Mapping of geologic conditions QUANTITATIVE

The formation of the natural slopes within the study area is attributed to erosion by flowing water. As silt and clay particles are eroded, the rivers, creeks, and streams become wider and deeper, and slopes develop along the banks. Eventually, erosion processes lead to shallow slope failures along the banks followed by deeper failures of the subsequent steeper/higher valley slopes. Determination of the areas of unstable slopes was performed using SLIDE, which is a two dimensional limit equilibrium slope stability program. Slope stability calculations take into account factors such as soil parameters, groundwater conditions, and the slope profile. The length of construction within areas of unstable slopes was determined through creation of a GIS layer indicating areas of unstable slopes, and overlapping this layer with the three alternative alignments (Figure 3-10). The South Alternative was identified to have the greatest impact, with 219 m of construction required within areas of unstable slopes. This is compared to 145 m for the North Alternative, and 139 m for the Median Alternative. The rankings for slopes and ravines can be found below in Table 3-47.

Table 3-47: Ranking for Slopes and Ravines

Measurement	Alternative		
	North	South	Median
Length of construction within areas of unstable slopes (m)	145 m	219 m	139 m
Rank	2	3	1

Figure 3-10: Unstable Slopes



4 CONCORDANCE METHOD

4.1 Concordance Methodology

The next step in the evaluation process is *Step 6: Apply Evaluation Method* including carrying out a Sensitivity Analysis. The evaluation methodology applied is a comparison approach known as the Concordance Method. This method involves a comparison of each alternative against the other, in turn, for each of the measurements. The alternative that is ranked higher for the measurement receives the weight value for that measurement or, if the alternatives are ranked equal, the weight value is divided by two. The degree of concordance between alternatives is determined by adding up the weight values received by each alternative for all measurements and then dividing by the total weight of all measurements.

4.2 Indicator/Measurement Weights

The list of indicators and measurements and their weights were developed prior to completion of the impact assessment and the ranking of alternatives. As noted in section 2.3 and 2.4 it was intended that:

- Only indicators/measurements that had an expected result of a measurable difference between the alternatives were selected for the evaluation; and
- A total of 100 points were available to apply to the various indicators and measurements.

4.3 Application of Concordance Methodology

The following presents the concordance matrix for the evaluation of the three (3) integrated alignments for the East LRT and HWY 174 widening west of Trim Road. For this table, the average weights submitted by the City of Ottawa and the Study Team were used. In developing their weights, the City considered municipal values reflected in their established policies and priorities. Members of the Study Team came from a variety of backgrounds, and their backgrounds influenced the selection of weights. In the next section, a sensitivity analysis using a wide range of weights in the analysis is presented to assess the robustness of this result.

The results in Table 4-1 indicate that the Median Alternative is the preferred alignment, followed by the North Alternative and then the South Alternative.

Table 4-1: Concordance Matrix using Blended Weights (City of Ottawa and Study Team)

	Alternatives				
Alternatives	**North**	**South**	**Median**	**Sum**	***Rank***
North Alignment		0.59	0.10	0.70	***2***
South Alignment	0.41		0.21	0.62	***3***
Median Alignment	0.90	0.79		1.68	***1***

4.4 Sensitivity Analysis

Sensitivity analyses were undertaken to test the rigour and strength of the concordance scoring (Table 4-2). “Sensitivity Test Adjustment Factors” were applied to the weightings of the different criteria groupings. These factors are multipliers used to determine how the ranking order changes if one or several of the categories were dropped from the analysis, or made more important than the others. Setting all factors to 1 is the base condition. Setting a factor to 0 means that category is eliminated from the analysis.

