Innovative Methods to Improve Traffic Flow

Hale Street / Trafalgar Street & CN Rail Crossing City of London

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1.0 ABSTRACT

The level railway crossing at the intersection of Trafalgar Street and Hale Street has been a longstanding bottleneck in the City of London's Arterial Road Network. This unique location features an arterial road, a collector road and three CN rail lines intersecting to form a single, level crossing in an area where land is a mix of residential, commercial and industrial uses. The crossing serves local and city-wide vehicular traffic, transit, cyclists and pedestrians as well as freight and high speed passenger trains.

Improvements to the crossing were required to:

- Address delays and safety concerns for the 15,000 vehicles using the crossing on a daily basis;
- Provide improved safety for cyclists and pedestrians;
- Reduce traffic infiltration through adjacent local neighbourhoods; and
- Enable the railway to improve efficiency for their shunting operations and for 47 daily freight and passenger trains.

Based on an initial evaluation and a review of public comments, provision of a grade separation clearly was the preferred planning solution. A grade separation at this location would benefit:

- **The Railway,** since they would obtain 3.9 km of track to assemble trains that is unencumbered by level crossings;
- **The Federal Government,** since improved rail efficiency would also support their objectives to reduce greenhouse gas emissions;
- **The Provincial Government,** since improved rail efficiency could also relieve some of the pressures commercial traffic places upon local roadways and freeways; and
- **The City of London,** by addressing neighbourhood traffic and safety concerns for a number of modes, and by reducing delays at five other crossings.

The recommended design alternative produced by the Environmental Assessment process consisted of a raised, signalized intersection perched over the rail line on a concrete rigid frame structure. A subsequent Value Engineering review concluded that implementing a roundabout rather than a signalized intersection would provide additional benefits as follows:

- Reduce the length of the bridge from 115m to 86m resulting in savings of $2M;
- Eliminate the need for traffic signals and their associated maintenance costs;
- Eliminate the need for left turn lanes;
- Reduce the number of potential traffic conflict points from 56 at a signalized intersection to 16, resulting in improved safety;
- Reduce the forecasted number and severity of collisions;
- Reduce unnecessary idling, air emissions and fuel consumption resulting in improved air quality; and
- Provide a focal point for community landscaping.

This project included funding from the Infrastructure Stimulus Program and was completed through a partnership between the Canadian Federal and Ontario Provincial Governments, the City of London, and the Canadian National Railway.

Property acquisition and utility relocations were finalized in late 2009 and construction of the grade separation commenced in February 2010. The intersection was opened to traffic in December 2010 with completion of landscaping scheduled for spring of 2011. This intersection is the first major roundabout in London, and it has been well received by the public. To date it is operating successfully and providing the intended improvements for the intersection and rail line.

2.0 INTRODUCTION

Delcan Corporation was retained by the City of London to provide environmental assessment, detailed design and construction administration services for improvements to the level railway crossing at the intersection of Trafalgar Street and Hale Street **(Exhibit I – Study Location Map)**. The crossing is located on the busiest rail line in London handling, VIA Rail passenger and Canadian National railway (CN) freight services. The crossing is also a strategic location for CN as this level crossing separates two existing railway yards.

This railway crossing has been a longstanding bottleneck in London's Arterial Road Network. As motorists attempt to avoid delays with through trains and shunting trains, the diversion of arterial traffic to other local routes has continued to increase. Brydges Street is one adjacent route that has for many years been forced to accommodate traffic demands that far exceed the normal capacity of a collector road. Increased traffic delays and driver frustration at the rail crossing have prompted individuals to take greater risks by disregarding the warning devices. Several tragic accidents have claimed the lives of members of the community in the past 10 years.

Improvements to the existing crossing have been proposed to:

- Address traffic delays and safety concerns at the rail crossing;
- Reduce traffic infiltration (short-cutting) through the adjacent local neighbourhoods;
- Enable the railway to improve the efficiency of their operations;
- Support future industrial growth within the London area.

The existing railway crossing at Hale and Trafalgar Streets is strategically located and a grade separation would provide the railway with 3.9 km of track to assemble trains that is unencumbered by level crossings. Shifting the shunting operations to this area would also reduce the traffic delays at five other railway crossings in downtown London west of the crossing.

CN employ 170 employees in London but more significantly provides transportation for over 37 industries in the London area. CN has identified that a grade separation at Hale Street would allow them to improve the efficiency of their operations while maintaining these jobs in London. Improving the efficiency of railway operations represents a strategic advantage for London to help attract and maintain industrial development.

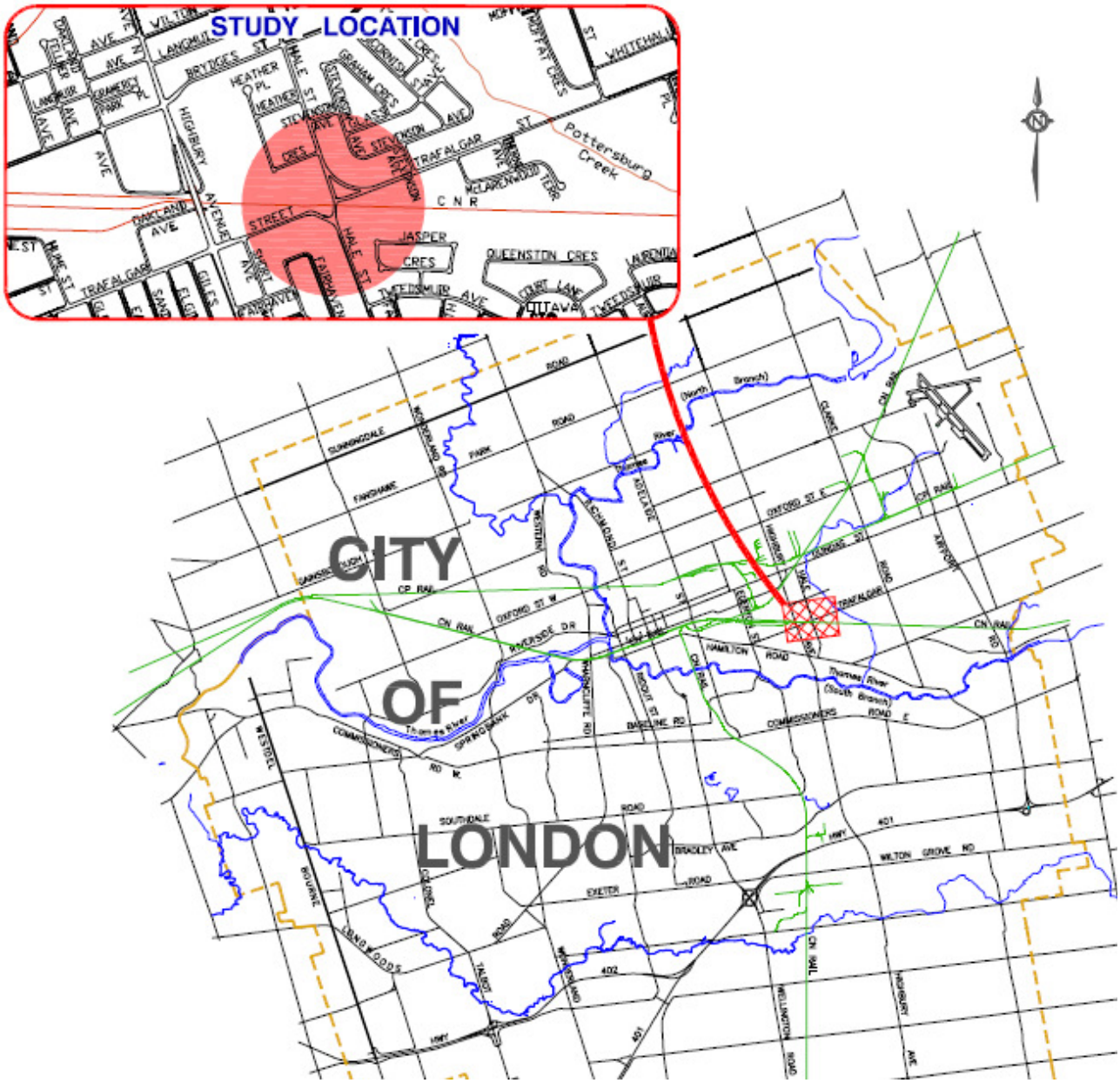
Improvements to the existing crossing and the provision of more efficient railway operations would benefit:

