

BRIDGE CHECK CANADA

Your Bridge & Concrete Inspection Specialists

DETAILED CONDITION SURVEY REPORT

Site No. 34-455/C, QEW @ Frenchman's Creek Culvert
Fort Erie, ON

Prepared for: AECOM

BCC Project No.: BCC18046
Report Date: October 22, 2018

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Structure Identification Sheet

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STRUCTURE IDENTIFICATION SHEET

GENERAL INFORMATION			
STRUCTURE NAME	***QEW @ Frenchman's Creek Culvert***		
SITE NUMBER	34-455/C	**DISTRICT NUMBER**	N/A
HIGHWAY	**above** QEW, E-W & E-E Ramps	**Below**	Frenchman's Creek
TYPE OF STRUCTURE	Reinforced cast-in-place concrete open footing culvert, rigid frame		
NUMBER OF SPANS	1	**CULVERT LENGTH**	70.00m
BARREL WIDTH	6.70m	**YEAR BUILT**	
DIRECTION OF STRUCTURE	East to West		
SEQUENCE NUMBER	N/A	**TOWNSHIP NUMBER**	N/A
LHRS NUMBER	N/A	**MUNICIPAL BRIDGE NUMBER**	N/A
LOCATION	Fort Erie, ON	**JURISDICTION**	MTO
INSPECTOR'S NAME	Alireza Keramati, P.Eng.		
PARTY MEMBERS	Mohammad Abdollahi, Mahdi Mahyar, Keyvan Vahedi		
DATE OF INSPECTION	16-Aug-18		
TEMPERATURE	28 °C	**WEATHER**	sunny
MTO REGION	Central	**AADT**	
DECK RIDING SURFACE	Asphalt		
YEAR LAST REHABILITATED	N/A		

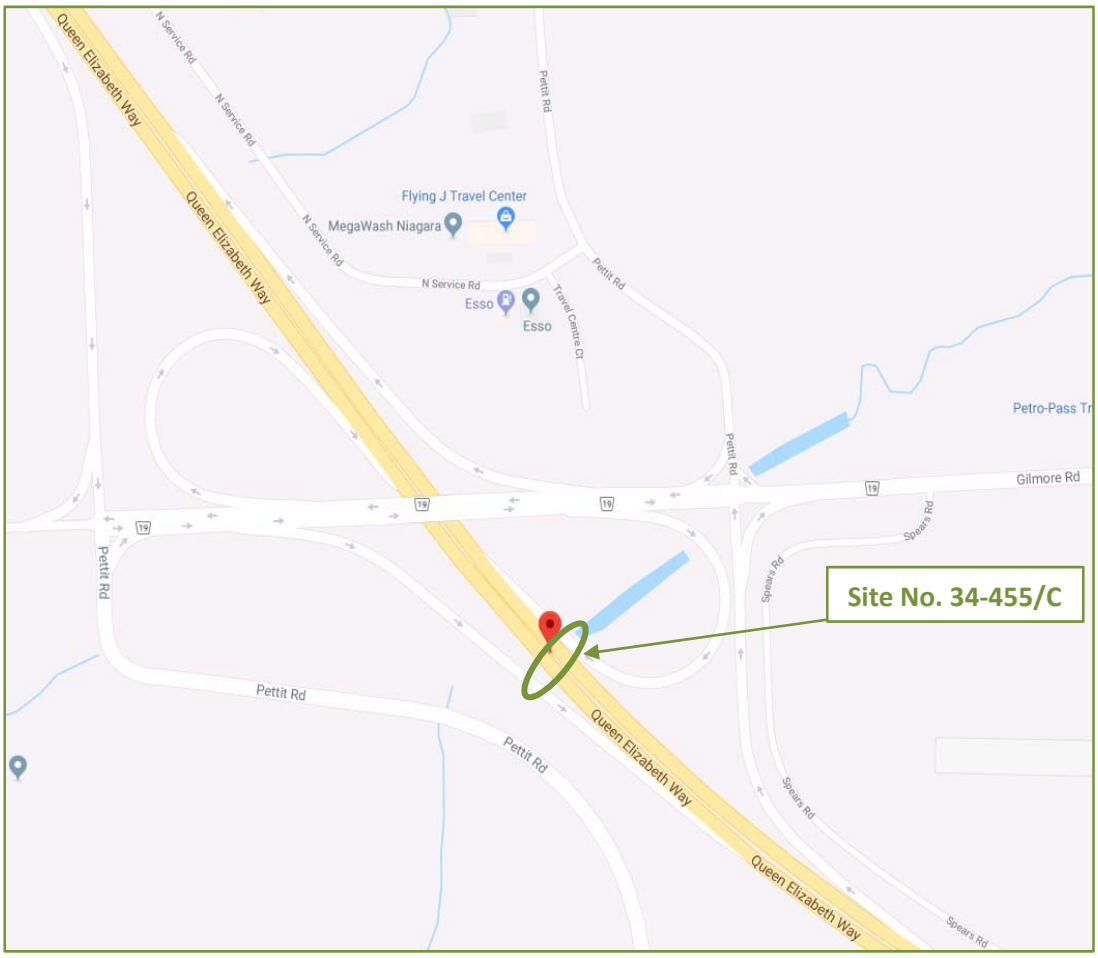
ENGINEER'S STAMP



Key Plan

KEY PLAN

Site No. 34-455/C, QEW @ Frenchman's Creek Culvert
Fort Erie, ON





Summary of Significant Findings

SUMMARY OF SIGNIFICANT FINDINGS

Site No. 34-455/C, QEW @ Frenchman's Creek Culvert, Fort Erie, Ontario

1.0 INTRODUCTION

Bridge Check Canada Ltd. was retained by AECOM to carry out detailed condition survey for two structural culverts and one non-structural culvert under MTO Central Region's Agreement # 2016-E-0029-008. This report presents *Bridge Check Canada's* findings, through the field investigations and laboratory testing, for the QEW E-W and E-E ramps (Site No. 34-455/C) located on QEW, 0.1 km south of Gilmore Road, in Fort Erie, Ontario. The investigation included visual condition survey, GPR survey to identify reinforcement steel cover and spacing, concrete cores to determine the compressive strength, and tensile/yield strengths of the reinforcing steel. The field investigations were carried out on August 16, 2018. In this investigation, *Bridge Check Canada Ltd.* deployed an innovative radar scan technology, Hilti PS 1000 X-Scan Radar Detection System, also referred to as the Ground Penetrating Radar (GPR), to identify rebar sizes, spacing, and concrete covers.

The site consists of a single span reinforced cast-in-place concrete open footing culvert, with a barrel width of 6.70 m and culvert length of 70.00 m. The structure has an east-west orientation. Photo P1 shows a view of the east elevation of the site. Photo P2 shows the west elevation. Photo P12 shows a view of the QEW at the culvert location. Drawing 1 shows the site plan.



East Elevation of Site No. 34-455/C

Rehabilitation history of the culvert is not available.

2.0 METHODOLOGY

This assignment involved general observation of surface defects, grid layouts (1.0 m x 1.0 m), concrete cores (100 mm ø), physical testing of the concrete cores, GPR survey, and testing of the reinforcing steel.

A Hilti PS 1000 X-Scan Radar Detection System was used to produce images of embedded reinforcing steel inside the exposed concrete components. The system consisted of a hand-guided scanner with a color display, a portable monitor unit for on-site use in conjunction with a professional computer software for the image evaluation and data management. Objects were shown as either 2D or 3D images for on-the-spot interpretation. The Hilti PS 1000 was used to identify rebar sizes, spacing and concrete covers. The device was also used to help find and mark reliable drilling locations to limit the damage to the embedded reinforcing steel.

Five (5) cores were taken from the barrel walls at locations shown on Drawing 2. The inside of the coreholes were examined carefully for cracks and the condition of the concrete. All the test holes were reinstated to their original condition using MTO-approved products.

Enclosed with this report are detailed condition survey summary sheets, survey equipment and calibration procedures, core photos/sketches, core logs, site photos, laboratory test results, and drawings.

3.0 CULVERT STRUCTURE

3.1 East Elevation/Headwall

The deteriorations of the east elevation/headwall are shown on Drawing 2 and in Photos P1, P3 to P6. The east elevation, with a total surveyed area of 18.80 m^2, was in fair-to-poor condition with stained medium width cracks (9.0 m), delaminations (1.40 m^2), and spalls (3.80 m^2). Exposed corroded reinforcement was observed in the spalled areas.

3.2 West Elevation/Headwall

The deteriorations of the west elevation/headwall are shown on Drawing 2 and in Photos P2, P7 to P11. The west elevation, with a total surveyed area of 18.60 m^2, was in fair-to-poor condition with delaminations (1.50 m^2), spalls (4.60 m^2), and honeycombing (0.45 m^2). Exposed corroded reinforcement was observed in the spalled areas.

3.3 Barrel Soffit

The deteriorations of the soffit are shown on Drawing 2 and in Photos P13 to P20. The barrel soffit, with a total surveyed area of 454.70 m^2, was in fair condition with clean/stained medium width cracks (116.0 m), clean/stained wide width cracks (14.0 m), delaminations (4.60 m^2), light scaling (0.68 m^2), and wet areas (51.20 m^2). The cracks were mainly transverse. The wet areas were found at soffit ends and along the transverse cracks.

3.4 Barrel North Wall

The deteriorations of the barrel's north wall are shown on Drawing 2 and in Photos P21 to P26. The north wall, with a total surveyed area of 69.50 m^2, was in fair-to-good condition with clean/stained medium width cracks (10.0 m), spalls (0.25 m^2), and wet areas (4.62 m^2). The cracks were mainly vertical. Core C5 was taken from the north wall at a location shown on Drawing 2. No defects were observed in the concrete core. No reinforcement was encountered in this corehole. Refer to the core logs and photos.

The chloride ion content was determined for Core C5 using MTO LS-417 "Method of Test for Determination of Total Chloride Ion in Concrete – Acid Soluble". The corrected chloride content, at the rebar level, was found to be 0.000% (the background chloride ion content was estimated to be 0.011%). The chloride threshold value necessary to depassivate embedded steel and to allow the onset of corrosion (in the presence of oxygen and moisture) is generally taken as 0.025% by mass of concrete. The background chloride content is the lowest chloride content value for all of the cores tested for chloride content. The "background" chlorides do not contribute to corrosion, and thus the results are corrected for the background chloride content. The corrected chloride content, at the rebar level, was below the chloride threshold level of 0.025% in core C5, indicating that the chloride contamination has not yet extended to the rebar level in this corehole location.

