Ninth Line Over Sixteen Mile Creek Bridge – Structural Design Memo

Environmental Assessment (EA) and Preliminary Design for Ninth Line from Eglinton Avenue West to Derry Road West

City of Mississauga

April 19, 2021

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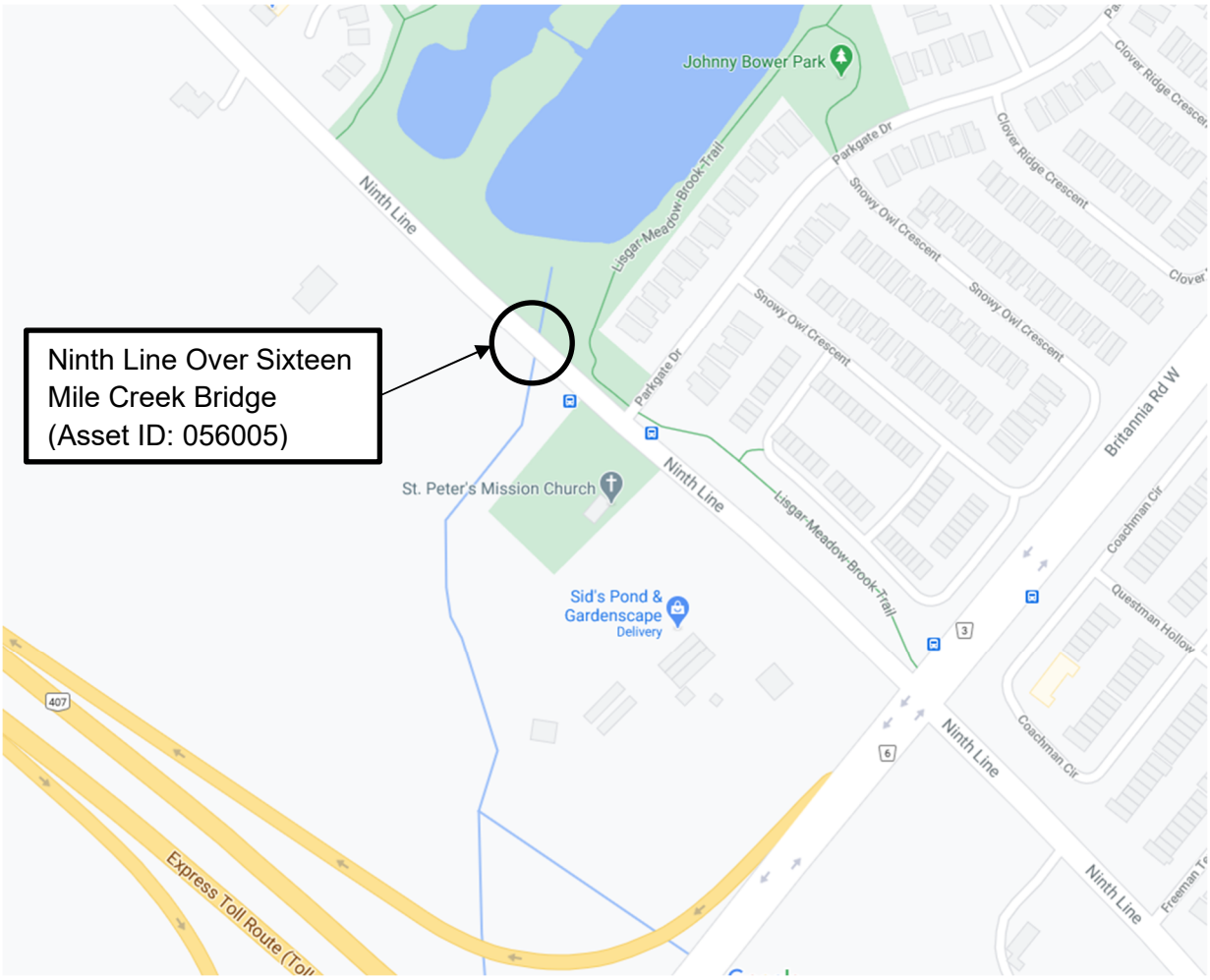
Contents

