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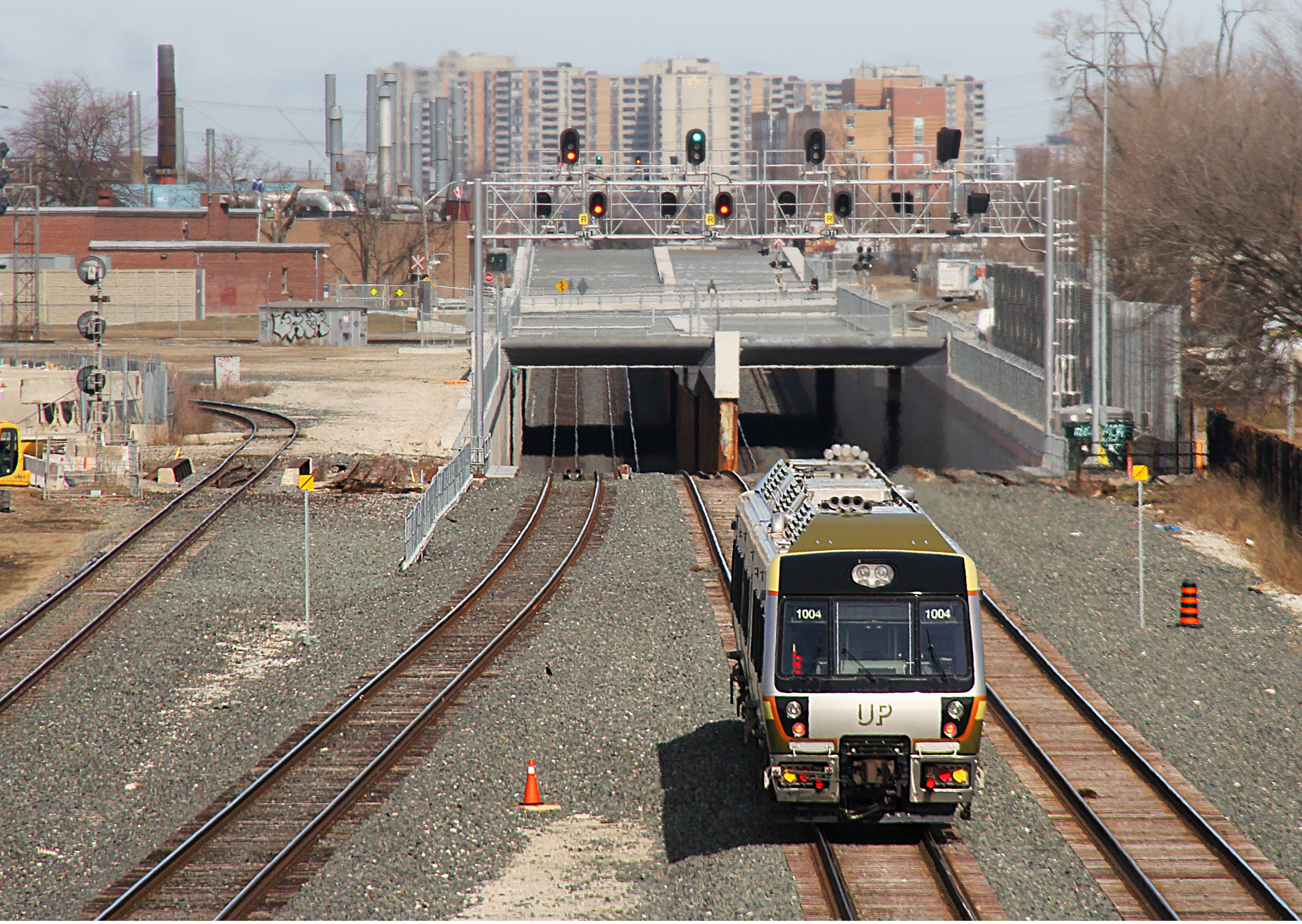
2016 Canadian Consulting Engineering Awards / Category B – Transportation

West Toronto Diamond Rail-Rail Grade Separation



Metrolinx needed to accommodate projected growth, including the new UP Express airport train—just in time for the Toronto 2015 Pan Am Games. Parsons provided detailed design and engineering services during construction for a new kilometer-long rail underpass separating commuter rail tracks from freight train tracks at one of Canada's busiest rail crossings. Using accelerated bridge construction, four railway bridges were built site-adjacent and slid laterally into place during four short-duration track closures.

PARSONS

West Toronto Diamond Rail-Rail Grade Separation

PROJECT OUTLINE

75-WORD DESCRIPTION

Include the client name and the client's objective, your role in the project, project complexity and/or use of innovation, and the project's social, economic and/or environmental benefits.

