METROLINX
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Board Report

To: Metrolinx Board of Directors

From: Leslie Woo, Vice President, Policy and Planning
Gary McNeil, President, GO Transit
Karen Pitre, Project Director, Electrification Study

Date: January 26th, 2011

Re: GO Electrification Study

RECOMMENDATION

Be it resolved

THAT the Board adopt the recommendations of this staff report dated January 26th 2011, entitled "GO Electrification Study", and submitted jointly by the Metrolinx Vice President, Policy and Planning, the President of GO Transit and the Electrification Study Project Director on January 26th 2011, to proceed with Option 3, the electrification of the combined Georgetown and Lakeshore rail corridors, based on transportation benefits,

THAT the implementation of Option 3 Phase One include;

i) the preliminary design and engineering and environmental assessments for the electrification of the combined Georgetown and Lakeshore rail corridors; and

ii) the implementation of the electrification of the Air Rail Link between Union Station and Pearson International Airport for the Georgetown corridor,

THAT the decision to proceed with electrification of the combined Georgetown and Lakeshore corridors be premised on continued funding of currently planned GO state of good repair, service optimization, foundation and expansion improvements, consistent with the Reference Case outlined in the GO Electrification Study,

THAT the Metrolinx President and CEO, on behalf of the Board, forward to the Ontario Minister of Transportation these recommendations,

THAT Metrolinx staff report back to the Board on completion of the environmental assessments.

1. BACKGROUND

On May 26, 2009, Metrolinx announced that it would be undertaking a one year study on the feasibility of electrification of the entire GO rail system.

Metrolinx's 25-year multi-modal Regional Transportation Plan, entitled *The Big Move*, sets out a fast, frequent and expanded regional rapid transit network as a principal element of the region's future transportation system. *The Big Move* includes the establishment of Express Rail and Regional Rail service at speeds and frequencies that would clearly be enhanced by system electrification. One of the goals of *The Big Move* is to increase transportation choices, reliability and convenience so as to increase the transit mode share in the GTHA.

GO Transit, an operating division of Metrolinx, has been anticipating the advent of electrification in its rehabilitation and expansion investments through its protection of vertical clearances for an overhead catenary system. A series of

prior studies have been undertaken to explore the possibility of electrification of aspects of the GO system, primarily focused on the Lakeshore corridor. These studies did not result in any commitment to electrification.

The Study Terms of Reference were developed utilizing the expertise of a multi-stakeholder Community Advisory Committee (CAC). The Study Terms of Reference were approved by the Metrolinx Board on October 20, 2009 and an RFP was issued to retain a consultant to undertake the study. The RFP closed on November 26, 2009 and attracted nine (9) reputable international, national and local teams.

The joint venture team of Delcan Corporation and Arup Canada Inc. was retained to undertake the Study. The study team, including its sub-consultants, possess the broad expertise needed to consider the economic, social, environmental, operational, health and technological costs and benefits of conventional and potential future rail system technologies.

This Study is unique as it examines the entire GO rail system, is comprehensive in its approach, and addresses the impact of different technologies at a high level of detail. The Study considered the economic, social, environmental, health, and technological factors for current and future diesel and electric technologies.

Metrolinx set a high bar with respect to the inclusiveness of stakeholder and external expertise early on in the process and the timeliness of the study completion. The goal was to ensure interested parties would have ample opportunity to contribute their views and comments.

The Analytical Elements of the Study include:

- Technologies, Capacities and Transit Service Impacts;
- Environmental and Health Impacts;
- Community and Land Use Impacts;
- Economic Impacts; and
- System Cost, Funding and Financing.

The project methodology, as recommended by the consultants, was divided into five phases:

Phase I: Project initiation (January 2010)
Phase II: Objectives, Baseline Conditions, Pre-screening criteria (late January – late March)
Phase III: Development of up to 16 technology/corridor/network scenarios (late March – late June)
Phase IV: Scenario screening and short-listing of scenarios (mid June – mid September)
Phase V: Detailed assessment, findings and conclusions, business case (mid October – late December)

2. STUDY METHODOLOGY

Terms of Reference

As part of the development of the Terms of Reference for the Electrification Study, a multi-stakeholder, inter-disciplinary Community Advisory Committee (CAC) was established to provide advice to staff. The membership of the CAC drew from the best experience and expertise in the GTHA community to ensure that the scope of the study was comprehensive and complete. This approach of developing the Terms of Reference with the input from a diverse constituency is unique and the result is a much broader and more comprehensive study scope. The CAC continued to provide ongoing feedback over the course of the one year study period. The CAC membership is included in Appendix A.

In addition to the deliberations of the CAC, public consultation was conducted, through an online consultation. The consultation provided input and affirmed central streams of study identified by the CAC. A stakeholder workshop was also held to provide further input from a range of interests including: community groups, academia, environmental groups and local electricity distribution companies.

