





# DRAFT Opinion of Probable Cost Assumptions Memorandum

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cc:			
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cost estimate assumptions memo v3.docx

The purpose of this memorandum is to provide documentation for the assumptions used for the calculations for the Cost Estimate proposed for the Durham Regional Transit LRTS examining LRT on Hwy 2. Exhibits of the LRT dated **November 2009** were utilized for the alignment calculations as well as a field visit conducted on **October 28, 2009**. Mainline alignment length was based on measurements using the centerline stationing on the exhibits for reference on street locations. The project is assumed to begin just west of Altona Road and continue to east of Solina Road.

The following is a list of item numbers, category description and assumptions:

## 1.0 Stations

The quantity was based on the preliminary stop locations identified and shown on the LRT Exhibits dated **November 2009**. The cost per station includes the cost of a raised concrete platform, shelter, solar lighting, benches, trash receptacles ticket vending machines, real time passenger information system, Wi-Fi service, news and ad panels, bicycle racks, handrail to protect for drop-offs, electrical conduit and pull boxes to power station / passenger amenities. Unit costs were derived from similar LRT systems.

## 2.0 Track Work and Electrification

### Track Slab (single) and (double)

The entire mainline alignment was assumed to be 'T' rail in a poured concrete track slab. Unit costs were derived from similar LRT systems.

### Turnouts / Crossings Installation

The quantity was calculated as the number of turnouts and 'T' rail crossings for the mainline alignment. Unit costs were derived from similar LRT systems.

### Catenary Poles and Overhead Wire

Includes the overhead contact wire, poles, conduit, connections and pull boxes for the entire length of the mainline alignment. The costs have been estimated using a per linear meter basis since the exact number of poles and conduit have not been determined at this time. Unit costs were derived from similar LRT systems.

### Substations

The quantity was based on typical LRT power requirements which include one substation per 1.5Km of track for the entire length of the alignment. Unit costs were derived from similar LRT systems.

### Train Signaling Equipment

The train signaling item is based on the number of LRT turnouts where the LRT transitions from double track to single track or where the LRT crosses existing freight rail lines at grade. The unit price is for each direction of the LRT, and was derived from similar systems.

## 3.0 Roadway, Structures, Traffic, Utilities and Drainage

### New Pavement / Widening

The placement of LRT in the median of Hwy 2 will require widening of the existing roadway to maintain traffic capacity. In those areas, a standard typical pavement section was proposed. The pavement section will consist of Granular B sub-base, Granular A base, Asphalt (Base Course), Asphalt (Surface Course), and tack coat between asphalt layers. Units for the base and asphalt quantities are metric tonnes, and for the sealing and tack coats quantities are square meters. The standard pavement section depths consist of 650mm Granular B, 150mm Granular A, 100 mm Asphalt (Base Course), and 50 mm Asphalt (Surface Course). Unit costs were derived from MTO cost data.

### Milling and Resurfacing Existing Pavement

Areas of the existing pavement will be disturbed by the construction of LRT and the widening areas. To rehabilitate the existing pavement and to ensure proper grading, milling and resurfacing will be completed. It is assumed that an average milling depth of 50mm. Pavement overlays will be done with 50 mm Asphalt (Surface Course). Unit costs were derived from MTO cost data.

### Structures

Several types of structures exist on the corridor including heavy rail structures over Hwy 2, roadway bridges over water, and bridge culverts conveying low stream volumes. Each structure type has its own issues and cost information. For heavy rail structures over the roadway or LRT, a unit cost of \$25,000/m<sup>2</sup> is being utilized. For roadway structures, a unit cost of \$3000/m<sup>2</sup> is being utilized. The quantity was calculated based on the reconstruction and/or modification of existing bridges which LRT would be traveling over. The cost includes modifications to the superstructure and substructure to accommodate the track slab and slope corrections. For bridge culverts, a unit cost of \$2500/m of extension is being used as a baseline due to the different sizes along the corridor. Unit costs were derived from similar LRT projects.

### Signing and Pavement Markings

It was assumed that 80 new signs would be installed every 1Km for the length of the project to get the estimated total number of signs. The unit cost for each sign was based on previous road design projects.

Pavement markings were estimated using number of stripes multiplied by the length of the project to get a total length of markings. Cost for pavement marking symbols is included as a part of the unit costs. Unit costs were derived from MTO cost data.

