

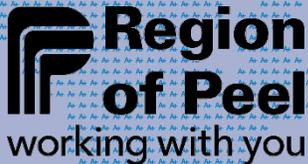
Region of Peel

Structural Engineering Technical Memorandum

Coleraine Drive Grade Separation

July 12th, 2019

B000738





Structural Engineering Technical Memorandum

Coleraine Drive CP Rail Grade Separation

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July 12th, 2019



REVIEW AND SUBMISSION REGISTER

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1. Mandate

The objective of the mandate is to provide structure-related information on the grade separation project for the CP Rail crossing at Coleraine Drive south of Old Ellwood Drive in the Town of Caledon. Two (2) options are identified and developed in this memorandum, including some preliminary sketches and a low-precision cost estimate.

The options for grade separation at Coleraine Drive crossing include road-over-rail and rail-over-road configurations. In both cases, the vertical alignment of the railway remains the same. Note that the traffic/construction staging is not part of the scope of this memorandum and will be considered in a future study.

2. Context

The crossing at Coleraine Drive is located on the CP MacTier subdivision, a moderately trafficked portion of CP's main transcontinental line located northwest of Toronto. The crossing is located between an industrial zone and a residential district. The Region of Peel consider a range of options for traffic improvements, and a grade separation is envisaged.

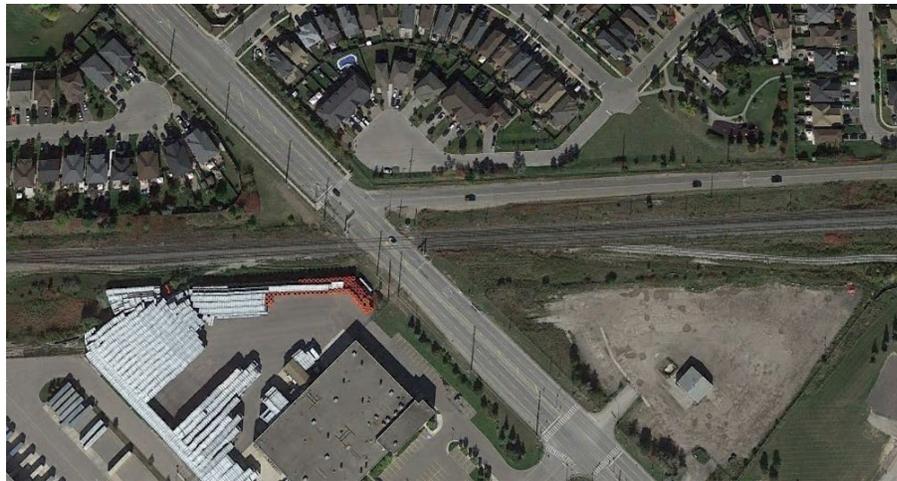


Figure 2.1: CP Rail crossing at Coleraine Drive

3. Inputs

This technical memorandum is based on the following inputs:

- + Transportation Report – Coleraine Drive Grade Separation EA (Project 16-4315), CIMA+, June 2017;
- + Peel Region Grade Separations – Railway Staging MEMO, CIMA+, July 2015;
- + Coleraine Drive – Road over Rail Option – Plan & Profile, June 2015;
- + Coleraine Drive – Rail over Road Option – Plan & Profile, June 2015;
- + Geotechnical/Pavement Investigation for Grade Separation and Rehabilitation/Widening of Coleraine Drive, Golder Associates, December 2017.

4. Design Criteria

Applicable standards

- + AREMA – American Railway Engineering and Maintenance-of-Way Association;
- + CAN/CSA-S6 – Canadian Highway Bridge Design Code;
- + Transport Canada Standards Respecting Railway Clearances (TC E-05);
- + TAC – Transport Association of Canada – Geometric Design Guide for Canadian Roads;
- + MTO Structural Manual;
- + Ontario Provincial Standard Specifications;
- + Ontario Provincial Standard Drawings;
- + Others, as applicable.

Road over Rail Structure

- + Surcharge: Truck CL-625 (ONT) (Total weight 625 kN);
- + Vertical clearance: 7 400 mm from the top of rail;
- + Horizontal clearance: 5 486 mm from the centreline of the track.

Rail over Road

- + Live load: COOPER E80 (80 000 lbs/axle or 357 kN/axle);
- + Vertical clearance: 5 000 mm;
- + Horizontal clearance: according to TAC.

5. Option 1 – Road over Rail

A preliminary design has been developed for this option. Two (2) single span structures are proposed to carry the Coleraine Drive alignment over the two (2) existing tracks and one future track. Each proposed structure has a span 30,9 m and skew of 42 degrees. The bridge's deck is a 225 mm thick slab on pre-stressed concrete girders supporting two (2) lanes in each direction. A 2 500 mm sidewalk is proposed on the south direction and a 4 500 mm multi-use path (MUP) is proposed on the north direction. Both structures are supported by a semi-integral abutment. According to the available information and the loads computed during this preliminary design, the bridges cannot be supported by shallow foundation and driven piles through the RSS walls are proposed.

