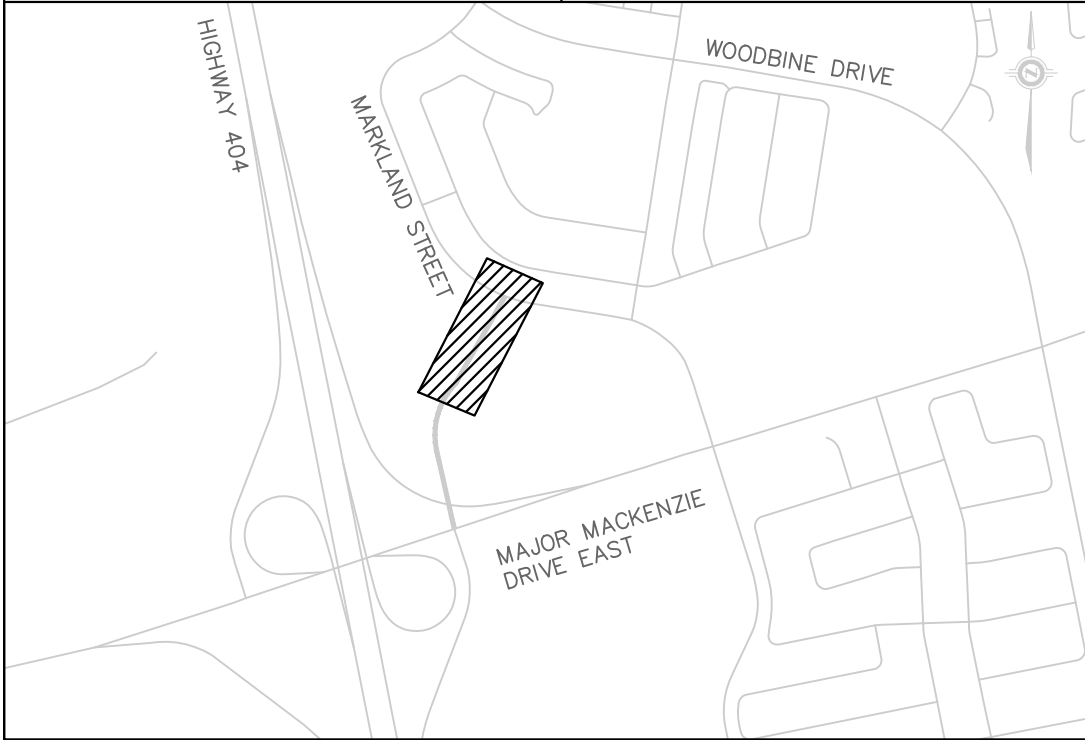
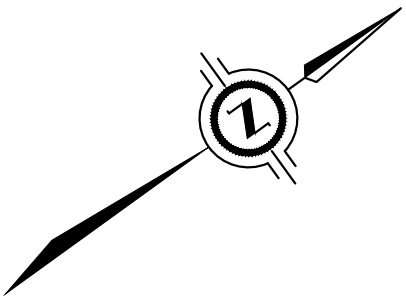


