

BRIDGE CHECK CANADA

Your Bridge & Concrete Inspection Specialists

DETAILED CONDITION SURVEY REPORT

Site No. 34-454/C, QEW Ramp W-W & Ramp E-E/W @
Frenchman's Creek
Fort Erie, ON

Prepared for: AECOM

BCC Project No.: BCC18046
Report Date: October 1, 2018

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Structure Identification Sheet

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STRUCTURE IDENTIFICATION SHEET

GENERAL INFORMATION

STRUCTURE NAME	*QEW Ramp W-W & Ramp E-E/W @ Frenchman's Creek*		
SITE NUMBER	34-454/C	**DISTRICT NUMBER**	N/A
HIGHWAY	**above** Gilmore Rd & Pettit Rd Jct & QEW E-W Ramp	**Below**	Frenchman's Creek
TYPE OF STRUCTURE	Reinforced cast-in-place concrete open footing culvert, rigid frame		
NUMBER OF SPANS	1	**CULVERT LENGTH**	95.0m
BARREL WIDTH	7.90m	**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		

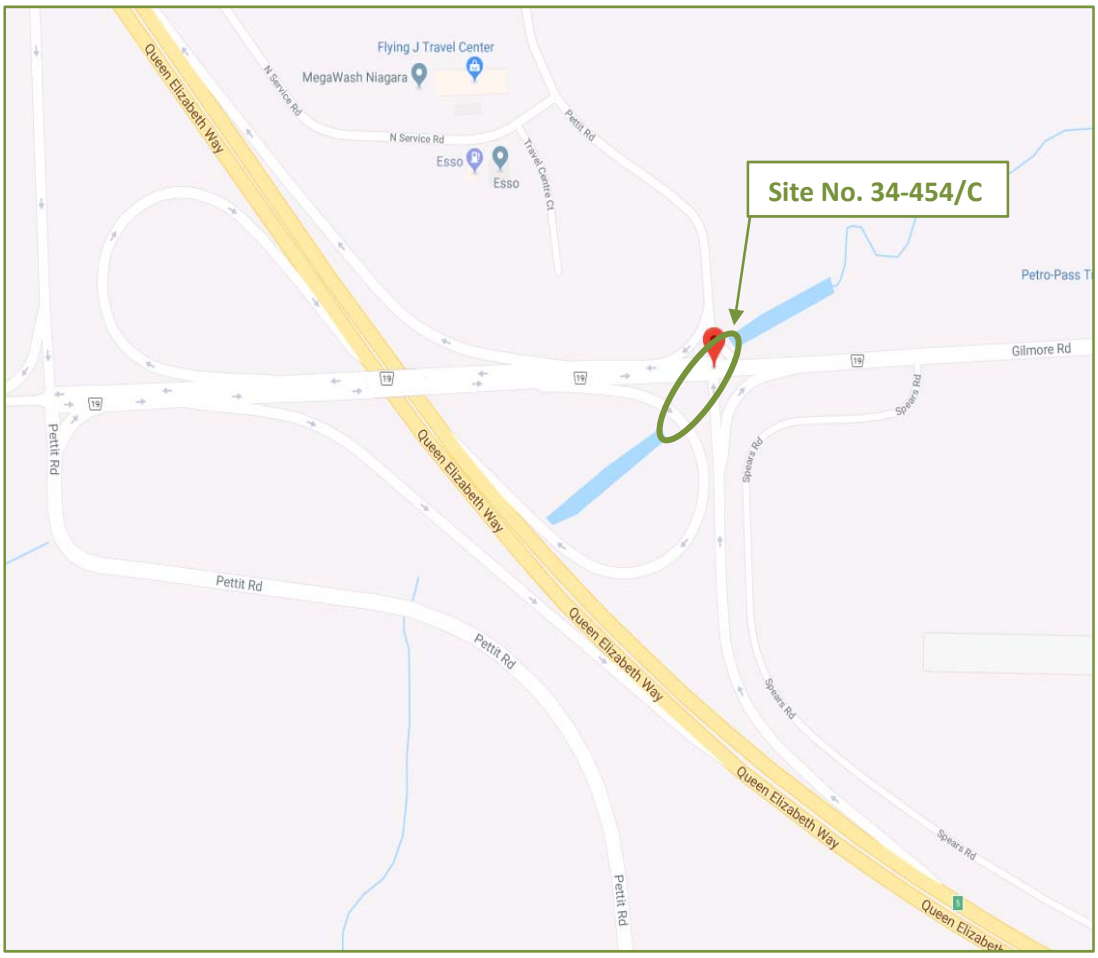
ENGINEER'S STAMP



Key Plan

KEY PLAN

Site No. 34-454/C, QEW Ramp W-W & Ramp E-E/W @ Frenchman's Creek
Fort Erie, ON





Summary of Significant Findings

SUMMARY OF SIGNIFICANT FINDINGS

Site No. 34-454/C, QEW Ramp W-W & Ramp E-E/W @ Frenchman's Creek, 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 Ramp W-W & Ramp E-E/W @ Frenchman's Creek (Site No. 34-454/C) located on the intersection of Gilmore Road and Pettit 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 7.90 m and culvert length of 95.00 m. The structure has an east-west orientation. Photo P1 shows a view of the west elevation of the site. Photo P2 shows the east elevation. Photo P13 shows a view of the pavement surface at the culvert location. Drawing 1 shows the site plan.



West Elevation of Site No. 34-454/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 P2 to P7. The east elevation, with a total surveyed area of 18.90 m^2, was in fair-to-poor condition with delaminations (0.25 m^2), spalls (2.90 m^2), and honeycombing (0.61 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 P1, P8 to P11. The west elevation, with a total surveyed area of 25.60 m^2, was in poor condition with stained medium width cracks (5.0 m), delaminations (1.35 m^2), and spalls (7.20 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 P19. The barrel soffit, with a total surveyed area of 634.00 m^2, was in fair condition with clean/stained medium width cracks (119.0 m), clean/stained wide width cracks (10.0 m), delaminations (2.90 m^2), spalls (1.90 m^2), light scaling (0.53 m^2), honeycombing (1.34 m^2), and wet areas (21.70 m^2). The cracks were mainly transverse. The wet areas were found at soffit ends and along the transverse cracks. Presence of mold was observed on soffit at east end of the culvert.

3.4 Barrel North Wall

The deteriorations of the barrel's north wall are shown on Drawing 2 and in Photos P20 to P25. The north wall, with a total surveyed area of 120.00 m^2, was in fair-to-good condition with clean/stained medium width cracks (17.0 m), spalls (0.75 m^2), and wet areas (4.16 m^2). The cracks were mainly vertical. Presence of mold was observed on the north wall near the east culvert end. Core C5 was taken from the north wall at a location shown on Drawing 2. Photo P37 shows the inside of the corehole C5. 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 0.007% (the background chloride ion content was estimated to be 0.010%). 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 upper 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 P26 to P30. The south wall, with a total surveyed area of 120.00 m^2, was in fair-to-good condition with clean/stained medium width cracks (15.0 m), delaminations (0.25 m^2), and wet areas (4.13 m^2). The cracks were mainly vertical. Presence of mold was observed on the south wall near the east culvert end. Cores C1 to C4 were taken from the south wall at locations shown on Drawing 2. Photos P33 to P36 show the inside of the coreholes. No defects were observed in the concrete cores. Reinforcement steel was encountered in cores C1 and C4, both exhibiting light rusting. Cores C2 and C3 were tested for compressive strength of the hardened concrete in accordance with CSA A23.2-14-14C. The compressive strength for these cores was found to be 66.3 MPa and 59.4 MPa, respectively. 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 marginal.

Core No.	Air Content (%)	Specific Surface (mm^{-1})	Spacing Factor (mm)
C4	4.2	22.66	0.247

The corrected chloride ion content, at the rebar level, for core C1 was found to be 0.002% (the background chloride ion content was estimated to be 0.010%), indicating that the chloride contamination has not yet extended to the upper rebar level in this corehole location.

