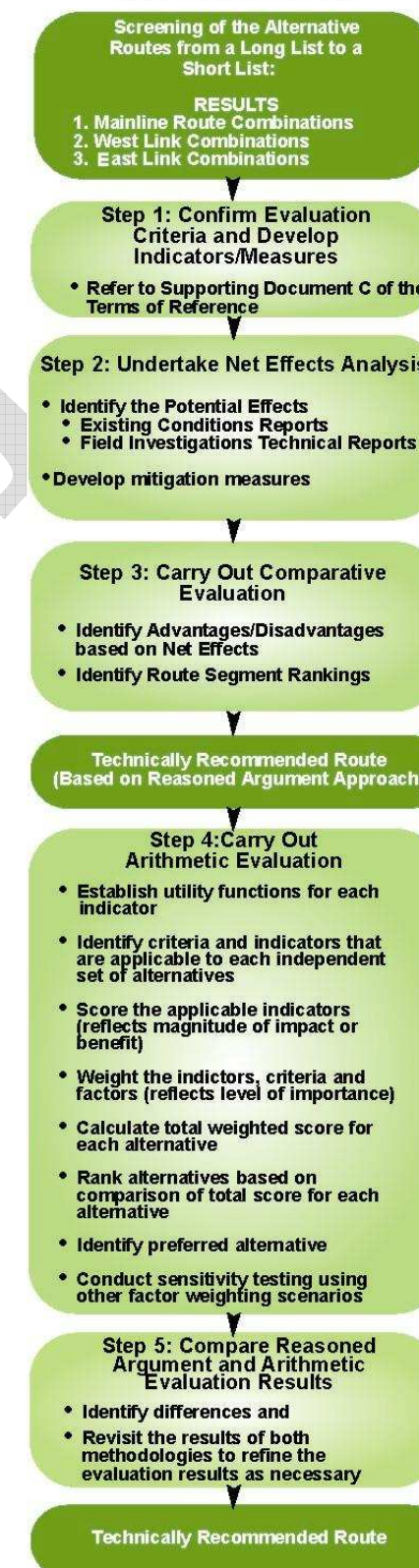


5. Assessment and Evaluation of the Short-listed Alternative Routes

5.1 Evaluation Methodology

Following the identification of the final short list of alternative routes, a detailed assessment and evaluation of the short-listed alternative routes was undertaken. As identified in **Figure 5.1**, the multi-step process began with confirming the evaluation criteria, indicators, and measures proposed in the approved 407 East EA ToR. With a final list of evaluation criteria, indicators, and measures established, they were applied to each of the short listed alternative routes through a “net effects analysis” to determine net positive or negative environmental effects. Next, a Reasoned Argument or Trade-off method was carried out using this information to determine a technically recommended route. Following this, an Arithmetic or Weighting-Scoring method was employed to verify the results of the Trade-off method.

Figure 5.1: Evaluation Methodology



5.1.1 Step No. 1 – Confirm the Proposed Evaluation Criteria, Indicators, and Measures

The approved 407 East EA ToR set out the draft criteria, indicators, and measures with the commitment that they would be reviewed and modified appropriately to suit the evaluation of the alternative routes reflecting more detailed information generated during the EA and through stakeholder input. Specifically, the criteria, indicators and measures were modified in consultation with review agencies and the public to ensure that an appropriate level of scrutiny and rigour was applied in evaluating the “short listed” routes. In doing so, the results of the evaluation phase consisted of clearly defined net effects for each “short listed” route that were suitable for comparison.

This finalized list of criteria and indicators was grouped according to the following factors so that each aspect of the “environment” as defined in the EA Act was addressed:

- **Natural Environment**having regard for the natural and physical components of the environment (i.e., air, land, water and biota). Specific criteria include groundwater, surface water quality and quantity, fisheries and aquatic habitat, vegetation, wetlands, wildlife, environmentally significant features, and landscape connectivity.
- **Social Environment**having regard for residents, property owners, institutional/recreational facilities, neighbourhoods, and community services. Specific criteria include noise, community fabric, recreational opportunities, property impacts, traffic nuisance, visual aesthetics, light, and air quality.
- **Land Use /Economic Environment**having regard for existing businesses (commercial, industrial, agricultural, aggregate, waste management, etc.) and future private and public sector development. Specific criteria include provincial/municipal/private land use development strategies, non-farm commercial activities, mineral aggregate resources, agriculture, property contamination, and waste management.
- **Cultural Environment**having regard for archaeological remains and built heritage and cultural landscape features. Specific criteria include archaeological features, built heritage features, and cultural landscape units.
- **Technical Considerations**having regard for the technical suitability, traffic operations, and other engineering aspects of the alternative route. Specific criteria include overall transportation system performance, transportation system compatibility, transportation system connectivity, accessibility, emergency access, and cost.