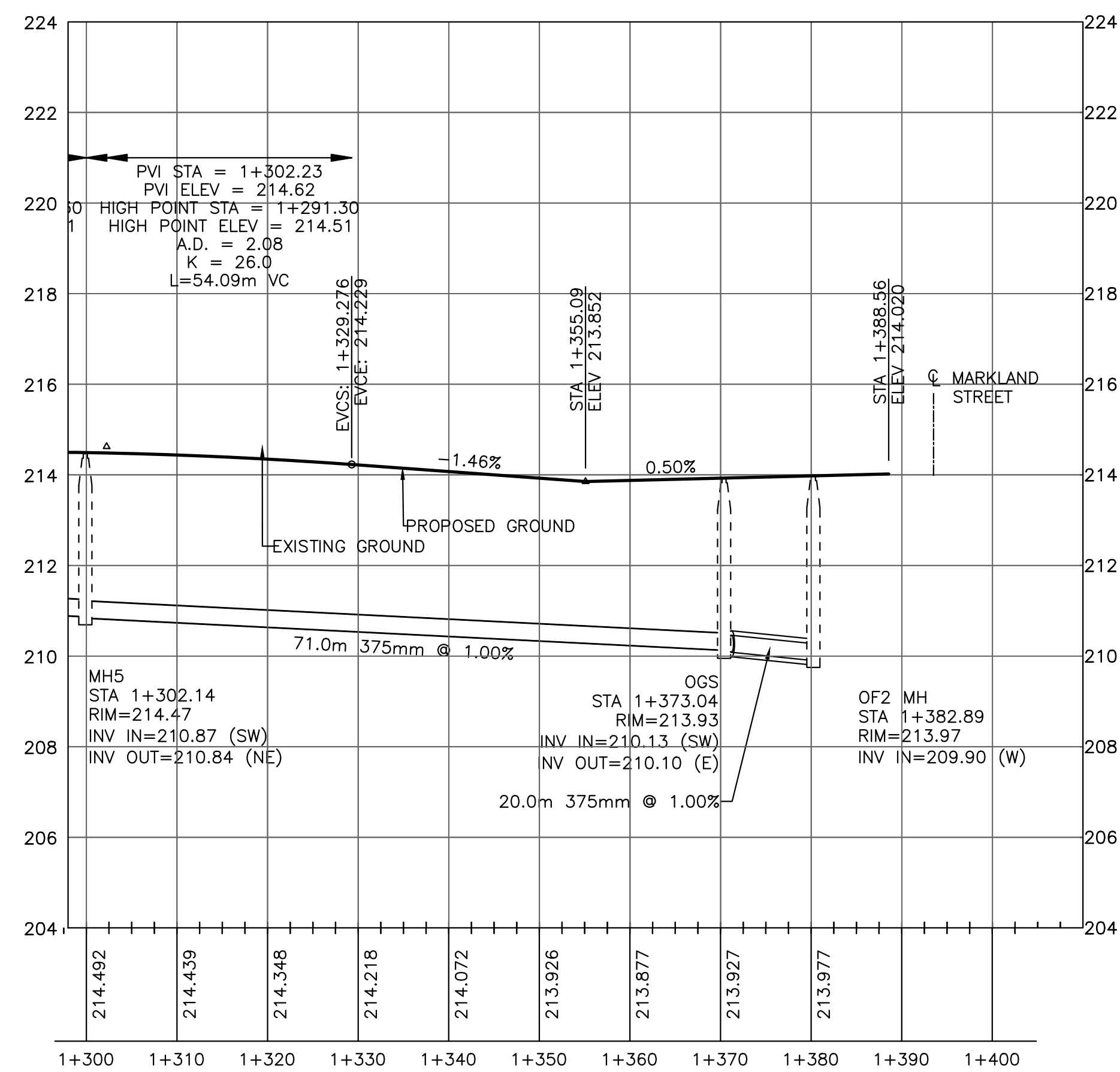
APPENDIX A

Design Drawings, Design Criteria & Preliminary Structural Design Report



LEGEND:

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|---|-------------------|
|  | PROPERTY LINE |
| | CYCLIST BARRICADE |
|  | GRADING LIMIT |
| | DRAINAGE FLOW |



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1.	PRELIMINARY DESIGN	2025/08/01
No.	DESCRIPTION	DATE

REVISIONS



THE CORPORATION OF THE CITY OF MARKHAM
ENGINEERING DEPARTMENT

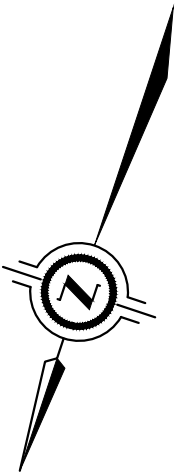
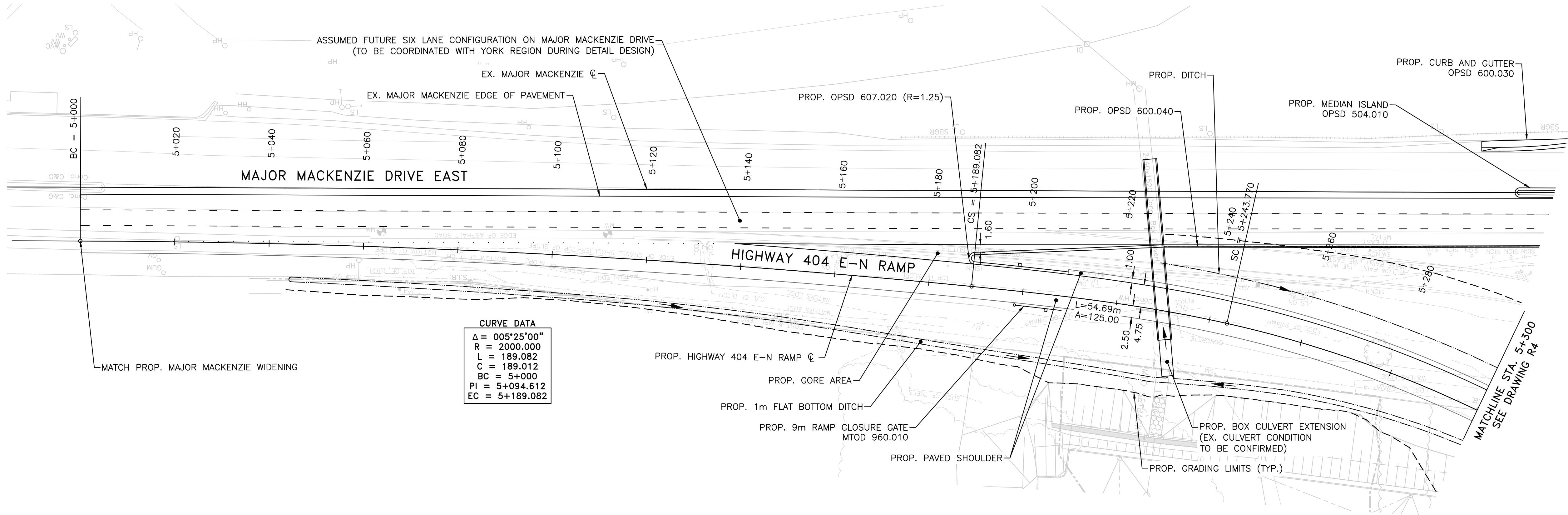
RECOMMENDED
ALTERNATIVE

