Appendix M
Railway Crossing Assessment

City of Barrie
Hewitt's Grade Separations

Issue and Revision Record					
Rev	**Date**	**Status**	**Originator** (Print) (Signature)	**Checker** (Print) (Signature)	**Approver** (Print) (Signature)
0	26.05.2017	Final	Adam Kolankowski	Robert Short	Robert Shamess
	Signatures:				

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1. Introduction & Background

The City of Barrie retained Hatch to undertake the Hewitt's Secondary Plan Area Class Environmental Assessment (EA) Study, including the feasibility of grade separation alternatives to replace level crossings along GO Transit's Barrie Rail Corridor at Lockhart Road and Mapleview Drive East. The purpose of the Schedule C Class EA is to evaluate alternative design concepts to accommodate future growth in the City of Barrie to the year 2031.

As per the City of Barrie's initial request for proposal (Technical Memorandum C8) and Hatch's ensuing response (Task 2, Clause 3.1.2; Task 3, Clause 3.1.3), this memo summarizes Hatch's assessment of alternative designs, initial cost estimates for overpass (road over rail) and underpass (road under rail) options at Lockhart Road and Mapleview Drive East, as well as our preliminary recommendations regarding constructability, structural properties, staging, and interim level crossing improvements. Current site photos are displayed in Figure 1through Figure 4.

Figure 1: Aerial view showing the existing rail crossing at Lockhart Road.

Figure 2: Looking east along Lockhart Road toward existing level crossing.

Figure 3: Aerial view showing the existing rail crossing at Mapleview Drive East.

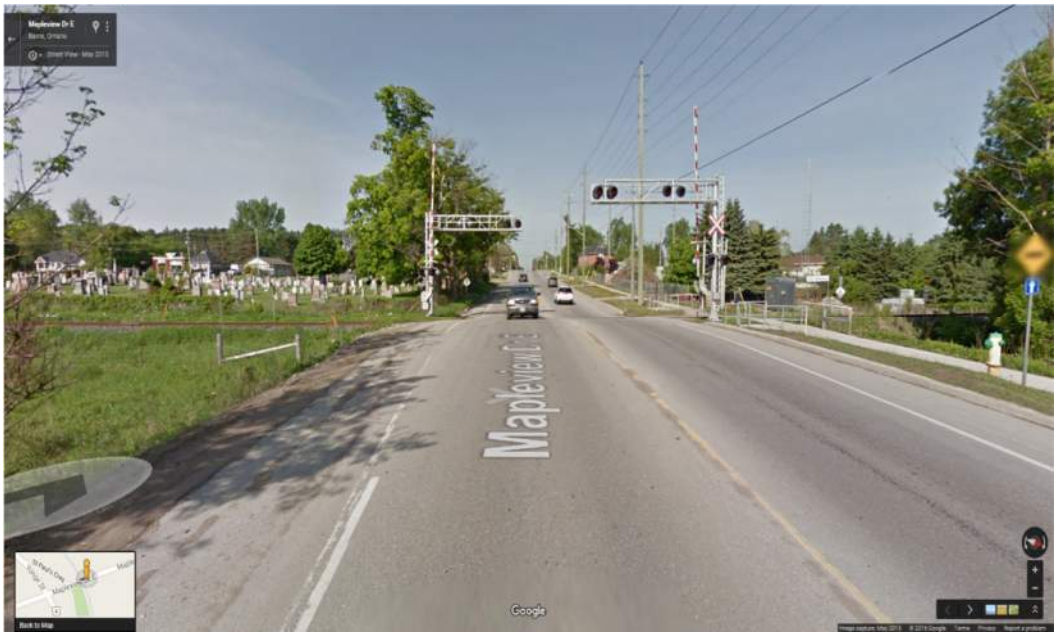


Figure 4: Looking west along Mapleview Drive East toward existing level crossing.

1.1 Grade Crossing Warrants – Lockhart Road

In the Phase 1 and 2 report undertaken for the Annexation Area the rail crossing exposure index was calculated to identify the warrant and appropriate means of providing protection for the rail crossing of Lockhart Road east of Yonge St. The analysis identified an exposure index of 181,692. Typically, exposure indexes between 50,000 and 200,000 would receive flashing lights, bells and gates for protection as a level crossing, while an index in excess of 200,000 would warrant a full grade separation. Given the proximity to 200,000 and the uncertainty at that time as to the timing of the increase in GO Transit service a recommendation was made in the MMATMP to replace the level crossing with a grade separation.

1.2 Grade Crossing Warrants – Mapleview Drive

An analysis of the level crossing exposure was undertaken during the Phase 1 and 2 components of the Annexation Lands EA. The crossing at Mapleview Drive East was found to have an exposure index of 354,396 by horizon year 2031. Typically values in excess of 200,000 are recommended for replacement with a grade separated crossing, while those less than 200,000 will have protection recommended ranging from “cross-bucks and advance warning signs” to “Flashing Lights, Bells and Gates” dependent upon the level of the exposure index.

2. Lockhart Road Grade Separation

2.1 Evaluation of Alternatives

Hatch conducted a preliminary comparative assessment of the overpass and underpass alternatives for the proposed grade separation at Lockhart Road. The advantages, disadvantages and estimated costs are presented in Table 2-1.

Table 2-1: Advantages and Disadvantages of Alternatives

Factor	Overpass Alternative	Underpass Alternative
Socio-Economic Environment	• Fill creates a visual barrier • Little anticipated effect on electrical sub-station in south-west quadrant. • Increase in projected noise due to elevated roadway. • Service road(s) and property acquisition required.	• Aesthetically pleasing • Protective measures required for electrical sub-station in south-west quadrant. • Decrease in projected noise due to sunken roadway. • Service road(s) and property acquisition required.
Natural Environment	• Simple drainage system due to elevated roadway. • Effects on wildlife and vegetation can be minimized through standard mitigation measures.	• Potentially complex drainage system due to sunken roadway. • Effects on wildlife and vegetation can be minimized through standard mitigation measures.
Transportation / Construction	• Rail operations unaffected during construction. • Detour can be accommodated within final right-of-way if bridge is constructed in stages, if road remains open. • Traffic delays reduced.	• Diversion track required to maintain rail operations during construction. • Additional land required to accommodate detour road during construction, if road remains open. • Traffic delays reduced.
Preliminary Cost Estimate	**$19 M**	**$35 M**

For the proposed grade separation at Lockhart Road, Hatch recommends an overpass, at an estimated cost of $19 M. This figure includes a 25% contingency, and accounts for the bridge and embankments only. Cost associated with elements such as road works (beyond the bridge and embankments), track works,

drainage, property acquisition, interim level crossing improvement, and temporary works must be considered separately. A conceptual general arrangement drawing and details of the initial cost estimate for are provided in Appendices A and B, respectively.

2.2 Structure Type

The overpass would be comprised of a single span of approximately 20 m (between support centrelines), assuming a rail right-of-way width of approximately 15 m, skewed approximately 24˚ with respect to the railway. The minimum clearance from the underside of the superstructure to the top of rail below is 7.5 m for an electrified track. A deck width of approximately 34 m would be required to accommodate traffic lanes, bike lanes, sidewalks, a median, curbs, barriers, and buffers, as the overpass would be designed for a service life of 75 years.

Precast concrete "I" girders, in conjunction with a composite concrete deck, would be suitable for this bridge. Further geotechnical investigation would be required before Hatch can definitively recommend a foundation configuration or span articulation. Concrete texturing, decorative railings, sleek lines, and minimization of materials are effective and economical means of achieving an aesthetically pleasing structure.

With respect to the approaches, Hatch recommends earth-fill embankments, assuming the bearing resistance of the underlying material is sufficient. The embankments would be supported laterally by retained soil system (RSS) walls, which could be faced with textured concrete panels or vegetated to suit the local environment. The embankments would also be designed for a service life of 75 years.

2.3 Staging

Hatch understands that a full closure of Lockhart Road may be permitted, in which case staging considerations would be minimal. However, if a full road closure is not desired, the bridge and embankments could be constructed in two stages to keep a portion of Lockhart Road open throughout construction. Such staging would negate temporary acquisition of additional land for a dedicated detour road, but additional costs would be incurred for support of the embankments during construction.

In any case, rail operations could continue uninterrupted during construction, with no track diversion required, although flagging would be required for work above the track, such as girder erection.

2.4 Rail Crossing Evaluation

In advance of grade separation construction, Hatch anticipates the following improvements will be required for the level crossing at Lockhart Road:

- Installation of rubber flange guards as per RTD-10 and GCS 2014 specifications.
- Ongoing brush removal to maintain sightlines.
- Upgrade of warning signals as per RTD-10 and GCS 2014 specifications.

See Appendix C for a more detailed evaluation.

3. Mapleview Drive East Grade Separation

3.1 Evaluation of Alternatives

Hatch has conducted a preliminary comparative assessment of the overpass and underpass alternatives for the proposed grade separation at Mapleview Drive East. The advantages, disadvantages and estimated costs are presented in Table 3-1.

Table 3-1: Advantages and Disadvantages of Alternatives

Factor	Overpass Alternative	Underpass Alternative
Socio-Economic Environment	• Fill creates a visual barrier, especially being next to an historic church. • Anticipated effect on cemetery in south-west quadrant (due to embankments) is small. • Increase in projected noise due to elevated roadway. • Truncation of existing routes and some property acquisition required.	• Aesthetically pleasing • Significant road offset from cemetery in south-west quadrant or intricate shoring is required to avoid encroachment. • Decrease in projected noise due to sunken roadway. • Truncation of existing routes and more substantial property acquisition required, in order to provide offset from cemetery.
Natural Environment	• Existing slope in road profile not well-suited to overpass. • Simple drainage system due to elevated roadway. • Effects on wildlife and vegetation can be minimized through standard mitigation measures.	• Existing slope in road profile well-suited to underpass. • Simple drainage system due to roadway profile. • Effects on wildlife and vegetation can be minimized through standard mitigation measures.

Factor	Overpass Alternative	Underpass Alternative
Transportation / Construction	• Access to adjacent developments would not be viable. • Volume of embankments for overpass would be greater than volume of cut for underpass. • Re-grading of Yonge Street not required. • Rail operations unaffected during construction. • Detour can be accommodated within final right-of-way if bridge is constructed in stages, if road remains open. • Traffic delays reduced.	• Access to adjacent developments would be viable. • Volume of cut for underpass would be less than volume of embankments for overpass. • Re-grading of Yonge Street required. • Diversion track required to maintain rail operations during construction. • Additional land required to accommodate detour road during construction, if road remains open. • Traffic delays reduced.
Preliminary Cost Estimate	**$21 M**	**$51 M**

For the proposed grade separation at Mapleview Drive East, Hatch recommends an underpass, at an estimated cost of $51 M. This figure includes a 25% contingency, and accounts for the bridge and embankments only. Cost associated with elements such as road works (beyond the bridge and cut), track work, drainage, property acquisition, interim level crossing improvement, and temporary works must be considered separately. A conceptual general arrangement drawing and details of the initial cost estimate for are provided in Appendices A and B, respectively.

Although an underpass would cost more (at least costs directly associated with the grade separation would be higher), potentially require more property and would create more challenges with respect to protection of the cemetery, the overriding factor is access to adjacent developments, which would not be viable with an overpass.

3.2 Structure Type

The underpass would be comprised of two 23 m spans (approximate distance between support centrelines), assuming a Mapleview Drive East right-of-way width of approximately 41 m, skewed at approximately 10° with respect to the roadway. The minimum clearance from the underside of the superstructure to the top of road below is 5.0 m. A bridge width of approximately 13 m would be required to accommodate two tracks (on a curve), trainmen's walks and concrete struts, whose purpose is to resist braking and acceleration

loads from trains. The overpass would be designed for a service life of 100 years, as it would be subjected to rail loads.