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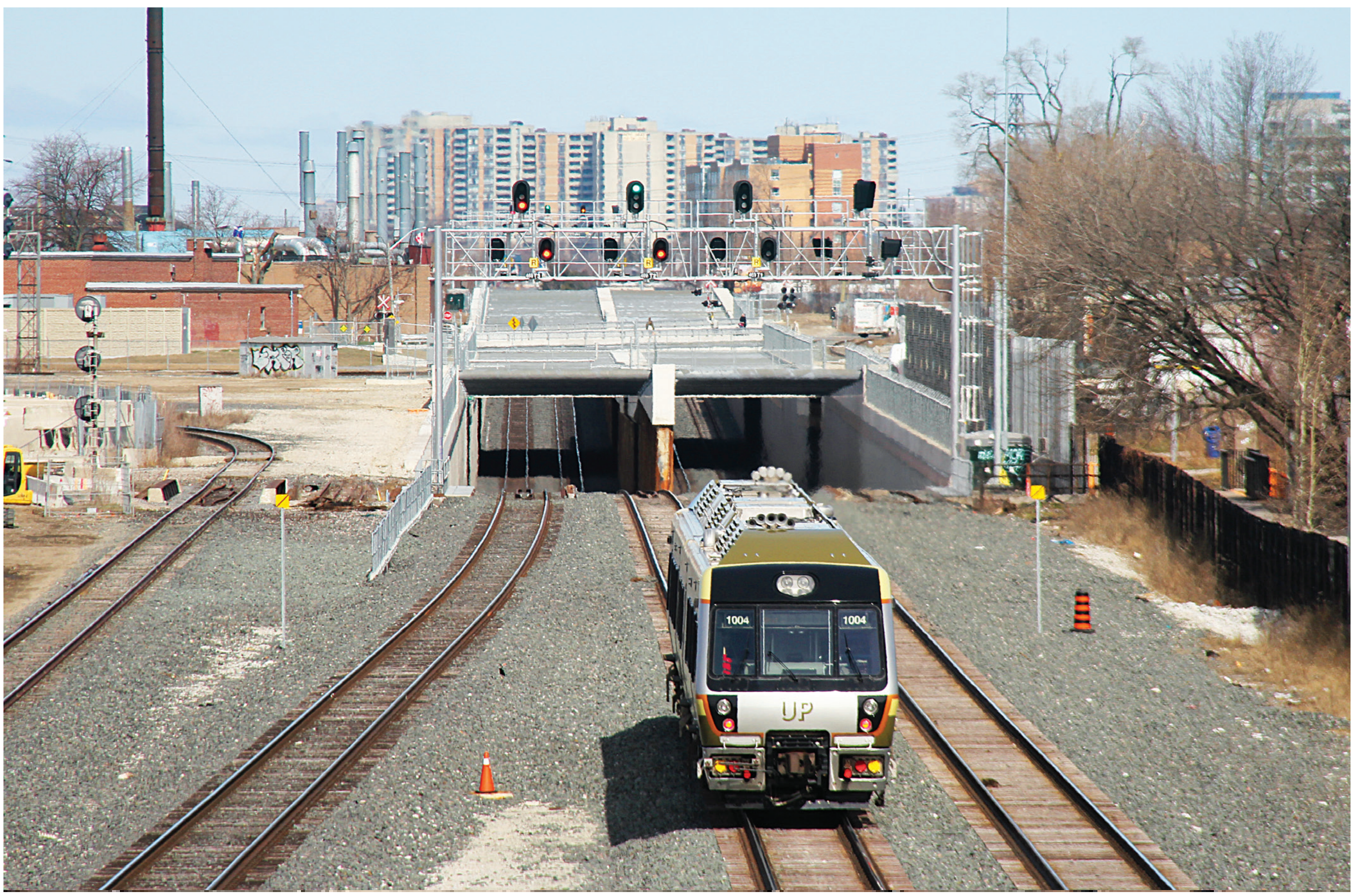


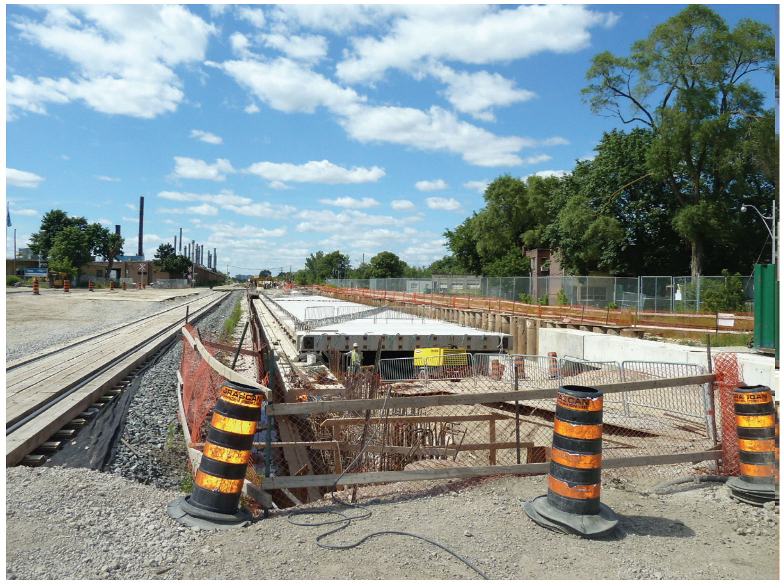
A northbound UP Express train enters the West Toronto Rail Grade Separation structure on its way to Pearson International Airport carrying passengers from the Toronto Union Station transit hub approximately seven kilometers to the south. The GO Transit Galt track (to Milton) is visible on the extreme left.