KEY PLAN


Ninth Line Over Sixteen Mile Creek Bridge (Asset ID: 056005)
Johnny Bower Park
Ninth Line
Lisgar Meadow Brook Trail
Parkgate Dr
Clover Ridge Crescent
Snowy Owl Crescent
Britannia Rd W
St. Peter's Mission Church
Sid's Pond & Gardenscape
Delivery
Coachman Cir
Questman Hollow
407
Express Toll Route
Freeman

1.0 INTRODUCTION

HDR has been retained by the City of Mississauga to carry out an Environmental Assessment and Preliminary Design for the proposed transportation improvements to Ninth Line from Eglinton Avenue West to Derry Road West in the City of Mississauga. This section of Ninth Line is proposed to be urbanized, widened from 2 to 4 lanes, accommodate Active Transportation improvements (sidewalks and cycle tracks) on both sides of Ninth Line, and streetscaping.

This project includes a Structural Assessment based on visual inspection of the culvert structures along the Ninth Line corridor, provide bridge engineering services and preliminary design for the proposed improvement of the culvert structures to accommodate the road widening.

An existing culvert at Osprey Marsh over the Sixteen Mile Creek is located in the corridor, this structure is referred to as Ninth Line over Sixteen Mile Creek Bridge (Asset ID No: 056005) in inspection reports and in this report. This project requires analysis and development of structural design alternatives to accommodate the widening of Ninth Line at this culvert. All the other culverts in the corridor do not require improvements to accommodate the roadway widening of Ninth Line.

This Structural Design Memo provides a comparison of the options to accommodate the widening of Ninth Line over Sixteen Mile Creek Bridge crossing. The options considered includes culvert extension, providing an independent structure at this culvert and culvert replacement. HDR will perform a Preliminary Design of the preferred alternative for the structure to develop technically to a 30% design level of detail and identify environmental impacts and proposed mitigation to obtain approval-in-principle from permitting agencies.

2.0 LOCATION

The Ninth Line over Sixteen Mile Creek Bridge (Asset ID No: 056005) is located approximately 335m north of Britannia Road West, in the City of Mississauga. It currently extends across the northbound and southbound lanes of Ninth Line over Sixteen Mile Creek. The culvert is crossing the Osprey Marsh located on the east side of the structure.

3.0 AVAILABLE INFORMATION

Available information on the existing culvert includes the following:

- Ninth Line Over Sixteen Mile Creek Bridge Biennial Inspection Report (Asset ID: 056005), prepared by Engineered Management Systems Inc., dated May 27, 2019;
- Ninth Line Culvert (Asset ID: 056005), Drawing No. C-32155 to C-32161, prepared by McCormick Rankin, dated April 1996;

4.0 EXISTING CONDITIONS

4.1 GENERAL CONDITIONS

The Ninth Line over Sixteen Mile Creek Bridge was constructed in 1996 and is owned by the City of Mississauga. The structure has a North-South orientation and consists of a 3 cell reinforced concrete box culvert with a total span length of 23.2m and a width of 27.26m. The size of each culvert opening is approximately 7.0m in width and 2.4m in height. Parapet walls with single railing were noted above the east and west headwalls. Four (4) retaining walls and two (2) approach slabs were also noted.

4.2 DRAINAGE

Preliminary hydraulic assessment shows that Ninth Line is overtopped by the Regional storm event at the culvert location. Extending the length of the culvert to accommodate the proposed road widening is anticipated to result in a 0.02 m increase in the Regional upstream flood level, which can be considered negligible. However, since the Regional storm is overtopping Ninth Line, a detailed hydraulic assessment will need to be carried out during detailed design. Raising the road profile at this crossing is not recommended due to a likely increase in upstream and downstream flood impacts. Opportunities to raise the road profile and mitigate potential flooding impacts may be reviewed in Detailed Design with a subsequent detailed hydraulic assessment when more detailed information is available.

4.3 UTILITIES

An existing 675mm diameter storm sewer is located along Ninth line and crosses the Sixteen Mile Creek Bridge. A 300 mm diameter watermain is located on the west side of the existing culvert and may be in conflict with the new extension of the culvert. Detailed utility investigations will need to be carried out at the detailed design stage to determine exact locations of existing utilities. Relocation of some existing utilities may be required to avoid conflict with the new culvert extension.

