

City of Hamilton

2017 Sign Support Inspections Summary Report

Prepared by:

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November 17, 2017

Ed Switenky CET
Superintendent Traffic Operations
City of Hamilton
Traffic Operations Centre
1375 Upper Ottawa Street
Hamilton, Ontario L8W 3L5

Dear Mr. Switenky:

Project No: 60554463

Regarding: 2017 Sign Support Inspections Summary Report


AECOM is pleased to submit this report with respect to the results of the 2017 City of Hamilton Sign Support Inspections.

The structures were reviewed in accordance with the most current version of the Sign Support Inspection Guidelines.

With this report, all sign support structure related data has been updated to present day values and the content of the report reflects the conditions as of the time of the field data collection.

We trust that this report will be beneficial to the City and wish to express appreciation for the opportunity for AECOM to undertake this work.

Sincerely,
AECOM Canada Ltd.



Scott Davis, P.Eng MASc
Manager Roads and Engineering
Scott.davis@aecom.com

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cc: file

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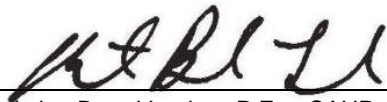
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Executive Summary

This report is a summary of the recommendations resulting from the City of Hamilton 2017 Sign Support Inspection Guidelines (SSIG) biennial inspection program. SSIG inspections include a complete element by element detailed visual inspection of the 44 highway sign support structures owned by the City of Hamilton. SSIG inspections provide valuable information for the City of Hamilton SSIG reports combined with upcoming biennial inspections. They are a tool to monitor and plan for the City of Hamilton's sign support infrastructure needs.

Each sign support inspected includes details specific to its condition and recommendations. Of note the maintenance walkways or catwalks should be removed from use due to the prevalence of broken and cracked C Clamps. Site 37 on Nicola Tesla Blvd on the eastbound side ahead of Woodward Ave is in very poor condition and should be removed and replaced.

At other sites an ongoing maintenance program is necessary including drilling of drain holes, welding members, tighten bolts, replacing C clamps, applying coatings, replacing missing members and repairing signs or other attachments as required. A maintenance program will slow the deterioration of the sign supports and ensure that they remain a valuable part of City of Hamilton infrastructure

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1. Introduction

AECOM Canada Ltd. (AECOM) was retained by the City of Hamilton to complete the 2017 sign support inspections in accordance with the current Sign Support Inspection Guidelines (SSIG). These structures are a vital part of the wayfinding infrastructure for the City of Hamilton and the goal of the SSIG inspections is to ensure that the structures are maintained to an acceptable standard to protect public safety and convenience. In order to ensure an effective structure management system, the SSIG require that systematic inspections be performed every two years on sign support structures. The inspections themselves involve detailed inspections of each element to assess material, performance, and maintenance requirements. In addition to the biennial inspections which are the subject of this report, routine maintenance and inspection by City of Hamilton maintenance crews are essential in identifying changes to structure condition.

1.1 Background

A detailed visual inspection of each of the City of Hamilton's sign support structures was completed as part of the 2017 inspections in coordination with Burgess Engineering Inc. SSIG inspections were completed by using cameras and accessed by climbing where the condition of the structure permitted. The inspections were previously completed in 2012. By conducting biennial inspections, any new visible deterioration and progression of deterioration can be monitored. A city map indicating the sites inspected is included in **Appendix A**. GPS Coordinates used for the mapping are included in the individual reports. The coordinates are taken at the right leg (in direction of traffic) at each structure.

The purpose of the report is to clearly identify the current and future physical and financial needs of the City of Hamilton with respect to its sign support structures. The report provides a rating of the general condition of the structures. The report information can be used for high level planning and budgeting. However, once a structure reaches the project design stage, further detailed review, investigation and design will be required to address the specific requirements of the project.

2. Methodology

A consistent approach to structure inspections is required for an SSIG inspection. The SSIG provides the framework to ensure that individual inspectors consider each element consistently every two years. The SSIG goes so far as to define the types of material defects and the grade of their severity in order to ensure that each inspector designates each deficiency and deterioration similarly. In addition, the SSIG inspection process requires the inspector to provide recommendations with regard to additional investigations, maintenance, and repair needs along with the urgency. Furthermore, inspectors are further required to identify performance deficiencies.

In Hamilton 6 types of sign support structures were inspected. Terminology, sample deficiencies and each type of structure are described in a more detailed document in **Appendix B**.

2.1 Additional Investigations

During structural inspections the need for detailed investigations may be identified. Examples of additional investigations include:

- Ultrasonic testing (UT) of the anchor bolts; and
- Liquid Penetrant Testing (LPT) of welds.

Non destructive testing (NDT) using liquid penetrant was used at Site 37 to show excessive weld cracking. Photographs and descriptions are included with the individual inspection.

2.2 Maintenance Needs

Maintenance work includes routine maintenance as well as targeted structural repairs. Maintenance is not typically considered capital work. Routine maintenance can prolong the life of a structure, but may include urgent safety items which are not structural. In several of the reports the drilling of drain holes is recommended under maintenance. Drain holes can allow the free drainage of water from a steel element and prevent cracking from expanded trapped moisture which freezes. Routine maintenance does not require engineering direction and can typically be performed by the City of Hamilton's maintenance personnel. Structural maintenance work may include emergency repairs to restore structural capacity and requires engineering direction.

A summary of recommended maintenance needs is included in **Appendix C**, with timelines in accordance with the urgency of the maintenance requirement. Urgent repairs are typically safety oriented. 1 year maintenance repairs should usually be part of the regular routine maintenance for a structure, and the 3 year timeframe applies to elements which will affect the long term durability of the structure.

2.3 Repair/ Rehabilitation

Where an element is identified as having all or a portion of material in the poor condition state, maintenance, a repair, or rehabilitation is recommended. Rehabilitations are typically recommended for small elements that require replacement, minor weld repairs, or concrete patch repairs. The recommended work includes a timeframe of 1 month, 1 year or 3 years. The recommended timing of a repair is related to the quantity of deterioration and whether the element is critical to the structure. A greater amount of deterioration on a critical element results in the 1 year timeframe being recommended, whereas a less critical repair may warrant the recommendation of a 3 year time frame. Urgent repairs include a recommended timing of 1 month. A summary of the repair and rehabilitation needs for City of Hamilton sign support structures is included in **Appendix C**.

2.4 Structural Ratings

Structural ratings (SSR) are a means of categorizing the structures' overall condition. The ratings and conditions can be used to rank the sign support structures based on the defects and performance of each site. The structure ranking can be used as a guide for programming repairs and replacement. The overall condition of each site based on the SSR is as follows:

- Excellent where SSR >95
- Good where SSR >75
- Fair where SSR >40
- Poor where SSR <40

A summary of SSR for City of Hamilton structures is included in **Appendix D**. The percentage of sign supports in each category in 2017 is provided in **Figure 1**.

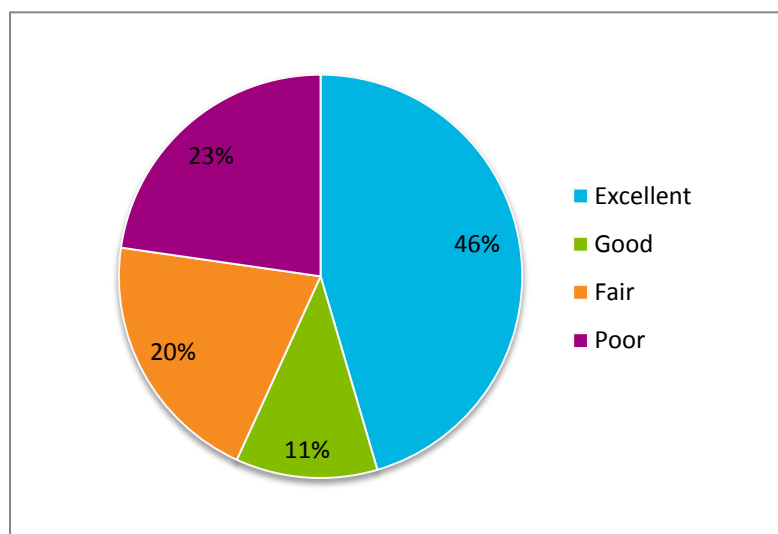


Figure 1. Summary of 2017 Sign Support Ratings

3. Situations to Monitor

3.1 Site 37

Site 37 is an Aluminum Tapered Leg (ATL) sign support located on the Nicola Tesla Blvd on the eastbound side ahead of Woodward Ave. Liquid Penetrant non destructive testing was done at this site on several cracked welds and in addition welds were visually observed to have cracked. Bolt corrosion in the truss, chord and support legs reduce the serviceability of this structure. In addition loose bolts in the walkway and support base and cracked clamps represent a hazard. The Structure Support rating is poor at -384; this sign support is in the worst condition of the supports that were safe enough to climb. This sign should be removed and replaced within a month to protect public safety.