4.0 REVIEW OF REINFORCING STEEL

A rebar sample of about 300 mm length was taken from the west 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 P40 and P41 show the rebar sample before and after washing, respectively. The yield strength of the rebar sample was found to be 390 MPa (56,500 psi). The ultimate tensile strength for this rebar sample was found to be 665 MPa (96,500 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 P42 to P47. The rebar size, spacing and depth are shown on Drawing 3. The GPS scan identified 32M rebar size in the top slab. Further, the GPR identified 25M rebar sizes in the barrel walls. In general, the rebar depth (concrete cover) in the culvert top slab (GPR Location 1) varied from 30 mm to 75 mm, while the rebar spacing at this location varied from 300 mm to 340 mm. The rebar depth in the culvert walls (GPR Locations 2 and 3) varied from 109 mm to 130 mm, while the rebar spacing at these locations varied from 290 mm to 350 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: **34-454/C**

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

1. Dimensions and Area

Width	-	Length	-	Height	-
Diameter	-	Total Area Surveyed	18.90 m²		

Remarks

Dimensions were taken from the structural drawings & site measurements

2. Cracks (medium and wide)

Type		Transverse	Longitudinal	Other	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: **34-454/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
-	-	-	-	-	%

6. Delaminations and Spalls

Remarks

Defect Type	Delaminations	Spalls	Patches
Area (m^2)	0.25	2.90	0.00
Total Delaminations and Spalls		Total Delaminations and Spalls in Areas ≤-0.35 V	
3.15 m²	16.7 %	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 0.61 m²

Site No: **34-454/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: **34-454/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

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

Site No: 34-454/C

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

1. Dimensions and Area

Width - Length - Height -

Diameter - Total Area Surveyed 25.60 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	5.0	**m**
	Stained	0.0	0.0	5.0		
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: **34-454/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)	1.35	7.20	0.00
Total Delaminations and Spalls		Total Delaminations and Spalls in Areas ≤-0.35 V	
8.55 m²	33.4 %	N/A	N/A

*Wet areas = 0.00 m²

Remarks

7. Scaling

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: **34-454/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: **34-454/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: **34-454/C**

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

1. Dimensions and Area

Width - Length - Height -

Diameter - Total Area Surveyed 634.00 m²

Remarks

Dimensions were taken from the structural drawings & site measurements

2. Cracks (medium and wide)

Type		Vertical	Horizontal	Diagonal	Total	
Medium Width	**Clean**	13.0	0.0	0.0	119.0	**m**
	Stained	91.0	2.0	13.0		
Wide Width	**Clean**	3.0	0.0	0.0	10.0	**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

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: **34-454/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)	2.90	1.90	0.00
Total Delaminations and Spalls		Total Delaminations and Spalls in Areas ≤-0.35 V	
4.80 m²	0.8 %	N/A	N/A

*Wet areas = 21.70 m²

7. Scaling

Remarks

Light	Medium	Severe to Very Severe	
0.53	0.00	0.00	m^2
0.1	0.0	0.0	%

8. Honeycombing

Total Area 1.34 m²

Site No: **34-454/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: **34-454/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: **34-454/C**

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

1. Dimensions and Area

Width - Length - Height -

Diameter - Total Area Surveyed 120.00 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	17.0	**m**
	Stained	13.0	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: **34-454/C**

Component Type & Location: Barrel - North 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	
-	-	-	-	-	V
-	-	-	-	-	m^2
-	-	-	-	-	%

6. Delaminations and Spalls

Remarks

Defect Type	Delaminations	Spalls	Patches
Area (m^2)	0.00	0.75	0.00
Total Delaminations and Spalls		Total Delaminations and Spalls in Areas ≤-0.35 V	
0.75 m²	0.6 %	N/A	N/A

*Wet areas = 4.16 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: **34-454/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*	0.007	-	-	-	-	-

* 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: **34-454/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: 34-454/C

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

1. Dimensions and Area

Width - Length - Height -

Diameter - Total Area Surveyed 120.00 m²

Remarks

Dimensions were taken from the structural drawings & site measurements

2. Cracks (medium and wide)

Type		Transverse	Longitudinal	Other	Total	
Medium Width	**Clean**	1.0	0.0	0.0	15.0	**m**
	Stained	12.0	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: **34-454/C**

Component Type & Location: Barrel - South 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
-	-	-	-	-	%

Remarks

6. Delaminations and Spalls

Defect Type	Delaminations	Spalls	Patches
Area (m^2)	0.25	0.00	0.00
Total Delaminations and Spalls		Total Delaminations and Spalls in Areas ≤-0.35 V	
0.25 m²	0.2 %	N/A	N/A

*Wet areas = 4.13 m²

Remarks

7. Scaling

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: **34-454/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.	C1	-	-	-	-	-
Chloride Content*	0.002	-	-	-	-	-

* 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: **34-454/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

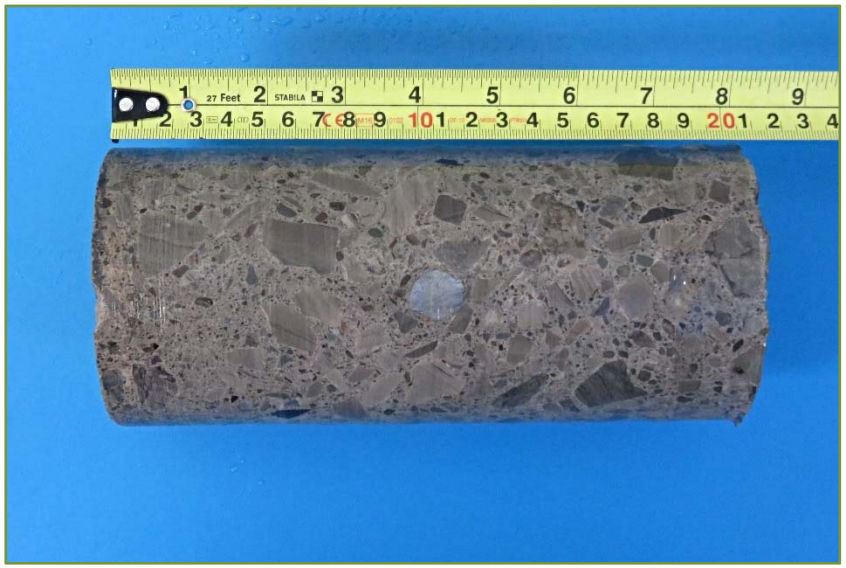
Average Compressive Strength: **62.8 MPa**

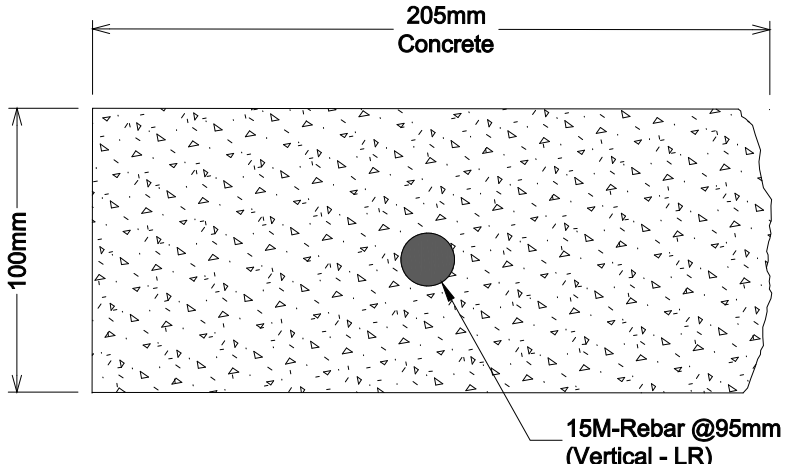
Appendix C:

Core Photographs and Sketches

200 Viceroy Road, Unit 4, Vaughan, ON L4K 3N8
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info@bridgecheckcanada.com