3.5 Barrel South Wall

The deteriorations of the barrel's south wall are shown on Drawing 2 and in Photos P27 to P31. The south wall, with a total surveyed area of 69.50 m^2, was in fair-to-good condition with clean/stained medium width cracks (12.0 m), spalls (0.10 m^2), and wet areas (5.50 m^2). The cracks were mainly vertical. Cores C1 to C4 were taken from the south wall at locations shown on Drawing 2. No defects were observed in the concrete cores. Reinforcement steel was encountered in core C3, exhibiting light rusting. Cores C1 and C2 were tested for compressive strength of the hardened concrete in accordance with CSA A23.2-14-14C. The compressive strength for each of these cores was found to be 51.2 MPa and 62.1 MPa, respectively with average of 56.6 MPa. Refer to the core logs and photos.

Core C4 was tested to determine the air void system of the hardened concrete in accordance with ASTM C457 using the Modified Point Count Method. Test results are summarized below. Concrete is normally considered to be properly air entrained if the air content exceeds 3.0%, the specific surface exceeds 24 mm^{-1}, and the average spacing factor is less than 0.200 mm. Therefore, the air void system for core C4 is considered air entrained with the exception of the spacing factor.

Core No.	Air Content (%)	Specific Surface (mm^{-1})	Spacing Factor (mm)
C4	5.4	24.36	0.207

The corrected chloride ion content, at the rebar level, for core C3 was found to be 0.001% (the background chloride ion content was estimated to be 0.011%), indicating that the chloride contamination has not yet extended to the rebar level in this corehole location.

4.0 REVIEW OF REINFORCING STEEL

A rebar sample of about 320 mm length was taken from the east headwall (where shown on Drawing 2) and tested by Cambridge Materials Testing Limited to determine the yield and ultimate tensile strengths according to ASTM A370-17a. Photo P35 and P36 show the rebar sample before and after washing, respectively. The yield strength of the rebar sample was found to be 455 MPa (66,000 psi). The ultimate tensile strength for this rebar sample was found to be 710 MPa (103,000 psi). The test results are given in Appendix E.

5.0 GPR SURVEY RESULTS

A Hilti PS 1000 X-Scan GPR System was used to identify rebar spacing and concrete cover at three locations shown on Drawing 3. The 2D and 3D images are given in Photos P37 to P42. The rebar size, spacing and depth are shown on Drawing 3. The GPS scan identified 29M (transverse) and 29M (longitudinal) rebar size in the top slab. Further, the GPR identified 25M rebar size in the barrel walls. In general, the rebar depth (concrete cover) in the culvert top slab (GPR Location 1) varied from 33 mm to 65 mm, while the rebar spacing at this location was measured at 340 mm. The rebar depth in the culvert walls (GPR Locations 2 and 3) varied from 75 mm to 100 mm, while the rebar spacing at these locations varied from 160 mm to 325 mm.

Appendix A:

Detailed Condition Survey Summary Sheets

Exposed Concrete Components

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EXPOSED CONCRETE COMPONENTS (Exposed Deck, Deck Soffit, Curbs, Medians, Sidewalks, Barrier/Parapet Walls, etc.): Use separate form for each component

Site No: **34-455/C**

Component Type & Location: East Elevation **OSIM Identifier: Culverts**

1. Dimensions and Area

Width	-	Length	-	Height	-
Diameter	-	Total Area Surveyed	18.80 m²		

Remarks

Dimensions were taken from the structural drawings & site measurements

2. Cracks (medium and wide)

Type		Vertical	Horizontal	Diagonal	Total	
Medium Width	**Clean**	0.0	0.0	0.0	9.0	**m**
	Stained	0.0	7.0	2.0		
Wide Width	**Clean**	0.0	0.0	0.0	0.0	**m**
	Stained	0.0	0.0	0.0		

3. Alkali Aggregate Reaction

Area of component with severe to very severe aggregate reaction 0.0 m²

4. Concrete Cover

Minimum	Maximum	Average	
-	-	-	**mm**

0 – 20 mm	-	**40 – 60 mm**	-	m^2
	-		-	%
20 – 40 mm	-	**over 60 mm**	-	m^2
	-		-	%

Remarks

Table # 4 is Not Applicable.

Site No: **34-455/C**

Component Type & Location: East Elevation **OSIM Identifier: Culverts**

Remarks
Table # 5 is Not Applicable.

5. Corrosion Activity

Minimum	Maximum	Average	
-	-	-	V

0 to -0.20	-0.20 to -0.30	-0.30 to -0.35	-0.35 to -0.45	< -0.45	V
-	-	-	-	-	m^2
-	-	-	-	-	%

Remarks

6. Delaminations and Spalls

Defect Type	Delaminations	Spalls	Patches
Area (m^2)	1.40	3.80	0.00
Total Delaminations and Spalls		Total Delaminations and Spalls in Areas ≤-0.35 V	
5.20 m²	27.7 %	N/A	N/A

*Wet areas = 0.00 m²

7. Scaling

Remarks

Light	Medium	Severe to Very Severe	
0.00	0.00	0.00	m^2
0.0	0.0	0.0	%

8. Honeycombing

Total Area 0.00 m²

Site No: **34-455/C**

Component Type & Location: East Elevation **OSIM Identifier: Culverts**

Remarks
Table # 9 and 10 are Not Applicable.

9. Adjusted Chloride Content Profile

Corrosion Activity at Core Location (volts)		0 to -0.20	-0.20 to -0.35	≤ -0.35
Chloride Content*	0-10 mm	-	-	-
	20-30 mm	-	-	-
	40-50 mm	-	-	-
	60-70 mm	-	-	-
	80-90 mm	-	-	-
	100-110 mm	-	-	-

* Average chloride content as % chloride by weight of concrete after deducting background chlorides for all cores taken in each range of corrosion potential.

10. Chloride Content at Rebar Level

Core No.	-	-	-	-	-	-
Chloride Content*	-	-	-	-	-	-

* Chloride content as % chloride by weight of concrete after deducting background chlorides.

Remarks
Table # 11 is Not Applicable.

11. AC Resistance Test Data of Epoxy Coated Rebar

Measured AC Resistance between Connection #1 and #2						Calculated AC Resistance *
Connection #1	Connection #2					
	G1	G2	G3	G4	G5	
G1	N/A	-	-	-	-	-
G2	-	N/A	-	-	-	-
G3	-	-	N/A	-	-	-
G4	-	-	-	N/A	-	-
G5	-	-	-	-	N/A	-

* See Appendix 1E for calculating AC resistance contributed by individual rebar.

Site No: **34-455/C**

Component Type & Location: East Elevation **OSIM Identifier: Culverts**

Remarks
Table # 12 is Not Applicable.

12. IR Drop and True Half Cell Potential Measurements of Epoxy Coated Rebar

IR Drop Between Connection #1 and #2						True Half Cell Potential *
Connection #1 (positive)	Connection #2 (negative)					
	G1	G2	G3	G4	G5	
G1	N/A	-	-	-	-	-
G2	-	N/A	-	-	-	-
G3	-	-	N/A	-	-	-
G4	-	-	-	N/A	-	-
G5	-	-	-	-	N/A	-

* Half cell reading taken on the same rebar with the ground connection.

13. Concrete Air Entrainment

Concrete Air Entrained: not tested

14. Compressive Strength

Average Compressive Strength: not tested

DETAILED CONDITION SURVEY SUMMARY SHEET

EXPOSED CONCRETE COMPONENTS (Exposed Deck, Deck Soffit, Curbs, Medians, Sidewalks, Barrier/Parapet Walls, etc.): Use separate form for each component

Site No: **34-455/C**

Component Type & Location: West Elevation

OSIM Identifier: Culverts

1. Dimensions and Area

Width	-	Length	-	Height	-
Diameter	-	Total Area Surveyed	18.60 m²		

Remarks

Dimensions were taken from the structural drawings & site measurements

2. Cracks (medium and wide)

Type		Vertical	Horizontal	Diagonal	Total	
Medium Width	**Clean**	0.0	0.0	0.0	0.0	**m**
	Stained	0.0	0.0	0.0		
Wide Width	**Clean**	0.0	0.0	0.0	0.0	**m**
	Stained	0.0	0.0	0.0		

3. Alkali Aggregate Reaction

Area of component with severe to very severe aggregate reaction 0.0 m²

4. Concrete Cover

Minimum	Maximum	Average	
-	-	-	**mm**

0 – 20 mm	-	**40 – 60 mm**	-	m^2
	-		-	%
20 – 40 mm	-	**over 60 mm**	-	m^2
	-		-	%

Remarks

Table # 4 is Not Applicable.

Site No: **34-455/C**

Component Type & Location: West Elevation **OSIM Identifier: Culverts**

Remarks
Table # 5 is Not Applicable.

5. Corrosion Activity

Minimum	Maximum	Average	
-	-	-	V

0 to -0.20	-0.20 to -0.30	-0.30 to -0.35	-0.35 to -0.45	< -0.45	
-	-	-	-	-	V
-	-	-	-	-	m^2
-	-	-	-	-	%

6. Delaminations and Spalls

Remarks

Defect Type	Delaminations	Spalls	Patches
Area (m^2)	1.50	4.60	0.00
Total Delaminations and Spalls		Total Delaminations and Spalls in Areas ≤-0.35 V	
6.10 m²	32.8 %	N/A	N/A

*Wet areas = 0.00 m²

7. Scaling

Remarks

Light	Medium	Severe to Very Severe	
0.00	0.00	0.00	m^2
0.0	0.0	0.0	%

8. Honeycombing

Total Area 0.45 m²

Site No: **34-455/C**

Component Type & Location: West Elevation **OSIM Identifier: Culverts**

Remarks
Table # 9 and 10 are Not Applicable.

9. Adjusted Chloride Content Profile

Corrosion Activity at Core Location (volts)		0 to -0.20	-0.20 to -0.35	≤ -0.35
Chloride Content*	0-10 mm	-	-	-
	20-30 mm	-	-	-
	40-50 mm	-	-	-
	60-70 mm	-	-	-
	80-90 mm	-	-	-
	100-110 mm	-	-	-

* Average chloride content as % chloride by weight of concrete after deducting background chlorides for all cores taken in each range of corrosion potential.

10. Chloride Content at Rebar Level

Core No.	-	-	-	-	-	-
Chloride Content*	-	-	-	-	-	-

* Chloride content as % chloride by weight of concrete after deducting background chlorides.

Remarks
Table # 11 is Not Applicable.

11. AC Resistance Test Data of Epoxy Coated Rebar

Measured AC Resistance between Connection #1 and #2						Calculated AC Resistance *
Connection #1	Connection #2					
	G1	G2	G3	G4	G5	
G1	N/A	-	-	-	-	-
G2	-	N/A	-	-	-	-
G3	-	-	N/A	-	-	-
G4	-	-	-	N/A	-	-
G5	-	-	-	-	N/A	-

* See Appendix 1E for calculating AC resistance contributed by individual rebar.

