

APPENDIX G

CLARIFIER 3 BRIDGE - STRUCTURAL CONDITION ASSESSMENT REPORT



AJP Engineering Services

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January 17, 2018

*City of Winnipeg
110-1199 Pacific Avenue
Winnipeg, MB. R3E 3S8*

Attention: *Brian Station, Senior Project Engineer*

Subject: *Structural Condition Assessment of Primary Clarifier Travelling Bridge Collector No. 3 at the South End Sewage Treatment Plant, Revision 0*

INTRODUCTION

The City of Winnipeg, represented by Brian Station, Senior Project Engineer, requested AJP Engineering Services to perform a structural assessment of the travelling bridge collector for Primary Clarifier No. 3, located at the South End Sewage Treatment Plant at 100 Ed Spencer Drive.

The intent of the assessment was to:

- Confirm the structural integrity of the bridge structure
- Provide observations, testing results and document significant changes in condition since the November 24th, 2015 Ovivo inspection/condition report
- Determine the remaining useful life of the bridge collector
- Provide recommendations and cost estimates for refurbishment and/or replacement work to maintain normal working operation for the next 10 years
- Outline tasks required for all subsequent inspections to certify structural integrity
- Recommend intervals for future inspections

Site visits were conducted by Tony Latiza P.Eng, Kyle Neufeld EIT and Michael Paredes of AJP Engineering Services on December 11th, 12th, and 18th, 2017 to inspect the bridge collector and take field measurements.

Canadian Quality Inspections (CQI), under AJP's direction, performed a visual weld inspection to determine compliance with the CSA requirements. CQI performed additional non-destructive examination of welds at critical joints using liquid penetrant. Bolted connections were also inspected for tightness and compliance with industry standards.

SCOPE OF WORK

Refer to Section 4.0 of Appendix A - Terms of Reference, attached to the City of Winnipeg Request for Proposal, File No. S-1074.

BACKGROUND INFORMATION

The travelling bridge collector for Primary Clarifier No. 3 was installed in 1992 as part of the expansion of the South End Sewage Treatment Plant. The bridge is constructed with aluminum square-tube sections and is approximately 67' long, 8' wide and 8' high. The bridge collector traverses the clarifier in a west to east direction. Two scum skimmers and one sludge scraper are attached to the underside of the bridge collector by means of pins and cables attached to the drive-shaft. Each end-truck has two driven-wheels bearing on a 3 ½ ASCE rail which are driven by a cog wheel and track arrangement.

In 2015, bridge operators reported the travel of the bridge was no longer smooth and had become jerky and rocky. An inspection was performed by OVIVO in late 2015 to investigate the potential causes. Their report indicated that elevation of the rails had dropped, causing the cog wheels to make undesirable contact with the cog-track teeth. Significant wear was found on the rails, wheels, cog-tracks and cog-wheels. They noted that the bridge collector itself appeared to be in good condition, but recommended that a thorough inspection should be performed. Ovivo also recommended replacement of the north and south rails (and re-leveling if required), replacement of both cog-tracks and replacement of all running-wheels and cog-wheels.

REFERENCE INFORMATION

The structural assessment was based on the field measurements and conditions observed on-site, as well as the drawings, specifications and reports provided by the City of Winnipeg and the weld inspection reports produced by Canadian Quality Inspections.

Weld inspection was performed to the requirements of:

- *CSA W59.2-13 - Welded Aluminum Construction*
- *CSA W59-13 - Welded Steel Construction*
- *ASTM E165 - Standard Practice for Liquid Penetrant Examination for General Industry*

ASSUMPTIONS

The original design of the travelling bridge collector is assumed to be adequate, in terms of strength, for its intended use. The scope of this report is limited to conditions that arose while in-service (i.e. cracking, deformation, reinforcement, etc.).

ENGINEERING FINDINGS, OBSERVATIONS AND RESULTS

Bridge Collector Layout

The grid system shown in Figure 1 was created to cross-reference between the AJP report and CQI weld inspection report. Several photos are labelled with this grid system as well.