PROJECT HIGHLIGHTS

INNOVATION (40%) - MAX. 400 WORDS

Briefly introduce your project, i.e. what was done and why? Then explain how the project demonstrates the innovative application of engineering principles or techniques. How is it distinguishable from similar projects of its type*?*

Constructed 130+ years ago, the West Toronto Diamond is one of Canada's busiest rail intersections, where four operating railways intersect in the area called "The Junction." These include Metrolinx tracks that carry primarily Metrolinx and VIA Rail passenger trains, as well as Canadian National Railway (CN) freight trains; the Canadian Pacific (CP) freight tracks; and CP Connection Track. With Metrolinx' plan to add passenger trains and Union-Pearson (UP) Express airport train service, the bottleneck at the diamonds had to be rectified before the Toronto 2015 Pan Am Games.



Looking north toward Old Weston Road, the east span of the Old Weston Road bridge is made ready for sliding north into its final position during a short possession of the CP connection track.

The solution was to eliminate two at-grade diamond crossings of the Metrolinx Kitchener Corridor and the CP North Toronto Subdivision/CP Connection tracks via a kilometer-long, grade-separated structure in which the north-south Metrolinx commuter train corridor was depressed below grade through an underpass while the CP freight tracks remained at current elevation and location. This involved four new railway bridges—all constructed with minimal interruption of railway operations. To accommodate future growth, the structures had to be designed for later addition of two tracks, making each four-track facilities.

Looking north toward Old Weston Road at the east span of the CP North Toronto Subdivision bridge as it is made ready for sliding south into its final position during a short possession of the CP tracks.

In the preliminary design (by others), project staging outlined multiple track diversions and conventional bridge construction at the crossings. This would have required a significant amount of rail and signal work, including a main signal bridge relocation and several complex signal and cable bungalow relocations—resulting in rail traffic disruptions and increased project scope, schedule, and cost.

Parsons re-worked the project, developing a staging program that eliminated six of the seven original track diversions by using bridge slide construction, an accelerated bridge construction (ABC) technique.

The four mainline railway bridge spans, weighing a total of 12,600 tons, were assembled site-adjacent and slid laterally up to 80m (262 ft) into their final positions. Each slide was powered by computerized high-speed tandem hydraulic jacks, moving the structures on steel/bronze slide paths, enabling the spans to move quickly and continuously into position during short-term track possessions. Due to railway possession time constraints, the bridges were slid on their permanent bearings and secured in place after the slides, without need for subsequent jacking or remedial work to the slide paths. This was one of the first times this specific ABC technology was used on Canadian railway bridges.

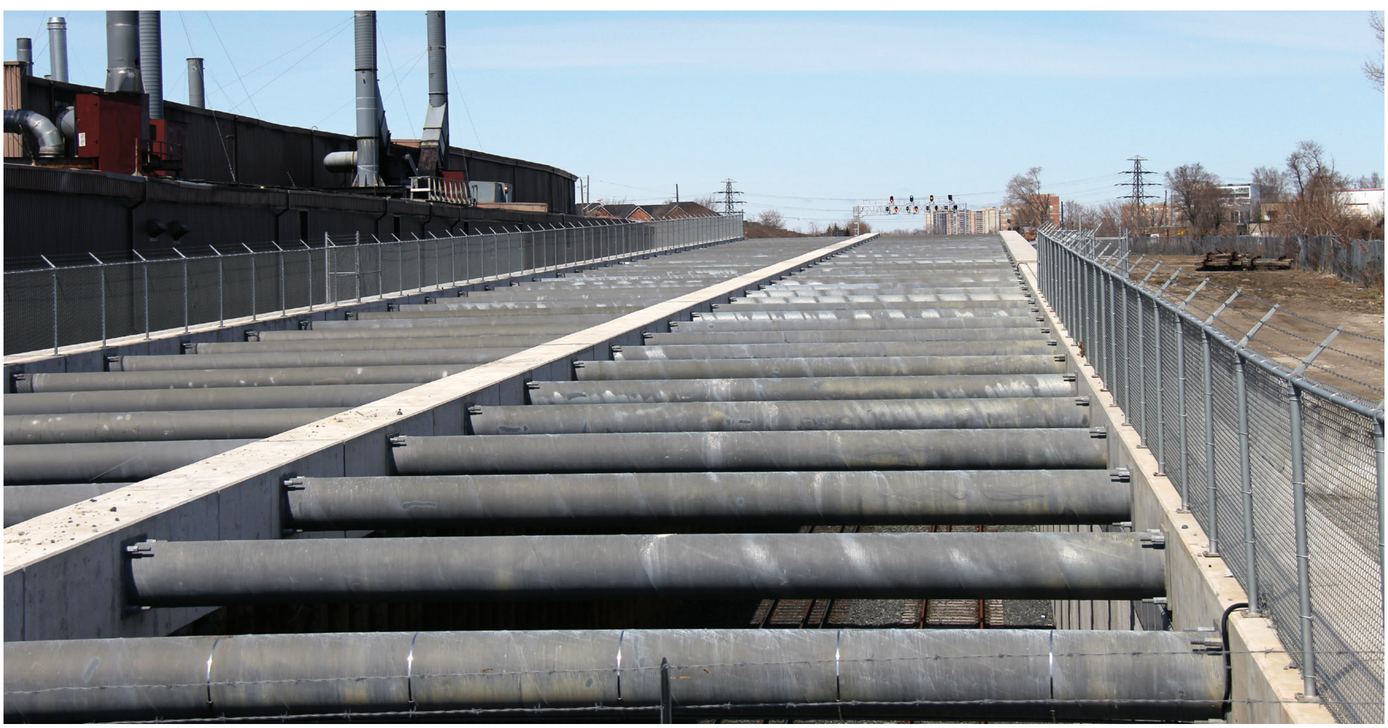
In addition, bridge construction was accelerated by incorporating full-depth precast deck slab elements—transversely connected by post-tensioning—and foundations consisting of a unique interlocking steel pipe pile wall system.