- **The Railway** since improved efficiency would enable them to compete for additional commercial freight, while maintaining jobs in London;
- **The Federal Government,** since improved rail efficiency would also support their objectives to reduce greenhouse gas emissions;

- **The Provincial Government,** since improved rail efficiency could also potentially reduce commercial traffic utilizing freeways such as Highways 401 and 402;
- **The City of London,** by supporting economic development and addressing neighbourhood traffic and safety concerns.

This paper outlines the planning and decision-making process that was followed during the study to examine the rail crossing and the options that could be available as well as the subsequent value engineering review and detailed design challenges that resulted in an innovative solution to a complex problem.

Exhibit I – Study Location Map



3.0 EXISTING CONDITIONS

Hale Street is classified as a collector road and carries 10,000 vehicles per day in a north-south direction across the three CN rail lines. Trafalgar Street is an east-west arterial carrying 13,000 vehicles per day. The west leg of Trafalgar connects to the south leg of Hale, crosses the tracks along Hale, and then continues east on the north side of the rail line. Approximately 15,000 vehicles per day cross the CN line and are frequently delayed by the 47 freight and high speed passenger trains. **(Exhibit II – Existing Travel Demands)**

The east leg of Trafalgar diverges into a northbound, single lane ramp onto Hale which experiences higher speed traffic and a second leg which forms a T-intersection with Hale for southbound and eastbound traffic.

The resulting traffic and safety concerns extend far beyond the immediate area of the rail crossing. To avoid the traffic delays along Trafalgar Street, motorists divert to other routes. This diversion of traffic has forced Brydges Street to accept increasing volumes of traffic and now operates beyond its capacity as a primary collector. Similarly, traffic delays along Highbury Avenue during peak periods have prompted increasing volumes of traffic to use Hale Street as an alternative route. Motorists have become willing to risk being caught in the periodic delays along Hale Street due to the rail crossing to avoid the almost certain delay along Highbury Avenue.

Crossings with multiple tracks such as this represent greater safety concerns. Individuals too frequently, after watching one train clear the crossing, do not expect a second train in the opposing direction. CN uses this area to assemble trains which leads to additional delays. They have indicated that the ability to assemble and operate longer trains leads to greater efficiency and better service however this often leads to the crossing being blocked for up to 10 minutes or more at a time.

These delays frustrate drivers and pedestrians who often resort to short cutting along local residential streets or traversing between active railway safety gates. Emergency service providers and local transit also experience delays at the crossing and on adjacent, congested streets. With residential and industrial growth expanding in the City's east end, the situation at the crossing is only expected to worsen.

The warrants for railway grade separations are defined on the basis of an "Exposure Index or "Cross Product". In a review of all the level railway crossings within the City, without accounting for shunting operations (using only scheduled trains), the City's Transportation Division identified the exposure index at Hale and Trafalgar to be over 3.5 times greater than the warrant for a grade separation. This makes the intersection the second highest priority in the City among 13 level crossings.

The London Urban Transportation Study (LUTS I) was completed in 1973 but many of its recommendations still remain relevant. The study emphasized increased transit ridership, especially in the core. Also among the recommendations put forward 30 years ago by LUTS I was the construction of a Railway Grade Separation at Hale and Trafalgar.