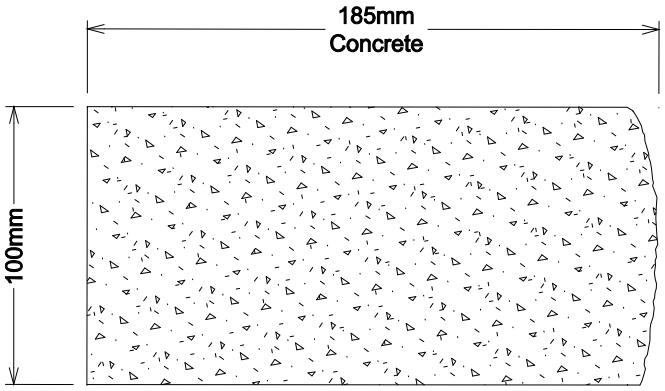
Core C1





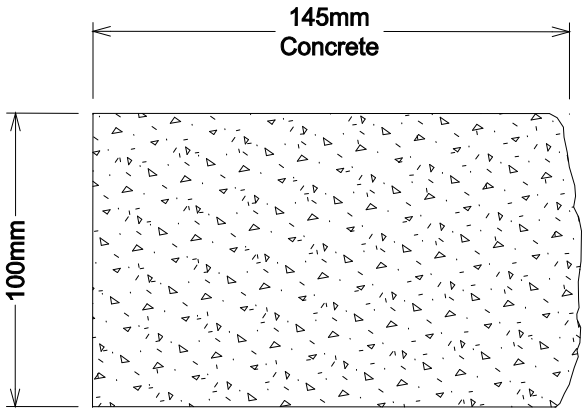
Core C2





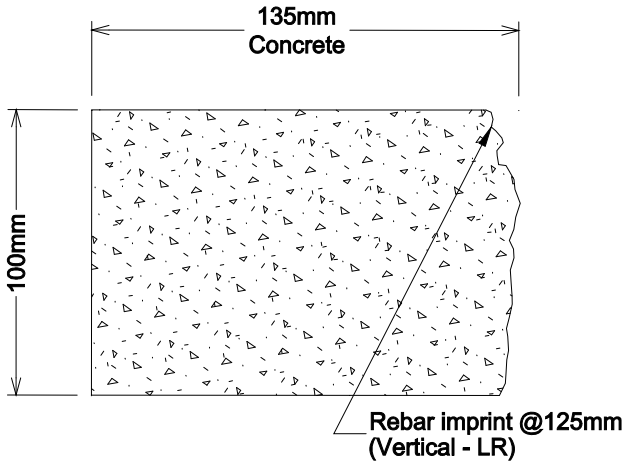
Core C3





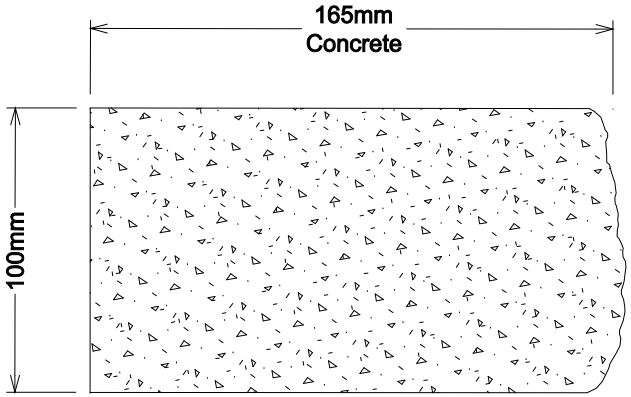
Core C4





Core C5





Appendix D:

Core Logs

200 Viceroy Road, Unit 4, Vaughan, ON L4K 3N8
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info@bridgecheckcanada.com

CORE LOG FOR EXPOSED CONCRETE

Site: 34-454/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		215.0		180.0		145.0	
Full Depth (yes/no)		No		No		No	
Defects in Concrete [1]		-		-		-	
Condition of Rebar [2]		LR		N/A		N/A	
Corrosion Potential							
Compressive Strength, MPa				66.3		59.4	
		Total	Corrected	Total	Corrected	Total	Corrected
Chloride Content % Chloride by Weight of Concrete	**0-10 mm**	0.087	0.077				
	20-30 mm	0.086	0.076				
	40-50 mm	0.033	0.023				
	60-70 mm	0.019	0.009				
	80-90 mm	0.012	0.002				
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 @95mm (Vertical - 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: 34-454/C

Core No.		**C4**		**C5**			
Location (between gridlines)		South Wall		North Wall			
Diameter, mm		100.0		100.0			
Length, mm		135.0		165.0			
Full Depth (yes/no)		No		No			
Defects in Concrete [1]		-		-			
Condition of Rebar [2]		LR		N/A			
Corrosion Potential							
Compressive Strength, MPa							
Chloride Content % Chloride by Weight of Concrete		Total	Corrected	Total	Corrected		
	0-10 mm			0.055	0.045		
	20-30 mm			0.042	0.032		
	40-50 mm			0.021	0.011		
	60-70 mm			0.021	0.011		
	80-90 mm			0.017	0.007		
	100-110 mm			0.010	0.000		
AIR VOIDS	**Air Content,%**	4.2					
	Spec. Surf.,mm^2/mm^3	22.66					
	Spacing Factor, mm	0.247					
TEST LABORATORY		BCC		BCC			
REMARKS **- orientation of rebars and cover** **- presence of overlay, patch and thickness** **- other observed defects**		Rebar imprint @125mm (Vertical - 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

Appendix G:

Site Photographs

200 Viceroy Road, Unit 4, Vaughan, ON L4K 3N8
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Photo P1 – West Elevation



Photo P2 – East Elevation



Photo P3 – East Elevation/Headwall (spall and delamination) note rusted 20M-rebar about 300mm spacing



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



Photo P5 – East Elevation, NE Retaining wall (spall)



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



Photo P7 – East Exterior Top Edge (vegetated)



Photo P8 – West Elevation/Headwall (spall) note rusted 20M-rebar about 300mm spacing



Photo P9 – West Elevation/Headwall (cracks and spall) note rusted horizontal 30M-rebar



Photo P10 – West Elevation, NW Retaining Wall (cracks, spall and delamination)



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



Photo P12 – Deck General View, Looking Southwest



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



Photo P14 – Barrel - Soffit @ West (spall, delamination and wet area)



Photo P15 – Barrel - Soffit – 34m from west (crack and delamination)



Photo P16 – Barrel - Soffit – 40m from west (wide crack)



Photo P17 – Barrel - Soffit – 79m from west (cracks, delamination and wet area)



Photo P18 – Barrel - Soffit @ East (spall and wet area) note mold on ceiling



Photo P19 – Barrel - Soffit – looking west (wet area)



Photo P20 – Barrel – North Wall – looking east (fair to good condition – cracks, spall and wet area)



Photo P21 – Barrel - North Wall – 12m from west (spall)

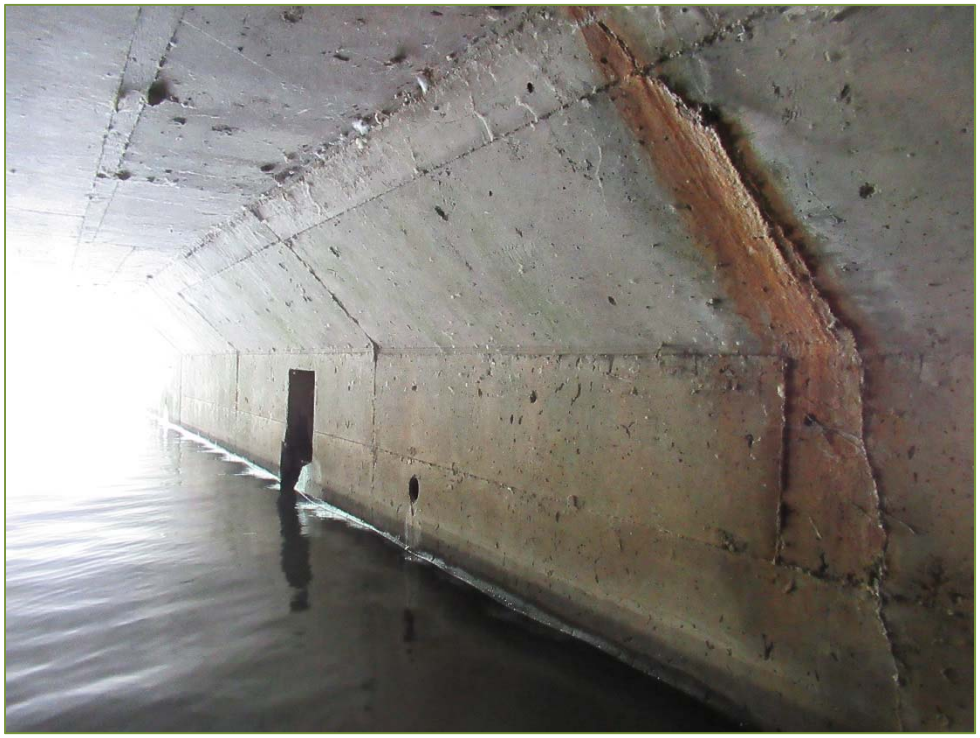


Photo P22 – Barrel - North Wall – 19m from west (crack and wet area)



Photo P23 – Barrel - North Wall – 28m from west (crack and wet area)



Photo P24 – Barrel - North Wall – 56m from west (cracks, spall and wet area)



Photo P25 – Barrel – North Wall – looking west note mold on wall



Photo P26 – Barrel – South Wall – looking east (fair to good condition – cracks, delamination and wet area)



Photo P27 – Barrel - South Wall @ West (crack)



Photo P28 – Barrel - South Wall – 19m from west (cracks and wet area)



Photo P29 – Barrel - South Wall – 34m from west (crack)