COMPLEXITY (20%) - MAX. 250 WORDS

Explain any extraordinary problems and conditions that were overcome.

Active Train Traffic Congestion—The project exists amidst four operating railways (Metrolinx, VIA, CN, CP) further complicated by an existing public grade crossing (Old Weston Road), an existing connecting track between the two railways in the southwest quadrant, and an additional CP connecting track over the Metrolinx tracks—all of which had to be maintained during the vast majority of construction with one operational Metrolinx track required at all times.

Looking north from the Old Weston Road bridge, the center wall divides the east and west sides of the West Toronto Rail Grade Separation structure.



Looking north from the Old Weston Road bridge, the older industrial building (to the left) formed a key constraint in the design and construction of the grade separation structure.

Geographic Constraints—Existing subways north and south of the project limited the distance over which a grade separation could be achieved. Also, the area was dense with industrial and residential properties—many extremely close to the project area—limiting the available area for construction work. This also required efforts to reduce noise, infringement on business operations and living conditions, and impacts to sensitive adjacent structures.

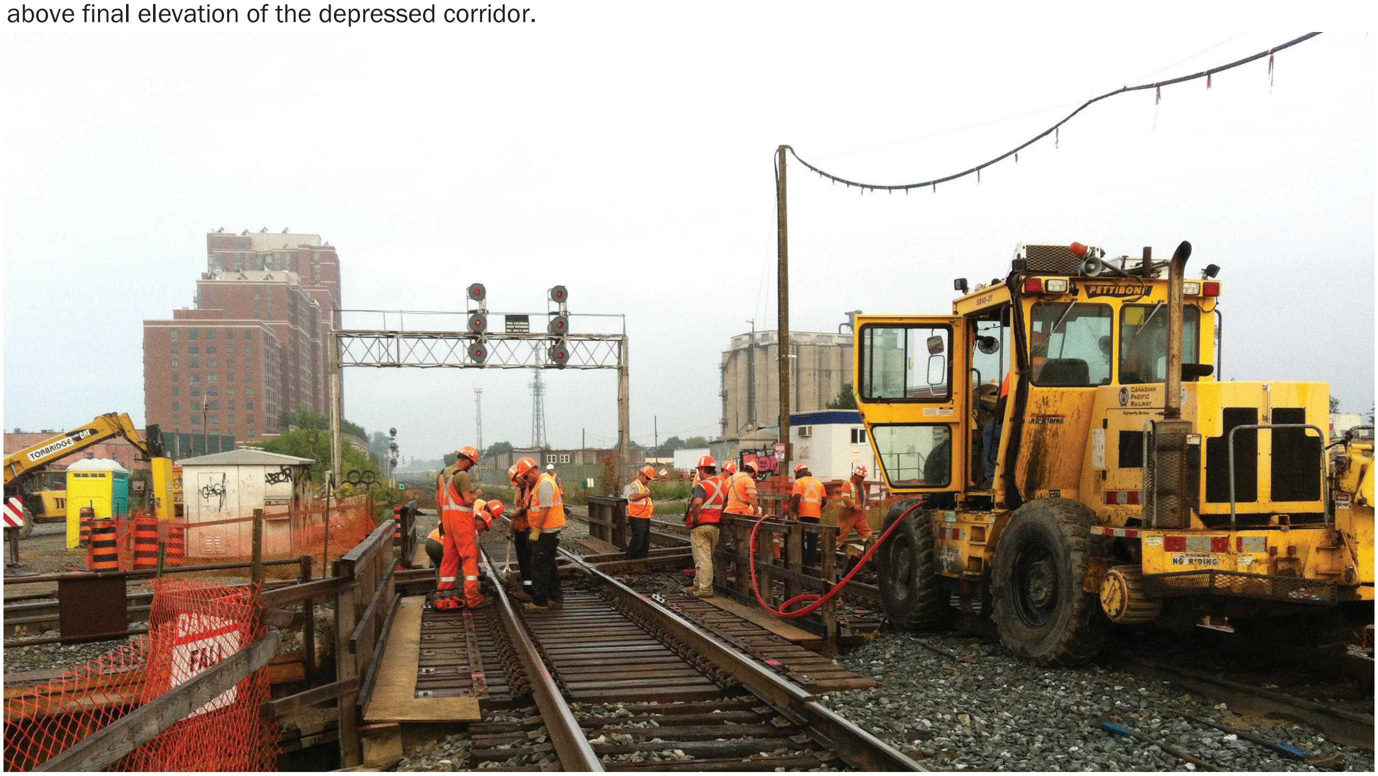
Geometrical Constraints—Due to overall property constraints, geometry of the roadway involved and that of the tracks, the most compact retaining structure system was required. This involved designing/building two separate corridors with a common center wall, negating any CP track lifts.