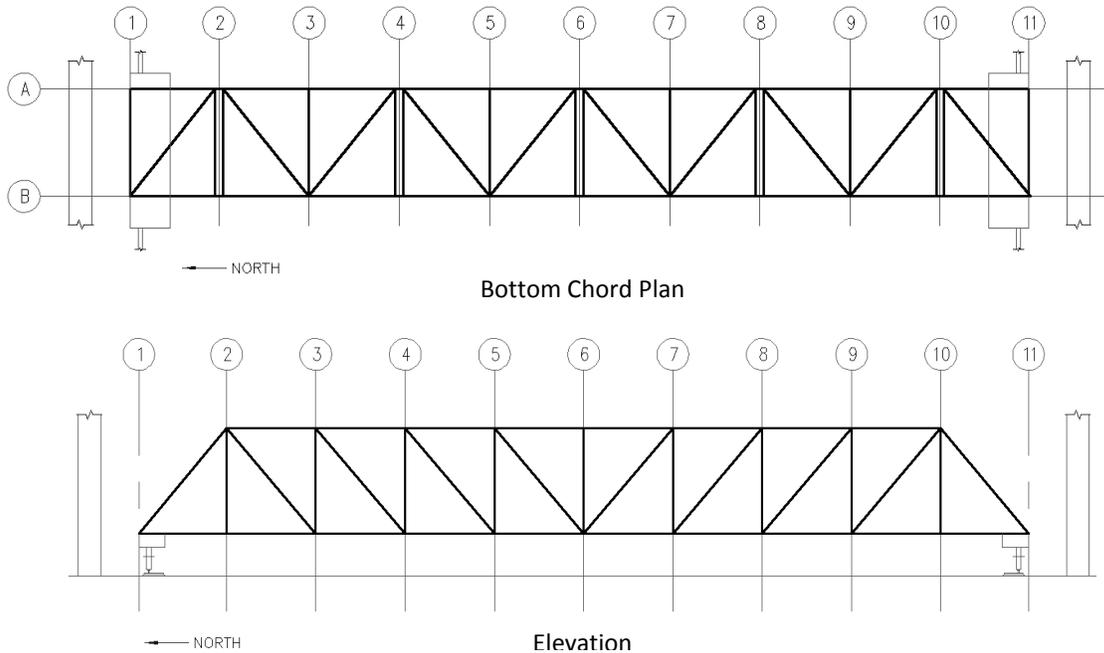


Figure 1: Bridge Collector Plan & Elevation

Welding

CQI's inspection found several issues related to both weld quality and weld cracking (Refer to CQI Project No. 1447, reports 1 & 2, pictures included).

Summary of Results:

1. Location 1B – Cracked weld on both sides of lower horizontal tube.
2. Location 1B – Cracked weld on end truck bearing mount weld.
3. Location 1B – Lack of fusion on reinforcement plate weld.
4. Location 1A – Cracked weld on lower horizontal weld.
5. Location 2B, 4B, 6B, 8B, 10B – Aluminum skimmer arm weld and material is corroded and pitted.
6. Location 7A – Porosity on upper horizontal tube weld
7. Location 9A – Missing weld on upper horizontal tube
8. Location 10A – Cracked welds on lower diagonal and horizontal tube.
9. Location 10B – Fish plate weld quality is unacceptable
10. Location 11B -- Crack in parent material penetrating from fish plate.
11. Location 11B – Lack of fusion on fish plate weld.
12. Location 11B – Cracked weld on lower horizontal tube.
13. Location 11A – Cracked weld on lower horizontal tube.

Corrosion

The front and rear skimmer arms have undergone extensive corrosion, affecting the main members and the welds at the elbow joint and the connection to the skimmer blade (Figure 2).

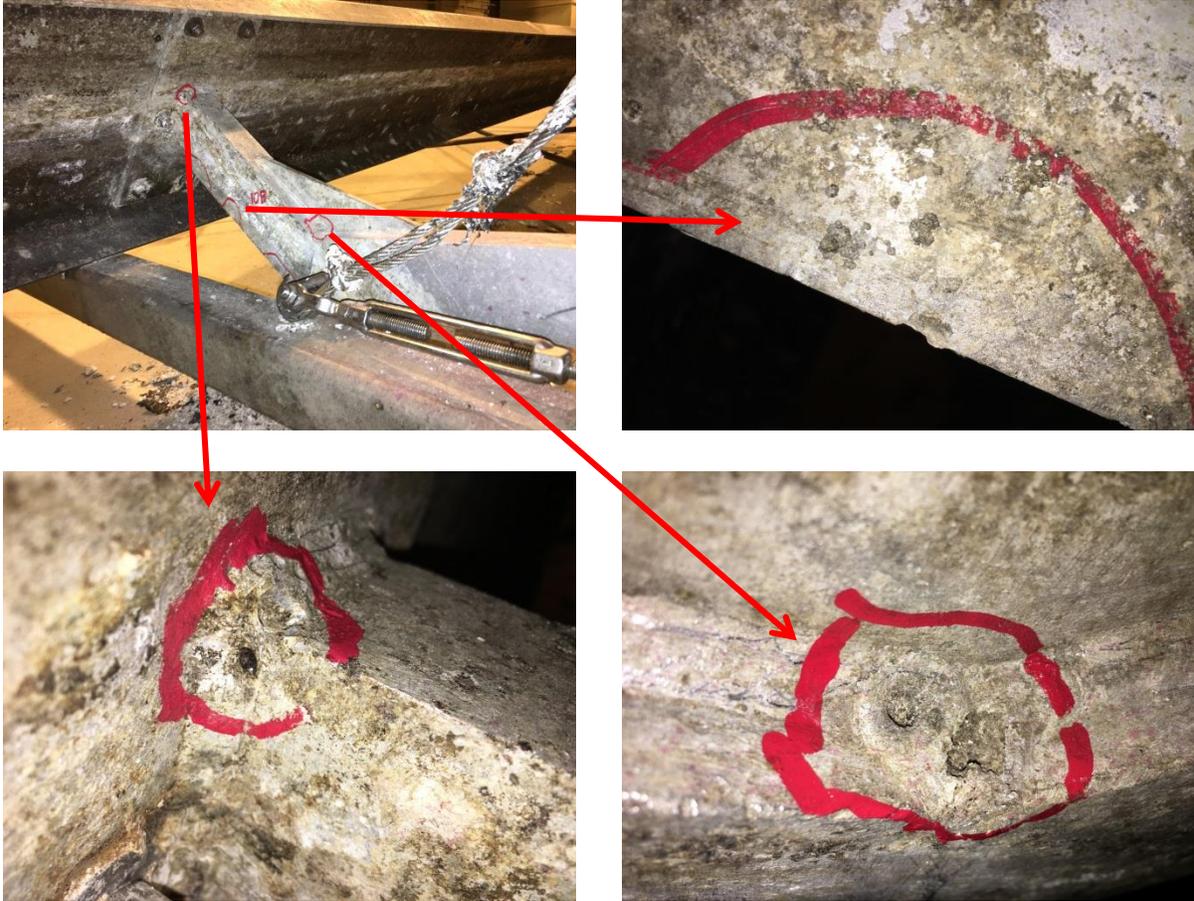


Figure 2: Skimmer Arm Corrosion

Bridge Collector Elevation

The elevation of the bottom chord along grid-line 'B' was taken using a self-levelling laser. The measurements are plotted in Figure 3