HIGHWAY 404 OFF RAMP EXTENSION



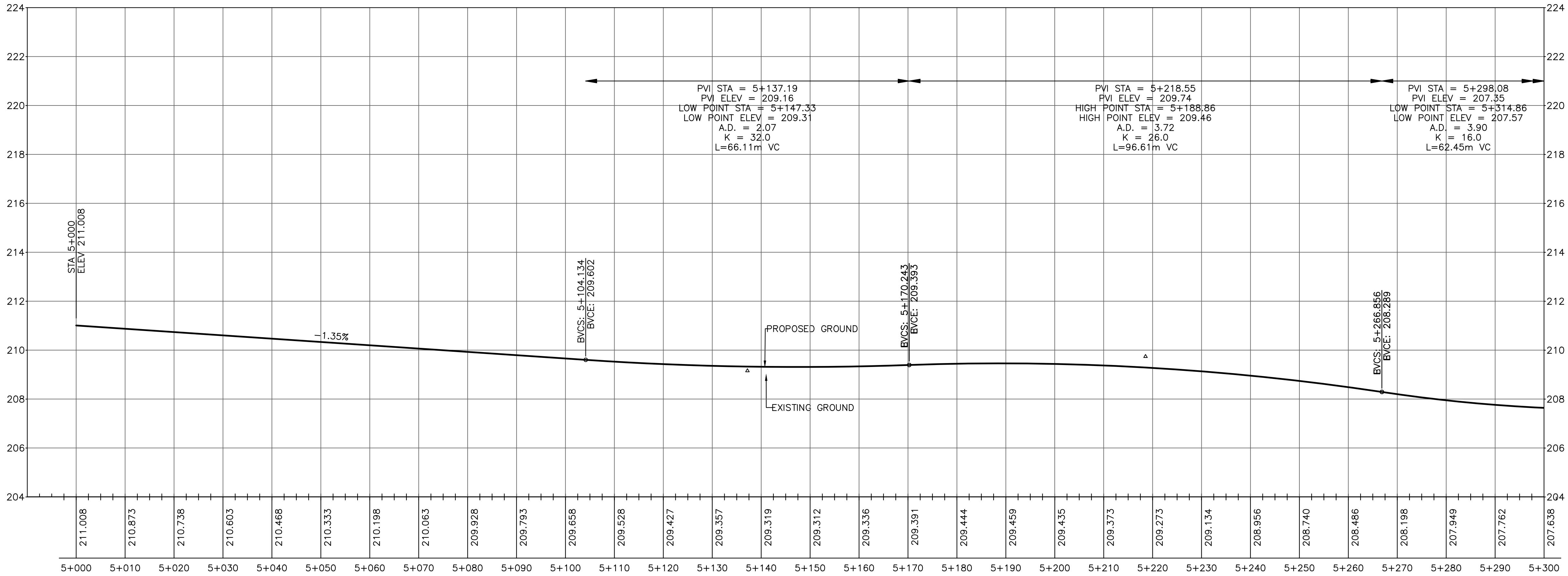
PLAN AND PROFILE
EXTENSION ROAD
1+300 - 1+400

DESIGNED BY: H.X.	CHECKED BY: C.V.	PROJECT NO.
DRAWN BY: H.X.	CHECKED BY: C.V.	
HORIZONTAL SCALE: 1:500		DRAWING NO. R2
VERTICAL SCALE: 1:100		
DATE: 2025/08/01		
CITY FILE NO.:		