Stakeholder Engagement

Over 100 non-government organizations, representing the broad geographic scope of the study and the diverse study topic areas, were invited to participate in the stakeholder engagement process. There were four stakeholder workshops and one public update meeting specifically for the Georgetown community, over the year of the Study. Valuable input was received during these workshops and the public meeting. A final stakeholder workshop was added at the request of the stakeholders to discuss the preliminary findings and conclusions. In addition, reports were posted on the Metrolinx website and comments were invited on-line.

Understanding GO Transit Rail

GO Transit operates a commuter rail service on seven corridors using diesel locomotives that all converge at Union Station. Commuter railways in other parts of the world typically operate on dedicated rail lines. GO trains operate on a shared-use network that also serves freight and trans-continental passenger trains. In addition, different sections of GO's rail network are owned by Canadian National Railway Company (CN) and Canadian Pacific Railway (CP). Even on the GO-owned sections of the corridors, there are agreements with CN and CP to ensure that freight can continue in these corridors, fulfilling their important role in the Canadian economy. Both passenger and freight traffic volumes have increased substantially over the past decade.

GO Transit currently operates a combination of high capacity, frequent peak period services on the Lakeshore corridors, and less frequent but also high capacity peak period service on the remaining corridors. Off peak service is currently provided primarily on the Lakeshore corridors. GO operates 10- and 12-car trains carrying close to 2000 people per train set in busier periods.

The capacity of the existing rail corridor and its ability to accommodate both passenger and freight depends on many factors including the quantity of the track (single, double, passing track), quality of the track and the signalling system.

The GO rail network includes many types of infrastructure components, including tracks, stations, platforms, parking lots, maintenance garages, signal systems, bridges, level crossings, road-rail and rail-rail grade separations, river crossings and culverts. The Electrification Study included the development of a detailed inventory of this rail infrastructure for the purposes of determining what new, or different, infrastructure would be needed to electrify parts of the corridors or the entire rail network of the future.

The Electrification Study examined how the future GO rail services will be powered when improved services are implemented in the future and includes the operation of the Air Rail Link (ARL). Targeted for a 2014/15 in service date, the ARL will be a self-propelled, single-level, multiple unit, and premium shuttle service connecting Union Station to Pearson International Airport.

Establishing the Basis for Comparison – The Reference Case

To ensure that only those costs and benefits associated with electrification were included, the Study assessed the incremental costs and benefits of electrifying the GO rail network. A Reference Case was established to provide the basis for comparison of technologies. The assumptions for the Reference Case were developed on the understanding that to meet growing ridership demand, service levels would increase to two-way all-day service, infrastructure would be upgraded and necessary rolling stock would be in place over the next decade or more. Two-way all-day service provides for a daily service running in both directions in and out of Union Station. GO has made the commitment that Tier 4 diesel locomotives would be in operation within the mid-term timeframe of the Reference Case. The Electrification Study examined the incremental differences amongst Tier 4 diesel technology, electric technologies and other technologies for the Reference Case. Tier 4 diesel technology refers to the emission

standards that have been mandated in the United States by 2015. GO Transit has committed to the higher emission standards when the technology is commercially available.

Assessing Options

A key task of the Electrification Study was to compare and assess a broad range of rolling stock technologies that could be used to provide future GO rail service. The vehicle technologies were compared and assessed by the Electrification Study team using the following "screening" questions:

- Is the technology proven?
- Is the technology commercially viable?
- Is the technology compatible with the Reference Case service levels and infrastructure?

This lead to the consideration of four possible technologies:

- Tier 4 Diesel Locomotives pulling Bi-Level coaches;
- Electric Locomotives pulling Bi-Level coaches;
- Electric Multiple Units, Bi-Level configuration; and
- Dual-Mode (both electric and diesel) Locomotives pulling Bi-Level coaches.

In the case of the ARL, it was assumed that the initial deployment of self-propelled Diesel Multiple Units (DMU's) would be replaced by Electric Multiple Units (EMU's), if the Georgetown line is electrified either in part or in full.

Any electric vehicle needs a power supply and, therefore, the Electrification Study team conducted a comprehensive review of power supply and distribution technologies used in North America and around the world. As a result of the analysis, the recommended power supply option for GO is the use of an overhead catenary system. This type of system is used extensively around the world and in North America. Currently, rail system operators in Quebec, New York, Connecticut, New Jersey and Pennsylvania use overhead catenaries to power their commuter rail services.

There were a number of assumptions made to help screen out a number of network options. The first set of assumptions were vetted at the Stakeholder Workshop and included:

1. Group technology alternatives into a single "family" of electric trains (i.e. Electric Locomotive, Electric Multiple Units and Dual Mode Locomotives (when in electric mode)).

2. Lakeshore East and Lakeshore West corridors should operate the same type of rolling stock technology.

3. Prioritize the highest service corridors.

Using these three assumptions, there were eighteen (18) network options considered in the high level evaluation. In order to reduce the number of options for the detailed evaluation, the study team completed a high level evaluation that looked at the transportation and environmental performance for each of the 18 options. In addition, a high level evaluation compared rolling stock options. Additional analysis determined that the electric locomotive was a more cost effective alternative to the diesel locomotive. The EMU is more expensive than electric locomotive but is a step change in journey time savings. The EMU provides approximately 10 to 20 minutes savings for most of the corridors. The EMU would remain a future option for service levels beyond the Reference Case in keeping with *The Big Move*.

