Appendix H

High-Level Geometric Feasibility Assessment

PARK LAWN LAKE SHORE
TRANSPORTATION MASTER PLAN

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Project name:
Park Lawn Lake Shore Area TMP

Project ref:
60494141

From:
Kevin Phillips, P.Eng.

Date:
February 27, 2017

Memo

High-Level Geometric Feasibility Assessment

The purpose of this memo is to provide a brief summary of the high-level feasibility review on the basis of geometric design and engineering for select potential alternative transportation solutions. The high-level feasibility assessment will contribute to the high-level screening of alternative solutions to assist with developing the short-list of alternative solutions for the Transportation Master Plan.

This geometric design and engineering review considers horizontal and vertical conditions that significantly affect or are constrained by factors such as the ability of the infrastructure improvements to be accommodated within the available area; property impacts and acquisition; and significant structural or other area fixed constraints, such as the Humber River, Gardiner Expressway and ramps, rail corridor, hydro corridor or even complex land ownership parcels (e.g. condominium corporations).

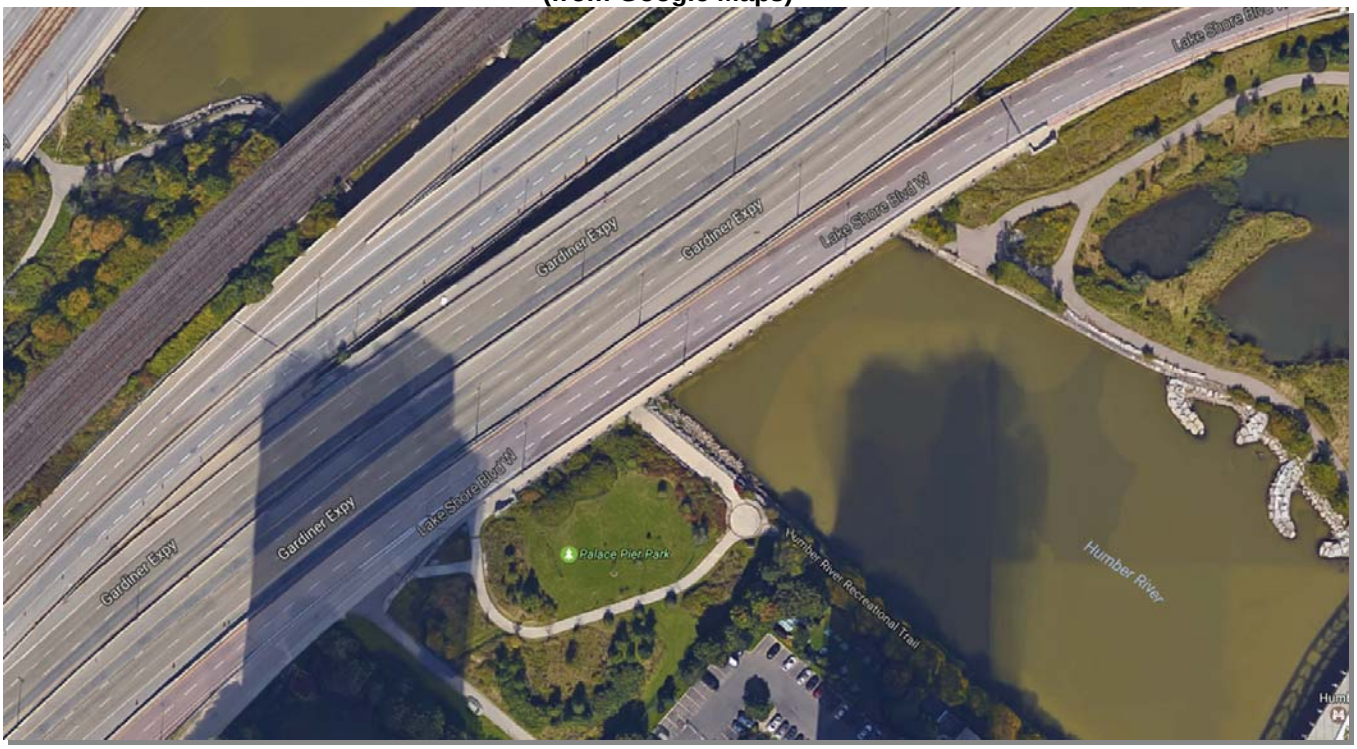
The screening was based on a review of the road alignments in consideration of the topographic survey prepared by Callon Dietz, Digital Terrain Model (DTM) prepared by Callon Dietz, engineering base plan provided by the City of Toronto, and typical engineering design standards/guidelines.

The following summary notes the key concepts that were considered in this review, and notes the challenges and viability of pursuing the concepts for further study in the TMP.

Widening of Eastbound Lake Shore Boulevard Across the Humber River

This alternative investigated the potential for widening the southernmost bridge crossing of the Humber River that is contained within the cluster of Gardiner Expressway and Lake Shore Boulevard bridges. This structure is illustrated in the figure below.

Lake Shore Boulevard at the Humber River
(from Google Maps)



This is a relatively routine task and can readily be accommodated via different methodologies. For example, girder type span bridges can be widened simply by widening the abutments and piers, and laying additional girders for a wider bridge deck. Alternatively, if this were a post-stressed type bridge, a direct bridge widening would not be possible; however a new parallel bridge directly adjacent to the existing structure could be constructed with a long longitudinal seam.