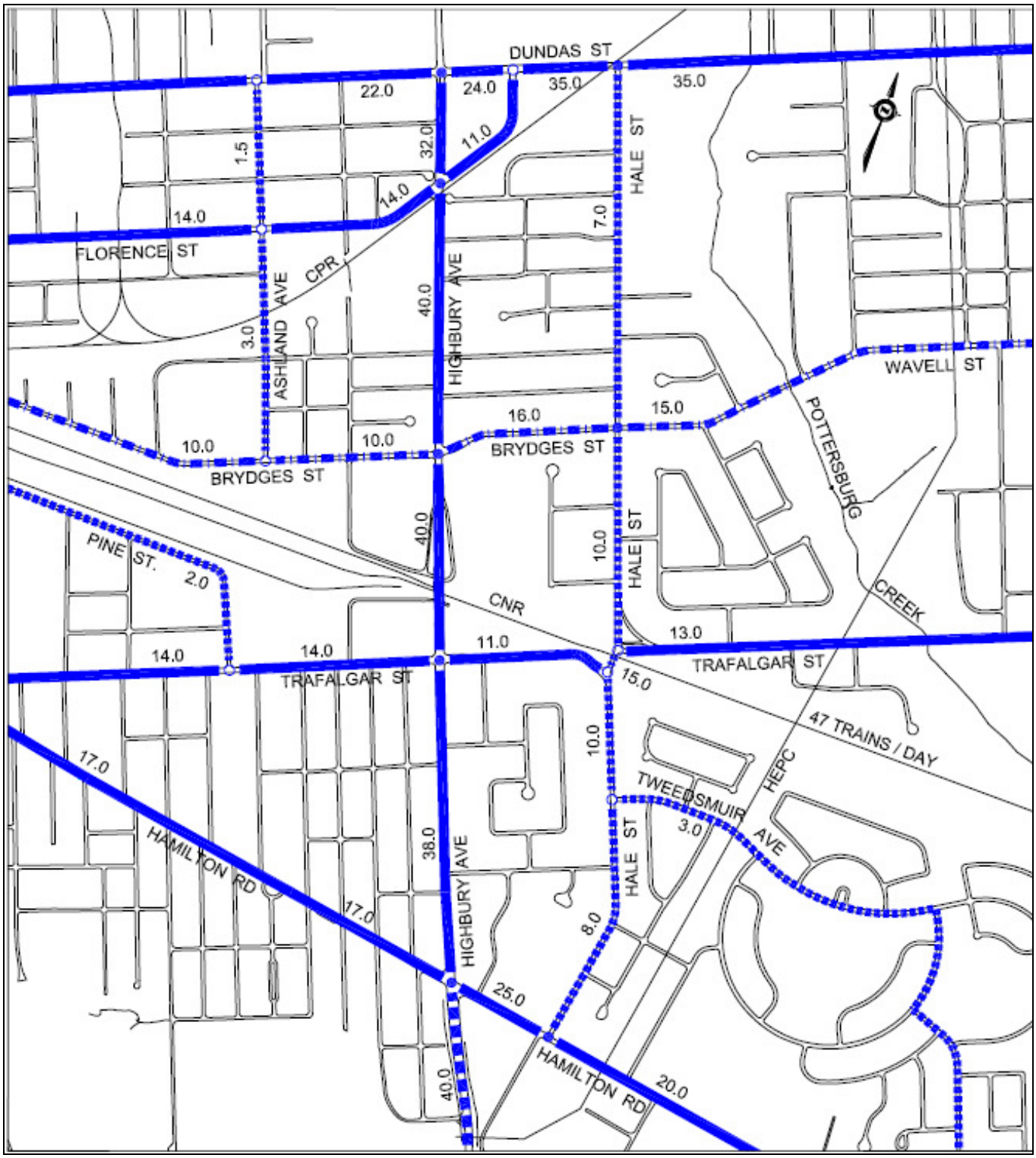


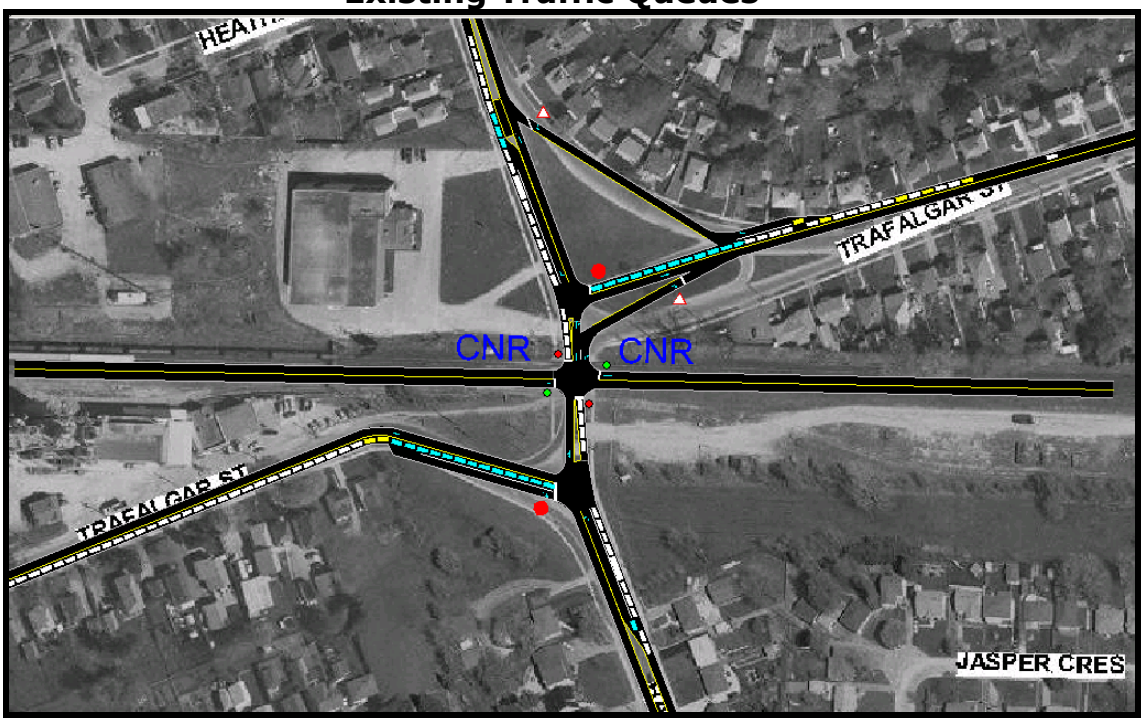
Exhibit II - Existing Travel Demands

ROAD LINK
SIGNALIZED INTERSECTION
0.0 2000 AVERAGE DAILY TRAFFIC (x 1000)

ARTERIAL
PRIMARY COLLECTOR
SECONDARY COLLECTOR
EXPRESSWAY

Trafalgar Street at Hale frequently operates at level of service F during peak periods. The traffic volumes at both existing intersections of Trafalgar and Hale Streets exceed the warrants for traffic signals. The close proximity of the two intersections however, makes it impractical to install traffic signals at both locations since it would result in virtual gridlock. Queuing motorists throughout the peak periods frequently block existing driveways near the intersections. Synchro/Simtraffic, a traffic analysis package, was used as a tool to examine both existing and projected traffic operations in the vicinity of the crossing and to present this in a format that is easily understood by the public. A micro-simulation of the traffic conditions clearly identified problems related to traffic queuing at the intersection. The delays and traffic queues along Trafalgar Street are lengthy throughout the peak periods. The resulting traffic queues depicted in **Exhibit III** are typical whenever a train is at the railway crossing.

Exhibit III
Existing Traffic Queues



4.0 PLANNING SOLUTIONS, ALTERNATIVES AND RECOMMENDED DESIGN

The Environmental Assessment Study (EA) examined four (4) potential Planning Solutions for consideration as follows:

- Do Nothing,
- At Grade Improvements,
- Closure of Hale and Trafalgar Streets, and
- Provision of a Grade Separation.

Of these potential Planning Solutions, only the closure of Hale and Trafalgar Streets would create new problems or make the existing situation worse. Adjacent streets such as Brydges Street, Hamilton Road and Highbury Avenue are overloaded today and would be unable to accommodate the diversion of any additional traffic.

Based on the initial evaluation and comments from the public, the provision of a Grade Separation was clearly the preferred Planning Solution. The public in large agreed that ignoring the existing problems by doing nothing is truly not a "solution". It was also noted that At Grade improvements could only be expected to offer very limited benefits.

Respecting the Environmental Assessment process, and to ensure that a potentially viable alternative is not screened out too early in the process, all of the planning solutions, with the exception of closing Hale and Trafalgar Streets, were carried forward for a more detailed evaluation as Design Alternatives.

Design Alternatives

A total of nine (9) Design Alternatives were developed and a detailed evaluation was completed for each of these which included:

- "Do Nothing"
- 2 options for At Grade Improvements, and
- 6 potential configurations for a Railway Grade Separation

In developing the various design alternatives the study identified that any changes to the elevation of the railway would influence such a large area it would be cost prohibitive. The study also identified that for the options of a grade separation, given the existing topography, the potential impact upon existing utilities, and drainage considerations, to raise the roadway over the tracks would be more cost effective than constructing a "subway" under the railway.

The following exhibits are graphical representations of the various grade separation alternatives that were developed.

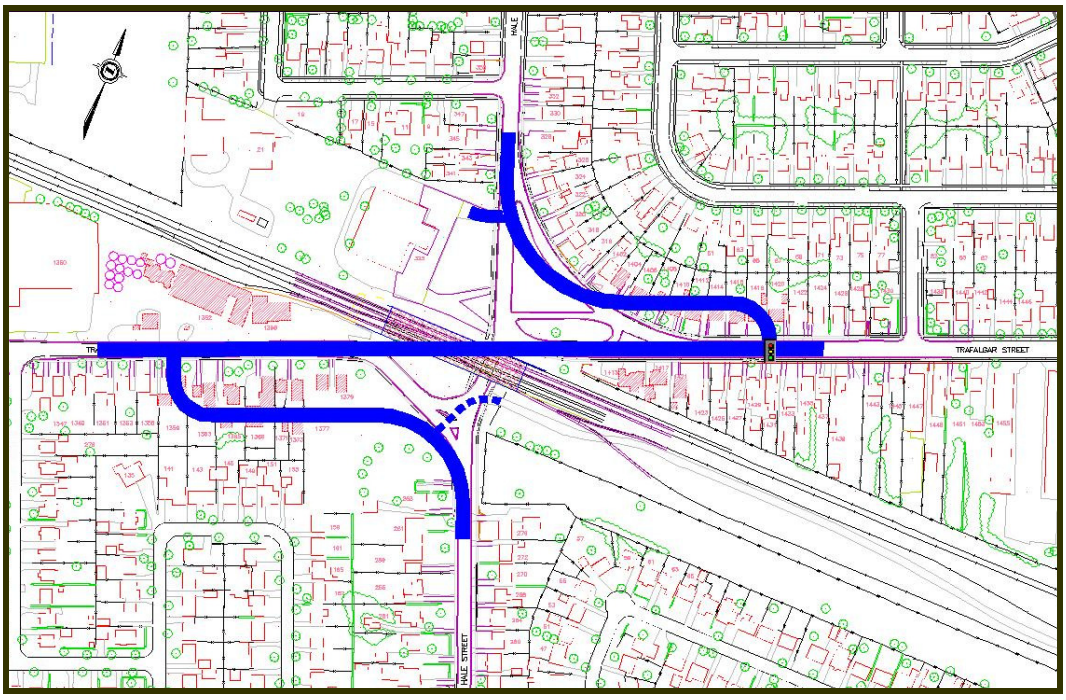


Exhibit IV - Grade separate Trafalgar Street as a continuous route along its existing alignment. (EA Option 3A)