Based on this analysis, six (6) Network Options were advanced for more detailed evaluation. These Network Options which range from only electrifying one rail corridor to the entire network are as follows:

OPTION 1: Georgetown (including the ARL) from Union to Kitchener

OPTION 2: Lakeshore East and West from Bowmanville to Hamilton James

OPTION 3: Georgetown and Lakeshore together

OPTION 11: Georgetown and Lakeshore plus Milton from Union to Milton

OPTION 15: Georgetown, Lakeshore and Milton plus Barrie from Union to Allandale

OPTION 18: The entire GO rail network.

The detailed multi-criteria evaluation looked at the following key categories as the basis of comparison for each of the options:

- Environment and Health: Considerations – greenhouse gas emissions; regional and local air quality; electromagnetic fields; noise and vibration.
- User Benefits/Quality of Life: Considerations – journey time savings; reliability.
- Social and Community: Considerations – impacts on residents and users of community, institutional and recreational facilities.
- Economic/Financial: Considerations – capital and operating cost; revenues; cost-effectiveness; land use and property values; employment effects.
- Implementation: Considerations – constructability; acceptability; deliverability; risk and uncertainties.

3. STUDY KEY FINDINGS AND CONCLUSIONS:

This Electrification Study is the most comprehensive study of its kind undertaken for the GO rail network. It is broad in its approach as well as deep in the level of detailed analysis. It concludes that in all key categories, there are modest incremental benefits due to electrification. These benefits will increase as the population grows and service is increased beyond the Reference Case. The benefits are greatest for Options 2 (Lakeshore), 3 (Georgetown/ Lakeshore) and 11 (Georgetown/Lakeshore/Milton). There is not a compelling case to electrify Option 1 (Georgetown), Option 15 (Georgetown/Lakeshore/Milton/Barrie) or Option 18 (the entire network).

Environment and Health: Regional and Local Air Quality (Study Appendix 8D)

The Study analysis concludes that none of the electrification options significantly reduce regional GHG emissions. In addition, the Study benchmarked air quality against World Health Organization standards. None of the technology options result in emissions that exceed these air quality standards. While there are health benefits associated with electrification, these benefits are expected to be marginal.

User Benefits/Quality of Life: Journey Time Savings (Study Appendix 5)

The Study concluded that more journey time savings can be achieved with electric locomotives compared to diesel locomotives. On average, the time savings per passenger are between 2.4 and 2.8 minutes per passenger per trip. While the electric locomotive was used in the detailed evaluation, the Study notes that Electric Multiple Units (EMU's) over the long term will be able to take the GO Rail system closer to *The Big Move* vision for Express Rail with significant journey time savings. The highest level of benefits are delivered by electrifying Lakeshore East and West (because these corridors have the highest ridership), followed by the Georgetown corridor. There are few benefits derived from electrifying Richmond Hill (due to track curvature and line speeds).

Social and Community (Study Appendix 8G)

The Georgetown Corridor has the most people living closest to the corridor and its electrification could therefore potentially provide the greatest benefits, albeit these benefits are marginal. The Study confirmed that the land value uplift attributable to the technology options were marginal.

Economic/Financial: Capital Cost (Study Appendix 8B)

The following table outlines the incremental capital cost of electrifying the six Network Options in 2010 dollars. It should be noted that the cost of electrifying both the Lakeshore and Georgetown corridors is materially lower than the sum of the individual parts. This is because there are costs that are common to both corridors. Pursing electrification of both corridors results in economic savings.

Table 1: Total Incremental Capital Cost by Option ($m 2010 prices)

Option	Total Capital Cost Estimate Range* (includes Electrification Infrastructure & Rolling Stock) ($ 2010 prices)		
OPTION 1 - Georgetown	$800M	to	$900M
OPTION 2 - Lakeshore	$1.1B	to	$1.3B
OPTION 3 - Georgetown & Lakeshore	$1.6B	to	$1.8B
OPTION 11 - Georgetown, Lakeshore & Milton	$1.9B	to	$2.2B
OPTION 15 - Georgetown, Lakeshore, Milton & Barrie	$2.5B	to	$2.8B
OPTION 18 – Entire Network	$3.8B	to	$4.2B

*These costs include contingencies and do not include Reference Case costs

The infrastructure capital cost components include a contingency range between 35% and 55% depending on the level of risk considered. This range reflects the early stage of the conceptual design. The costs would be refined as preliminary design and engineering progresses and during the environmental assessment.

Economic/Financial: Operating and Maintenance (O & M) Cost (Study Appendix 8C)

The following table outlines the operating and maintenance cost savings of the six Network Options in 2010 dollars. It should be noted that the cost of diesel fuel is currently greater than electricity. The cost of electricity is expected to increase at a slower rate compared to diesel.