3.2 Catwalks/Maintenance Walkways

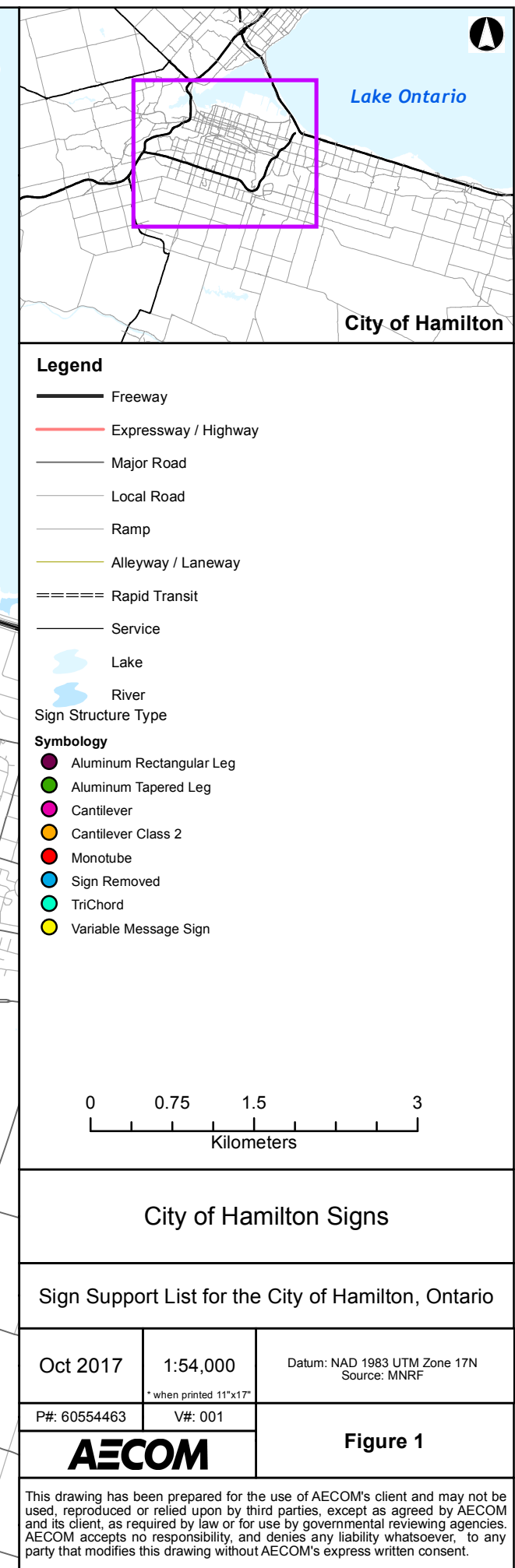
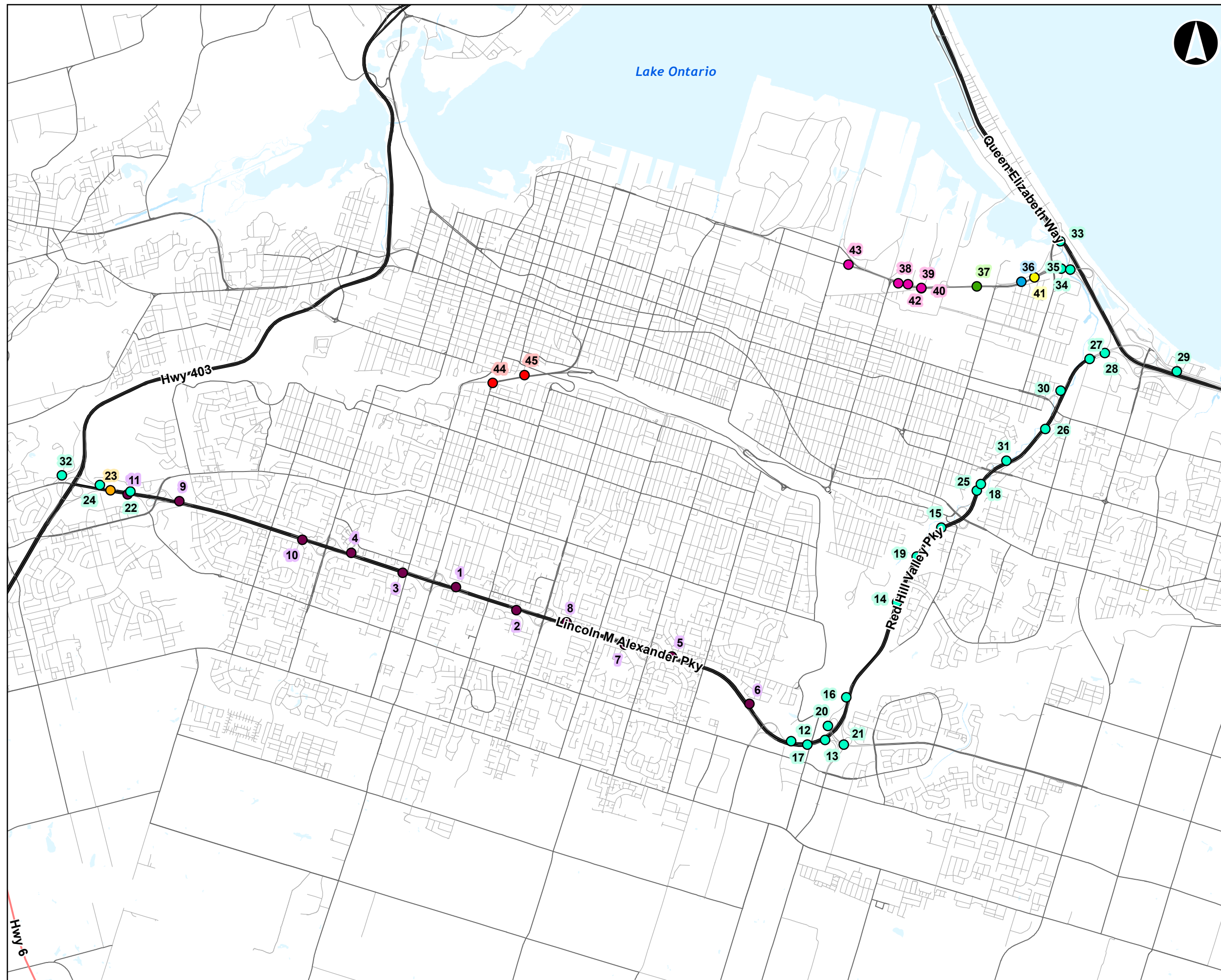
It is recommended that the Catwalks to install or maintain signs be removed and their use prohibited. The catwalks for Aluminum Rectangular Leg (ARL) signs in particular should be removed. This includes Sites 2, 3, 6 and 7. The C-Clamps used to support the catwalks are cast with a crack-susceptible steel. The clamps are often cracked and can result in a safety issue if the catwalks are used. It is recommended that Catwalks be removed. Further details regarding the maintenance walkway catwalks and the issues surrounding the cracked C-Clamps are included in **Appendix B**.

4. Conclusion

SSIG inspections were completed on 44 bridge structures in the City of Hamilton. The City of Hamilton will need to continue to contemplate increasing repair and rehabilitation costs for its aging sign support structure infrastructure to protect its assets and the public safety. The City of Hamilton may find that for some structures deterioration begins to accelerate, whereas other structures may stabilize allowing the deferral of repairs. As a result, the maintenance, rehabilitation and repair needs should continue to be updated in upcoming biennial inspections.