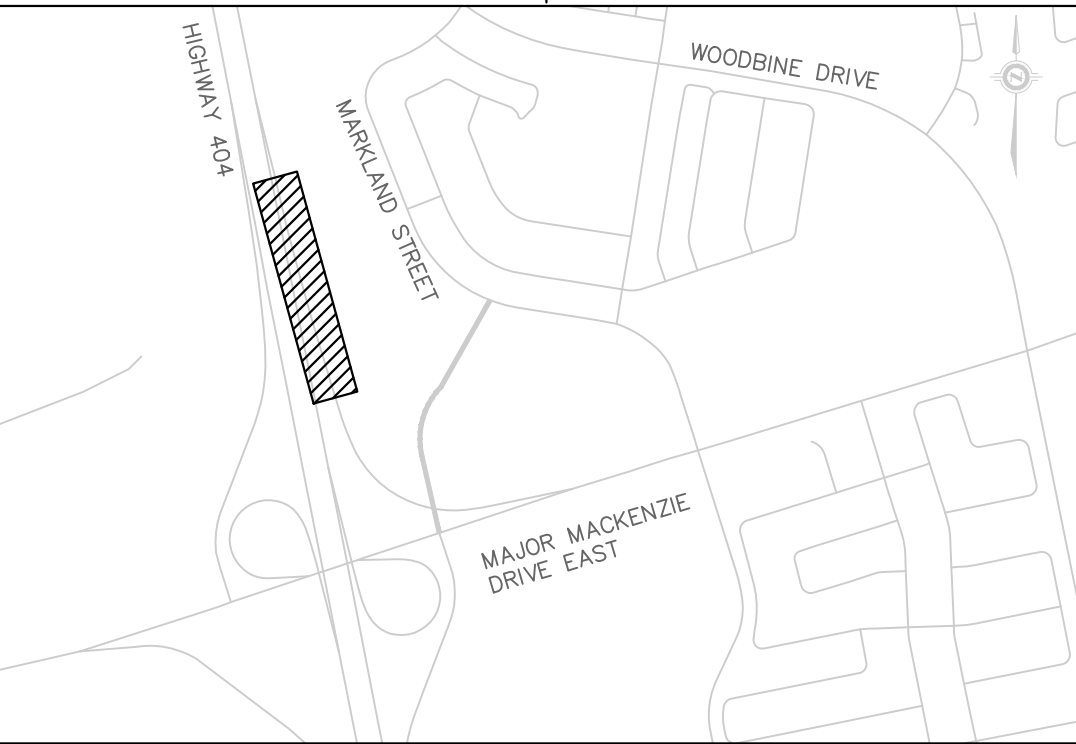
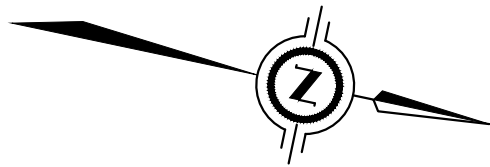