### Traffic Signals- New (or Full Replacement)

The following table is a list of additional traffic signals which are required to be added along the alignment. For cost estimating purposes, one additional traffic signal was added beyond those listed in the table below for each of the proposed alignments with the specific location to be determined during the preliminary engineering phase. The number of signals was provided per a field visit on **October 28, 2009**. Unit costs were derived from similar LRT projects and MTO cost data.

The following is a list of intersections that will require new signals or complete replacements:

- Altona Road
- Rougemount Road
- Rosebank Road
- Whites Road
- Hwy 401 Ramp
- Fairport Road
- Dixie Road
- Liverpool Road
- Glenanna Road
- Valley Farm Road
- Brock Road
- Bainbridge Drive
- Notion Road
- Elizabeth Street
- Church Street
- East of Rotherglen Road
- Westney Road
- Ritchie Ave/ Chapman Dr
- Harwood Ave
- Private Entrance
- Salem Road
- Audley Road

- Lake Ridge Road
- West Durham Link
- Coronation Road
- McQuay Blvd
- Cochrane Street
- Byron Street
- Brock Street
- East of Garden Street
- Anderson Street
- Bowman Road
- Thicksen Road
- Thornton Road
- Harmony Road
- Grandview Road
- Townline Road
- Prestonvale Road
- Tulls Road
- Courtice Road
- Hancock Road
- East Durham Link

#### Traffic Signals- Modified

The signalized intersections along the alignment which will require modifications are listed below. It has been assumed that one-half of the traffic signal poles at each intersection will require modifications to accommodate the catenary wire crossing through intersection. The number of signals was provided per a field visit on **October 28, 2009**. Unit costs were derived from similar LRT projects and MTO cost data.

The following is a list of intersections that will require modifications to the existing traffic signals:

- Steeplehill
- Delta Blvd
- Walnut Lane
- Rotherglen Road
- Private Entrance
- Private Entrance
- Private Entrance
- Private Entrance
- Alexander's Cross
- White Oaks Court
- Fire Station
- Euclid Street
- Hickory Street
- Garden Street
- Lupin Drive
- Glen Hill Drive
- Kathleen Street
- Garrard Road
- Stevenson Road (2-King and Bond)
- Gibbons Street (2-King and Bond)
- Park Road (2-King and Bond)
- McMillan Drive (2-King and Bond)
- Centre Street 2-King and Bond)
- Simcoe Street (2-King and Bond)
- Mary Street (2-King and Bond)
- Division Street (2-King and Bond)
- Ritson Road (2-King and Bond)
- Central Park Blvd. (2-King and Bond)
- Wilson Road (2-King and Bond)
- Farewell Street
- Keewatin Street
- Kingsway College
- Eastlawn Street
- Varcoe Road
- Centerfield Drive
- Sandringham Drive
- Solina Road

#### Utility Relocation - Allowance

The allowance for utility relocations was divided into three categories (high, medium and low) to help determine an order of magnitude cost estimate. The existing water and sanitary utilities were assumed to remain in place. Horizontal and vertical adjustments of valves and meter boxes to these utilities were considered a low impact. For one or two relocations, plus additional adjustments would be considered a medium level of impact. In some locations where a higher percentage of multiple utilities such as gas were potentially being affected, it was assumed that a rating of high should be used. Where minimal disruptions of utilities are anticipated, a low impact was assigned.

After reviewing the corridor on **October 28, 2009**, it was assumed that one half of the corridor will have medium level of impacts. The other half of the system would be divided equally between high and low impacts. Generalized utility relocation costs were derived from similar LRT / roadway projects.

#### Drainage

The drainage allowance, based on the entire length of the alignment, is for potential modifications to the existing storm water system to accommodate the roadway improvements and potential drainage requirements for the LRT. The unit cost was derived from the similar LRT systems for generalized drainage improvements associated with the proposed improvements.

#### Curb and Gutter Removal

Based on the proposed improvements, the existing curb and gutter will have to be removed in many locations. Unit costs were derived from MTO cost data.

#### Street Lighting

The street lighting, based on the entire length of the alignment, is for the lighting of the LRT and potential modifications to the existing lighting system. The unit cost was derived from previous road design projects.