Photo P30 – Barrel – South Wall – looking west note mold on wall



Photo P31 – Barrel – Bottom Face – looking west



Photo P32 – Northeast Embankment

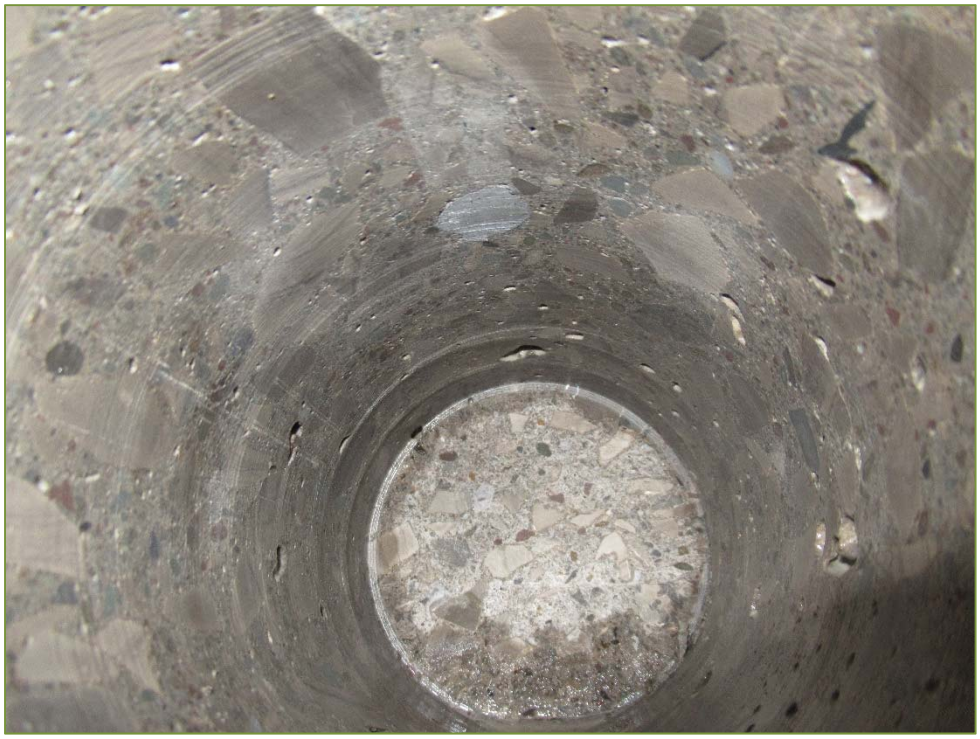


Photo P33 – Typical Condition of Inside Core – C1 (south wall)



Photo P34 – Typical Condition of Inside Core – C2 (south wall)



Photo P35 – Typical Condition of Inside Core – C3 (south wall)



Photo P36 – Typical Condition of Inside Core – C4 (south wall)



Photo P37 – Typical Condition of Inside Core – C5 (north wall)



Photo P38 – Upstream



Photo P39 – Downstream



Photo P40 – Rebar Sample No.1 at West Elevation/Headwall (Unwashed)



Photo P41 – Rebar Sample No.1 at West Elevation/Headwall (Washed)