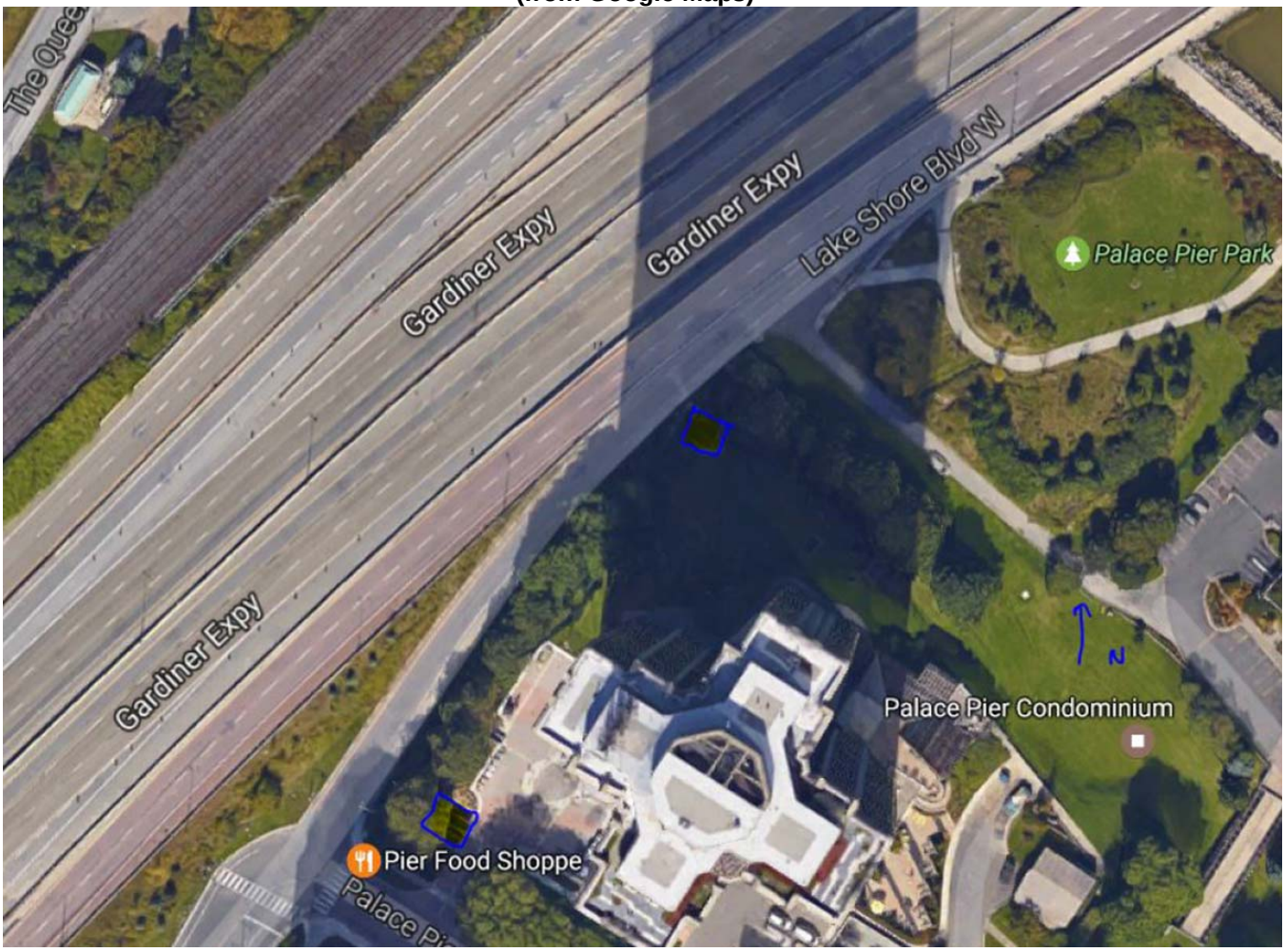
In short, the provision of one or two new traffic/transit lanes can be accommodated. The biggest challenges would be the usual planning and design challenges for a span of this nature, such as:

- Addressing the ≈75m river span;
- Providing for ≈100m span between bridge abutments in order to accommodate embankment slopes and the multi-use trail (MUT) adjacent to the Humber River, including provision for an environment that promotes security for MUT users such as wide platforms and illumination;
- Work over water;
- Work in close proximity to the Gardiner Expressway and Lake Shore Boulevard; and
- Accommodating all vehicle types and loads, including consideration for light rail transit vehicles (rail vibration impacts), and designing according to the Canadian Highway Bridge Design Code (CHBDC).

Additional Lake Shore Boulevard Lanes at Palace Pier

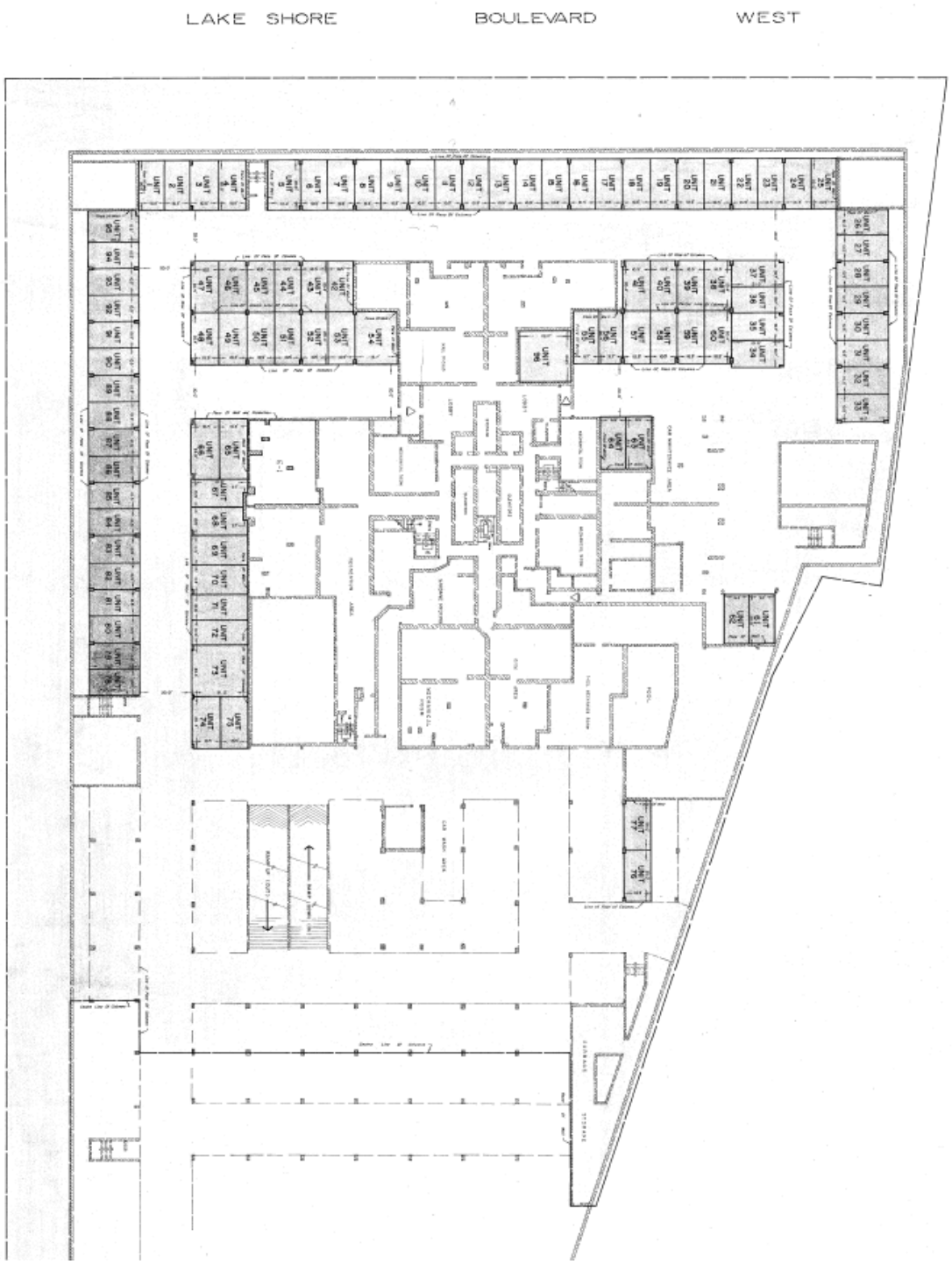
Lake Shore Boulevard adjacent to Palace Pier is currently one-way eastbound. This merges with the two-lane Gardiner Expressway sub-collector, resulting in a combined three-lane cross-section for Lake Shore Boulevard as it approaches and traverses over the Humber River. This is illustrated in the figure below. In general, the single eastbound Lake Shore Boulevard lane is rising in elevation to the merge point with the sub-collector as it then crosses the Humber River.