Table 4-2: Sensitivity Analysis

		Alternative Concordance Results			
Sensitivity Test Description:		**North**	**South**	**Median**	***Preferred***
City of Ottawa Weights	Sum	0.64	0.71	1.65	***Median***
	Rank	3	2	**1**	
Study Team Weights	Sum	0.75	0.54	1.71	***Median***
	Rank	2	3	**1**	
Blended Weights (City of Ottawa and Study Team)	Sum	0.70	0.62	1.68	***Median***
	Rank	2	3	**1**	
All Weights Equal	Sum	0.74	0.60	1.66	***Median***
	Rank	2	3	**1**	
No Social considered	Sum	0.68	0.57	1.74	***Median***
	Rank	2	3	**1**	
No Transportation considered	Sum	0.86	0.42	1.72	***Median***
	Rank	2	3	**1**	
No Infrastructure considered	Sum	0.62	0.68	1.70	***Median***
	Rank	3	2	**1**	
No Cost considered	Sum	0.68	0.68	1.63	***Median***
	Rank	2	2	**1**	
No Biological considered	Sum	0.71	0.65	1.65	***Median***
	Rank	2	3	**1**	
No Physical considered	Sum	0.68	0.65	1.67	***Median***
	Rank	2	3	**1**	
Only Social considered	Sum	0.75	0.83	1.42	***Median***
	Rank	3	2	**1**	
Only Transportation considered	Sum	0.46	0.92	1.63	***Median***
	Rank	3	2	**1**	
Only Infrastructure considered	Sum	1.27	0.17	1.56	***Median***
	Rank	2	3	**1**	
Only Cost considered	Sum	0.78	0.22	2.0	***Median***
	Rank	2	3	**1**	
Only Biological considered	Sum	0.62	0.39	2.0	***Median***
	Rank	2	3	**1**	
Only Physical considered	Sum	1.0	0	2.0	***Median***
	Rank	2	3	**1**	
Social Multiplier (Social Weights Multiplied by 200)	Sum	0.75	0.83	1.43	***Median***
	Rank	3	2	**1**	

4.5 Results of Sensitivity Analysis

Based on the sensitivity analysis, the Median Alternative is preferred in all seventeen (17) of the sensitivity tests performed. The North Alternative is ranked second in 11 out of 17 sensitivity tests, whereas the South Alternative is ranked second in 5 out of 17 sensitivity tests. With no costs considered, the South and North Alternatives tie for second.

4.6 Preliminary Preferred Alternative

The next step in the evaluation process is *Step 7: Review Evaluation Results and Select Preliminary Preferred Alternative*. To accomplish this, a sectional analysis was undertaken to determine the segments of the corridor wherein each segment functions best. Subsequently, additional investigations were completed and a reasoned argument was made for the preliminary preferred alternative based on professional experience and the evaluation factors discussed in Section 3.

4.6.1 Sectional Analysis

It can be expected that along the length of the corridor the various integrated alternatives may potentially have conflicting results, with one alternative performing well at one end and not the other. An overview assessment was undertaken to determine if a hybrid alignment that takes sections from more than one alternative would be the overall best performing route. In each of the alternatives, there are cross-over points identified for the LRT at the end of each of the following segments:

- Blair Station to Jasmine Park;
- Jasmine Park to east of Montreal Road interchange (Green's Creek area);
- East of Montreal Road interchange to Place d'Orléans; and
- Place d'Orléans to Trim Road.

A review of the following key indicators for reaching a decision was undertaken:

- Supports City policies regarding intensification and community planning;
- Opportunities to encourage Transit Oriented Development;
- Compatibility with future network (2031) rapid transit and transit priority network concepts;
- Multi-use pathway opportunities;
- Number of changes to existing structures and interchanges including new structures required; and
- Capital costs.

Based on this review, a hybrid solution was developed that uses the North Alternative for the LRT corridor from Blair Station to east of the Montreal road interchange where a natural depression in the road would facilitate a transition to the Median Alternative (Figure 4-1). The LRT would then stay in the median easterly to Trim Road.

Some of the possible advantages of this hybrid alignment are noted below:

- Station proximity to developed areas from Blair Road to Montreal Road that can encourage TOD and ridership;
- Allows for potential connections to LRT stations in the future (i.e. Jasmine Park or Gloucester High School);
- Better connections to multi-use pathways from Blair to Green's Creek;
- Reduces the number of structures required;
- Maintains the existing transitway (bus) 174 overpass during much of the construction;
- Reduces overall capital costs; and
- Provides less staging impacts on both existing transit and vehicular traffic.