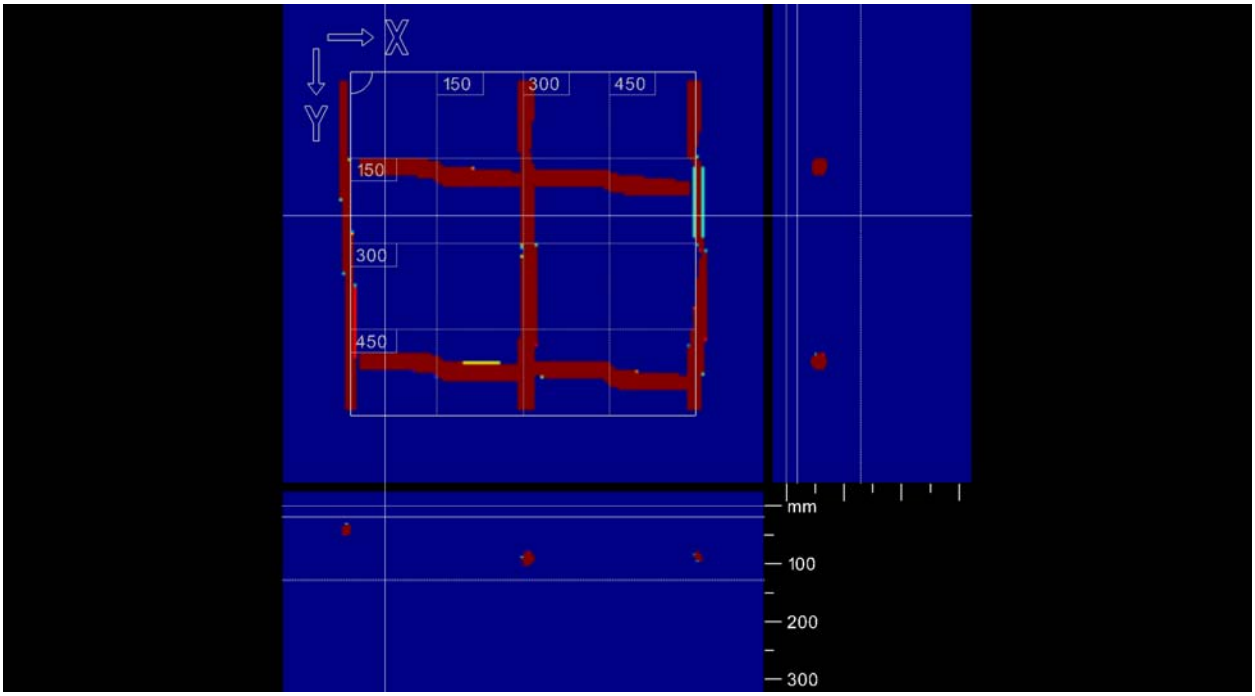


Photo P42 – 2D Image of Location No. 1

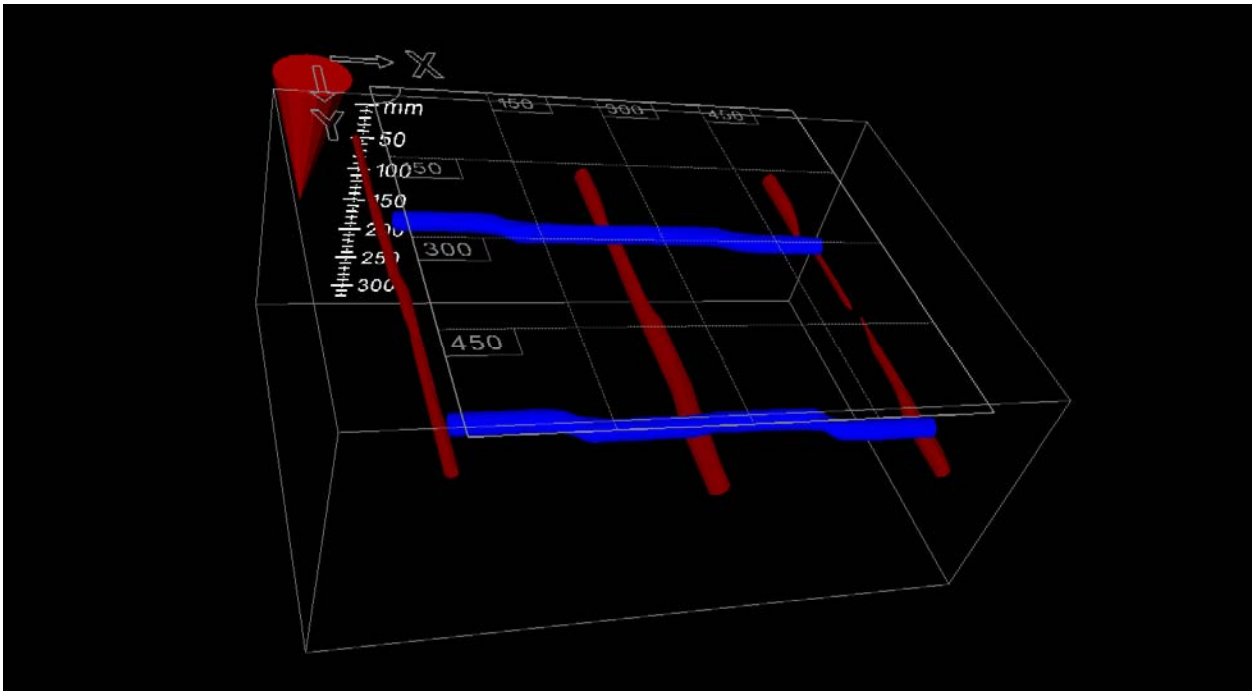


Photo P43 – 3D Image of Location No. 1

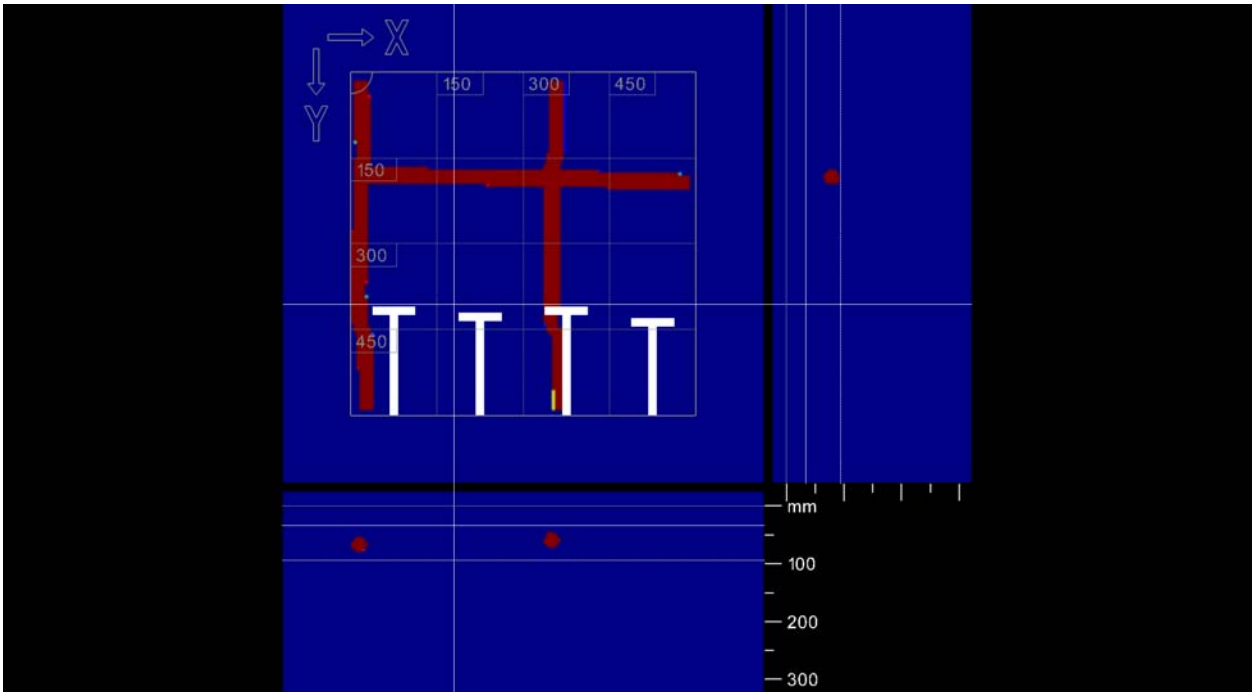


Photo P44 – 2D Image of Location No. 2

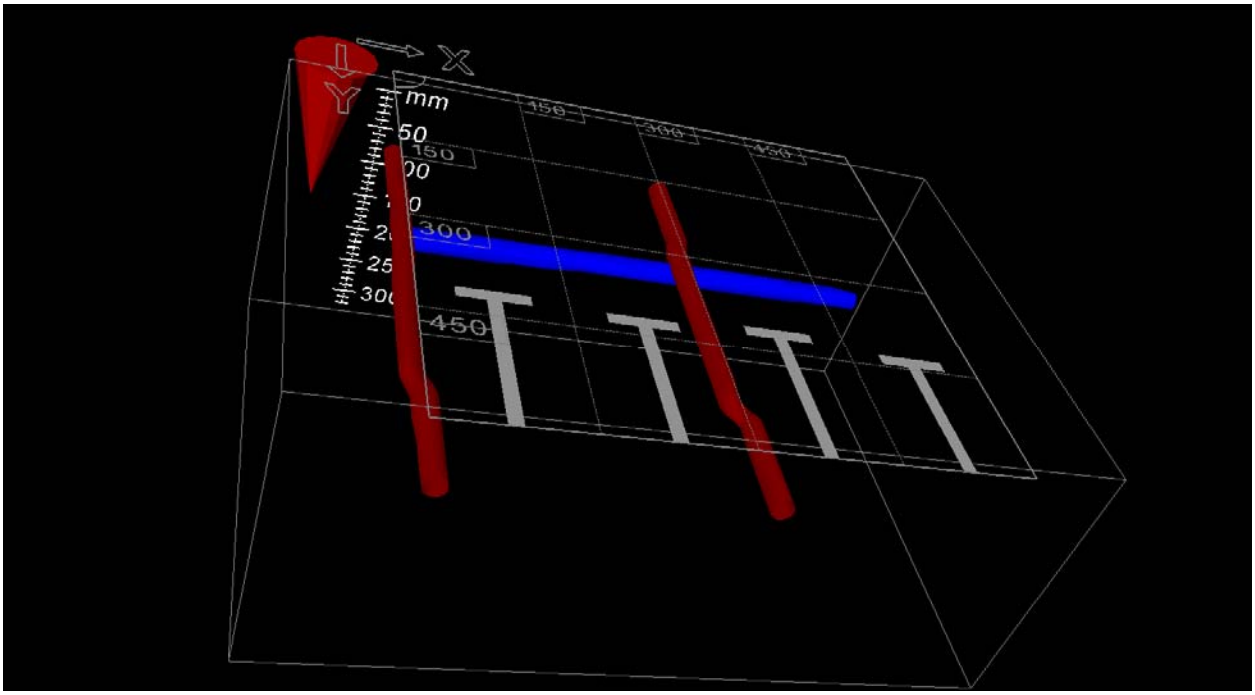


Photo P45 – 3D Image of Location No. 2

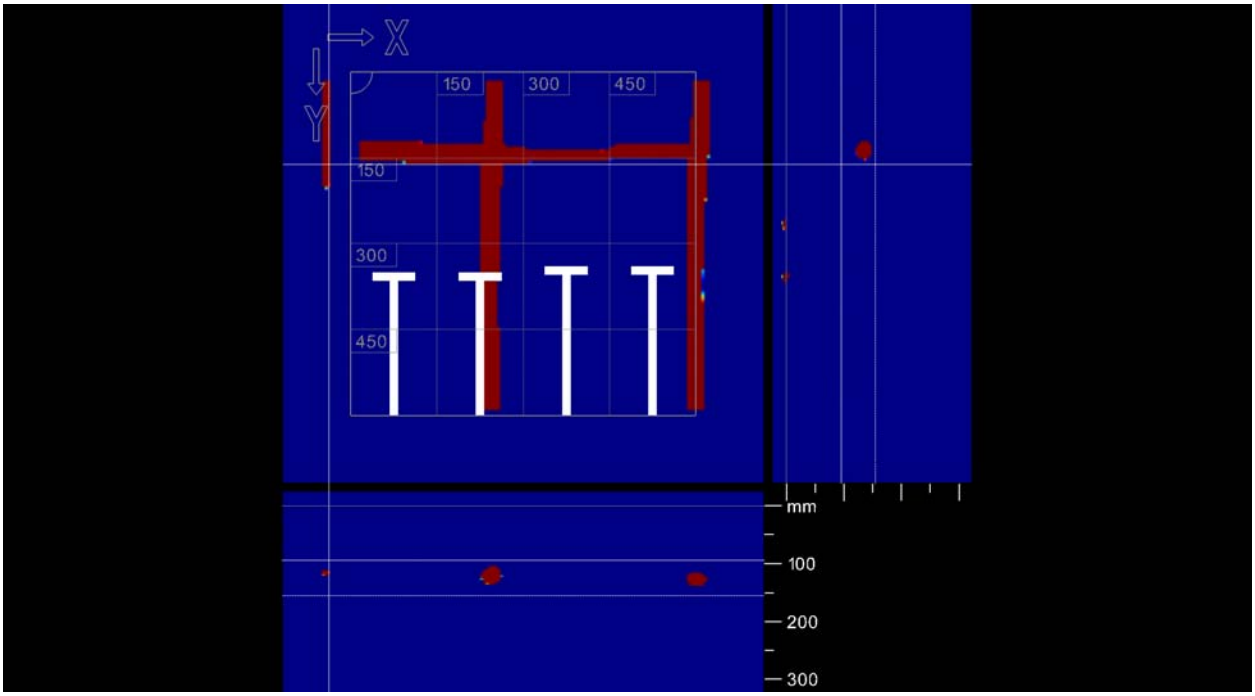


Photo P46 – 2D Image of Location No. 3

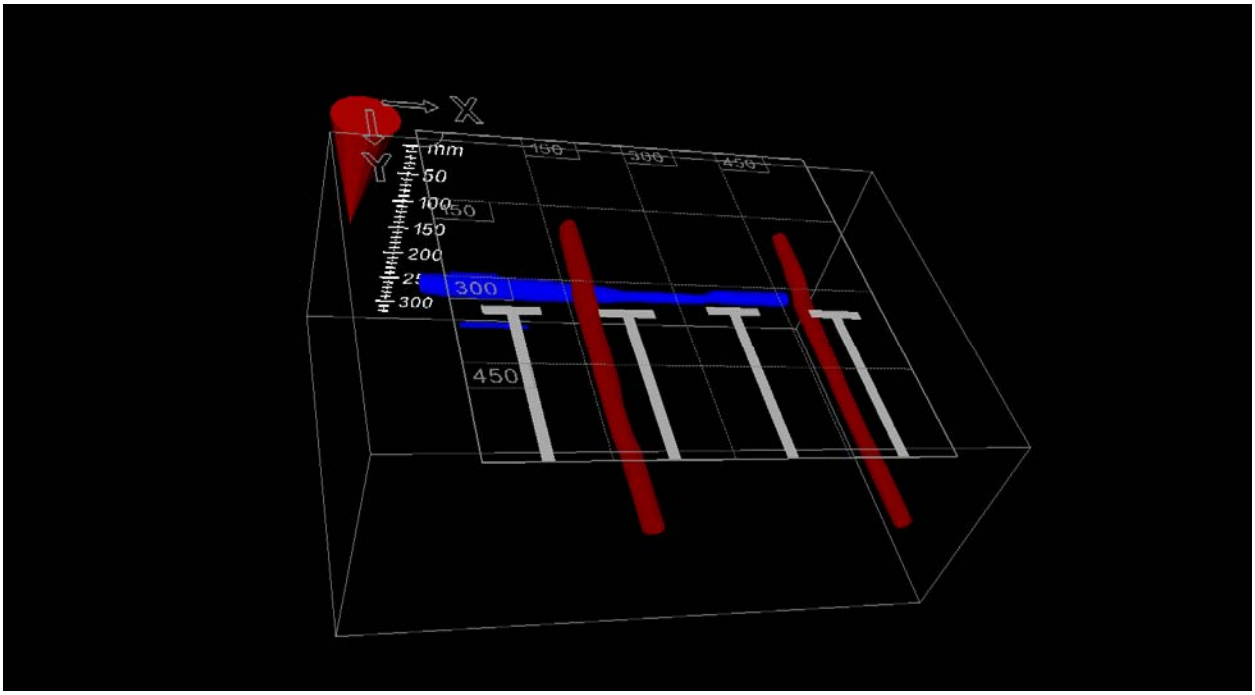


Photo P47 – 3D Image of Location No. 3



Photo P48 – GPR Scan Location of Barrel - Soffit @ West

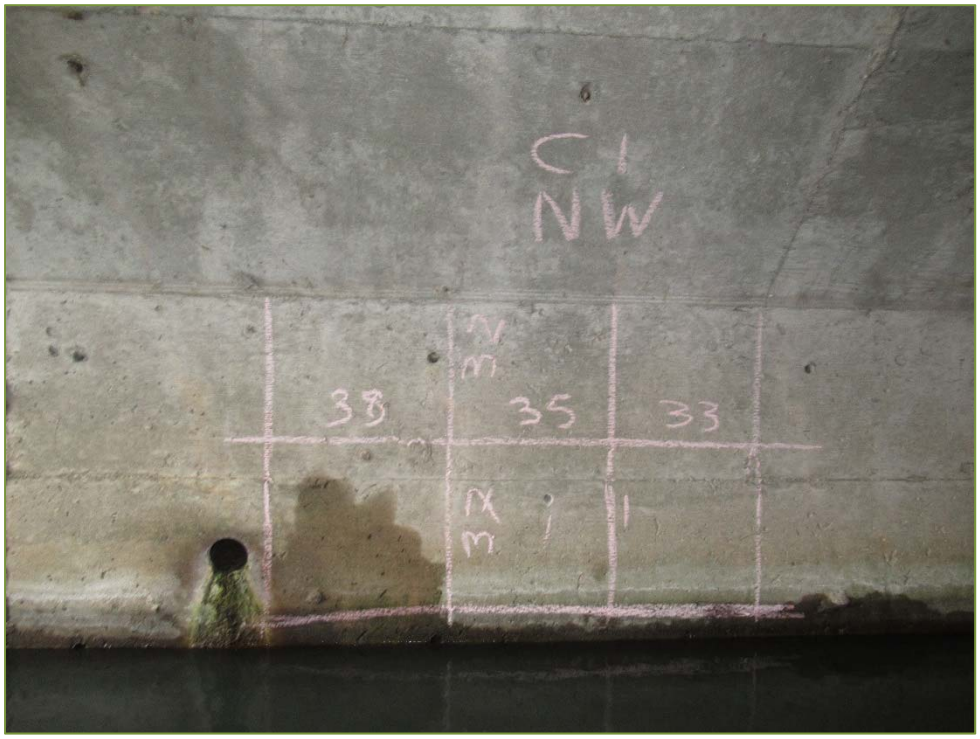


Photo P49 – GPR Scan Location of Barrel - North Wall @ West

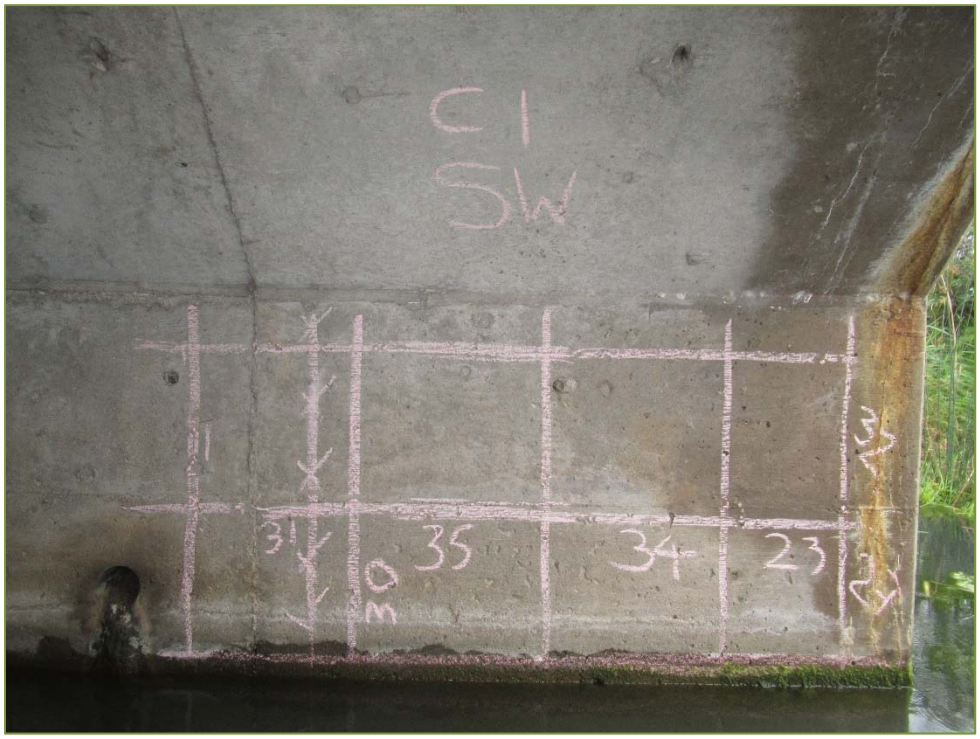


Photo P50 – GPR Scan Location of Barrel - South Wall @ West

Appendix H:

Laboratory Test Results

200 Viceroy Road, Unit 4, Vaughan, ON L4K 3N8
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info@bridgecheckcanada.com

COMPRESSIVE STRENGTH OF CONCRETE CORES

(CSA A23.2-14C)

Project No.:	**BCC18046**
Site No.:	**34-454/C**
Location:	**QEW Ramp W-W & Ramp E-E/W @ Frenchman's Creek**

Core ID	**C2**	C3
Location	South Wall	South Wall
Lab No.	L18-0787	L18-0788
Date Cast	-	-
Date Cored	Aug 17, 2018	Aug 17, 2018
Date Tested	Aug 27, 2018	Aug 27, 2018
Capped Height (mm)	158.0	127.6
Average Diameter (mm)	100.0	100.0
Density (kg/m^3)	2316	2275
Corrected Compressive Strength (MPa)	66.3	59.4
*** Direction of Loading**	Perpendicular	Perpendicular
Moisture Content at Time of Test	as-received	as-received
Remarks	*Average Strength = 62.8 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.:	**34-454/C**