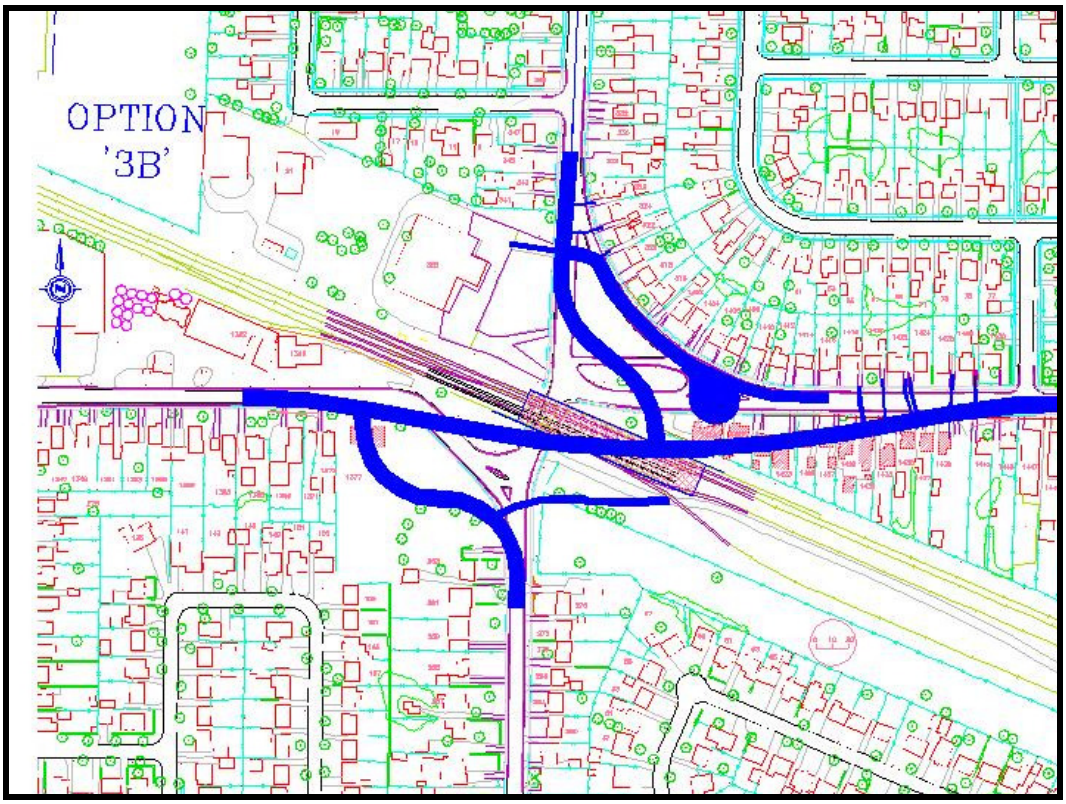


Exhibit V - Grade separate Trafalgar Street along a curvilinear alignment, effectively shifting the required structure to the east and helping to minimize the property requirements (EA Option 3B)

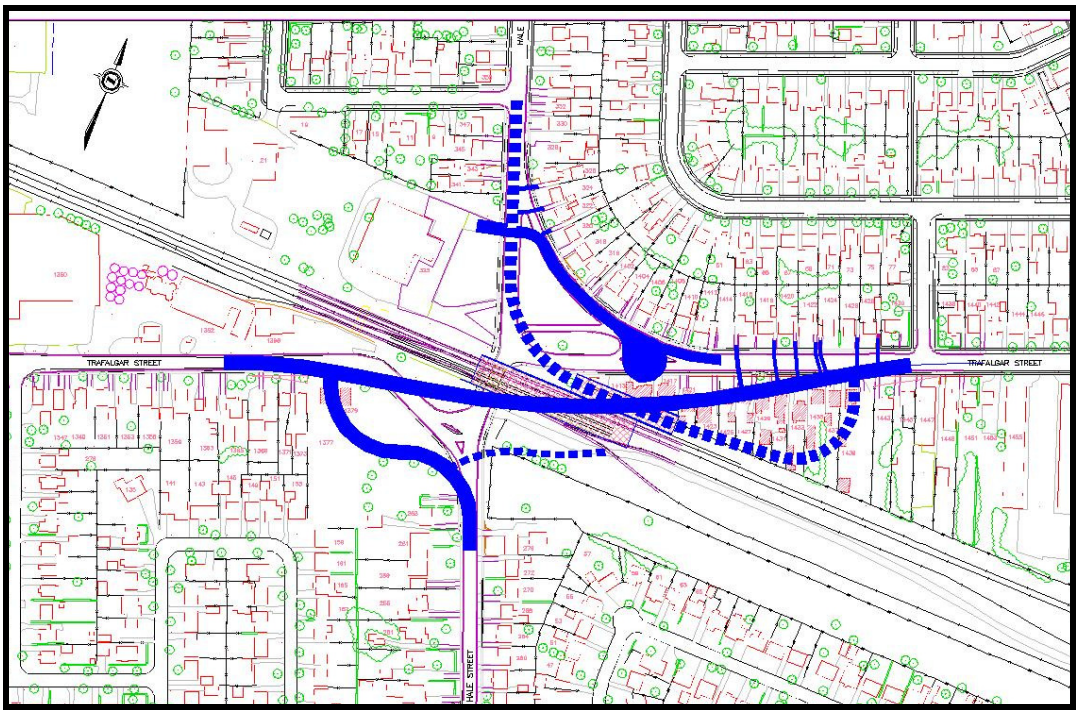


Exhibit VI - Grade separate Trafalgar Street along a curvilinear alignment. The north leg of Hale Street would pass under Trafalgar Street. (EA Option 3C)