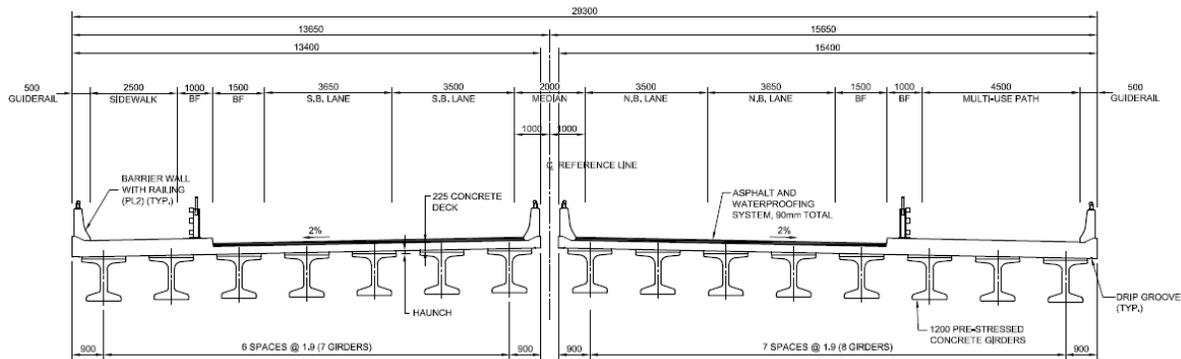


Figure 5.1: Option 1 - Cross-Section of the Bridge

For the approaches, RSS walls up to 9 m are required to retain the embankment. According to the preliminary geotechnical report, the Factored Serviceability Geotechnical Resistance for 25 mm Settlement is 100 kPa, which represents around 5 m of embankments if we assume a backfill weight of 20 kN/m³. Therefore, soil improvement technique, such CMC (Control Modulus Column), or preloading could be required.

6. Option 2 –Rail Over Road

A preliminary design has been developed for this option where the road is going under the CP tracks. A continuous two (2) spans structure is proposed to carry the railway tracks over the Coleraine Drive alignment. The proposed structure has a two (2) continuous spans of 22,8 and 25,2 m and has a skew of 42 degrees.

The bridge's deck is a 250 mm thick slab on 10 steel girders supporting three ballasted tracks: two (2) existing and one future. By crossing under the natural ground, the environment is more likely to be humid and a special protection of the steel against corrosion, such painted atmospheric steel or painted metallized steel, would be recommended.

The structure is supported by semi-integral abutments and one central pier. The pier consists of four (4) columns of 1 500 mm (diameter) on a pile cap. According to the available information and the loads computed during this preliminary design, the bridge cannot be supported by shallow foundation and driven piles are proposed for the abutments and the central pier. Depressed approached slabs are used in order to avoid any differential settlement in the rail.

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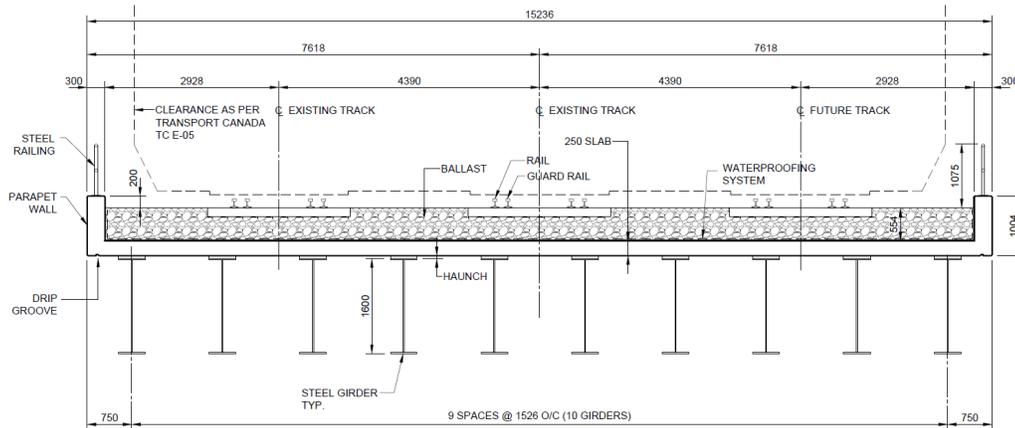


Figure 6.1: Option 2 - Cross-Section of the Bridge

It is important to mention that the road elevation would be under the water table. So, a permanent drainage system (drains, pumps, wells, etc.) shall be implemented for this option. Only limited information is available and a detailed hydrological study is required to confirm the possibility of using permeable retaining walls such as RSS walls proposed previously.

7. Estimation

Cost estimates of both options are provided for the grade separation. The costs are only a very low level of precision. As a reflection of this, a 50 % contingency has been incorporated.

	OPTION 1 : ROAD OVER RAIL	OPTION 2 : RAIL OVER THE ROAD
BRIDGE	4 380 228 \$	6 922 498 \$
APPROACHES & RSS WALLS	12 217 020 \$	12 324 375 \$
SUB-TOTAL	16 597 248 \$	19 246 873 \$
CONTINGENCY (50 %)	8 298 624 \$	9 623 437 \$
TOTAL	24 895 872 \$	28 870 310 \$

It is important to keep in mind the following assumptions and exclusions when reading these costs:

Option 1 – Road over Rail

- + Excluding the roadway, civil & electrical works;
- + Excluding the soil improvement techniques (CMC, preloading, etc.);
- + Excluding the railway cost (protection, waste of time, etc.);
- + Excluding the traffic staging;
- + Excluding the protection / relocation of the utilities;

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- + Excluding additional investigations/studies;
- + Assuming a complete closure of the Coleraine Drive during work.