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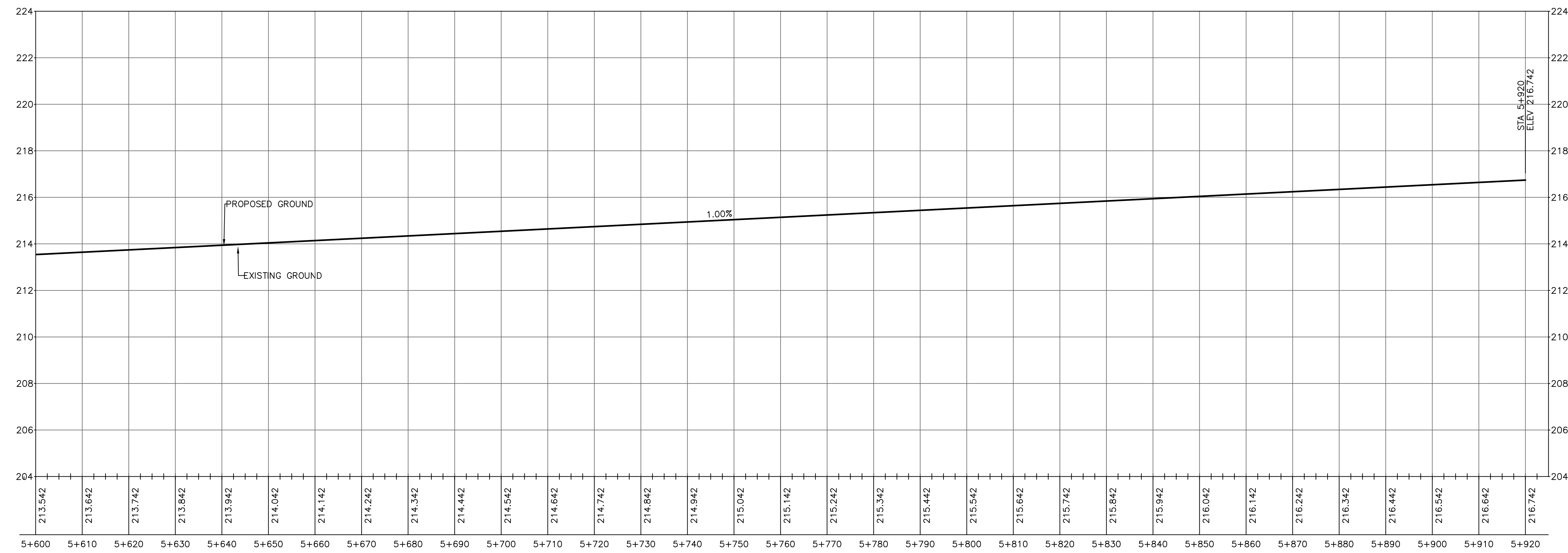
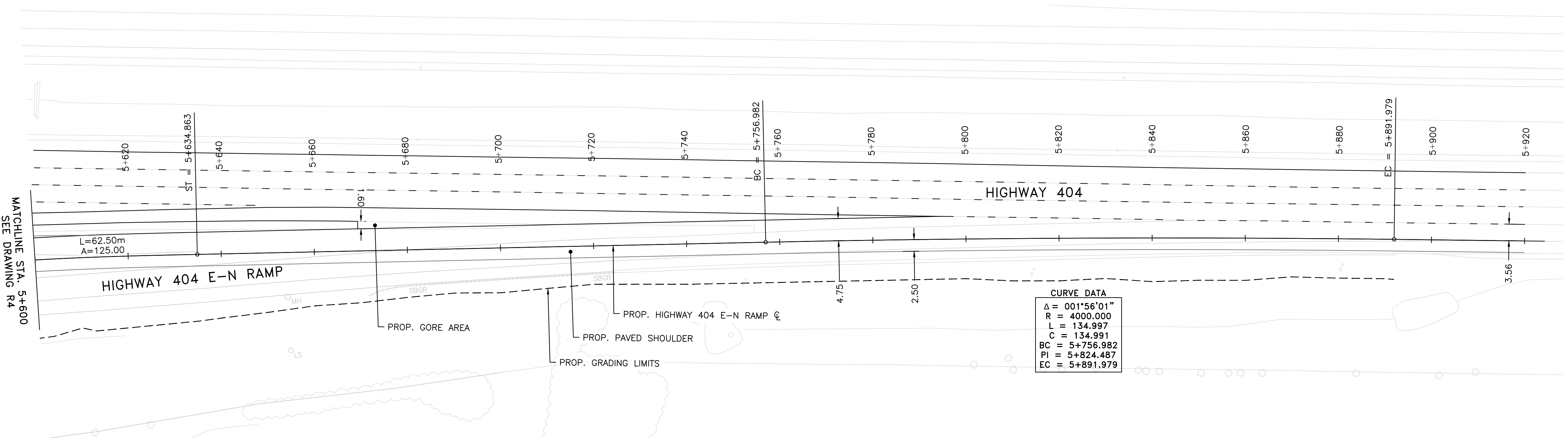
- PROPERTY LINE
- CYCLIST BARRICADE
- GRADING LIMIT
- DRAINAGE FLOW



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1.	PRELIMINARY DESIGN	2025/08/01
No.	DESCRIPTION	DATE
REVISIONS		
 THE CORPORATION OF THE CITY OF MARKHAM ENGINEERING DEPARTMENT		
RECOMMENDED ALTERNATIVE	HIGHWAY 404 OFF RAMP EXTENSION	
	GANNETT FLEMING	
	PLAN AND PROFILE - HIGHWAY 404 E-N RAMP STA. 5+000 - 5+300	
DESIGNED BY: H.X.	CHECKED BY: C.V.	PROJECT NO.
DRAWN BY: H.X.	CHECKED BY: C.V.	DRAWING NO.
HORIZONTAL SCALE: 1:500		R3
VERTICAL SCALE: 1:100		
DATE: 2025/08/01	CITY FILE NO.:	



- LEGEND:**
- PROPERTY LINE
 - CYCLIST BARRICADE
 - GRADING LIMIT
 - DRAINAGE FLOW



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1	PRELIMINARY DESIGN	2025/08/01
No.	DESCRIPTION	DATE