Electric locomotives are cheaper to maintain and operate because there are fewer moving parts to maintain and because of the cost of electricity. The Study found that there are important annual operating and maintenance savings through a reduction in operating subsidy needs.

Table 2: Annual Operating & Maintenance Cost Savings by Option ($ 2010 prices)

Option	Annual O & M Cost Savings* ($ 2010)
Option 1 - Georgetown	$ -3M
Option 2 – Lakeshore	$ -15M
Option 3 – Georgetown & Lakeshore	$ -18M
Option 11 – Georgetown, Lakeshore & Milton	$ -21M
Option 15 - Georgetown, Lakeshore, Milton & Barrie	$ -25M
Option 18 – Entire Network	$ -29M

*These costs do not include Reference Case costs

Implementation (Study Appendix 10)

The Electrification Study also concluded that conversion of the entire network to electrify is a lengthy process. Waiting to electrify after service is expanded, such as that assumed in the Reference Case, will increase both the cost and construction timeline, as it is more difficult to construct in rail corridors that have more frequent service.

4. STAFF OVERVIEW

The Electrification Study concluded there are incremental transportation benefits derived from electrification and that these benefits only increase over time. This increase over time is based on the higher service levels and more passengers in the future, which in turn improves the case for electrification. The prime benefits to electrification over Tier 4 diesel technology are in journey time savings and important operating and maintenance cost savings.

The incremental benefits under any one of the evaluation criteria are modest on their own. The cumulative impacts of these benefits, as well as the increase in benefits as service expands, build the case to begin the process for electrification now.

In past electrification studies undertaken by GO Transit, the benefits and costs of electrification had always been weighed against the benefits and costs for service expansion. The decision has always been to invest scarce dollars into the infrastructure needed to provide more service, rather than invest in electrification. With limited funding, GO Transit could not justify electrification in the past, as it would have meant committing scarce funding away from base infrastructure investments and state of good repair.

For the purposes of comparison, the Electrification Study assumed that regardless of technology choice, state of good repair, system optimization and base foundation investments - included in the Reference Case - are integral to increasing and expanding service levels on all corridors. The Electrification Study shows that the benefits from electrification increase with increases in passenger volumes and service levels beyond the Reference Case.

To ensure that the costs of electrification were clearly defined, the costs developed in the Electrification Study only include the incremental costs required to convert the network to electric technology. Study costs did not include costs of the Reference Case that is part of ongoing planned GO state of good repair, optimization, foundation or expansion.

The comprehensiveness of the findings and conclusions of this consultant Study, combined with Metrolinx's *The Big Move*, vision for the future of integrated transportation in the GTHA, now provides a new basis for evaluating the case

for electrification. When examined as an integral component of GO rail expansion, rather than a separate independent project, there are tangible and practical benefits.

The Big Move

Metrolinx has an ambitious plan for increased transit and transportation connectivity articulated in *The Big Move,* to set the GTHA to move ahead of the growing demand. As service and infrastructure is further improved, and as the region's population grows, the case for electrification becomes stronger. *The Big Move* forecasts continued population and employment growth beyond the Reference Case and anticipates demand for a higher-order Express Rail service in the first 15 years of the plan on the Lakeshore and Georgetown corridors, and a further demand within 25 years on the Milton and Richmond Hill corridors. The GO Electrification Study provides a much more detailed analysis of which corridors it would be most practical to begin the transformation to an electrified service.

The Study does not find strong justification for electrifying corridors other than the combined Georgetown and Lakeshore corridors right now. The study does note that electrification of Milton and Barrie corridors may still be worthwhile in the longer term beyond the Reference Case. This Electrification Study provides significantly more detailed level of analysis that will inform Metrolinx's overall strategic planning, specifically the forthcoming Progress Report (*The Big Move 2.0*).

Other Metrolinx Initiatives

Prioritization:

Metrolinx's ongoing prioritization framework identifies GO state of good repair, system optimization and foundation investments as having the highest priority above future GO expansion. Expansion projects are then examined against the triple bottom line objectives of *The Big Move*, which are a high quality of life, economic competitiveness and environmental sustainability. This two-phased analysis produces a project scorecard which sets out priority project groupings scored against a range of criteria that respond firstly, to quality of life, the environment and the economy and secondly, to project implementation deliverability and constructability. The Electrification Study findings will continue to inform the ongoing Prioritization Process.

Union Station:

Metrolinx had undertaken, in parallel, two additional studies looking at: i) Union Station capacity; and ii) long term transportation demand management opportunities to divert trips away from Union Station. Both studies are now close to completion. Early findings of the Union Station Capacity study indicate that, with some key investments, there is the ability to create adequate capacity to meet the Reference Case service levels anticipated without significant re-configuration of Union Station beyond current plans.

The second study's preliminary findings highlight that the final destination of the majority of GO trips into Union Station are within walking distance of Union Station. Therefore, with continued employment growth in downtown Toronto, there will still be the need to address capacity constraints at Union Station beyond the Reference Case, as projected final destinations will continue to be in the downtown core.