Simply-supported steel deck plate girders, in conjunction with a ballast deck, would be suitable for this bridge. Further geotechnical investigation would be required before Hatch can definitively recommend a foundation configuration. However, drilled concrete caissons would be conducive to “top-down” construction, where much of the site is excavated after the bridge is built, thereby reducing costs associated with temporary shoring. Steel coating, concrete texturing, decorative railings, sleek lines, and minimization of materials are effective and economical means of achieving an aesthetically pleasing structure.

With respect to the approaches, Hatch recommends the road cut be retained by a “U” shaped, cast-in-place concrete trench, in combination with secant piles along the north side of the right-of-way, which would also serve as temporary shoring for the excavation. The secant pile would require tie-back anchors, and would therefore not be viable along the south side of the right-of-way, as the tie-backs would encroach into the cemetery, or the zone directly below. To construct the concrete trench without temporary shoring, a significant offset (perhaps 10 to 15 m, depending on soil conditions) from the cemetery would be required to provide sufficient space for a temporary cut slope. Alternatively, construction of the concrete trench along the southern right-of-way may be feasible with more intricate shoring and staging techniques. Textured concrete and / or public art could enhance the visual appeal of the trench walls. Components of the road-cut subjected to rail loads would be designed for a service life of 100 years, while other components would be designed for a service life of 75 years.

3.3 Staging

For road traffic, a full closure of Mapleview Drive East would be preferable, given the complexity of the site. It is theoretically possible to keep Mapleview Drive East open to traffic throughout construction by building the rail bridge in four segments and the road cut in three. However, doing so would necessitate elaborate shoring, and would therefore lead to a significant increase in cost, which Hatch preliminarily estimates to be on the order of $9 million, and an extended schedule. A dedicated detour road north of the work zone is also possible, but would not be practical due to property constraints.

For rail traffic, assuming a full closure of Mapleview Drive East, construction would be staged as follows:

- Close Mapleview Drive East and re-locate utilities, as required.
- Construct bridge and walls for new track alignment.
- Construct diversion track.
- Divert rail traffic to diversion track.
- Construct bridge and walls for existing track alignment.
- Reinstate rail traffic to existing track and re-open Mapleview Drive East.
- Metrolinx to install second permanent track when ready.

3.4 Rail Crossing Evaluation

In advance of grade separation construction, Hatch anticipates the following improvements will be required for the level crossing at Mapleview Drive East:

- Installation of rubber flange guards as per RTD-10 and GCS 2014 specifications.
- Reduction of grade to 2% or less within 8 m of crossing on east approach, if practical.
- Reinstatement of “X” markings as per MUTCD Figure C1-5 on both approaches.
- Upgrade of warning signals and cantilever light units as per RTD-10 and GCS 2014 specifications.

See Appendix C for a more detailed evaluation.

4. Design Codes

The design of the proposed grade separations shall be in accordance with the latest versions of CAN/CSA S6, the MTO Structural Manual and AREMA.

5. Conclusion and Recommendations

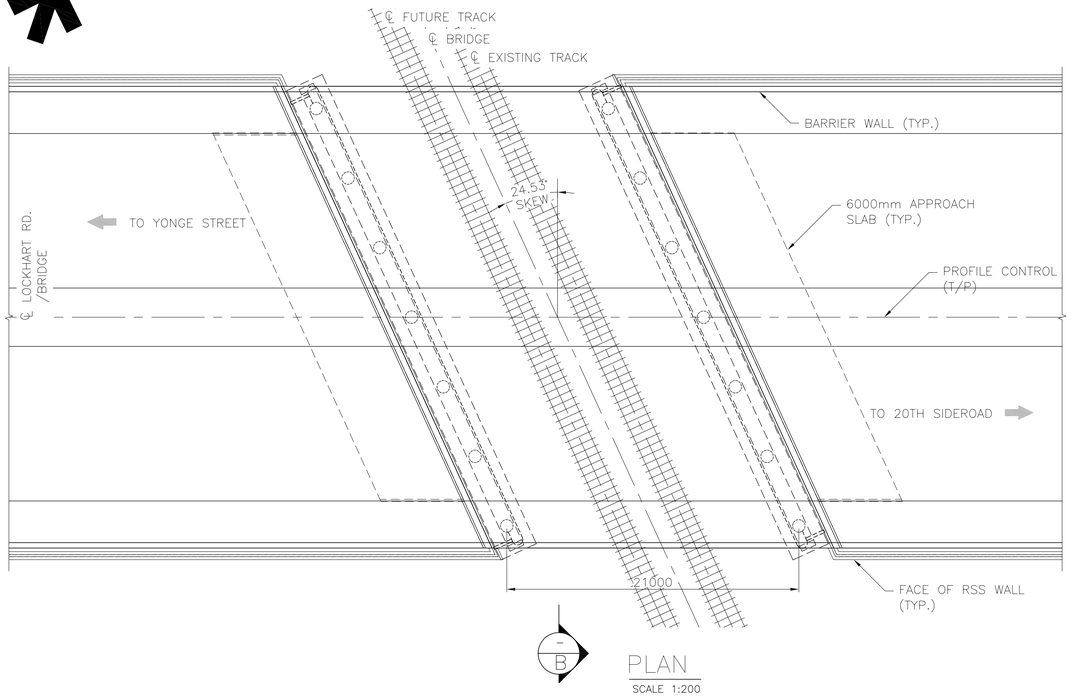
After preliminary analysis, Hatch recommends the following structures for the Hewitt’s grade separations:

- An overpass for the proposed grade separation at Lockhart Road, at a cost of $19 M.
- An underpass for the proposed grade separation at Mapleview Drive East, at a projected cost of $51 M.

Each figure includes a 25% contingency, and only accounts for costs directly associated with the grade separations. Costs associated with elements such as road works (beyond the bridge and approaches), track work, drainage, property acquisition, interim level crossing improvement, and temporary works must be considered separately. Further design, including geotechnical investigation, will be required for Hatch to provide more accurate estimates

Appendix A

Conceptual General Arrangements Drawings



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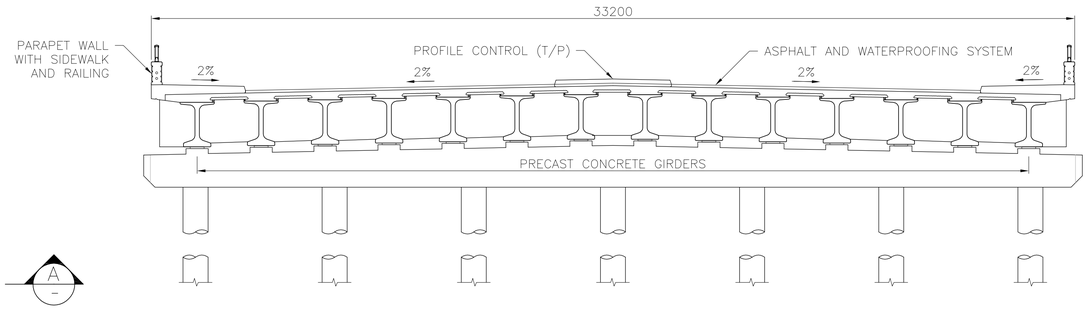

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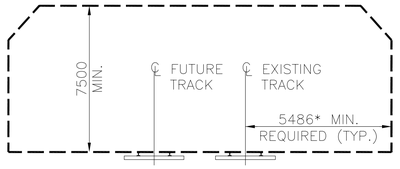

RAILWAY CLEARANCE ENVELOPE
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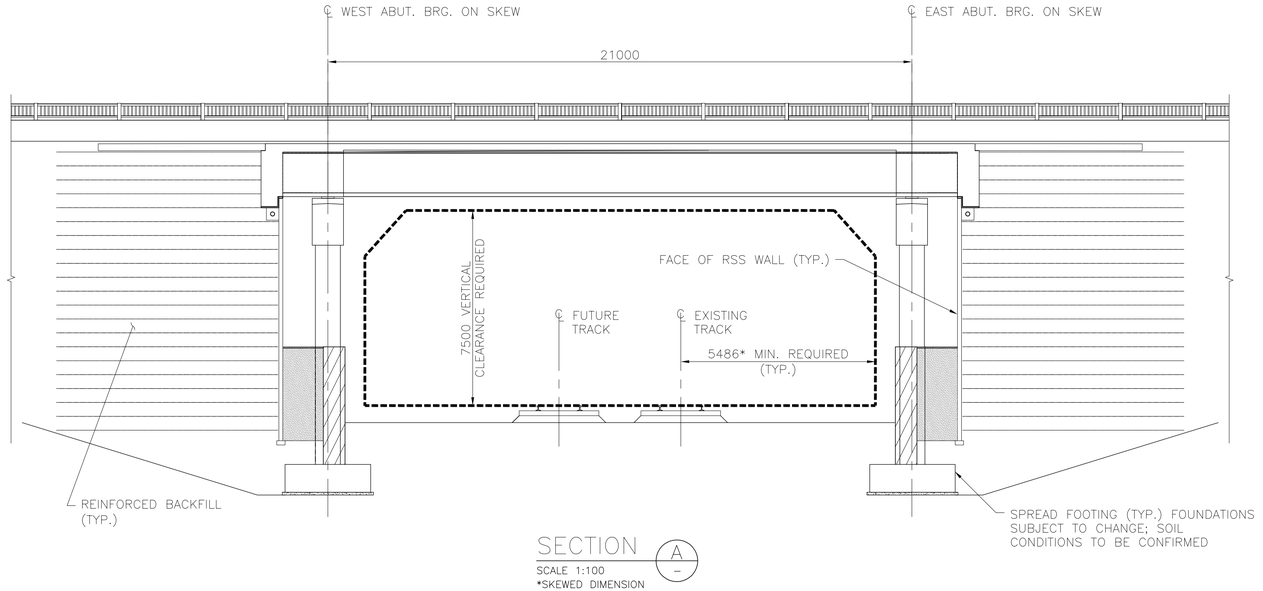

SECTION
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*SKEWED DIMENSION
A

LIST OF ABBREVIATIONS

BRG	BEARING	SB	SOUTHBOUND
BVC	BEGINNING OF VERTICAL CURVE	SHLD	SHOULDER
		STA.	STATION
DIA.	DIAMETER	T&B	TOP AND BOTTOM
EB	EASTBOUND	TLL	TOP LOWER LEVEL
ELEV.	ELEVATION	T.O.	TOP OF
EXP	EXPANSION	T/P	TOP OF PAVEMENT
IF	INSIDE FACE	T/RAIL	TOP OF RAIL
LVC	LENGTH OF VERTICAL CURVE	TUL	TOP UPPER LAYER
		THK.	THICK
LG.	LONG	TYP.	TYPICAL
MAX.	MAXIMUM	U/S	UNDERSIDE
MIN.	MINIMUM	U.N.O.	UNLESS NOTED OTHERWISE
NB	NORTHBOUND	UHPC	ULTRA HIGH PERFORMANCE CONCRETE
N.T.S.	NOT TO SCALE		
RW	RETAINING WALL	VERT.	VERTICAL
		WB	WESTBOUND
		WP	WORKING POINT

APPLICABLE STANDARD DRAWINGS

OPSD-3101.150	WALL – ABUTMENT BACKFILL MINIMUM GRANULAR REQUIREMENTS.
OPSD-3360.200	DECK LIGHT POLE BASES STRUCTURES WITH PARAPET WALLS.
OPSD-3370.100	DECK, WATERPROOFING HOT APPLIED ASPHALT MEMBRANE WITH PROTECTION BOARD.
OPSD-3370.101	DECK, WATERPROOFING HOT APPLIED ASPHALT MEMBRANE AT ACTIVE CRACKS GREATER THAN 2mm WIDE AND CONSTRUCTION JOINTS.
OPSD-3419.100	BARRIERS AND RAILINGS – STEEL GUIDE RAIL AND CHANNEL ANCHORAGE.
OPSD-3941.200	FIGURES IN CONCRETE SITE NUMBERS AND DATE LAYOUT.
OPSD-0912.430	GUIDE RAIL SYSTEM, STEEL BEAM STRUCTURAL CONNECTION.
OPSD-3102.100	WALLS ABUTMENT BACKFILL DRAIN.
OPSD-3390.100	DECK DRIP CHANNEL.
SS110-75	PARAPET WALL WITH SIDEWALK ON THE RSS WALL
SS110-98	PARAPET WALL WITH SIDEWALK ON THE BRIDGE
SS116-1	6000mm APPROACH SLAB

GENERAL NOTES
1. DESIGN CODE CAN/CSA S6-14.
2. LIVE LOAD: CL-625-ONT.