Site No: **34-455/C**

Component Type & Location: West Elevation **OSIM Identifier: Culverts**

Remarks
Table # 12 is Not Applicable.

12. IR Drop and True Half Cell Potential Measurements of Epoxy Coated Rebar

IR Drop Between Connection #1 and #2						True Half Cell Potential *
Connection #1 (positive)	Connection #2 (negative)					
	G1	G2	G3	G4	G5	
G1	N/A	-	-	-	-	-
G2	-	N/A	-	-	-	-
G3	-	-	N/A	-	-	-
G4	-	-	-	N/A	-	-
G5	-	-	-	-	N/A	-

* Half cell reading taken on the same rebar with the ground connection.

13. Concrete Air Entrainment

Concrete Air Entrained: not tested

14. Compressive Strength

Average Compressive Strength: not tested

EXPOSED CONCRETE COMPONENTS (Exposed Deck, Deck Soffit, Curbs, Medians, Sidewalks, Barrier/Parapet Walls, etc.): Use separate form for each component

Site No: **34-455/C**

Component Type & Location: Barrel - Soffit **OSIM Identifier: Culverts**

1. Dimensions and Area

Width - Length - Height -

Diameter - Total Area Surveyed 454.70 m²

Remarks

Dimensions were taken from the structural drawings & site measurements

2. Cracks (medium and wide)

Type		Transverse	Longitudinal	Other	Total	
Medium Width	**Clean**	10.0	0.0	0.0	116.0	**m**
	Stained	65.0	5.0	36.0		
Wide Width	**Clean**	7.0	0.0	0.0	14.0	**m**
	Stained	7.0	0.0	0.0		

3. Alkali Aggregate Reaction

Area of component with severe to very severe aggregate reaction 0.0 m²

4. Concrete Cover

Minimum	Maximum	Average	
-	-	-	**mm**

0 – 20 mm	-	**40 – 60 mm**	-	m^2
	-		-	%
20 – 40 mm	-	**over 60 mm**	-	m^2
	-		-	%

Remarks

Table # 4 is Not Applicable.

Site No: **34-455/C**

Component Type & Location: Barrel - Soffit **OSIM Identifier: Culverts**

Remarks
Table # 5 is Not Applicable.

5. Corrosion Activity

Minimum	Maximum	Average	
-	-	-	V

0 to -0.20	-0.20 to -0.30	-0.30 to -0.35	-0.35 to -0.45	< -0.45	
-	-	-	-	-	V
-	-	-	-	-	m^2
-	-	-	-	-	%

6. Delaminations and Spalls

Remarks

Defect Type	Delaminations	Spalls	Patches
Area (m^2)	4.60	0.00	0.00
Total Delaminations and Spalls		Total Delaminations and Spalls in Areas ≤-0.35 V	
4.60 m²	1.0 %	N/A	N/A

*Wet areas = 51.20 m²

Remarks

7. Scaling

Light	Medium	Severe to Very Severe	
0.68	0.00	0.00	m^2
0.1	0.0	0.0	%

8. Honeycombing

Total Area 0.00 m²

Site No: **34-455/C**

Component Type & Location: Barrel - Soffit **OSIM Identifier: Culverts**

Remarks
Table # 9 and 10 are Not Applicable.

9. Adjusted Chloride Content Profile

Corrosion Activity at Core Location (volts)		0 to -0.20	-0.20 to -0.35	≤ -0.35
Chloride Content*	0-10 mm	-	-	-
	20-30 mm	-	-	-
	40-50 mm	-	-	-
	60-70 mm	-	-	-
	80-90 mm	-	-	-
	100-110 mm	-	-	-

* Average chloride content as % chloride by weight of concrete after deducting background chlorides for all cores taken in each range of corrosion potential.

10. Chloride Content at Rebar Level

Core No.	-	-	-	-	-	-
Chloride Content*	-	-	-	-	-	-

* Chloride content as % chloride by weight of concrete after deducting background chlorides.

Remarks
Table # 11 is Not Applicable.

11. AC Resistance Test Data of Epoxy Coated Rebar

Measured AC Resistance between Connection #1 and #2						Calculated AC Resistance *
Connection #1	Connection #2					
	G1	G2	G3	G4	G5	
G1	N/A	-	-	-	-	-
G2	-	N/A	-	-	-	-
G3	-	-	N/A	-	-	-
G4	-	-	-	N/A	-	-
G5	-	-	-	-	N/A	-

* See Appendix 1E for calculating AC resistance contributed by individual rebar.

Site No: **34-455/C**

Component Type & Location: Barrel - Soffit **OSIM Identifier: Culverts**

Remarks
Table # 12 is Not Applicable.

12. IR Drop and True Half Cell Potential Measurements of Epoxy Coated Rebar

IR Drop Between Connection #1 and #2						True Half Cell Potential *
Connection #1 (positive)	Connection #2 (negative)					
	G1	G2	G3	G4	G5	
G1	N/A	-	-	-	-	-
G2	-	N/A	-	-	-	-
G3	-	-	N/A	-	-	-
G4	-	-	-	N/A	-	-
G5	-	-	-	-	N/A	-

* Half cell reading taken on the same rebar with the ground connection.

13. Concrete Air Entrainment

Concrete Air Entrained: not tested

14. Compressive Strength

Average Compressive Strength: not tested

EXPOSED CONCRETE COMPONENTS (Exposed Deck, Deck Soffit, Curbs, Medians, Sidewalks, Barrier/Parapet Walls, etc.): Use separate form for each component

Site No: **34-455/C**

Component Type & Location: Barrel - North Wall **OSIM Identifier: Culverts**

1. Dimensions and Area

Width	-	Length	-	Height	-
Diameter	-	Total Area Surveyed		69.50 m²	

Remarks

Dimensions were taken from the structural drawings & site measurements

2. Cracks (medium and wide)

Type		Vertical	Horizontal	Diagonal	Total	
Medium Width	**Clean**	2.0	0.0	0.0	10.0	**m**
	Stained	7.0	0.0	1.0		
Wide Width	**Clean**	0.0	0.0	0.0	0.0	**m**
	Stained	0.0	0.0	0.0		

3. Alkali Aggregate Reaction

Area of component with severe to very severe aggregate reaction 0.0 m²

4. Concrete Cover

Minimum	Maximum	Average	
-	-	-	**mm**

0 – 20 mm	-	**40 – 60 mm**	-	m^2
	-		-	%
20 – 40 mm	-	**over 60 mm**	-	m^2
	-		-	%

Remarks

Table # 4 is Not Applicable.

Site No: **34-455/C**

Component Type & Location: Barrel - North Wall **OSIM Identifier: Culverts**

Remarks
Table # 5 is Not Applicable.

5. Corrosion Activity

Minimum	Maximum	Average	
-	-	-	V

0 to -0.20	-0.20 to -0.30	-0.30 to -0.35	-0.35 to -0.45	< -0.45	
-	-	-	-	-	V
-	-	-	-	-	m^2
-	-	-	-	-	%

6. Delaminations and Spalls

Remarks

Defect Type	Delaminations	Spalls	Patches
Area (m^2)	0.00	0.25	0.00
Total Delaminations and Spalls		Total Delaminations and Spalls in Areas ≤-0.35 V	
0.25 m²	0.4 %	N/A	N/A

*Wet areas = 4.62 m²

7. Scaling

Remarks

Light	Medium	Severe to Very Severe	
0.00	0.00	0.00	m^2
0.0	0.0	0.0	%

8. Honeycombing

Total Area 0.00 m²

Site No: **34-455/C**

Component Type & Location: Barrel - North Wall **OSIM Identifier: Culverts**

Remarks
Table # 9 is Not Applicable.

9. Adjusted Chloride Content Profile

Corrosion Activity at Core Location (volts)		0 to -0.20	-0.20 to -0.35	≤ -0.35
Chloride Content*	0-10 mm	-	-	-
	20-30 mm	-	-	-
	40-50 mm	-	-	-
	60-70 mm	-	-	-
	80-90 mm	-	-	-
	100-110 mm	-	-	-

* Average chloride content as % chloride by weight of concrete after deducting background chlorides for all cores taken in each range of corrosion potential.

10. Chloride Content at Rebar Level

Core No.	C5	-	-	-	-	-
Chloride Content*	0.000	-	-	-	-	-

* Chloride content as % chloride by weight of concrete after deducting background chlorides.

Remarks
Table # 11 is Not Applicable.

11. AC Resistance Test Data of Epoxy Coated Rebar

Measured AC Resistance between Connection #1 and #2						Calculated AC Resistance *
Connection #1	Connection #2					
	G1	G2	G3	G4	G5	
G1	N/A	-	-	-	-	-
G2	-	N/A	-	-	-	-
G3	-	-	N/A	-	-	-
G4	-	-	-	N/A	-	-
G5	-	-	-	-	N/A	-

* See Appendix 1E for calculating AC resistance contributed by individual rebar.

Site No: **34-455/C**

Component Type & Location: Barrel - North Wall **OSIM Identifier: Culverts**

Remarks
Table # 12 is Not Applicable.

12. IR Drop and True Half Cell Potential Measurements of Epoxy Coated Rebar

IR Drop Between Connection #1 and #2						True Half Cell Potential *
Connection #1 (positive)	Connection #2 (negative)					
	G1	G2	G3	G4	G5	
G1	N/A	-	-	-	-	-
G2	-	N/A	-	-	-	-
G3	-	-	N/A	-	-	-
G4	-	-	-	N/A	-	-
G5	-	-	-	-	N/A	-

* Half cell reading taken on the same rebar with the ground connection.

13. Concrete Air Entrainment

Concrete Air Entrained: not tested

14. Compressive Strength

Average Compressive Strength: not tested

EXPOSED CONCRETE COMPONENTS (Exposed Deck, Deck Soffit, Curbs, Medians, Sidewalks, Barrier/Parapet Walls, etc.): Use separate form for each component

Site No: **34-455/C**

Component Type & Location: Barrel - South Wall **OSIM Identifier: Culverts**

1. Dimensions and Area

Width - Length - Height -

Diameter - Total Area Surveyed 69.50 m²

Remarks

Dimensions were taken from the structural drawings & site measurements

2. Cracks (medium and wide)

Type		Vertical	Horizontal	Diagonal	Total	
Medium Width	**Clean**	0.0	0.0	1.0	12.0	**m**
	Stained	9.0	0.0	2.0		
Wide Width	**Clean**	0.0	0.0	0.0	0.0	**m**
	Stained	0.0	0.0	0.0		

3. Alkali Aggregate Reaction

Area of component with severe to very severe aggregate reaction 0.0 m²

4. Concrete Cover

Remarks

Table # 4 is Not Applicable.