Appendix **A**

Sign Support Location Map



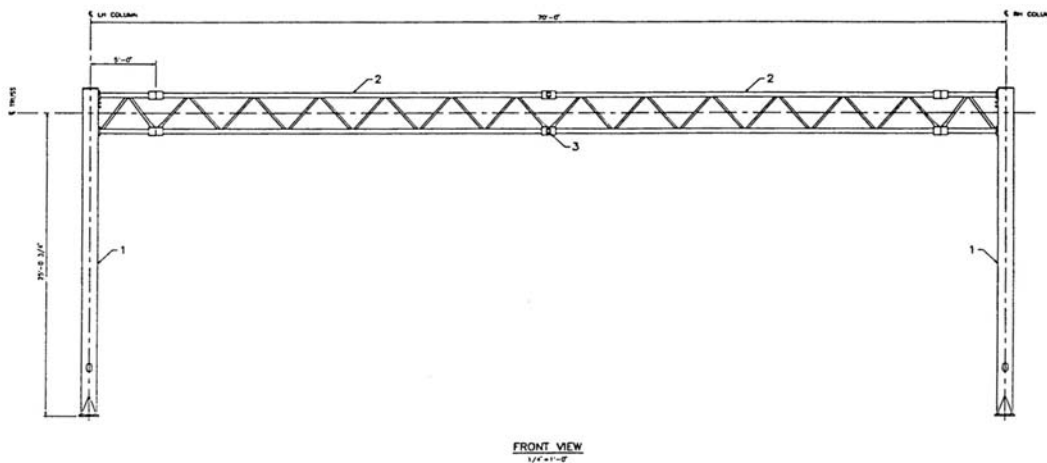
Appendix **B**

Detailed Inspection Methodology

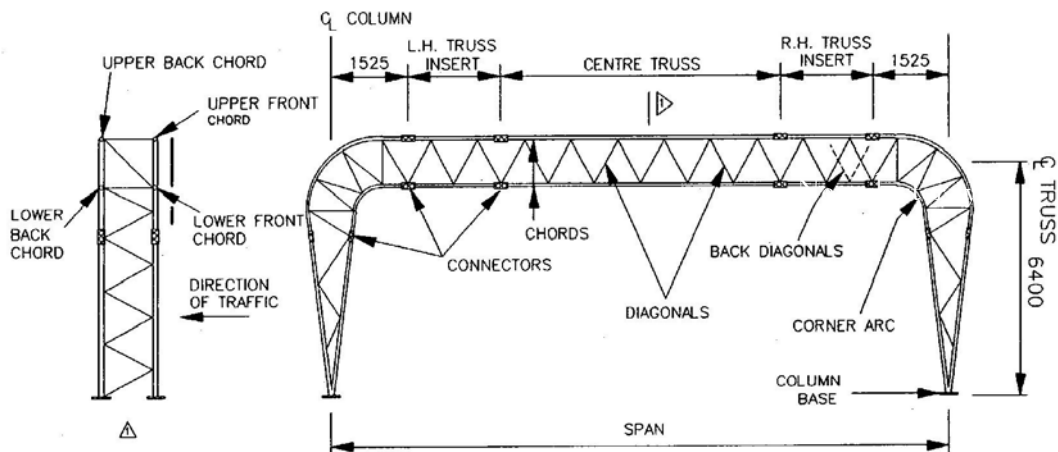
Background and Detailed Methodology

As a part of the City of Hamilton's overhead sign support inspection program, Burgess Engineering Inc. was retained to inspect and report on the condition of forty-four overhead sign support structures. The following are the various structure types covered in this report.

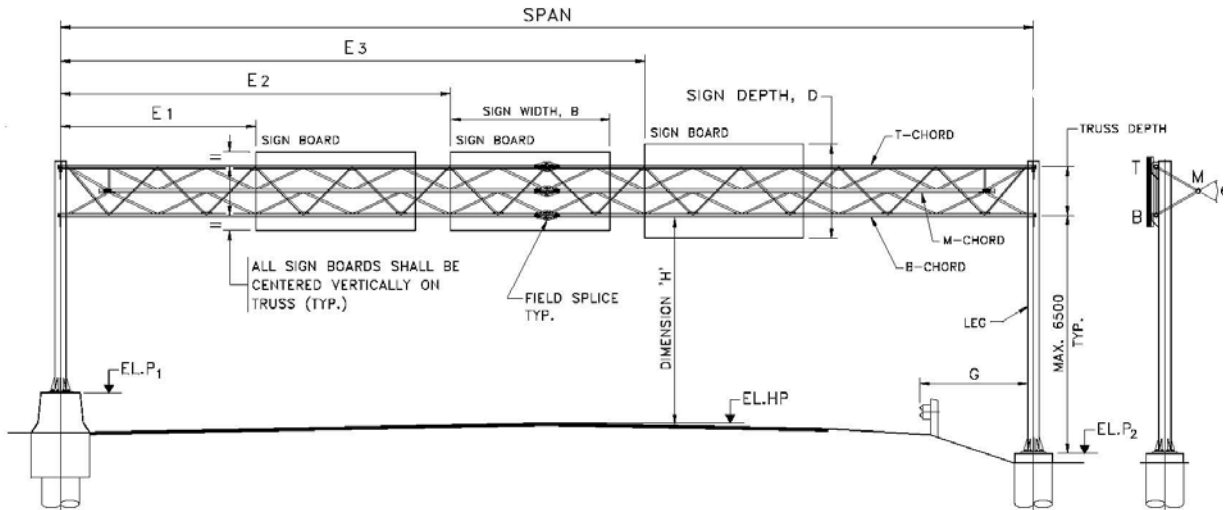
Aluminum Rectangular Leg (ARL) - The general arrangement of this structure is shown below.



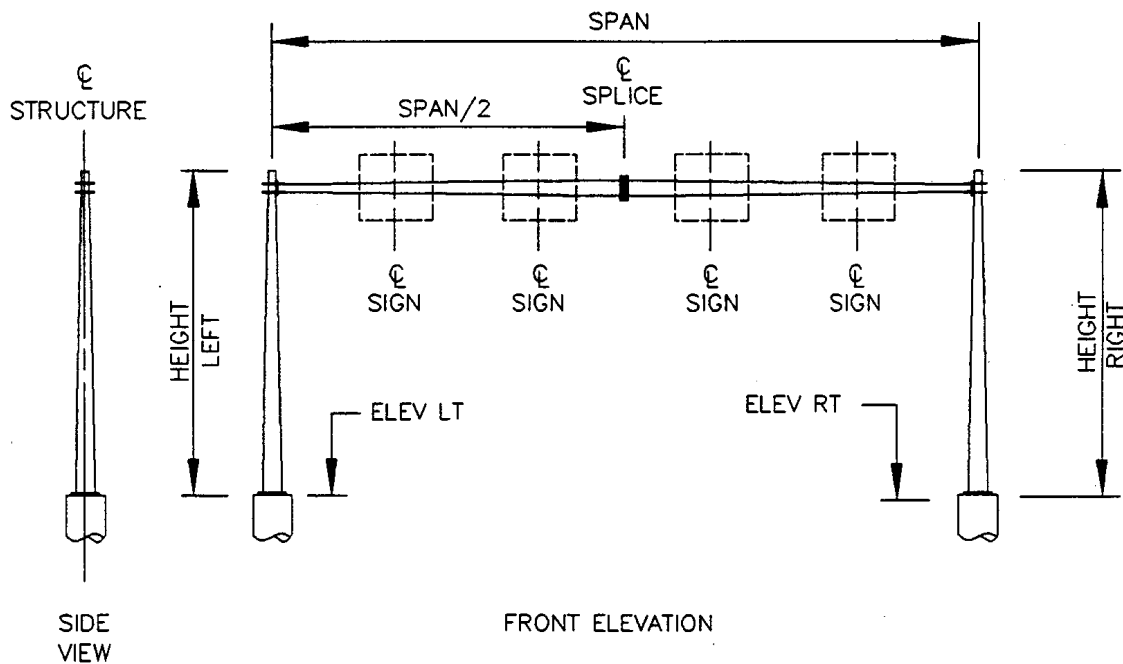
Aluminum Tapered Leg (ATL) - The general arrangement of this structure is shown below.



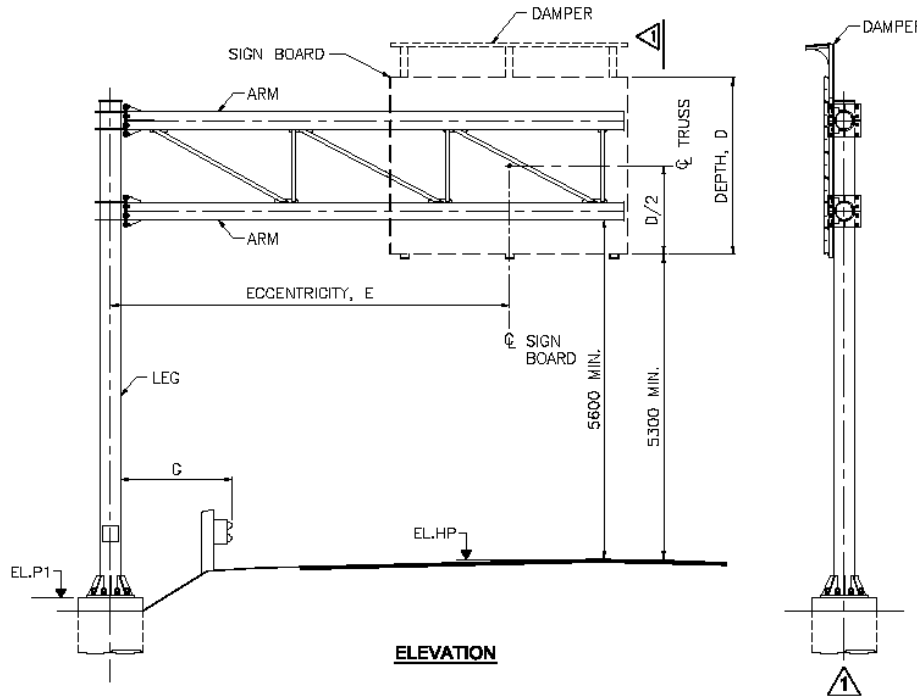
Tri-Chord - The general arrangement of this structure is shown below.



