CITY OF TORONTO

Functional Design Report

Milne Bridge (No. 813) on Old Finch Avenue
Rouge Park Bridges Transportation Master Plan

February 2025 - 19-1924

Table of Contents

Figures

Tables

Appendices

1.0 Introduction

1.1 Project Description

The City of Toronto (City) has retained Dillon Consulting Limited (Dillon) to complete a Transportation Master Plan (TMP) focused on the development of renewal strategies for the following five municipal bridges located on City rights-of-way within the Rouge National Urban Park (RNUP):

- Maxwell Bridge on Twyn Rivers Drive (No. 802)
- Stotts Bridge on Twyn Rivers Drive (No. 803)
- Hillside Bridge on Meadowvale Road (No. 806)
- Sewell's (Suspension) Bridge on Sewell's Road (No. 812)
- Milne (Bailey) Bridge on Old Finch Avenue (No. 813).

These bridges have been designated under *The Ontario Heritage Act, R.S.O. 1990, c. O.18* as amended, with the exception of the Milne Bridge, which was listed by the City in 2006 and has not yet been designated.

The Rouge Park Bridges TMP will be completed in accordance with the provisions of the Municipal Class Environmental Assessment (EA) process, Approach #2. The purpose of the TMP is to undertake a comprehensive review, develop and evaluate Alternative Solutions for each of the bridges, including the retention, rehabilitation, or replacement of each, and prioritize the implementation of the recommended solutions.

This Functional Design Report is focussed on bridge engineering factors, with reference to roadway geometrics and other factors as appropriate. This report provides input to the "Rouge Park Bridges Transportation Master Plan Report", which documents the evaluation of alternative solutions from a comprehensive, multi-factored perspective, and identifies a recommended solution, and is supported by other technical and professional studies and reports.

This report summarizes the existing conditions and provides an assessment of alternative solutions for retaining, rehabilitating, or replacing the **Milne Bridge on Old Finch Avenue (No. 813)** from a bridge engineering perspective**.** It also provides functional design recommendations for the recommended alternative.

1.2 Project Location

Milne Bridge is located on Old Finch Avenue between Sewell's Road to the west and Reesor Road to the east, crossing over the Rouge River.

The Rouge River flows east to west at the bridge. For reporting purposes the bridge spans in a north-south direction.

The site location is labelled as site "B" in **Figure 1.**

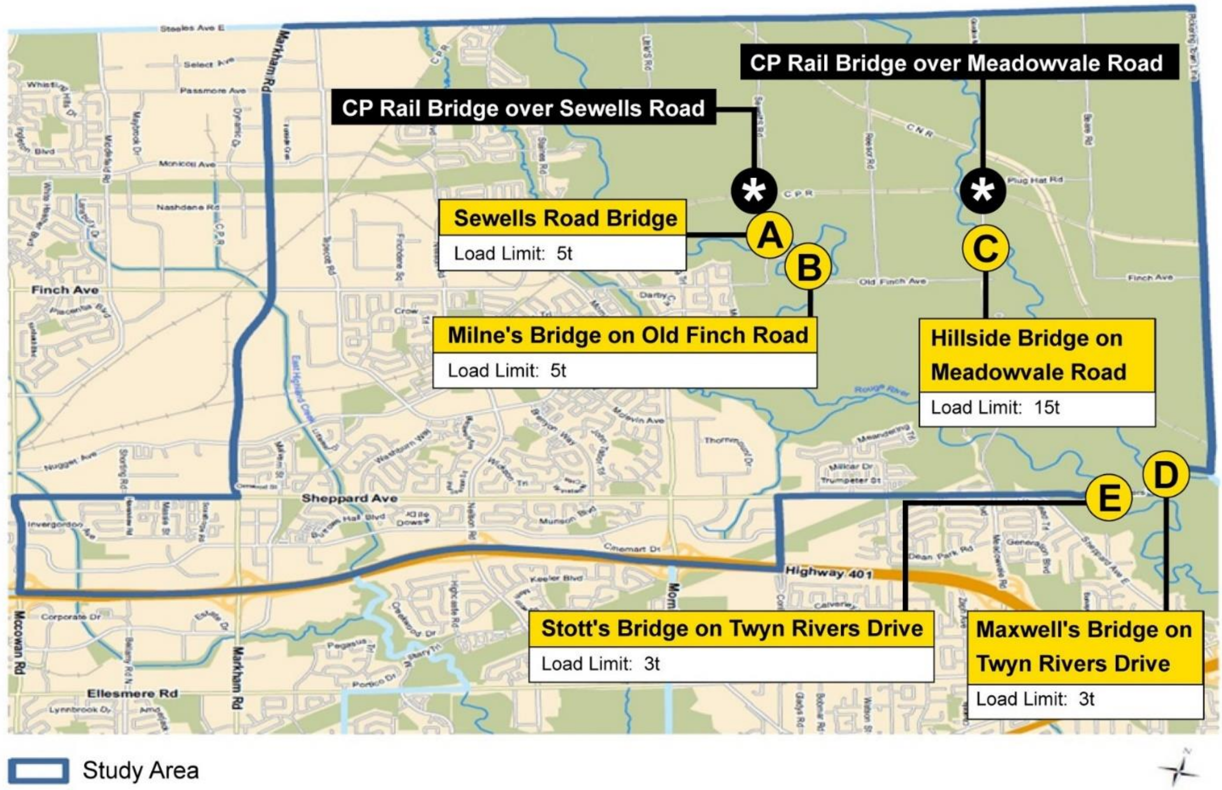


Figure 1: Site location

2.0 Available Information

2.1 Drawings

The following historical drawings are available for reference:

- Drawing 5013-S-1, “Finch Avenue Bailey Bridge Replacement, City of Scarborough”, Sandwell Swan Wooster, 1988.
- Drawings S-5013-2 to S-5013-4, “Prop Gabion Wall Rouge River at Finch Avenue”, 1966.
- Drawings 813-5013-S-5 to 813-5013-S-8, “813 Old Finch Avenue over Rouge River, Bridge Repairs”, Associated Engineering, 2013.

2.2 Reports

The following documents are available for reference:

- City of Toronto, Bridge Inspection Form, Structure No. 813, Structure Name: Old Finch Avenue over Rouge River, 2021.
- Multiple bridge Inspection and rehabilitation in North-East Scarborough, Old Finch Avenue over Rouge River (Bridge No. 813), Associated Engineering, 2013.
- “Old Finch Avenue Bailey Bridge Over Rouge River Load Rating” (letter), Associated Engineering, File 2012-5548, January 25, 2018.
- “Rouge Park Bridges TMP: Traffic Analysis Memo”, Dillon Consulting, April 2021.
- Transportation Assessment Memo, Rouge Park Bridges TMP, Dillon Consulting, May 2021.
- “Hydraulic Report - Rouge Park Bridges Transportation Master Plan”, Dillon Consulting, November 2020.
- “Desktop Study Geotechnical and Hydrogeological Assessment. Rouge Park Bridges Transportation Master Plan EA, Toronto, Ontario”, Thurber Engineering Ltd, November 2020.