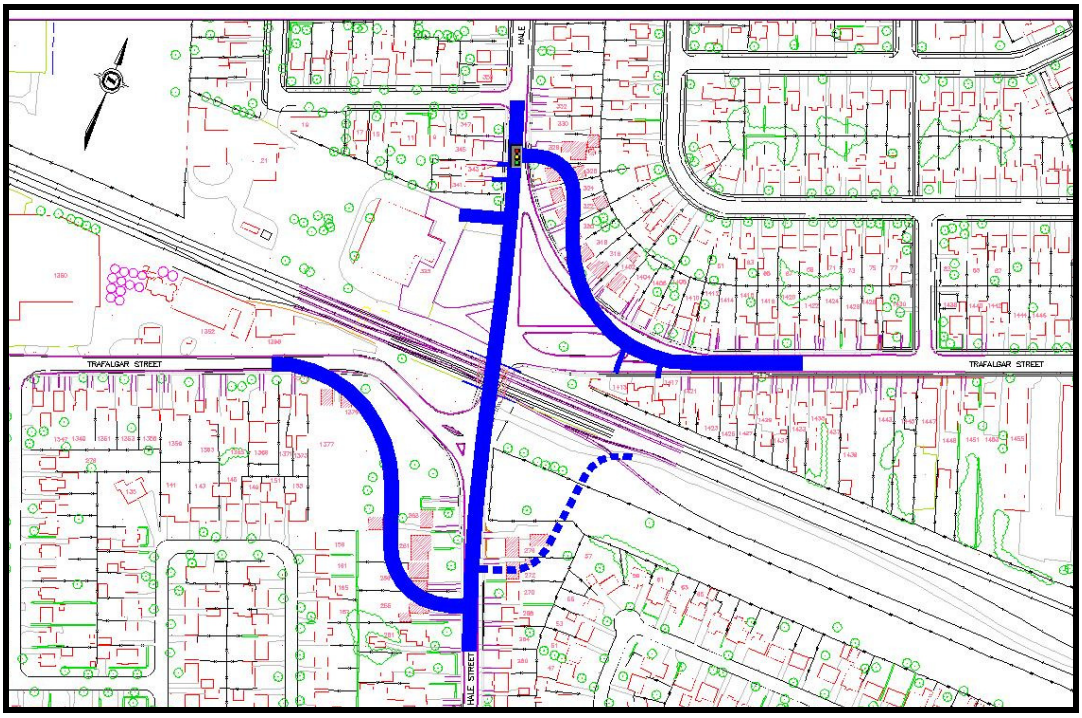


Exhibit VII - Grade separate Hale Street while increasing the discontinuity that already exists in Trafalgar Street (EA Option 4)

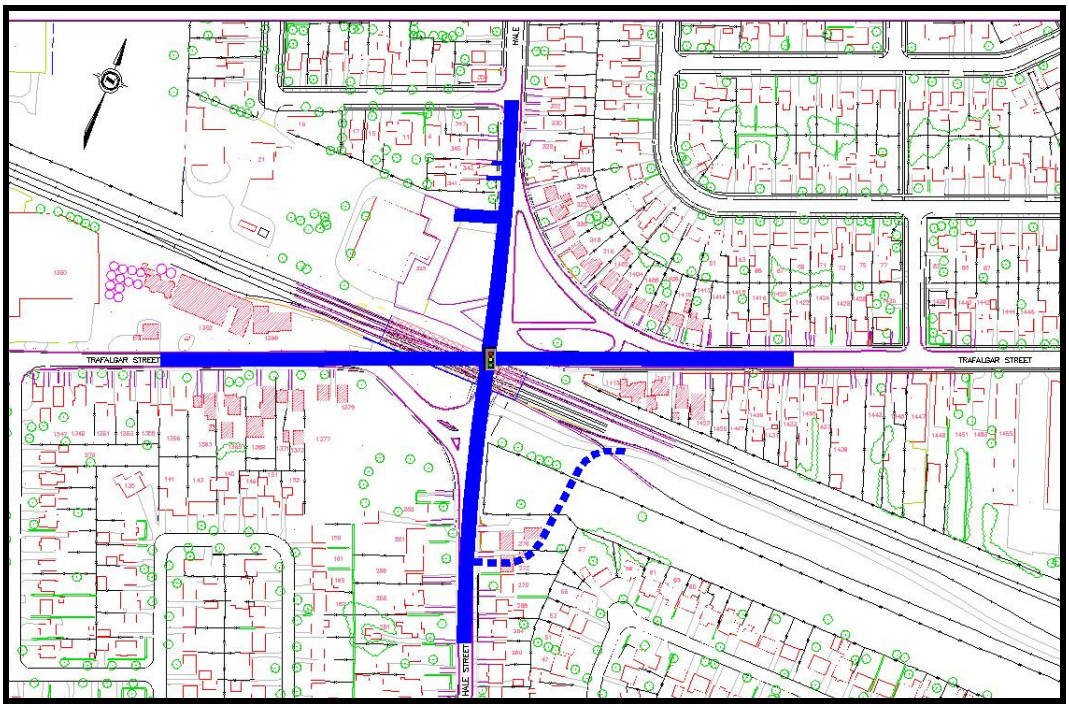


Exhibit VIII - Extend Trafalgar St and Hale St, both along their current alignments, grade separating them with a signalized intersection over the railway. (EA Option 5A)

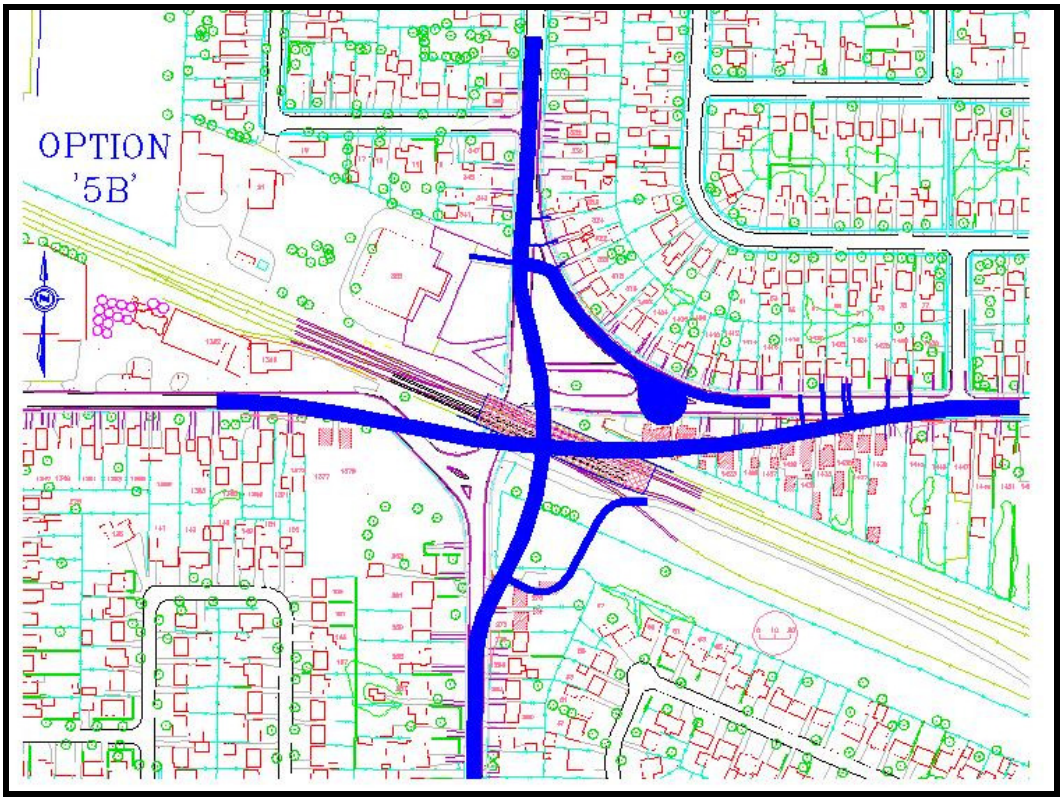


Exhibit IX - Grade separate both Trafalgar Street and Hale Street along new curvilinear alignments with a signalized intersection over the existing railway. This was the recommended alternative. (EA Option 5B)

Recommended Alternative

A computer visualization of the recommended design is presented in **Exhibit X**. The provision of a grade separation, raising Trafalgar and Hale Streets over the railway, was selected based upon a detailed technical evaluation and public response that overwhelmingly supported the recommended alternative. The evaluation had identified "Option 5B" as the preferred design alternative creating one signalized intersection grade separated over the rail line.

The provision of a single signalized intersection greatly simplifies the traffic operations and virtually eliminates the excessive backups that were observed along Trafalgar Street. With increased traffic along Trafalgar Street, the intersection should operate at Level of Service C rather than at Level F.