Buried Utilities—Running through the main railway corridor was a trunk watermain, a combined large sanitary/storm sewer, railway signals, and four fiber optic companies' services with main conduits—all of which required rerouting during initial enabling works.

Three Property Owners—CP, Metrolinx, and City of Toronto, which required extensive consultation and review of design and construction plans.

Relatively Shallow Groundwater Table—Approximately five meters below existing grade—above final elevation of the depressed corridor.

Looking south from the CP North Toronto Subdivision bridge location showing east corridor construction well advanced, including the stepped wall caps in the foreground being made ready to receive the east bridge span when it is slid into position.



Railway crews maintain track at the temporary, removable bridges carrying the two CP North Toronto Subdivision tracks over the center and west walls of the new depressed corridor. The Metrolinx GO Weston diversion track and its "diamond" crossings are visible in the background.

SOCIAL AND/OR ECONOMIC BENEFITS (15%) - MAX. 250 WORDS

Explain the social and economic benefits to society provided by your project. Be specific and provide qualitative and quantitative information.

This 100-year service life project will provide positive benefits for many years ahead.

By reducing rail traffic congestion on multiple lines, adding capacity for two additional tracks on each corridor in the future, plus the ability to add more commuter trains immediately, this project greatly enhances all rail operations in West Toronto. In fact, on opening day, ten commuter trains were added for a total of 29 on the Kitchener line. The commuting public now gets more frequent train departures and shorter travel times. Increased ridership, in turn, stimulates business growth since the available labor pool expands geographically as commuter rail service improves. Freight carriers also benefit immediately with the elimination of the diamond-crossing and may add two more tracks in the future—allowing them to efficiently transport an increasing volume of products needed by a rapidly growing population.

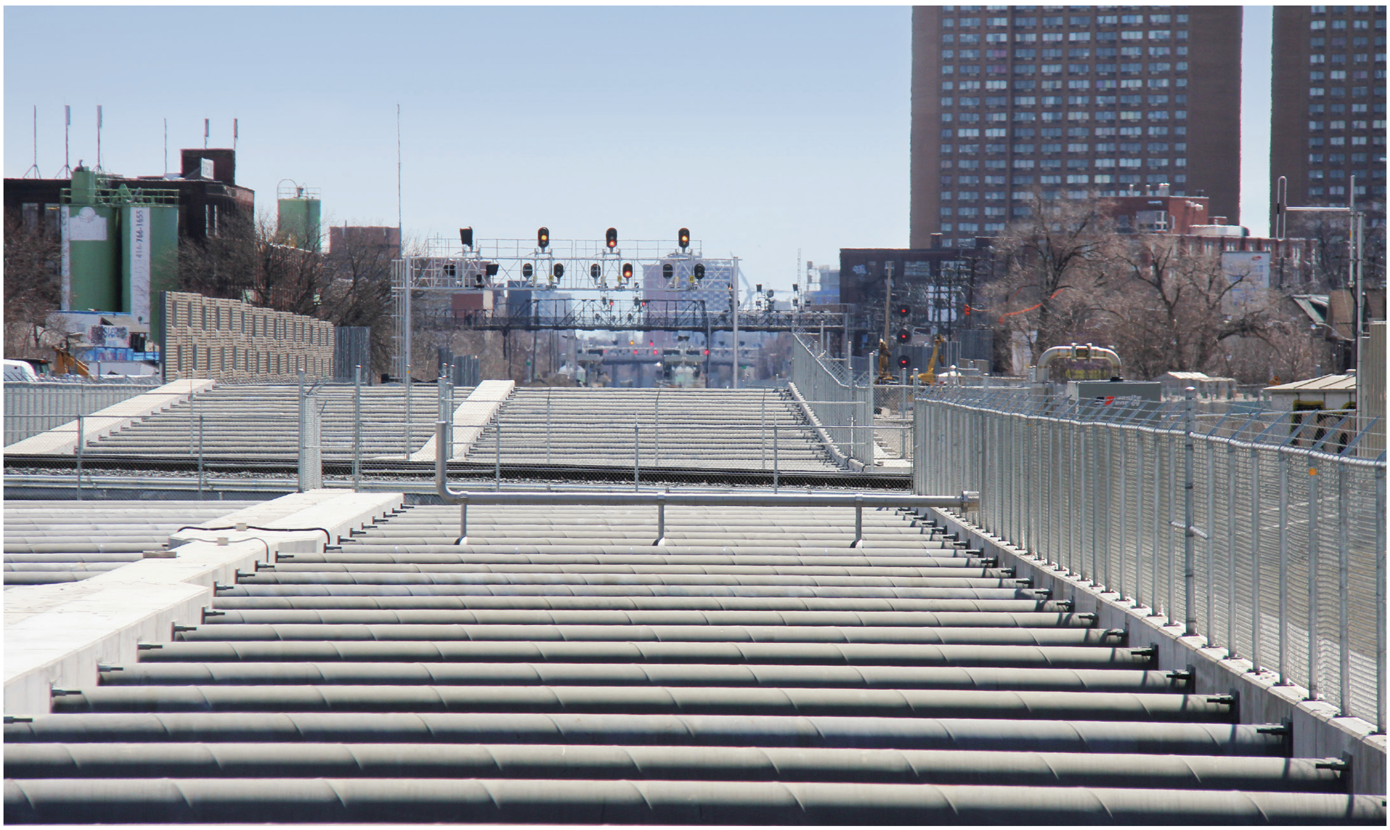
The project allowed Metrolinx to launch a new airport express rail system—UP Express. It is North America's first dedicated express rail train, providing service between Downtown Toronto's Union Station and Toronto Pearson International Airport in just 25 minutes, with trains departing every 15 minutes, 19 ½ hours a day. It gives travelers and tourists an environmentally friendly travel option between Canada's two busiest transportation hubs. In the first year alone, it expects to transport nearly 1 million passengers and take at least half that many cars off the road. Now, Toronto joins other global cities with a seamless airport-to-downtown connection, enhancing the region's competitiveness, reducing gridlock, and promoting tourism.