4.4 CULVERT CONDITION

A Biennial Inspection Report dated May 27, 2019, was carried out by Engineered Management Systems Inc. The findings of this report showed that the culvert was in generally good condition, with the exception of the following:

- Spall, delamination and narrow to medium transverse cracks on concrete sidewalks;
- Medium to wide longitudinal, transverse and map cracks on the asphalt wearing surface. Cracks were recently sealed after the last inspection;
- Narrow to medium cracks on parapet walls; and
- Efflorescence stained cracks inside culvert barrels soffit and walls.

Minor rehabilitation work may be required for the structure including the following:

- Repave asphalt wearing surface;
- Seal concrete cracks; and
- Concrete patch repair.

Furthermore, as part of their mandate, HDR carried out a visual inspection of the Ninth Line over Sixteen Mile Creek Bridge on October 1, 2020. The structural assessment report has been

submitted to the City of Mississauga on November 7, 2020. The inspection verified that the 2019 Biennial Inspection Report findings and recommendations are consistent with the current site conditions.

5.0 CROSS SECTION

5.1 EXISTING CROSS SECTION

The existing Ninth Line carries two (2) lanes of traffic in each direction with a centre left turn lane with intermittent sidewalks at key intersections of Ninth Line. The existing Ninth Line does not have a raised centre median.

5.2 PROPOSED CROSS SECTION

The proposed cross-section of Ninth Line at the Sixteen Mile Creek Bridge will consist of two (2) 3.5m wide traffic lanes one on each side of Ninth Line, two (2) 3.35m wide traffic lanes one on each side of Ninth Line and one (1) 3.35m wide left turn lane in the centre of Ninth Line as shown in the proposed cross section figure below.

Two (2) 2.0m wide in-boulevard cycle track and two (2) 2.0m sidewalk will be located one on each side of Ninth Line as shown in the proposed cross section figure below. There are 1.0m buffers on both side of the active transportation facilities, pedestrian/cyclist railings, 1.7m shoulders on each side of Ninth Line and one (1) 1.65m centre median provided on the structure.

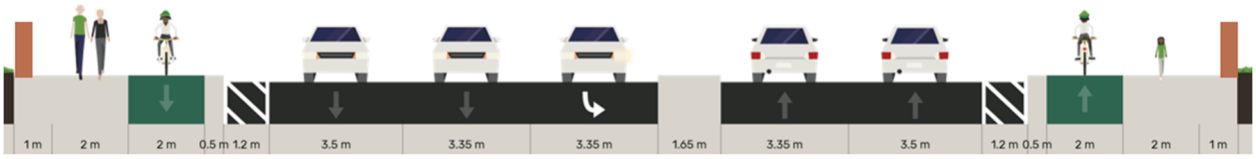


Figure 1 – Cross Section at Ninth Line over Sixteen Mile Creek Bridge

6.0 GEOTECHNICAL INVESTIGATION

Thurber Engineering Ltd. carried out a preliminary geotechnical investigation in August 2020. The following summarizes the findings of the investigation and recommendations. The Preliminary Geotechnical Investigation Report was issued on April 9, 2021.

In general, the subsurface conditions generally consist of asphalt and granular fill to a depth of between 0.5m and 1.0m, covering native firm to very stiff silty clay to a depth of 4.1m and overlaying firm to stiff silty clay till to at least 5.2m depth. Ground water level was measured at approximately Elevation 187.3m.

The geotechnical report proposed that the base of the culvert extension should be placed at the same level or lower than the existing culvert base and founded on native stiff to hard or compact to very dense soil. The base of the Ninth Line over Sixteen Mile Creek Bridge is at approximate Elevation 186.7 m, which corresponds to firm to stiff silty clay till. Due to the size of this culvert,

additional deeper boreholes should be advanced during detailed design to confirm the founding soil conditions.

The report also proposes that all existing fill, topsoil, organic/streambed deposits and soft / loose soils should be removed from the culvert subgrade prior to placement of the culvert bedding material and recommends that the exposed base shall be inspected and approved by a geotechnical engineer. The geotechnical report also recommends that subgrade below the culvert extension on the firm silty clay be sub-excavated down to the underlying stiff to very stiff silty clay till and replaced with compacted Granular A or Granular B Type II material to the appropriate subgrade level, in order to minimize the potential for differential settlement on the subgrade silty clay or silty clay till. If it is necessary to maintain the culvert extension at the same or lower elevation as the existing culvert during detailed design, the grade may be raised using Granular A backfill, compacted to 100% of SPMDD.