2.3 Relevant Design Guidelines

References for the assessment of feasible alternative solutions for retention, rehabilitation or replacement of the bridge structures included, but was not limited to the following:

- MTO Structural Planning Guideline
- MTO Structural Manual
- Canadian Highway Bridge Design Code (CHBDC)
- MTO Structural Financial Manual
- MTO Design Supplement for TAC Geometric Design Guide for Canadian Roads
- MTO Roadside Safety Manual
- City of Toronto - Road Engineering Design Guidelines
- Accessibility for Ontarions with Disabilities Act (AODA)

3.0 Existing Site Conditions

3.1 Roadway Features and Geometry

Old Finch Avenue has a two-lane rural cross section with no paved shoulder, bike lanes or sidewalks. The road is posted with “no trucks” signage at entry points. It is classified as collector with a posted speed of 50 km/h.

The roadway approaches have tight curves and the bridge width (approximately 3.6 m wide) allows only one lane of traffic on the bridge at a time. Traffic at the far end of the bridge cannot be seen by approaching traffic, which necessitates the use of traffic signals at both ends of the bridge. See **Appendix A** for the General Arrangement drawing of the bridge. At the bridge, the tight horizontal curves, combined with a bump transition at the north end of the bridge tends to slow the operating speed of traffic substantially with several southbound vehicles observed to slow or stop before driving onto the bridge deck. The bridge has no skew angle and no crown on the deck.

In addition, the traffic signals also create queues of traffic, resulting in cohorts of several closely-spaced vehicles crossing the bridge at the same time, increasing the load density on a frequent basis.

Southwest of the bridge there is a parking area for access to the RNUP *Finch Meander Trail*.

3.2 Traffic

A Traffic Analysis Memo was prepared as part of the Rouge Park Bridges TMP, which provided an analysis and overview of the existing and future traffic conditions within the RNUP. The reported 2021 Annual Average Daily Traffic (AADT) at the structure is 8,900 vehicles per day and the forecasted 2041 AADT is 12,500 vehicles per day. The road is posted with “no trucks” signage at entry points.

The bridge width of 3.6 m restricts traffic to a single-lane, alternating direction configuration. Pedestrians and cyclists must walk on the bridge deck to cross the bridge.

3.3 Roadside Safety

There is guide rail approaching the bridge and anchored into the end walls in all four quadrants of the structure. The guide rail is in good condition. A detailed road safety audit was not completed.

3.4 Property

The bridge is located on City property, within an approximate 20 m right-of-way. Beyond the 20 m right-of-way limit most of the property is owned by Parks Canada. Additional property owners exist within the boundaries of the park and the extents of these should be determined in preliminary design.

3.5 Utilities

Overhead utility lines cross the river approximately 2-3 m to the west of the bridge limit at the south abutment to 10 m to the west of the bridge limit from approximately 13 m north of the south abutment to the north abutment.

3.6 Water and Sewer

Water and sewer information was not available at this time.

3.7 Posted Signage

The following posted signage was observed at the bridge:

- There is signage commonly associated with traffic signals.
- The bridge has a load posting sign of 5 tonnes.
- There is signage warning cyclists about the open-grating deck as a hazard, and signage for cyclists to dismount while crossing the bridge.

3.8 Survey

Existing topographic survey information was obtained from the City. Hydraulic models for the Rouge River at the location of the bridge were provided by the Toronto and Region Conservation Authority.

4.0 Existing Bridge

Milne Bridge, constructed in 1988, is a 57.9 m long two-span (27.4 m, 30.5 m) steel Bailey bridge with an open grating deck carrying Old Finch Avenue over the Rouge River.

The bridge width of 3.6 m restricts traffic to a single-lane, alternating direction configuration. The bridge is located in the middle of an S-curve horizontal roadway alignment, essentially eliminating sight lines to the far side of the bridge from either approach. To accommodate the combination of the single lane bridge and the lack of sight lines, traffic signals were installed at the ends of the bridge, actuated on a timer.

The bridge has a load posting of 5 tonnes.

A General Arrangement drawing from the 1988 construction is provided in **Appendix A**, and site photographs are included in **Appendix B**.

4.1 Superstructure

The superstructure is constructed of three trusses connected laterally on each side of the deck connected by floor beams, in a configuration known as a triple-single, representing three trusses wide per side, and one high. The bridge is fabricated from individual panels that are 1.52 m high and 3.05 m long and bolted together. The south span is 27.4 m (9 panels) and the north span is 30.5 m (10 panels) long for a total of 57.9 m.

The bridge width of 3.6 m restricts traffic to a single-lane, alternating direction configuration.

The trusses support a floor beam and bracing system with an open-grated steel deck.

4.2 Substructure

The bridge abutments are 1.0 m thick cast-in-place concrete grade beams approximately 2.3 m deep. The abutments were constructed in 1988 to replace previous abutments that were damaged by collision with debris flow in the river.

The bridge pier is constructed of four wood piles with a steel cap frame and vertical steel bracing. The pier is located near the center of the river channel, making it vulnerable to debris and ice flows. A debris deflector was constructed upstream of the pier using armour stone and concrete.

A system of groynes and guide banks was installed as river training along the north side of the river banks in the 1960s.

4.3 Maintenance and Repair History

The following repair work was completed, in 2013:

- Removal of debris collected at the pier and reinstatement of armor rock
- Jacking and replacement of the pier cap
- Removal of old non-functional pier bent framing
- Installation of repair plates to steel deck grating
- Guide rail extensions and improvements.

See **Appendix A** for the Rehabilitation General Arrangement drawing from 2013.

4.4 Condition of Structure

The condition of the structure was determined from a review of available documentation, visual site walk-through surveys of the structure in November 2019 and October 2020, and interviews with City staff.

The 2021 biennial bridge inspection was assigned a Bridge Condition Index (BCI) of 71.3, which relates to a bridge in good condition. It should be noted that these inspections are intended to identify repairs required in the next two years and do not address functional obsolescence or long-term considerations.

The deck grating has been damaged numerous times and repaired with flat plate. The deck panels are loose, causing significant noise under traffic, with abrasion observed and loose bolted connections. The deck appears to be at or near the end of its useful service life.

The wood piles at the pier have not been subjected to non-destructive testing such as coring to investigate the amount of decay, which typically initiates at the core of the pile and is usually worst at or just below grade level. Based on the age of the piles, and the exposure to wetting effects, there is a significant risk that the piles are at or near the end of their useful service life, and replacement of the pier should be considered.

The load evaluation completed in 2018 confirmed the 5 tonne load posting.

Panel bridges were originally designed for temporary use, but in practice have been kept in service for decades. However, the reasonable normal service life for these bridges in long-term use has been about 25 to 35 years.

Based on the age of the bridge and the condition of the pier and the deck, the bridge is considered to be nearing the end of its service life.

5.0 Heritage Evaluation

An advertisement was published in the Scarborough Mirror on June 5, 1996, listing five bridges addressed in the *Rouge Park Bridges TMP EA* for proposed designation under *The Ontario Heritage Act, R.S.O. 1990, Chapter O.18*.

The reasons for the proposed designation at Milne Bridge were given as follows:

> <u>"SHORT STATEMENT OF THE REASONS FOR THE PROPOSED DESIGNATION:</u>
>
> THE MILNE BRIDGE is recommended for designation for historical and structural reasons. This bridge is typical of Bailey bridges. Designed by Sir Donald Bailey of Britain, this type of bridge was used extensively as a temporary military bridge during the Second World War. The Bridge was erected in 1955 by the 2nd field Engineer Regiment of Toronto to replace the old Milne bridge destroyed by Hurricane Hazel. The current structure (1988) is a triple single Bailey Bridge and one of the last remaining structures of its kind in Ontario. As this is one of the few remaining Bailey Bridges, it should be protected so as to ensure further generations will appreciate its initial contribution to transportation."