CLASS OF CONCRETE

ALL PRECAST CONCRETE	50 MPa
CONCRETE WORKING SLAB	20 MPa
REMAINDER	30 MPa

CLEAR COVER TO REINFORCEMENT

APPROACH SLAB – TOP	70±10
APPROACH SLAB – BOTTOM	40±10
FOOTINGS	100±25
REMAINDER U.N.O.	70±20

REINFORCEMENT
1. REINFORCING STEEL SHALL BE GRADE 400W UNLESS OTHERWISE SPECIFIED AND SHALL BE IN ACCORDANCE WITH CAN/CSA-G30.18-09.
2. UNLESS NOTED OTHERWISE, TENSION LAP SPLICES SHALL BE CLASS B.
3. BAR HOOKS SHALL HAVE STANDARD HOOK DIMENSIONS USING MINIMUM BEND DIAMETERS, WHILE STIRRUPS AND TIES SHALL HAVE MINIMUM HOOK DIMENSIONS. ALL HOOKS SHALL BE IN ACCORDANCE WITH THE STRUCTURAL STANDARD DRAWINGS SS12-1 UNLESS INDICATED OTHERWISE.
4. STAINLESS STEEL SHALL BE TYPE 316LN OR DUPLEX 2205 AND HAVE A MINIMUM YIELD STRENGTH OF 500MPa. BAR MARKS WITH PREFIX 'S' DENOTES STAINLESS STEEL BARS.

RSS WALLS
1. RETAINED SOIL SYSTEM WALLS SHALL HAVE THE FOLLOWING ATTRIBUTES:
   - APPLICATION: FALSE ABUTMENT AND WINGWALLS
   - PERFORMANCE: HIGH
   - APPEARANCE: HIGH

CONSTRUCTION NOTES
1. THE CONTRACTOR SHALL ESTABLISH THE BEARING SEAT ELEVATIONS BY DEDUCTING THE ACTUAL BEARING THICKNESSES FROM THE TOP OF BEARING ELEVATIONS. IF THE ACTUAL BEARING THICKNESSES ARE DIFFERENT FROM THOSE GIVEN WITH THE BEARING DESIGN DATA, THE CONTRACTOR SHALL ADJUST THE REINFORCING STEEL TO SUIT.
2. THE CONTRACTOR SHALL VERIFY ALL DIMENSIONS OF THE PROPOSED WORK AND ALL DETAILS ON SITE AND REPORT ANY DISCREPANCIES TO THE CONTRACT ADMINISTRATOR BEFORE PROCEEDING WITH THE WORK.
3. TEMPORARY EXCAVATION, SUBGRADE EXPOSURE AND PROTECTION, AND BACKFILLING SHALL CONFORM TO OPSS 902.
4. CONTRACTOR TO CONFIRM TOP OF RAIL ELEVATION.
5. TRACK PROTECTION SYSTEM SHALL BE DESIGNED BY THE CONTRACTOR IN ACCORDANCE WITH CN GUIDELINES FOR DESIGN OF RAILWAY STRUCTURES. SEE CONTRACT DOCUMENTS FOR MORE DETAILS. TRACK PROTECTION TO BE CONSTRUCTED IN STAGES TO SUIT BRIDGE CONSTRUCTION.

NOT FOR CONSTRUCTION

GENERAL NOTES

REFER TO CURRENT CITY OF BARRIE STANDARDS FOR APPLICABLE GENERAL NOTES.

NO.	REVISIONS	DATE	APPROVED
A	FOR INFORMATION	17/01/17	RS

HATCH

CITY OF BARRIE
APPROVED
DATE. . . . . .
. . . . . .
DIRECTOR OF ENGINEERING

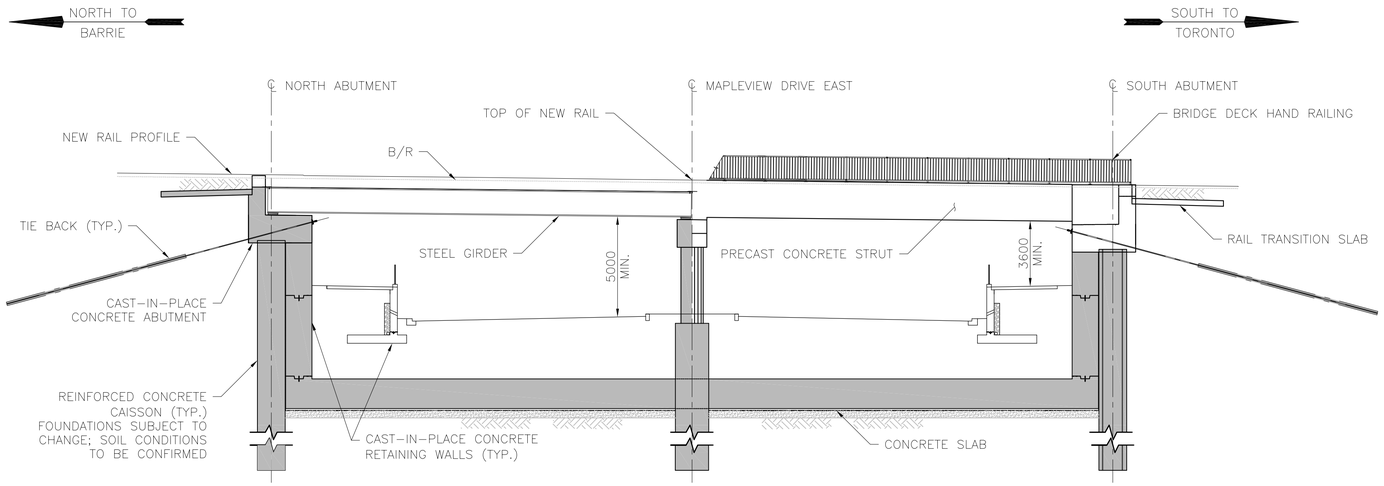
LOCKHART ROAD
WIDENING

The City of BARRIE
ENGINEERING DEPARTMENT

SCALE HOR.	AS NOTED	VERT.	AS NOTED
DESIGN	RDS	DRAWN	CP
REVIEWED	RS	DATE	17/01/17

CONTRACT NO.

SHEET NO. 1



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HALF SECTION B
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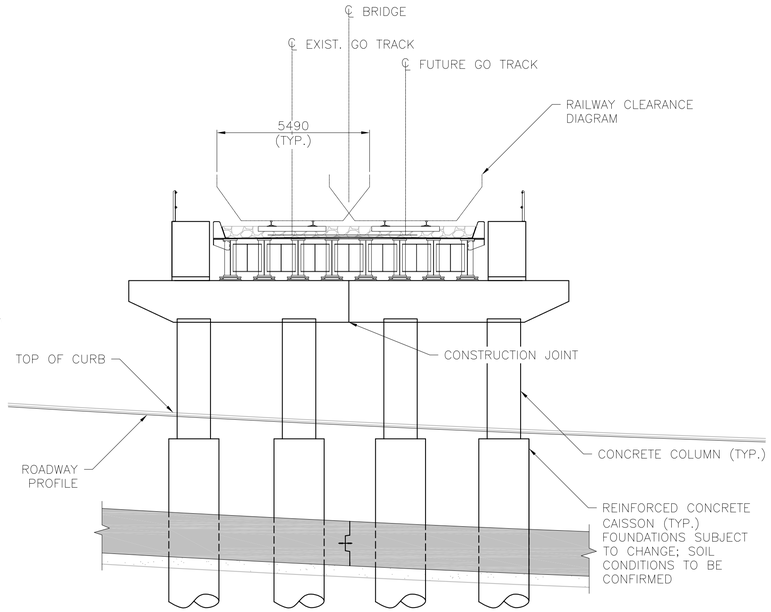
ELEVATION OF PROPOSED BRIDGE



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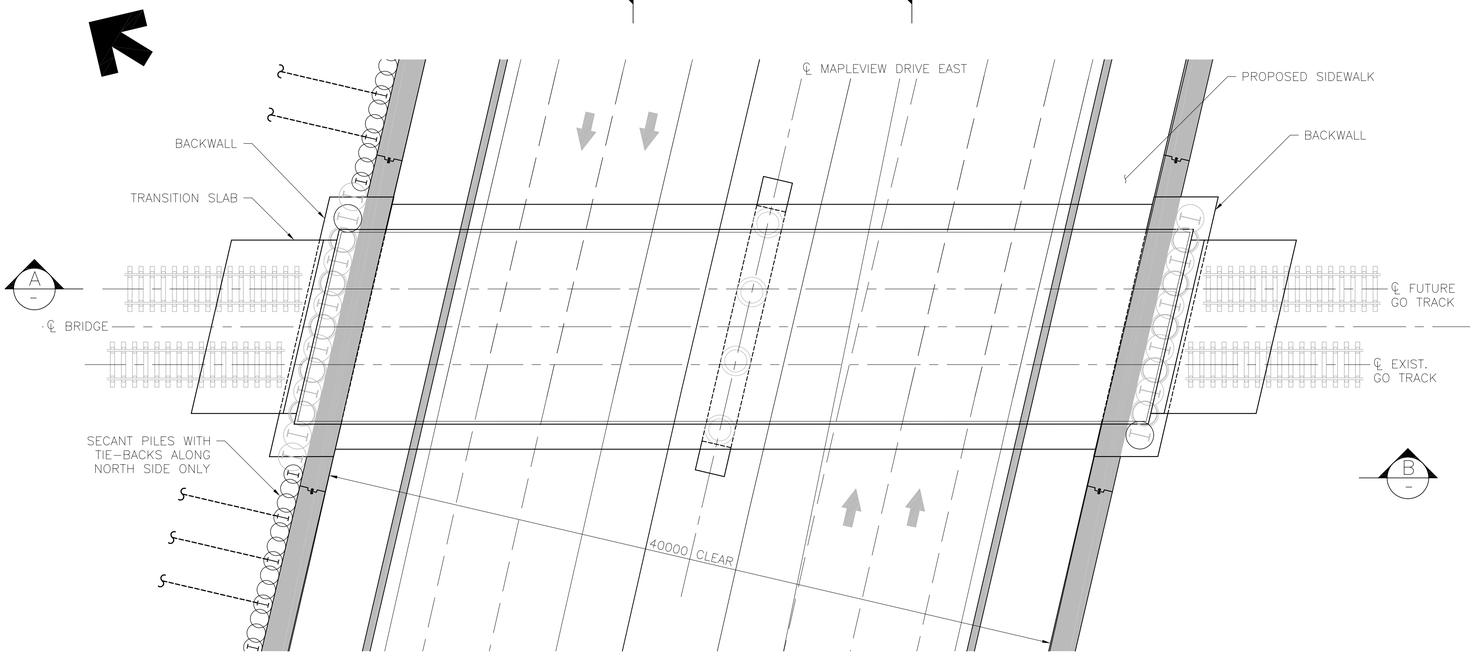
D

C



PLAN
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GENERAL NOTES:

- IT IS PROPOSED TO CONSTRUCT A NEW TWO SPAN BRIDGE SUPPORTING 2 TRACKS AND CONSISTING OF A BALLAST DECK ON STEEL BEAMS SUPPORTED BY A REINFORCED CONCRETE CAISSON PIER AND SECANT PILE WALL ABUTMENTS. IN ADDITION TO THE STEEL SPAN, PERMANENT CONCRETE STRUTS ARE PROPOSED ON EITHER SIDE OF THE BRIDGE.
- RAIL BRIDGE LIVE LOAD: COOPER E80 + DIESEL IMPACT.
- ABUTMENT, WINGWALL AND TEMPORARY SHORING DESIGN TO BE CARRIED OUT IN ACCORDANCE WITH THE LATEST EDITION OF "CN GUIDELINES FOR DESIGN OF RAILWAY STRUCTURES".
- DESIGN TO BE COMPLETED IN ACCORDANCE WITH AREMA CHAPTERS 8 AND 15, AS WELL AS "CN GUIDELINES FOR DESIGN OF RAILWAY STRUCTURES" THE MOST RECENT EDITIONS.
- NEAREST STATION: BARRIE SOUTH, NEWMARKET SUBDIVISION;

SPECIFICATIONS:

- STRUCTURAL STEEL: CAN/CSA-G40.21 GRADE 350AT OR 350WT CAT. 5 FOR WEB PLATES AND FLANGES OF MAIN GIRDERS; CAT. 3 FOR BEARING STIFFENERS AND LIFTING BEAMS; GRADE 350A OR 350W FOR DIAPHRAGMS, STIFFENERS, DECK PLATES AND ALL OTHER BRIDGE COMPONENTS; 300W FOR GALVANIZED MISCELLANEOUS STEEL.
- CONCRETE: C.S.A. CAN3-A23.1 AND A23.2-2014;
- REINFORCING STEEL: C.S.A. CAN3-G30.18-2014;
- WELDING: C.S.A. W59-03 (R2008) AND AWS D1.5;
- GALVANIZATION: A.S.T.M. A123;
- HIGH STRENGTH BOLTS: ASTM A325, M22, TYPE 3;
- ANCHOR BOLTS ASTM F1554, GRADE 105 OR EQUIVALENT.