Location:	**QEW Ramp W-W & Ramp E-E/W @ Frenchman's Creek**

Core ID	Lab No.	Horizon from the Top of the Core (mm)	Chloride Ion Content (%)	Chloride Ion Content Corrected for Background* (%)
C1 (South Wall)	L18-0786	0-10	0.087	0.077
		20-30	0.086	0.076
		40-50	0.033	0.023
		60-70	0.019	0.009
		80-90	0.012	0.002
C5 (North Wall)	L18-0790	0-10	0.055	0.045
		20-30	0.042	0.032
		40-50	0.021	0.011
		60-70	0.021	0.011
		80-90	0.017	0.007
		100-110	0.010	0.000

**Background chloride (original concrete) = 0.010%*
**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.:	**34-454/C**
Location:	**QEW Ramp W-W & Ramp E-E/W @ Frenchman's Creek**

Core ID	**C4**		
Lab No.	L18-0789		
Air Content (%)	4.2		
Specific Surface (mm^{-1})	22.66		
Spacing Factor (mm)	0.247		
Length of Traverse (mm)	3653.1		
Area Traversed (mm^2)	10229		
Average Chord Length	0.176		
Number of Stops	1353		
No. of Voids per mm	0.239		
Paste-Air Ratio	7.561		
Paste Content (%)	31.86		
Aggregate Content (%)	63.93		

Tested By: Brad Wiersma
Date Tested: Aug 24. 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. 788323–18

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

Attention: Mohammad Abdollahi

Specimen: Rebar Sample #1 (Washed), Job Number BCC18046,
Site No. 34-454C, QEW Ramp W-W & Ramp E-E-W @ Frenchman's Creek
(West Elevation/Headwall) Fort Erie, ON

TENSILE TEST REPORT

	RESULT	
Specimen Diameter:	0.249	in.
Yield Strength (0.2% Offset):	56,500	psi
Ultimate Tensile Strength:	96,500	psi
Elongation in 1.00 in.:	24	%
Reduction of Area:	49	%

Testing performed according to ASTM A370-17a.