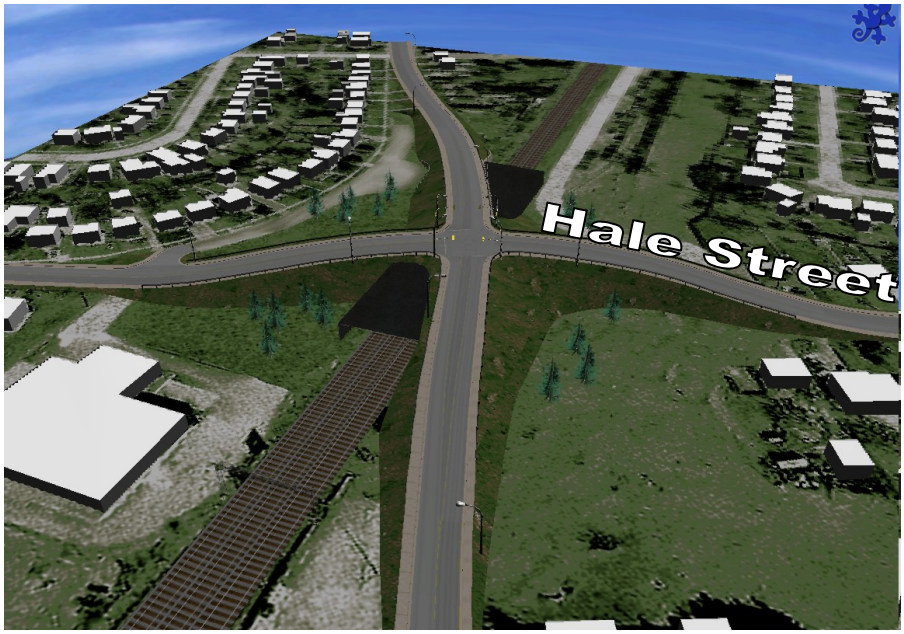
The provision of a Grade Separation along Trafalgar Street will attract additional traffic to Trafalgar Street relieving the traffic congestion that exists today along adjacent east-west collectors such as Brydges and Wavell Streets. As an arterial road, it is more appropriate for this traffic to use Trafalgar Street and to allow Brydges and Wavell to function as collector roads as they were designed.

The configuration of the new intersection also allows the high speed east to north Trafalgar Street ramp to be converted into a low speed, quiet cul-de-sac with the roadway embankments mitigating railway noise effects. The properties required to construct the crossing are those located closest to the rail line.

Consistent with current City policy to promote cycling, commuter cyclists will be accommodated with the provision of wider curb lanes along Trafalgar Street. Area recreational cyclists will be accommodated by the City Parks and Recreation Department's plans to extend the multi-use pathway in Kiwanis Park to the south. Ultimately this new pathway will connect to the Thames Valley Parkway network.

The structure would be constructed using an orthogonal layout, as a rigid frame to reduce the required deck thickness along with the height of the required fill slopes and the resulting property requirements. A fundamental condition to not impact the 47 scheduled trains and shunting operations was imposed by CN. During construction, the use of temporary falsework would reduce the vertical clearance that is available for the railway.

Exhibit X
Computer Visualization of the Proposed Improvements



View looking east along Trafalgar Street

5.0 VALUE ENGINEERING REVIEW AND RECOMMENDATION

Prior to proceeding with the detailed design, Delcan undertook a Value Engineering review of the project in order to identify opportunities for functional improvements and cost savings.

In examining alternative design concepts, the review team took the position that any new alternatives must fit within the property limits defined by the Environmental Assessment (EA) to avoid the need to acquire new properties. To acquire additional property would introduce added costs and force the EA to be reopened with an addendum to be completed and filed.

Value Engineering Design considerations were evaluated based upon alternative:

- Roadway Designs;
- Bridge Designs;
- Geotechnical Designs;

Changes to the road design geometry that would shorten the structure were viewed as having the greatest potential in reducing cost while maintaining or improving functionality.

A signalized intersection with reduced skew and tighter radii was examined. In exploring this option, it became apparent that to gain any significant change, it would require less than desirable horizontal radii on the approach legs.

Selection of a lower design speed for the design of smaller radii would be incompatible with expected operating speeds, especially for through traffic movements on a green signal phase.

A number of alternative roundabout configurations were examined as roadway approach geometry can be specifically designed to reduce speeds by introducing tighter curves. Roundabouts force traffic to slow down and deflect around a central island and the potential for higher speed through movements is eliminated. The configuration that provided the greatest reduction in the length of required structure within the available property was a single lane roundabout.

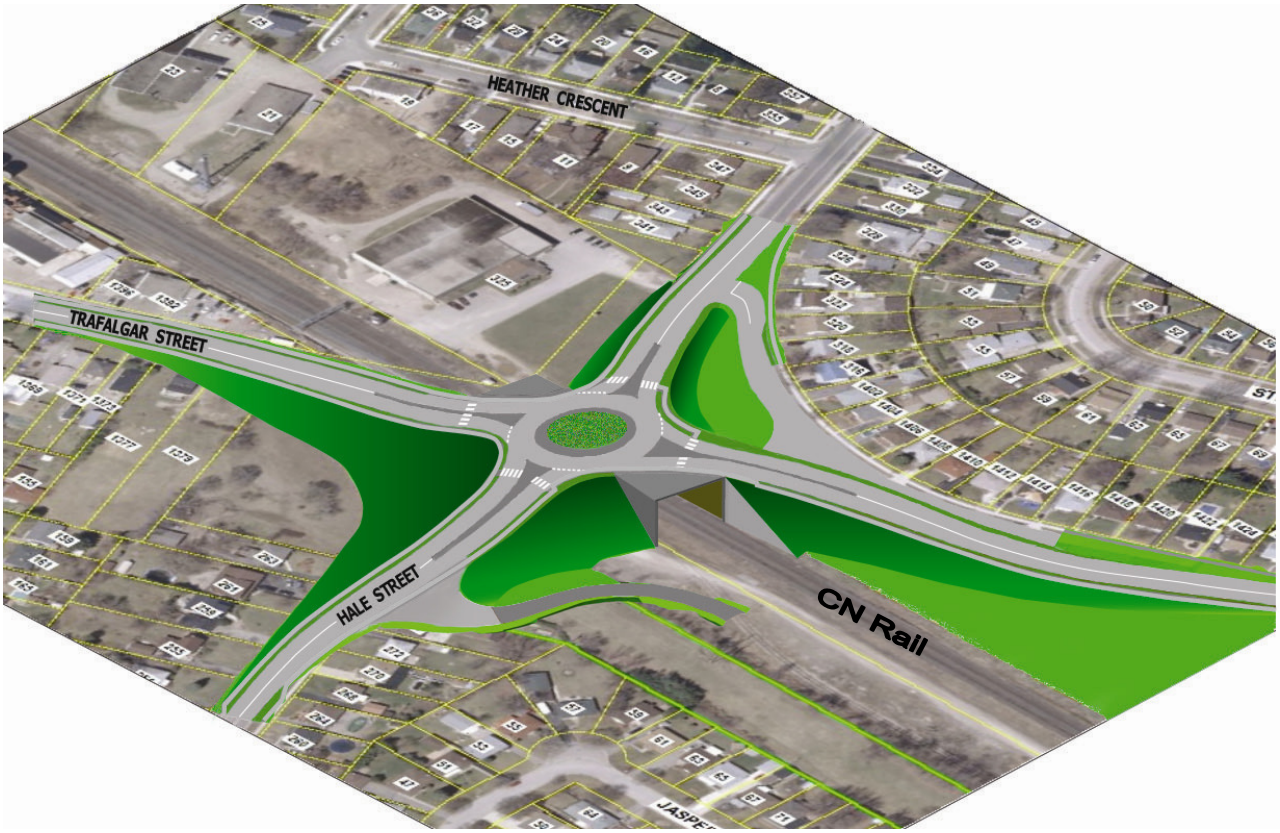
The traffic operations and safety advantages of roundabouts versus signalized intersections are well documented. Roundabouts generally provide a reduction in potential conflict points, a reduction in collision potential and improved operations by reducing queues and delays. At this particular location, the added benefits of cost savings from a reduction in the structure length made this alternative very attractive.