A minimum 300 mm thick layer of bedding material conforming to OPSS.MUNI 1010 Granular A or Granular B Type II requirements should be provided under the base of the box culvert extension as per OPSD 803.010. Following inspection and approval, the bedding material should be placed on the prepared subgrade as soon as practicable. A 75 mm minimum thick top levelling course consisting of uncompacted Granular A should be provided to support the box culvert as per OPSS 422. All subgrade preparation, placement and compaction of the bedding material should be carried out in the dry. Construction equipment is not allowed on the bedding or the prepared subgrade during construction and the bedding should be protected from disturbance.

The recommended culvert factored bearing resistance is 225kPa at ULS and the bearing resistance at SLS is 150kPa for up to 25mm settlement. A consequence factor of 1.0 was adopted. Geotechnical resistance factor of 0.5 for bearing and 0.8 for settlement were used to obtain the bearing resistance as per Canadian Highway Bridge Design Code (CHBDC) 2019. An ultimate coefficient of friction of 0.45 shall be assumed, to calculate the resistance to sliding between the concrete and the underlying Granular A or B Type II bedding material. The geotechnical resistances are for vertical, concentric loads, if eccentric or inclined loads are applied, the resistance values used must be reduced in accordance with CHBDC 2019, Clause 6.10.3 and Clause 6.10.4.

Frost penetration at this culvert is at approximately 1.2 m. Frost treatment as per OPSD 803.010. shall be included if the concrete box culvert extension is constructed within the frost penetration depth.

Free-draining, non-frost susceptible granular materials conforming to OPSS Granular A or Granular B Type II requirements, shall be used for the backfill to the culvert extension and headwall. Widened embankment slopes beyond the culverts should be constructed at the same slope inclination as the existing embankment, but not steeper than 2H:1V.

Erosion protection should be provided at the culvert extension inlet and outlet areas. In order to minimize the potential for seepage through the granular bedding and backfill material and avoid consequent erosion of these materials, a concrete/steel cut-off wall or clay seal should be installed at the culvert inlet. The clay seal should have a minimum thickness of 0.5m, completely surround the culvert, extend laterally the width of the granular backfill material, extend above the high water level and the material used should conform to the requirements of OPSS 1205.

7.0 PROPOSED OPTION

7.1 OPTION 1 – CULVERT EXTENSION

The existing 3 cell reinforced concrete box culverts will be extended to accommodate the widening of Ninth Line at Sixteen Mile Creek. Three reinforced concrete box culvert cells will be added on each of the east and west side of the culvert for a total culvert width of 32.5m. The existing retaining walls will be removed, and 4 new retaining walls will be constructed at the end of the culvert. A portion of the existing concrete slope will be removed to facilitate the new culvert extension construction, the concrete slope will then be reinstated after construction of the new culvert extension.

Based on the hydraulic analysis results, the clearance between the soffit of the top slab and the normal water level cannot satisfy the requirements in CHBDC. A detailed hydraulic assessment will need to be carried out during detailed design.

The capital cost for this construction will be $1,704,000. This option is the technically preferred alternative with supporting hydraulic modelling and analysis to be completed and confirmed during Detailed Design.

7.2 OPTION 2 – INDEPENDENT STRUCTURE

The existing 3 cell reinforced concrete box culverts will remain. Additional three (3) reinforced concrete box culvert cells will be added as an independent structure on each of the east and west side of the culvert for a total culvert width of 32.5m. The existing retaining walls will be removed, and 4 new retaining walls will be constructed at the culvert. A portion of the existing concrete slope will be removed to facilitate the new independent structure construction, the concrete slope will then be reinstated after construction of the new culvert extension.

Based on the hydraulic analysis results, the clearance between the soffit of the top slab and the normal water level cannot satisfy the requirements in CHBDC. A detailed hydraulic assessment will need to be carried out during detailed design. The capital cost for this construction will be $1,635,000. This option is not recommended as there will be various durability and maintenance issues if this option was to be chosen.

7.3 OPTION 3 - STRUCTURE REPLACEMENT

The existing 3 cell reinforced concrete box culverts will be replaced with a new 2 span voided slab girder, matching the existing hydraulic opening for a total culvert span of 32.5m. The existing retaining walls will be removed, and new abutments and wing walls will be constructed. A portion of the existing concrete slope will be removed to facilitate the new voided slab girder construction, the concrete slope will then be reinstated after construction.