The cost of the work for this option is estimated at 24,2 M\$, including a contingency of 50 % and excluding taxes.

Option 2 – Rail over Road

- + Excluding the roadway, civil & electrical works;
- + Excluding the railway costs (shooflies, protection, waste of time, etc.);
- + Excluding the permanent drainage systems to be implanted (drains, manhole, sewer, etc.);
- + Excluding the pumping station (construction and maintenance);
- + Excluding lightning works;
- + Excluding the traffic staging;
- + Excluding the protection / relocation of the utilities;
- + Excluding additional investigations/studies;
- + Assuming that the temporary railway tracks (shoe flies) are constructed on only one side (no railway crossing for the construction accesses).

The cost of the work for this option is estimated at 28,9 M\$, including a contingency of 50 % and excluding taxes.

8. Conclusions

The objective of the mandate is to provide structure-related information on the grade separation project for the CP Rail crossing at Coleraine Drive south of Old Ellwood Drive in the Town of Caledon. Two (2) options were studied in this memorandum. Both options are technically feasible.

Comparing the options, Option 2 (Rail over Road) requires excavation up to 9 m under the ground, under the water table. Therefore, complex dewatering and water control would be required during the construction. A permanent drainage system, including a pump station, would also be required. It is important to note that this option has huge impacts on the railways operations and temporary track diversion would be required. In addition, further studies are required in order to determine the potential impacts on the existing buildings and houses by lowering the water table.

Option 1 (Road over Rail) is easier in terms of construction because no depth excavation is required and the impacts on the railway operations are limited. Also, the total cost of the project would be lower than Option 2. But it is very important to mention that this option requires the construction of very tall retaining walls next to private properties. So the social acceptability of the project would be a challenge and shall be carefully studied.

In conclusion, the Coleraine Drive Grade Separation is a complex project and require additional investigations and studies of the overall impacts to select the right option.

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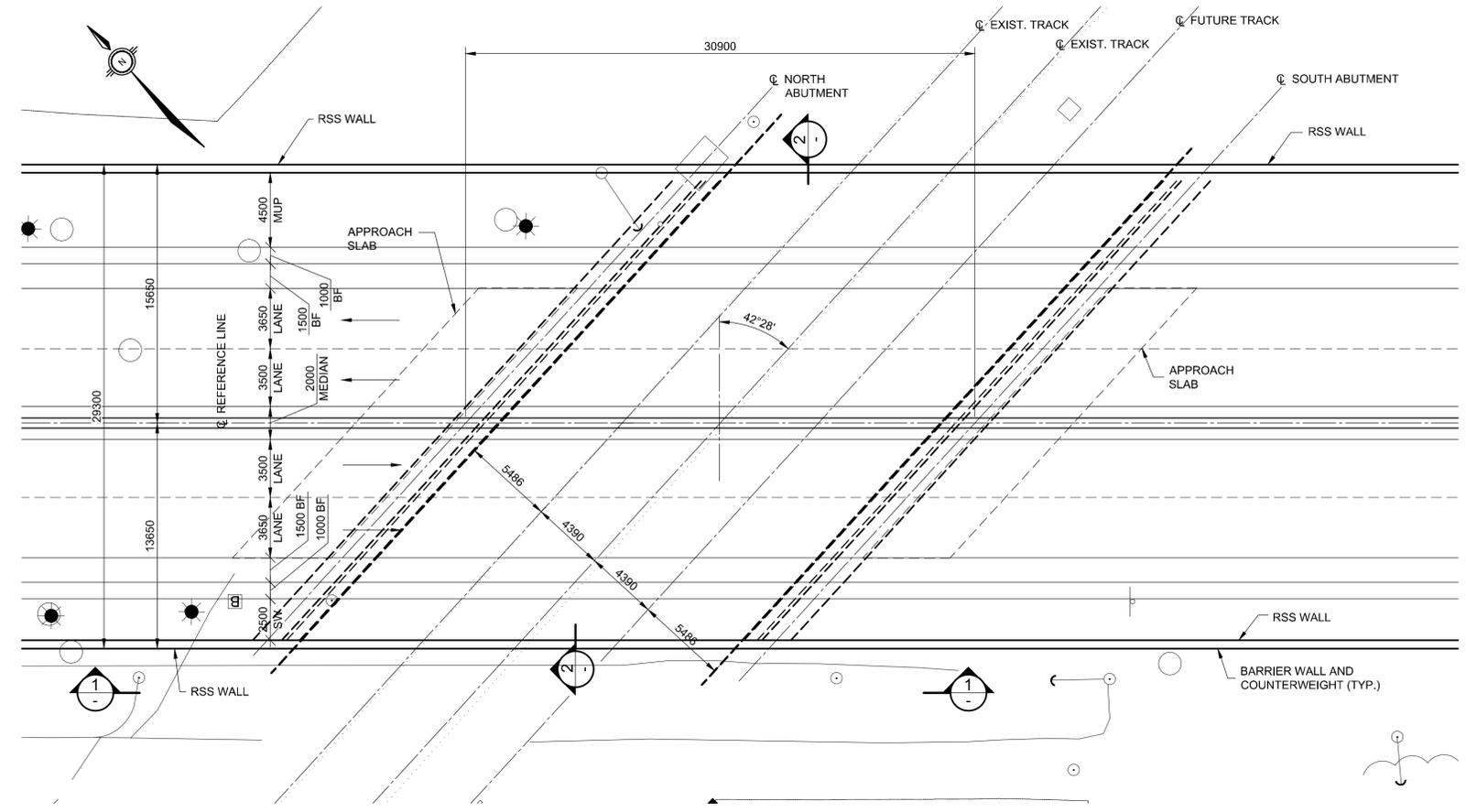