Minimum	Maximum	Average	
-	-	-	**mm**

0 – 20 mm	-	**40 – 60 mm**	-	m^2
	-		-	%
20 – 40 mm	-	**over 60 mm**	-	m^2
	-		-	%

Site No: **34-455/C**

Component Type & Location: Barrel - South Wall **OSIM Identifier: Culverts**

5. Corrosion Activity

Remarks

Table # 5 is Not Applicable.

Minimum	Maximum	Average	
-	-	-	V

0 to -0.20	-0.20 to -0.30	-0.30 to -0.35	-0.35 to -0.45	< -0.45	
-	-	-	-	-	m^2
-	-	-	-	-	%

6. Delaminations and Spalls

Remarks

Defect Type	Delaminations	Spalls	Patches
Area (m^2)	0.00	0.10	0.00
Total Delaminations and Spalls		Total Delaminations and Spalls in Areas ≤-0.35 V	
0.10 m²	0.1 %	N/A	N/A

*Wet areas = 5.50 m²

7. Scaling

Remarks

Light	Medium	Severe to Very Severe	
0.00	0.00	0.00	m^2
0.0	0.0	0.0	%

8. Honeycombing

Total Area 0.00 m²

Site No: **34-455/C**

Component Type & Location: Barrel - South Wall **OSIM Identifier: Culverts**

Remarks
Table # 9 is Not Applicable.

9. Adjusted Chloride Content Profile

Corrosion Activity at Core Location (volts)		0 to -0.20	-0.20 to -0.35	≤ -0.35
Chloride Content*	0-10 mm	-	-	-
	20-30 mm	-	-	-
	40-50 mm	-	-	-
	60-70 mm	-	-	-
	80-90 mm	-	-	-
	100-110 mm	-	-	-

* Average chloride content as % chloride by weight of concrete after deducting background chlorides for all cores taken in each range of corrosion potential.

10. Chloride Content at Rebar Level

Core No.	C3	-	-	-	-	-
Chloride Content*	0.001	-	-	-	-	-

* Chloride content as % chloride by weight of concrete after deducting background chlorides.

Remarks
Table # 11 is Not Applicable.

11. AC Resistance Test Data of Epoxy Coated Rebar

Measured AC Resistance between Connection #1 and #2						Calculated AC Resistance *
Connection #1	Connection #2					
	G1	G2	G3	G4	G5	
G1	N/A	-	-	-	-	-
G2	-	N/A	-	-	-	-
G3	-	-	N/A	-	-	-
G4	-	-	-	N/A	-	-
G5	-	-	-	-	N/A	-

* See Appendix 1E for calculating AC resistance contributed by individual rebar.

Site No: **34-455/C**

Component Type & Location: Barrel - South Wall **OSIM Identifier: Culverts**

Remarks
Table # 12 is Not Applicable.

12. IR Drop and True Half Cell Potential Measurements of Epoxy Coated Rebar

IR Drop Between Connection #1 and #2						True Half Cell Potential *
Connection #1 (positive)	Connection #2 (negative)					
	G1	G2	G3	G4	G5	
G1	N/A	-	-	-	-	-
G2	-	N/A	-	-	-	-
G3	-	-	N/A	-	-	-
G4	-	-	-	N/A	-	-
G5	-	-	-	-	N/A	-

* Half cell reading taken on the same rebar with the ground connection.

13. Concrete Air Entrainment

	Yes	No	Marginal
Concrete Air Entrained:			
	C4		X

14. Compressive Strength

Average Compressive Strength: **56.6 MPa**

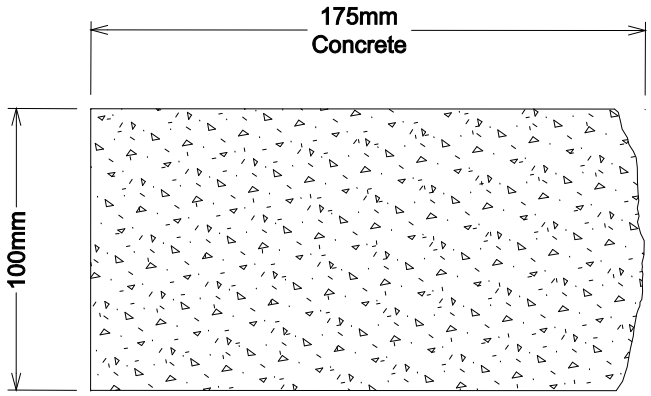
Appendix C:

Core Photographs and Sketches

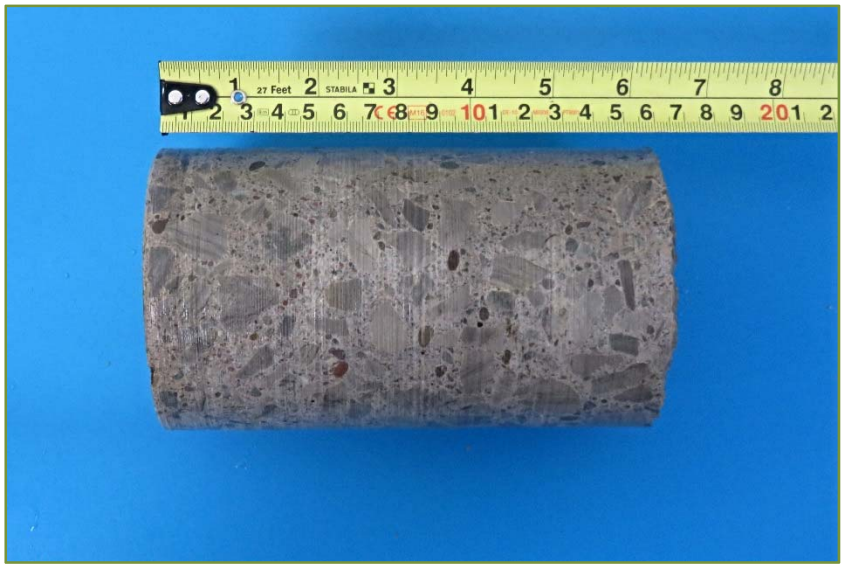
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info@bridgecheckcanada.com

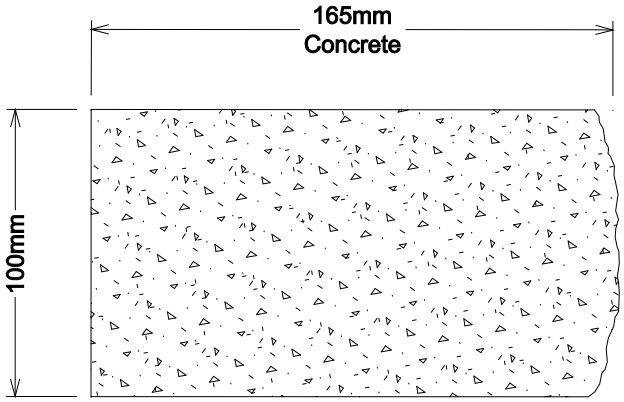
Core C1





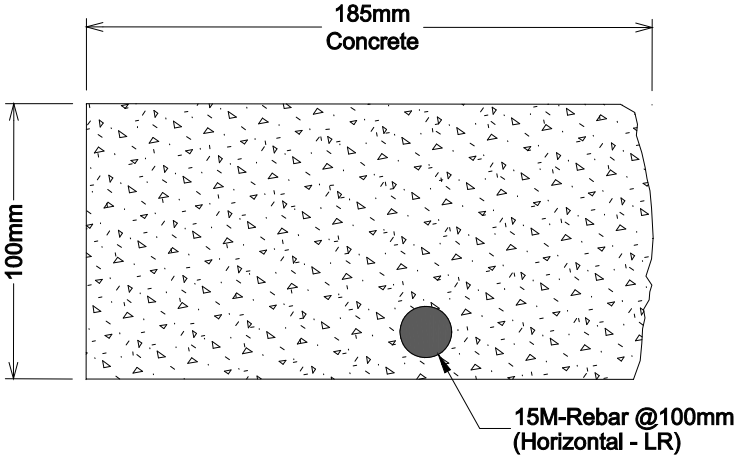
Core C2





Core C3

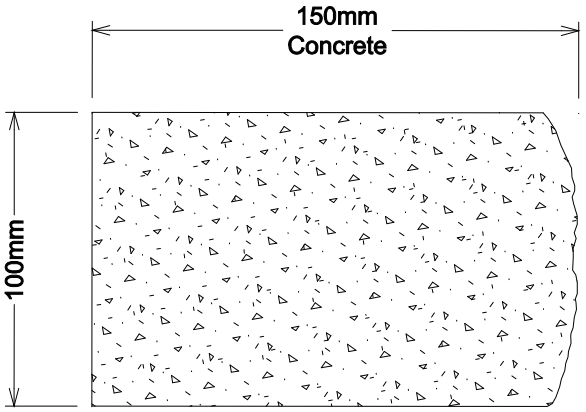




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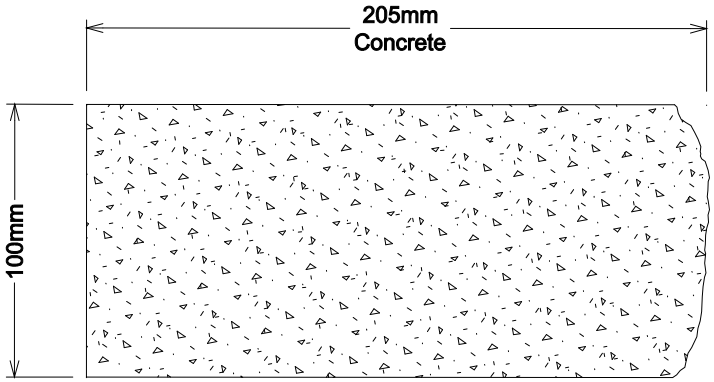
Core C4





Core C5





Appendix D:

Core Logs

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CORE LOG FOR EXPOSED CONCRETE

Site: 34-455/C

Core No.		**C1**		**C2**		**C3**	
Location (between gridlines)		South Wall		South Wall		South Wall	
Diameter, mm		100.0		100.0		100.0	
Length, mm		175.0		165.0		185.0	
Full Depth (yes/no)		No		No		No	
Defects in Concrete [1]		-		-		-	
Condition of Rebar [2]		N/A		N/A		LR	
Corrosion Potential							
Compressive Strength, MPa		51.2		62.1			
		Total	Corrected	Total	Corrected	Total	Corrected
Chloride Content % Chloride by Weight of Concrete	**0-10 mm**					0.016	0.005
	20-30 mm					0.015	0.004
	40-50 mm					0.015	0.004
	60-70 mm					0.014	0.003
	80-90 mm					0.012	0.001
AIR VOIDS	**Air Content,%**						
	Spec. Surf.,mm^2/mm^3						
	Spacing Factor, mm						
TEST LABORATORY		BCC		BCC		BCC	
REMARKS **- orientation of rebars and cover** **- presence of overlay, patch and thickness** **- other observed defects**						15M-Rebar @100mm (Horizontal - LR).	