LEGEND:

- B/R: BASE OF RAIL;
- TYP: TYPICAL

NOT FOR CONSTRUCTION

GENERAL NOTES

REFER TO CURRENT CITY OF BARRIE STANDARDS FOR APPLICABLE GENERAL NOTES.

NO.	REVISIONS	DATE	APPROVED
A	FOR INFORMATION	17/01/17	RS

HATCH

CITY OF BARRIE
APPROVED
DATE. . . . . .
. . . . . .
DIRECTOR OF ENGINEERING

MAPLEVIEW DRIVE EAST WIDENING

HURONIA ROAD TO 20TH SIDE ROAD

The City of BARRIE
ENGINEERING DEPARTMENT

SCALE HOR.	AS NOTED	VERT.	AS NOTED	CONTRACT NO.
DESIGN	RDS	DRAWN	CP	SHEET NO. 1
REVIEWED	RS	DATE	17/01/17	

Appendix B

Initial Cost Estimates

1. Lockhart Road Overpass Alternative Costs

Overpass Structure Cost per square meter			Comments
Reference Structure Cost	$ 6,120,549.00		
Reference Structure Area			
Deck Width	34.6	m	
Deck Length (incl. App. Slabs)	45	m	
Deck Area	1557	m2	
Reference Structure Overpass Cost/m2	$ 3,930.99	cost/m2	
Lockhart Overpass Area			
Deck Width	34	m	
Deck Length (incl. App. Slabs)	32	m	
Deck Area	1088	m2	
Lockhart Overpass Cost	$ 4,276,915.42		calculated multiplying area of deck by reference structure overpass cost/m2
Volume of Backfill Required			See pdf showing Area1 and Area2
Area1 - West Side of Structure			
Average Height	5.5	m	
Length	285	m	
Area	1567.5	m2	
Area2 - East Side of Structure			
Average Height	5	m	
Length	435	m	
Area	2175	m2	
Area of Backfill	3742.5	m2	
Width of Bridge	34	m	
Volume of Backfill	127245	m3	
RSS Walls Cost			
RSS Wall Unit Cost	$ 835.00	cost/m2	Estimate
RSS Wall Area	7485	m2	Area of Backfill x2
RSS Wall Cost	$ 6,249,975.00		
Road Approach Cost			
Reference Structure Road Approach Cost	$ 6,304,596.00		
Reference Structure Volume of Backfill	218025	m3	
Lockhart Volume of Backfill	127245	m3	
Average Height of RSS Wall	5	m	
Average Strap Length	4	m	
RSS Wall Volume	29940	m3	
Net Volume of Reference Structure	188085	m3	Reference Structure Volume of Backfill - RSS Wall Volume
Lockhart Road Approach Cost	$ 4,265,243.47		

Total Cost	$ 14,792,133.89
Total Cost (incl. 25% contingency)	$ 18,490,167.36

2. Lockhart Road Underpass Alternative Costs

Underpass Structure Cost per square meter			Comments
Reference Structure Cost	$ 5,697,471.66		
Reference Structure Area			
Deck Width	16	m	
Deck Length (incl. App. Slabs)	50.96	m	
Deck Area	815.36	m2	
Reference Structure Overpass Cost/m2	$ 6,987.68	cost/m2	
Lockhart Rail Structure Area			
Deck Width	13	m	
Deck Length (incl. App. Slabs)	34	m	
Deck Area	442	m2	
Lockhart Rail Structure Cost	$ 3,088,552.88		calculated multiplying area of deck by reference structure overpass cost/m2
Volume of Excavation Required			See pdf showing Area1 and Area2
Area1 - West Side of Structure			
Average Height	4.25	m	
Length	300	m	
Area	1275	m2	
Area2 - East Side of Structure			
Average Height	3.25	m	
Length	250	m	
Area	812.5	m2	
Area of Excavation	2087.5	m2	
Length of Bridge	34	m	
Volume of Excavation	70975	m3	
Excavation Cost			
Reference Structure			
Excavation Volume	116250	m3	Estimate
			Area of Backfill x2
U-Shaped Channel	$ 15,681,242		
MUE walls	$ 1,001,004.00		
SOE	$ 13,937,560.00		
Permanent Road Works	$ 8,564,439.13		
Streetlight & Traffic Signals	$ 1,760,000.00		
Total Excavation Cost	$ 40,944,245		
Lockhart Structure			
Excavation Volume	70975	m3	
Excavation Cost	$ 24,998,002.56		Determined by comparing excavation volume of Lockhart to Reference Structure

Total Cost	$ 28,086,555.44
Total Cost (incl. 25% contingency)	$ 35,108,194.30

3. Mapleview Drive East Underpass Alternative Costs

Underpass Structure Cost per square meter			Comments
Reference Structure Cost	$ 5,697,471.66		
Reference Structure Area			
Deck Width	16	m	
Deck Length (incl. App. Slabs)	50.96	m	
Deck Area	815.36	m2	
Reference Structure Overpass Cost/m2	$ 6,987.68	cost/m2	
Mapleview Rail Structure Area			
Deck Width	13	m	
Deck Length (incl. App. Slabs)	46	m	
Deck Area	598	m2	
Mapleview Rail Structure Cost	$ 4,178,630.36		calculated multiplying area of deck by reference structure overpass cost/m2
Volume of Excavation Required			See pdf showing Area1 and Area2
Area1 - West Side of Structure			
Average Height	4	m	
Length	215	m	
Area	860	m2	
Area2 - East Side of Structure			
Average Height	4.5	m	
Length	305	m	
Area	1372.5	m2	
Area of Excavation	2232.5	m2	
Length of Bridge	46	m	
Volume of Excavation	102695	m3	
Excavation Cost			
Reference Structure			
Excavation Volume	116250	m3	Estimate
			Area of Backfill x2
U-Shaped Channel	$ 15,681,242		
MUE walls	$ 1,001,004.00		
SOE	$ 13,937,560.00		
Permanent Road Works	$ 8,564,439.13		
Streetlight & Traffic Signals	$ 1,760,000.00		
Total Excavation Cost	$ 40,944,245		
Mapleview Structure			
Excavation Volume	102695	m3	
Excavation Cost	$ 36,170,058.10		Determined by comparing excavation volume of Mapleview to Reference Structure

Total Cost $ 40,348,688.46

Total Cost (incl. 25% contingency) $ 50,435,860.58

4. Mapleview Drive East Overpass Alternative Costs

Overpass Structure Cost per square meter			Comments
Reference Structure Cost	$ 6,120,549.00		
Reference Structure Area			
Deck Width	34.6	m	
Deck Length (incl. App. Slabs)	45	m	
Deck Area	1557	m2	
Reference Structure Overpass Cost/m2	$ 3,930.99	cost/m2	
Lockhart Overpass Area			
Deck Width	34	m	
Deck Length (incl. App. Slabs)	32	m	
Deck Area	1088	m2	
Lockhart Overpass Cost	$ 4,276,915.42		calculated multiplying area of deck by reference structure overpass cost/m2
Volume of Backfill Required			See pdf showing Area1 and Area2
Area1 - West Side of Structure			
Average Height	5.25	m	
Length	205	m	
Area	1076.25	m2	
Area2 - East Side of Structure			
Average Height	6.5	m	
Length	480	m	
Area	3120	m2	
Area of Backfill	4196.25	m2	
Width of Bridge	34	m	
Volume of Backfill	142673	m3	
RSS Walls Cost			
RSS Wall Unit Cost	$ 835.00	cost/m2	Estimate
RSS Wall Area	8392.5	m2	Area of Backfill x2
RSS Wall Cost	$ 7,007,737.50		
Road Approach Cost			
Reference Structure Road Approach Cost	$ 6,304,596.00		
Reference Structure Volume of Backfill	218025	m3	
Lockhart Volume of Backfill	142673	m3	
Average Height of RSS Wall	5	m	
Average Strap Length	4	m	
RSS Wall Volume	33570	m3	
Net Volume of Reference Structure	184455	m3	Reference Structure Volume of Backfill - RSS Wall Volume
Mapleview Road Approach Cost	$ 4,876,487.34		

Total Cost	$ 16,161,140.26
Total Cost (incl. 25% contingency)	$ 20,201,425.33

Appendix C

Crossing Safety Assessments

HATCH

MAPLEVIEW DRIVE CROSSING

Crossing Safety Assessment

Issue and Revision Record					
Rev	Date	Originator	Checker	Approver	Description

The safety assessment of this grade crossing covers physical features which may affect road and rail user safety and it has sought to identify potential safety hazards. However, the auditors point out that no guarantee is made that every deficiency has ben identified. Further, if all the recommendations in this assessment were addressed, this would not confirm that the crossing is 'safe'; rather, adoption of the recommendations should improve the level of safety of the facility.

1. Summary

A safety assessment of the above captioned grade crossing was undertaken on November 17, 2015.

During the assessment conditions were observed that require attention to bring the grade crossing into compliance with Canadian Railway - Roadway Grade Crossings Standards (CRRGCS):

Road Crossing Geometry, Road Geometry, Sightlines, Road Signs & Pavement Markings, & Future Area Development

2. Purpose

The Fundamental objectives of this assessment were:

1. Reduce crash risk within the grade crossing environment.
2. Minimize the frequency and severity of preventable crashes.
3. Consider the safety of all grade crossing users.
4. Verify compliance of the technical standards referred to in the Railway Safety Act/Grade crossing regulations and contained in the RTD 10 Road/Railway Grade Crossing Technical Standards and Inspection, Testing and Maintenance Requirements document.
5. Ensure that all the crash mitigation measures/factors aimed to eliminate or reduce the identified safety problems are fully considered, evaluated and documented for review/action by the appropriate authorities.

3. Methodology

The assessment team assembled for this review included:

- Andrew McNailey
- Anders Bergenwall, Engineering Intern, HMM.

During the assessment, the team was accompanied by a RailTerm maintainer.

Data on the crossing were collected in accordance with the Transport Canada Field Guide for conducting Detailed Safety Assessments. Completed field data forms from the guide are attached as Part 1. Scene photographs can be seen in Part 3.

For the purposes of this report, Mapleview Drive crossing is described in an East/West orientation, while the rail line is described in a North/South orientation. The crossing, which typically has 15 train movements daily, is equipped with an active crossing equipped with flasing lights, bell(s) and gates.