Based on the hydraulic analysis results, the clearance between the soffit of the structure and the normal water level cannot satisfy the requirements in CHBDC as raising the road profile is not recommended. A detailed hydraulic assessment will need to be carried out during detailed design.

The capital cost for this structure will be $4,660,000. This option is not recommended due to the high cost involved.

8.0 SUMMARY OF OPTIONS

The table below is a summary of the advantages and disadvantages of the 3 Options:

Ninth Line over Sixteen Mile Creek Bridge	Option 1 – Culvert Extension	Option 2 - Independent Structure	Option 3 - Structure Replacement
Description	The existing reinforced concrete box culverts will be extended to accommodate the widening of Ninth Line at the Sixteen Mile Creek Bridge. Three (3) reinforced concrete box culvert cells will be added on each of the east and west side of the culvert for a total culvert width of 32.5m	The existing 3 cell reinforced concrete box culverts will remain. Additional three (3) reinforced concrete box culvert cells will be added as an independent structure on each of the east and west side of the culvert for a total culvert width of 32.5m.	The existing 3 cell reinforced concrete box culverts will be replaced with a new 2 span voided slab girder, matching the existing hydraulic opening for a total culvert span of 32.5m.
Capital Cost	$1,704,000	$1,635,000	$4,660,000
LCCA (at Year 50)	$ 2,410,921	$ 2,686,798	$ 5,401,374
Utilities	Overhead power lines will likely impact the bridge construction. The existing 300mm diameter watermain may be in conflict with the new culvert extensions and may need to be relocated.	Overhead power lines will likely impact the bridge construction. The existing 300mm diameter watermain may be in conflict with the new independent culvert structure and may need to be relocated.	Overhead power lines, existing 675mm dia. storm sewer and existing 300mm diameter watermain will have a significant impact on the replacement of the existing culvert structure and may need to be relocated. There may be other existing utilities like gas lines, other watermains, or sewer lines below Ninth Line roadway that may also impact the construction of the new culvert structure.
Environmental Concerns and Mitigation Measures	As long as the water is diverted from upstream of the culvert and released downstream for the fish habitat downstream of the culvert during construction of the culvert extension, there	As long as the water is diverted from upstream of the culvert and released downstream for the fish habitat downstream of the culvert during construction of the independent culvert structure, there is no environmental concerns and	The creek at the Ninth Line over Sixteen Mile Creek Bridge does not directly support fish habitat, but the flow conveyed contributes to downstream fish habitat. As long as the water is diverted during

Ninth Line over Sixteen Mile Creek Bridge	Option 1 – Culvert Extension	Option 2 - Independent Structure	Option 3 - Structure Replacement
	is no environmental concerns and there will be no impact to Sixteen Mile Creek as it does not directly support fish habitat.	there will be no impact to Sixteen Mile Creek as it does not directly support fish habitat.	construction from upstream of the culvert and released downstream for the fish habitat downstream of the culvert, there is no environmental concerns and no impact to Sixteen Mile Creek at the culvert.
Constructability	Common construction materials and techniques will be required for the extension of the culvert. There will be minimal in-water works required to extend the culvert, the water in the culvert can de temporarily diverted during construction. The site is readily accessible from Ninth Line.	Common construction materials and techniques will be required for the extension of the culvert. There will be minimal in-water works required to extend the culvert, the water in the culvert can de temporarily diverted during construction. The site is readily accessible from Ninth Line.	Common construction materials and techniques will be required for the construction of the new bridge. There will be significant in-water works required to remove the existing culvert and to construct the new culvert. Water in the existing culvert can de temporarily diverted during construction. The site is readily accessible from Ninth Line.
Traffic	Traffic can be maintained in the existing two lanes in the centre of Ninth Line at the Sixteen Mile Creek Bridge. The new culvert extension construction can be staged. A traffic staging plan will need to be developed during the detailed design stage in consultation with the City of Mississauga.	Traffic can be maintained in the existing two lanes in the centre of Ninth Line at the Sixteen Mile Creek Bridge. The new independent culvert structure can be constructed in stages. A traffic staging plan will need to be developed during the detailed design stage in consultation with the City of Mississauga.	Traffic cannot be maintained on Ninth Line at the Sixteen Mile Creek Bridge during construction of the new voided slab girder. Traffic will need to be diverted.
Durability/ Maintenance	The existing concrete box culverts are 25 years old and will likely not need to be replaced for another 40 to 50 years due to its current age and condition of the culvert. Regular conventional maintenance will be required.	The existing concrete box culverts are 25 years old and will likely not need to be replaced for another 40 to 50 years due to its current age and condition of the culvert. However, the new independent structure may require additional maintenance and may cause differential settlements. Due to increased freeze thaw effects, the life expectancy	The new voided slab girder bridge will not need to be replaced for another 75 years. Regular conventional maintenance will be required.