#### Concrete Curb and Gutter

Proposed curb and gutter is assumed based on the concept plans and shown on the proposed typical sections. No curb separation of the LRT is proposed. Unit costs were derived from MTO cost data.

#### Sidewalk Removal

Based on the proposed improvements, the majority of the existing sidewalk will have to be removed. It was assumed that one half of the 1.5 meter sidewalk could be salvaged. Unit costs were derived from MTO cost data.

#### Concrete Sidewalk

Proposed sidewalk is assumed based on the concept plans and shown on the proposed typical sections. It is assumed that a 3.0 meter sidewalk is located on one side and a 1.5 meter sidewalk is on the other side. It was assumed that one half of the 1.5 meter sidewalk could be salvaged and is therefore not required to be replaced. Unit costs were derived from MTO cost data.

#### Earth Excavation, Grading

Grading was estimated to fill the widening areas along the roadway. Ten cubic meters per linear meter of roadway was used as a base assumption for cost purposes. Actual cut and fill will vary once survey is obtained.

#### Erosion Control

Several methods of erosion control can be used for projects depending on urban, rural settings, etc. For the purposes of this estimate a general per meter cost of \$10 was assumed.

### **4.0 Miscellaneous Costs**

#### Clearing and Grubbing

Clearing and grubbing costs have been estimated using the entire project area in hectares. Unit costs were derived from MTO cost data.

#### Property Requirements

A general amount of 20 hectares was assumed for acquisition for the proposed improvements. This includes the right-of-way necessary for the roadway improvements, stations, and maintenance and operations facility. A cost of approximately \$2.5 million per hectare has been allocated for the acquisition.

#### LRT Vehicles (includes testing, spare parts, etc.)

The quantity was estimated using 3 minute headways with an average speed of 30kph plus 10% spares. A total of 49 vehicles are anticipated.

Operations and Maintenance Facility Allowance

The cost includes the construction of the building, physical plant, machinery and storage track for the Maintenance and Operations Facility. No costs have been included for track to/from the facility locations. It was determined through conversations with DRT staff that two (2) facilities will be required to minimize operation costs due to dead head maneuvers at the beginning and end of each shift/day. Unit costs were derived from similar LRT systems.

Landscaping and Streetscaping

Estimated 4% of the construction subtotal for the landscaping and streetscaping improvements for the entire project. The percentage was derived from similar projects.

Construction Management / CEI

Construction management / CEI costs have been estimated as 4% of the construction subtotal. The percentage was derived from similar LRT systems.

Mobilization

Estimated 10% of the construction subtotal for the contractor to mobilize for the construction activities. Unit costs were derived from MTO cost data.

Maintenance of Traffic / Traffic Control

Estimated 10% of the construction subtotal for the contractor to maintain traffic during construction. Includes temporary signals, barrier walls, signing, etc. Unit costs were derived from MTO cost data.

Preliminary, Detail Design, and Vehicle Specifications

Engineering and Administration costs have been estimated as 12% of the construction subtotal. The percentage was derived from similar LRT systems.

Contingency

The contingency has been estimated as a percentage of the Construction subtotal. The percentage was derived from similar LRT systems and was estimate that 25% was an adequate contingency at this level / phase of planning.