4. Recommendations

Outstanding safety issues are outlined in Part 2 along with suggested actions for remediation. Note that provisions are made in the table for recording the decision of the appropriate authorities relative to the assessment findings.

A	ROAD CROSSING			
Date:	November 17, 2015	Reason for Assessment:	Significant change in infrastructure	
Completed By:	S. Harpe			
Approved By:	V. Czarnocki			
Railway Authority:	GO Transit	Road Authority:	Simcoe County	
Subdivision/Spur:	Newmarket	Province:	Ontario	
Mileage:	59.29	Municipality:	City of Barrie	
Location Number:	Mapleview Drive	Road Name/Number:	Mapleview Drive	
Type of Grade Crossing:	Active: FLB & G	Road Classification:	Arterial	
Track Type:	Mainline	Crossing Plans Available?	Yes	

B:	COLLISION HISTORY	
Number of property damage collisions (a):		-
Number of personal injury collisions (b):		-
Number of fatal injury collisions (c):		-
Total collisions in last 5 year period (a+b+c):		N/A
Number of fatalities:		-
Number of personal injuries:		-
Details of collisions:	Information not provided by road authority	

C:	TRAIN/RAILWAY DATA		
Rail orientation:		North/South	
Number of tracks:			1
Can two trains occupy the crossing at the same time?			No
		Day	**Night**
Does switching occur?		No	No
Number of passenger trains (per day):		14	0
Number of freight trains (per day):		1	0
Total daily train traffic (per day):			15
		North	**South**
Passenger train speeds (mph):		30	60
Freight train speeds (mph):		15	50
Maximum railway operation speed "V_T" (mph):			60
Railway data comments:			

D:	ROAD DATA			
			West	**East**
Design speed (km/h):				
Posted road speed (km/h):			50	50
Max operating speed (km/h):			50	50
Surrounding land use:	Residential	Urban/Rural?	Rural	
Do dangerous goods trucks use the crossing?				No
Are there public transit stops within the vicinity of the crossing?				No
Is crossing on a school bus route?				No
Are there any schools, retirement homes, etc. nearby?				Yes
Road data comments:	Church and cemetery in SW corner. Vehicle use information not provided from road authority. Conservative assumptions made from site visit.			

Roadway illumination:	Yes
Details:	
Is vehicle parking allowed in vicinity of crossing which may obstruct sightlines?	No
Details:	
Conflicts between indications given by road and railway signs and nearby traffic signals?	No
Details:	

E: VEHICLE DATA

Design vehicle type:	Passenger car	
Design vehicle length "L" (m):		5.6
Pedestrians (per day):		100
Cyclists (per day):		30
Regular use of crossing by persons with assistive devices?:		Yes
Special vehicles (per day):		-
	AADT	**Year**
Average annual daily traffic "AADT" (vpd):	11000	2015
Forecasted AADT (vpd):	-	-
Source:	City of Barrie	
High seasonal fluctuation in volumes?		No
Vehicle data comments:	Pedestrian and cyclist traffic not provided by road authority. Conservative assumptions made from site visit.	

F: ROAD CROSSING GEOMETRY

	West	**East**
Clearance distance "cd" (m):	12.7	13.4
Vehicle travel distance "S" (m):	18.3	19
Departure time "t" (s):	4.79	4.88
Maximum approach grade within "S" (%):	3%	1%
Grade adjustment factor "G":	1.2	1.05
Additional time due to crossing conditions "K":	0	0
Design vehicle departure time "T_D" (s) (2 + t * G + K):	7.75	7.13
Measured time (s):	5.8	5.2
Do field acceleration times exceed T_D?	No	No
Pedestrian clearance distance (m):	12.7	13.4
Pedestrian, cyclist and assistive devices departure time "T_p"(s):	15.49	16.35

	West	**Crossing**	**East**
Road and grade surface materials:	Ashpalt	Ashpalt	Ashpalt
Condition:	Fair	Fair	Fair
Grade crossing surface width (m):	14	14	14
Grade crossing width consistent with approaches?	Yes	N/A	Yes
Does crossing allow road users to cross at normal speed without consequence?			Yes
Crossing geometry comments:			

	North	South
Roadway extensions beyond traveled lanes (min 0.5m):	1.8	1.8
Sidewalk present?	Yes	No
Distance from centerline of sidewalk to centerline of signal mast (m):	3.2	-
Are separate light units required for sidewalk?	No	No
Distance between travel lane and edge of sidewalk (m):	4	-
Sidewalk/ path/ trail extension beyond sidewalk (min 0.5m):	1.5	-
Sidewalk/ path/ trail crossing width (min 1.5m):	1.7	-
	Min	**Max**
Flangeway width (max 75mm):	60	80
Side grinding width (max 0mm):	0	0
Flangeway depth (min 50mm to max 75mm):	45	0
Side grinding depth (max 0mm):	0	0
Elevation of top rail above/below road surface (-7mm to 13mm):	0	0
Crossing geometry comments:		

G: ROAD GEOMETRY		
What is the *estimated* stopping sight distance "SSD" (m)	65	65
	West	**East**
Traveled portion of road on approaches (m):	400	400
Are horizontal & vertical alignments smooth and continuous throughout SSD?	Yes	Yes
Is horizontal alignment straight beyond rails for a distance equal to design vehicle length "L"?	Yes	Yes
	West	**East**
What is the slope within 5m of the nearest rail? (max 1%)	4%	-6%
What is the slope within 8m of the nearest rail? (max 2%)	3%	-5%
What is the slope between 8m and 18m of the nearest rail? (max 5-10%)	-3%	1%
What is the general approach grade?	-1%	1%
Are rail tracks super-elevated?		Yes
Would "low bed" trucks have difficulty using the crossing?		No
What is the angle between the crossing and the roadway? (30° -150°)		78
Road geomtery comments:	Undulating to accommodate super elevation. Approach grades obtained from LiDAR survey	

H: QUEUING POTENTIAL		
	West	**East**
Distance "D" from stop sign (min 30m):	80	-
Distance "D" from traffic signal (min 60m):	200	-
Is 'D' insufficient such that road vehicles might queue onto the tracks?	No	N/A
Are there pedestrian crossings that may cause vehicles to queue onto tracks?	No	N/A
Can traffic queue from adjacent intersection to within 2.4m of nearest track?	No	N/A
Can traffic queue from crossing into adjacent intersections?	No	N/A
Queuing comments:	Graveyard entrance 8m from rail	

I: SIGHTLINES		
SSD	**West**	**East**
SSD *calculated* (assumed wet pavement and max down slope) (m):	66	69
SSD actual (m):	400	400
D_{SSD}	**West**	**East**
Max railway operating speed "V_T"	60	60
T_{SSD}	10	10
D_{SSD} *minimum (m):*	269	269
Distance to driver's left (m):	-	-
Distance to driver's right (m):	-	-
$D_{STOPPED}$	**West**	**East**
Vehicle departure time "T_D"(s):	7.75	7.13
$D_{STOPPED}$ *minimum (m):*	209	192
Distance to driver's left (m):	140	400
Distance to driver's right (m):	275	400
Ped./Cyclist $D_{STOPPED}$	**West**	**East**
Pedestrian, cyclist and assistive devices departure Time "T_p"(s):	15.49	16.35
Ped./Cyclist $D_{STOPPED}$ *minimum (m):*	417	440
Distance to pedestrian's left (m):	200	400
Distance To pedestrian's right (m):	300	400
Are minimum sightlines met?	No	No
Road Right of Way (ROW):	**West**	**East**
Are sightlines within **road** ROW clear of vegetation within 15m of crossing?	Yes	Yes
Can sightlines be maintained on an ongoing basis? (snow)	Yes	Yes
Obstacles in sight triangles (except traffic signs/utility poles) that affect visibility?	Yes	Yes
Are there special considerations for large trucks	No	No
Is there sufficient visibility at all pedestrian crossing points?	Yes	Yes
Rail Right of Way (ROW):	**North**	**South**
Are sightlines within **rail** ROW clear of vegetation within 30m of crossing?	Yes	Yes
Can sightlines be maintained on an ongoing basis? (snow)	Yes	Yes
Is there a clear view along the railway right of way?	Yes	Yes
Is visibility along track impaired due to the angle of crossing?	Yes	Yes
Sightline comments:	Crossing in curve	

K: TRAIN ILLUMINATION		
Flood lighting is required if **all** of the following exist:	**Not Required**	
Unrestricted grade crossing:		Yes
Road Speed Limit > or = 50km/h		Yes
No grade crossing warning system or traffic signal is present		No
Equipment is routinely on rails after dark, either stopped or traveling at 15mph		No
	West	**East**
Are luminaires present?	N/A	N/A
Illumination comments:		

J: ROAD SIGNS AND PAVEMENT MARKINGS *Manual of Uniform Traffic Control Devices For Canada (Except "Maximum Speed Sign" - Ontario Traffic Manual)*		
RAILWAY CROSSING SIGN	**West**	**East**
Sign Required?	Yes	Yes
Distance from nearest rail (m):	6	6
Height (m):	4.08	3.88
Distance from edge of road (m):	1.5	1.5
Retroreflective material on back of crossing sign?	N/A	N/A
Retroreflective material on front and back of post?	N/A	N/A
Are there number of track Signs (RA-6)?	N/A	N/A
DO NOT STOP ON TRACK	**West**	**East**
Sign required?	No	No
Does queued traffic encroach closer than 5m from cossing surface?	N/A	N/A
Condition:	N/A	N/A
RAILWAY CROSSING AHEAD (WA 18-20)	**West**	**East**
Sign required?	Yes	Yes
Is this an urban area that does not require an WA-18 sign?	No	No
Distance from crossing (m):	134	140
Symbol orientation correct?	Yes	Yes
Condition:	Fair	Fair
PREPARE TO STOP AT RAILWAY CROSSING (WB-6)	**West**	**East**
Sign required?	No	No
Are any front light units obscured within minimum approach distances?	No	No
Do environmental conditions frequently obscure signal visibility?	No	No
Does sign flash during operation of grade crossing warning system?	N/A	N/A
What Is the distance from the sign to 2.4 m beyond the furthest rail?	N/A	N/A
Does flash precede crossing warning system by time required to clear crossing?	N/A	N/A
What is the distance from the sign to the closest gate?	N/A	N/A
Does flash precede gate desent by time required to clear closest gate?	N/A	N/A
What Is time required for all queued vehicles to reach road operating speed?	N/A	N/A
Condition:	N/A	N/A
ADVISORY SPEED SIGN *(Used with WA 18-20 if reduced speeds necessary)*	**West**	**East**
Sign required?	N/A	N/A
Posted speed (km/h):	N/A	N/A
Condition:	N/A	N/A
STOP SIGN (RA-1)	**West**	**East**
Sign required?	No	No
Sign mounted on same post as Railway Crossing Sign?	N/A	N/A
Condition:	N/A	N/A
Signage comments:		

STOP SIGN AHEAD	**West**	**East**
Sign required?	No	No
Distance from nearest rail (m):	N/A	N/A
Condition:	N/A	N/A
MAXIMUM SPEED SIGN (RB-1)	**West**	**East**
Sign required?	No	No
Condition:	N/A	Fair
Posted speed (km/h):	50	50
EMERGENCY NOTIFICATION SIGN *(on each approach, or parallel to roadway)*	**West**	**East**
Contains location and railway company's emergency contact number?	Yes	Yes
Condition:	Fair	Fair
Signage comments:		
PAVEMENT MARKINGS	**West**	**East**
Are pavement markings consistent with the MUTCD Manual?	No	No
Are there lines to delineate sidewalks / paths?	Yes	Yes
"X" MARKINGS	**West**	**East**
Markings required?	Yes	Yes
Actual distance to rail (m):	130	130
Condition:	Poor	Poor
"NO PASSING" LINES	**West**	**East**
Markings required?	Yes	Yes
Actual distance to rail (m):	130	120
Condition:	Fair	Fair
"STOP" BARS	**West**	**East**
Markings required?	Yes	Yes
Req'd distance to rail (m):	5	5
Actual distance to rail (m):	8	9
Condition:	Fair	Fair
Markings comments:		
Other Distractions:	**West**	**East**
Intersections on road approaches:	N/A	N/A
Merging traffic lanes or driveways:	N/A	N/A
Vehicle parking:	N/A	N/A
Bus stops:	N/A	N/A
Highway or commercial signs:	N/A	N/A
Light intensity:	N/A	N/A
Traffic control:	N/A	N/A
Sunlight:	N/A	N/A
Other signage:	N/A	N/A
Other:	N/A	N/A
Distraction comments:		