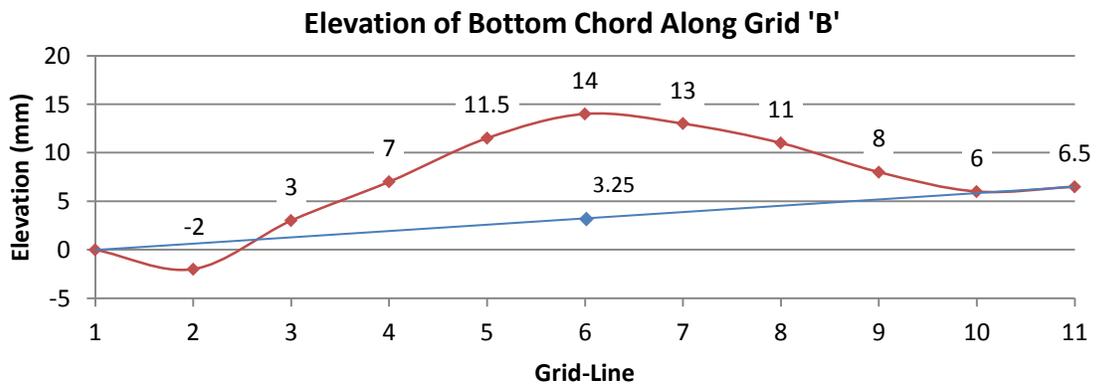


Figure 3: Bottom Chord Elevation

There is an elevation difference of 6.5mm (1/4") between the north and south sides of the bridge collector. The center of the bridge has deformed upwards approximately 10.75mm (7/16") relative to the theoretical straight line between the north and south end.

Bolted Connections

A few of the bolts that connect the collector bridge to the end trucks were not long enough to bring the ends flush with the nut (Figure 4). This is a minimum requirement for structural bolts.

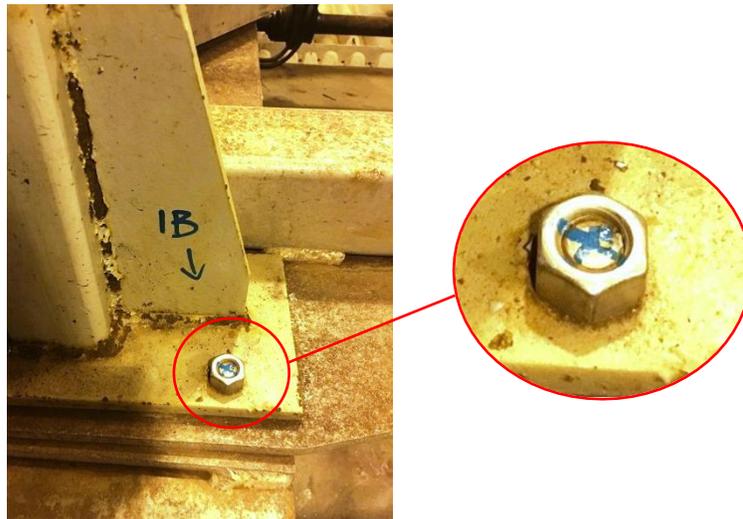


Figure 4: Bolt with Inadequate Length

Field-Welded Plates

Three plates were field-welded to the bottom chord along grid 'B' on the south side of the bridge collector (Figure 5). Two were welded on the vertical and horizontal faces of the chord near grid 11. The other one was welded on the vertical face near grid 10.



Figure 5: Field-Welded Plates

Wear on Wheels and Rail

On the north end-truck wheels, significant wear was observed on the interior radii where the flanges meet the bearing surface (Figure 6). One side had substantially more wear than the other. Significant wear was also noticed on the interior side of the top flange on the north rail, starting at the bridge collector's in-service position on the west side of the clarifier (Figure 7). On the south end-truck, approximately 2mm of wear was measured on the non-flanged wheels.



Figure 6: Wear on North End-Truck Wheels



Figure 7: North Rail Wear

INTERPRETATIONS

Weld Cracking

Welds subject to repeated tensile forces will crack eventually, given enough time. Normally, the fatigue life of the weld far exceeds the design life of the structure. The cracking present in the welds on the bridge collector are likely due to the jerky motion of the bridge, which will have introduced vibration and additional stresses into the welds. Unbalanced loading of the skimmer arms/scrapper may have also caused unintended stresses in the welds which may have caused cracking.

Wear on Wheels, Rails, Cog-Wheels & Cog-Track

It was observed that the drive sprocket for cog-wheels is not centered along the length of the drive shaft. It is offset by 3315mm to the north of the center-line of the unit. This would mean that 40%

more torque is transferred to the north cog-wheel than the south cog-wheel. However, our Mechanical Engineer, Dan Carriere P.Eng, stated that skewing should not occur since both cog wheels are rigidly attached to the shaft, assuming there is no slippage within the couplings along the drive-shaft.