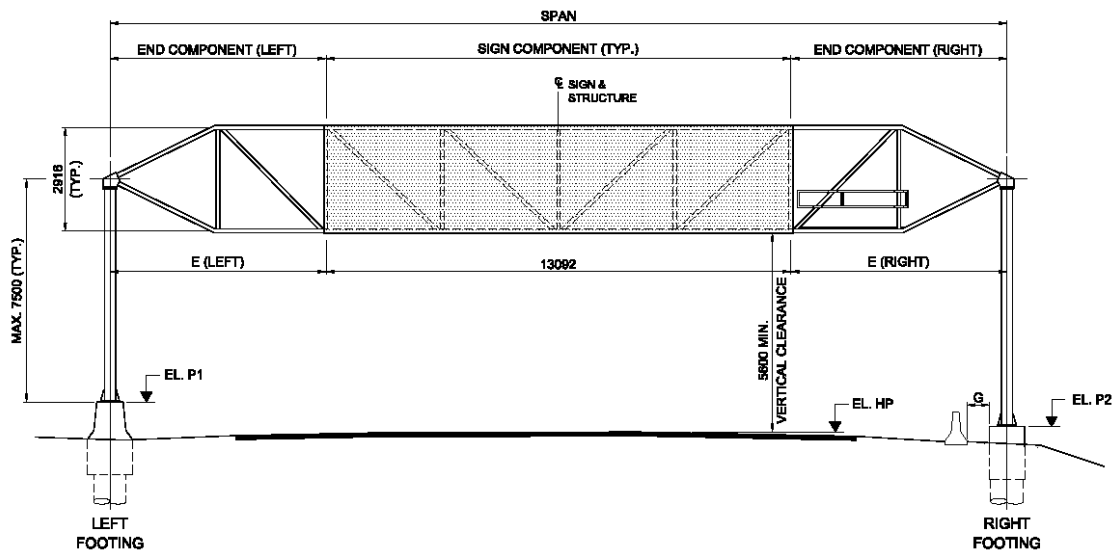
Mono-tube - The general arrangement of this structure is shown below.



Cantilever support - The general arrangement of this structure is shown below:



Walk-in CMS - The general arrangement of this structure is shown below:



All structures were inspected in detail and deficiencies requiring repair were flagged with trail blazing tape and are described in each report. In addition to the detailed visual inspection, site #37 was subjected to non-destructive testing. Photographs of each test are given with the test findings documented. At the time of inspection the global positioning coordinates were taken from the right leg.

Inspection Terminology & Method of Repair

The following terminology is referenced throughout the reports:

Terminology	Description	Repair Methodology
Initial Cracking	Start of weld crack propagation.	Weld & grind smooth
% Cracked	The % of weld length that has cracked.	Weld & grind smooth
Bent	A member has been impacted.	Complete member replacement with equal
Split	A member has ruptured, typically from freezing of entrapped water.	Complete member replacement with equal & drill drain holes
Cracked or Broken Sign 'C' Clamp	An aluminum casting that affixes the sign to the chords.	Replacement with equal, or better to eliminate ongoing replacement
Cracked or Broken Walkarm 'C' Clamp	An aluminum casting that affixes the catwalk arm to the chords.	Replacement with equal, or better to eliminate ongoing replacement
Loose bolts (walkarm, 'C' clamp, cluster, 'T' bar...)	Loose bolts, typically installed in this manner.	Tighten to a snug tight condition as defined in the Steel handbook

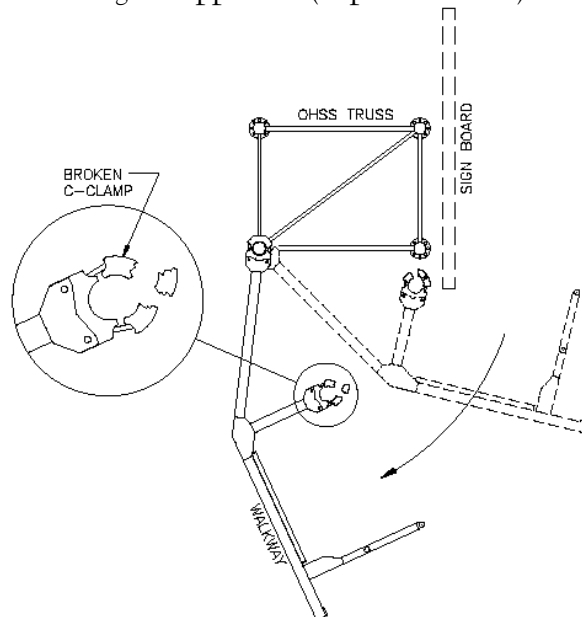
All inspections and report documentation were completed in accordance with the Sign Support Inspection Guidelines (SSIG).

General Inspection Comments

The following describes findings commonly observed. It should be noted that typically the deficiencies documented in these reports are not a result of externally applied loads (ie. wind) causing structural distress and fatigue. They were either present at the time of erection, a result of long-term corrosion, lack of member drainage or vehicle impact. The concern is that these structures are non-redundant and once a member is deficient, regardless of the cause, the support becomes unstable and failure may result under normal loadings.

Cracked C-clamps

C-Clamps are used to support both the sign boards and the maintenance walkway. These clamps are constructed of a brittle casting and various factors result in cracking. These factors are: quality of casting, over tightening, imperfections of mating chord, and excessive structure movements/vibrations. The most critical C-clamps are the maintenance walkway support arms. Two clamps support each arm; one on the front and one on the back. The critical of these two is the front. When this support is lost (broken C-clamp) the walk arm can rotate around the back chord and is no longer supported (depicted below).



This is the reason that the maintenance walkway should not be utilized until all crack/broken C-clamps are replaced. Of particular concern are all front clamps. After replacement, a general inspection is still recommended prior to each use of the maintenance catwalk. During the design of the first overhead sign support (1960's) the main reason for the catwalks was to provide support for lighting and access to allow sign re-facing (overlay). Due to today's long life span of sign reflective sheeting signs no longer require lighting and/or re-facing. Based on this we recommend all catwalks be removed. This will dramatically reduce ongoing maintenance, reduce the dead load on the support and inhibit further vandalism.

Re-design of the sign clamp should be considered to eliminate on-going clamp replacement and reduce the risk of injury. One design by Burgess Engineering Inc. that has been successfully installed is depicted:



Debris at Base

The base of several structures is covered with debris and in some cases the base could not be inspected. This debris should be removed to reduce the rate of deterioration and allow for inspection.

This issue is more critical for structures with leveling nuts. The debris increases the rate of corrosion of the critical leveling nuts. The top of the footings for these structure types should be pressure washed on a routine basis.

Drain Holes Required

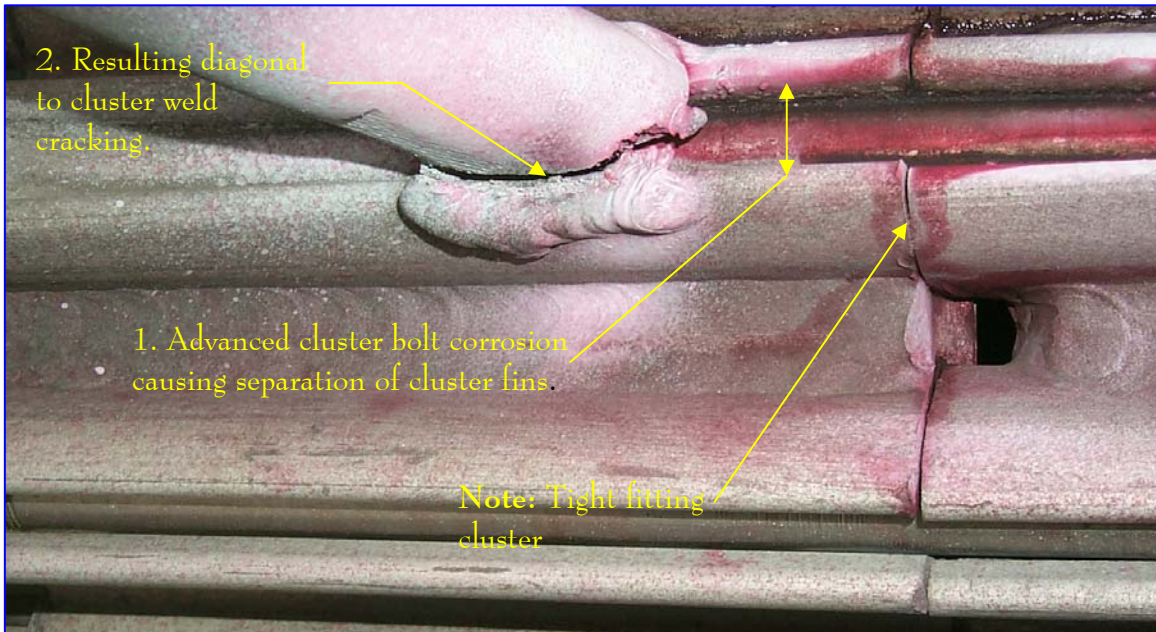
Several members have a drain hole (originally meant to vent gasses during fabrication) at the top only. Entrapped water expands during freezing and splits the member. All members should have a hole located at the lowest region outside of the weld to allow for proper draining. In addition, field replaced members should also have proper drainage. It is important that all holes are located at the lowest part of the member to allow full member drainage. Holes should never be drilled elsewhere (ie. top of the member).