Roundabout Design Guidelines generally suggest that it is not desirable to locate roundabouts in locations where grades are greater than four percent. However, the grades for the raised signalized intersection option would be greater than four percent as well so a roundabout was maintained as a potential solution.

Ourston Roundabouts Canada assisted Delcan by confirming that the forecasted traffic volumes can be accommodated and that there is residual capacity for an approximate 10 percent overall increase in traffic. The analysis was completed using RODEL computer software. An increase in traffic is anticipated since the elimination of delays will attract additional traffic. It is expected that Trafalgar will better serve its function as an arterial road and adjacent collectors such as Brydges will revert to functioning as collectors.

A computer rendering the roundabout alternative is depicted in **Exhibit XI** and a design plan is included as **Exhibit XIII**.

Exhibit XI - Value Engineering Recommended Alternative



6.0 DESIGN FEATURES

The Trafalgar St. / Hale St. & CN Rail grade separation supporting an elevated roundabout on top of a busy rail line is a unique solution and the first such installation in North America. It resulted in the resolution of a number of issues for a variety of stakeholders as well as significant cost savings over the original solution with minimal impact to adjacent lands. The solution is consistent with the original EA recommendations for a raised intersection but with a different form of control.

Development of the engineering plans for the elevated crossing required design of roadway and structural elements from basic first principles as common design guidelines and standards could not directly be applied to this situation.

The placement of an intersection on an upgrade needs to be done with careful consideration in order that adequate sight lines and stopping distances are provided to pedestrian crossings, the roundabout yield line and to the circulatory road. The vertical grades, roadway and bridge geometry were carefully designed to facilitate these needs.

The vertical grades on the circulatory portion of the roundabout were designed with a 2% crossfall to the outside to facilitate drainage. To avoid the need to place fill on the structure to achieve this, the crossfall was built into the top deck of the structure.

A breakpoint with a 3% downgrade was introduced at the yield line and extended beyond the crosswalk providing a platform for vehicles waiting for a gap in traffic. A conventional crest vertical curve was then introduced along the downgrade followed directly by a sag curve which transitioned the approach to the existing roadway. This method maximized the sight distance to the yield line at the roundabout entry as well as on the approaches. Visibility to the crosswalk at the entry point and to vehicles within the circulatory roadway of the roundabout was provided.

Since the rail line is positioned in a natural depression the overall grade raise was minimized. To encourage drivers approaching the intersection to decelerate, the splitter islands were extended down the approaches and superelevation of curves was not applied.

To accommodate local transit, stops were positioned at the bottom of the approach grades rather than adjacent to the roundabout.

Sidewalks were introduced on each leg of the approaches with the exception of the north side of the east leg. In this quadrant of the intersection, the sidewalk from the east to the north followed the old Trafalgar ramp. Curb depressions and openings in the splitter islands were placed to accommodate several physically challenged community members in the area using wheelchairs. In the south east quadrant, the City initiated development of a recreational pathway into a nearby parkland.

The City also undertook a public education campaign consisting of newspaper ads, brochures and internet postings to provide motorists with information on navigating the City's first major roundabout.

Exhibit XII – Environmental Assessment Recommended Plan: Elevated Signalized Intersection