L: WARNING SYSTEM WARRANTS		
Warning System Requirements:	**Required**	
A cross product = or > 1000?	165000	Yes
Max rail operating speed = or > 50mph?	60	Yes
Obscured sightlines?		Yes
More than two tracks where trains can Pass each other?		No
At least one of the proximity Conditions from "K" met?		No
Gate Requirements:	**Required**	
A cross product = or > 50,000?	165000	Yes
Max rail operating speed = or > 50mph?	60	Yes
Obscured sightlines?		Yes
More than two tracks where trains can Pass each other?		No
At least one of the proximity Conditions from "K" met?		No

M: WARNING SYSTEM		
Signal Mast Equipment:	**Northeast**	**Southwest**
Bells:	N/A	N/A
Gates:	N/A	N/A
Light units:	N/A	N/A
Cantilever units:	N/A	N/A
Warning Signals:	**Northeast**	**Southwest**
Top of warning signal foundation to ground level (max 100mm):	50	220
Height from road to bottom of signal (2.3m to 2.9m):	2.64	2.88
Distance from bottom of signal to # of tracks sign (125mm to 175mm):	-	-
Distance from top of signal to railway crossing sign (125mm to 175mm):	92	92
Distance from signal center to edge (305mm):	240	240
Distance from signal center to center of mast (380mm):	-	-
Flashing Light Units:	**Northeast**	**Southwest**
Minimum distance to primary light units (m):	65	65
Recomended distance to primary light units (m):	125	125
Actual distance to primary light units (m):	200	200
Are flashing lights within 5 degrees horizontally of road through approach?	Yes	Yes
Does horizontal/vertical curvature neccessitate supplemental units?	No	No
Are lights obscured by vehicles stopped on adjacent intersections?	No	No
Are additional lights required for vehicles turning onto approach from side street?	No	No
Can back lights be seen by all stopped drivers?	Yes	Yes
Cantilever Light Units:	**West**	**East**
Cantilever required?	Yes	Yes
Does D_R exceed 7.7m?	Yes	Yes
Does D_L exceed 8.7m?	N/A	N/A
Height from road to bottom of light (5.2m to 6.0m):	6	6.18
Condition:	Fair	Fair
Multiple Lanes:	**West**	**East**
Can front light units be seen by drivers in all lanes?	Yes	Yes
Can back light units be seen by all stopped drives in all lanes?	Yes	Yes
Warning System Comments:		

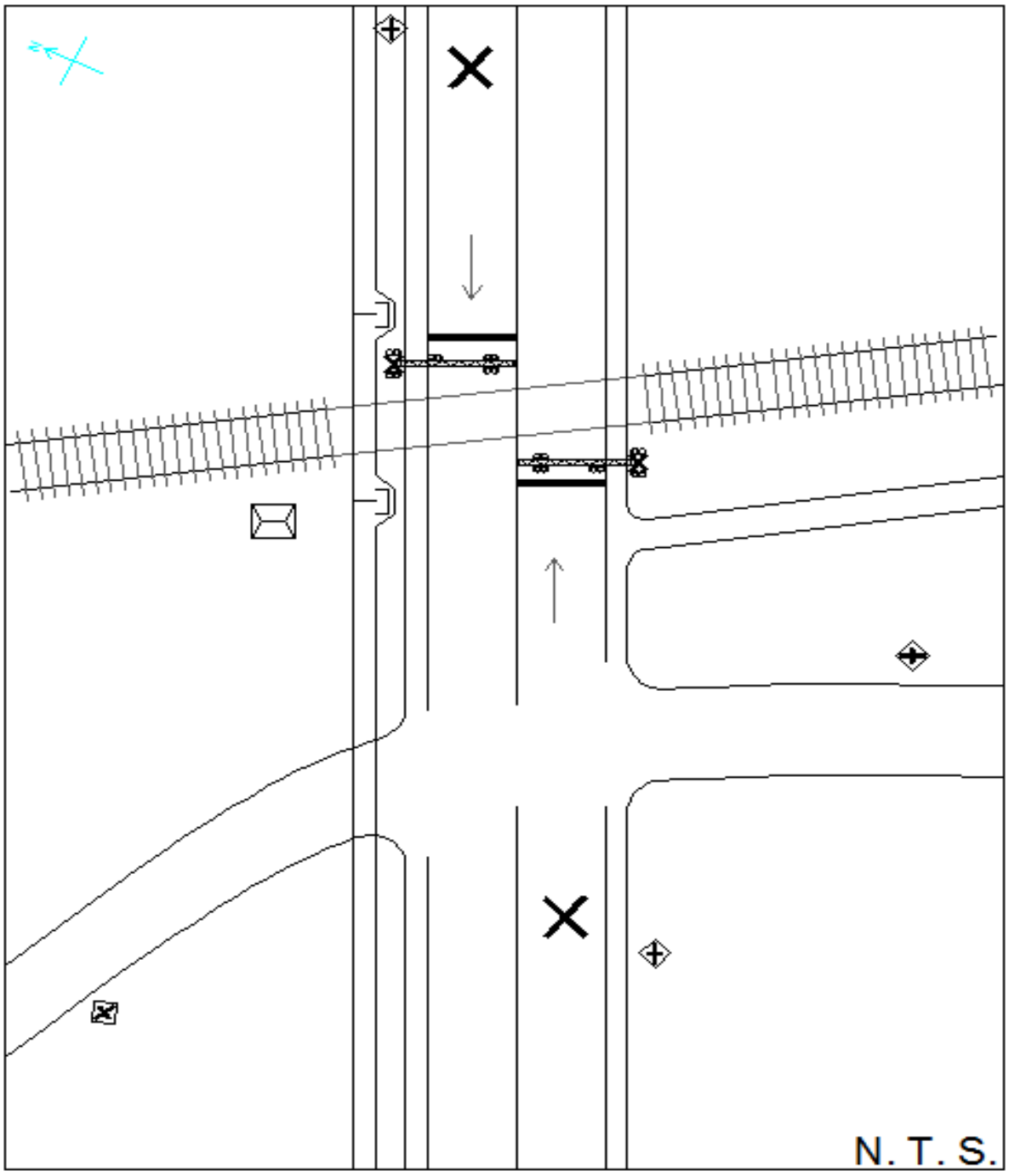
Gates:	Northeast	Southwest
Gate controller box protrusion from mast (max 650mm):	-	-
Distance from gate tip to first light (490mm to 1900mm):	440	460
Distance between first light and last light along arm (min 2.74m):	5.72	5.81
Distance from center of mast to tip of gate (max 11.6m):	8.46	8.98
Height from road to bottom of lowered gate (1.1m to 1.4m):	1.15	1.16
Space between gate lights evenly spaced?	Yes	Yes
Raised gate protrudes outside of mast signal before a height of 5.2m?	No	No
Calculated gate arm clearance times (s):	6	6
Calculated gate arm delay time (s):	7	7
Measured gate arm delay time (s):	8	8
Measured gate arm descent time (s):	11	11
Measured gate arm down time until train arrival (s):	-	-
Measured gate arm ascent time (s):	5	5
Gate arms ascend and descend smoothly and continuously?	-	-
Signal Housing:		
Distance from housing to nearest rail (min 8m):		6
Distance from housing to edge of road (min 9m):		15
Warning System Comments:		

N: PREEMPTION OF TRAFFIC SIGNALS	West	East
Is preemption required?	No	No
Distance "D" from traffic signal (min 60m):	200	-
Are there known issues of queuing?	No	No
Date of last preemption check:	N/A	N/A
Preemption has enough time to clear traffic from crossing before train arrives?	N/A	N/A
Preemption prohibits traffic from moving through intersection towards crossing?	N/A	N/A
Preemption accommodates pedestrians?	N/A	N/A
Have longer and slower vehicles been considered?	N/A	N/A
Are additional signs required (no right on red, etc.)?	N/A	N/A
Preemption comments:		

O: AREAS WITHOUT TRAIN WHISTLING	
Is train whistling prohibited at this crossing?	Yes
Evidence of unauthorized access (trespassing) on rail line in area of crossing?	No
Train whistle comments:	

P:	COMMENTS AND RECOMMENDATIONS
-Road undulation has been designed to accommodate rail super-elevation. It does not meet transport Canada Standards but appears to be a good design for the location. - Passenger terminal to the north of the crossing - Flangeway not in compliance - Approach grades exceed standards - X markings should be repainted - Warning signals not in compliance - Cantilever Light Units not in compliance	

Q:	SITE SKETCH



Hatch Infastructure Findings			Client Response	
Observations		Suggested Action	Agree YES/NO	Comments
1.00	**ROAD CROSSING GEOMETRY**			
1.01	Flangeway not in compliance with RTD-10 Figure 6-2	Rubber flange guards to be installed to meet specification as outlined in RTD-10 and GCS 2014. Where conflict exists, GCS 2014 should be used as latest standard.		
2.00	**ROAD GEOMETRY**			
2.01	Approach grades too steep and may cause difficulty for crossing vehicles	Road authority to fix grade within 8m of crossing on East approach to a maximum of 2% grade. Opportunity for improvement may be limited due to rail super-elevation		
3.00	**QUEUING POTENTIAL**			
	No issues observed during assessment.			
4.00	**SIGHTLINES**			
	No issues observed during assessment.			
5.00	**ROAD SIGNS & PAVEMENT MARKINGS**			
5.01	'X' markings in poor condition on both approaches	Road authority to repaint 'X' markings in compliance with MUTCD Figure C1-5 on both approaches		
6.00	**WARNING SYSTEM**			
6.01	Warning Signals not in compliance with RTD-10 Figure 18-1 & 18-2	Signals to be installed in accordance to RTD-10, and GCS 2014. Where conflict arises, GCS 2014 to be used as latest standard.		
6.02	Cantilever Light Units not in compliance with RTD-10 Figure 13-2	Signals to be installed in accordance to RTD-10, and GCS 2014. Where conflict arises, GCS 2014 to be used as latest standard.		

Hatch Infastructure Findings			Client Response	
Observations		Suggested Action	Agree YES/NO	Comments
7.00	**PREEMPTION, WHISTLE BLOWING, & TRAIN ILLUMNINATION**			
	No issues observed during assessment.			
8.00	**MISCELLANEOUS**			
8.01	Missing road authority information	Due to deficiencies in the reports from local road authority, not all information was available at time of report. Observations and estimates were made on site, but given limited time frames and road related equipment, information was not all available. It is recommended that the road authority provides full traffic assessment prior to implementing additional rails through this crossing.		

Site Photos

Facing North

Facing South

Facing East

Facing West

West of Track - Driver Left

West of Track - Driver Right

East of Track - Driver Left

East of Track - Driver Right

HATCH

LOCKHART ROAD CROSSING

Crossing Safety Assessment

Issue and Revision Record					
Rev	Date	Originator	Checker	Approver	Description

The safety assessment of this grade crossing covers physical features which may affect road and rail user safety and it has sought to identify potential safety hazards. However, the auditors point out that no guarantee is made that every deficiency has ben identified. Further, if all the recommendations in this assessment were addressed, this would not confirm that the crossing is 'safe'; rather, adoption of the recommendations should improve the level of safety of the facility.

1. Summary

A safety assessment of the above captioned grade crossing was undertaken on November 17, 2015.