Lake Shore Boulevard at Palace Pier
(from Google Maps)



Palace Pier, an adjacent high-rise residential condominium structure, is located to the south of Lake Shore Boulevard in this area. Based on a review of architectural drawings dated 1978 (drawn 1977 and approved 1978), a four-level underground parking structure for Palace Pier extends beyond the high-rise structure envelope northerly to Lake Shore Boulevard. The architectural plans also illustrate a mechanical vent shaft for the garage at the north-easternmost area of the garage, located in close proximity to Lake Shore Boulevard. The layout of the parking structure is illustrated in the figure below.

Palace Pier Architectural Plan (1978)



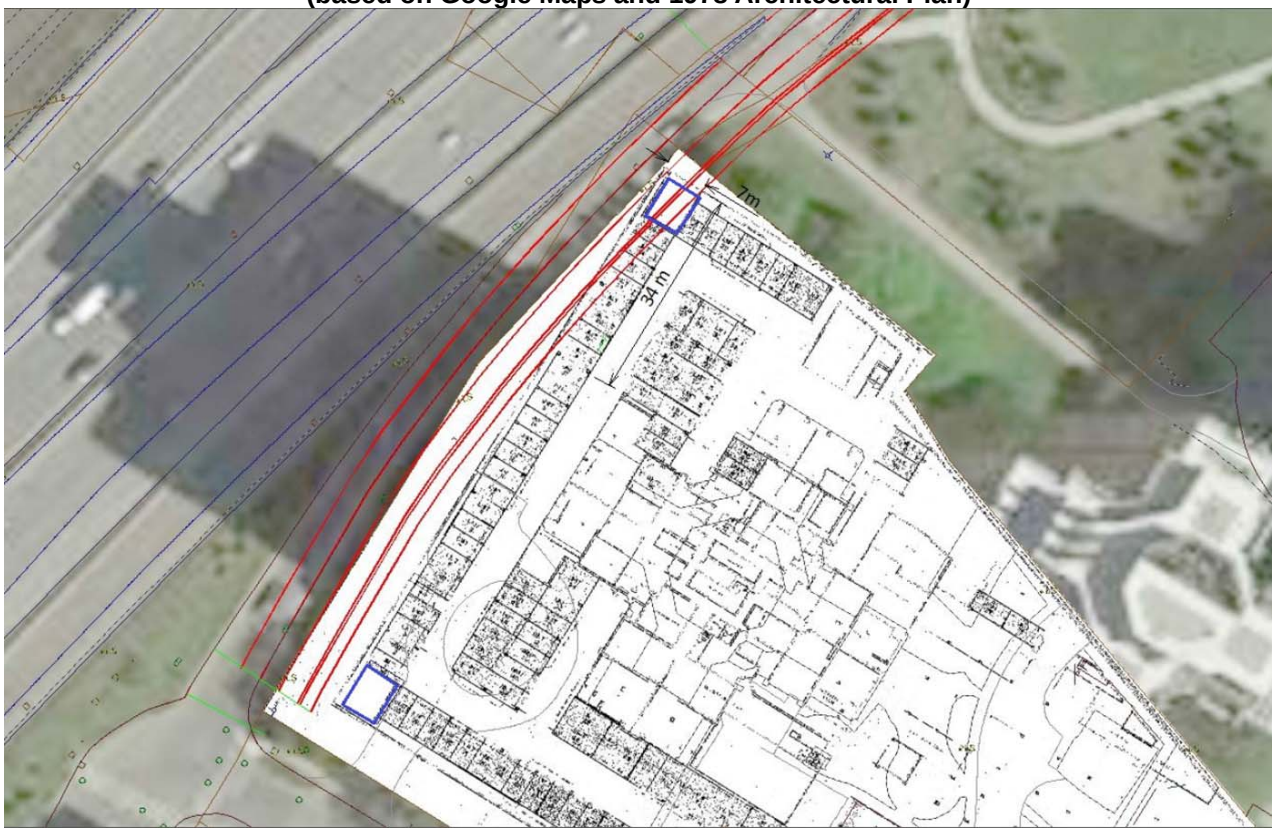
Based on a review of topographical elevation data as well as the architectural plans (depicting the bottom elevation of the garage roof slab), it is estimated that the depth from the bottom of the roof slab to the ground surface is in the order of 0.4m to 1.1m.

The current proximity of the parking structure vent shaft to Lake Shore Boulevard is illustrated in the figure below.

Lake Shore Boulevard adjacent Palace Pier (from Google Maps)

The contemplated widening of Lake Shore Boulevard to provide for one or two new traffic/transit lanes would result in the travelled portion of the roadway being extended southerly over the Palace Pier parking structure. The following figure illustrates the potential widening of Lake Shore Boulevard to provide for up to two additional traffic lanes, plus a monolithic curb and sidewalk (i.e. sidewalk adjacent to the road curb). Alternatively, the widening could be a single new lane plus bicycle lanes or a cycle track. The provision of the types of facilities and the specific widths can be determined in future tasks of the TMP study.

Lake Shore Boulevard Palace Pier; with Parking Plan and Widening Overlay (based on Google Maps and 1978 Architectural Plan)



As illustrated in the figure, the contemplated widening would extend into the envelope of the below-grade parking structure by several metres. The concern with the road widening extending over the parking structure is that it is likely that the parking garage would have been designed to Ontario Building Code (OBC) design guidelines, and would not have considered dynamic live loading associated with road or rail transit vehicles. Thus, it would be very important to consider the structural conditions (including design life), and consider a structural analysis and design for the contemplated new loading conditions. Some considerations include:

- Highway planning would require Canadian Highway Bridge Design Code (CHBDC) truck loading. Since the garage is on private property, the design live load probably would have been less. Strengthening or partial replacement may be required. A structural evaluation would be needed to determine feasibility, cost, etc.
- Future repair and maintenance is also an issue. A highway over the structure may impede access for future repair/maintenance. Conversely, highway operations may be impacted during future repair/maintenance.
- Property ownership – agreements would need to be put in place regarding who owns the land and who is responsible to pay for future repair/maintenance. Likewise, impacts to parking would need to be addressed with owners and the condominium corporation.
- Age of structure? Parking garages designed to CSA S413 may have a design service life of 50 years. This should be considered in life- cycle costing and design.
- There may or may not be other code issues – the OBC should be reviewed for compliance under this “change of use” of a garage roof slab scenario.
- Underground garage ventilation – the highway should not block the mechanical vent shafts unless new vent shafts are provided.
- Access ramps and pedestrian access should not be impacted.