Table 5.1 presents the finalized list of factors, criteria, and indicators.

Table 5.1: Evaluation Factors, Criteria and Indicators

FACTOR/CRITERIA	INDICATOR/EFFECTS
Natural Environment	
Groundwater	1. Effect on groundwater recharge areas. 2. Effect on groundwater discharge areas 3. Shallow water supply wells within 500 m of the alternative. 4. Changes to groundwater quality
Surface Water Quality and Quantity Fisheries and Aquatic Habitat	5. Watercourse crossings and surface water features 6. Degree of Highly Sensitive Fish Habitat Affected 7. Degree of Moderately Sensitive Fish Habitat Affected 8. Degree of Low Sensitive Fish Habitat Affected 9. Degree of Unconfirmed Sensitivity Fish Habitat Affected
Vegetation	10. Effect on upland vegetation units. 11. Effect on significant vegetation communities. 12. Effect on known species of conservation concern or Species at Risk
Wetlands	13. Effect on wetlands (Evaluated and Unevaluated)
Wildlife	14. Effect on core wildlife habitat (including indirect effects such as noise and light) 15. Effect on specialized or sensitive wildlife habitat areas (including indirect effects such as noise and light) 16. Effect on habitat of known species of conservation concern or Species At Risk (including indirect effects such as noise and light)
Environmentally Significant Features Landscape Connectivity	17. Effect on identified ESAs and ANSIs 18. Effect on linkages between core wildlife habitat
Social Environment	
Noise	1. Separation distance to sensitive receptors, sound levels and impacts.
Community Fabric	2. Encroachment on or severance of established and/or proposed settlement areas. 3. Likely effects on planned/ approved community structure, as may be identified or proposed in provincial land use policies and/or regional official plans, within and east of the study area. 4. Delivery of community services (emergency, school bus). 5. Urban or rural barrier effects
Recreational Opportunities	6. Effect on hiking, hunting, fishing, nature viewing (golf course) and educational opportunities
Property Impacts	7. Residential and institutional property effects: <ul style="list-style-type: none"> • Full removal/Displacement • Frontage/Reduced frontage • Severance - Complete/Partial • Loss of Access/Access Impacted
Traffic Nuisance	8. Potential for diversion of longer distance travel to/from local roadways
Visual Aesthetics	9. Total aesthetic value of visibly accessible landscape components.
Light	10. Effect on light sensitive receptors
Air Quality	11. Separation distance to sensitive receptors, predicted concentrations and impacts

Table 5.1: Evaluation Factors, Criteria and Indicators

FACTOR/CRITERIA	INDICATOR/EFFECTS
Land Use/Economic Environment	
Provincial/Municipal/Private Land Use Development Strategies	<ol style="list-style-type: none"> 1. Degree of compatibility with municipal and regional development goals and objectives. 2. Capability to provide transportation service/stimulate development of major development initiatives (Seaton, Pickering Airport). 3. Compatibility with federal/provincial/municipal planning goals/objectives/policies, including principles and policy directions under development in the Greater Golden Horseshoe Growth Plan and Greenbelt Plan, the Watershed based Source Protection Planning and the proposed GTA Transportation Strategy. 4. Effects on approved private development proposals.
Non-Farm Commercial Activities	<ol style="list-style-type: none"> 5. Businesses displaced. 6. Businesses with access affected. 7. Number of employees working for businesses displaced within the right-of-way 8. Changes (+/-) in business exposure. 9. Construction impacts on businesses.
Mineral Aggregate Resources	<ol style="list-style-type: none"> 10. Effect on licensed aggregate resource facilities. 11. Effect on aggregate resource areas.
Agriculture	<ol style="list-style-type: none"> 12. Removal or sterilization of Class 1-3 agricultural land(s). 13. Specialty crops/cropland affected. 14. Dairy/livestock operations affected. 15. Field crop operations affected. 16. Farm properties greater than 20 ha affected. 17. Severed parcels greater than 20 ha created. 18. Severed parcels less than 20 ha created. 19. High investment operations affected. 20. Farm equipment transportation routes affected. 21. Division of agricultural community areas.
Property Contamination	<ol style="list-style-type: none"> 22. Impact on properties in urban areas. 23. Impact on properties in rural areas.
Waste Management	<ol style="list-style-type: none"> 24. Impact on known operating and closed waste management facilities (e.g. transfer stations, stormwater treatment plants, waste disposal sites, landfills).
Cultural Environment	
Archaeological Features	<ol style="list-style-type: none"> 1. Disturbance or destruction of known significant archaeological sites 2. Disturbance of areas of archaeological potential
Built Heritage Resources	<ol style="list-style-type: none"> 3. Displacement or disruption of built heritage resources
Cultural Heritage Landscape Resources	<ol style="list-style-type: none"> 4. Displacement or disruption of heritage landscape resources
Technical Considerations	
Overall Transportation System Performance	<ol style="list-style-type: none"> 1. Out of way travel 2. Support for transit service
Transportation System Compatibility	<ol style="list-style-type: none"> 3. Transportation Network Compatibility
Transportation System Connectivity	<ol style="list-style-type: none"> 4. Ability of each alternative to support or connect to existing or proposed travel modes