5. STAFF RECOMMENDATIONS

- There is a case for electrification of Study Network Option 3 - the combined Georgetown and Lakeshore rail corridors, based on transportation benefits;
- Option 3 Phase One implementation should include;
    - i) the preliminary design and engineering and environmental assessments for the electrification of the combined Georgetown and Lakeshore rail corridors; and
    - ii) the implementation of the electrification of the Air Rail Link between Union Station and Pearson International Airport for the Georgetown corridor,
- Electrification of Option 3 corridors should be premised on continued funding of GO state of good repair, service optimization, foundation and expansion improvements, consistent with the Reference Case outlined in the GO Electrification Study.

The Case for Electrification

The case for electrification is based on transportation benefits and ability to integrate ongoing GO state of good repair, service optimization, foundation, and expansion improvements. Overall, there are four key reasons why implementing electrification is recommended:

1. Journey Time Savings

There are journey time savings with electrification which over time will increase as service expands. On average, the options considered identify the trip time savings are between 2.4 and 2.8 minutes per passenger per trip. Over the longest trips, journey time savings would be between 5 and 10 minutes. This reduction in journey time will benefit existing riders and attract new ones. The greatest journey time savings are on the Lakeshore and Georgetown corridors.

Table 3: Sample Journey Time Savings with Electrification

Sample Journey	Electric Locomotive (minutes saved)
Brampton to Union Station	5
Kitchener to Union Station	7
Oakville to Union Station	3
Hamilton to Union Station	6
Oshawa to Union	4

2. *The Big Move* Objectives

Electrification would be a significant step towards achieving the long term goals and objectives of *The Big Move* for a GO Express Rail service. Express Rail is a vision for even faster and more frequent service beyond the Reference Case, with trains operating in the peak period as low as every five minutes. Such a major transformation would take time and continuous commitment, but would be an important part of meeting future population and job growth in the GTHA.

3. Anticipating Future Ridership Growth

The conversion to electrification of Option 3 is a long-term investment. To wait until expanded future services are in place would increase both the time and the cost of implementation. Commencing a phased approach now, while service levels are lower, minimizes construction disruption and ensures that the electrification infrastructure is in place as ridership grows.

4. Operating and Maintenance Cost Savings

Net operating cost savings would range between $3M annually (Option 1 - Georgetown only) and $29M annually (Option 18 - entire network). The cost of diesel fuel is significantly higher compared to electricity and it is expected that the price of diesel would increase at a greater rate than electricity in the future.

Electric locomotives are significantly more energy efficient and are considerably lighter than diesel locomotives. They have higher overall acceleration and speed. Electric locomotives have the potential to convert braking energy back into electricity and this electricity could supply the heating, ventilation and air conditioning on the train. They are also cheaper to maintain because of the mechanical advantage of fewer moving parts.

The Electrification Study found that the highest performing network options for electrification are Option 2 (Lakeshore), Option 3 (Lakeshore and Georgetown) and Option 11 (Lakeshore/Georgetown/Milton) and Options 1 (Georgetown), 15 (Georgetown, Lakeshore, Milton and Barrie) and 18 (Entire Network) are the lowest performing options.

The recommended Network Option is Option 3 – the combined Georgetown and Lakeshore corridors. The key reasons for recommending Option 3 are as follows:

1. On the Georgetown corridor, some Reference Case investments are currently underway

2. On the Georgetown corridor, a small window to integrate electrification infrastructure design considerations with the current construction schedule

3. The Georgetown corridor between Union and Bramalea is owned by Metrolinx

4. On the Lakeshore corridor some Reference Case investments have already been made

5. These corridors have the greatest journey time savings

6. These corridors have the highest ridership demand

7. On Lakeshore East, there are plans to establish a second maintenance facility around Whitby. Early planning for the maintenance of electric locomotives could be integrated

8. There are capital cost savings of the combined Georgetown and Lakeshore corridors

9. There are significant operating and maintenance cost savings in Option 3, in the order of $18M net annually. This represents a 25% reduction from comparable current estimates

Metrolinx staff recommendations are based upon the Study findings that the benefits associated with electrifying GO train services are only derived when coupled with GO's ability to expand and enhance service levels, up to the Reference Case levels.

The recommendation to proceed with the implementation of Option 3 – Georgetown and Lakeshore corridor electrification, is premised on continued funding in place for ongoing GO state of good repair, system optimization and foundation investments to support planned service expansion.

6. OPTION 3 PHASING

The conversion from a diesel service to an electrified service is a significant long term investment. Based on experience from around the world, implementation schedules have been developed for each of the network options. There is a lengthy approval and design process before any construction can commence. Once the approvals are in place, the construction period for each corridor section has been proposed based upon an assumed best practice construction rate for similar projects in other jurisdictions. Construction would be complex and time-consuming as both freight and GO rail service would have to continue to operate while construction is underway. The daily window for construction would therefore be limited. If the objective is to provide frequent two-way all-day service in the future then it is necessary to start now, before the window for construction is reduced even further.