Ninth Line over Sixteen Mile Creek Bridge	Option 1 – Culvert Extension	Option 2 - Independent Structure	Option 3 - Structure Replacement
		of the structure may also be decreased.	
Technically Preferred Alternative	**Recommended Option**		

9.0 RECOMMENDATION

Option 1 - Culvert Extension is the technically preferred alternative. This option involves extending the existing culvert with new 3 cell reinforced concrete box culverts on each side of Ninth Line. This is the most cost-effective option and in addition to that, there will be less impact to traffic during construction, lower impact to the environment and it is much less complex to construct compared to the other 2 options.

10.0 ENVIRONMENTAL Constraints

There are no Provincially Significant Wetlands (PSW), and no Natural and Scientific Interest (ANSIs) within 120m of the study area. There are minor impacts to vegetation due to construction of the road widening.

11.0 MISCELLANEOUS

11.1 DESIGN Code

The design of the bridges and retaining walls will be undertaken in accordance with the CAN/CSA-S6—19 Canadian Highway Bridge Design Code (CHBDC), Ministry of Transportation of Ontario's "Structural Manual", and all other current directives and standards.

11.2 ACCESS to the Site

The site is readily accessible from Ninth Line. The number of traffic lanes will be maintained on Ninth Line throughout the construction. A traffic staging plan will be developed during the detailed design in consultation with the City of Mississauga and Peel Region.

11.3 PROPERTY

Property acquisition is anticipated on either side of the Ninth Line within the project limits.

11.4 CONCRETE

All cast-in-place concrete will be class C—1 concrete as per CSA A23.I.

11.5 REINFORCING Steel

Stainless steel reinforcement will be used in areas of the components where their surfaces are within the splash zone.

For all other components, black steel (Grade 400W) will be used as specified in Section 12 of the MTO Structural Manual and the MTO Bridge Office Memorandum dated November 22, 2010 “Reinforcing Steel”.