A view of the two tracks in the west corridor of the grade separation structure and the center wall, looking south from the Old Weston Road bridge.

ENVIRONMENTAL BENEFITS (15%) - MAX. 250 WORDS

Explain how your project addresses environmental/sustainability issues.

This project has enhanced residents' quality of life, reducing pollution and noise by having commuter trains run through the lowered corridor below freight traffic. This eliminated the train traffic bottleneck that required trains to stop and idle in the neighborhood. In addition, there is reduced noise from freight train wheels no longer impacting the multi-jointed diamond-crossing configuration. Auto emissions are reduced by the increased rail line capacity achieved, which has allowed added commuter trains and the launch of an airport express rail system—UP Express. In the first year alone, UP expects to transport nearly 1 million passengers and take at least half that many cars off the road.



Looking south from the Old Weston Road bridge, toward the new CP North Toronto Subdivision bridge, which replaces the old "diamond" crossing.

Throughout design and construction, sustainability measures were important:

Economic Efficiency—The lateral bridge slides reduced rail traffic disruption by eliminating track diversions. It also required only minimal track closure time, eliminating adverse impacts on commuters and freight train operations.

Environmental Performance—The unique interlocking steel pipe piles provided wall construction efficiencies while virtually eliminating de-watering by cutting-off groundwater. Conventional de-watering would likely have been costly; subject to risks, claims and delays; and environmentally hazardous as long-term de-watering could draw contaminants to the site.

Social Responsibility—Lateral bridge slide technology enhanced safety of construction and train crews, as well as commuters, by eliminating track diversions. Plus, in consideration of an older building within 2 meters of the site, zero vibration silent piling (hydraulic press-in piling) was used where warranted, reducing risk to the nearby structurally sensitive building while also reducing noise.

MEETING CLIENT'S NEEDS (10%) - MAX. 250 WORDS

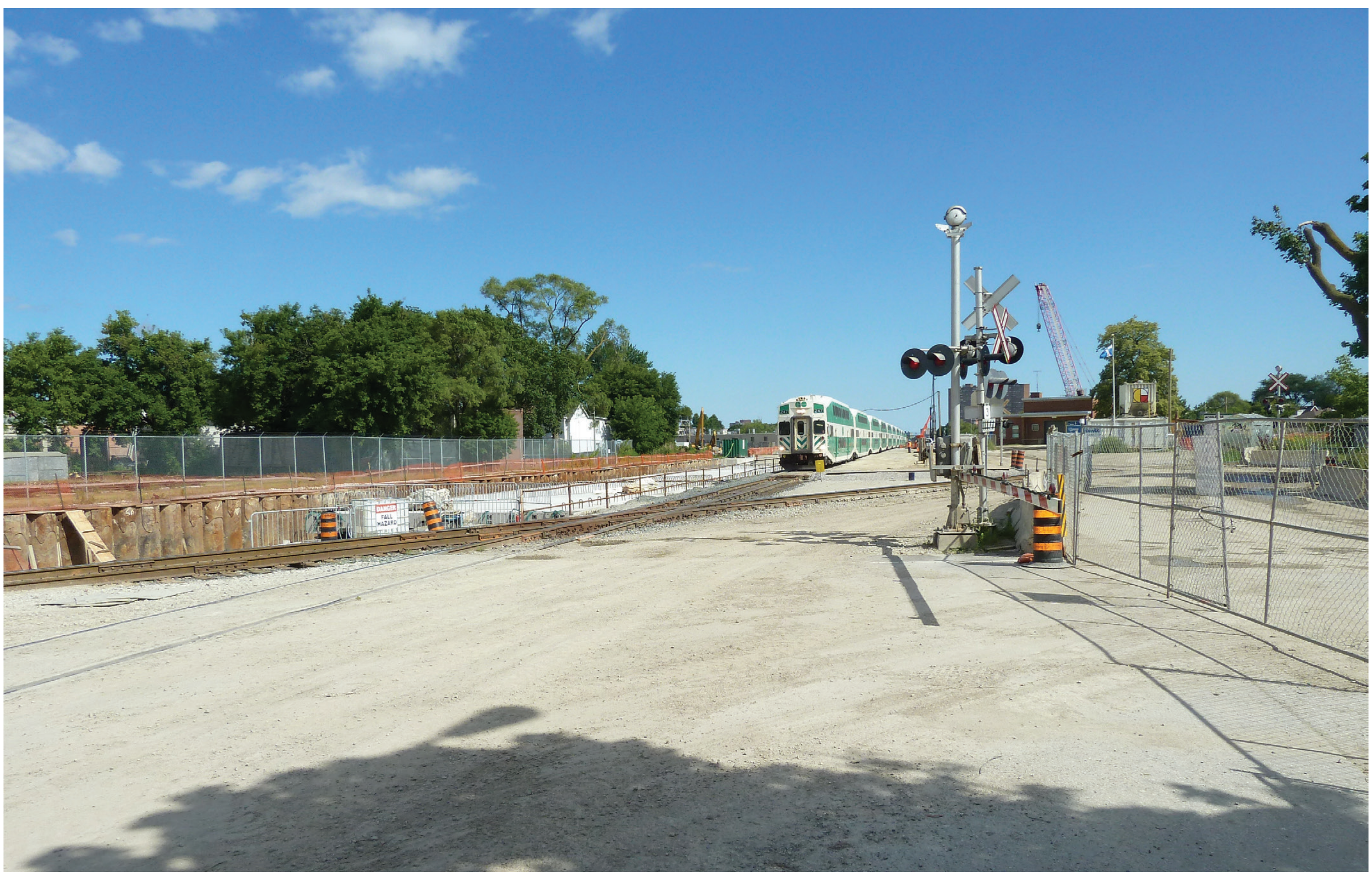
Explain the client's main project goals and how you met them.