1. Defects-C= Cracked, D= Delamination, R= Rough, Sc= Scaling, S= Spalling
2. Condition Rebar- G= Good, LR= Light Rust, SR= Severe Rust, N/A= No rebar exposed

Condition of Epoxy Coating – ECG=Good, ECF=Fair, ECP=Poor-rusted & debonded areas

CORE LOG FOR EXPOSED CONCRETE

Site: 34-455/C

Core No.		**C4**		**C5**			
Location (between gridlines)		South Wall		North Wall			
Diameter, mm		100.0		100.0			
Length, mm		150.0		205.0			
Full Depth (yes/no)		No		No			
Defects in Concrete [1]		-		-			
Condition of Rebar [2]		N/A		N/A			
Corrosion Potential							
Compressive Strength, MPa							
Chloride Content % Chloride by Weight of Concrete		Total	Corrected	Total	Corrected		
	0-10 mm			0.017	0.006		
	20-30 mm			0.016	0.005		
	40-50 mm			0.016	0.005		
	60-70 mm			0.016	0.005		
	80-90 mm			0.011	0.000		
	100-110 mm			0.011	0.000		
AIR VOIDS	**Air Content,%**	5.4					
	Spec. Surf.,mm^2/mm^3	24.36					
	Spacing Factor, mm	0.207					
TEST LABORATORY		BCC		BCC			
REMARKS **- orientation of rebars and cover** **- presence of overlay, patch and thickness** **- other observed defects**							

1. Defects-C= Cracked, D= Delamination, R= Rough, Sc= Scaling, S= Spalling
2. Condition Rebar- G= Good, LR= Light Rust, SR= Severe Rust, N/A= No rebar exposed

Condition of Epoxy Coating – ECG=Good, ECF=Fair, ECP=Poor-rusted & debonded areas

Appendix G:

Site Photographs

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Photo P1 – East Elevation



Photo P2 – West Elevation



Photo P3 – East Elevation/Headwall (spall and delamination) note rusted 15M-rebar about 300mm spacing



Photo P4 – East Elevation/Headwall (spall and delamination)



Photo P5 – East Elevation, NE Retaining wall



Photo P6 – East Elevation, SE Retaining wall (spall)



Photo P7 – West Elevation/Headwall (cracks, spall and delamination)



Photo P8 – West Elevation/Headwall (spall and delamination) note rusted 15M-rebar about 300mm



Photo P9 – West Elevation, NW Retaining Wall (spall and delamination)



Photo P10 – West Elevation, SW Retaining Wall



Photo P11 – West Elevation, SW Retaining Wall (spall)



Photo P12 – Deck General View, Looking West



Photo P13 – Barrel - Soffit – looking east (fair condition – cracks, spall, delamination, light scaling and wet area)



Photo P14 – Barrel - Soffit – 10m from west (crack, delamination and wet area)



Photo P15 – Barrel - Soffit – 30m from west (cracks, delamination and wet area)



Photo P16 – Barrel - Soffit – 33m from west (cracks, delamination and wet area)



Photo P17 – Barrel - Soffit – 57m from west (wide crack, delamination and wet area)



Photo P18 – Barrel - Soffit – 57m from west (wide crack, delamination and wet area)



Photo P19 – Barrel - Soffit @ East (delamination and wet area)



Photo P20 – Barrel - Soffit – looking west



Photo P21 – Barrel – North Wall – looking east (fair to good condition – cracks, spall and wet area)



Photo P22 – Barrel - North Wall @ West (spall and wet area)



Photo P23 – Barrel - North Wall – 28m from west (cracks)



Photo P24 – Barrel - North Wall – 33m from west (crack and wet area)



Photo P25 – Barrel - North Wall – 39m from west (cracks and wet area)



Photo P26 – Barrel – North Wall – looking west



Photo P27 – Barrel – South Wall – looking east (fair to good condition – cracks and wet area)



Photo P28 – Barrel - South Wall @ West (crack, spall and wet area)



Photo P29 – Barrel - South Wall – 30m from west (cracks and wet area)



Photo P30 – Barrel - South Wall – 52m from west (cracks)



Photo P31 – Barrel – South Wall – looking west



Photo P32 – Barrel – Bottom Face – looking east



Photo P33 – Barrel – Bottom Face – looking west



Photo P34 – Downstream



Photo P35 – Rebar Sample No.1 at East Elevation/Headwall (Unwashed)



Photo P36 – Rebar Sample No.1 at East Elevation/Headwall (Washed)