REVISIONS

THE CORPORATION OF THE CITY OF MARKHAM
ENGINEERING DEPARTMENT

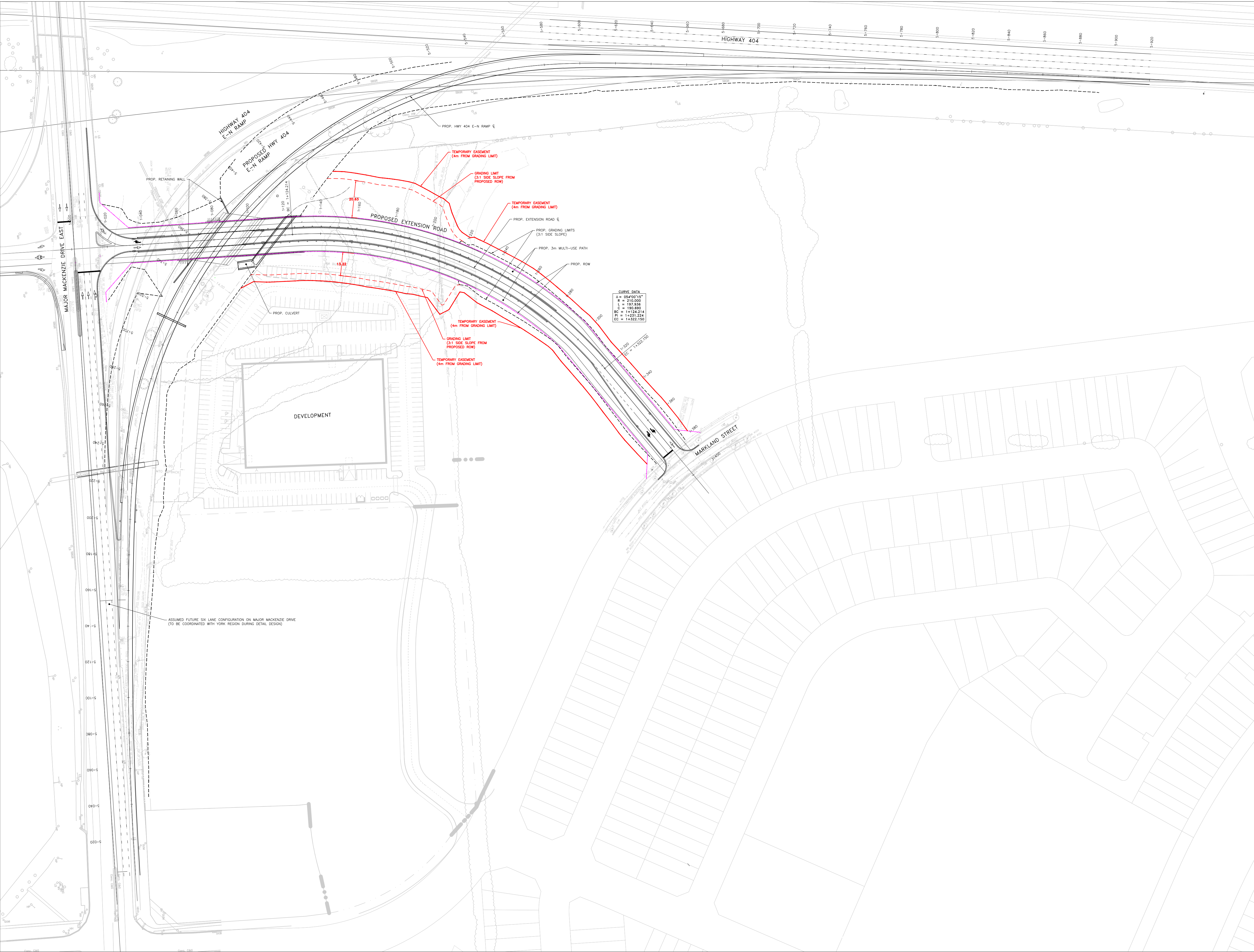
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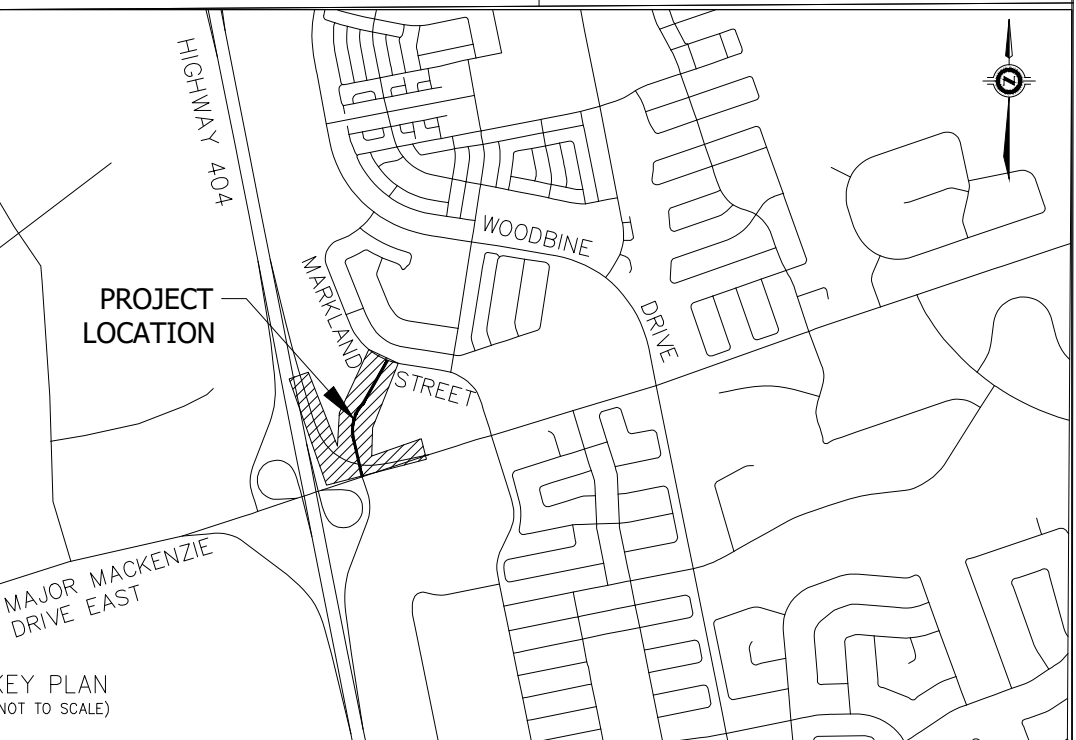
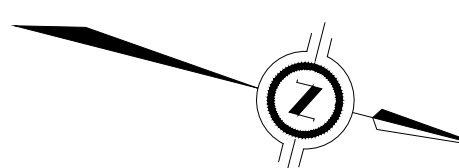
HIGHWAY 404 OFF RAMP EXTENSION