Removal of Electrical Equipment

A majority of the older generation sign supports still have the old electrical equipment in place. This equipment is no longer required and in many instances has advanced deterioration. The concern is that some of these elements may eventually fall from its support. All old electrical equipment should be removed to avoid possible vehicle/pedestrian hazard.

Diagonal to Cluster Weld Cracking

As documented in previous reports and as seen in this report, several structures have advanced cluster bolt corrosion resulting in extensive diagonal to cluster weld cracking. The below photograph generally describes this area:



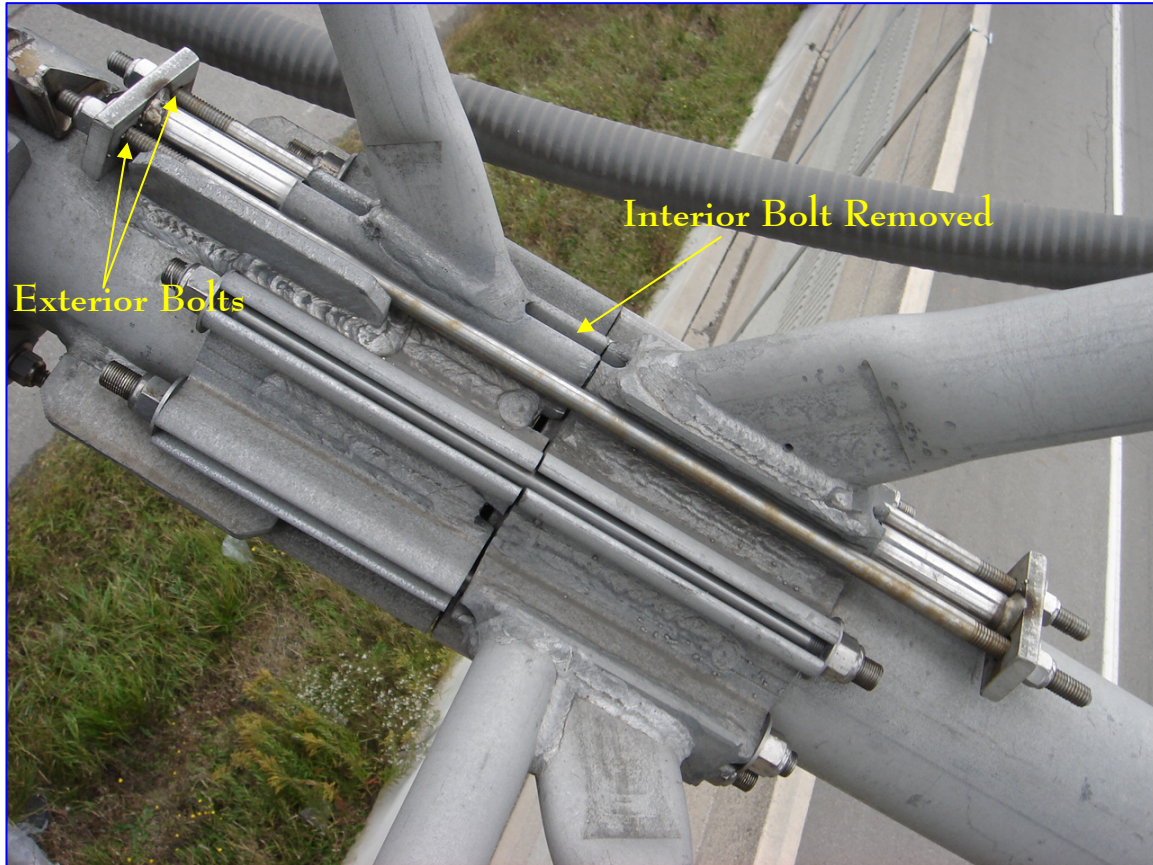
This problem typically occurs in the lower horizontal clusters of older ATL and ACL structures. One factor that affects the advancement of this cracking is the degree of water tightness between the two adjoining clusters. A tight fitting connection retains water, which increases the rate of deterioration of the cluster bolt. For each site-specific condition refer to the individual inspection summaries.

The below photograph depicts further weld cracking of this area after repairs were completed in a relatively short time period. Continuing corrosion build up between the cluster bolt and the fins is causing the fins to further separate. This results in on-going weld cracking and continuous weld repair. To eliminate the need for this on-going repair work it is recommended that this area be modified.



As previously mentioned, this problem mainly occurs for the ATL and the ACL. Historically this is because the ARL have not been in service long enough to allow for the cluster bolt corrosion. However, several ARL supports have started to show initial signs of this issue. It is recommended that this area be modified to eliminate on-going maintenance needs and possible failure.

One approach as designed by Burgess Engineering Inc. is depicted below. This was successfully completed on several MTO, Advanced Traffic Management ARL.



In this approach the bolt that corrodes and causes the weld cracking is removed and replaced with two exterior bolts. It should be noted that at the time of this retrofitting all damaged and cracked areas should be repaired. Once this is completed the need for on-going weld repair will be eliminated.

Critical Structures Requiring “1 Month” Repair

Priority should be given to all structures having a lower structural rating and/or “1 Month Needs”. It should be noted that all of the sign supports inspected are non-redundant and all truss members are primary and critical to the supports integrity.



Overhead Sign Support Structure Inspection Report City of Hamilton, October 2017.

Inspection and Report Methodology

The following section describes the inspection and report format.

Photographs

During the inspection, three general photographs were taken, the Elevation, Left Leg & Right Leg. In addition, a photograph was taken of each structure deficiency and Non-destructive test. All photographs are provided and described in each report.

Non-destructive Testing

The test findings are summarized on the subject photograph with the following abbreviation:

No Linear Indications Observed (liquid penetrant) - N.L.I.O.

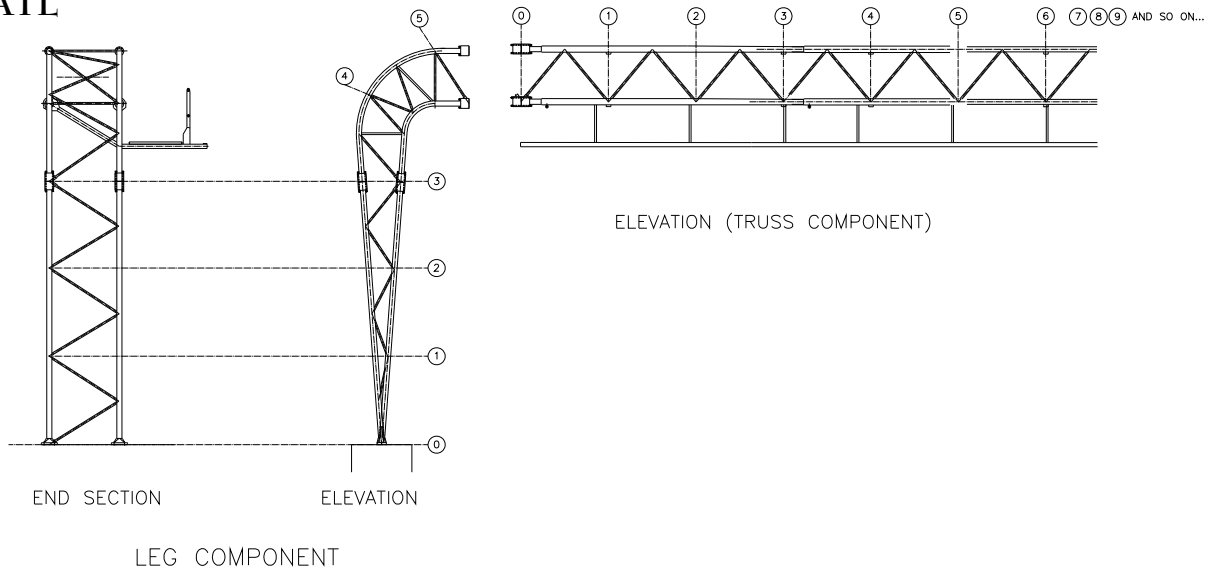
No Relevant Indicators Observed (ultrasonic) - N.R.I.O.

If a deficiency was noted, the corrective measures are stated in the rehab needs field with an associated time period.