Opinion of Probable Cost				
Durham Regional Transit LTTS				
1.0 Stations - Each				
Description	Units	Quantity	Unit Price	Total Cost
LRT Platform (Concrete)	m <sup>2</sup>	240	\$ 110	\$ 26,400
Shelter	LS	1	\$ 100,000	\$ 100,000
Handrail	m	100	\$ 150	\$ 15,000
Electrical Conduit	m	90	\$ 50	\$ 4,500
Pull Boxes	each	3	\$ 500	\$ 1,500
Passenger Amenities	LS	1	\$ 125,000	\$ 125,000
			<b>Subtotal Stations EA</b>	<b>\$ 272,400</b>
Stations	each	92	\$ 272,400	\$ 25,060,800
			<b>Total</b>	<b>\$ 26,000,000</b>
2.0 Track Work and Electrification				
Description	Units	Quantity	Unit Price	Total Cost
Single Track Slab	m	20,200	\$ 1,500	\$ 30,300,000
Double Track Slab	m	24,600	\$ 3,000	\$ 73,800,000
Turnouts / Crossings	each	1	\$ 275,000	\$ 275,000
Catenary Poles / Overhead Wire	m	34,700	\$ 1,000	\$ 34,700,000
Substations	each	23	\$ 750,000	\$ 17,340,000
Train Signaling Equipment	each	2	\$ 550,000	\$ 1,100,000
			<b>Subtotal</b>	<b>\$ 158,000,000</b>
3.0 Roadway / Structures / Traffic / Utilities / Drainage				
Description	Units	Quantity	Unit Price	Total Cost
<i>New Pavement:</i>				
Granular Base B Type 1	t	451,000	\$ 25	\$ 11,275,000
Granular Base A	t	125,000	\$ 35	\$ 4,375,000
Asphalt (Base Course)	t	94,000	\$ 110	\$ 10,340,000
Asphalt (Surface Course)	t	43,000	\$ 140	\$ 6,020,000
Tack Coat	m <sup>2</sup>	1,040,000	\$ 1	\$ 1,040,000
<i>Milling and Resurfacing:</i>				
Milling	m <sup>2</sup>	243,000	\$ 7	\$ 1,701,000
Asphalt Resurfacing	t	33,000	\$ 140	\$ 4,620,000
Tack Coat	m <sup>2</sup>	243,000	\$ 1.00	\$ 243,000
<i>Structures:</i>				
Hwy Structure Reconstruction for Rail	m <sup>2</sup>	2,700	\$ 3,000	\$ 8,100,000
Heavy Rail Structure Reconstruction	m <sup>2</sup>	600	\$ 25,000	\$ 15,000,000
Culvert Extensions	m	65	\$ 2,500	\$ 162,500
<i>Signing and Pavement Markings:</i>				
Signage	each	2,700	\$ 350	\$ 945,000
Pavement Markings Durable	m	277,000	\$ 15	\$ 4,155,000
<i>Traffic Signals:</i>				
Traffic Signals New/Full Replacement	each	42	\$ 275,000	\$ 11,550,000
Traffic Signals Upgrade	each	48	\$ 125,000	\$ 6,000,000
<i>Utility Relocation:</i>				
Utilities - High Relocation Allowance	m	8,680	\$ 5,000	\$ 43,400,000
Utilities - Medium Relocation Allowance	m	17,340	\$ 2,500	\$ 43,350,000
Utilities - Low Relocation Allowance	m	8,680	\$ 1,250	\$ 10,850,000
Drainage	m	34,700	\$ 530	\$ 18,391,000
Street Lighting	m	34,700	\$ 370	\$ 12,839,000
Curb and Gutter Removal	m	61,700	\$ 15	\$ 925,500
Concrete Curb and Gutter	m	69,400	\$ 85	\$ 5,899,000
Sidewalk Removal	m <sup>2</sup>	78,000	\$ 20	\$ 1,560,000
Concrete Sidewalk	m <sup>2</sup>	130,000	\$ 90	\$ 11,700,000
Earth Excavation, Grading	m <sup>3</sup>	340,000	\$ 20	\$ 6,800,000
Sodding	m <sup>2</sup>	140,000	\$ 10	\$ 1,400,000
Erosion Control	m	34,700	\$ 10	\$ 347,000
			<b>Subtotal</b>	<b>\$ 243,000,000</b>
			<b>Construction Subtotal</b>	<b>\$ 427,000,000</b>
4.0 Miscellaneous Costs				
Description	Units	Quantity	Unit Price	Total Cost
Clearing and Grubbing	ha	104	\$ 40,000	\$ 4,161,600
Property Requirements	ha	20	\$ 2,500,000	\$ 50,000,000
LRT Vehicles	each	49	\$ 4,500,000	\$ 220,500,000
Maintenance and Operations Facility	each	2	\$ 10,000,000	\$ 20,000,000
Landscaping and Streetscaping	LS	1	4%	\$ 17,080,000
Construction Management	LS	1	4%	\$ 17,080,000
Mobilization	LS	1	10%	\$ 42,700,000
Maintenance of Traffic / Traffic Control	LS	1	10%	\$ 42,700,000
Preliminary, Detail Design and Vehicle Specs	LS	1	12%	\$ 51,240,000
Contingency	LS	1	25%	\$ 106,750,000
			<b>Subtotal</b>	<b>\$ 573,000,000</b>
			<b>PROJECT TOTAL</b>	<b>\$ 1,000,000,000</b>