Based on the analysis to date, the following phasing factors need to be considered:

1. A phased approach is required:

   - To minimize disruption to existing operations and future service.
   - To ensure integrated planning with the Reference Case infrastructure improvements.
   - To build expertise in the conversion process on a portion of a corridor and then proceed incrementally in a logical sequence.

2. Constructability and approval processes need to be carefully mapped out:

   - Design and approval would be a lengthy process (3 - 4 years) due to complexity, the need for community engagement on issues like the location of hydro sub-stations, visual impacts and significant field work to identify the infrastructure needs, including the grounding of all metal objects within and adjacent to the right-of-way.
   - Design for electrification should be integrated into future projects
   - Construction is quicker and cheaper while train volumes and service levels are lower.

7. IMPLEMENTING NETWORK OPTION 3 – Electrification of the Georgetown and Lakeshore corridors

The conversion of an operating commuter rail system to an electrified system is a long term investment. Initially, there would be a need to assemble an experienced project electrification team. Negotiations with key stakeholders, such as CN and the Greater Toronto Airport Authority, will be critical to the implementation of the project.

The Study's power supply analysis (see Study Appendix 7) indicates that electrification of Georgetown and Lakeshore corridors would require six substations, four switching stations and four auto-transformer stations. In addition, four bridges would need to be rebuilt and an additional 24 bridges would need to be reworked to allow for sufficient clearance of the overhead wires.

The Study's conceptual implementation analysis has been divided into seven phases which are outlined below. This phasing would still need to be confirmed upon completion of the preliminary design and environmental assessments. There is currently construction underway in the Georgetown corridor which needs to be co-ordinated with the phasing of electrification.

The recommended phasing of Option 3 is as follows:

Phase 1: Electrify Georgetown corridor starting with the ARL from Union Station to the Pearson International Airport. This phase also includes electrification to the maintenance yard at Willowbrook (total length of 22.3 miles / 35.6 km).

Electrification would be a major long term investment and would significantly transform the GO network. It would therefore be prudent to commence with a component of the system where risk is minimized. As such, the ARL is a sound first step, being a distinct service that is already planned in a high state of readiness, in a corridor where Reference Case improvements are well underway and a project that would have minimal immediate impact on Union Station. In addition, this portion of the corridor is wholly owned by Metrolinx.

Phase 2: Electrify Georgetown Corridor from the airport spur to Brampton (7.8 miles / 12.5 km). This is a short extension which would meet the demand for higher frequency service to Brampton.

Phase 3: Electrify Lakeshore corridor east from Union Station to Oshawa (36.3 miles/ 58 km). This would start the electrification of a high demand corridor and would also enable access to the proposed second maintenance facility in the east.

Phase 4: Electrify Lakeshore corridor west from Willowbrook to Oakville (13.7 miles / 21.9 km). This would mark the beginning of Lakeshore through-service, connecting the east and west portions of Lakeshore corridor

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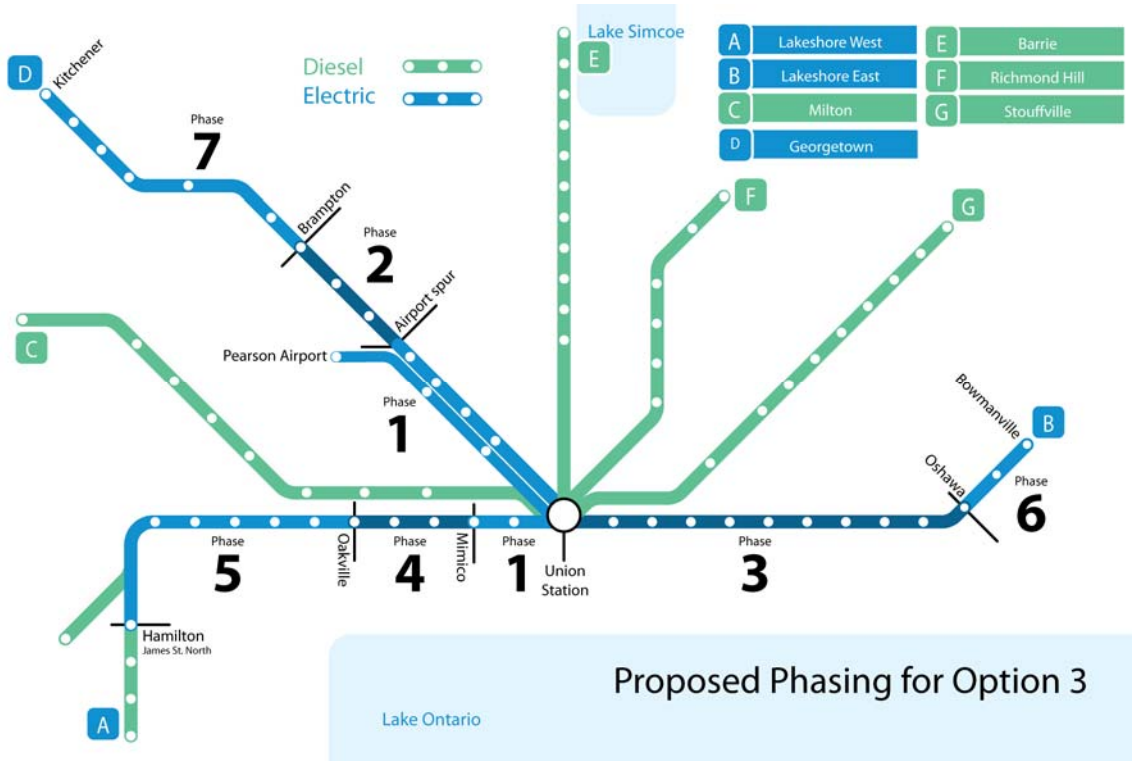
Phases 5-7: Electrify to end of the Lakeshore and Georgetown lines (72 miles / 115.4 km). These remaining corridor portions are currently not owned by Metrolinx and have the highest freight traffic, thus making negotiations with CN and CP, likely the most complicated and also construction the most challenging.