During the assessment conditions were observed that require attention to bring the grade crossing into compliance with Canadian Railway - Roadway Grade Crossings Standards (CRRGCS):

Road Crossing Geometry, Road Geometry, Sightlines, Road Signs & Pavement Markings, & Future Area Development

2. Purpose

The Fundamental objectives of this assessment were:

1. Reduce crash risk within the grade crossing environment.
2. Minimize the frequency and severity of preventable crashes.
3. Consider the safety of all grade crossing users.
4. Verify compliance of the technical standards referred to in the Railway Safety Act/Grade crossing regulations and contained in the RTD 10 Road/Railway Grade Crossing Technical Standards and Inspection, Testing and Maintenance Requirements document.
5. Ensure that all the crash mitigation measures/factors aimed to eliminate or reduce the identified safety problems are fully considered, evaluated and documented for review/action by the appropriate authorities.

3. Methodology

The assessment team assembled for this review included:

- Andrew McNailey
- Anders Bergenwall, Engineering Intern, HMM.

During the assessment, the team was accompanied by a RailTerm maintainer.

Data on the crossing were collected in accordance with the Transport Canada Field Guide for conducting Detailed Safety Assessments. Completed field data forms from the guide are attached as Part 1. Scene photographs can be seen in Part 3.

For the purposes of this report, Lockhart Road crossing is described in an East/West orientation, while the rail line is described in a North/South orientation. The crossing, which typically has 15 train movements daily, is equipped with an active crossing equipped with flasing lights, bell(s) and gates.

4. Recommendations

Outstanding safety issues are outlined in Part 2 along with suggested actions for remediation. Note that provisions are made in the table for recording the decision of the appropriate authorities relative to the assessment findings.

A	ROAD CROSSING			
Date:	November 17, 2015	Reason for Assessment:	Significant change in infrastructure	
Completed By:	S. Harpe			
Approved By:	V. Czarnocki			
Railway Authority:	GO Transit	Road Authority:	Simcoe County	
Subdivision/Spur:	Newmarket	Province:	Ontario	
Mileage:	58.47	Municipality:	Town of Innisfil	
Location Number:	Lockhart Road	Road Name/Number:	Lockhart Road	
Type of Grade Crossing:	Active: FLB & G	Road Classification:	Collector	
Track Type:	Mainline	Crossing Plans Available?	Yes	

B:	COLLISION HISTORY	
Number of property damage collisions (a):		-
Number of personal injury collisions (b):		-
Number of fatal injury collisions (c):		-
Total collisions in last 5 year period (a+b+c):		N/A
Number of fatalities:		-
Number of personal injuries:		-
Details of collisions:	Information not provided by road authority	

C:	TRAIN/RAILWAY DATA		
Rail orientation:		North/South	
Number of tracks:			1
Can two trains occupy the crossing at the same time?			No
		Day	**Night**
Does switching occur?		No	No
Number of passenger trains (per day):		14	0
Number of freight trains (per day):		1	0
Total daily train traffic (per day):			15
		North	**South**
Passenger train speeds (mph):		80	80
Freight train speeds (mph):		60	60
Maximum railway operation speed "V_T" (mph):			80
Railway data comments:			

D:	ROAD DATA			
			West	**East**
Design speed (km/h):				
Posted road speed (km/h):			60	60
Max operating speed (km/h):			60	60
Surrounding land use:	Farm	Urban/Rural?	Rural	
Do dangerous goods trucks use the crossing?				
Are there public transit stops within the vicinity of the crossing?				No
Is crossing on a school bus route?				Yes
Are there any schools, retirement homes, etc. nearby?				No
Road data comments:	Vehicle use information not provided from road authority. Conservative assumptions made from site visit.			

Roadway illumination:	No
Details:	
Is vehicle parking allowed in vicinity of crossing which may obstruct sightlines?	No
Details:	
Conflicts between indications given by road and railway signs and nearby traffic signals?	No
Details:	

E: VEHICLE DATA

Design vehicle type:			WB-20 tractor-semitrailers
Design vehicle length "L" (m):			22.7
Pedestrians (per day):			30
Cyclists (per day):			10
Regular use of crossing by persons with assistive devices?:			No
Special vehicles (per day):			-
		AADT	**Year**
Average annual daily traffic "AADT" (vpd):		4000	2015
Forecasted AADT (vpd):		-	-
Source:	Town of Innisfil		
High seasonal fluctuation in volumes?			
Vehicle data comments:	Pedestrian and cyclist traffic not provided by road authority. Conservative assumptions made from site visit.		

F: ROAD CROSSING GEOMETRY

		West	**East**
Clearance distance "cd" (m):		10.4	10.4
Vehicle travel distance "S" (m):		33.1	33.1
Departure time "t" (s):		11.39	11.39
Maximum approach grade within "S" (%):		1%	1%
Grade adjustment factor "G":		1	1.1
Additional time due to crossing conditions "K":		0	0
Design vehicle departure time "T_D" (s) (2 + t * G + K):		13.39	14.53
Measured time (s):	School Bus	5	6
Do field acceleration times exceed T_D?		No	No
Pedestrian clearance distance (m):		10.4	10.4
Pedestrian, cyclist and assistive devices departure time "T_p"(s):		12.69	12.69

	West	**Crossing**	**East**
Road and grade surface materials:	Ashpalt	Ashpalt	Ashpalt
Condition:	Fair	Fair	Fair
Grade crossing surface width (m):	7	7	7
Grade crossing width consistent with approaches?	Yes	N/A	Yes

Does crossing allow road user's to cross at normal speed without consequence?	Yes
Crossing geometry comments:	

	North	South
Roadway extensions beyond traveled lanes (min 0.5m):	2	2
Sidewalk present?	No	No
Distance from centerline of sidewalk to centerline of signal mast (m):	-	-
Are separate light units required for sidewalk?	No	No
Distance between travel lane and edge of sidewalk (m):	-	-
Sidewalk/ path/ trail extension beyond sidewalk (min 0.5m):	-	-
Sidewalk/ path/ trail crossing width (min 1.5m):	-	-
	Min	**Max**
Flangeway width (max 100mm):	60	80
Side grinding width (max 0mm):	0	0
Flangeway depth (min 50mm to max 75mm):	45	45
Side grinding depth (max 0mm):	0	0
Elevation of top rail above/below road surface (-25mm to 25mm):	0	0
Crossing geometry comments:		
G: ROAD GEOMETRY		
What is the *estimated* stopping sight distance "SSD" (m)	130	130
	West	**East**
Traveled portion of road on approaches (m):	>500	>500
Are horizontal & vertical alignments smooth and continuous throughout SSD?	Yes	Yes
Is horizontal alignment straight beyond rails for a distance equal to design vehicle length "L"?	Yes	Yes
	West	**East**
What is the slope within 5m of the nearest rail? (max 2%)	-1%	1%
What is the slope within 8m of the nearest rail? (max 2%)	1%	1%
What is the slope between 8m and 18m of the nearest rail? (max 5-10%)	0%	1%
What is the general approach grade?	0%	1%
Are rail tracks super-elevated?		No
Would "low bed" trucks have difficulty using the crossing?		No
What is the angle between the crossing and the roadway? (30° -150°)		66
Road geomtery comments:	Approach grades obtained from LiDAR survey	
H: QUEUING POTENTIAL		
	West	**East**
Distance "D" from stop sign (min 30m):	-	-
Distance "D" from traffic signal (min 60m):	-	-
Is 'D' insufficient such that road vehicles might queue onto the tracks?	No	No
Are there pedestrian crossings that may cause vehicles to queue onto tracks?	No	No
Can traffic queue from adjacent intersection to within 2.4m of nearest track?	No	Yes
Can traffic queue from crossing into adjacent intersections?	No	Yes
Queuing comments:		

I: SIGHTLINES		
SSD	**West**	**East**
SSD *calculated* (assumed wet pavement and max down slope) (m):	86	84
SSD actual (m):	300	230
D_{SSD}	**West**	**East**
Max railway operating speed "V_T"	80	80
T_{SSD}	10	10
D_{SSD} *minimum (m):*	359	359
Distance to driver's left (m):	-	-
Distance to driver's right (m):	-	-
$D_{STOPPED}$	**West**	**East**
Vehicle departure time "T_D"(s):	13.39	14.53
$D_{STOPPED}$ *minimum (m):*	480	521
Distance to driver's left (m):	310	320
Distance to driver's right (m):	320	140
Ped./Cyclist $D_{STOPPED}$	**West**	**East**
Pedestrian, cyclist and assistive devices departure Time "T_p"(s):	12.69	12.69
Ped./Cyclist $D_{STOPPED}$ *minimum (m):*	455	455
Distance to pedestrian's left (m):	310	320
Distance To pedestrian's right (m):	320	140
Are minimum sightlines met?	No	No
Road Right of Way (ROW):	**West**	**East**
Are sightlines within **road** ROW clear of vegetation within 15m of crossing?	Yes	Yes
Can sightlines be maintained on an ongoing basis? (snow)	Yes	Yes
Obstacles in sight triangles (except traffic signs/utility poles) that affect visibility?	No	No
Are there special considerations for large trucks	No	No
Is there sufficient visibility at all pedestrian crossing points?	N/A	N/A
Rail Right of Way (ROW):	**North**	**South**
Are sightlines within **rail** ROW clear of vegetation within 30m of crossing?	Yes	Yes
Can sightlines be maintained on an ongoing basis? (snow)	Yes	Yes
Is there a clear view along the railway right of way?	Yes	Yes
Is visibility along track impaired due to the angle of crossing?	No	No
Sightline comments:	Curve to north limits sightline. Valley to East limits sightline - uphill to crossing equipped with gates negates the need for alterations	

K: TRAIN ILLUMINATION		
Flood lighting is required if **all** of the following exist:	**Not Required**	
Unrestricted grade crossing:		Yes
Road Speed Limit > or = 50km/h		Yes
No grade crossing warning system or traffic signal is present		No
Equipment is routinely on rails after dark, either stopped or traveling at 15mph		No
	West	**East**
Are luminaires present?	No	No
Illumination comments:		

J: ROAD SIGNS AND PAVEMENT MARKINGS *Manual of Uniform Traffic Control Devices For Canada (Except "Maximum Speed Sign" - Ontario Traffic Manual)*		
RAILWAY CROSSING SIGN	**West**	**East**
Sign Required?	Yes	Yes
Distance from nearest rail (m):	4	4
Height (m):	3.28	3.28
Distance from edge of road (m):	2.5	2.7
Retroreflective material on back of crossing sign?	N/A	N/A
Retroreflective material on front and back of post?	N/A	N/A
Are there number of track Signs (RA-6)?	N/A	N/A
DO NOT STOP ON TRACK	**West**	**East**
Sign required?	No	No
Does queued traffic encroach closer than 5m from cossing surface?	No	No
Condition:	N/A	N/A
RAILWAY CROSSING AHEAD (WA 18-20)	**West**	**East**
Sign required?	Yes	Yes
Is this an urban area that does not require an WA-18 sign?	No	No
Distance from crossing (m):	142	140
Symbol orientation correct?	Yes	Yes
Condition:	Fair	Fair
PREPARE TO STOP AT RAILWAY CROSSING (WB-6)	**West**	**East**
Sign required?	No	No
Are any front light units obscured within minimum approach distances?	N/A	N/A
Do environmental conditions frequently obscure signal visibility?	N/A	N/A
Does sign flash during operation of grade crossing warning system?	N/A	N/A
What Is the distance from the sign to 2.4 m beyond the furthest rail?	N/A	N/A
Does flash precede crossing warning system by time required to clear crossing?	N/A	N/A
What is the distance from the sign to the closest gate?	N/A	N/A
Does flash precede gate desent by time required to clear closest gate?	N/A	N/A
What Is time required for all queued vehicles to reach road operating speed?	N/A	N/A
Condition:	N/A	N/A
ADVISORY SPEED SIGN *(Used with WA 18-20 if reduced speeds necessary)*	**West**	**East**
Sign required?	N/A	N/A
Posted speed (km/h):	N/A	N/A
Condition:	N/A	N/A
STOP SIGN (RA-1)	**West**	**East**
Sign required?	No	No
Sign mounted on same post as Railway Crossing Sign?	N/A	N/A
Condition:	N/A	N/A
Signage comments:		