Figure 4-1: Hybrid Alternative Transition from North to Median Alignment

A Hybrid LRT Alignment Solution, described as follows, was presented during public consultation:

- Travel under a new underpass through the Blair Road interchange immediately after Blair Station (straight track geometry has better user comfort and lower operating costs);
- Modify Blair ramp structures as needed, protecting for the future Cumberland Transitway facility;
- Travel along the north side of HWY 174 to Montreal Road Station;
- Climb over the westbound HWY 174 lanes and drop into the median;
- Continue in the median of HWY 174 easterly to Trim Road.

4.6.2 Reasoned Argument for the Preferred Hybrid Alignment Solution

The performance of the Median Alternative in all of the sensitivity tests reflects the strong feasibility of this alternative when compared to the South and North Alternative alignments. The following discussion summarizes the rationale for why the Hybrid Alignment, including locating the LRT on the north side from Blair to Montreal and then transitioning the LRT into the highway median from Green's Creek easterly to Trim Road, is preferred from the perspective of each of the criteria groups used in the evaluation.

Social:
The Hybrid Alignment places Montreal Station and a potential future station in the vicinity of Gloucester High School closer to residential homes between Blair Station and Montreal Road, providing a higher level of service to these communities by allowing for shorter, more efficient connections to the LRT than if the station were in the median along this stretch, as no residential development exists to the south.

After transitioning to the median, the alignment is located slightly further, but equidistant from residential land uses than the North and South Alternatives. These land uses could be adversely impacted by the perception of an LRT corridor on their side of the right of way. Although its greater distance from adjacent communities can also be perceived as having less benefit than the alternatives that are closer, it provides equal opportunities to both the communities located to the north and to the south. The Hybrid Alignment is also located in a corridor that is already impacted by the presence of a highway, and therefore its impact, from a social perspective, is lessened.

Transportation:
The LRT is a transportation initiative and it is therefore important that the preferred alignment facilitates the achievement of the transportation-oriented goals outlined in the City of Ottawa's Official Plan and Transportation Master Plan. The Hybrid Alternative is highly compatible with these plans, as it has negligible adverse impact on existing networks and provides opportunities that will integrate well with future additions to the network. It, once again, provides equal opportunities to communities located to the north and south of the existing highway corridor to access the LRT, and services the residential and business communities to the north between Blair Station and Montreal Road.

Infrastructure:
The Hybrid Alternative is preferred because it is located in a portion of the corridor where fewer utilities have been installed, and therefore there are fewer impacts. The alignment between Blair Station and Montreal Road takes advantage of existing infrastructure and maintains the bus transitway structure for the longest period of time during construction. In transitioning to the median at Montreal Road, extensive restructuring of existing highway interchanges to the east that would be required with the North or South Alternatives is avoided, making the Hybrid Alternative preferred from this perspective.

Costs:
The Hybrid Alternative takes advantage of the existing right-of-way from Blair Station to Montreal Road. The north side alignment from Blair to Montreal Road has less impact on the existing HWY 174 as the existing median is not wide enough to accommodate the LRT, requiring more reconstruction of the highway for the median alternative. East of the transition to the Median Alignment, fewer alterations are required to existing interchanges and infrastructure.

Biological:
The stretch between Blair Station and Montreal Road has limited natural habitat, with the exception of a small stretch along Jasmine Park. The alignment along the median is located between the lanes of an existing highway, in an area that has already been disturbed. The Hybrid Alternative alignment from Montreal Road to Trim Road has fewer natural heritage features, fewer watercourse crossings, less woodland area, less significant wildlife habitat and less habitat potentially used by species at risk than the North and South Alternatives.

Physical:
Slopes and ravines was the indicator used for evaluating the alternatives' impacts on the physical environment. There are no unique exposures to slope instability along the northern portion from Blair to Montreal Road. Due to its location between lanes of an existing highway, the median portion is less exposed to areas of unstable slopes and therefore has the least impact.