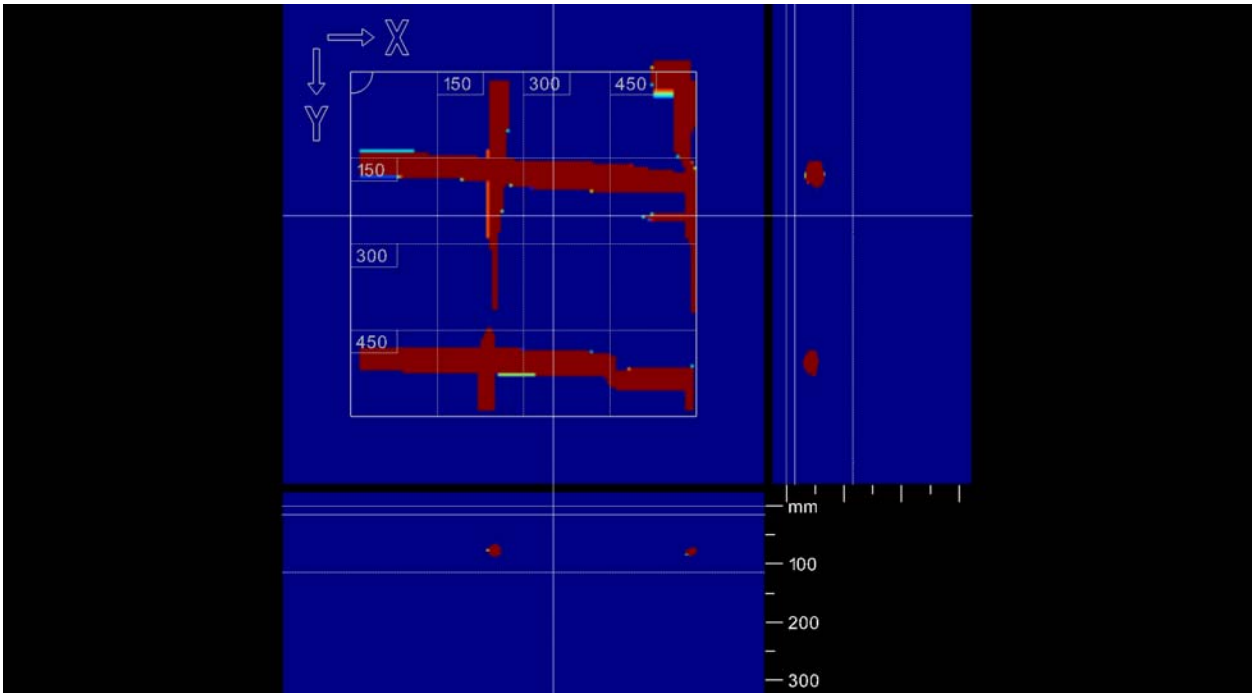


Photo P37 – 2D Image of Location No. 1

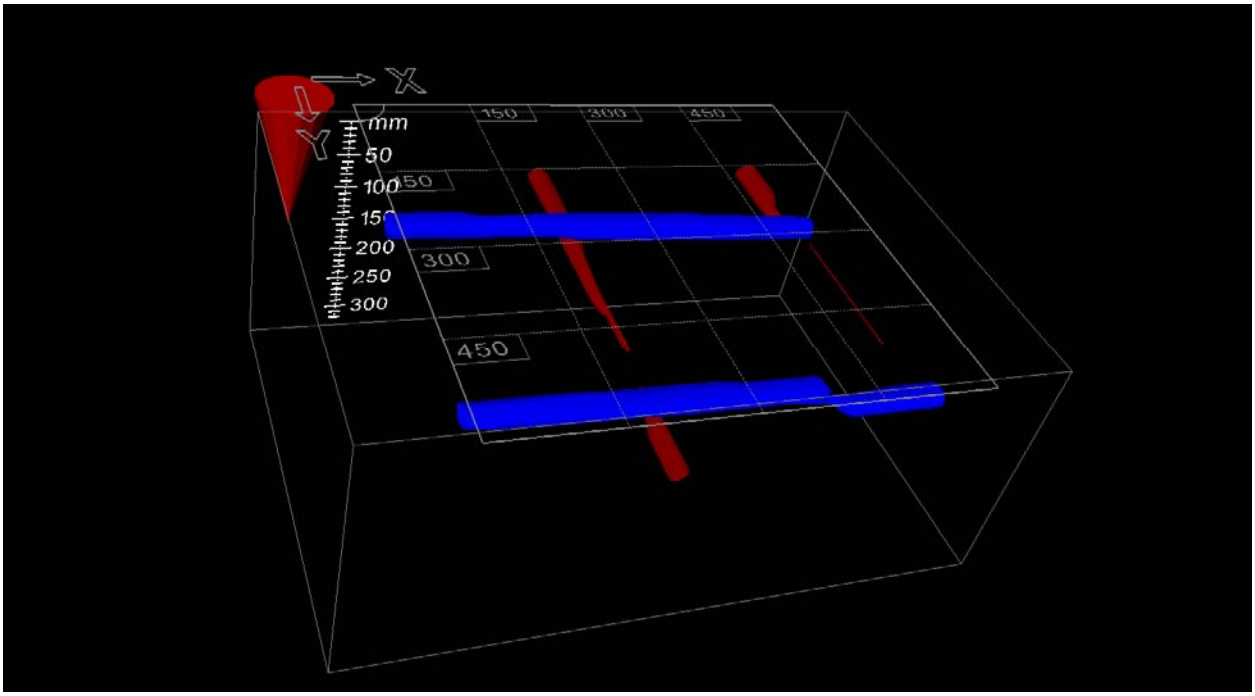


Photo P38 – 3D Image of Location No. 1

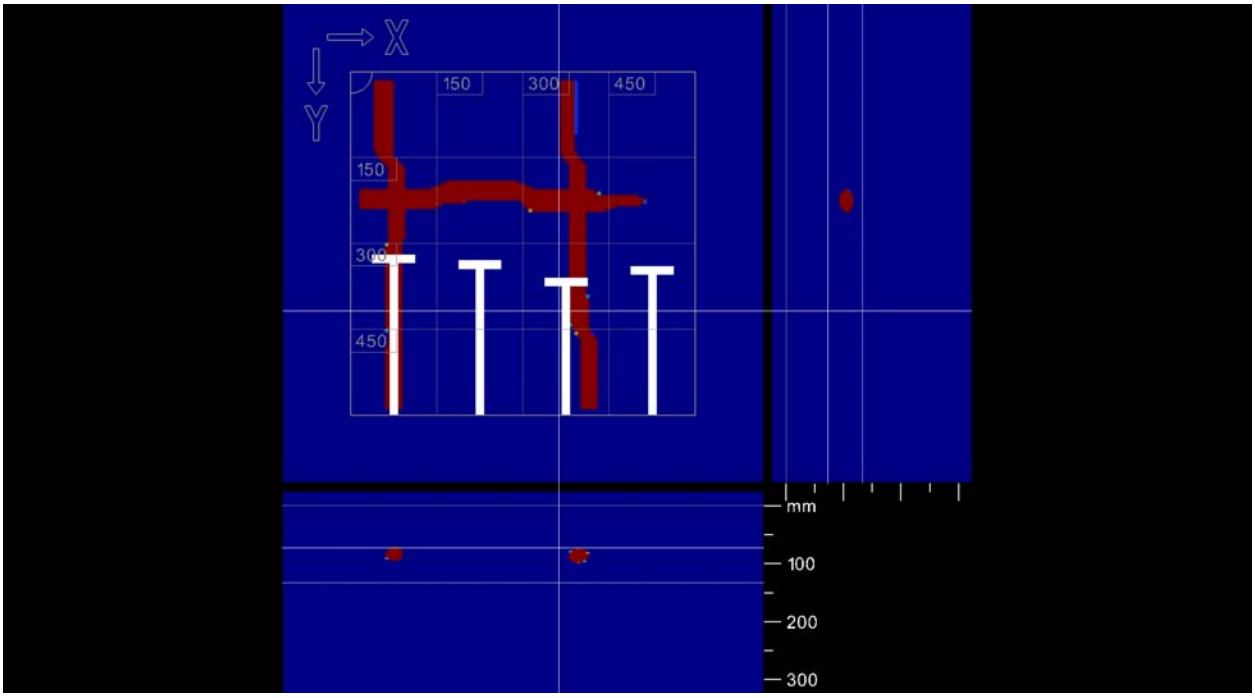


Photo P39 – 2D Image of Location No. 2

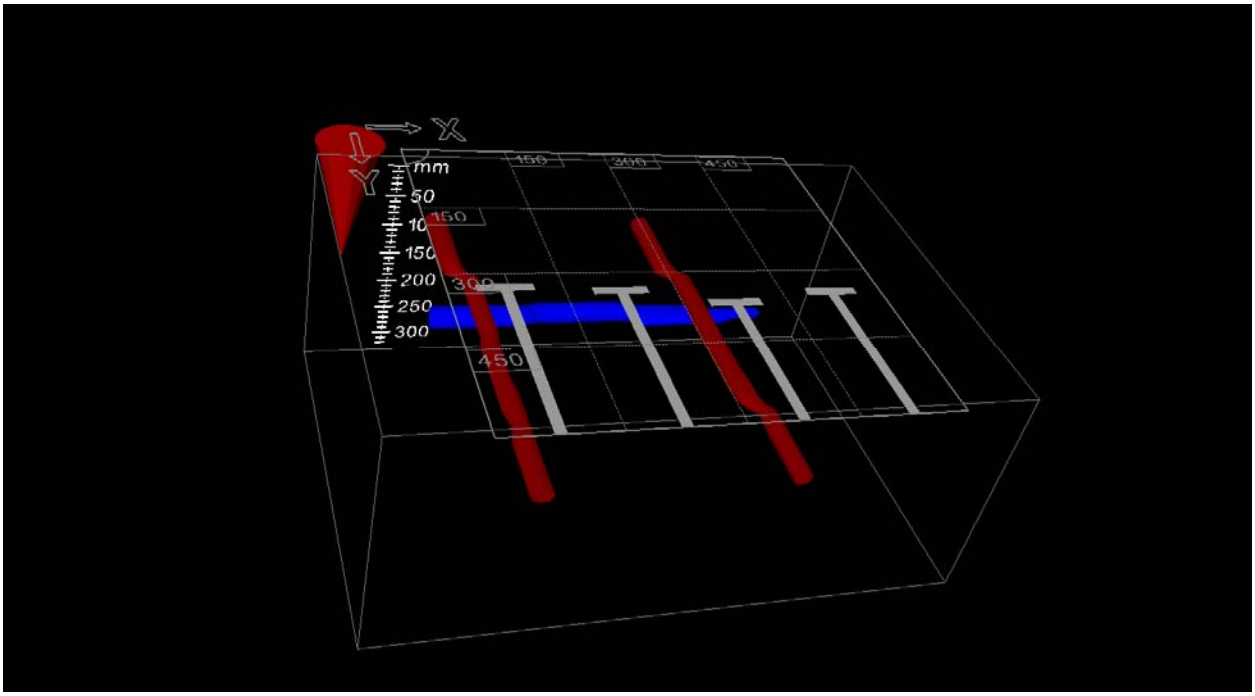


Photo P40 – 3D Image of Location No. 2

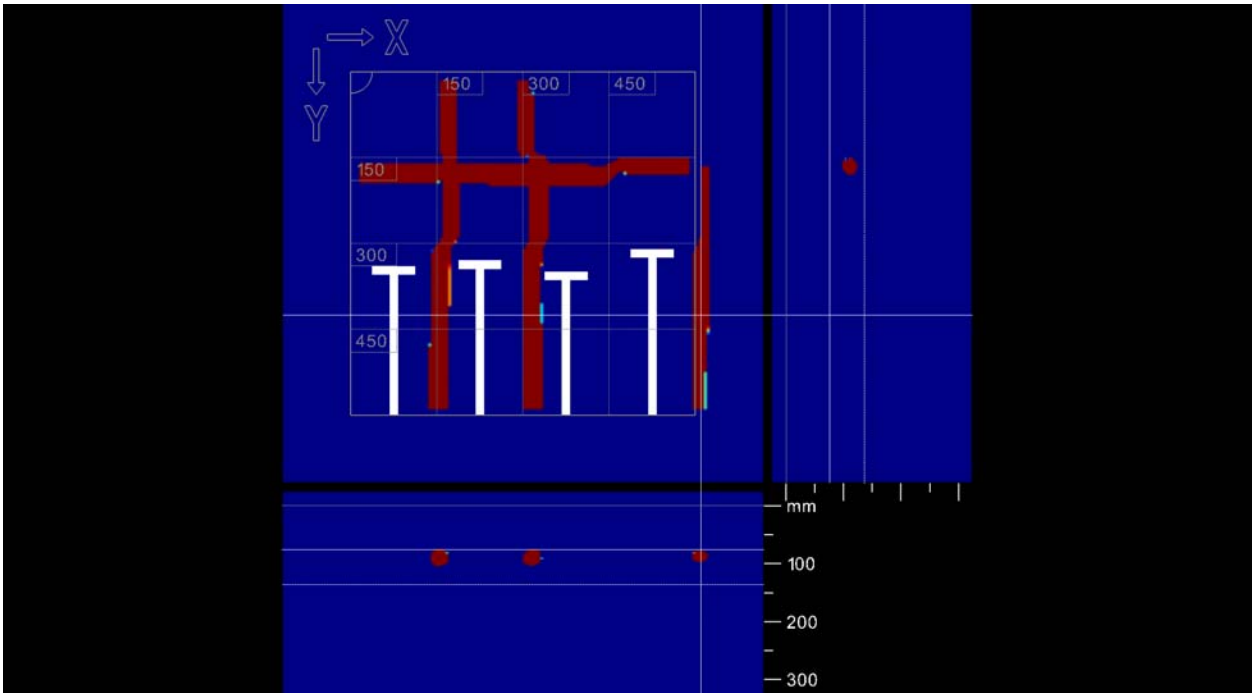


Photo P41 – 2D Image of Location No. 3

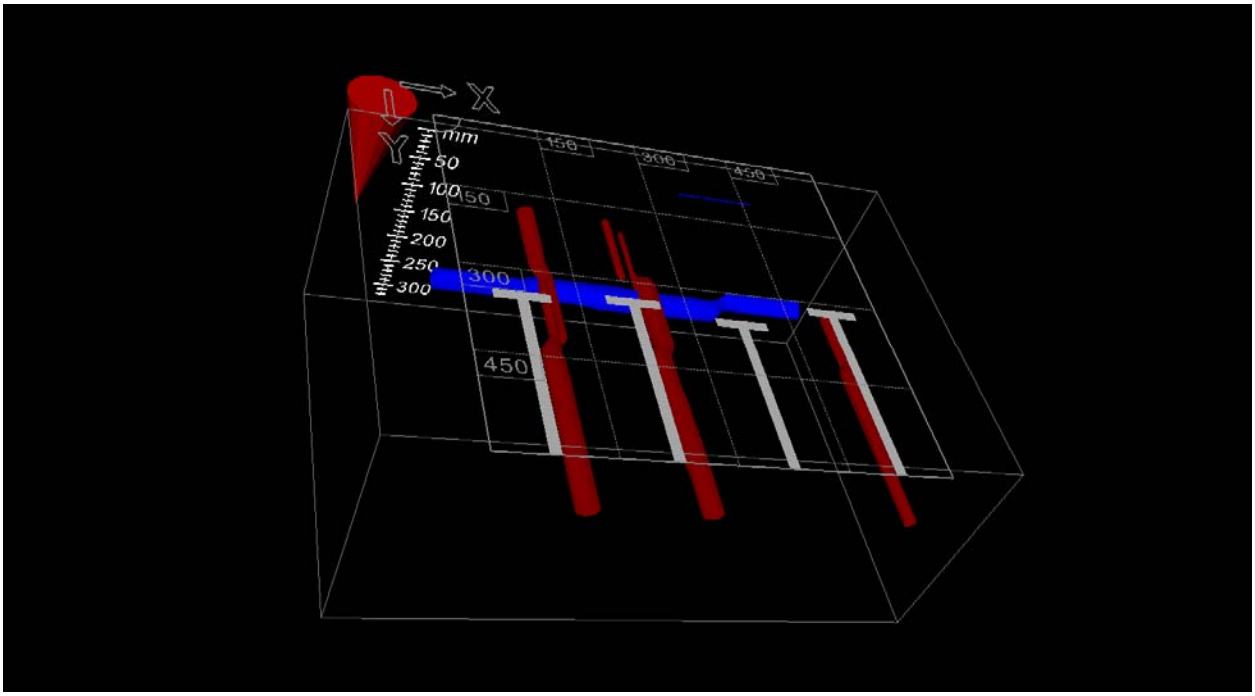


Photo P42 – 3D Image of Location No. 3



Photo P43 – GPR Scan Location of Barrel - Soffit @ East



Photo P44 – GPR Scan Location of Barrel - North Wall @ East



Photo P45 – GPR Scan Location of Barrel - South Wall @ East

Appendix H:

Laboratory Test Results

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COMPRESSIVE STRENGTH OF CONCRETE CORES

(CSA A23.2-14C)

Project No.:	**BCC18046**
Site No.:	**34-455/C**
Location:	**QEW @ Frenchman's Creek Culvert**

Core ID	C1	C2
Location	South Wall	South Wall
Lab No.	L18-0791	L18-0792
Date Cast	-	-
Date Cored	Aug 16, 2018	Aug 16, 2018
Date Tested	Aug 27, 2018	Aug 27, 2018
Capped Height (mm)	149.9	141.6
Average Diameter (mm)	100.0	100.0
Density (kg/m^3)	2312	2331
Corrected Compressive Strength (MPa)	51.2	62.1
*** Direction of Loading**	Perpendicular	Perpendicular
Moisture Content at Time of Test	as-received	as-received
2331Remarks	*Average Strength = 56.6 MPa*	

*Relative to the direction of original placement.