Subsequent to this, four of the five bridges listed were designated under City of Scarborough By-Laws, with the exception being Milne Bridge.

Based on an interview conducted in 2020 with Brian Ellis, P.Eng., the engineer-of-record for the 1988 replacement, the replacement involved erection by the military to establish common historic ties to the 1954 construction. The Bailey Bridge panels were replaced to achieve a triple-single configuration.

A monument was installed in 1985 at the southwest corner of the bridge, commemorating the bridge construction of 1954.

Heritage conservation is an important consideration in the assessment of bridge alternative solutions, and in the overall evaluation of alternative solutions in the TMP, which are addressed in the "Cultural Heritage Resource Assessment Report" and a "Scoped Heritage Impact Assessment Report" by ASI, to assess the recommended alternative solutions from a heritage perspective.

5.1 Heritage Guideline Options

The "Ontario Heritage Bridge Guidelines" (Ontario Ministry of Transportation, 2008) has been used as a supplementary reference to the primary heritage guide used by the City, "Conservation of Historic Places in Canada" (Parks Canada, 2010). The former guide articulates a series of heritage treatment options to be considered in rank order (from most desirable to least) as follows:

1. Retention of existing bridge with no major modifications;
2. Retention with restoration of missing or deteriorated elements;
3. Retention of bridge with sympathetic modification;

4. Retention of bridge with sympathetically designed new structure nearby;
5. Retention of bridge adapted for alternative use;
6. Retention of bridge as heritage monument for viewing purposes;
7. Relocation of bridge – applicable for smaller, lighter structures; and
8. Bridge removal and replacement with sympathetically designed structure.

Reference will be made to these options in the remainder throughout this report.

6.0 Identification of Alternative Solutions

Need for a Crossing

At the onset of the project, the need for a bridge crossing at the site was evaluated based on traffic needs, detour route availability, and other factors. It was concluded that the crossing could not be closed and decommissioned permanently. Therefore, **all alternative solutions to be considered require a bridge crossing to be in service for the next 20 years**, representing the study period for the TMP.

Three Alternative Solutions for the bridge crossing have been identified:

- Alternative 1: Retain Bridge
- Alternative 2: Rehabilitate Bridge
- Alternative 3: Replace Bridge

Each alternative is described below, for clarity.

6.1 Alternative 1: Retain Bridge

Retention of the existing bridge means keeping the bridge in its existing configuration with minimal changes, if any. It may include maintenance repairs, or improvements to roadway approaches, sight lines, signage or other ancillary features. However, functional improvements that change the cross-section of the bridge, or strengthening that substantially alters the form and appearance of the structure are not considered in this alternative.

This alternative involves continued operation of the bridge with minimal modifications at the start and no planned repairs in the next 20 years. Normal maintenance and inspections are anticipated. No improvement to functional adequacy would be achieved. Roadside safety would typically not be improved.

This alternative would only be feasible if the level of risk, safety and reliability of continued operations is deemed acceptable.

6.2 Alternative 2: Rehabilitate Bridge

Rehabilitation means strengthening and altering the existing bridge to address deficiencies, and the process may allow improvements to its functional adequacy. This may include adding structural components to supplement the existing ones, replacing components of the structure or other similar improvements. However, significant alterations in form and appearance may occur.

Rehabilitation is defined in the Canadian Highway Bridge Design Code (CHBDC) as a modification, alteration, or improvement of the condition of a structure or bridge subsystem that is designed to correct deficiencies in order to achieve a particular design life and live load level.

Functional adequacy may be viewed as encompassing not only design life and live load levels, but also operational risk, maintenance requirements, geometric constraints, and other factors.

A minor rehabilitation may focus solely on correcting deficiencies without any improvement in functional adequacy. However, corrective actions that require more extensive modifications are considered major rehabilitations.

Major rehabilitations provide the opportunity (and often the obligation) to achieve an acceptable level of functional adequacy. For example, the CHBDC indicates that consideration shall be given to closing bridges that would be posted for a load limit below 7 tonnes. For older bridges, it is often not feasible to strengthen bridges to load levels comparable to a new bridge, thus lower load levels would be targeted. Table 15.1 of the CHBDC provides guidance on target load levels for bridges to be rehabilitated for restricted normal traffic. In this case, bridges carrying emergency vehicles, single unit trucks, school buses and maintenance vehicles should be capable of supporting a CL3-ONT design live load, which relates to a posted load limit of 25 tonnes. (For comparison, a bridge that can support unrestricted normal traffic would be comparable at 63 tonnes.)

Rehabilitation typically extends the service life of a bridge for 25 to 35 years, which would correlate to no planned repairs during the 20-year planning horizon for this study. Normal maintenance and inspections are anticipated. Roadside safety (e.g. barriers) could be improved in some cases, but it may not be possible to achieve the level of performance possible with new construction.

The benefits of rehabilitation should be evaluated against associated costs, risks and consequences.

Risks may include increasing loads to the substructure (e.g., abutments) beyond acceptable levels, the potential to uncover problems during construction that are much worse than could be known at the beginning, hazards to worker or public safety during the rehabilitation, and other issues.

Consequences include potential impacts to the heritage value and aesthetic appearance of the bridge, and these should be minimized or avoided where feasible. Rehabilitation may involve adding structural components to supplement the existing ones, replacing components of the structure or other significant modifications. Such significant alterations in form, proportion, massing, or materials may be so extensive that the heritage value cannot be appropriately preserved, therefore rehabilitation is not recommended.

Widening of this bridge through a major rehabilitation would require such an extensive dismantling and replacement of the original structure and abutments that it is not considered feasible.

6.3 Alternative 3: Replace Bridge

Replacement of the existing bridge means complete removal of the existing bridge, and replacement with a new structure. This allows the greatest improvement in the functional adequacy of the bridge such as load-carrying capacity, width, and service life. For replacement of heritage bridges, it must be demonstrated that the other alternative solutions are not suitable before replacement is considered.

Replacement would remove constraints such as load limits, span limits, bridge clearance for hydraulics, bridge width, number of lanes, shoulder widths, roadside safety barriers, bicycle lanes, and pedestrian accommodation. It also provides the opportunity to use new materials and structure forms to improve durability. Typically, the design life for a new bridge designed according to the CHBDC is 75 years. Minimal maintenance would be required for the first 20 years after construction.

Replacement would involve removal of the existing bridge span and its abutments, affecting the heritage characteristics of the bridge and its surrounding area. However, the existing bridge superstructure could be removed carefully and adapted for alternate use away from its current location, potentially elsewhere in the RNUP or in the City, providing a degree of heritage conservation.

In many cases the original bridge could be adapted for a new use such as a pedestrian crossing, cycle path or scenic viewing, or retained as a heritage monument for viewing purposes only. The bridge could be relocated to a new site for these purposes.

Retention of the existing bridge on the current site is not considered feasible at this site, due to limitations in right-of-way and span limitations to achieve appropriate hydraulic clearance.