Table 5.1: Evaluation Factors, Criteria and Indicators

FACTOR/CRITERIA	INDICATOR/EFFECTS
Accessibility	5. Accessibility of alternative to population and employment centres
Emergency Access	6. Impact of alternative on emergency access to adjacent lands
Cost	7. Examines the short and long term costs associated with each alternative

A more detailed table outlining the factors, criteria, indicators, measures, and data sources is provided in **Appendix D**.

5.1.2 Step No. 2 – Undertake the Net Effects Analysis

The finalized evaluation criteria, indicators, and measures were applied to each of the short listed alternative routes through a “net effects analysis” to determine net positive or negative environmental effects. The “net effects analysis” of the short listed alternative routes, as endorsed by the Ministry of the Environment, consisted of the following activities:

- Identify the potential effects on the environment
- Develop and apply avoidance, mitigation, compensation and enhancement measures
- Determine net effects on the environment

Identification of Potential Effects

In order to identify potential effects on the environment, the information contained in the Existing Conditions reports (Appendices to the Alternatives To the Undertaking Report) as augmented by field investigations was reviewed within the context of Functional Plans prepared for each route. The Functional Plans identified the route footprint, which included both the proposed highway and transitway facility and associated interchanges.

The following Existing Condition reports were prepared for the purposes of generating a detailed description and understanding of the environment within the Study Area, based on Secondary Source information:

1. Natural Environment Existing Conditions;
2. Drainage Existing Conditions;
3. Noise Existing Conditions;
4. Socio-Economic Existing Conditions;
5. Air Quality Existing Conditions;
6. Agriculture Existing Conditions;
7. Waste and Property Contamination Existing Conditions;
8. Archaeological Existing Conditions; and
9. Cultural Heritage Existing Conditions.

The secondary source data contained within each of the preceding Existing Condition reports was supplemented through field investigations to gather Primary data.

By utilizing the data from the Existing Conditions reports, and the field investigations undertaken within the context of the Functional Plans provided, the evaluation criteria were then applied to the “short-listed” alternative routes to determine the potential effects associated with each route segment.

Specifically, this was accomplished by applying the indicators to each “short-listed” route on a route segment basis. The results of applying these indicators is expressed in the context of their corresponding measures, either quantitatively or qualitatively, as appropriate, in the potential effects column of the net effects table (see tables in **Supporting Documents 1 through 5**).

Development and Application of Avoidance/ Mitigation/ Compensation/ Enhancement Measures

Once the potential effects on the environment were identified for each “short-listed” route segment, the appropriate avoidance/ mitigation/ compensation/ enhancement measures were developed and documented in the net effects table for each indicator. The intent of these measures was as follows:

- **Avoidance:** The first priority is to prevent the occurrence of negative effects (adverse environmental effects) associated with implementing an alternative.
- **Mitigation:** Where adverse environmental effects cannot be avoided, it will be necessary to develop the appropriate measures to remove or alleviate to some degree the negative effects associated with implementing the alternative.
- **Compensation:** In situations where appropriate mitigation measures are not available, or significant net adverse effects will remain following the application of mitigation, compensation measures may be required to counterbalance the negative effect through replacement in kind, or provision of a substitute or reimbursement.
- **Enhancement:** Wherever possible, the opportunity should be taken to enhance the positive environmental effects associated with implementing an alternative rather than merely mitigating and/or compensating.