GETTING STARTED

Phase 1 – Step One

The first step is to start the preliminary design, engineering and environmental assessments for the electrification of Option 3. This would include the preliminary design for the infrastructure and enabling works as well as design of the power supply and overhead catenary system (OCS). Included in the preliminary design would be:

- The development of the operating plan;
- Determination of the power requirements based on the operating plan;
- Determination of substation location and access; and
- Confirmation of spacing of OCS supports and locations along the corridor.

This could take three to four years as it requires preliminary design and engineering for the power supply, approval of a sub-station and the environmental assessment work.

There are a number of issues that would require a more detailed analysis from an operational perspective. For example, the question of whether it would be necessary to provide an electrified service to Willowbrook for maintaining and servicing the ARL trains would be answered during the preliminary design process. There are a number of possible options for maintenance and servicing an electric fleet of the size required for the implementation of Phase 1 - ARL service.

The design for electrification of the ARL spur can be accommodated in the current construction schedule. The ARL service would start with Diesel Multiple Units (DMU's) in 2015 and Electric Multiple Units (EMU's) would be introduced at the time of electrification. These EMU's could be conversions of the DMU's, or new vehicles with the DMU's redeployed to other GO corridors.

Phase 1 – Step Two

After finalizing the design and the budget for Option 3, and upon approval of the necessary environmental assessments, the second step of Phase 1 would include the tendering and construction to start the electrification of the Georgetown corridor with the Air Rail Link from Union Station to the Pearson International Airport spur. The Air Rail Link spur itself and electrification to the Willowbrook maintenance yard. This would all be subject to the decisions taken through the preliminary design and environmental assessments.

COST ESTIMATES - Electrification Phase 1

The preliminary cost estimate has been developed for the electrification of Option 3 (Georgetown and Lakeshore). A percentage of the capital cost has been a proportioned to the preliminary design and engineering necessary to complete the first step.

In the first step it is necessary to identify and document all the parameters and gather the data. This data would be the basis for the design required to develop the terms of reference for the environmental assessments. The preliminary design and engineering falls into two categories: infrastructure and power supply

A detailed survey of the right–of-way, including 250 m on either side of the corridors, is required to identify items such as: all utilities, metal structures requiring grounding, all bridge and overhead crossing heights and widths. GO Stations, Union Station and the Willowbrook Maintenance facility would need to be reviewed to identify all items that need grounding and prepare a preliminary design for the grounding infrastructure.

The purpose of the preliminary design of the power supply is to confirm the power requirements, based on the operating plan to prepare for the design and layout of the power supply infrastructure. This includes the substations, autotransformers and switching stations. In addition, it would include the design of OCS pole/structure, the location of each OCS pole/structure and the visual appearance of each OCS structure.

All of this is necessary to develop the terms of reference for the environmental assessments.

Table 4: Option 3 – Phase 1 Implementation Cost Estimates

Electrification Phase 1		($ 2010)
Step One	• Preliminary Design and Engineering • Environmental Assessments	$17M
Step Two	Detailed Design and Construction: • Union Station to Pearson Airport • Union Station to Willowbrook	$440M

COST ESTIMATES Reference Case Improvements with Option 3 - Phase 1

Beyond current GO construction, planning has been underway in the Georgetown corridor to accommodate a fourth track and a tunnel under Highway 401 to provide for the future service capacity. This was identified in the approved environmental assessment for the Georgetown South corridor and are needed to deliver the planned service expansion in this corridor. Having the fourth track in place, would facilitate improved operational staging for the construction of electric infrastructure like the overhead catenaries and power supply.

Table 5: Option 3 – Phase 1 Reference Case Cost Estimates

Phase 1 – Associated Reference Case Improvements		
	Georgetown South corridor - 4th track and tunnel under 401	$400M

Option 3 Implementation: Remaining Phases 2 to 7

Completing the implementation of Option 3 beyond Phase 1, would require sustained commitment to the ongoing integration of the GO state of good repair, optimization, foundation and expansion improvements over the next twenty years. Implementation of the remaining phases would also require steady funding to ensure the full benefit of the recommended option is achieved and to better realize the vision of *The Big Move*.