The use of the existing bridge for a single lane of traffic while providing a replacement bridge for the opposing direction would cause undesirable roadside safety characteristics by requiring significant horizontal curves for the roadway and separated bridge lanes and create collision hazards at the median location. This approach also creates future issues when the existing bridge is removed, because the replacement bridge would require significant rework, widening or removal and replacement to remedy geometric concerns. The rehabilitation of the existing bridge must be demonstrated to be feasible and acceptable for this approach to be considered further.

The Ontario Heritage Bridge Guidelines (MTO, 2008) recommends the heritage impact of a bridge replacement could be mitigated using sympathetic design which means making the new structure physically and visually compatible with the heritage attributes of the original. It would be compatible in terms of the massing, size, scale, and architectural features to protect the cultural heritage value of the bridge and its environment.

A commemorative monument, plaque or sign could be erected at the site to recognize the history of the original bridge.

A heritage bridge often has contextual value attached to its cultural heritage value, requiring the scenic characteristics of the river crossing, the roadway alignment, and natural setting be taken into account for any replacement structure that may be considered.

7.0 Evaluation of Alternative Solutions

As part of the broader Transportation Master Plan, alternative solutions are being evaluated against the following six factors:

- Bridge Condition and Function
- Transportation
- Heritage and Archaeology
- Natural Environment & Hydraulics
- Public Uses in Rouge National Urban Park
- Implementation

This report focuses on the 'Bridge Condition and Function' for each alternative, and the review has been supported by other technical and professional studies. The evaluation of alternative solutions is described in the following sections.

7.1 Alternative 1: Retain Bridge

Alternative 1 is a 'holding strategy' where the existing bridge is retained and maintenance repairs are completed for the remainder of the service life until a major rehabilitation is completed or the structure is replaced.

Repairs would be focused on maintaining the structure in a safe operating condition, but would not include strengthening or provide a significant increase in service life. Based on a review of previous inspection and engineering reports, the scope of work is expected to include:

- Localized steel repairs to address severe section loss and perforations;
- Localized repairs to open grate decking; and
- Repairs to the timber pier members to address severe rot.

A regular monitoring and maintenance program would be required for the remainder of the service life to address ongoing deterioration.

Alternative 1 provides the lowest capital cost alternative, but also provides the smallest extension of service life to the structure. Based on the proprietary structural system that is no longer manufactured, single lane cross section, and load limit the structure is functionally obsolete.

Maintenance repairs alone are not expected to extend the service life of the structure to the end of the 20 year study period, due to the poor condition of the existing pier. Regular monitoring and a major rehabilitation including replacement of the pier bent (as described in **Section 4.3**) is expected to be required to keep the structure in service for the remainder of the 20 year study period.

Trucks traffic would continue to be required to use an alternate route, which limits access to fire and other emergency services as well as access for other service vehicles.

Traffic signals would remain to control the single lane alternating direction traffic, which is not well suited to the approach roadway width and operating speeds. Cyclists would continue to share the road with vehicular traffic and would need to dismount to safely cross the open grate decking. The narrow existing deck width would continue to pose a risk for collision with the bridge truss panels.

The existing soffit elevation meets current hydraulic clearance requirements. Stream bank stabilization measures including groynes and guide banks are present at the north bank, suggesting that erosion is a concern at the site. The south abutment is currently constraining the watercourse and does not provide any allowance for future meandering.

Retaining the bridge is not feasible and not recommended for reasons of structure condition.

7.2 Alternative 2: Rehabilitate Bridge

Alternative 2 includes a major rehabilitation with the intent to extend the service life of the bridge.

The ability to strengthen panel bridge structures is limited by the availability of replacement parts for the proprietary system. At this site, the proprietary system is now obsolete and replacement truss panels, components, and launching systems are not readily available. Similarly, widening of the bridge would essentially require complete replacement of the superstructure. Therefore, significant strengthening or widening of the bridge through rehabilitation is considered impractical and not recommended.

Rehabilitation work would focus on replacing the pier bent and extending the service life of the superstructure. Based on a review of previous inspection and engineering reports, the scope of work is expected to include:

- Replacement of the pier bent;
- Replacement of the steel open grate decking; and,
- Repair or replacement of damaged steel members.

Replacement of the pier bent is expected to require removal and dismantling of the superstructure for access. Redesign and alteration of the structure is expected to be required to reuse it, since replacement panels, components, and the original launching system are not readily available.

Constructing a wider pier with the superstructure in place, would require temporary pier bents on either side of the existing pier to support the structure while the existing pier is removed and replaced. The new foundation elements and columns would need to be located beyond the current extents of the structure for access and a relatively deep cap beam would be required to span under the bridge. Jacking and blocking operations would be required to lift the structure from the existing pier and lower it on to the new cap beam. The cost of temporary works is expected to be prohibitive compared to removing the superstructure.

A regular monitoring and maintenance program would be required for the remainder of the service life.

Alternative 2 includes an extension of the service life, by replacing the pier bent, but would not address the current safety and functional concerns at the crossing or the current load posting.

The feasibility of Alternative 2 is largely impacted by risks regarding design responsibility for re-using the existing proprietary bridge system. The existing system is now obsolete and replacement truss panels, components, and launching systems are not readily available. Removal and temporary dismantling of the bridge is expected to be required to replace the existing pier bent. Without spare parts, re-design and alteration would be required to repair damaged components, which would be difficult to manage during construction.

The scarcity of parts also precludes the ability to widen the structure or strengthen it to improve the load rating. Truck traffic would continue to be required to use an alternate route, which limits access to fire and other emergency services as well as access for other service vehicles.

Traffic signals would remain to control the single lane alternating direction traffic, which is not well suited to the approach roadway width and operating speeds. Cyclists would continue to share the road with vehicular traffic and would need to dismount to safely cross the open grate decking. Replacing the open grate decking with a new closed system is not expected to be feasible, given the existing load restrictions. The narrow existing deck width would continue to pose a risk for collision with the bridge trusses.

Similar to Alternative 1, this alternative maintains the existing hydraulic opening and may not accommodate the future meander belt width for the river.

There is risk associated with reusing an existing proprietary structure that is now obsolete. The risks around design responsibility and potential for delays due to redesign and alteration may warrant replacement of the structure.

Since dismantling is required to allow replacement of the existing pier, reinstatement with a new bridge is recommended.

7.3 Alternative 3: Replace Bridge

Alternative 3, complete replacement, provides the most improvements to the safety and overall function of the structure, but also represents the highest initial capital cost.

The replacement structure would be designed in accordance with current standards and would provide full access for truck traffic, including emergency vehicles and large service trucks.

The two lane configuration eliminates the need for traffic signals, reduces collision risks, and is better suited to the approach roadway width and operating speed. The new closed deck and asphalt wearing surface improves the rideability for all users and reduces the chloride exposure to the primary structural members, reducing maintenance requirements.

The hydraulic opening would provide increased conveyance and the span and embankment design would include an allowance for spanning the meander belt or erosion limits of the river.

Minimal maintenance is expected to be required for the first 20 years. Modern structural configurations and materials would be used, resulting in a more durable structure with lower future maintenance requirements.