Dan Carriere also posited that the groove on the south end-truck wheels (caused by the wear) may be preventing the wheels from floating. These wheels do not have a flange and are intended to move freely in order to relieve horizontal forces from the rail. The groove may be causing friction and additional stresses on the south rail.

The 6.5mm difference in elevation between the north and south end-trucks probably did not contribute to the excessive wear or jerky motion, as this measurement was taken from the top of the end-trucks and not the rail. This may be an effect of the wear, rather than a cause.

RECOMMENDATIONS

Rail Replacement

The City of Winnipeg has indicated that it intends to replace the rails, wheels cog-track and cog-wheels in the near future. Installation of the new rails should conform to tolerances specified in the original construction drawings.

End-trucks

After the rails are replaced, the top elevation of the end-trucks should be measured again to ensure that they are an equivalent height from their respective tracks and that they are level with respect to the horizontal plane. If they are not, then the wheels should be shimmed accordingly.

Skimmer Arms

Due to the extensive corrosion, both front and rear skimmer arms should be replaced. This is not an immediate concern, but should be addressed within the next 3-5 years.

Welding

All issues identified in the CQI report should be addressed. Welds should be repaired by a CWB certified welder with appropriate credentials for aluminum welding. The missing weld on grid 9A on the upper tube should be added.

Field-Welded Plates

The field-welded plates on the bottom chord along grid 'b' (Figure 5) should be removed and re-inspected to determine the reason that they were installed. Based on this information, an appropriate solution for reinforcement should be determined by a qualified professional engineer.

Bolts

All bolts that are not long enough to be flush with outside face of the nut should be replaced with longer bolts of the same diameter and grade.

Regular Inspections

All components related to the rail system should be inspected annually and in conformance with the requirements of CSA B167-08. This inspection should include a rail alignment survey, which will help identify potential issues by tracking changes in the rail alignment due to normal operation.

Structural components and connections of the bridge collector should be thoroughly inspected every two years. Members and plates should be checked for excessive deformation, corrosion, cracking and local buckling. Welds should be visually examined and spot-checked for cracks using liquid penetrant.

Bolts on the bridge collector should be checked for tightness on an annual basis as part of the rail inspection.

Service Life

Provided that the recommendations for rail replacement and maintenance are undertaken, AJP estimates a remaining useful life of 25-30 years for all structural components of the bridge collector and end-trucks. This does not include the scum skimmers, sludge scraper, end-truck wheels, rail, cog-wheels or cog-track.

LIMITATIONS

The findings and recommendations provided in this report were prepared by AJP in accordance with generally accepted professional engineering principles and practices. The information contained in this report represents the professional opinion of AJP and their best judgment under the natural limitations imposed by the Scope of Work.

This report is limited in scope to only those items that are specifically referenced in this report. There may be existing conditions that were not recorded in this report. Such conditions were not apparent to AJP due to the limitations imposed by the scope of work. AJP, therefore, accepts no liability for any costs incurred by the client for subsequent discovery, manifestation or rectification of such conditions.

This report is solely for the City of Winnipeg as a general indication of the visible or reported physical condition of the items addressed in the report at the time of the assessment. The material in this report reflects AJP's best judgment in light of the information available to it at the time of preparation.

This report and the information and data contained herein are to be treated as confidential and may be used only by the client and its officers and employees in relation to the specific project that it was prepared for. Any use a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. AJP accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

This report has been written to be read in its entirety, do not use any part of this report as a separate entity.

We trust this provides you with what you need. If you have any questions, or require further assistance related to this matter, please contact the undersigned.

Sincerely,

Prepared by:

Kyle J. Neufeld

Kyle Neufeld, EIT
Structural EIT

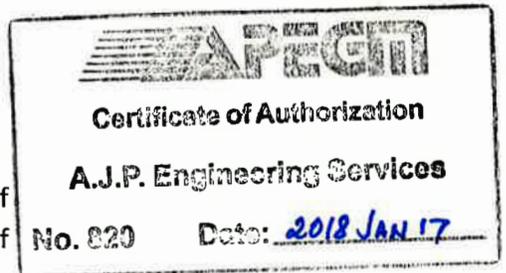
Reviewed by:

Tony Latiza, P.Eng.
Senior Structural Engineer



Enclosures:

1. 0000001447-1 - AJP - SEWPCC - Clarifier Bridge Inspection.pdf
2. 0000001447-2 - AJP - SEWPCC - Clarifier Bridge Inspection.pdf
3. 18300001-AS BUILT-01-A





CANADIAN QUALITY INSPECTIONS LTD.
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Phone: (204) 663-7775 Fax: (204) 663-9464
Website: www.cqinspections.ca email: cqi@cqinspections.ca

INSPECTION REPORT

Client:	AJP Engineering	Project No:	1447
Project:	Clarifier Bridge Inspection	Report No:	1
Location:	South End Sewage Treatment Plant SEWPCC	Date:	December 11, 2017
Contact:	Tony Latiza		
Inspector:	Michael Mestdagh David Cuddihy		

Reference Drawings & Contract Documents:

City Of Winnipeg Works And Operations Division Drawing SEP-256 and SEP-259

Applicable Standards & Specifications:

CSA W59.2-13, ASTM E165

Associated Inspection Checklists:

As directed by AJP Engineering

Scope of Inspection Work:

Visual inspection of Primary Clarifier Travelling Bridge Collector No.3 structure including all structural members, joints, welds, connections, repairs and reinforcement. Liquid Penetrant testing of critical structural members and suspect areas.