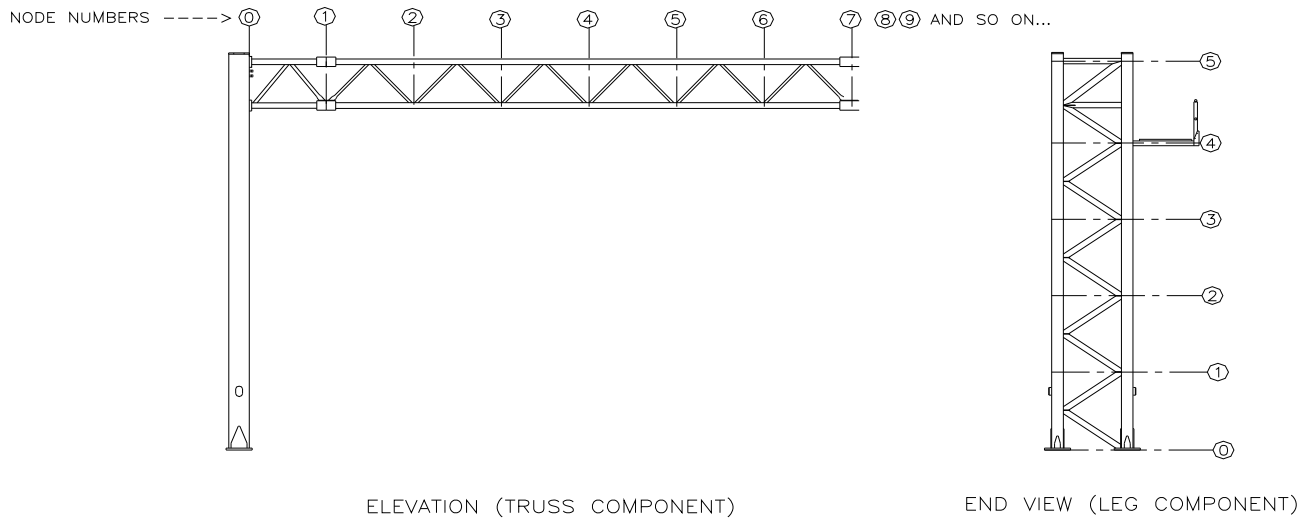


Location (node numbering) of Deficiency or NDT

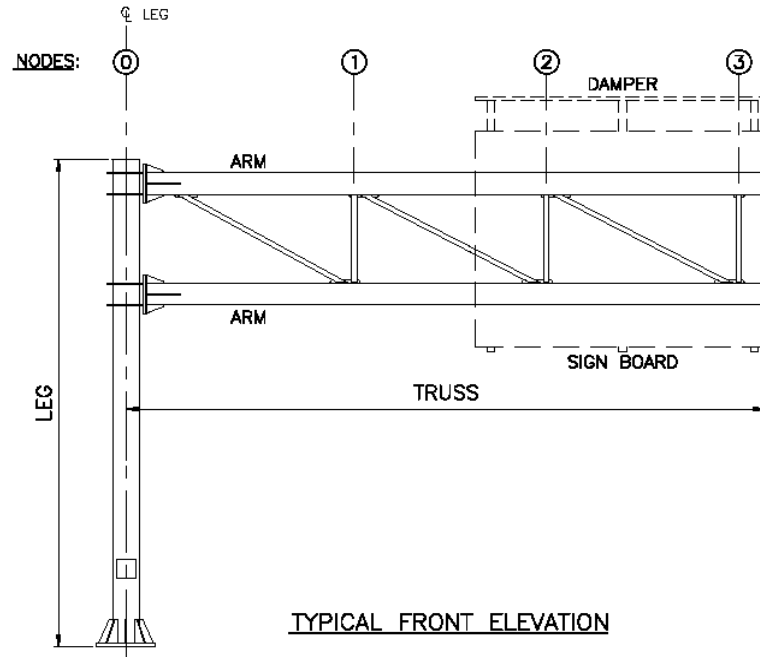
ATL



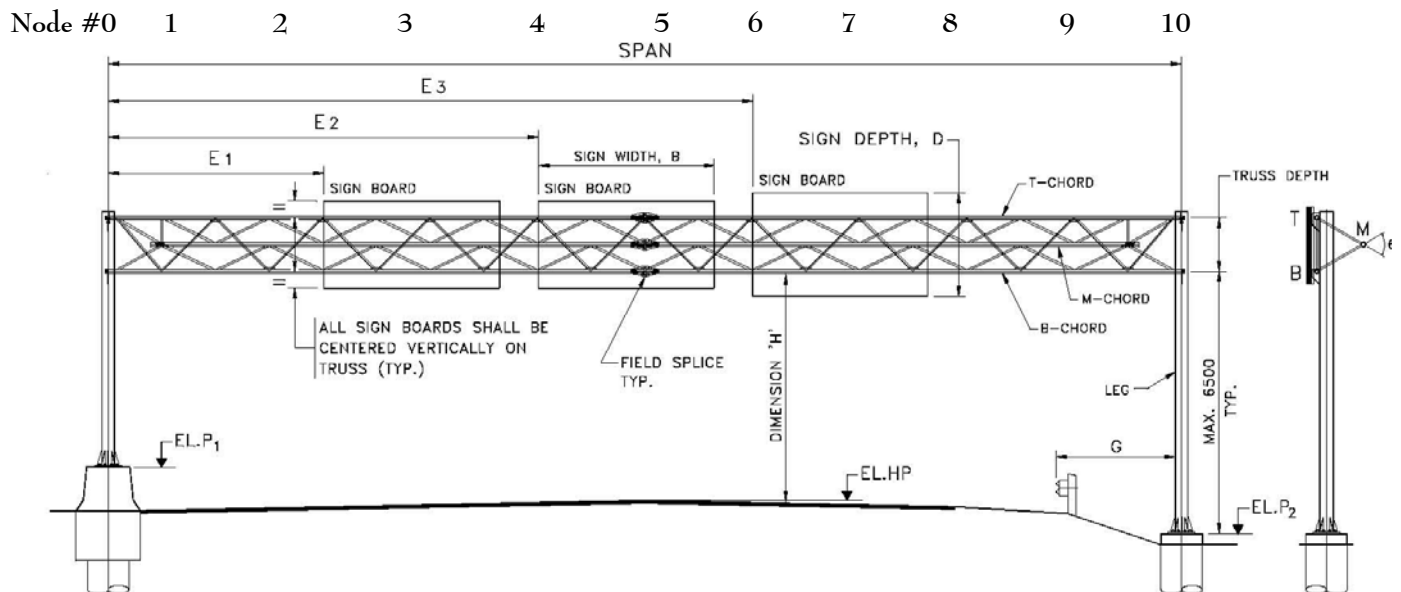
ARL



Cantilever



Tri-Chord



Appendix **C**

Maintenance Needs Summary

2017 Maintenance Needs

Site Number	Structure Name	Structure Type	Element Name	Element Group	Maintenance Needs	Comments	Timing
1	Upper James Street - Exit	ARL	Truss Diagonals	Diagonal	Drill Drain Hole	Recommend drain holes be drilled at the bottom of each diagonal to allow for water drainage to avoid member cracking, resulting from freezing of entrapped water.	3 years
2	Upper Wentworth St - EXIT	ARL	Base Connections	Connection	Minor Repair of Sign or Other Attachment (17)	Weld interference preventing washer to be flush with base plate. Recommend grind side of washer and tighten anchor bolt.	1 year
2	Upper Wentworth St - EXIT	ARL	Truss Diagonals	Diagonal	Drill Drain Hole, Repair Weld	Various missing drain holes at truss clusters. Truss, back, lower, N-1: Severed weld, gap between diagonal and cluster fin.	1 year
3	Upper James Street - EXIT	ARL	Truss Diagonals	Diagonal	Drill Drain Hole	Various missing drain holes at truss clusters.	3 years
6	Dartnall Road - EXIT	ARL	Truss Diagonals	Diagonal	Drill Drain Hole	Various missing drain holes at truss clusters.	3 years
7	Upper Gage Avenue - EXIT	ARL	Truss Diagonals	Diagonal	Drill Drain Hole	Various missing drain holes at truss clusters.	3 years
10	Garth Street - EXIT	ARL	Truss Diagonals	Diagonal	Drill Drain Hole	Various missing drain holes at truss clusters.	3 years
		ARL	Foundation	Concrete	Remove Vegetation	Vegetation over growth.	3 years
11	Golf Links/Mohawk Rd - EXIT	ARL	Truss Diagonals	Diagonal	Drill Drain Hole, Repair Weld	Various missing drain holes at truss clusters. Truss, back, upper, N-18: 30 mm weld crack.	1 year
21	Lincoln M. Alexander Parkway - EXIT	Tri-Chord	Accessory Connection	Connection	Minor Repair of Sign or Other Attachment (17)	Right Leg: Loose leg cap bolt.	1 year
22	403 Brantford, 403 Toronto Split - ADVANCED	Tri-Chord	Other - Accessory	Attachment	Minor Repair of Sign or Other Attachment (17)	Left leg, lower: Missing chord end cap.	1 year
39	Strathearne Ave./Parkdale Ave. - ADVANCED	Non Std. Cantilever	Other - Accessory	Attachment	Minor Repair of Sign or Other Attachment (17)	Missing front and back cover plates.	1 year
42	Hamilton Ave. Local Access - EXIT	Non Std. Cantilever	Other Accessory	Attachment	Minor Repair of Sign or Other Attachment (17)	Loose arm end cap, lower.	1 year
43	Nikola Tesla Boulevard - EXIT	Non Std. Cantilever	Other Accessory	Attachment	Minor Repair of Sign or Other Attachment (17)	Missing leg end cap.	1 year
		Non Std. Cantilever	Sign	Connection	Minor Repair of Sign or Other Attachment (17)	Bent flat bar supporting down arrows. Sign Connection, lower: Lack of bolt protrusion.	1 year
44	Upper James St. & West 5th St. - SPLIT	Monotube	Other Accessory	Attachment	Minor Repair of Sign or Other Attachment (17)	Right leg: Missing end cap and front cover plate.	1 year