Based on the contemplated widening and the above noted issues, a variety of structural planning concepts were considered to provide for the contemplated widening. These are described below.

Truncate the Garage Structure

In association with the widening of Lake Shore Boulevard, one possible alternative would be to remove the existing garage structure below the widened road. However, this is extremely complex and would need to consider:

- Extremely deep excavation to at least the depth of the four-level garage in a constrained environment between the structure and Gardiner Expressway/Lake Shore Boulevard; and
- Reconfiguration of the piers and parking layout in the garage. Parking spaces would be removed, and may need to be compensated for elsewhere on the site.

Given the complexity of this concept, and in view of other simpler concepts, this approach is not deemed viable to consider.

Garage Structure Strengthening

A different consideration to achieve the Lake Shore Boulevard widening would be to strengthen the existing garage structure to accommodate the additional dynamic loading of the road, and vibration associated with rail if rail is put in place. This would require enhancements to the following:

- Column strengthening, however this would widen the columns and potentially result in impacted/less parking spaces; and
- Foundation/footing enhancement, through underpiling (although this may be difficult) or through micropiles (this is a relatively common approach in parking garages).

This is a reasonable and viable construction approach to consider.

Bridge

The Lake Shore Boulevard widening could potentially be achieved by creating a bridge type structure over the garage, supported by new auger drilled (not driven) piles adjacent to the structure walls.

However, the available depth to the structure roof slab would need to be reviewed and considered. It is likely that the profile of Lake Shore Boulevard would need to be raised somewhat in order to achieve the bridge girder depth over the roof slab. That said, this is a reasonable and viable construction approach to consider.

Load Distribution Slab

The final considered construction approach would be to provide for a load distribution slab over the garage such that the live loads of the road are distributed and transferred.

As with the bridge alternative above, the available depth to the structure roof slab would need to be reviewed and considered. It is likely that the profile of Lake Shore Boulevard would need to be raised somewhat in order to achieve the load distribution slab over the roof slab. That said, this is a reasonable and viable construction approach to consider.

Other Consideration – Realign Lake Shore Boulevard

A potential additional consideration would be to slightly re-align Lake Shore Boulevard in this area such that it is directly adjacent to the two-lane Gardiner Expressway to Lake Shore Boulevard sub-collector. This would reduce some of the encroachment of the Lake Shore Boulevard widening over the parking structure.

Given that there are potential construction methodologies to achieve a Lake Shore Boulevard widening in the vicinity of Palace Pier, the concept of widening Lake Shore Boulevard in the area is deemed viable to consider in the forthcoming alternatives development and analysis of the Transportation Master Plan. As noted above, design for any selected alternative would need a structural evaluation of the Palace Pier garage, and a design to accommodate all vehicle types and loads, including consideration for light rail transit vehicles (rail vibration impacts), and designing according to the Canadian Highway Bridge Design Code (CHBDC).

New North-South Connection between The Queensway and Lake Shore Boulevard

A variety of alternative new connections were considered, generally as follows:

- Lake Shore Boulevard (near or at Brookers Lane) to The Queensway (through the Ontario Food Terminal (OFT) lands). This included three concepts (1A and 1B, as well as modified 1B to provide for modified Lake Shore Boulevard ramps to/from the Gardiner Expressway); and
- Lake Shore Boulevard (near Marine Parade or Palace Pier Court) to The Queensway (through the divided The Queensway alignment at the TTC Humber Loop). This included two concepts (4A and 4B).

All of the above alternatives are depicted in figures appended to this memo.

Given the topography of the area, a new road connection over the rail corridor and the Gardiner Expressway is unreasonable due to the hydro corridor overhead electrical wires, and also since the Gardiner Expressway is already elevated in this area as it overpasses the rail corridor. As such, overpass concepts are not considered.

New underpass concepts were considered employing the following parameters:

- Where possible, the concept profiles have been generated on the basis of a 60 km/h design speed; and
- 7.6m elevation difference from the top of rail to road asphalt (allowing for approximately 5.1m of vehicle space under a 2.5m bridge).

The general alignment and profiles of the various alternatives are attached to this memo. Although not discussed as part of this high-level concept review, it is noted that any new north-south connections should also consider in

future evaluations the needs for pedestrians and cyclists, including provisions that promote a safe and secure environment for all users given the length of the new links in/under structure.

1A and 1B Concept Alternatives

These concept profiles have been generated on the basis of the 60 km/h design speed, and have maximum grades of ≈2-3%.

Given that the new road is going below the rail corridor and the Gardiner Expressway, the road features grades that would separate the east-west parcels of the OFT lands. However, it is noted that the grades could be increased to ≈6% which would reduce the impact of the road cut for the grade changes, thereby allowing for connectivity between east and west OFT parcels, as well as the commercial lands to the east.

Notwithstanding the land impacts and the challenges associated with constructing the underpass of the rail corridor and the Gardiner Expressway, this is a viable alternative to consider in the forthcoming alternatives development and analysis of the Transportation Master Plan.

It should be noted that any developed alternatives in this area should also consider the existing hydro towers and foundations/footings in order to assess potential conflicts. This may require a retaining wall on the east side of the new north-south road, or perhaps orienting the new road slightly to the west so that it avoids footings.

4A and 4B Concept Alternatives

Due to the reduced spacing between The Queensway and Lake Shore Boulevard in this area, the concepts are generated on the basis of an undesirably lower 40 km/h design speed, meaning that the posted speed would be equal to the design speed. The maximum grades are ≈4-6%.

The biggest issue with these alternatives is that the new road cannot achieve the elevation of both the adjacent arterial roads.

In the case of concept alternative 4A, Lake Shore Boulevard would need to be re-profiled so that it is ≈2.2m lower at Marine Parade Drive. Alternative 4B would need to lower The Queensway by ≈2.8m, and Lake Shore Boulevard at Palace Pier Court by ≈2.6m.

A grade lowering of Lake Shore Boulevard and either Marine Parade Drive or Palace Pier Court would be a significant undertaking, and would also result in an undesirable retaining wall along the south side of Lake Shore Boulevard for much of the frontage from west of Marine Parade Drive to Palace Pier Court. This would impact the entrances to properties in this area, of which some may not be able to be lowered due to subsurface garage elevations.