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Test Report Template Revision January 2013

Cambridge Materials Testing Limited

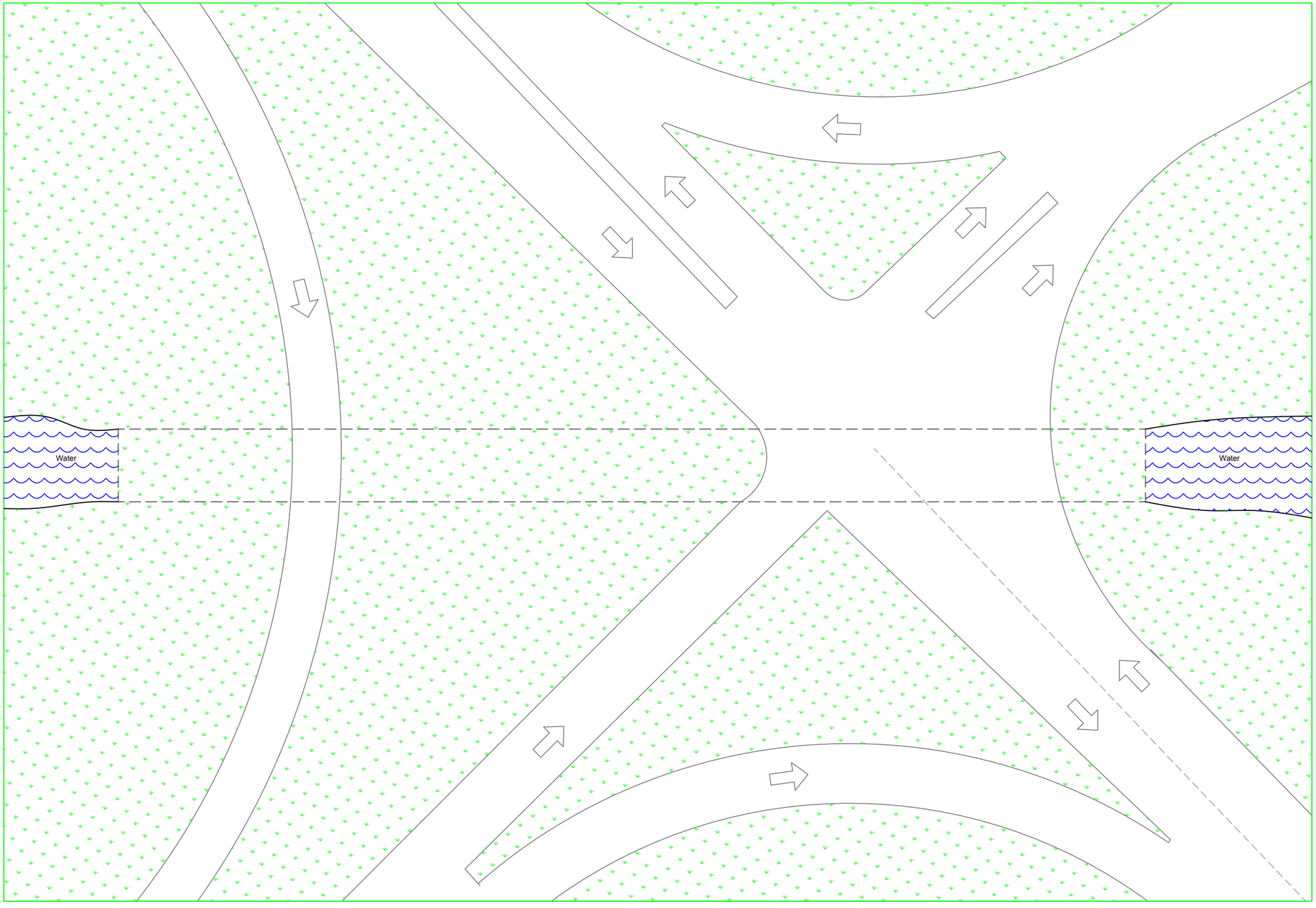
Per Randi Lee
Randi Lee
Quality Assurance

Per Nicholas Cooper
Nicholas Cooper
Technician

Appendix J:

ACAD Drawings

200 Viceroy Road, Unit 4, Vaughan, ON L4K 3N8
www.bridgecheckcanada.com
Tel: 905-660-6608 Fax: 905-660-6609
info@bridgecheckcanada.com



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

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

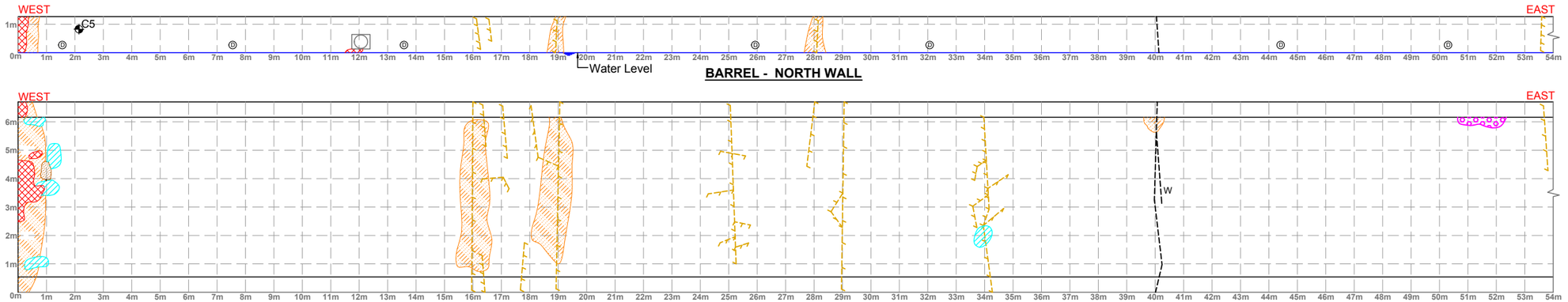
PROJECT:

QEW Ramp W-W & Ramp E-E/W
@ Frenchman's Creek
Site No. 34-454/C
Fort Erie, Ontario

TITLE:

SURFACE DETERIORATION
OF DECK PLAN

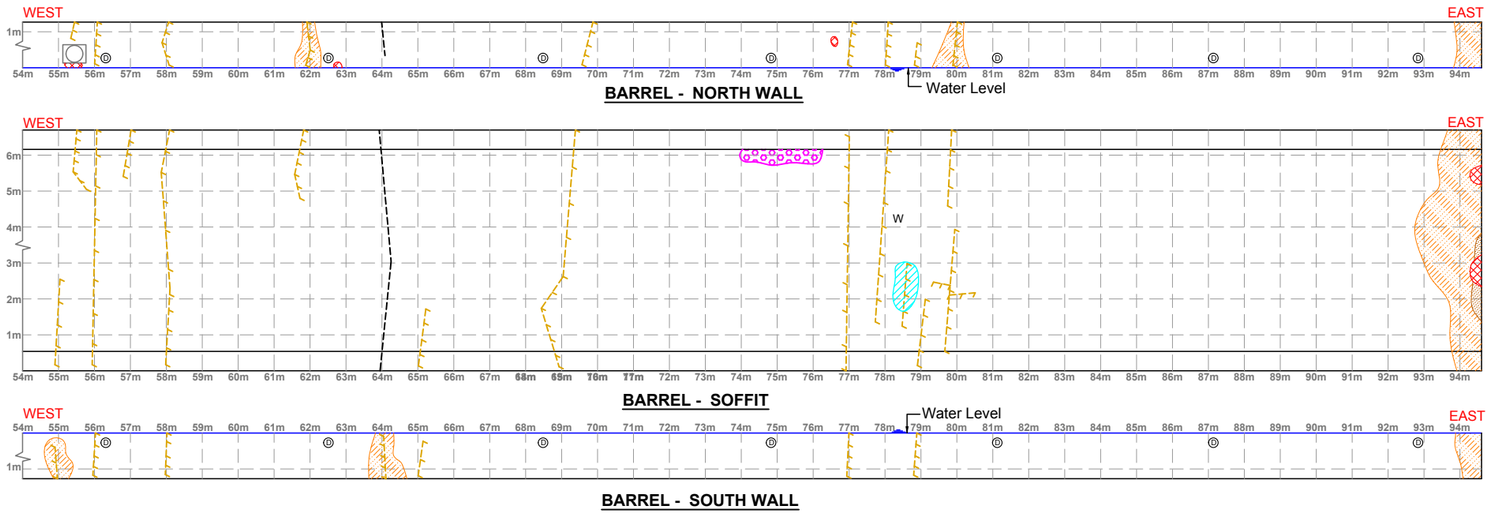
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Project No.:	BCC18046
Date:	October 2018
Scale:	1:400
Drawn by:	KL
Checked by:	MA