STOP SIGN AHEAD	**West**	**East**
Sign required?	No	No
Distance from nearest rail (m):	-	-
Condition:	N/A	N/A
MAXIMUM SPEED SIGN (RB-1)	**West**	**East**
Sign required?	No	No
Condition:	Fair	Fair
Posted speed (km/h):	60	60
EMERGENCY NOTIFICATION SIGN *(on each approach, or parallel to roadway)*	**West**	**East**
Contains location and railway company's emergency contact number?	Yes	Yes
Condition:	Fair	Fair
Signage comments:		
PAVEMENT MARKINGS	**West**	**East**
Are pavement markings consistent with the MUTCD Manual?	No	No
Are there lines to delineate sidewalks / paths?	Yes	Yes
"X" MARKINGS	**West**	**East**
Markings required?	Yes	Yes
Actual distance to rail (m):	132	140
Condition:	Fair	Fair
"NO PASSING" LINES	**West**	**East**
Markings required?	Yes	Yes
Actual distance to rail (m):	230	330
Condition:	Fair	Fair
"STOP" BARS	**West**	**East**
Markings required?	Yes	Yes
Actual distance to rail (m):	132	140
Condition:	Fair	Fair
Markings comments:		
Other Distractions:	**West**	**East**
Intersections on road approaches:	No	Yes
Merging traffic lanes or driveways:	No	Yes
Vehicle parking:	No	No
Bus stops:	No	No
Highway or commercial signs:	No	No
Light intensity:	No	No
Traffic control:	No	No
Sunlight:	No	No
Other signage:	No	No
Other:	No	No
Distraction comments:	Driveways to the East	

L: WARNING SYSTEM WARRANTS		
Warning System Requirements:	**Required**	
A cross product = or > 1000?	60000	Yes
Max rail operating speed = or > 50mph?	80	Yes
Obscured sightlines?		Yes
More than two tracks where trains can Pass each other?		No
At least one of the proximity Conditions from "K" met?		Yes
Gate Requirements:	**Required**	
A cross product = or > 50,000?	60000	Yes
Max rail operating speed = or > 50mph?	80	Yes
Obscured sightlines?		Yes
More than two tracks where trains can Pass each other?		No
At least one of the proximity Conditions from "K" met?		Yes

M: WARNING SYSTEM		
Signal Mast Equipment:	**Northeast**	**Southwest**
Bells:	Fair	N/A
Gates:	Fair	Fair
Light units:	Fair	Fair
Cantilever units:	N/A	N/A
Warning Signals:	**Northeast**	**Southwest**
Top of warning signal foundation to ground level (max 100mm):	140	100
Height from road to bottom of signal (2.3m to 2.9m):	2.52	2.57
Distance from bottom of signal to # of tracks sign (125mm to 175mm):	N/A	N/A
Distance from top of signal to railway crossing sign (125mm to 175mm):	190	190
Distance from signal center to edge (305mm):	250	250
Distance from signal center to center of mast (380mm):	400	400
Flashing Light Units:	**Northeast**	**Southwest**
Minimum distance to primary light units (m):	130	130
Recomended distance to primary light units (m):	160	160
Actual distance to primary light units (m):	230	300
Are flashing lights within 5 degrees horizontally of road through approach?	Yes	Yes
Does horizontal/vertical curvature neccessitate supplemental units?	No	No
Are lights obscured by vehicles stopped on adjacent intersections?	No	No
Are additional lights required for vehicles turning onto approach from side street?	No	No
Can back lights be seen by all stopped drivers?	Yes	Yes
Cantilever Light Units:	**West**	**East**
Cantilever required?	No	No
Does D_R exceed 7.7m?	N/A	N/A
Does D_L exceed 8.7m?	N/A	N/A
Height from road to bottom of light (5.2m to 6.0m):	-	-
Condition:	N/A	N/A
Multiple Lanes:	**West**	**East**
Can front light units be seen by drivers in all lanes?	N/A	N/A
Can back light units be seen by all stopped drives in all lanes?	N/A	N/A
Warning System Comments:		

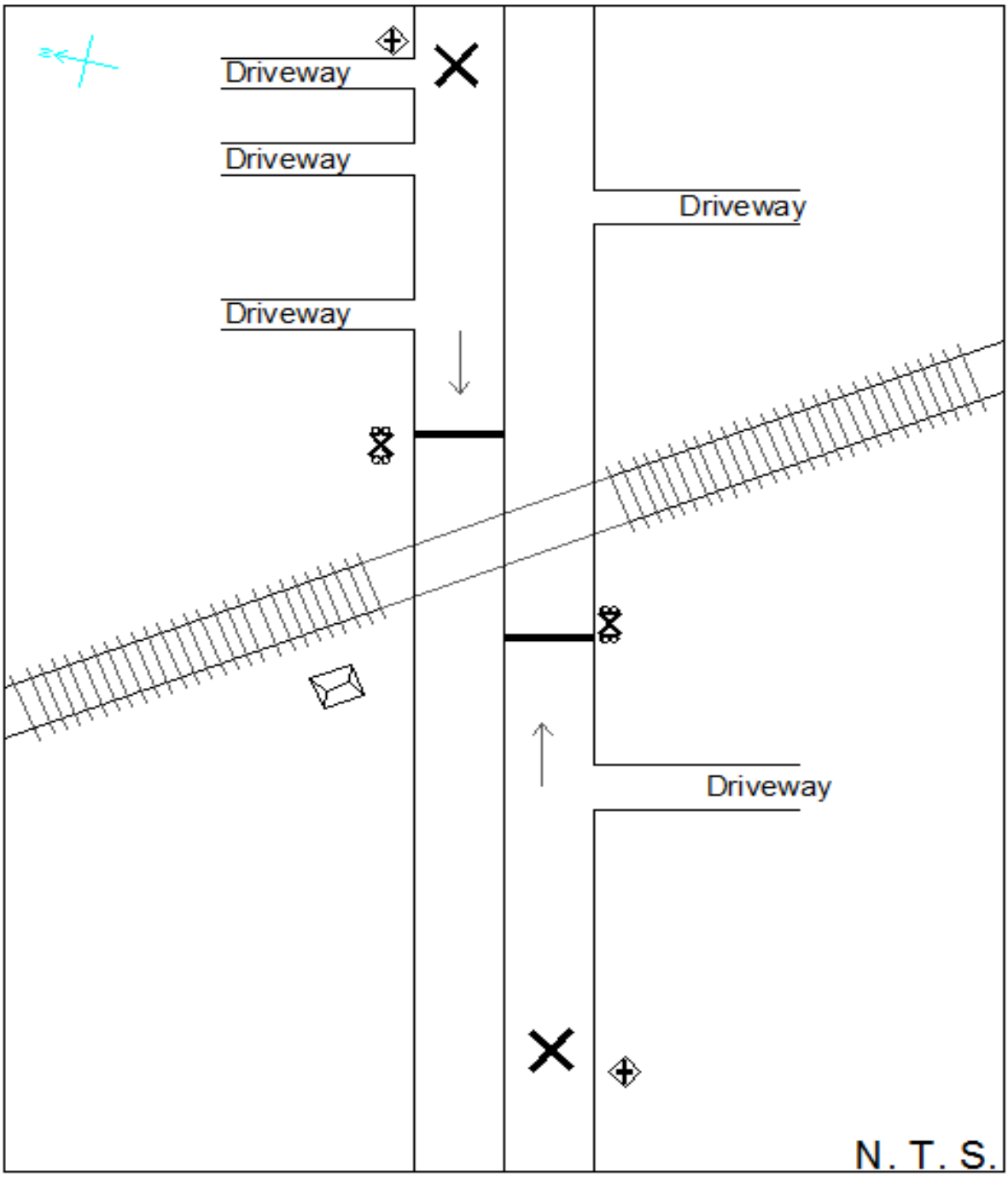
Gates:	**Northeast**	**Southwest**
Gate controller box protrusion from mast (max 650mm):	450	450
Distance from gate tip to first light (490mm to 1900mm):	460	460
Distance between first light and last light along arm (min 2.74m):	3.09	3.13
Distance from center of mast to tip of gate (max 11.6m):	6.73	6.3
Height from road to bottom of lowered gate (1.1m to 1.4m):	1.12	1.12
Space between gate lights evenly spaced?	Yes	Yes
Raised gate protrudes outside of mast signal before a height of 5.2m?	No	No
Calculated gate arm clearance times (s):	10	10
Calculated gate arm delay time (s):	10.5	10.5
Measured gate arm delay time (s):	8	8
Measured gate arm descent time (s):	10	10
Measured gate arm down time until train arrival (s):	-	-
Measured gate arm ascent time (s):	5	5
Gate arms ascend and descend smoothly and continuously?	Yes	Yes
Signal Housing:		
Distance from housing to nearest rail (min 8m):		7.7
Distance from housing to edge of road (min 9m):		12
Warning System Comments:		

N:	**PREEMPTION OF TRAFFIC SIGNALS**	
	West	**East**
Is preemption required?	No	Yes
Distance "D" from traffic signal (min 60m):	-	-
Are there known issues of queuing?	No	Yes
Date of last preemption check:	N/A	N/A
Preemption has enough time to clear traffic from crossing before train arrives?	N/A	N/A
Preemption prohibits traffic from moving through intersection towards crossing?	N/A	N/A
Preemption accommodates pedestrians?	N/A	N/A
Have longer and slower vehicles been considered?	N/A	N/A
Are additional signs required (no right on red, etc.)?	N/A	N/A
Preemption comments:		

O:	**AREAS WITHOUT TRAIN WHISTLING**
Is train whistling prohibited at this crossing?	No
Evidence of unauthorized access (trespassing) on rail line in area of crossing?	No
Train whistle comments:	

P:	COMMENTS AND RECOMMENDATIONS
- Flangeway not in compliance - Curve in railway to North blocks sightlines - Warning signals not in compliance - Deep valley in road to the East	

Q:	SITE SKETCH



Hatch Infastructure Findings			Client Response	
Observations		Suggested Action	Agree YES/NO	Comments
1.00	**ROAD CROSSING GEOMETRY**			
1.01	Flangeway not in compliance with RTD-10 Figure 6-2	Rubber flange guards to be installed to meet specification as outlined in RTD-10 and GCS 2014. Where conflict exists, GCS 2014 should be used as latest standard.		
2.00	**ROAD GEOMETRY**			
	No issues observed during assessment.			
3.00	**QUEUING POTENTIAL**			
	No issues observed during assessment.			
4.00	**SIGHTLINES**			
4.01	Curve in railway to North limits sightlines	Brush removal program to be implemented to ensure sightlines down track remain free of brush		
5.00	**ROAD SIGNS & PAVEMENT MARKINGS**			
	No issues observed during assessment.			
6.00	**WARNING SYSTEM**			
6.01	Warning Signals not in compliance with RTD-10 Figure 18-1 & 18-2	Signals to be installed in accordance to RTD-10, and GCS 2014. Where conflict arises, GCS 2014 to be used as latest standard.		
7.00	**PREEMPTION, WHISTLE BLOWING, & TRAIN ILLUMNINATION**			
	No issues observed during assessment.			

Hatch Infastructure Findings			Client Response	
Observations		Suggested Action	Agree YES/NO	Comments
8.00	**MISCELLANEOUS**			
8.01	Missing road authority information	Due to deficiencies in the reports from local road authority, not all information was available at time of report. Observations and estimates were made on site, but given limited time frames and road related equipment, information was not all available. It is recommended that the road authority provides full traffic assessment prior to implementing additional rails through this crossing.		

Site Photos

Facing North

Facing South

Facing East

Facing West

West of Track - Driver Left

West of Track - Driver Right

East of Track - Driver Left

East of Track - Driver Right