In addition, a lowering of Lake Shore Boulevard in this area would preclude the earlier noted opportunities to widen Lake Shore Boulevard over the Palace Pier parking garage.

Given these noteworthy geometric and structural constraints, the 4A and 4B concept alternatives are not considered viable for future consideration.

1B-Modified Concept Alternative

The modified 1B alternative extends from Lake Shore Boulevard at Brookers Lane and extends to the existing signals along The Queensway for the Humber Treatment Plant. The new north-south road salvages some of the alignment of the ramps to/from the Gardiner Expressway to the east. In fact, the structure over these ramps for the two-lane Gardiner Expressway sub-collector to Lake Shore Boulevard can likely be salvaged, however a new structure/tunnel portal under the Gardiner Expressway and rail corridor would need to be constructed.

This north-south alignment configuration provides for orthogonal connection of the existing westbound Gardiner Expressway off-ramp such that westbound left and right turns could be achieved at the new north-south road (labelled as E-N/S ramp in the graphic attached to the memo). Likewise, the eastbound on-ramp can also be configured to provide for northbound and southbound access to the eastbound on-ramp to the Gardner Expressway (labelled as N/S-E ramp).

Attached to this memo are profile drawings for the new north-south road, as well as the reconfigured on/off ramps. The impacts are described below:

- New North-south Road: The concept profile has been generated on the basis of a 60 km/h design speed, and has maximum grades of ≈3-6%. A maximum grade of 6% has been assumed for the OFT and commercial lands in order to minimize cut impacts.

It should be noted that an alignment in this area should also consider conflicts associated with the existing hydro towers and foundations/footings. As noted earlier, this may require a retaining wall on the east side of the new north-south road, or perhaps orienting the new road slightly to the west so that it avoids footings.

- New E-N/S Ramp: The existing E-S ramp would be realigned to intersect with the new north-south road, but would also need to be lowered by ≈6.9m in order to achieve the intersection. This would result in a significant cut between the rail corridor and the westbound Gardiner Expressway, and re-profiling of the existing E-S ramp for ≈250m (to just before the TTC Humber Loop portal). The resultant intersection with the new north-south road would be largely in cut and somewhat under the rail corridor.
- New N/S-E Ramp: The existing S-E ramp would be realigned to intersect with the new north-south road, but would also need to be lowered by ≈3.7-5.1 m in order to achieve the intersection. This would result in a cut between the eastbound Gardiner Expressway and two-lane sub-collector to Lake Shore Boulevard, and re-profiling of the existing S-E ramp for ≈300m (to the TTC Humber Loop portal).

Implementing the new north-south road link with the reconfigured Gardiner Expressway ramps is achievable, however with significant engineering. Development of this concept would also need to consider other attributes for operations and safety of all users at the below-grade intersections (e.g. security, accessibility, visibility for turning traffic, etc.), and for construction needs such as complex freeway staging, closure of the ramps during construction, shoring and support, and protection for rail and vehicular traffic.

AECOM

4B

4A

1B

1A

HUMBER RIVER

N

QUEENSWAY

RAIL

LAKESHORE

GARDINER

RAIL

LAKESHORE

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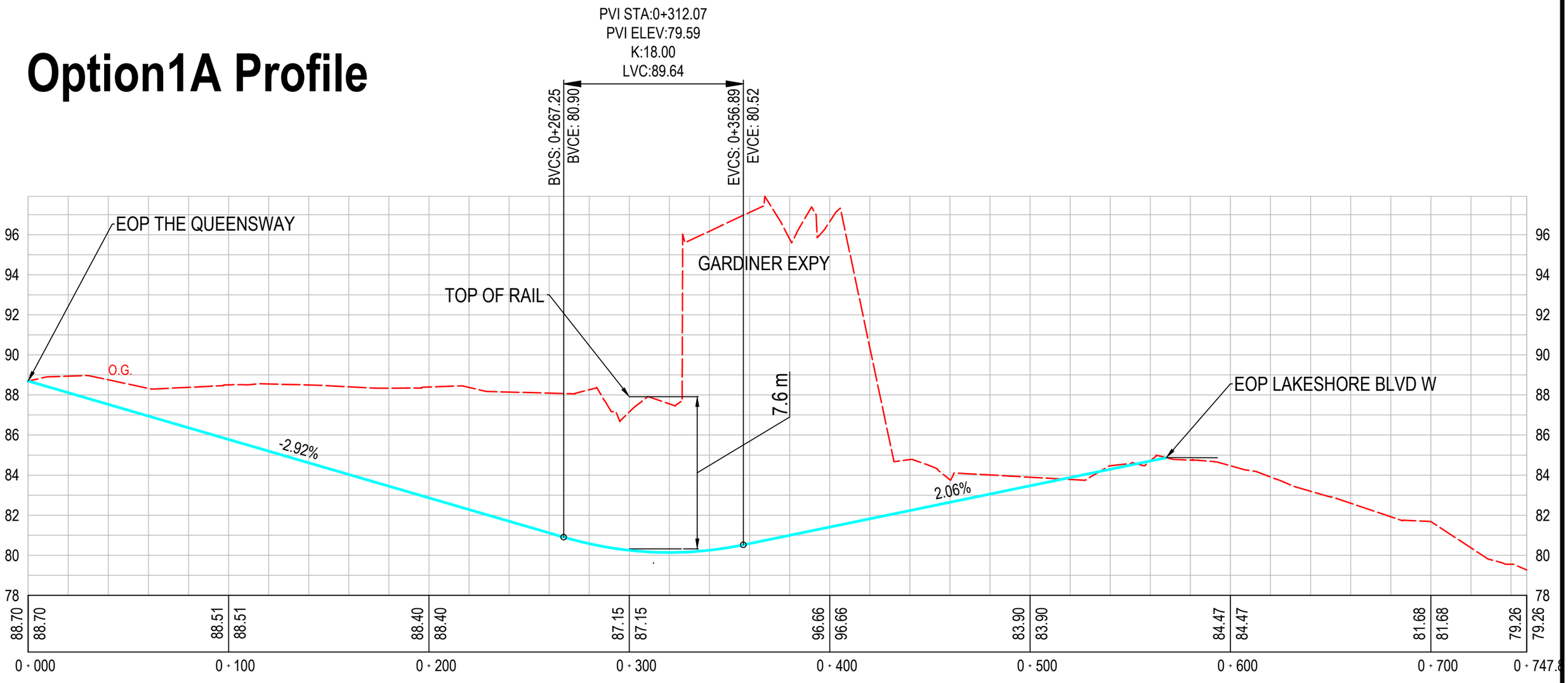
Option1A Profile