Savio DeSouza, M.A.Sc., P.Eng.
Senior Principal Engineer

TOTAL CHLORIDE ION CONTENT

(Testing Method: MTO LS – 417)

Project No.:	**BCC18046**
Site No.:	**34-455/C**
Location:	**QEW @ Frenchman's Creek Culvert**

Core ID	Lab No.	Horizon from the Top of the Core (mm)	Chloride Ion Content (%)	Chloride Ion Content Corrected for Background* (%)
C3 (South Wall)	L18-0793	0-10	0.016	0.005
		20-30	0.015	0.004
		40-50	0.015	0.004
		60-70	0.014	0.003
		80-90	0.012	0.001
C5 (North Wall)	L18-0795	0-10	0.017	0.006
		20-30	0.016	0.005
		40-50	0.016	0.005
		60-70	0.016	0.005
		80-90	0.011	0.000
		100-110	0.011	0.000

**Background chloride (original concrete) = 0.011%*
**The threshold of chloride ion generally regarded to be able to initiate reinforcing bar corrosion is 0.025%.*

Tested By: Shayan Esmaeil
Date Tested: Aug 23, 2018

_____

Savio DeSouza, M.A.Sc., P.Eng.
Senior Principal Engineer

AIR VOID TEST RESULTS

(Modified Point Count – ASTM C457, Procedure B)

Project No.:	**BCC18046**
Site No.:	**34-455/C**
Location:	**QEW @ Frenchman's Creek Culvert**

Core ID	**C4**		
Lab No.	L18-0794		
Air Content (%)	5.4		
Specific Surface (mm^{-1})	24.36		
Spacing Factor (mm)	0.207		
Length of Traverse (mm)	3819.2		
Area Traversed (mm^2)	11076		
Average Chord Length	0.164		
Number of Stops	1364		
No. of Voids per mm	0.330		
Paste-Air Ratio	6.0		
Paste Content (%)	32.55		
Aggregate Content (%)	62.02		

Tested By: Brad Wiersma
Date Tested: Aug27. 2018



Savio DeSouza, M.A.Sc., P.Eng.
Senior Principal Engineer

Cambridge
materials testing limited

1177 Franklin Boulevard,
Cambridge, Ontario N1R 7W4
Tel: (519) 621-6600 Fax: (519) 621-6082
www.cambridgematerials.com

Report for: Bridge Check Canada
200 Viceroy Road, Unit 4
VAUGHAN, Ontario
L4K 3N8

Laboratory No. 788324–18

Report Date: August 27, 2018
Received Date: August 23, 2018

Attention: Mohammad Abdollahi

Specimen: Rebar Sample #1 (Washed), Job Number BCC18046, Site No. 34-455C, QEW @ Frenchman's Creek Culvert (East Elevation/Headwall) Fort Erie, ON

TENSILE TEST REPORT

	RESULT	
Specimen Diameter:	0.246	in.
Yield Strength (0.2% Offset):	66,000	psi
Ultimate Tensile Strength:	103,000	psi
Elongation in 1.00 in.:	21	%
Reduction of Area:	43	%

Testing performed according to ASTM A370-17a.

This report is subject to the following terms and conditions: 1. This report relates only to the specimen provided and there is no representation or warranty that it applies to similar substances or materials or the bulk of which the specimen is a part. 2. The content of this report is for the information of the customer identified above only and it shall not be reprinted, published or disclosed to any other party except in full. Prior written consent from Cambridge Materials Testing Limited is required. 3. The name Cambridge Materials Testing Limited shall not be used in connection with the specimen reported on or any substance or materials similar to that specimen without the prior written consent of Cambridge Materials Testing Limited. 4. Neither Cambridge Materials Testing Limited nor any of its employees shall be responsible or held liable for any claims, loss or damages arising in consequence of reliance on this report or any default, error or omission in its preparation or the tests conducted. 5. Specimens are retained 6 months, test reports and test data are retained 7 years from date of final test report and then disposed of, unless instructed otherwise in writing.
Test Report Template Revision January 2013

Cambridge Materials Testing Limited

Per Randi Lee
Randi Lee
Quality Assurance

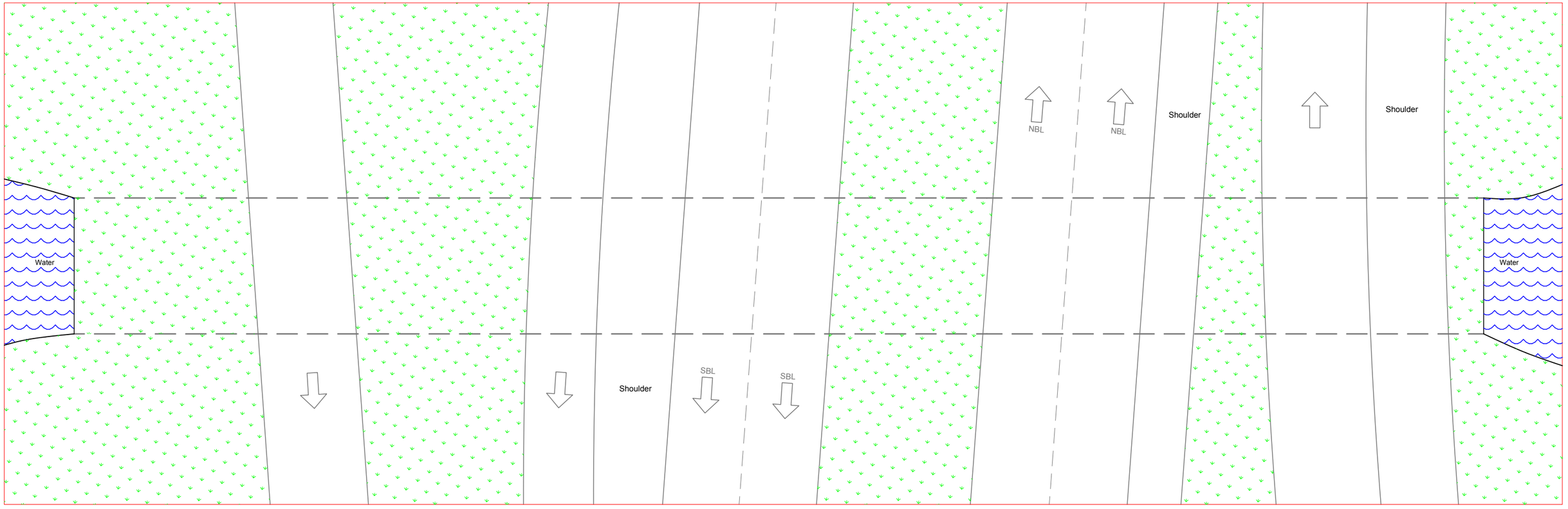
Per Nicholas Cooper
Nicholas Cooper
Technician

Appendix J:

ACAD Drawings

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CONSTRUCTION NORTH



DECK PLAN

KEY PLAN



LEGEND:

C1

- Patched Spalls
- Delaminations
- Spalls
- Light Scaling
- Grass
- Medium Scaling
- Severe Scaling
- Honeycombed Areas
- Wet Areas
- Concrete Pattern cracks
- Medium Concrete Cracks
- W — Wide Concrete Cracks
- Medium Stained/ Efflorescence Cracks

BRIDGE CHECK CANADA

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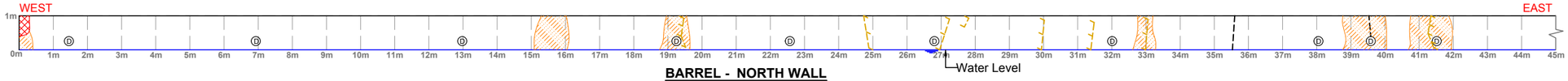
PROJECT:

QEW @ Frenchman's Creek Culvert
Site No. 34-455/C
Fort Erie, Ontario

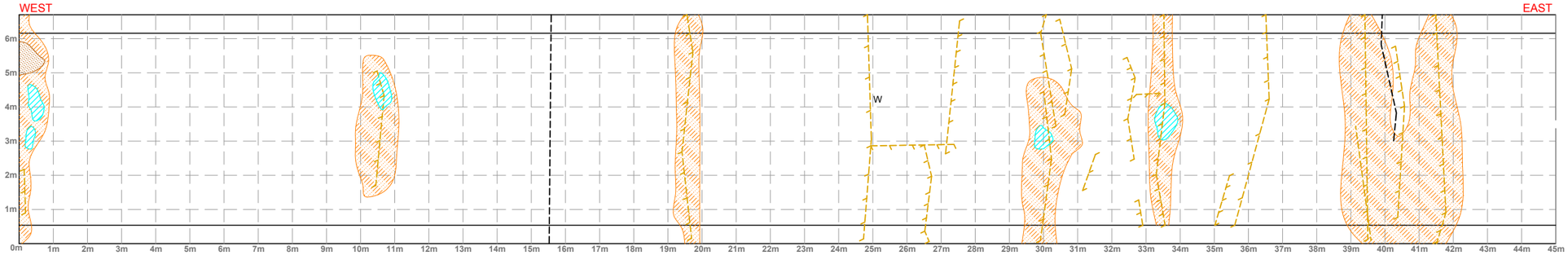
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SURFACE DETERIORATION OF DECK PLAN

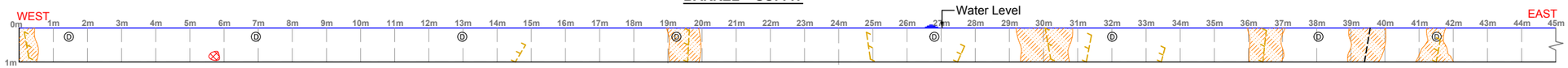
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Project No.:	BCC18046
Date:	October 2018
Scale:	1:200
Drawn by:	KL
Checked by:	MA