Appendix **D**

Repair/Rehabilitation Summary

2017 Repair/ Rehabilitation Needs

Site Number	Structure Name	Structure Type	Element Group	Element Name	Performance deficiencies	Description	Comments	Rehab time period
1	Upper James Street - Exit	ARL	Connection	Walkway Arm Connection	Load carrying capacity	Replace walkarm C-clamp	Loose walkarm clamp. Truss, back, lower, N-12. Cracked walkarm clamp (Back - 5"), Truss, back, lower, N-11 & Truss, back, lower, N-10, Cracked walkarm clamp (5"). Truss, back, lower, N-15: & Truss, front, lower, N-7.	1 Month
2	Upper Wentworth St - EXIT	ARL	Diagonal	Truss Diagonals	Load carrying capacity	Cluster modification & re-weld	Various missing drain holes at truss clusters. Truss, back, lower, N-1: Severed weld, gap between diagonal and cluster fin.	1 Month
		ARL	Connection	Sign Connection	None	Replace sign C-clamp	Cracked sign clamp (back, 5"): Truss, front, lower, N-12, Truss, front, upper, N-12 & Truss, front, upper, N-10. Broken sign clamp (back, 5"): Truss, front, upper, N-8, truss, front, upper, N-4 & truss, front, upper, N-3.	1 Month
		ARL	Connection	Walkway Arm Connection	Load carrying capacity	Replace walkarm C-clamp	Cracked walkarm clamp (5"): Truss, front, lower, N-13 & Truss, back, lower, N-8,	1 Month
3	Upper James Street - EXIT	ARL	Connection	Sign Connection	Load carrying capacity	Replace sign C-clamp	Cracked sign clamp (back, 5"): Truss, front upper, N-9, Truss, front, lower, N-9 & Truss, front, upper, N-5. Cracked sign clamp (5"): Truss, front, upper, N-6. Broken sign clamp (back, 5"): Truss, front, upper, N-4 & Truss, front, upper, N-3.	1 Month
		ARL	Connection	Walkway Arm Connection	Load carrying capacity	Replace walkarm C-clamp	Cracked walkarm clamp (back, 5"): Truss, back, lower, N-9 & Truss, back, lower, N-8. Broken walkarm clamp (back, 5"): Truss, back, lower, N-7, Truss, back, lower, N-6 & Truss, back, lower, N-3.	1 Month
4	Garth Street - EXIT	ARL	Diagonal	Truss Diagonals	None	Weld member	Truss, front, lower, N-16: Split in diagonal.	3 Years
		ARL	Connection	Sign Connection	None	Replace sign C-clamp	Cracked sign clamp (Back portion - 5"): Truss, front, upper, N-9, Truss, front, lower, N-9 & Truss, front, lower, N-10.	3 Years
5	Upper Gage Avenue - EXIT	ARL	Connection	Walkway Arm Connection	None	Replace walk-arm C-clamp	Truss, front/lower, N-14: Cracked walkarm clamp (5").	1 Year
		ARL	Connection	Base Connections	None	Tighten bolt	Left leg, front, inside: 1 loose anchor bolt.	1 Year
		ARL	Connection	Sign Connection	None	Replace sign C-clamp	Cracked sign clamp (back portion, 5"), Truss, front/upper, N-2 & Truss, front/upper, N-8.	1 Year

2017 Repair/ Rehabilitation Needs

Site Number	Structure Name	Structure Type	Element Group	Element Name	Performance deficiencies	Description	Comments	Rehab time period
6	Dartnall Road - EXIT	ARL	Connection	Sign Connection	None	Replace Clamp & Tighten bolts	Broken sign clamp (back, 5'): Truss, front, upper, N-4. 2 loose sign T-bar bolts: Truss, front, upper, N-10, Truss, front, lower, N-13) & Truss, front, lower, N-10.	1 Year
		ARL	Connection	Walkway Arm Connection	Load carrying capacity	Replace walk-arm C-clamp	Cracked walkarm clamp (back, 5'): Truss, back, lower, N-6, Truss, back, lower, N-7. Truss, front,lower,N-15 & N-16. Broken walkarm clamp (back, 5'): Truss, front, lower, N-6, Truss, front, lower, N-7, N-8, N-9, N-10, N-11, N-12, N-13, N-14, N-15, N-16.	1 Month
7	Upper Gage Avenue - EXIT	ARL	Connection	Sign Connection	Load carrying capacity	Replace sign C-clamp	Cracked sign clamp (back, 5''): Truss, front, upper, N-9,, Truss, front, upper, N-6, Truss, front, lower, N-4 & Truss, front, upper, N-4. Broken sign clamp (back, 5'): Truss, front, upper, N-8.	1 Month
		ARL	Connection	Walkway Arm Connection	Load carrying capacity	Replace walkarm C-clamp	Broken walkarm clamp (back, 5''): Truss, back, lower, N-10, Truss, back, lower, N-5, Truss, back, lower, N-4, Truss, back, lower, N-3, N-2, & N-1.	1 Month
8	Upper Wentworth St. - EXIT	ARL	Connection	Sign Connection	None	Replace sign C-clamp	Cracked sign clamp (back - 5''): Truss, front, upper, N-8, Truss, front, upper, N-7 & Truss, front, upper, N-2.	1 Year
		ARL	Foundation	Concrete	None	Repair crack/spall in concrete	Left leg, back: Spalled concrete.	3 Years
		ARL	Connection	Base Connections	None	Tighten bolt	Left leg, front: 1 loose anchor bolt.	1 Year
9	Mohawk & Golf Links Rd - EXIT	ARL	Connection	In Line Chord	None	Tighten bolt	Truss, front, upper, N-1: Very loose cluster bolt.	1 Year
		ARL	Connection	Sign Connection	None	Replace sign C-clamp	Cracked sign clamp (back portion - 5"), Truss, front, upper, N-12, Truss, front, lower, N-12, Truss, front, upper, N-6 & Truss, front, upper, N-5. Cracked sign clamp (5"), Truss, front, upper, N-11.	1 Year
		ARL	Connection	Walkway Arm Connection	None	Replace walk-arm C-clamp	Truss, front, lower, N-8: Cracked walkarm clamp (5").	1 Year
		ARL	Foundation	Concrete	None	Repair crack/spall in concrete	Right Leg, Inside: Delaminated/cracked concrete.	1 Year
10	Garth Street - EXIT	ARL	Connection	Walkway Arm Connection	Load carrying capacity	Replace walk-arm C-clamp	Cracked walk-arm clamp (back, 5''): Truss, back lower, N-13, 11, 10, 9, 8, 7, 4, 2 & 1.	1 Month
		ARL	Connection	Sign Connection	None	Replace sign C-clamp	Truss, front, lower, N-11: Cracked sign clamp (back, 5'').	1 Year
11	Golf Links/Mohawk Rd - EXIT	ARL	Diagonal	Truss Diagonals	None	Weld member	Various missing drain holes at truss clusters. Truss, back, upper, N-18: 30 mm weld crack.	1 Year
		ARL	Connection	Sign Connection	None	Replace sign C-clamp	Truss, front, upper, N-6: Cracked sign clamp (back, 5'').	1 Year
		ARL	Connection	Walkway Arm Connection	None	Replace walkarm C-clamp	Truss, back, lower, N-9: Broken walk-arm clamp (5'').	1 Year
		ARL	Diagonal	Leg Diagonal	None	Weld member	Left leg, back, N-5: 40mm weld crack	1 Year