APPENDIX A

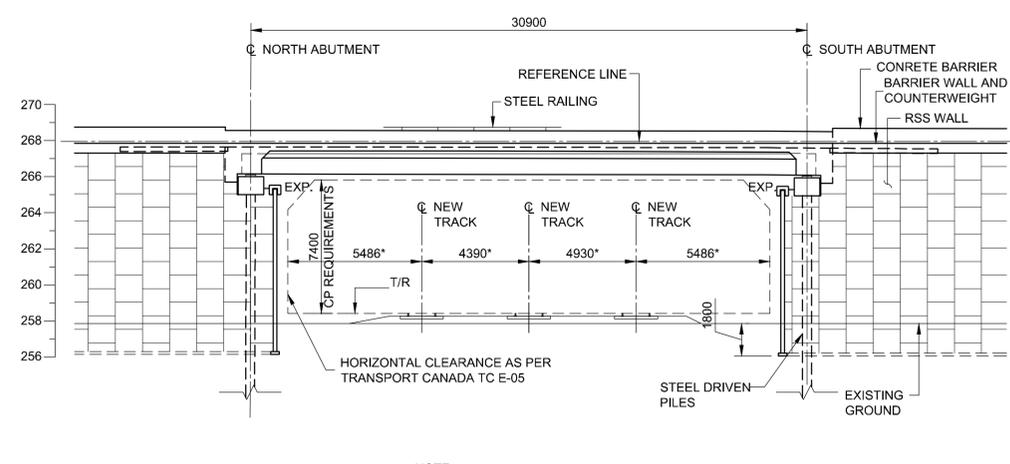
Option 1: Road over rail – General Arrangement

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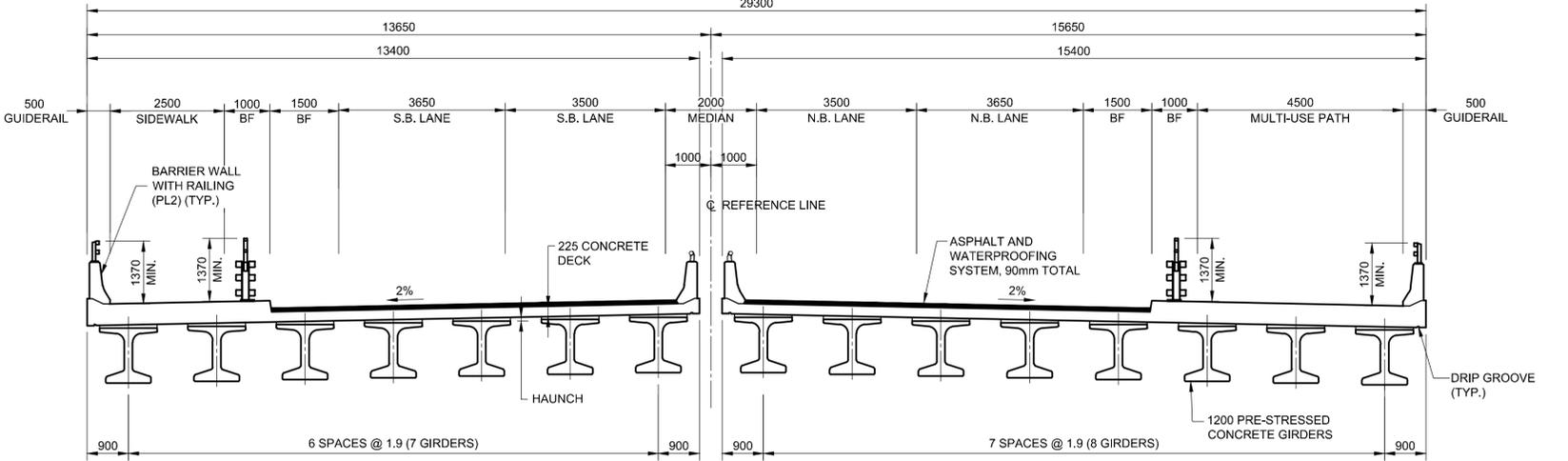


PLAN
1:200



NOTE:
*** DENOTES DIMENSIONS MEASURED PERPENDICULAR TO C TRACK

SECTION 1
1:200



SECTION 2
1:75

GENERAL NOTES

- DESIGN AND WORKMANSHIP:
 - CANADIAN HIGHWAY BRIDGE DESIGN CODE CAN/CSA S6-14
 - ONTARIO PROVINCIAL STANDARD SPECIFICATIONS AND DRAWINGS
- CLASS OF CONCRETE:
 - PRESTRESSED GIRDERS 50 MPa
 - REMAINDER 35 MPa
- CLEAR COVER TO REINFORCING STEEL:

FOUNDATIONS	100 ± 25
DECK TOP	70 ± 20
BOTTOM	40 ± 10
REMAINDER	70 ± 20 UNLESS NOTED OTHERWISE
- REINFORCING STEEL:

BLACK REINFORCING STEEL SHALL BE GRADE 400W, UNLESS OTHERWISE SPECIFIED.