7.4 Recommended Alternative

Structure replacement (Alternative 3) is recommended at this site. Retaining the original structure (Alternative 1) is not feasible based on the condition of the existing pier bent. Risks associated with rehabilitating (Alternative 2) an obsolete proprietary system would be difficult to manage and could lead to significant delays and alterations during construction.

This Functional Design Report is focused on bridge engineering factor, with reference to roadway geometrics and other factors as appropriate. The evaluation of alternative solutions, from this perspective, is summarized in **Table 1**. A more comprehensive multi-factor evaluation of alternative solutions is included in the TMP report.

Table 1: Evaluation of Alternative Solutions Summary

Criteria	Alternative 1: Retain	Alternative 2: Rehabilitate	Alternative 3: Replace
Bridge Condition and Function	Capacity, durability, reliability, risk, and traffic signals remain.	Service life extended, but bridge would remain one lane with load posting and traffic signals remain.	New two-lane bridge would meet current standards and eliminate traffic signals.
Heritage	Cultural heritage value would be maintained for study period.	Rehabilitation would deter from the cultural heritage at the site	Sympathetic design and adaptive reuse may mitigate impacts.
Implementation	Pier is in poor condition and needs to be replaced.	Condition makes it infeasible to reuse superstructure after dismantlement.	Normal bridge and roadway design and construction.

For the purposes of this report, a modern truss bridge has been recommended as the replacement structure type with a focus on sympathetic design, given the uncertainty of other heritage mitigations.

7.5 Heritage Conservation Options Review

Heritage conservation options are based on the 'Conservation of Historic Places in Canada;' (Parks Canada, 2010) which provides principles for infrastructure conservation and references the Ontario Heritage Bridge Guidelines (MTO, 2008) for the specific case of bridges. This provides a rank-order approach to heritage bridge conservation options, ranging from least to most heritage impact.

The rank-order approach requires each option to be evaluated and found to be non-viable before the subsequent option is considered. The rank-order options that were considered are listed in **Table 2** below.

Table 2: Heritage Options Review

Conservation Option	Evaluation Summary
1. Retain existing bridge with no major modifications	Not viable due to the poor condition of the bridge pier.
2. Retain & restore missing or deteriorated elements	Same evaluation as option #1. Not viable to restore because this type of bridge uses proprietary ("Bailey Bridge") panels that cannot be sourced in new condition, used panels are difficult to find, and there are known fatigue details that greatly increase the risk associated with the reuse of these panels.
3. Retain bridge with sympathetic modification	Same evaluation as option #2.
4. Retain with sympathetically designed new structure nearby	Same evaluation as option #1. Since existing bridge cannot be retained, bypass options are not considered further.
5. Retain & adapt for alternative use	Not viable to retain the bridge in-place for alternative use because a vehicular crossing is required at this location.
6. Retain as heritage monument for viewing purposes	Not viable to retain the bridge in-place as a monument because a vehicular crossing is required at this location.
7. Relocate – applicable for smaller, lighter structures	Relocation of the steel modular panel truss and floor is a viable option, requiring modifications for an alternative use (e.g. pedestrian crossing on a trail). This option may be considered if a suitable site can be determined, and it should be recognized the rehabilitation or replacement of the floor system and a shorter bridge span will likely be required to reduce the load demands, and to account for disposal of deteriorated components. The bridge could be reconstructed at a new location using fewer panels. This option could be applied in conjunction with a replacement bridge (option 8), but is considered optional, since a suitable site may not be available, and sympathetic replacement is recommended for the vehicular bridge.
8. Remove & replace – consider sympathetic details	For sympathetic details, the replacement bridge could be constructed using a modern truss or panel bridge. The span lengths and pier placement would be modified to suit the site. Removal of the existing bridge could also include relocation for alternative use as outlined under option 7.
Recommendation:	**Remove and replace bridge (option #8, perhaps with option #7).**

Heritage conservation is an important consideration in the assessment of bridge alternative solutions, and in the overall evaluation of alternative solutions in the TMP, which will be addressed in the "Cultural Heritage Resource Assessment Report" and a "Heritage Impact Assessment Report" by ASI, to assess the recommended alternative solutions from a heritage perspective.

8.0 Functional Design (Recommended Alternative)

The layout of the recommended alternative has been advanced to an approximate 10% level of design development. Future preliminary and detailed engineering studies will be required to refine the design.

8.1 Functional Design of Replacement Structure

Based on the existing profile and stream alignment, it is anticipated that the current span arrangement is acceptable for hydraulic conveyance. However, elimination of the pier is proposed to improve hydraulic conveyance and minimize environmental impacts and in-water work requirements. A single span bridge of approximately 46 m is anticipated. Fluvial geomorphology investigations (to be completed under future design phases of the project) may require lengthening the structure or bank stabilization measures to be installed. Review of bridge alignment to improve sight lines is also recommended for the future design phases.

The new structure is expected to remain on the existing (straight) alignment and include two traffic lanes with shoulders. The roadway width on the bridge is anticipated to be 11.6 m (31.5 ft) wide from face-to-face of curbs, with a bridge layout as described below:

- Two – 3.3 m traffic lanes;
- Two – 2.5 m wide raised concrete shoulders separated from the main lanes by a mountable concrete curb;
- Two bicycle-height four tube combination TL-4 (SS110-34) traffic railings mounted on concrete curbs; and
- Truss members located outside of the bridge railings.

A sympathetically designed truss bridge is recommended given the uncertainty of the other heritage mitigations. A detailed analysis will need to be completed as part of the preliminary design to assess feasibility of proposed deck width based on proposed construction materials to be supported by a "sympathetic" modern pony truss bridge structure.

The test level requirements of the barrier system are based on the approach roadway/structure geometry, traffic volumes and barrier side clearance. A TL-4 four tube combination traffic/bicycle railing is recommended to both satisfy the test level requirements and provide protection to above deck truss components with respect to potential vehicle impact loads as the railing is offset from the structure itself. An alternate parapet wall or parapet wall/railing system could also be considered to provide better protection from de-icing chemicals to truss components within the splash zone. However, this type of system would add additional weight, be less aesthetically pleasing and will be less sympathetic to the existing structure from a heritage perspective.

No sidewalk facility is included. In the future, if pedestrian accommodation is needed within the City right-of-way, a separate pedestrian bridge could be added adjacent to the crossing.

During preliminary design the relative advantages of increased structure width versus optimization of the structure load carrying components will need to be assessed, particularly with respect to the unbraced top chord and the U-Frames providing the necessary stiffness to prevent buckling of the top chord. Future design considerations could include but are not limited to restricting deck width between curbs to 10 m (restricting to two design lanes rather than three design lanes, as defined by the CHBDC), stiffening of the floor system (i.e. H-shaped pony truss), use of lightweight deck materials, arching of the top chord and/or use of stiffer steel components with closed sections that are less prone to buckling, deepening of the truss and provision of sway bracing and/or top chord bracing (i.e. through truss design).

A functional design general arrangement drawing of the proposed bridge is provided in **Appendix C**, and a cost estimate is provided in **Appendix D.**

Heritage Plaque

It is recommended that a second commemorative plaque be erected at the site to recognize the history of this structure to accompany the existing monument installed in 1986, and to recognize the 1988 bridge replacement as well. This would connect to the public memory of all three bridges since the Hurricane Hazel event and provide a form of heritage commemoration.