Visual Examination Work Performed *(Comments are italicized)*

- 1) *Visual inspection was carried out on accessible areas of Clarifier Travelling Bridge Collector No.3.*
 1. *Structural members*
 2. *Joints*
 3. *Welds*
 4. *Connections*
 5. *Repairs*
 6. *Reinforcement*
-

Non-Destructive Testing Work Performed:

Type: Liquid Penetrant
Method: Visible Solvent Removable CQI Procedure # 9302

Penetrant: Spotcheck SKL-WP2
Developer: Spotcheck SKD-S2
Cleaner: Spotcheck SKC-S
Technician: Michael Mestdagh & David Cuddihy
CGSB: PT Level II #12898 and #19731

Inspection Results:

See photo section for photos of deficiencies listed below. All deficiencies have been marked in paint pen for easy identification.

1. *Location 1B – Cracked weld on both sides of lower horizontal tube.*
 2. *Location 1B – Cracked weld on end truck bearing mount weld.*
 3. *Location 1B – Lack of fusion on reinforcement plate weld.*
 4. *Location 1A – Cracked weld on lower horizontal weld.*
 5. *Location 2B, 4B, 6B, 8B, 10B – Aluminum skimmer arm weld and material is corroded and pitted.*
 6. *Location 7A – Porosity on upper horizontal tube weld, see photos.*
 7. *Location 9A – Missing weld on upper horizontal tube, see photos.*
 8. *Location 10A – Cracked welds on lower diagonal and horizontal tube.*
 9. *Location 10B – Fish plate weld quality is unacceptable*
 10. *Location 11B -- Crack in parent material penetrating from fish plate.*
 11. *Location 11B – Lack of fusion on fish plate weld.*
 12. *Location 11B – Cracked weld on lower horizontal tube.*
 13. *Location 11A – Cracked weld on lower horizontal tube.*
-



Report Prepared By:
Michael Mestdagh and
David Cuddihy

CSA W178.2 Certified Level I
Inspector No: 18350
CSA W178.2 Certified Level I
Inspector No: 16221