STAINLESS REINFORCING STEEL SHALL BE TYPE 316LN OR DUPLEX 2205 AND HAVE A MINIMUM YIELD STRENGTH OF 500 MPa, UNLESS OTHERWISE SPECIFIED.

APPLICABLE MTO STANDARD DRAWINGS

OPSD 3000.100	FOUNDATION, PILES, STEEL H-PILE DRIVING SHOE
OPSD 3000.150	FOUNDATION, PILES, STEEL H-PILE SPLICES
OPSD 3101.150	WALLS - ABUTMENT, BACKFILL MINIMUM GRANULAR REQUIREMENT
OPSD 3329.100	DECK, REINFORCEMENT, SUPPORTS FOR REINFORCING STEEL FOR SLAB DEPTHS 300mm OR LESS
OPSD 3390.100	DECK DRIP CHANNEL
OPSD 3950.100	JOINTS - CONCRETE EXPANSION AND CONSTRUCTION ON STRUCTURE
OPSD 980.001	PEDESTRIAN BARRICADE INSTALLATION
SS12	HOOK DIMENSIONS FOR REINFORCING STEEL BARS
SS110-21	RAILING FOR BARRIER/PARAPET WALL
SS110-54	BARRIER WALL WITH RAILING - PL2, STAINLESS STEEL REBAR

SURCHARGE

CL-625 (ONTARIO) TRUCK

COLERAINE DRIVE
GRADE SEPARATION
TOWN OF CALEDON

COLERAINE DRIVE
BRIDGE OVER
RAIL TRACK

N/A Director, Infrastructure Services

N/A Project Manager



Contract No.	B000738	Dwg. No.	001
Sheet	-	of	-
Asset No.	N/A		
Asset Group	N/A		
Des.	-	Chkd.	-
Dwn.	-	Chkd.	-
Utility Circ. No.	N/A	Index No.	N/A
Const. Inspector	N/A		
Scale:	N/A		

NOTE: The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

No.	Description	By	Date (dd/mm/yy)
-	-	XX	DD/MM/YY
-	-	XX	DD/MM/YY
-	-	XX	DD/MM/YY
-	-	XX	DD/MM/YY
-	-	XX	DD/MM/YY

ABBREVIATIONS

EL.	DENOTES ELEVATION
EXP.	DENOTES EXPANSION
FIX.	DENOTES FIXED
MUP	DENOTES MULTI-USE PATH
T/P	DENOTES TOP OF PAVEMENT
T/R	DENOTES TOP OF RAIL
R.O.W.	DENOTES RIGHT-OF-WAY
WP	DENOTES WORKING POINT
BF	BUFFER
SW	SIDEWALK
CG	CURB & GUTTER