NOTE: K= 18, DESIGN SPEED = 60

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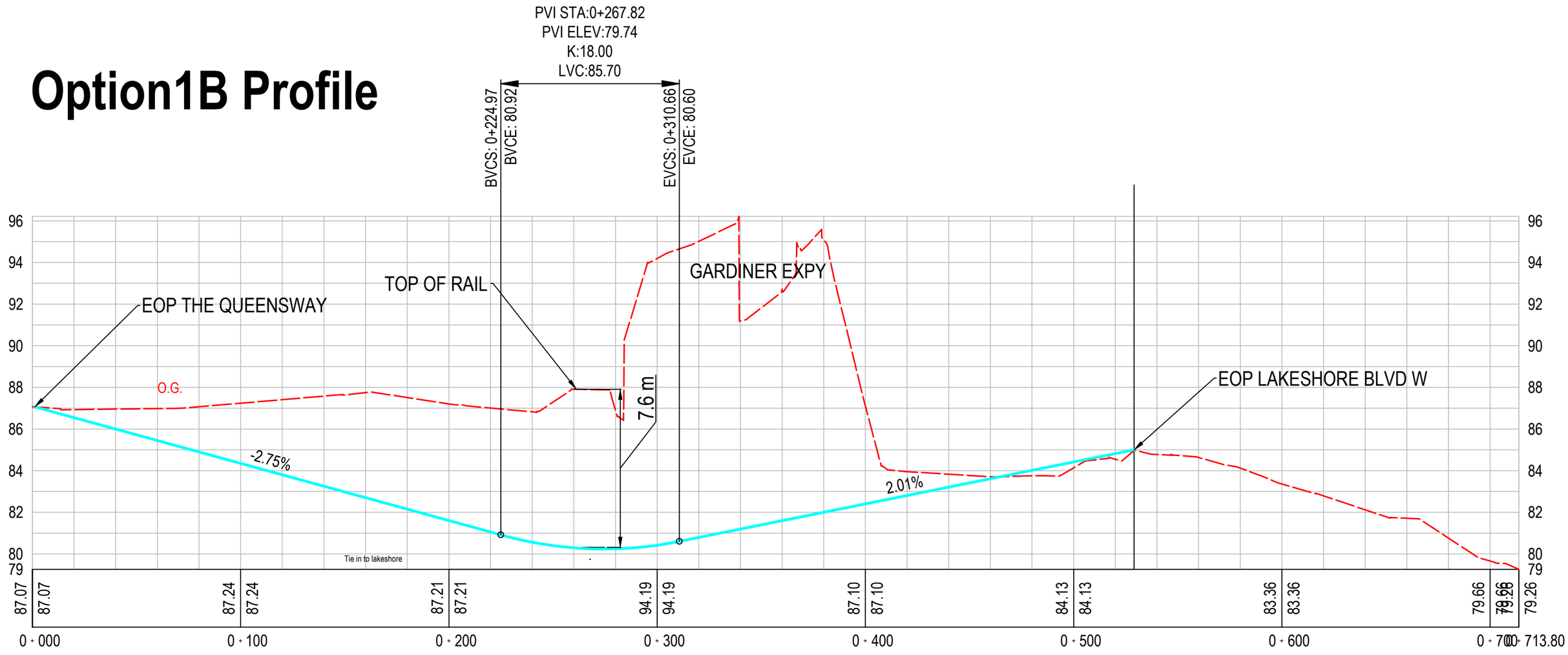
Option1B Profile



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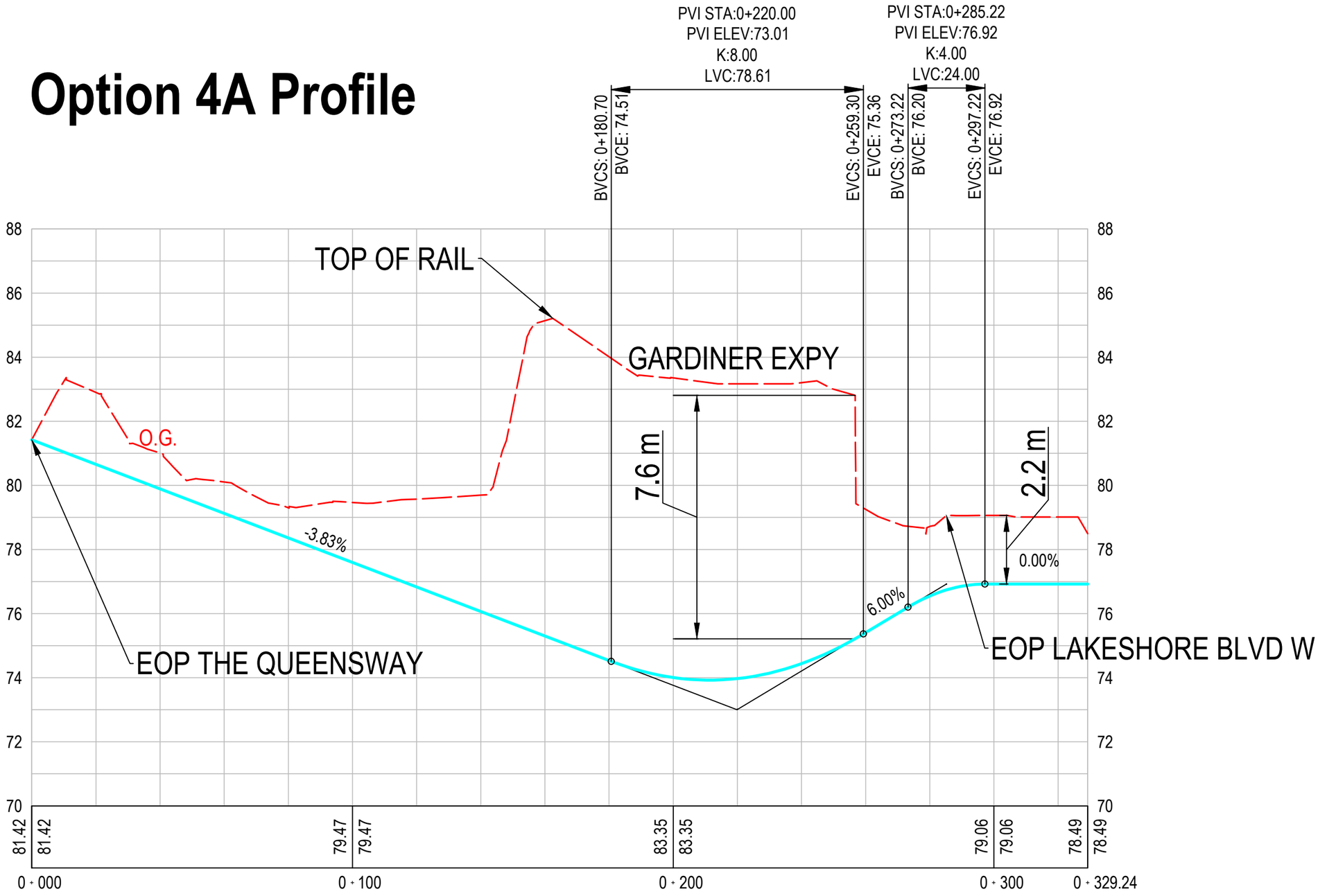
Option 4A Profile