Report Reviewed By:
Blake Penner

CSA W178.2 Certified Level III
Inspector No: 6326

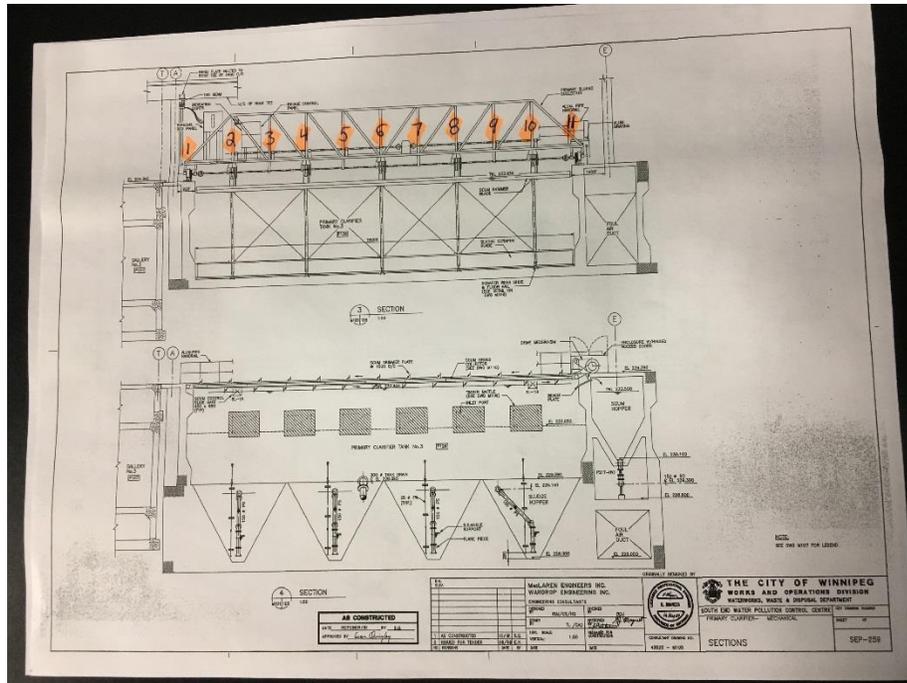
Date: Dec. 12 2017

Date: Dec. 14/ 2017

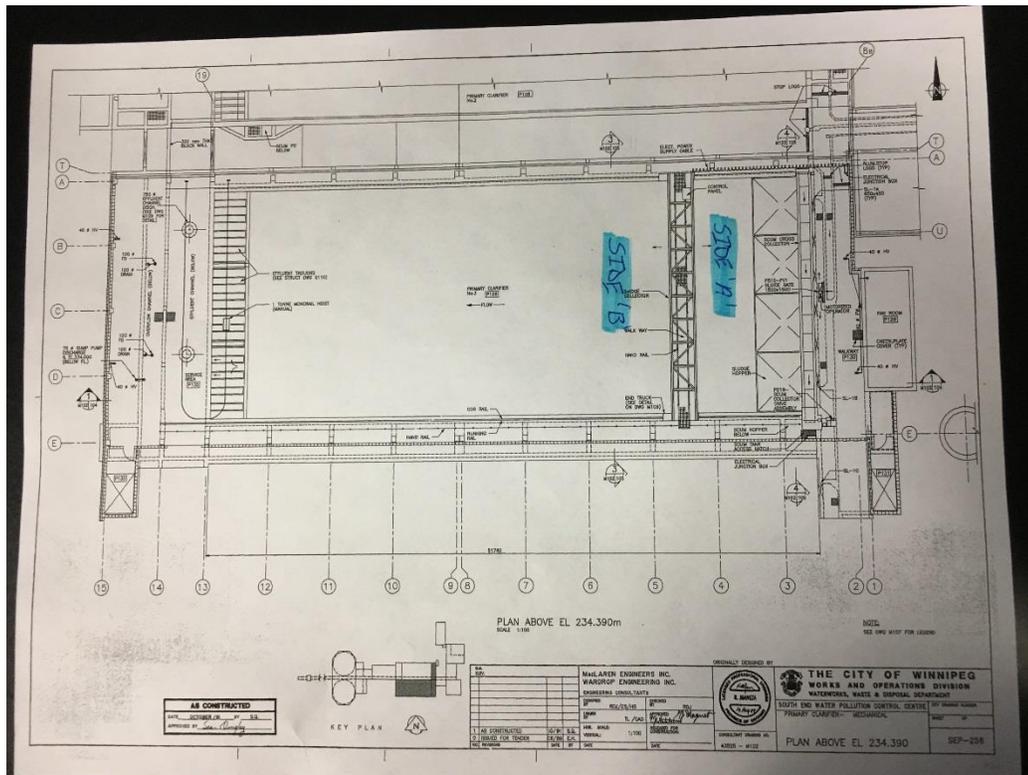
PHOTOS:



Overall view of Clarifier Bridge No.3



Annotated Drawing with Inspection Locations
 With location 1 to 11 from north to south



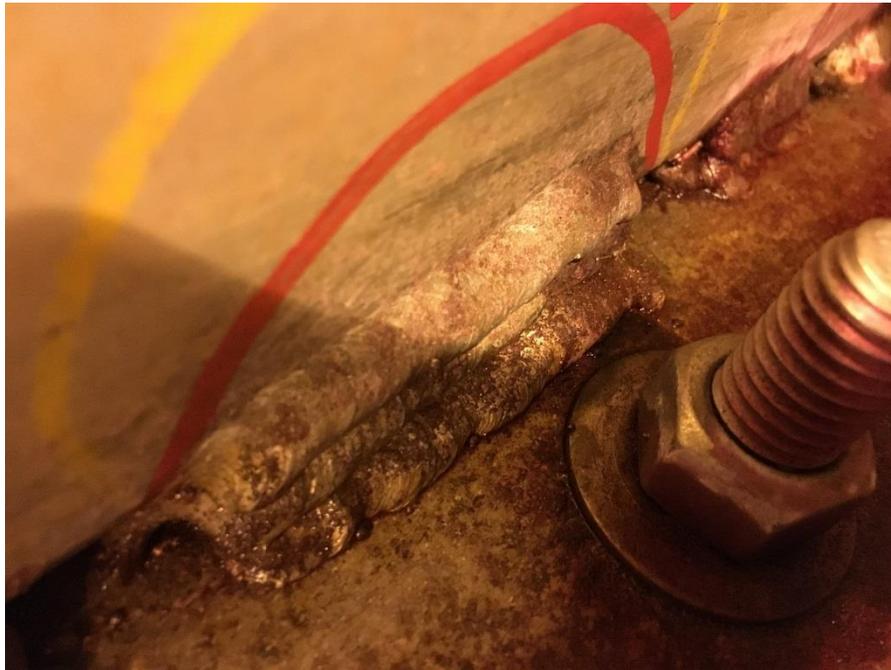
Annotated drawing showing side "A" as east side and Side "B" as west side



Crack at location 1B



Crack at location 1B



Lack of weld fusion on repair weld at location 1B



*Cracked bearing mount
plate weld at location 1B*



*Photo showing pitted corrosion in scum paddle arm
This is typical to all below water line aluminum members*