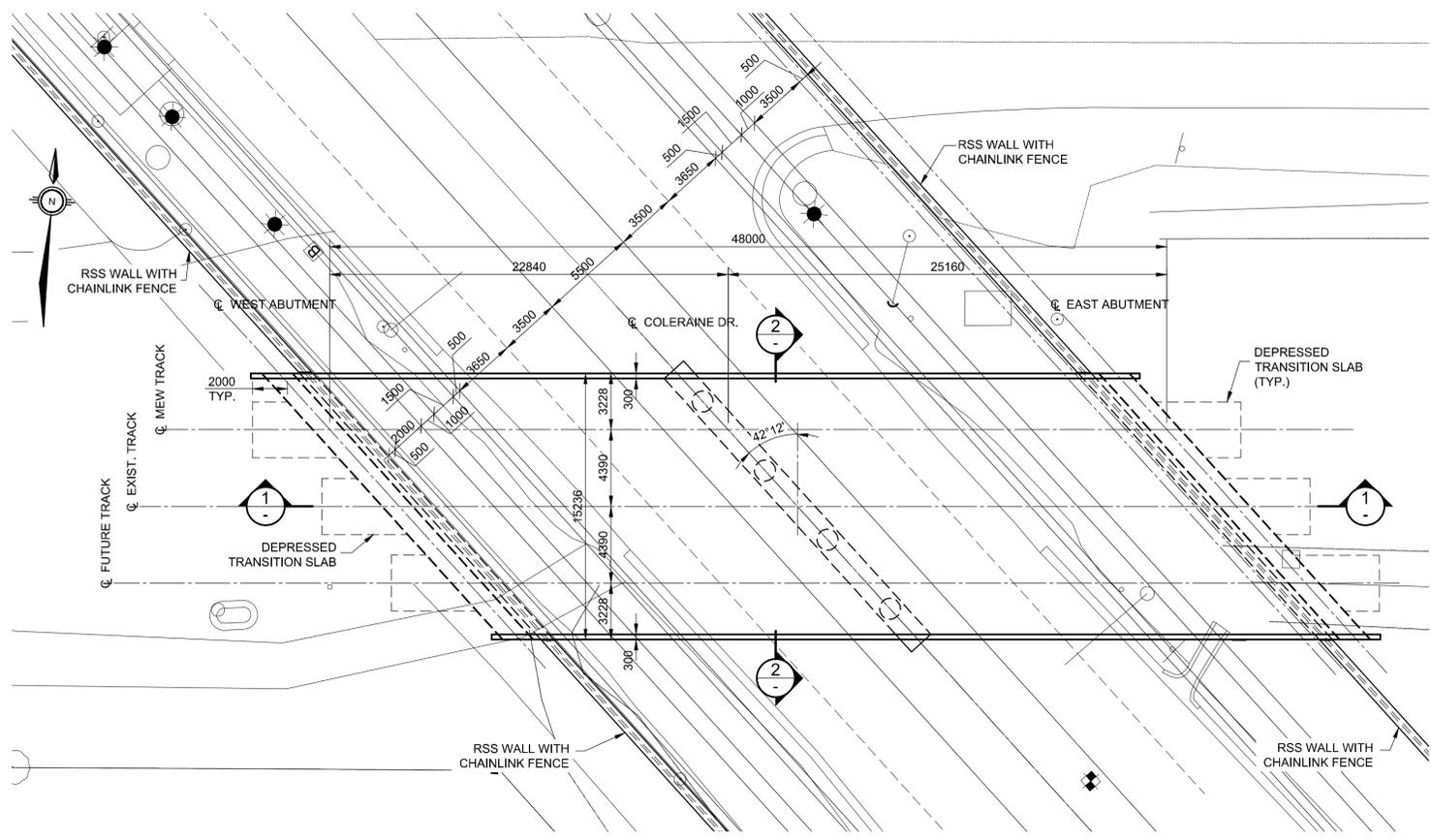
NOT FOR CONSTRUCTION

APPENDIX B

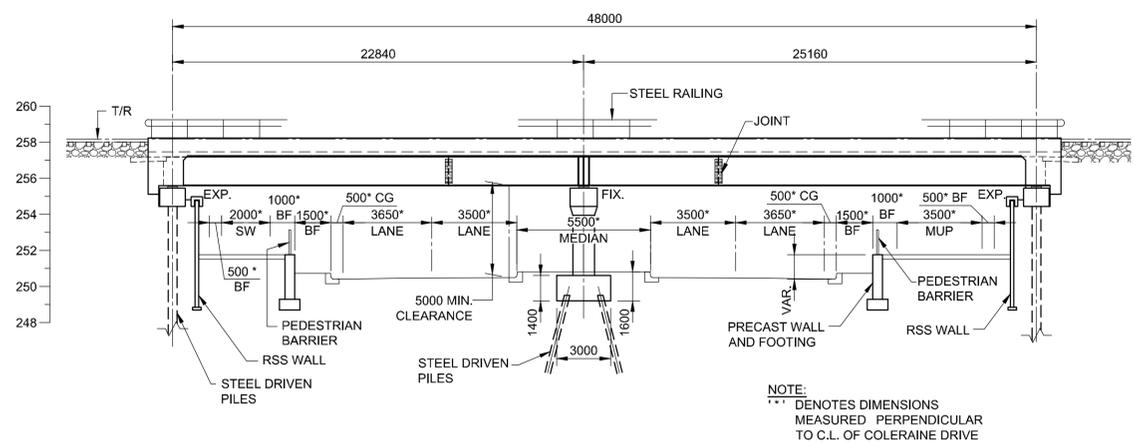
Option 2: Rail Over the Road – General Arrangement

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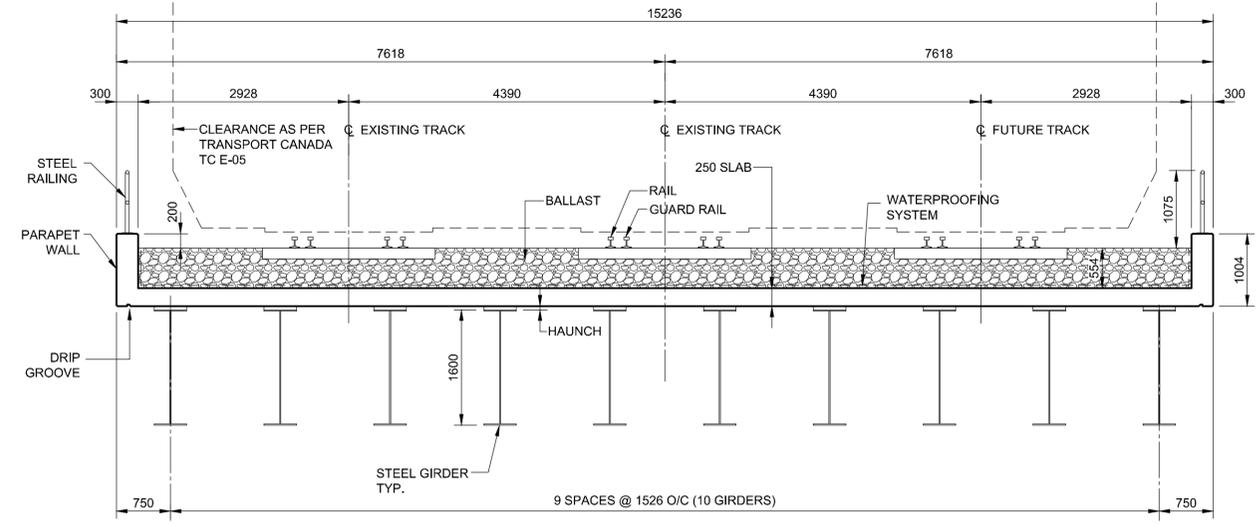