Based on this review, the Hybrid Alignment Solution was identified as the preliminary preferred alternative.

4.6.3 Refinements to the Preferred LRT Alignment

Following consultation in Spring 2015, the Hybrid Alignment Solution was carried forward for further examination. Subsequent investigation of the costs for structures including bridges and retaining walls and the costs of building suitable foundations for these structures, revealed that the long structure needed between Montreal Station and Green's Creek is an area of soft, deep clays, and would have resulted in higher costs. Other structural designs and other locations for the LRT to transition from the north side at Blair Station into the median were reviewed and assessed.

As an initial step, the bridge carrying the East LRT over the westbound HWY 174 lanes was shortened as much as practical. Subsequently, design assumptions were refined in consultation with the City of Ottawa and the Stage 2 LRT team commenced preliminary engineering and the review of alignment options. for the East LRT between Blair Road and Montreal Road. The results of their studies are summarized below.

LRT Alignment under Blair Road:
The preferred LRT alignment heading east from Blair Station and under the Blair Road interchange, is generally straight in the Hybrid Alignment Solution. When compared with the alternative of using the existing East Transitway for LRT, the preferred alignment:

- Has better horizontal alignment for LRT operation;
- Protects the existing East Transitway for the Cumberland Transitway; and
- Has higher footprint impacts and capital cost and therefore protects for the "worst case".

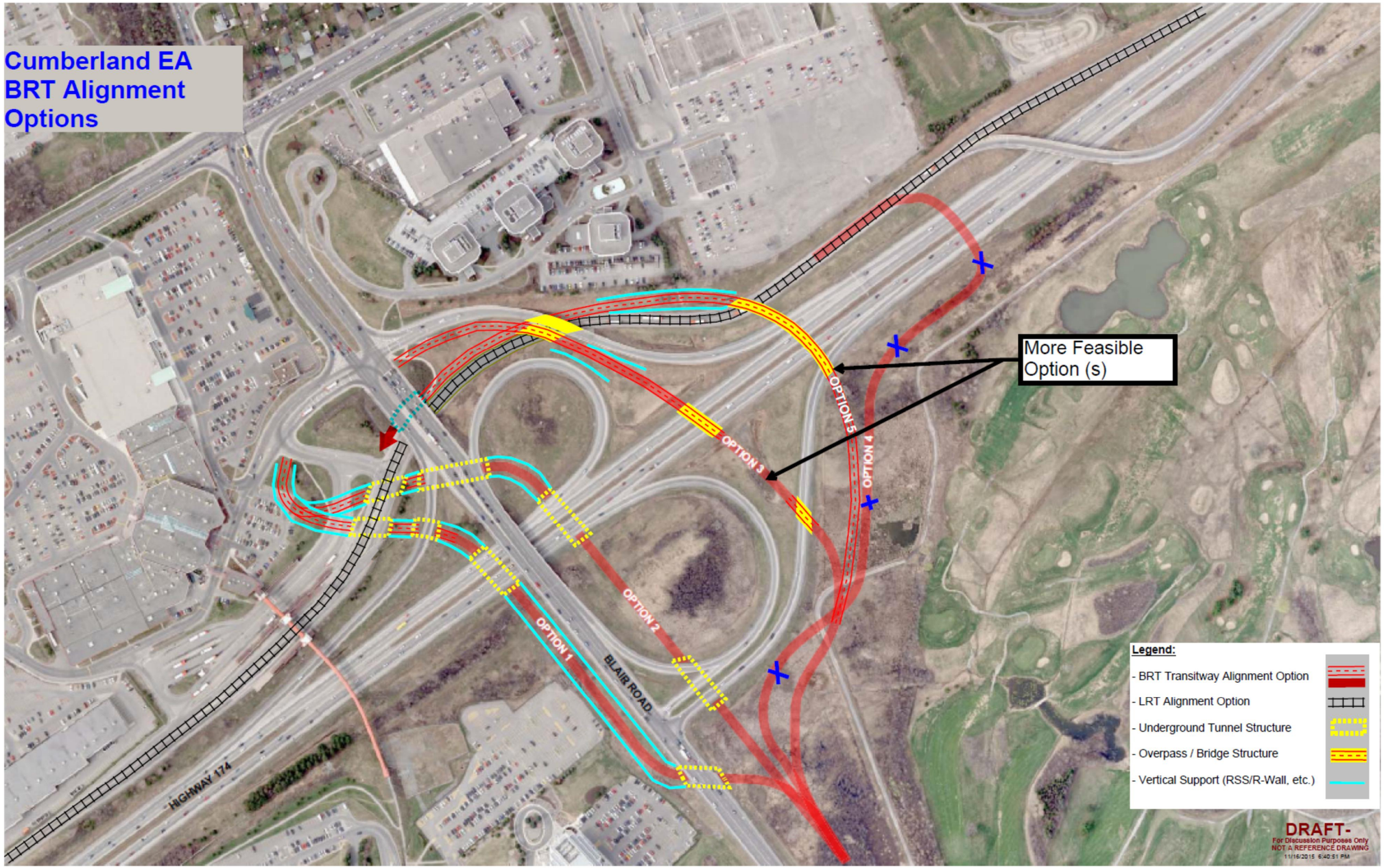
In reviewing the assumptions originally stated for the EA Study, the City of Ottawa decided that the LRT could use the existing Transitway structure under Blair Road as long as the future Cumberland BRT could be accommodated with an appropriate design. The Blair interchange area was therefore investigated with respect to the needs of the East LRT and the Cumberland Transitway. An alignment that follows the existing East Transitway east of Blair Station uses three existing structures (under Blair Road, the westbound off-ramp and the northbound to westbound on-ramp). This alignment involves back to back curves. The vertical alignment would follow the existing Transitway.