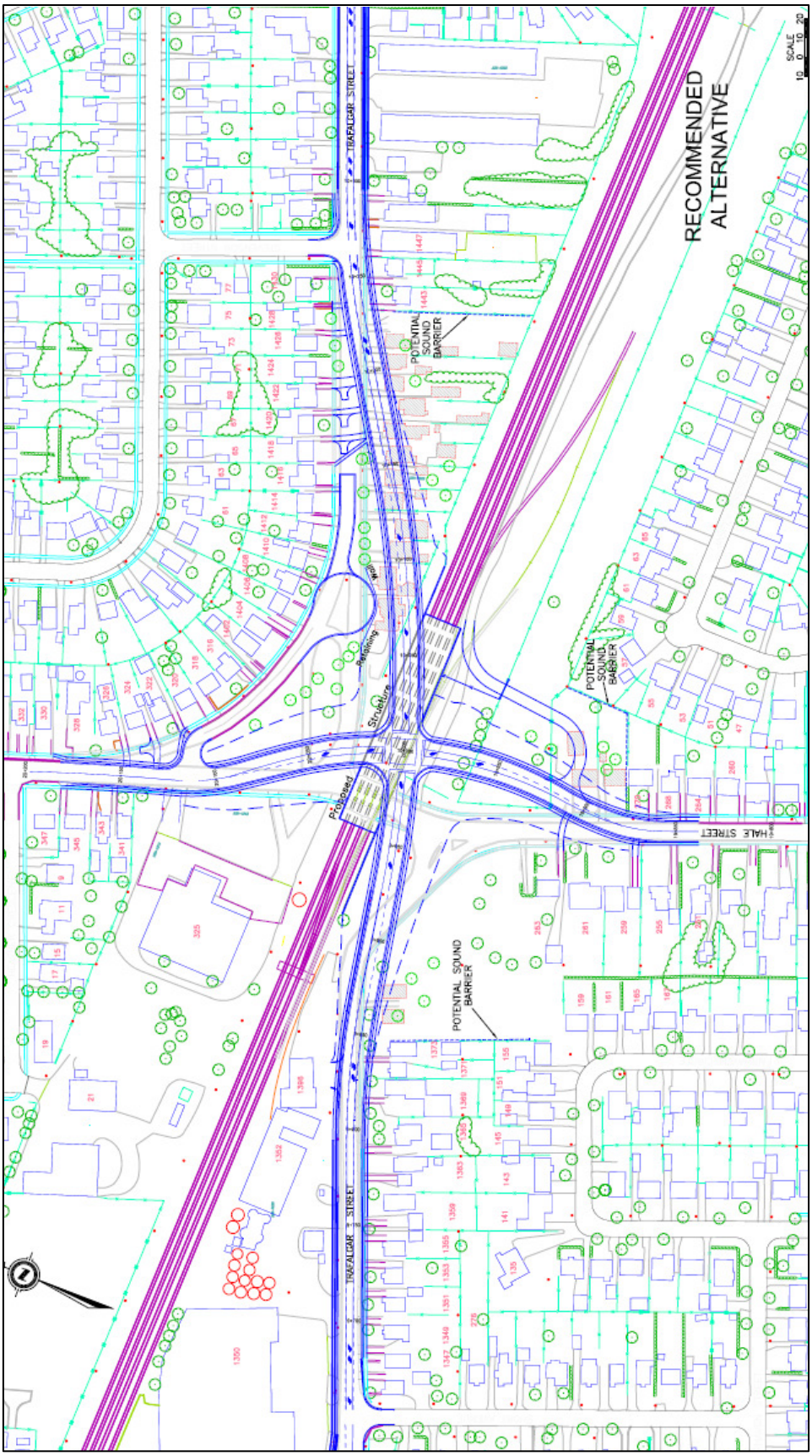
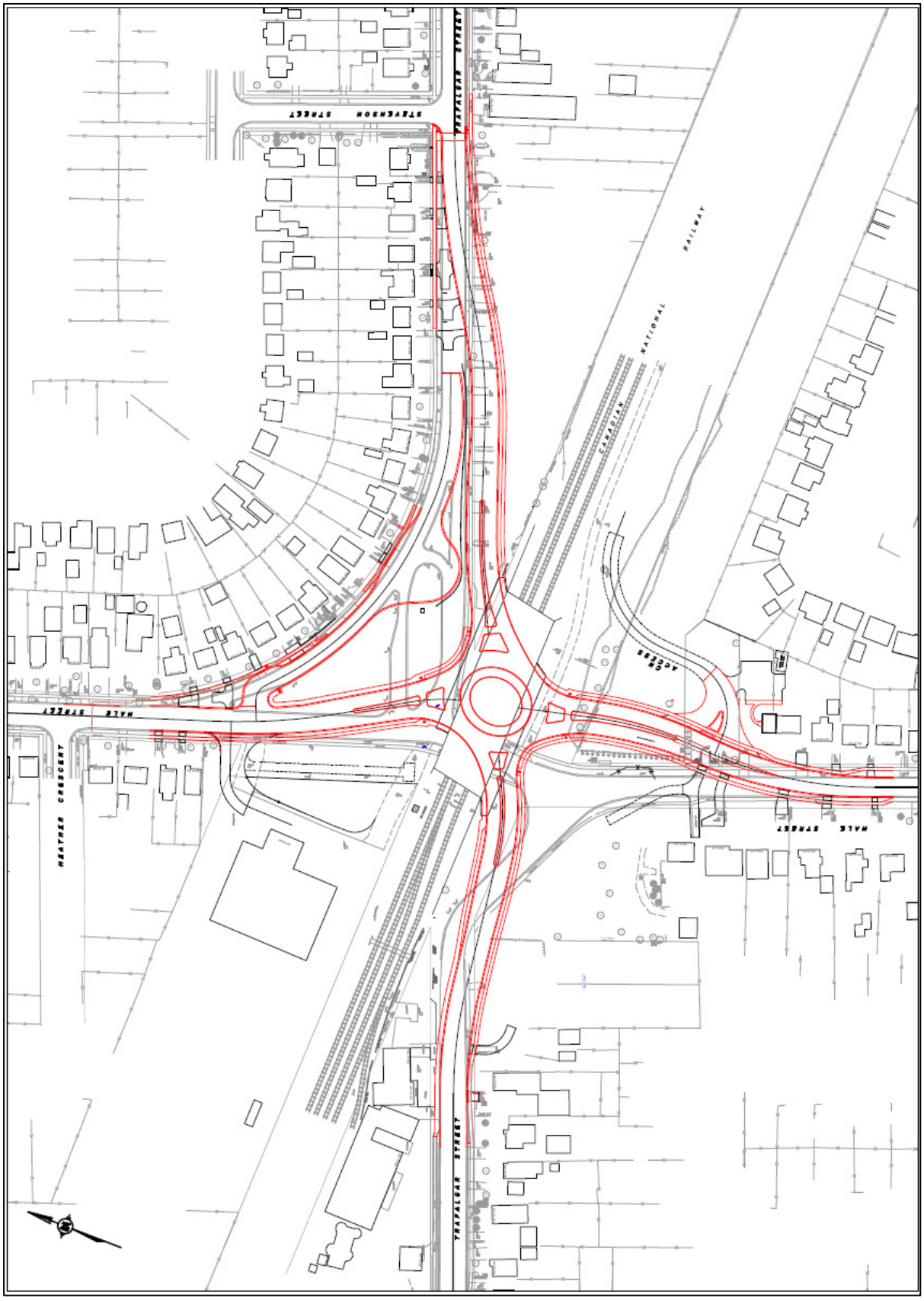


Exhibit XIII – Value Engineering Recommended Plan: Elevated Roundabout



7.0 PROJECT COMPLEXITIES

This multi-year, multi-phase project demonstrates a significant and varied scope of work completed by Delcan. Services involved the complete end to end project life, including environmental impact assessment and approvals, detailed design of all disciplines of physical infrastructure, and construction administration. In addition, Delcan coordinated utility relocations, CN track relocations and facilitated property acquisition by participating in legal hearings and working directly with homeowners. Throughout, Delcan managed a large team of local specialist sub-consultants, and employed key experts for various specified tasks. Coordinated stakeholder engagement and management through the various phases provided for continuity of input for local government interests, the local community, property owners and CN Rail.

Implementation of the project required resolution of a number of challenges.

- The design of the elevated roundabout required careful consideration of sightlines for vehicles approaching the intersection.
- Drainage of the bridge deck, center of the roundabout and landscaping areas on the bridge required measures that were unobtrusive to the users.
- The new roadway embankments approaching the roundabout blocked the natural overland drainage path resulting in the need for placement of oversized stormwater culverts.
- Support of the bridge foundations and lengthy retaining walls on the native silty and sandy soils was accomplished by the installation of 184 steel piles.
- Scheduling of the property acquisitions, utility relocations and construction were influenced by the strict deadlines imposed by the Federal Stimulus funding;
    - The implementation phase began with acquisition and demolition of 18 homes and one home-based business;
    - Following property acquisition, Bell Canada, Rogers Communications, Union Gas, Hydro One and London Hydro utilities were relocated. Relocations were coordinated to avoid having two utilities working in the same area at the same time. Bell fibre relocations were delayed to avoid impacting data communications from the 2010 Winter Olympics in Vancouver;
    - CN Rail relocated buried fibre optic lines, aerial communications lines and a short spur line within their right-of-way.
- Construction of the new overpass commenced in February 2010 with a fundamental condition to not impact the 47 scheduled trains and shunting operations by CN. Access to their adjacent rail yard was also maintained;
- Specialized formwork, temporary supports and construction sequencing was developed by the contractor to erect the steel reinforcing and to place the concrete for the 86m wide structure;

Delcan achieved a successful construction program with careful staging of construction elements, continuous coordination with rail operations, local residents and businesses and allocation of experienced resources for oversight and management.

8.0 PROJECT BENEFITS

Construction of a raised roundabout at the Trafalgar/Hale and CN rail crossing eliminates a bottleneck in the City's arterial network and resulted in a number of benefits to the community's economic, social and environmental quality of life:

- A reduction in delays to traffic and emergency services at the crossing and on adjacent side streets;
- A reduction in air emissions by improved traffic operations;
- A reduction in noise to surrounding homes;
- An improvement in safety for pedestrians and cyclists who often crossed the railway tracks when crossing gates were active;
- Improvement in linkages to nearby community parks, pathways and cycling routes;
- Creation of an area of surplus property available for re-development as parkland or residential/ commercial use;
- Creation of an unencumbered 3.9 km length of railway track allowing CN to assemble longer trains in order to optimize efficiency of operations;
- Conversion of a portion of Trafalgar Street from an arterial road to a quiet cul-de-sac on the north side of the tracks. A public process is currently underway to choose a new street name in honour of a local public servant or veteran;
- Creation of a focal point for landscaping and community art work within the roundabout commemorating the actions of Canadian veterans and WWII fighter pilot Charlie Fox.

RESULTS AND EXPERIENCE SINCE OPENING

Observations of the roundabout operation to date indicate that it is functioning as intended. Queues of up to a dozen vehicles on any given leg quickly clear the intersection and congestion on local collectors is greatly reduced. Feedback from the community noted in local media has been very positive.