PLAN
1:200



SECTION 1
1:200



SECTION 2
1:50

GENERAL NOTES

- DESIGN AND WORKMANSHIP:
 - AREMA MANUAL FOR RAILWAY ENGINEERING
 - ONTARIO PROVINCIAL STANDARD SPECIFICATIONS AND DRAWINGS
- CLASS OF CONCRETE: 35 MPa
- CLEAR COVER TO REINFORCING STEEL:
 - FOUNDATIONS 100 ± 25
 - DECK TOP 70 ± 20
 - BOTTOM 40 ± 10
 - REMAINDER 70 ± 20 UNLESS NOTED OTHERWISE
- REINFORCING STEEL:
 - BLACK REINFORCING STEEL SHALL BE GRADE 400W, UNLESS OTHERWISE SPECIFIED.
 - STAINLESS REINFORCING STEEL SHALL BE TYPE 316LN OR DUPLEX 2205 AND HAVE A MINIMUM YIELD STRENGTH OF 500 MPa, UNLESS OTHERWISE SPECIFIED.
- STRUCTURAL STEEL: ACCORDING TO G40.21
 - GIRDERS AND PLATES: GRADE 350A
 - BRACINGS, BEARINGS AND OTHER: GRADE 350A
 - STEEL SHALL BE PAINTED

APPLICABLE MTO STANDARD DRAWINGS

OPSD 3000.100	FOUNDATION, PILES, STEEL H-PILE DRIVING SHOE
OPSD 3000.150	FOUNDATION, PILES, STEEL H-PILE SPLICES
OPSD 3101.150	WALLS - ABUTMENT, BACKFILL MINIMUM GRANULAR REQUIREMENT
OPSD 3329.100	DECK REINFORCEMENT, SUPPORTS FOR REINFORCING STEEL FOR SLAB DEPTHS 300mm OR LESS
OPSD 3390.100	DECK DRIP CHANNEL
OPSD 3950.100	JOINTS - CONCRETE EXPANSION AND CONSTRUCTION ON STRUCTURE
OPSD 980.001	PEDESTRIAN BARRICADE INSTALLATION
SS12	HOOK DIMENSIONS FOR REINFORCING STEEL BARS
SS110-21	RAILING FOR BARRIER/PARAPET WALL
SS110-54	BARRIER WALL WITH RAILING - PL2, STAINLESS STEEL REBAR

LIVE LOAD

COOPER E90 + IMPACT

COLERAINE DRIVE
GRADE SEPARATION
TOWN OF CALEDON

RAIL BRIDGE OVER
COLERAINE DRIVE
GENERAL ARRANGEMENT

N/A	N/A
Director, Infrastructure Services	Project Manager

Region of Peel
Working for you

Contract No.	Dwg. No.
B000738	002
Sheet	of
Asset No.	N/A
Asset Group	N/A
Des.	Chkd.
Dwn.	Chkd.
Utility Circ. No.	Index No.
N/A	N/A
Const. Inspector	N/A
Scale:	

NOTE: The location of utilities is approximate only, the exact location should be determined by consulting the municipal authorities and utility companies concerned. The contractor shall prove the location of utilities and shall be responsible for adequate protection from damage.

No.	Description	By	Date (dd/mm/yy)
-	-	XX	DD/MM/YY
-	-	XX	DD/MM/YY
-	-	XX	DD/MM/YY
-	-	XX	DD/MM/YY
-	-	XX	DD/MM/YY

ABBREVIATIONS

EL.	DENOTES ELEVATION
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T/R	DENOTES TOP OF RAIL
R.O.W.	DENOTES RIGHT-OF-WAY
WP	DENOTES WORKING POINT
BF	BUFFER
SW	SIDEWALK
CG	CURB & GUTTER

NOT FOR CONSTRUCTION

APPENDIX C

Coleraine Drive Grade Separation – Cost Estimate

B000738



VERY LOW PRECISION COST ESTIMATE

Project # B000738	Road Coleraine Drive
Works Coleraine Grade Separation at CPR crossing	Town Caledon

COST ESTIMATE - OPTION 1 - ROAD OVER RAIL

DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	COSTS
-------------	------	----------	------------	-------