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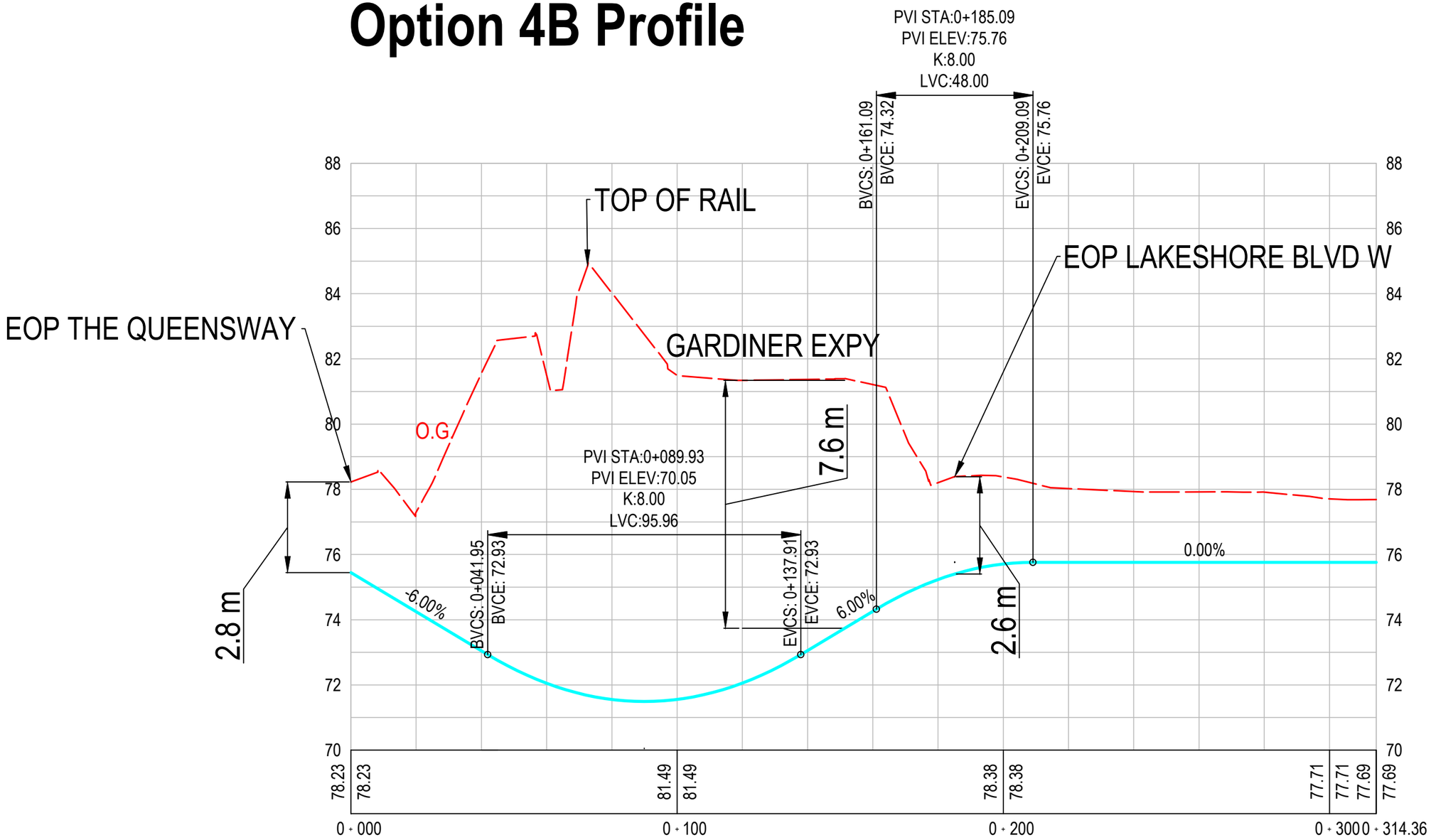
Option 4B Profile



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AECOM

QUEENSWAY

1A

1B MODIFIED

4A

1B, E-N/S RAMP

1B, N/S-E RAMP

RAIL

GARDINER

LAKESHORE

N

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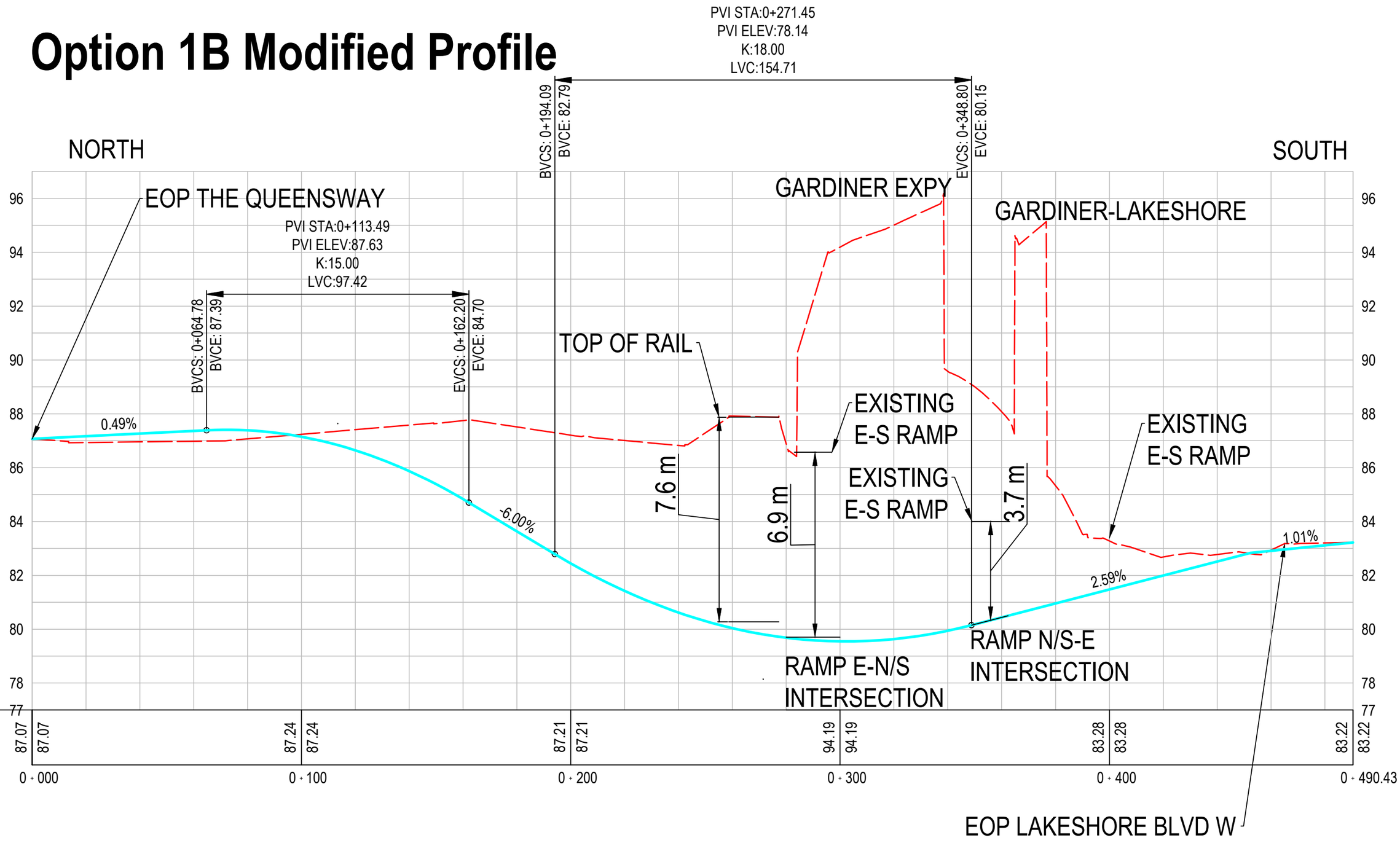
Option 1B Modified Profile