9.0 Other Considerations

9.1 Hydraulics and Hydrology

A Hydraulic Report was provided under separate cover. The key hydraulic design criteria for Milne Bridge are summarized as follows:

High water level based on 1:50 year design flow is estimated to be 119.55 m. Existing freeboard and clearance are estimated to be 3.75 m and 2.68 m, respectively. The minimum requirements for freeboard and clearance are 1.0 m. Therefore, the existing structure has more than adequate hydraulic clearance.

9.2 Navigability

The Rouge River is not included on the List of Scheduled Waters under the *Canadian Navigable Waters Act*.

9.3 Access to Site

The site is readily accessible from Old Finch Avenue.

Based on discussions with the City, full closure of the road during bridge construction is feasible. Further development of closure details or alternate staged construction recommendations should be investigated as part of the (future) preliminary design.

9.4 Environmental Considerations

This Transportation Master Plan is being completed in accordance with the Municipal Class Environmental Assessment process, using Approach #2, where the level of investigation, consultation and documentation shall fulfil the requirements for Schedule B projects, as a minimum. This includes completion of Phase 1 (problem/opportunity definition) and Phase 2 (evaluation and selection of a recommended solution) of the Class EA process.

Identification of environmental factors (e.g., natural habitat, archaeology, cultural heritage, hydrology and hydraulic conveyance, fluvial geomorphology, geotechnical and foundation conditions, traffic, etc.) will need to be completed as part of the Preliminary Design for the recommended alternative following completion of the Rouge Park Bridges TMP.

9.5 Hazardous Materials

No hazardous materials have been identified on the bridge.

9.6 Future Study Requirements

Additional studies that should be undertaken as part of preliminary design of the recommended alternative include, but are not limited to:

- Geotechnical Investigation - to determine subsurface conditions at proposed bridge foundations.
- Natural Habitat Studies – to determine potential environmental impacts of replacement alternatives and alternate alignments (including SAR, tree inventory, etc).
- Archaeological Study
- Cultural Heritage Study
- Hydrology, Hydraulic Conveyance and Fluvial Geomorphology Study – including a detailed hydraulic model to confirm hydraulic requirements and determine bank erosion limits.
- Traffic Study – to better determine proposed construction staging impacts.
- Survey – to confirm roadway geometry and provide detailed basemapping.

10.0 Closure

The foregoing summarizes the structural existing conditions at **Milne Bridge on Old Finch Avenue (No. 813)**. Alternative Solutions for retaining, rehabilitating, and replacing the structure are presented and assessed and a recommended solution is recommended for this bridge project site, one of five bridge project sites considered under the Rouge Park Bridges Transportation Master Plan.

DILLON CONSULTING LIMITED

Reviewed by:

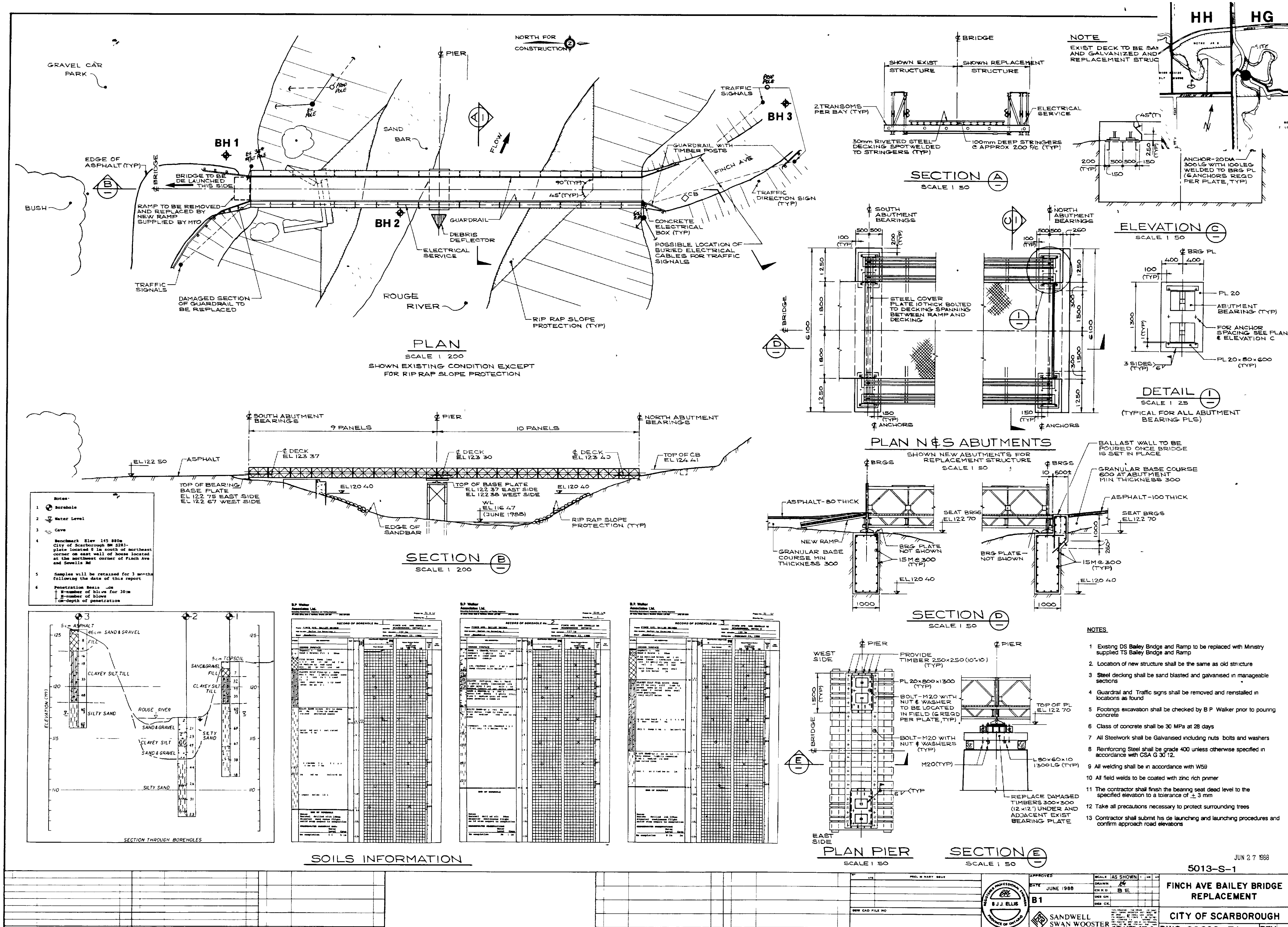
Janette McCann, M. Eng, P.Eng.
Associate, Structural Engineer

Reviewed by:

Chris Haines, P.Eng.
Project Manager, Structural Engineer

Appendix A

Drawing of Existing Bridge



PLAN
SCALE 1 200
SHOWN EXISTING CONDITION EXCEPT FOR RIP RAP SLOPE PROTECTION
GRAVEL CAR PARK
NORTH FOR CONSTRUCTION
℄ PIER
BH 1
BH 2
BH 3
SAND BAR
FLOW
EDGE OF ASPHALT (TYP)
℄ BRIDGE
BRIDGE TO BE DE LAUNCHED THIS SIDE
BUSH
RAMP TO BE REMOVED AND REPLACED BY NEW RAMP SUPPLIED BY MTO
TRAFFIC SIGNALS
DAMAGED SECTION OF GUARDRAIL TO BE REPLACED
GUARDRAIL
DEBRIS DEFLECTOR
ELECTRICAL SERVICE
ROUGE RIVER
RIP RAP SLOPE PROTECTION (TYP)
GUARDRAIL WITH TIMBER POSTS
FINCH AVE
CONCRETE ELECTRICAL BOX (TYP)
POSSIBLE LOCATION OF BURIED ELECTRICAL CABLES FOR TRAFFIC SIGNALS
TRAFFIC DIRECTION SIGN (TYP)
SECTION B
SCALE 1 200
℄ SOUTH ABUTMENT BEARINGS
℄ PIER
℄ NORTH ABUTMENT BEARINGS
9 PANELS
10 PANELS
EL 122 50
ASPHALT
℄ DECK EL 123 37
℄ DECK EL 123 30
℄ DECK EL 123 43
TOP OF CB EL 124 41
TOP OF BEARING BASE PLATE EL 122 75 EAST SIDE EL 122 67 WEST SIDE
EL 120 40
TOP OF BASE PLATE EL 122 37 EAST SIDE EL 122 38 WEST SIDE
WL EL 116 47 (JUNE 1988)
EDGE OF SANDBAR
RIP RAP SLOPE PROTECTION (TYP)
SECTION A
SCALE 1 50
℄ BRIDGE
SHOWN EXIST STRUCTURE
SHOWN REPLACEMENT STRUCTURE
2 TRANSOMS PER BAY (TYP)
ELECTRICAL SERVICE
30mm RIVETED STEEL DECKING SPOTWELDED TO STRINGERS (TYP)
100mm DEEP STRINGERS ℄ APPROX 200 ℄/℄ (TYP)
NOTE
EXIST DECK TO BE SA... AND GALVANIZED AND... REPLACEMENT STRUC...
HH
HG
ELEVATION C
SCALE 1 50
ANCHOR-20 DIA 300 LG WITH 100 LEG WELDED TO BRG PL (6 ANCHORS REQD PER PLATE, TYP)
PLAN N & S ABUTMENTS
SHOWN NEW ABUTMENTS FOR REPLACEMENT STRUCTURE
SCALE 1 50
℄ SOUTH ABUTMENT BEARINGS
℄ NORTH ABUTMENT BEARINGS
STEEL COVER PLATE 10 THICK BOLTED TO DECKING SPANNING BETWEEN RAMP AND DECKING
℄ ANCHORS
DETAIL 1
SCALE 1 25
(TYPICAL FOR ALL ABUTMENT BEARING PLS)
℄ BRG PL
PL 20
ABUTMENT BEARING (TYP)
FOR ANCHOR SPACING SEE PLAN & ELEVATION C
PL 20 x 80 x 600 (TYP)
3 SIDES (TYP)
SECTION D
SCALE 1 50
℄ BRGS
ASPHALT-80 THICK
NEW RAMP
GRANULAR BASE COURSE MIN THICKNESS 300
BRG PLATE NOT SHOWN
15M @ 300 (TYP)
EL 120 40
SEAT BRGS EL 122 70
BALLAST WALL TO BE POURED ONCE BRIDGE IS SET IN PLACE
GRANULAR BASE COURSE 600 AT ABUTMENT MIN THICKNESS 300
ASPHALT-100 THICK
PLAN PIER
SCALE 1 50
WEST SIDE
EAST SIDE
℄ PIER
PROVIDE TIMBER 250 x 250 (10"x10") (TYP)
PL 20 x 800 x 1300 (TYP)
BOLT-M20 WITH NUT & WASHER TO BE LOCATED IN FIELD (6 REQD PER PLATE, TYP)
BOLT-M20 WITH NUT & WASHERS (TYP)
M20 (TYP)
SECTION E
SCALE 1 50
TOP OF PL EL 122 70
L 80 x 60 x 10 300 LG (TYP)
REPLACE DAMAGED TIMBERS 300 x 300 (12 x 12") UNDER AND ADJACENT EXIST BEARING PLATE
SOILS INFORMATION
SECTION THROUGH BOREHOLES
RECORD OF BOREHOLE No 1
RECORD OF BOREHOLE No 2
RECORD OF BOREHOLE No 3
B.P. Walker Associates Ltd.
5cm ASPHALT
46cm SAND & GRAVEL
FILL
CLAYEY SILT TILL
SILTY SAND
ROUGE RIVER
SAND & GRAVEL
CLAYEY SILT
SILTY SAND
5cm TOPSOIL
ELEVATION (m)
NOTES
1 Existing DS Bailey Bridge and Ramp to be replaced with Ministry supplied TS Bailey Bridge and Ramp
2. Location of new structure shall be the same as old structure
3 Steel decking shall be sand blasted and galvanised in manageable sections
4 Guardrail and Traffic signs shall be removed and reinstalled in locations as found
5 Footings excavation shall be checked by B P Walker prior to pouring concrete
6 Class of concrete shall be 30 MPa at 28 days
7 All Steelwork shall be Galvanised including nuts bolts and washers
8 Reinforcing Steel shall be grade 400 unless otherwise specified in accordance with CSA G 30 12.
9 All welding shall be in accordance with W59
10 All field welds to be coated with zinc rich primer
11 The contractor shall finish the bearing seat dead level to the specified elevation to a tolerance of ± 3 mm
12 Take all precautions necessary to protect surrounding trees
13 Contractor shall submit his de launching and launching procedures and confirm approach road elevations
JUN 2 7 1988
5013-S-1
JUNE 1988
B1
SCALE AS SHOWN
S.J.J. ELLIS
SANDWELL SWAN WOOSTER
FINCH AVE BAILEY BRIDGE REPLACEMENT
CITY OF SCARBOROUGH
DWG 26200-T1
REV

1902 E

1905 E

Appendix B

Site Photographs

Southbound Approach to Traffic Signals

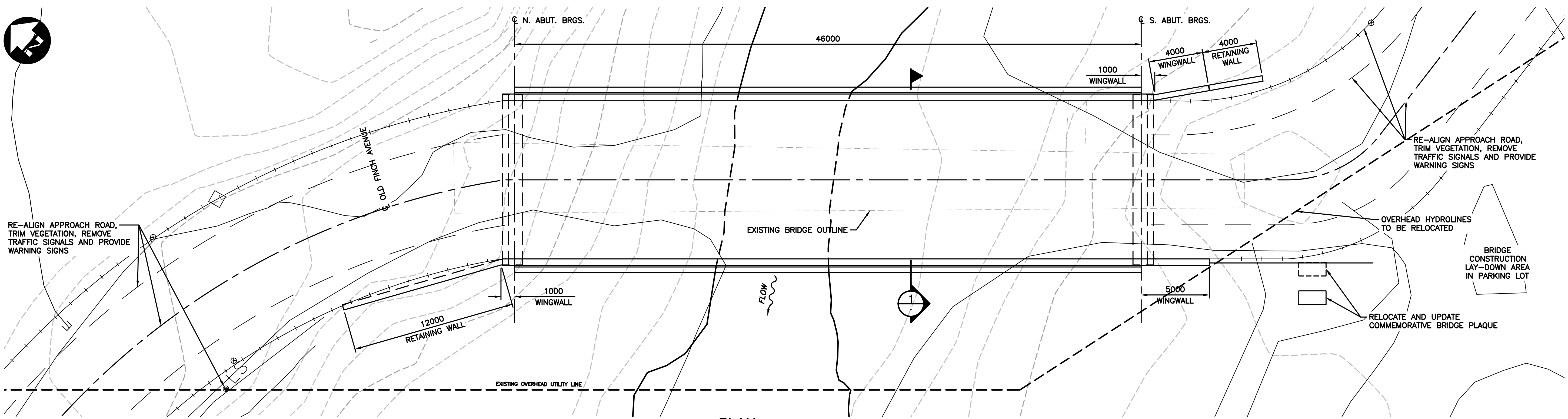
View Looking South (Note Plate Repairs to Deck)