Metrolinx needed to accommodate currently increasing ridership and plan for projected future growth in the years ahead. It committed to creating track capacity for the new UP Express airport train, and providing it before the Toronto 2015 Pan Am Games. And, it needed to do it all with minimal impacts to train movements and site-adjacent homes and industrial buildings.

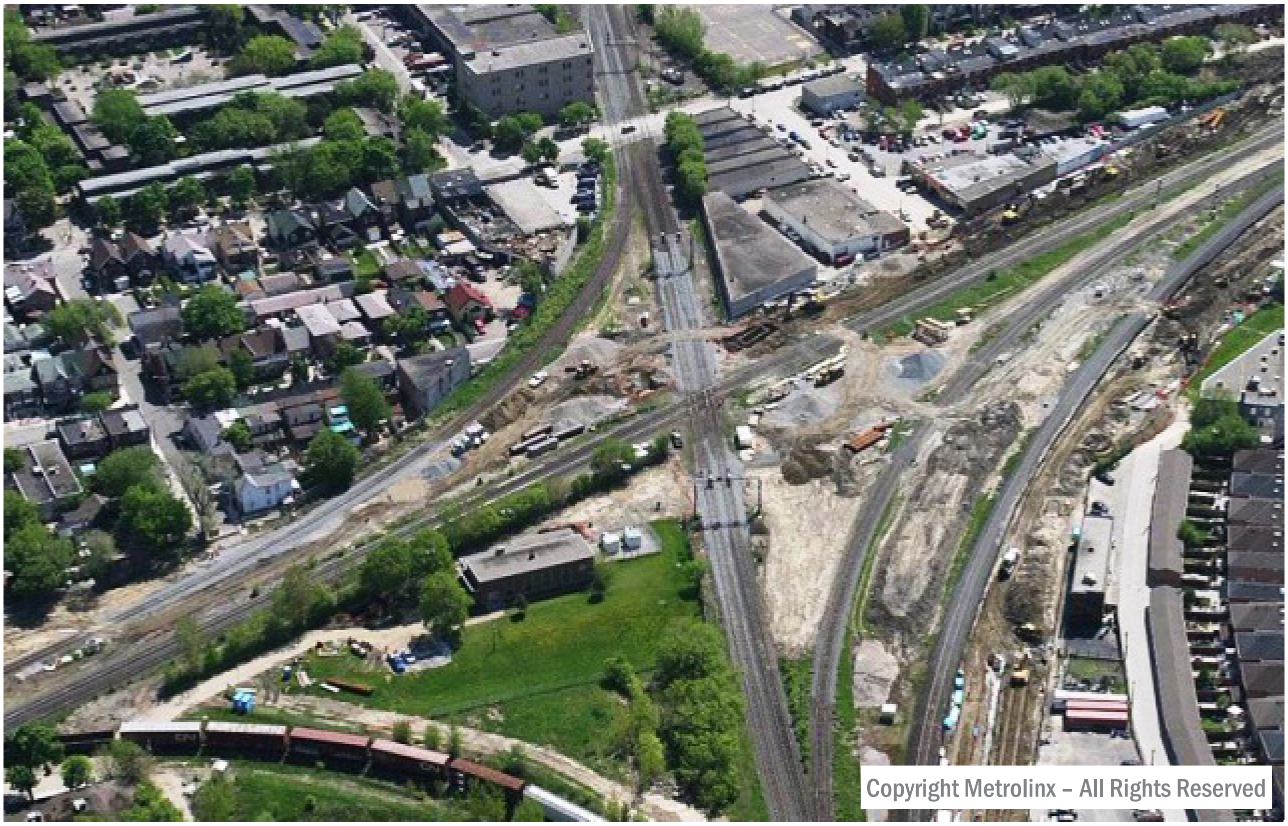
The solution was to eliminate two at-grade diamond crossings of the Metrolinx Kitchener Corridor and the CP North Toronto Subdivision/CP Connection tracks by means of an underpass for commuter rail, and four new bridges for freight tracks, while also including the capacity for two future track additions each on both the commuter and the freight lines, making each future four-track facilities.