Using the existing East Transitway facility for the East LRT, alternatives for the Cumberland BRT taken from the Cumberland BRT EA Study were assessed and refined (see Figure 4-2). Alternatives 1, 2, 3 and 4 shown on the figure were rejected in the original EA Study. As a result, Alternative 5 and a refinement of Alternative 3 were assessed by the Stage 2 team. However, an acceptable profile (vertical alignment) for the BRT was not attainable, given the available distances between the structures. Therefore, Alternative 5 was selected as the preferred alignment for the Cumberland BRT.

The Cumberland BRT protected as part of the East LRT closely follows the geometry of the approved Recommended Plan from the Cumberland Transitway EA study. North of the Pineview Golf Course, the BRT swings easterly over HWY 174 to position the Cumberland BRT immediately to the north of the proposed East LRT.

The existing bridge under the westbound off-ramp will need to be modified or replaced, when the Cumberland BRT is constructed in the future. It appears that the bridge under Blair Road is wide enough to accommodate both BRT and LRT in the future. The existing Multi-Use Pathway (MUP) located underneath this structure may be accommodated by narrowing it slightly from 3.0m to 2.5m, by modifying the structure or by building a separate structure.

Figure 4-2: Alternative Alignments for BRT and Proposed Alignment for East LRT



As a result of this investigation, the alignments of the East LRT and the Cumberland BRT (Option 5) through the Blair interchange, illustrated in Figure 4-2, were selected as preferred for the following reasons:

- Comparable impacts with respect to the Hydro One transmission line as approved in the EA Study;
- Subsurface soil/rock conditions are good;
- Fewer impacts to natural environment features than the new structures under the interchange;
- Less structural work and costs, especially in the short term (that is, by using the existing East Transitway facility, this alignment eliminates new structures under Blair Road and the Blair interchange ramps);
- Simplified construction staging for the East LRT for Blair Road traffic;
- No property impacts.

Based on the review of the alternatives, the preferred alternative is for the LRT alignment to use the existing East Transitway facility east of Blair Station.

Transition into the HWY 174 Median:
As noted above, the high structural costs associated with a transition into the median at Montreal Road and the poor subsurface soil conditions in that area led to the review of alternative transition locations. It should be noted that the existing highway bridges over Montreal Road are approaching the end of their useful life and bundling the bridge replacement with the LRT project could be advantageous.