Porosity at location 7A



Missing Weld at location 9A



Crack at location 10A



Crack at location 10A



Photo of fish plate at location 10B. Poor weld quality



Crack at location 11A

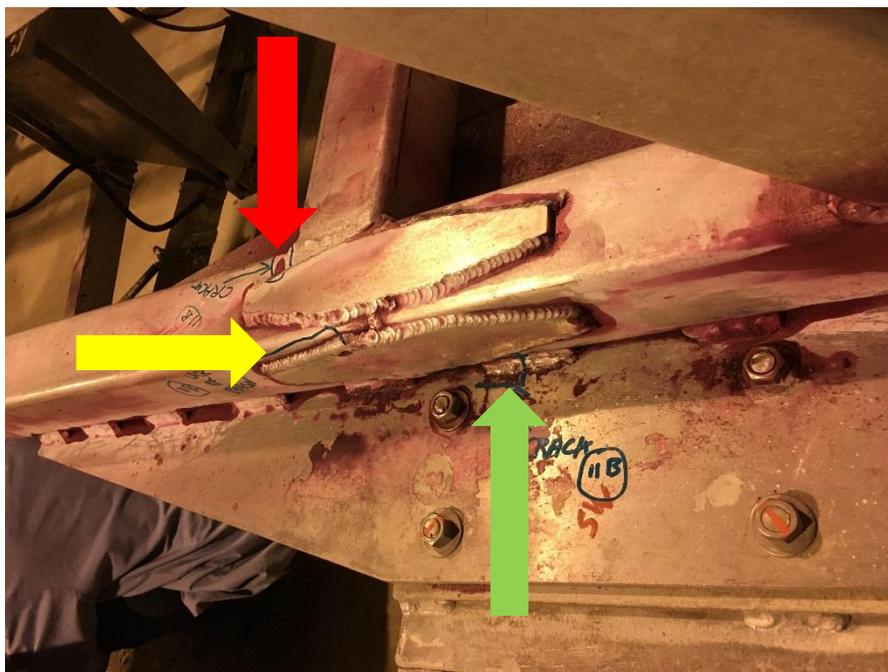


Photo of area 11B Red arrow shows location of crack in parent material yellow arrow shows lack of fusion on fish plate weld and green arrow shows crack on stitch weld. All at location 11B



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INSPECTION REPORT

Client:	AJP Engineering	Project No:	1447
Project:	Clarifier Bridge Inspection	Report No:	2
Location:	South End Sewage Treatment Plant SEWPCC	Date:	Dec. 18, 2017
Contact:	Tony Latiza		
Inspector:	David Cuddihy		

Reference Drawings & Contract Documents:

City Of Winnipeg Works And Operations Division Drawing SEP-256 and SEP-259

Applicable Standards & Specifications:

CSA W59.2-13, ASTM E165

Associated Inspection Checklists:

As directed by AJP Engineering

Scope of Inspection Work:

Visual inspection of Primary Clarifier Travelling Bridge Collector No.3 structure including all structural members, joints, welds, connections, repairs and reinforcement. Liquid Penetrant testing of critical structural members and suspect areas.

Visual Examination Work Performed (Comments are italicized)

- 1) *Visual inspection was carried out on areas not accessible on December 18, 2017 visit on Clarifier Travelling Bridge Collector No.3.*
 - 1) *East side (side "A") Skimmer Arms assembly and scum paddle*
 - 2) *Additional areas as requested by City Of Winnipeg Engineer*

Non-Destructive Testing Work Performed:

Type: Liquid Penetrant
Method: Visible Solvent Removable CQI Procedure # 9302

Penetrant: Spotcheck SKL-WP2
Developer: Spotcheck SKD-S2
Cleaner: Spotcheck SKC-S
Technician: David Cuddihy
CGSB: PT Level II #19731

Inspection Results:

- All welding was found to be acceptable.
- No damage or deformation was found on the above noted items and locations.



A handwritten signature in blue ink, appearing to read "Blake R. Penner", is written over a light blue rectangular background.

Report Prepared By:
David Cuddihy

Report Reviewed By:
Blake Penner

CSA W178.2 Certified Level I
Inspector No: 16221

CSA W178.2 Certified Level III
Inspector No: 6326

Date: Dec. 19 2017

Date: Dec. 20 2017

PHOTOS:

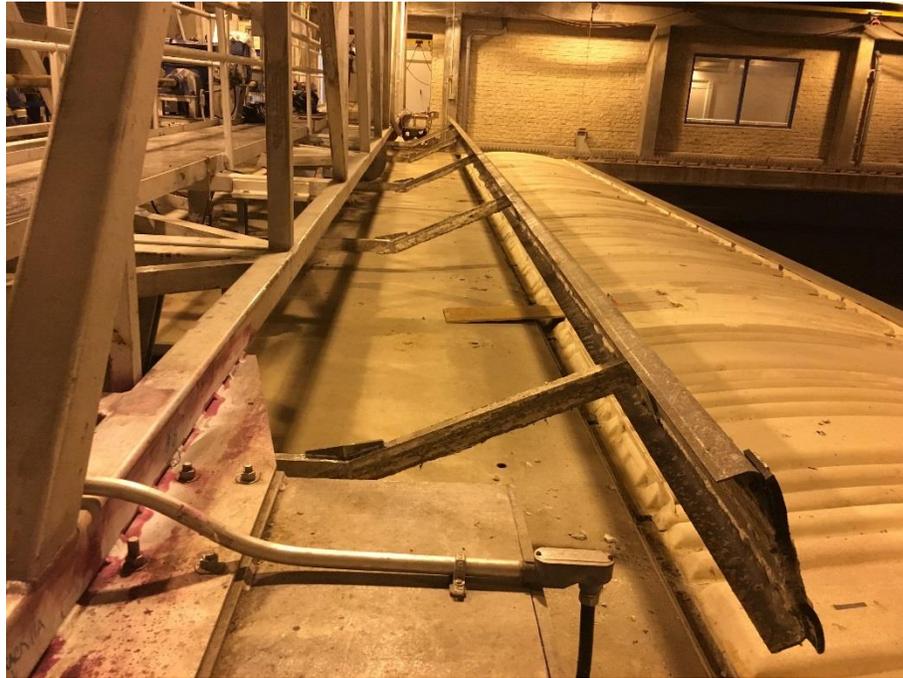
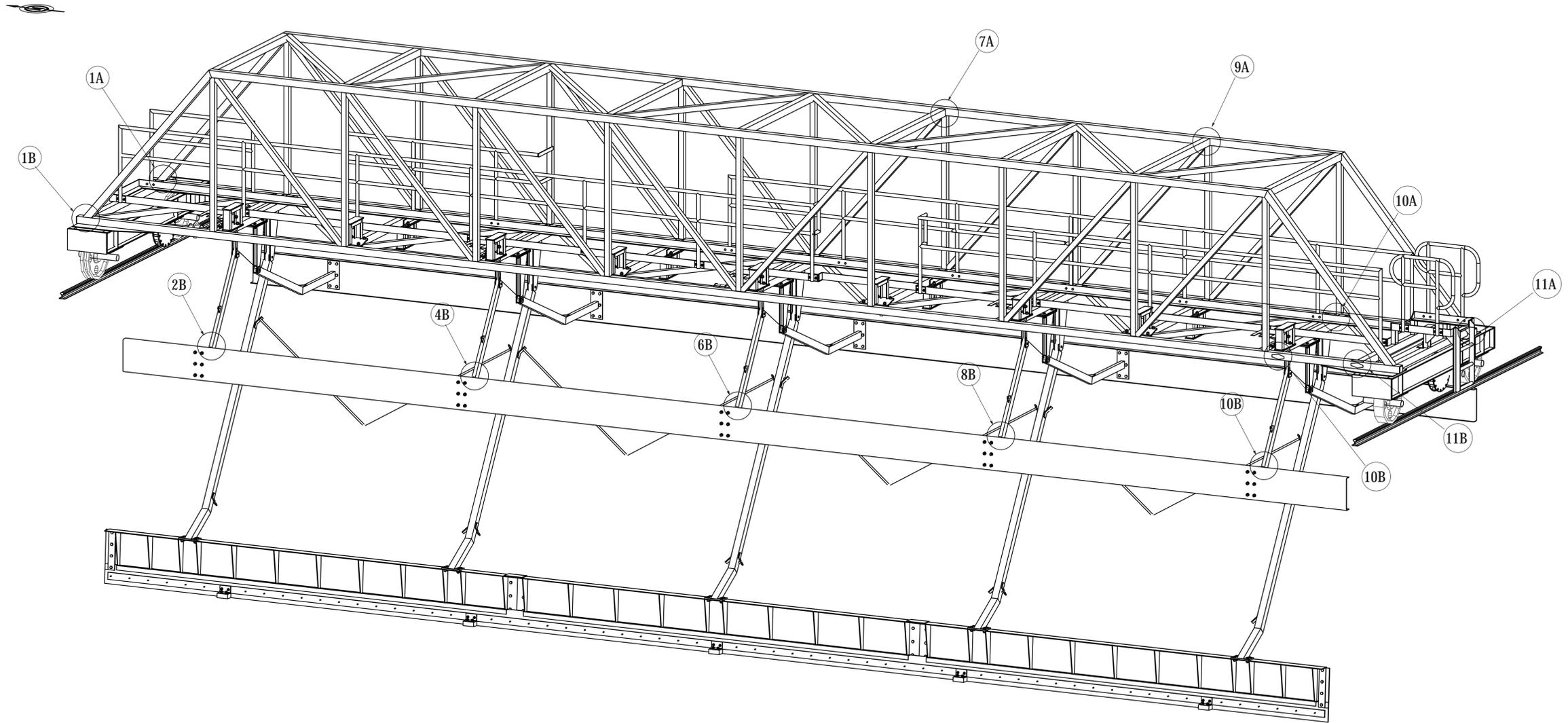


Photo of east side Skimmer Arm and Scum Paddle



Photo showing general condition of welds on Skimmer Arms



PERSPECTIVE VIEW

LEGENDS:

1. LOCATION 1B - CRACKED WELD ON BOTH SIDES OF LOWER HORIZONTAL TUBE.
2. LOCATION 1B - CRACKED WELD ON END TRUCK BEARING MOUNT WELD.
3. LOCATION 1B - LACK OF FUSION ON REINFORCEMENT PLATE WELD.
4. LOCATION 1A - CRACKED WELD ON LOWER HORIZONTAL WELD.
5. LOCATION 2B, 4B, 6B, 8B, 10B - ALUMINUM SKIMMER ARM WELD AND MATERIAL IS CORRODED AND PITTED.
6. LOCATION 7A - POROSITY ON UPPER HORIZONTAL TUBE WELD.
7. LOCATION 9A - MISSING WELD ON UPPER HORIZONTAL TUBE.
8. LOCATION 10A - CRACKED WELDS ON LOWER DIAGONAL AND HORIZONTAL TUBE.
9. LOCATION 10B - FISH PLATE WELD QUALITY IS UNACCEPTABLE.
10. LOCATION 11B - CRACK IN PARENT MATERIAL PERPETRATING FROM FISH PLATE.
11. LOCATION 11B - LACK OF FUSION ON FISH PLATE WELD.
12. LOCATION 11B - CRACKED WELD ON LOWER HORIZONTAL TUBE.
13. LOCATION 11A - CRACKED WELD ON LOWER HORIZONTAL TUBE.

A		ISSUED FOR REVIEW AND COMMENTS	11-Jan-18	MP
REV.	Description	Date	BY	
SEAL	C OF A			
 ENGINEERING SERVICES MAILING: 125 HIGGINS AVE. WINNIPEG, MB R3B 0B6 PHYSICAL: 2475-B DAY ST. WINNIPEG, MB R2C 2X5 TEL: (204) 488-6674 FAX: (204) 488-3361 www.ajpengineering.ca email: ajp@ajpengineering.ca		CLIENT: THE CITY OF WINNIPEG PROJECT: SEWPCC CLARIFIER TRAVELLING BRIDGE		
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