2017 Repair/ Rehabilitation Needs

Site Number	Structure Name	Structure Type	Element Group	Element Name	Performance deficiencies	Description	Comments	Rehab time period
12	Upper Red Hill, Mud Street - EXIT	Tri-Chord	Foundation	Concrete	None	Repair crack/spall in concrete	Left leg, wide cracking in caisson.	3 Years
		Tri-Chord	Coating	Coating - Chords/Main Member	None	Apply Overall Coating	Truss, back chord: coating breakdown.	3 Years
		Tri-Chord	Coating	Coating - Chords/Main Member	None	Apply Overall Coating	Right Leg: Overall coating breakdown.	3 Years
13	Upper Red Hill Valley Parkway - EXIT	Tri-Chord	Coating	Coating - Chords/Main Member	None	Apply Localized Coating	Right Leg: Localized coating breakdown.	3 Years
		Tri-Chord	Connection	Base Connections	Load carrying capacity	Tighten anchor bolts	Right Leg: 8 of 8 anchor bolts are loose. Left leg, 4 of 8 anchor bolts loose.	1 Month
14	Greenhill Avenue - EXIT	Tri-Chord	Connection	Base Connections	None	Tighten anchor bolts	Right Leg: 1 loose anchor bolt and missing all jam nuts.	1 Year
15	King Street - EXIT	Tri-Chord	Connection	Leg Connection	None	Install Member	Left leg, lower: Missing keeper plate.	1 Year
16	Upper Red Hill & Mud Street - EXIT	Tri-Chord	Connection	Leg Connection	None	Install Member	Truss, Lower, N-10: Missing keeper plate.	1 Year
		Tri-Chord	Connection	Base Connections	None	Tighten anchor bolts	Right Leg, inside: 2 loose anchor bolts.	1 Year
17	Dartnall Road - EXIT	Tri-Chord	Coating	Coating - Chords/Main Member	None	Apply Overall Coating	Right Leg: Overall coating breakdown.	3 Years
		Tri-Chord	Coating	Coating - Chords/Main Member	None	Apply Overall Coating	Back Chord, coating breakdown.	3 Years
18	King Street - EXIT	Tri-Chord	Connection	Base Connections	Load carrying capacity	Tighten bolt	Left leg, 6 of 8 anchor bolts loose.	1 Month
19	Greenhill Avenue - EXIT	Tri-Chord	Connection	Base Connections	None	Tighten bolt	Left leg, inside: 1 loose anchor bolt & missing jam nut.	1 Year
20	Upper Red Hill Valley Pkwy - EXIT	Tri-Chord	Connection	Base Connections	None	Tighten anchor bolts	Right Leg: 2 loose anchor bolts.	1 Year
25	Queenston Road - EXIT	Tri-Chord	Connection	In Line Chord	None	Tighten bolt	Truss, bottom Cluster, N-5: Loose cluster bolt. Truss, Middle Cluster, N-5: Loose cluster bolt. Recommend all bolts be tightened/checked.	1 Year
31	Queenston Road - EXIT	Tri-Chord	Diagonal	Truss Diagonals	None	Replace diagonal	Truss, lower, N-9 (left): Diagonal crack.	3 Years
		Tri-Chord	Connection	Base Connections	Load carrying capacity	Tighten bolt	Left leg, 8 of 8 anchor bolts loose.	1 Month
32	Rousseaux Street - EXIT	Tri-Chord	Diagonal	Truss Diagonals	None	Weld member	Truss, Front, Upper, N-3: Crack in truss diagonal.	1 Year
39	Strathearne Ave./Parkdale Ave. - ADVANCED	Non Std. Cantilever	Connection	Base		Tighten anchor bolts	Connection/base: One loose anchor bolt (back/inside).	1 Year
40	Strathearne Ave./Parkdale Ave. - EXIT	Non Std. Cantilever	Connection	Base	Load carrying capacity	Tighten anchor bolts	6 of 8 anchor bolts are loose. Only 2 bolts (front/inside) are working, structure movement.	1 Month
43	Nikola Tesla Boulevard - EXIT	Non Std. Cantilever	Connection	Leg	None	Tighten bolt	Upper connection: Gap between plates resulting from loose bolts.	1 Year
44	Upper James St. & West 5th St. - SPLIT	Monotube	Coating	Chord/Main Member	None	Apply Localized Coating	General overall coating breakdown, consider localized coating in splash zones (base of legs).	1 Year
		Monotube	Coating	Connections	None	Apply Localized Coating	General overall coating breakdown, consider localized coating in splash zones (base of legs).	1 Year

Appendix **E**

Structural Ratings

Structural Rating

Site Number	Structure Name	Structural Rating	Date of Inspection	Span	Total Sign Area	Structure Type
37	Woodward Ave - Advanced	-384	31-Aug-17	22.9	16.7	ATL
6	Dartnall Road - EXIT	-63	15-Sep-17	25.9	25.3	ARL
7	Upper Gage Avenue - EXIT	-10	15-Sep-17	27.4	29.5	ARL
13	Upper Red Hill Valley Parkway - EXIT	-1	28-Aug-17	20.4	20.8	Tri-Chord
40	Strathearne Ave./Parkdale Ave. - EXIT	0	31-Aug-17	5.2	10.2	Non Std. Cantilever
2	Upper Wentworth St - EXIT	23	15-Sep-17	24.4	25.6	ARL
3	Upper James Street - EXIT	26	15-Sep-17	22.9	28.4	ARL
10	Garth Street - EXIT	27	06-Sep-17	24.4	29	ARL
5	Upper Gage Avenue - EXIT	29	06-Sep-17	27.4	30.5	ARL
8	Upper Wentworth St. - EXIT	29	06-Sep-17	27.4	30.7	ARL
16	Upper Red Hill & Mud Street - EXIT	45	28-Aug-17	28.5	27.8	Tri-Chord
1	Upper James Street - Exit	49	06-Sep-17	27.4	27.9	ARL
39	Strathearne Ave./Parkdale Ave. - ADVANCED	50	31-Aug-17	7.2	8.9	Non Std. Cantilever
31	Queenston Road - EXIT	50	28-Aug-17	28.4	23.3	Tri-Chord
19	Greenhille Avenue - EXIT	50	28-Aug-17	26.5	26	Tri-Chord
20	Upper Red Hill Valley Pkwy - EXIT	50	28-Aug-17	29.6	18.2	Tri-Chord
18	King Street - EXIT	50	28-Aug-17	28.4	26.6	Tri-Chord
11	Golf Links/Mohawk Rd - EXIT	60	06-Sep-17	29.0	30.5	ARL
9	Mohawk & Golf Links Rd - EXIT	62	06-Sep-17	27.4	29.6	ARL
43	Nikola Tesla Boulevard - EXIT	81	13-Oct-17	7.2	4.7	Non Std. Cantilever
32	Rousseaux Street - EXIT	90	29-Aug-17	34.6	25.2	Tri-Chord
25	Queenston Road - EXIT	90	29-Aug-17	28.4	22.5	Tri-Chord
44	Upper James St. & West 5th St. - SPLIT	94	13-Oct-17	18.0	3.8	Monotube

Structural Rating

Site Number	Structure Name	Structural Rating	Date of Inspection	Span	Total Sign Area	Structure Type
45	Upper James St. & West 5th St. - ADVANCED	94	13-Oct-17	17.3	8.8	Monotube
14	Greenhill Avenue - EXIT	95	29-Aug-17	26.1	21.1	Tri-Chord
15	King Street - EXIT	95	29-Aug-17	26.4	23.7	Tri-Chord
4	Garth Street - EXIT	96	06-Sep-17	25.9	21	ARL
17	Dartnall Road - EXIT	99	28-Aug-17	27.9	27.8	Tri-Chord
12	Upper Red Hill, Mud Street - EXIT	99	28-Aug-17	26.2	27.3	Tri-Chord
22	403 Brantford, 403 Toronto Split - ADVANCED	99	29-Aug-17	20.2	36.7	Tri-Chord
21	Lincoln M. Alexander Parkway - EXIT	100	28-Aug-17	16.1	20	Tri-Chord
26	Barton Street - EXIT	100	29-Aug-17	27.6	18.2	Tri-Chord
27	QEW Toronto, QEW Niagara, Split - ADVANCED	100	28-Aug-17	19.1	23.4	Tri-Chord
28	QEW Toronto, QEW Niagara - SPLIT	100	28-Aug-17	24.8	31.4	Tri-Chord
29	Red Hill Valley Parkway - EXIT	100	28-Aug-17	21.8	34.3	Tri-Chord
30	Barton Street - EXIT	100	28-Aug-17	29.1	23.7	Tri-Chord
33	Woodward Avenue - EXIT	100	29-Aug-17	19.2	22.2	Tri-Chord
34	QEW, Red Hill Parkway - SPLIT	100	13-Oct-17	21.6	31.3	Tri-Chord
35	QEW Toronto, QEW Niagara, Split - EXIT	100	29-Aug-17	18.2	20	Tri-Chord
23	Rousseaux Street - EXIT	100	29-Aug-17	6.0	10.4	Cantilever Class 2
38	Nikola Tesla Blvd - On Ramp	100	31-Aug-17	4.7	2.9	Non Std. Cantilever
42	Hamilton Ave. Local Access - EXIT	100	13-Oct-17	5.0	5.6	Non Std. Cantilever
41	DMS - South of Woodward Avenue	100	31-Aug-17	20.2	40.2	Walk-in VMS
24	403 Brantford, 403 Toronto Split - EXIT	100	29-Aug-17	26.1	28.4	Tri-Chord