Alternative alignments for the East LRT in this area were evaluated with the goal of reducing the cost of the long LRT structure over westbound HWY 174 through the Montreal Road interchange. It was recognized that swinging into the median west of Montreal Road would incur costs associated with widening of the highway and these had to be compared with the costs associated with a long structure in poor soils. These new alternative alignments would result in a median station at Montreal Road and not require relocation of the Hydro Ottawa lines that cross through the interchange.

Three alternatives were evaluated, including a cut and cover (tunnel) option under HWY174 westbound lanes just west of Montreal Road, a flyover (bridge) option just west of Montreal Road and a flyover option in the vicinity of the existing eastbound Transitway structure over HWY 174 near Gloucester High School.

Cut and Cover Option:
Although tunnels are generally more expensive than bridge structures, given the poor soils in the area driving up foundation costs, a tunnel option was investigated close to Montreal Road to minimize the costs associated with highway widening.

Retaining walls would be used where there is insufficient property available for earth slopes. The LRT would cross under the westbound highway lanes in a cut and cover box approximately 50m long, before turning into the median and rising up to median grade west of Montreal Road. The LRT station would be more or less centered on Montreal Road, though the station location would be flexible.

Flyover Option East:
A flyover option just west of Montreal Road minimized the extent of median widening required, while recognizing the poor soil conditions in the area. The requirements for construction staging of the flyover would depend on the type of foundation selected. Spread footings, used to construct the existing HWY 174 structures over Montreal Road would be suitable, however, the significant size of footings needed to support the structure on the poor soils would greatly impact HWY 174 lanes during construction. This would necessitate significant staging or long bridge spans.

The LRT profile would have a relatively steep grade in this flyover option. The LRT would be contained within retaining walls due to the proximity of the highway and the adjacent residential area. The structure would cross over the westbound highway lanes and swing into the median. Again the retaining walls would be required in the median until the LRT reached the elevation of the highway median.

As with the cut and cover option, the location of the Montreal Road station would be more or less centered on Montreal Road and would be flexible, as necessary.

Flyover Option West:
The second flyover option evaluated was located near the existing Transitway structure. This location takes advantage of better foundation (soil) conditions and makes use of the existing embankment that carries the East Transitway up to the eastbound structure over HWY 174. This option will include a greater length of median widening to fit the LRT into the median. As well, this option swings into the median west of the potential future station in the vicinity of Trillium Park and the proposed pocket track. A pocket track may fit between Blair Road and the LRT flyover. The location of the future potential station would need to be shifted to the east when compared with the North Side Alternative.

The LRT would be contained within retaining walls where needed due to the proximity of the highway and then cross over the westbound lanes and swing into the median over a series of spans. The profile would then drop into the highway median. Again the structure would be contained within retaining walls in the median before reaching the same elevation as the highway.

As with the other two options, the location of the Montreal Road station would be flexible, likely more or less centered on Montreal Road.

Conclusion with Respect to the LRT Alignment from Blair Road to Montreal Road:
Following analysis of the key indicators and the characteristics of the possible alternatives, the Flyover Option West, which has the LRT enter the median of HWY 174 earlier than the Hybrid Alignment Solution, was selected as preferred for the following reasons:

- Median or north side station locations are reasonably equivalent in terms of serving the residential area and the business park;
- Supports city policies regarding intensification and community planning as well as transit-oriented development;
- There is additional space for a multi-use pathway on the north side of HWY 174, connecting into the community;
- The structure carrying the LRT over westbound HWY 174 is located in an area of improved subsurface foundation conditions;
- The structure carrying the LRT into the median would be further away from the residential area and the earth embankments/ retaining walls would also act as informal noise walls for a portion of the traffic;
- Creates an opportunity to address issues with a portion of the concrete pavement along HWY 174 that is deteriorating;
- The design requires replacement of the bridges carrying HWY 174 over Montreal Road, providing an opportunity to address existing condition and clearance deficiencies; and
- Results in cost savings;
- A future station near Gloucester High School can be protected.