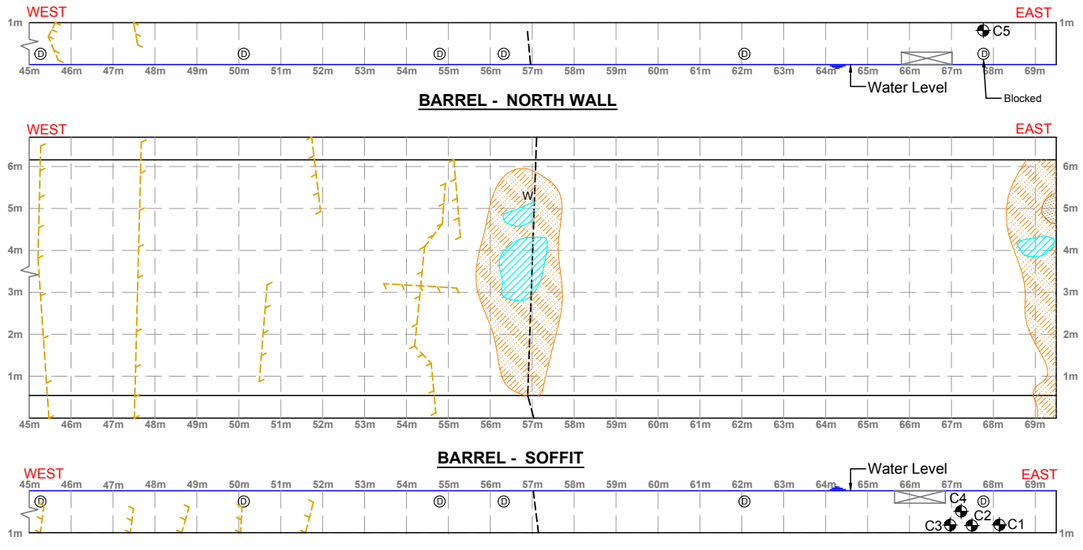
BARREL - NORTH WALL



BARREL - SOFFIT



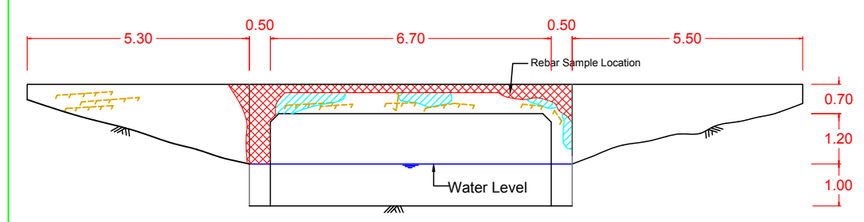
BARREL - SOUTH WALL



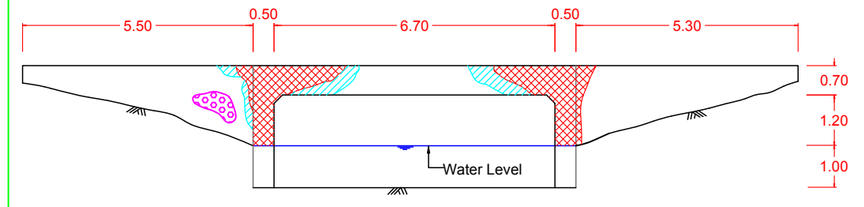
BARREL - NORTH WALL

BARREL - SOFFIT

BARREL - SOUTH WALL



EAST ELEVATION



WEST ELEVATION

KEY PLAN



LEGEND:

- Drain
- C1 Core Sample Location
- Patched Spalls
- Delaminations
- Spalls
- Light Scaling
- Medium Scaling
- Severe Scaling
- Honeycombed Areas
- Wet Areas
- Concrete Pattern cracks
- Medium Concrete Cracks
- W Wide Concrete Cracks
- Medium Stained/ Efflorescence Cracks

BRIDGE CHECK CANADA

200 Viceroy Road, Unit 4
Vaughan, ON L4K 3N8
T: 905-660-6608 F: 905-660-6609

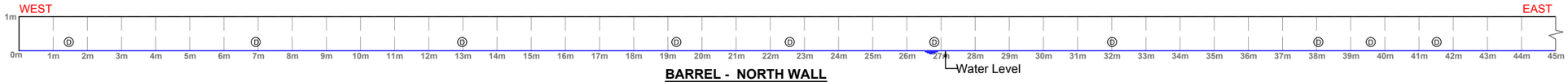
PROJECT:

QEW @ Frenchman's Creek Culvert
Site No. 34-455/C
Fort Erie, Ontario

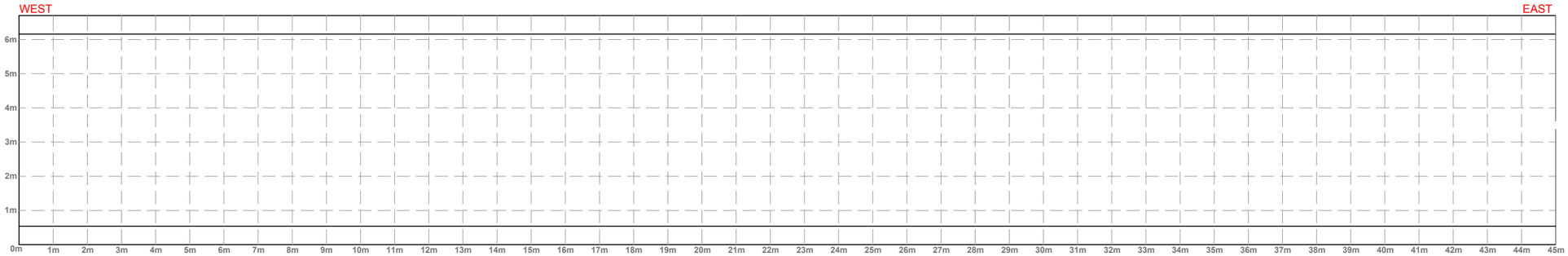
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SURFACE DETERIORATION OF CULVERT

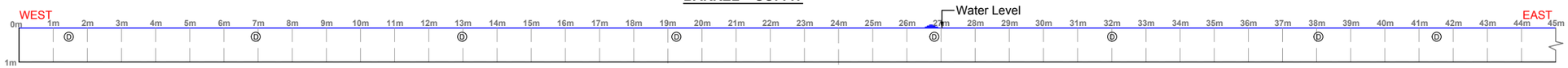
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Checked by:	MA



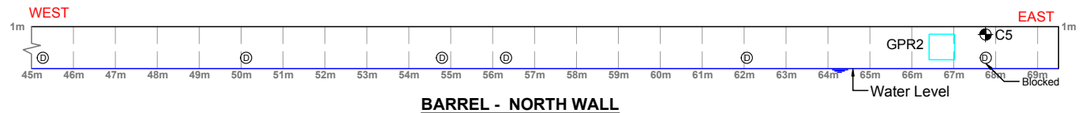
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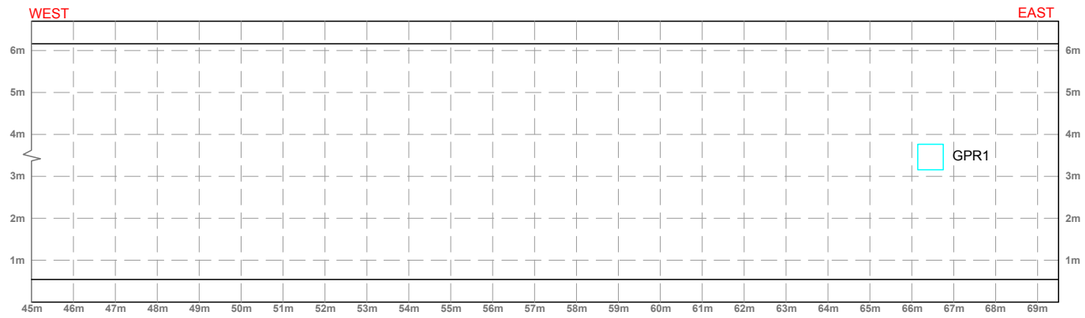
BARREL - SOFFIT



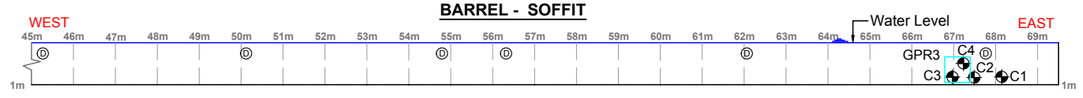
BARREL - SOUTH WALL



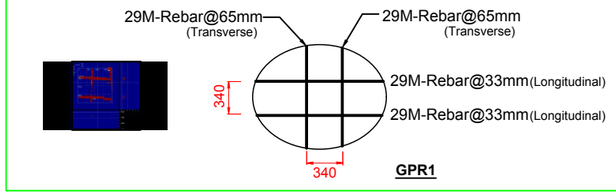
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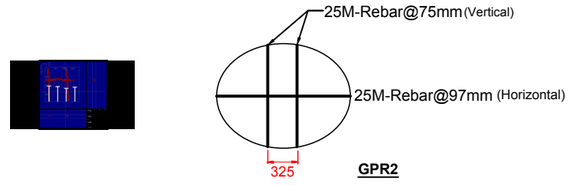
BARREL - SOFFIT



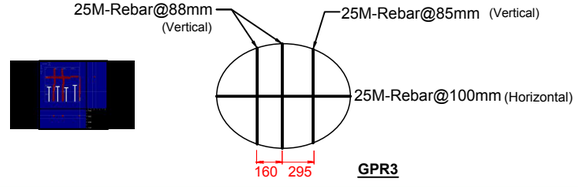
BARREL - SOUTH WALL



GPR1



GPR2



GPR3

KEY PLAN



LEGEND:

- Drain
- C1 Core Sample Location
- SS1 Sawn Sample Location
- Patched Spalls
- Delaminations
- Spalls
- Light Scaling
- Medium Scaling
- Severe Scaling
- Honeycombed Areas
- Wet Areas
- Concrete Pattern cracks
- GPR Scan Location
- Medium Concrete Cracks
- W Wide Concrete Cracks
- Medium Stained/ Efflorescence Cracks

BRIDGE CHECK CANADA

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Vaughan, ON L4K 3N8
T: 905-660-6608 F: 905-660-6609

PROJECT:

QEW @ Frenchman's Creek Culvert
Site No. 34-455/C
Fort Erie, Ontario

TITLE:

CORE SAMPLE LOCATIONS AND GPR SURVEY OF CULVERT

Drawing No.:	3
Project No.:	BCC18046
Date:	October 2018
Scale:	1:150
Drawn by:	KL
Checked by:	MA

CONSTRUCTION NORTH