With these intentions in mind, the avoidance/ mitigation/ compensation/ enhancement measures were developed based on the professional expertise of the Project Team reflecting current procedures, historical performance, and existing environmental conditions. These developed measures were documented in the avoidance/ mitigation/ compensation/ enhancement measures column of the net effects table.

Determination of Net Effects on the Environment

Once the appropriate avoidance/ mitigation/ compensation/ enhancement measures were developed and applied to the potential environmental effects of each “short-listed” route segment, the remaining net negative or net positive effect was determined and documented by the Project Team members in the “net effects” column of the net effects table. In cases where the net negative or net positive effect could not be improved through the application of avoidance/ mitigation/ compensation/ enhancement measure(s), the potential net effect remained unchanged and

therefore, was still identified as the “net effect”. Upon completion of Step No. 2, the net effects associated with each ‘short listed’ route segment was determined and carried forward to Step No. 3.

The net effects analysis for all routes has been documented on a section by section basis, with a summary of the results provided in subsequent sections of this report and the detailed documentation provided in the Specialist Reports (refer to **Appendices E through M**) and **Supporting Documents 1 through 5**.

5.1.3 Step No. 3 – Carry out the Comparative Evaluation

In Step No. 3, two complementary evaluation approaches were utilized to identify a TRR (in accordance with the approved 407 East EA ToR) based on the net effects identified for each “short-listed” route segment in Step No. 2. As previously mentioned, the two evaluation methods were the reasoned argument approach and arithmetic approach. As stated in the approved 407 East EA ToR, the reasoned argument approach was the primary method for identifying a TRR whereas the arithmetic approach was the secondary method used to verify the results of the reasoned argument or trade-off method.

Details on the Reasoned Argument and Arithmetic evaluation methodologies are outlined in the following sections with the results of applying them described in subsequent sections.

5.1.3.1 Reasoned Argument Approach

The Reasoned Argument method highlighted the relative differences in net effects associated with the “short-listed” route segments. Based on these differences, the key trade offs of each alternative route segment were identified allowing for a ranking of most preferred to least preferred to be assigned. More specifically, this approach was carried out through the following two activities:

- 1st Activity - Identify the level of effect (‘No’, ‘Low’, ‘Moderate’ or ‘High’) associated with each short-listed route segment for each indicator
- 2nd Activity - Rank each route segment from most preferred to least preferred based on the identified level of effect from each indicator (i.e., first, second, third, etc.)
 - Indicator rankings for each route segment;
 - Criteria rankings for each route segment;
 - Factor specific rankings for each route segment
 - Overall route segment rankings.

The process followed in Step 3 and the results of these two activities are described in further detail in the following sections.

Level of Effect Determination of the ‘Short-listed’ Routes

The Project Team members reviewed the net effects determined in Step No. 2 and assigned a relative level of effect ranging from ‘No effect’, ‘Low effect’, ‘Moderate effect’ or ‘High effect’ for each indicator for each short-listed route segment. The assignment exercise was based on the range of net effects determined in Step No. 2 reflecting the professional expertise of the Project Team.

Ranking of the 'Short-listed' Route Segments

With the relative level of effect documented for each indicator by route segment, the Project Team members used this information to collectively assign a ranking to each route segment. The rankings given by the Project Team members ranged from 'First' (most preferred route segment) to 'Second' (least preferred route segment) in case of only two route segments being comparatively evaluated. In the situations where three or more alternative route segments were being comparatively evaluated, then additional rankings were given (e.g., 'First', 'Second', 'Third', 'Fourth', etc.). Similarly, the Project Team members could determine that two or more route segments were similar in ranking, and could then apply a tied ranking (e.g., 'First (tied)').

With this in mind, the Project Team members first assigned rankings for each individual Criterion based on the level of effect determined for each indicator under that Criterion. For example, the evaluation criterion of "Groundwater" has four indicators. In each indicator's case, a level of effect (e.g., either 'No', 'Low', 'Moderate' or 'High') was given. Next, these four level of effects were considered collectively in order to determine an overall ranking for that Criterion. After each Criterion was ranked, rankings were determined for each Factor Area (Natural Environment, Social Environment, Economic/Land Use, Cultural Environment, and Technical) based on the rankings from each evaluation criterion. For example, in the case of the Natural Environment Factor, the Project Team members considered all eight of the identified rankings for a route segment corresponding to the eight Natural Environment evaluation criteria (incorporating tradeoffs and their professional judgment) in determining the Natural Environment Factor ranking.