4.6.4 Reasoned Argument for the Overall Recommended Plan

Subsequent to the review of the East LRT alignment alternatives, the following discussion summarizes the rationale for the Recommended Plan for the LRT from Blair Station to Trim Road from the perspective of each of the criteria groups used in the evaluation.

Social:
The Recommended Plan has stations located to serve residential and employment land uses. A future median station near Gloucester High School and Jasmine Park can be protected. The median location is further from residences on both sides of the highway corridor that could be adversely impacted by the perception of a LRT corridor if it were located along the North or South Alternative alignments. The Recommended Plan is also located in a corridor that is already impacted by the presence of a highway, and therefore its impact, from a social perspective, is lessened.

Transportation:
The Recommended Plan helps to achieve the transportation-oriented goals outlined in the City of Ottawa's Official Plan and Transportation Master Plan. It is highly compatible with these plans, as it has negligible adverse impact on existing networks and provides opportunities that will integrate well with future additions to the network. It provides equal opportunities to communities located to the north and south of the existing highway corridor to access the LRT.

Infrastructure:
The Recommended Plan in the median is located where fewer utilities have been installed, and therefore there are fewer impacts. The median station at Montreal Road eliminates the impact on the Ottawa Hydro lines that cross HWY 174 at the interchange and minimizes the impacts on the Hydro One transmission line. The median alignment between the East Transitway and east of Montreal Road provides the opportunity for the City to address deficiencies with the concrete pavement between Blair Road and Montreal Road and also allows the Montreal Road bridges that are at the end of their service lives to be replaced in a coordinated manner. East of Montreal Road, the Recommended Plan's median alignment avoids extensive restructuring of existing highway interchanges through Orléans that would be required with the North or South Alternatives.

Costs:
The Recommended Plan takes advantage of the existing right-of-way through the Blair Road interchange and locates the transition into the median in an area of better foundation materials, thus reducing costs. While the existing HWY 174 will require more reconstruction as the existing median is not wide enough to accommodate the LRT, this pavement structure is nearing the end of its service life and reconstruction is required. The additional investment in the pavement structure of HWY 174 is less than the costs associated with building the structures required in the vicinity of Montreal Road and Blair Road with the Hybrid Alignment Solution. Also, the Recommended Plan would result in the future potential Gloucester High School station being located in the median of HWY 174, resulting in additional costs associated with a pedestrian structure needed for access. As noted under infrastructure, east of Montreal Road, the median LRT alignment requires fewer alterations to existing interchanges and infrastructure, with significant cost savings over the North and South Alternatives.

Biological:
The alignment along the median is located between the lanes of an existing highway, in an already disturbed area. The Recommended Plan has fewer natural heritage features, fewer watercourse crossings, less woodland area, less significant wildlife habitat and less habitat potentially used by species at risk than the North or South Alternatives or the Hybrid Alignment Solution.

Physical:
Slopes and ravines were the indicator retained for evaluating the alternatives' impacts on the physical environment. Due to its location between lanes of an existing highway, the median alignment is less exposed to areas of unstable slopes and therefore has the least impact when compared with the other alternatives considered.

With consideration for the results from the evaluation and the review, and the reasoned argument presented above, the alignment identified as the preferred alignment is described in the following section.

4.6.5 Preferred LRT Alignment

As a result of extensive investigation, the following LRT Alignment was carried forward as the Preferred Alignment:

- Follow the existing East Transitway, passing under Blair Road and the westbound off-ramp using existing structures.
- Climb up the existing East Transitway embankment to a new structure to carry the East LRT into the median;
- Cross over the westbound lanes of HWY 174 and drop into a median, widened as needed to accommodate the LRT;
- Follow the median of HWY 174 through to the end of the East LRT at Trim Road;
- Construct stations in the HWY 174 median at Montreal Road, Jeanne d'Arc Boulevard, Orléans Boulevard, Place d'Orléans, Orléans Town Centre, east of Tenth Line Road and at Trim Road.