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1B Mod Ramp E-NS Profile

WEST

EAST

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PVI ELEV:80.00
K:18.00
LVC:101.35

PVI STA:0+192.81
PVI ELEV:88.27
K:15.00
LVC:133.46

BVCS: 0+004.33
BVCE: 79.81

EVCS: 0+105.67
EVCE: 83.04

BVCS: 0+126.08
BVCE: 84.26

EVCS: 0+259.54
EVCE: 86.34

O.G.

0.37%

6.00%

-2.90%

96
94
92
90
88
86
84
82
80
78
77

90.46 | 90.46 | 88.15 | 88.15 | 88.35 | 88.35 | 85.01 | 85.01 | 83.38 | 83.38

0 + 000 | 0 + 100 | 0 + 200 | 0 + 300 | 0 + 361.68

POSED
RMINAL

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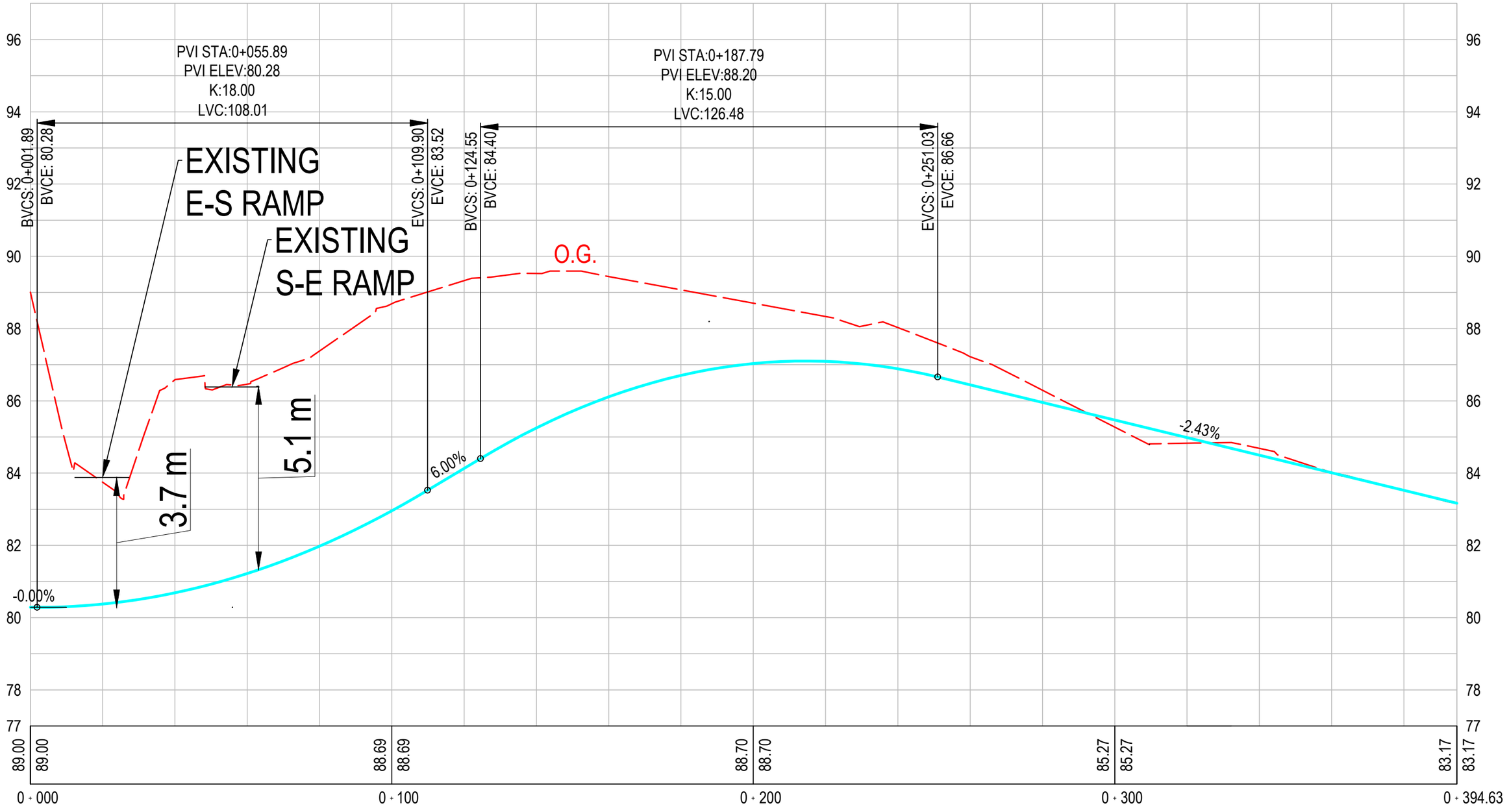
1B Mod Ramp NS-E Profile

AECOM

WEST

EAST



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