11.6 PARAPET Wall and Railing

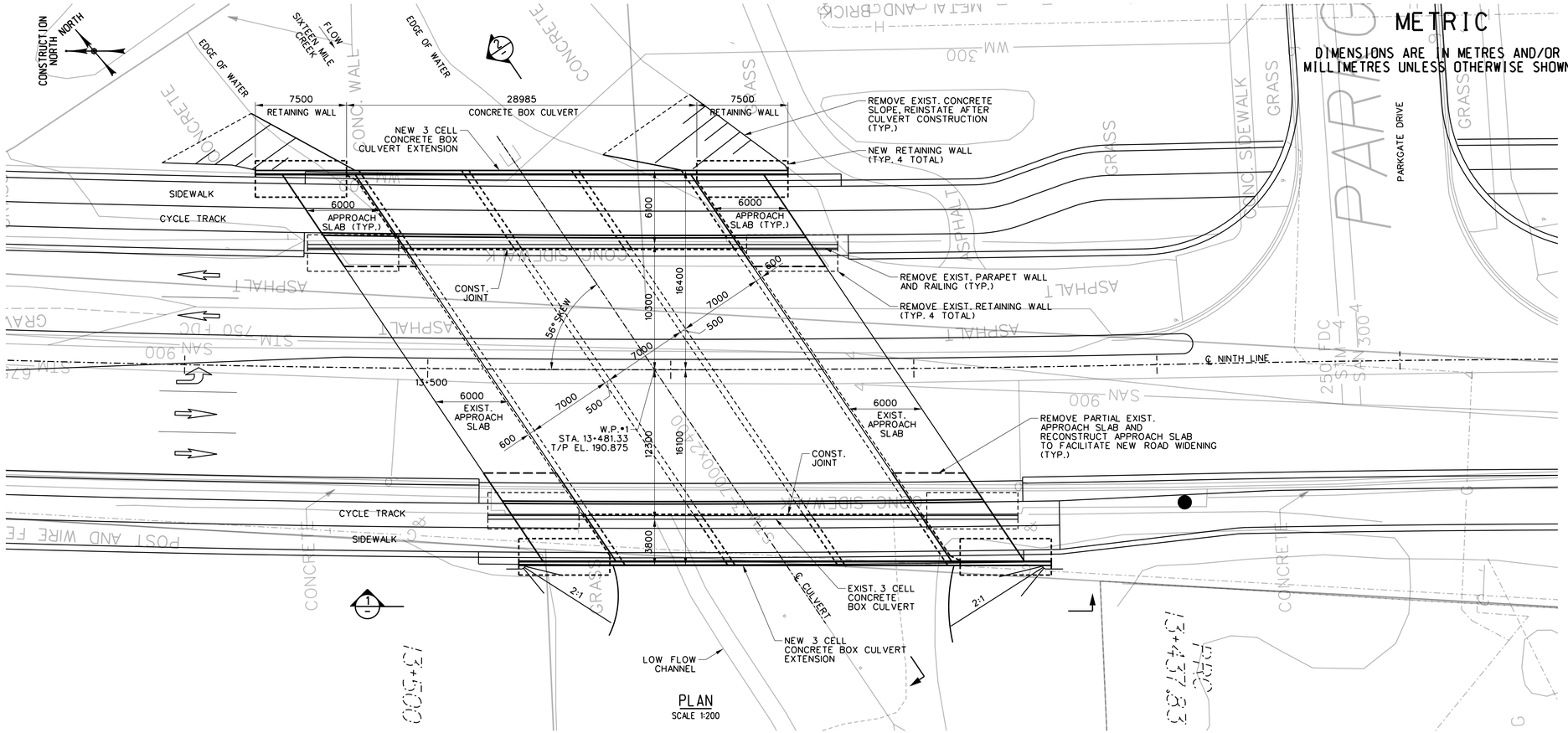
Parapet wall and railing in accordance with MTO standard structure drawing of SS 110-83 is provided for combination traffic/bicycle rail as shown in the General Arrangement (GA) drawing. Alternatively, since the bridge is being overtopped during flood condition we can consider providing a modified four tube railing on multi-use path, TL-4 (SS 110-46) to permit unobstructed flow water.

11.7 CATWALK FOR WILDLIFE PASSAGE

Requirement of a catwalk for small to medium wildlife passage across Ninth Line shall be confirmed in both the existing/proposed culvert structure during Detailed Design.

A

Appendix



PLAN
SCALE 1:200

METRIC

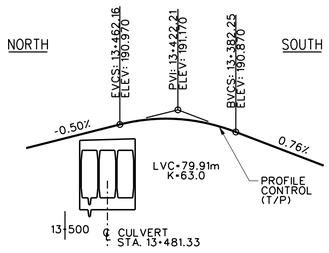
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

SERVICE DATA					
SERVICE	DATE	INIT.	SERVICE	DATE	INIT.
SAN. SEWERS			GAS MAINS		
STM. SEWERS			BELL U/G CABLE		
WATERMAINS			HYDRO U/G CABLE		
M.O.E.			ROGERS U/G CABLE		

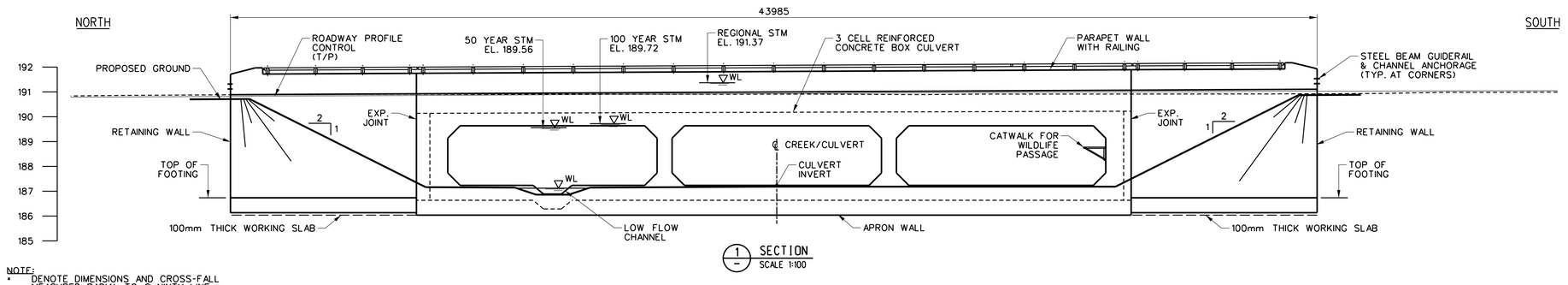
REVISIONS		
DATE	DETAILS	INIT.