West Side of Bridge

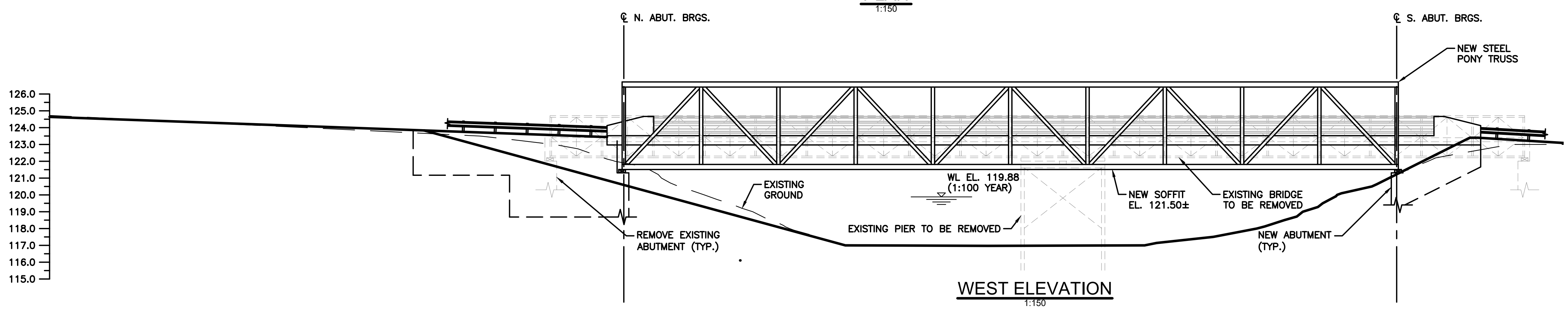
Monument Recognizing 1954 Bridge

Appendix C

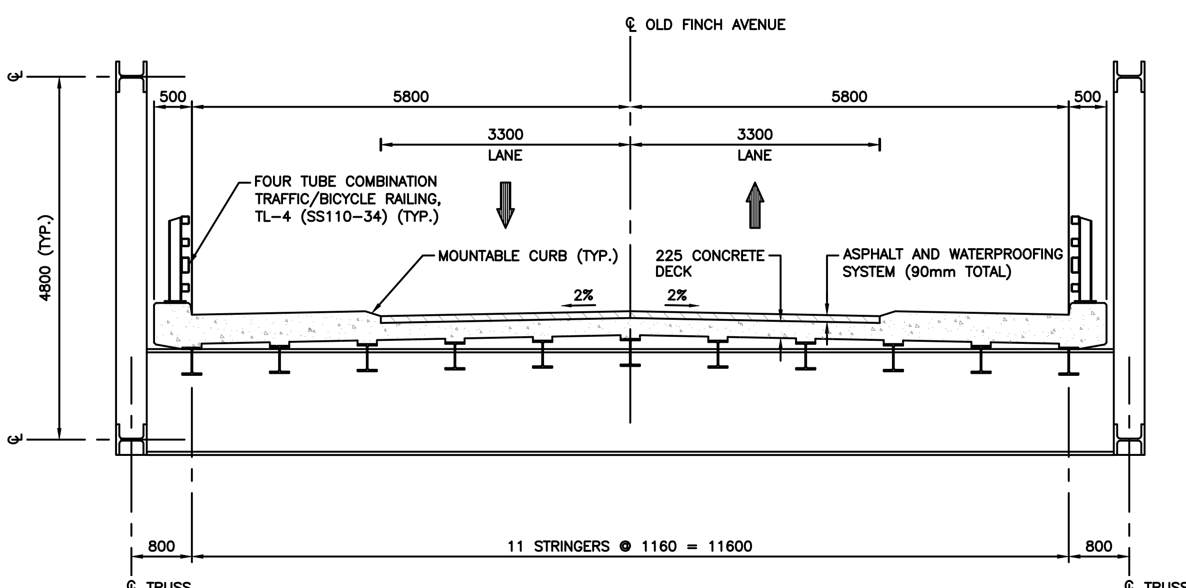
General Arrangement Drawing for the Recommended Alternative



PLAN
1:150



WEST ELEVATION
1:150



1 SECTION
1:50

PRELIMINARY

No.	DATE	REVISIONS	INITIAL	SIGNED

DILLON CONSULTING

235 Yorkland Blvd., Suite 800, Toronto, ON M2J 4Y8
Phone: (416) 229-4646 Fax (416) 229-4692

APPROVED

SIGNATURE

NAME (PRINT)

DATE

ROUGE PARK BRIDGES TRANSPORATION MASTER PLAN

MILNE BRIDGE (No. 813) ON OLD FINCH AVENUE OVER ROUGE RIVER

DESIGN	---	DRAWN	SJM	CHECKED	---	JOB No. 19-1924
SCALE:	AS NOTED				DWG:	
DATE:	DECEMBER 2023				SHEET	OF

Appendix D

Cost Estimate

Rouge Park Bridges Transportation Master Plan Milne Bridge (Site ID 813) Recommended Alternative (Replace Bridge)					
No.	Item Description	Unit	Quantity	Unit Price	Total
1	Removal of existing span (disassemble, catalog, deliver)	lump sum	1	$ 200,000	$ 200,000
2	Removal of existing aburments and pier	lump sum	3	$ 25,000	$ 75,000
3	Abutments (incl. joints & approach slabs)	lump sum	2	$ 250,000	$ 500,000
4	Steel pony truss (fabrication, coating, delivery, erection)	m2	580	$ 8,500	$ 4,930,000
5	Concrete deck and curbs (incl. reinforcing)	m3	195	$ 2,000	$ 390,000
6	Asphalt and waterproofing	m2	390	$ 150	$ 60,000
7	Traffic railing (bicycle height)	m	120	$ 1,000	$ 120,000
8	Approach road improvements (grade raise, paving, railings)	lump sum	1	$ 300,000	$ 300,000
9	Retaining walls	lump sum	1	$ 70,000	$ 70,000
10	Bank stabilization at abutments (riprap, topsoil, sod, etc.)	lump sum	1	$ 150,000	$ 150,000
11	Commemorative monument	lump sum	1	$ 15,000	$ 15,000
12	Contingency allowance (25%)				$ 1,700,000
				Construction:	$ 8,510,000
				Environmental & Preliminary Design (5%):	$ 430,000
				Detailed Design (10%):	$ 850,000
				Contract Administration (10%):	$ 850,000
				TOTAL:	$ 10,640,000

Notes:

1. Costs in 2023 dollars. Taxes and permits additional.