In order to reduce project scope, schedule, costs, and impacts to the neighborhood and rail operations, Parsons employed the ABC technique of bridge slide technology and further accelerated the project by incorporating full depth precast deck slab elements—transversely connected by post-tensioning—and foundations consisting of a unique interlocking steel pipe pile wall system. Construction also involved zero vibration silent piling (hydraulic press-in piling), reducing risk to nearby sensitive buildings, services, and utilities—while reducing noise.

The project was successfully completed on schedule and within budget, allowing capacity for the new airport rail express train service prior to the Toronto 2015 Pan Am Games, and immediate addition of commuter trains, delivering on Metrolinx' promise to improve train service in the area for now and in the future.

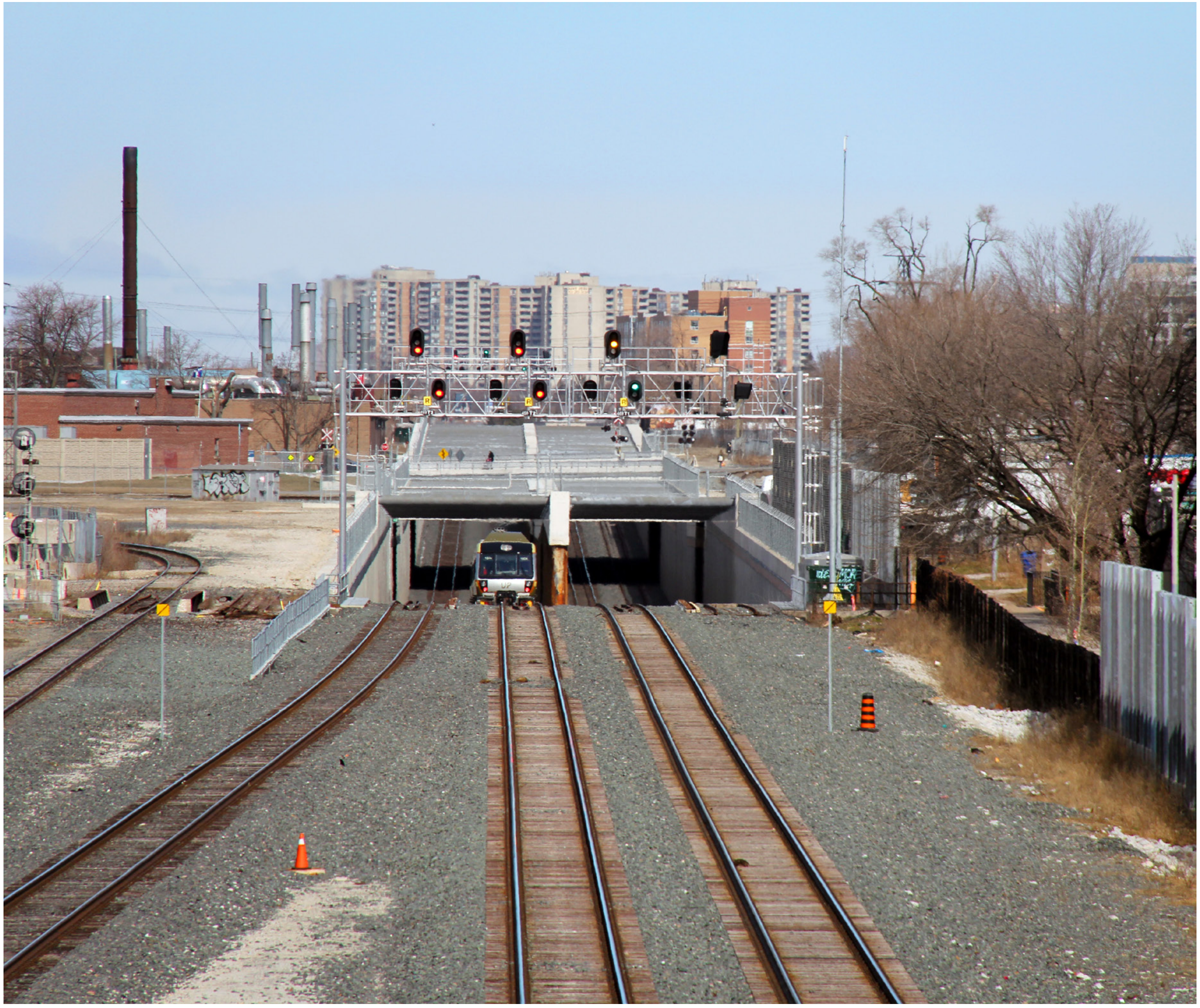


A northbound Metrolinx GO Transit train on the GO Weston diversion track approaches the CP Connection Track "diamond" crossing and the Old Weston Road grade crossing with the east span of the new Old Weston Road bridge visible (to the left of center) as it is made ready for its slide north into its final position.



Before construction of the West Toronto Diamond Rail-Rail Grade Separation.

After construction of the West Toronto Diamond Rail-Rail Grade Separation.



Successfully completed, the West Toronto Diamond Rail-Rail Grade Separation project will help keep Toronto moving.