Following this, the Project Team members determined an overall ranking of each route segment for each 'short-listed' route based on the individual Factor rankings. With this in mind, an overall ranking of 'First' for an entire route would have a greater number of higher placed individual Factor rankings (e.g., more 'First' and 'Second' place rankings).

5.1.3.2 Arithmetic Approach

As previously noted, the Arithmetic Evaluation method was the secondary method of evaluation and incorporated both the level of importance of each environmental attribute, referred to as the *weight*, and the magnitude of the effect associated with an alternative, referred to as the *score*. Numerical values were derived for both the weight and the score associated with each alternative.

The weight was multiplied by the score to obtain a total. The totals for each alternative were compared to determine the preferred alternative route. This evaluation method also allowed for sensitivity testing as various weighting scenarios were applied.

Scoring of Impacts

The score assigned to each environmental criterion was relative to the effect generated and the potential to effectively mitigate it. Relative effects ranged from a positive benefit to the environment to a negative impact or detriment to the environment.

The assessment of effects was derived from field measurements, prediction model results, secondary data sources and other means, as necessary.

Weighting the Level of Importance

Generally, more weight was assigned to those factors that were considered to be more important in assessing effects generated by alternatives, and less weight was given to those factors that were considered to be less important.

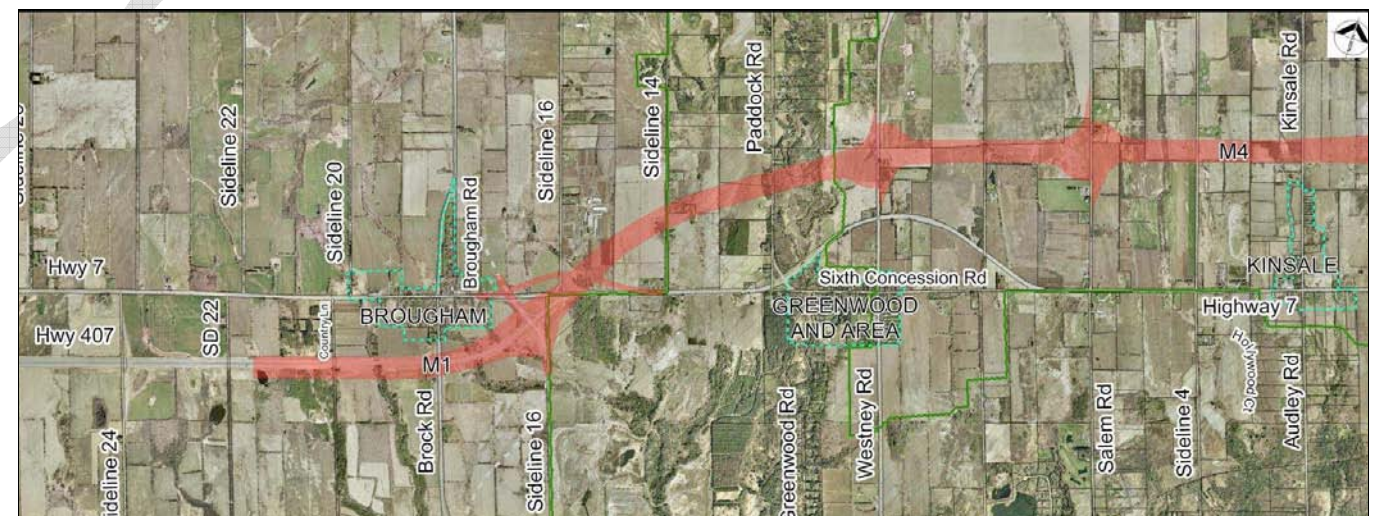
Weighting scenarios were developed in consultation with the public, regulatory agencies and municipalities. Such input provided the Project Team with an understanding of community values with respect to the relative importance of each environmental feature. It should be noted that weighting scenarios varied for different route segments in recognition of the diversity of features found across the study area. In addition, various sensitivity tests were run for the three highest ranked alternatives from the reasoned argument approach to reflect input received from stakeholders and the public.

5.2 Section 1 – West Mainline, Brock Road to Audley Road

5.2.1 Net Effects Analysis

The following provides the key net environmental effects for the single route within Section 1 as illustrated in **Figure 5.2**. Refer to the Specialist Reports in **Appendices E through M** for additional information.

Figure 5.2: West Mainline Alternative, Brock Road to Audley Road



Natural Environment

This route segment crosses an area of predominately agricultural land use with scattered rural residential and settlement areas. Within this landscape, natural features consist of scattered natural and cultural woodland patches