BRIDGE				4 380 228 \$
Excavation	global	1	75 000,00 \$	75 000 \$
Piling mobilisation	global	1	212 625,00 \$	212 625 \$
Driven piles	m	4 050	350,00 \$	1 417 500 \$
Dynamic Test (piles)	unit	10	1 500,00 \$	15 000 \$
Pile Cap Concrete	m3	100	650,00 \$	65 000 \$
Bearing Block Concrete	m3	3	1 500,00 \$	4 500 \$
Shear Block Concrete	m3	4	1 500,00 \$	6 000 \$
Diaphragm Concrete	m3	175	1 500,00 \$	262 500 \$
Approach Slab Concrete	m3	114	550,00 \$	62 700 \$
Reinforcing steel (pile cap, blocks, diaphragm, approach slab)	tonne	31,93	2 500,00 \$	79 822 \$
Premium Reinforcing Steel (diaphragm & approach slab)	tonne	1,24	10 000,00 \$	12 414 \$
Bearing	unit	26	2 500,00 \$	65 000 \$
Deck Lifting	global	1	150 000,00 \$	150 000 \$
Prestressed Concrete Girder - NU1200	m	415	1 750,00 \$	726 250 \$
Deck Concrete	m3	235	1 500,00 \$	352 500 \$
Sidewalk Concrete (Bridge)	m3	52	1 200,00 \$	62 400 \$
Barrier Wall Concrete (Bridge)	m3	40	1 250,00 \$	50 000 \$
Reinforcing steel (deck)	tons	41	2 500,00 \$	102 813 \$
Premium Reinforcing Steel (barrier wall+sidewalk+deck)	tons	11,8	10 000,00 \$	118 008 \$
Waterproofing membrane (deck & approach slab)	m2	903	50,00 \$	45 150 \$
RSS walls (front wall)	m2	610	750,00 \$	457 500 \$
Asphalt (deck & approach slab)	tons	215	175,00 \$	37 547 \$
APPROACHES & RSS WALLS (STATION 0+660 TO 1+180)				12 217 020 \$
Excavation	m3	12 000	25,00 \$	300 000 \$
RSS walls (including structural backfill behind the wall)	m2	6 200	750,00 \$	4 650 000 \$
Backfill material	m3	120 000	20,00 \$	2 400 000 \$
Counterweight & Coping Concrete (RSS Wall)	m3	920	1 250,00 \$	1 150 000 \$
Barrier Wall Concrete (RSS Wall)	m3	275	1 500,00 \$	412 500 \$
Median Barrier Concrete (Approaches)	m3	960	1 000,00 \$	960 000 \$
Reinforcing steel (Counterweight & Coping) - RSS Walls	ton	69	2 000,00 \$	137 700 \$
Premium Reinforcing Steel (barrier wall) - RSS Walls	ton	93	10 000,00 \$	926 250 \$
Road infrastructure	m3	4 302	35,00 \$	150 570 \$
Sidewalk Concrete (Approach)	m3	1 050	600,00 \$	630 000 \$
Asphalt (approaches)	ton	2 000	250,00 \$	500 000 \$
SUB-TOTAL				16 597 248 \$
Contingency			50,00%	8 298 624 \$
TOTAL (BRIDGE AND RSS WALLS ONLY)				24 895 872 \$

VERY LOW PRECISION COST ESTIMATE

Project # B000738	Road Coleraine Drive
Works Coleraine Grade Separation at CPR crossing	Town Caledon

COST ESTIMATE - OPTION 2 - RAIL OVER ROAD

DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	COSTS
-------------	------	----------	------------	-------

BRIDGE				6 922 498 \$
Excavation	global	1	350 000,00 \$	350 000 \$
Temporary retaining walls / falseworks	global	1	700 000,00 \$	700 000 \$
Dewatering and water control	global	1	175 000,00 \$	175 000 \$
Piling mobilisation	global	1	250 000,00 \$	250 000 \$
Driven piles	m	4 320	350,00 \$	1 512 000 \$
Dynamic Test (piles)	unit	10	1 500,00 \$	15 000 \$
Pile Cap Concrete (abutments & piers)	m3	230	650,00 \$	149 500 \$
Bearing Block Concrete	m3	3	1 500,00 \$	4 500 \$
Shear Block Concrete	m3	4	1 500,00 \$	6 000 \$
Diaphragm Concrete (abutments)	m3	175	1 500,00 \$	262 500 \$
Transition Slab Concrete	m3	40	550,00 \$	22 000 \$
Column Concrete (pier)	m3	20	1 250,00 \$	25 000 \$
Pier Cap (pier)	m3	55	1 250,00 \$	68 750 \$
Reinforcing steel (pile cap, blocks, diaphragm, approach slab)	tonne	31,10	2 500,00 \$	77 757 \$
Premium Reinforcing Steel (column, pier cap, diaphragm & approach slab)	tonne	17,68	10 000,00 \$	176 804 \$
Expansion Bearing	unit	20	3 500,00 \$	70 000 \$
Fixed Bearing	unit	10	5 000,00 \$	50 000 \$
Deck Lifting	global	1	115 000,00 \$	115 000 \$
Steel Structure (girders, braces, plates & joints)	ton	280	7 500,00 \$	2 100 000 \$
Deck Concrete	m3	202	1 500,00 \$	303 000 \$
Parapet Wall Concrete	m3	23	1 250,00 \$	28 750 \$
Reinforcing steel (deck & parapet)	tons	39	2 500,00 \$	98 438 \$
Steel Railing (Bridge)	m	100	350,00 \$	35 000 \$
Waterproofing system (including protection board)	m2	775	100,00 \$	77 500 \$
RSS walls (front wall)	m2	250	1 000,00 \$	250 000 \$
APPROACHES & RSS WALLS (STATION 0+660 TO 1+180)				12 324 375 \$
Excavation	global	1	3 750 000,00 \$	3 750 000 \$
Dewatering and water control	global	1	1 000 000,00 \$	1 000 000 \$
RSS walls (including structural backfill behind the wall)	m2	4 500	1 000,00 \$	4 500 000 \$
Coping Concrete (RSS Wall)	m3	102	1 250,00 \$	127 500 \$
Gutter Concrete	m3	315	450,00 \$	141 750 \$
Precast wall & footing (sidewalk / MUP)	m3	1 000	750,00 \$	750 000 \$
Sidewalk & MUP Concrete	m3	1 100	450,00 \$	495 000 \$
Reinforcing steel (copping, gutter, sidewalk, MUP)	tons	157	2 500,00 \$	391 375 \$
Granular backfill	m2	20 000	30,00 \$	600 000 \$
Road, MUP & Sidewalk Infrastructure	m3	3 750	35,00 \$	131 250 \$
Asphalt (approaches)	ton	1 750	250,00 \$	437 500 \$
SUB-TOTAL				19 246 873 \$
Contingency			50,00%	9 623 437 \$
TOTAL (BRIDGE AND RSS WALLS ONLY)				28 870 310 \$