Cost Estimates of Remaining Option 3 - Phases

- Phases 2 to 7 Electrification: $1.1B to 1.3B
- Phases 2 to 7 Reference Case Improvements: see Appendix B

8. MANAGING RISKS

The magnitude of the transformation to electrification presents significant risks. A risk mitigation plan would have to be developed to address:

1. Funding
   - Reference Case infrastructure delay due to capital and operating funding gaps
   - Lack of sustained funding committed to implement all phases of Network Option 3
   - Long-term funding for both the infrastructure investment and operating subsidies
2. Technical
   - Yet to be discovered technical obstacles
   - Start-up challenges in dealing with a new technology
3. Third Party Negotiations
   - May significantly increase cost and schedule
   - Corridor ownership gaps
4. Community Issues
   - Potential need to re-design service for an electric network to ensure positive community impacts and to minimize or avoid any negative impacts

The following factors are important considerations to ensure the risks are minimized while maximizing benefits:

- Focus on GO owned corridors/sections of corridors:
  - Easier to implement
  - Main freight service needs to be protected
- Phased approach required:
  - To minimize disruption to service
  - Ensure integrated planning with Reference Case infrastructure improvements
  - To plan rolling stock decisions as additional service added
  - To develop in-house expertise
- Leverage existing corridor investments:
  - The Georgetown corridor is currently undergoing enhancements with the construction of additional tracks. In addition, there is a proposal call underway for the construction of the Air Rail Link spur.

9. NEXT STEPS

Pending Board and Provincial acceptance of the staff recommendation, there would be the need to establish a start-up team of experts with the following next steps in mind:

Commence the RFP process to retain consultants for preliminary design and develop the terms of reference for the environmental assessments to address the following:

- Preliminary design:
    - Survey right of way and overhead structures
    - Survey of every facility for grounding
    - Integrate design in approved capital infrastructure projects
    - Power system design (supply and distribution system)

- EA terms of reference:
    - Substations, autotransformers, switching stations, overhead catenary, grounding, etc.
    - Civil works (structures, track lowering, etc)
    - Stakeholder Engagement and public engagement

- Commence negotiations
    - CN/CP
    - Hydro One
    - GTAA
    - Land owners
    - Municipalities

APPENDIX A

Electrification Study Terms of Reference

Community Advisory Committee Members

Chair, Daniel Burns, former Ontario Deputy Minister of Health and Long Term Care

Vice Chair, Pamela Robinson Ph.D., MCIP RPP, Assistant Professor, School of Urban & Regional Planning, Ryerson University and Member, Metrolinx Advisory Committee on the RTP

Frank Giannone, President, FRAM Building Group, President, Ontario Home Builders' Association

Dina Graser, Former Associate, Goodmans LLP and Chair, People Plan Toronto

Dr Linn Holness, Professor and Director, Gage Occupational and Environmental Health Unit, University of Toronto and St Michael's Hospital

Gerry Johnston, former Assistant Deputy Minister, Ontario Ministry of Transportation

Ed Levy, Senior Consultant and former President and Chairman, BA Consulting Group

Eva Ligeti, Executive Director, Clean Air Partnership

Eli Malinsky, Member, Centre for Social Innovation; Member, Clean Train Coalition

Brian E. McCarry, Professor and Chair, Department of Chemistry and Chemical Biology, McMaster University,

Danny Nikitopoulos, Member, GO Customer Service Advisory Committee CA, MBA, Specialist, Valuation Services, KPMG LLP

Bob Oliver, Executive Director, Pollution Probe

Murray Skinner, former President and CEO Metroland Media Group Ltd.

Jim Tovey, President of the Lakeview Ratepayers Association

Michael Warren, Chair and CEO, The Warren Group and former Chief GM TTC

Alan Wells, Chair, Rouge Park Alliance, former Provincial Development Facilitator and former CAO York Region

APPENDIX B

Option 3 (Georgetown and Lakeshore)

Estimated Capital Cost included in Study Reference Case

	Corridor Sections for Electrification	Planned Investments	Proposed 10 Year Capital Plan
Phase 1	Union Station to Airport and Lakeshore to Willowbrook	Union to Malton	~ $400M
		Georgetown South 4th track and tunnel under 401	
Phase 2	Airport to Brampton	Malton to Georgetown	~ $500M
Phase 3	Union to Oshawa	Union Station	~ $300M
		Union to Scarborough	~ $250M
		East Maintenance Facility	~ $350M
		Guildwood to Durham Jct	~ $250M
Phase 4	Willowbrook to Oakville	Mimico to Oakville	Completed in 2011
Phase 5-7	Completion of Lakeshore West, Lakeshore East and Georgetown	Georgetown to Kitchener	~ $170M
		Oshawa to Bowmanville	~ $300M