BARREL - NORTH WALL

BARREL - SOFFIT

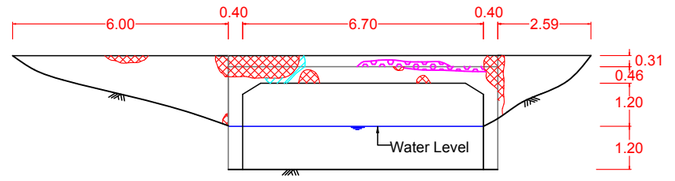
BARREL - SOUTH WALL



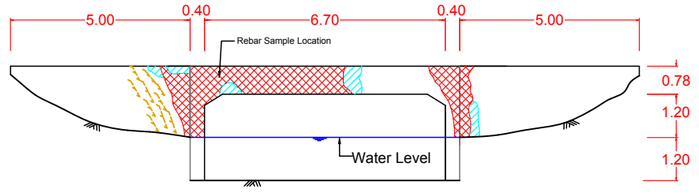
BARREL - NORTH WALL

BARREL - SOFFIT

BARREL - SOUTH WALL



EAST ELEVATION



WEST ELEVATION

KEY PLAN



LEGEND:

- Drain
- C1 Core Sample Location
- SS1 Sawn 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

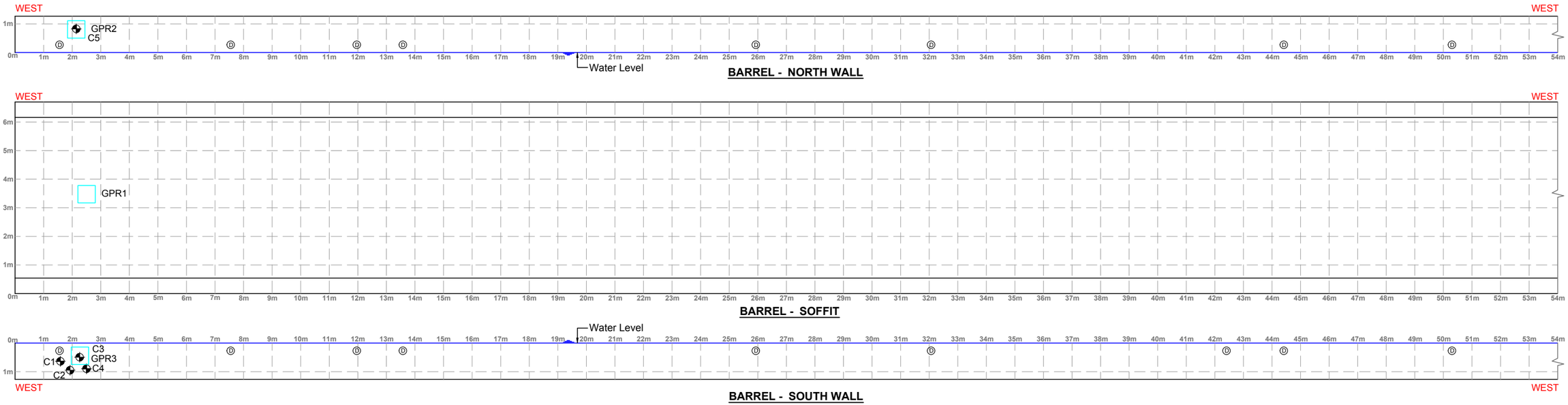
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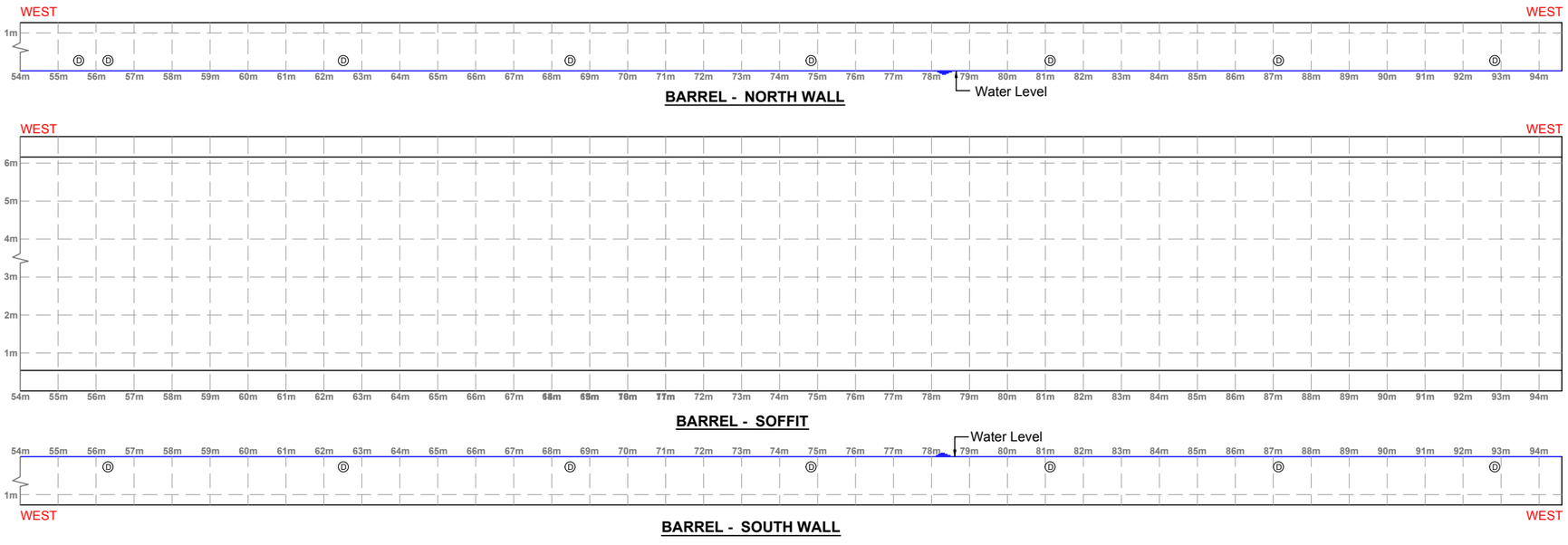
QEW Ramp W-W & Ramp E-E/W
@ Frenchman's Creek
Site No. 34-454/C
Fort Erie, Ontario

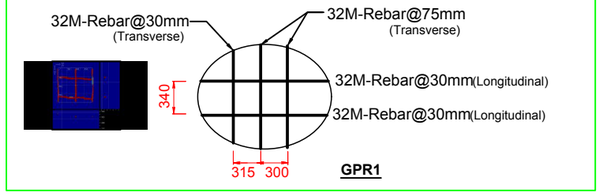
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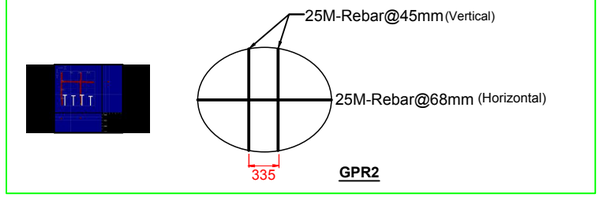
SURFACE DETERIORATION
OF CULVERT

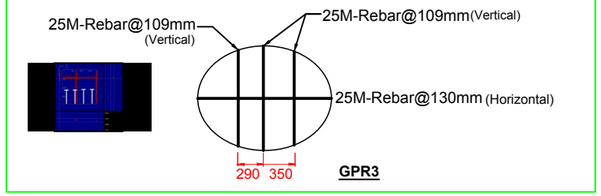
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Drawn by:	KL
Checked by:	MA

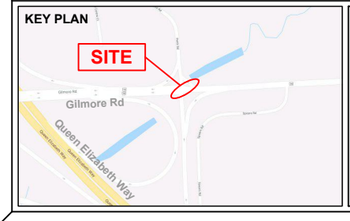












LEGEND:

- 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

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

PROJECT:

QEW Ramp W-W & Ramp E-E/W
@ Frenchman's Creek
Site No. 34-454/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