NOTES

1. DESIGN OF THE CIP CONCRETE CULVERT EXTENSION, HEADER WALLS AND RETAINING WALLS SHALL BE IN ACCORDANCE WITH THE CANADIAN HIGHWAY BRIDGE DESIGN CODE, CAN/CSA-S6-14. LIVE LOAD SHALL BE CL-625-ONT.
2. SEE ROADWAY DRAWINGS FOR ALIGNMENT AND PROFILE DETAILS.
3. EXISTING UTILITIES MAY BE IN CONFLICT WITH NEW CULVERT EXTENSION
4. CLEARANCE HEIGHT FOR THE WILDLIFE CROSSING CATWALK SHALL BE PROVIDED BY THE NATURAL HERITAGE SUB DURING THE DETAILED DESIGN STAGE.



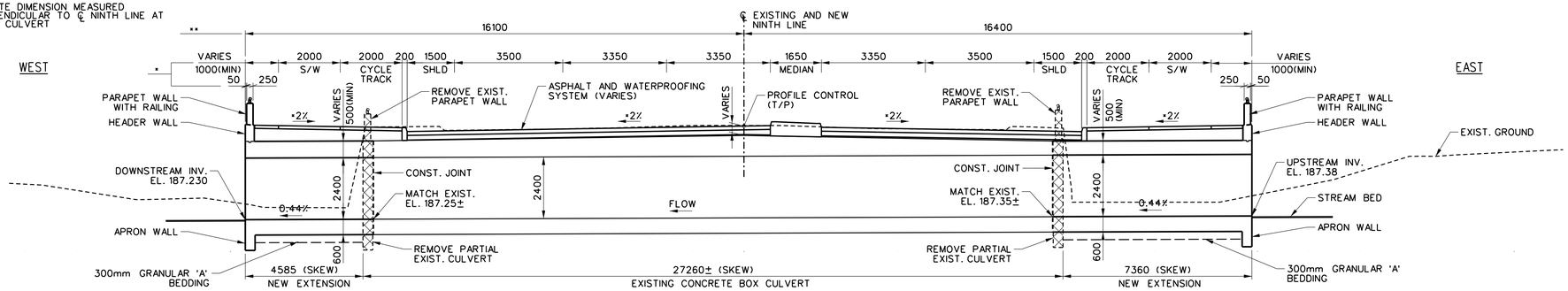
NEW NINTH LINE PROFILE
N.T.S.



1/- SECTION
SCALE 1:100

NOTE:
* DENOTE DIMENSIONS AND CROSS-FALL MEASURED RADIAL TO ℄ NINTH LINE

** DENOTE DIMENSION MEASURED PERPENDICULAR TO ℄ NINTH LINE AT ℄ OF CULVERT



2/- SECTION
SCALE 1:100

NOT FOR CONSTRUCTION

DESIGN BY	APPROVED BY
SS C.E.T.	
DEPARTMENTAL APPROVAL	
SILVIO CESARIO P.ENG.	

MISSISSAUGA
PRODUCED FOR - T&W, ENGINEERING AND WORKS

HDR
100 York Blvd., Suite 300,
Richmond Hill, ON, L4B 1J8
Ph. (289) 695-4600
Fax. (289) 695-4601

NINTH LINE
SIXTEEN MILE CREEK CROSSING
GENERAL ARRANGEMENT

SCALE AS SHOWN	AREA	PROJECT No. 10214514
C.A.D.D. BY MN	CHECKED BY GH	PLAN No. S01
DATE APRIL 12, 2021	SHEET	