PLAN AND PROFILE -
HIGHWAY 404 E-N RAMP
STA. 5+600 - 5+920

DESIGNED BY: H.X.	CHECKED BY: C.V.	PROJECT NO.
DRAWN BY: H.X.	CHECKED BY: C.V.	DRAWING NO.
HORIZONTAL SCALE: 1:500	VERTICAL SCALE: 1:100	R5
DATE: 2025/08/01		

CITY FILE NO.:





KEY PLAN
(NOT TO SCALE)

LEGEND:

NOTES:

BENCH MARK:
(MIN. TWO FOR SUBDIVISION AND ONE FOR SITE PLAN)

No.	DESCRIPTION	DATE
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REVISIONS		
 THE CORPORATION OF THE CITY OF MARKHAM ENGINEERING DEPARTMENT		
PREFERRED DESIGN CONCEPT	HIGHWAY 404 EXTENSION ROAD	 ROLL PLAN - EXTENSION ROAD (3:1 SIDE SLOPE)

DESIGNED BY: H.X.	CHECKED BY: C.V.	PROJECT NO.
DRAWN BY: H.X.	CHECKED BY: C.V.	DRAWING NO.
SCALE: 1 : 1000		A2
DATE: 2025/11/11		
CITY FILE NO.:		

Highway 404 EA Addendum - Design Criteria Extension Road

Prepared By:
Last Updated:

C. Voytenkov
30-Sep-24

	Design Standard 2009 ESR	Proposed Standard 2009 ESR	Design Standard TAC 2017/City of Markham	Proposed Standard ESR Addendum	Source/Notes
Road Classification	Arterial	Arterial	Collector	Collector	Markham OP (2014)
Lanes	2	3 (2 NB / 1 SB)	2	2	Transportation Study Update (2024) [Arcadis]
Design Speed	60 km/h	80 km/h	50 km/h	50 km/h	Transportation Study Update (2024) [Arcadis]
Posted Speed	50 km/h	50 km/h	40 km/h	40 km/h	Transportation Study Update (2024) [Arcadis]
Minimum Horizontal Radius	250 m	250 m	115 m 150 m	210 m	TAC Table 3.2.4 COM Eng Stds Sec B Table 2
Minimum Vertical Curve					
Crest	35	35	7	7	TAC Table 3.3.2
Sag	30	40	13	13	TAC Table 3.3.4
Sag Illuminated			6	6	TAC Table 3.3.5
Maximum Grade	12.00%	1.70%	6.00%	6.00%	City of Markham Eng Stds Sec B- Table 2
Minimum Grade	0.50%	0.50%	0.70%	0.5% (Note 2)	City of Markham Eng Stds Sec B- Table 2
Lane Width Minimum	3.5 m	3.5 m	3.5 m	3.5 m	City of Markham
Right of Way	20m	20m	20m	20m	City of Markham
Boulevard	Not Provided	Not Provided	NA	2.8 m	NA
Crossfall	Not Provided	Not Provided	2.00%	2.00%	City of Markham
Active Transportation	Not Provided	Not Provided	NA	3.0m Multi-Use Path (Note 3)	GF Memo
Sidewalk	Not Provided	Not Provided	NA	NA	City of Markham
Clear Zone	Not Provided	Not Provided	4.5m	4.5m	TAC table 7.3.1

1. Development Engineering and Urban Design requirements to be reviewed during detailed design.

2. The proposed minimum grade of 0.5% falls short of the applicable standard of 0.7% per City of Markham standard. Requirements to be reviewed during detailed design.

3. The Design Guidelines for Separated Cycling Facilities, Multi-Use Paths & Trails, developed as part of the City of Markham Active Transportation Master Plan (ATMP), provide design standards for multi-use paths (MUPs). Requirements to be validated during detailed design.

HIGHWAY 404 / MAJOR MACKENZIE RAMP EXTENSION

PRELIMINARY STRUCTURAL DESIGN REPORT

CITY OF MARKHAM

Markham, ON

August 2026

FIRM PROJECT NO.: 074748

Prepared for:
City of Markham



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FIGURES

Figure 1 – Location Plan 2

APPENDICES

Appendix A – Preliminary General Arrangement Drawing

1. INTRODUCTION

The City of Markham is proposing to construct a new road extending north from the existing northbound ramp terminal at the Highway 404 / Major Mackenzie Drive interchange. This includes realignment of the existing E-N ramp and construction of a bridge over the realigned ramp. A Structural Planning Report for this project was prepared in 2008 as part of the Municipal Class Environmental Assessment process. Some refinements have been made to the previous design as part of the current study. This Preliminary Structural Design Report documents the updated preliminary design for the proposed bridge.

2. PROJECT LOCATION



Figure 1 – Location Plan

3. PROPOSED WORK

The proposed new bridge will carry the new road over the realigned E-N ramp. A single-span reinforced concrete rigid frame structure is proposed. In addition, mechanically stabilized earth (MSE) retaining walls are proposed at the four corners of the bridge, to support the embankments adjacent to the realigned ramp.

4. HORIZONTAL AND VERTICAL ALIGNMENT

5.1 Highway 404 E-N Ramp

The horizontal alignment of the E-N ramp will be shifted to the north of the existing ramp, on a new alignment. The proposed radius of the new alignment is 250 m, and the proposed vertical profile is on a constant grade of 0.90% at the bridge.

5.2 New Road

The horizontal alignment of the new road will be tangential at the bridge, and the proposed vertical profile is on a constant grade of 0.66% at the bridge.

5. CROSS-SECTIONS

5.1 Highway 404 E-N Ramp

The realigned E-N ramp will have a lane width of 4.75 m. On the south side of the ramp lane, a 1.0 m wide shoulder is provided, along with a concrete barrier (0.4 m width) cast against the abutment and retaining walls. On the north side of the ramp lane, a 2.5 m wide shoulder is provided. In addition, a horizontal clearance of at least 8.4 m is provided from the edge of the ramp lane to the north abutment and retaining walls, in order to satisfy stopping sight distance requirements.

5.2 New Road

The new road extending from the ramp terminal will have one northbound lane and one southbound lane over the new bridge, along with multi-use paths (MUPs) and associated elements. The bridge cross-section will comprise the following:

MUP Bicycle Barrier:	380 mm
Buffer:	300 mm
MUP:	3000 mm
Buffer:	2550 mm
Separation Barrier:	250 mm
Buffer:	200 mm
Southbound Lane:	3500 mm
Northbound Lane:	3500 mm
Buffer:	200 mm
Separation Barrier:	250 mm
Buffer:	2550 mm
MUP:	3000 mm
Buffer:	300 mm
MUP Bicycle Barrier:	380 mm

6. STRUCTURE TYPE

Several structure types were considered, with relevant advantages and disadvantages listed below:

Structure Type	Advantages	Disadvantages
Reinforced Concrete Rigid Frame	- Efficient for bridges with high abutments (deck acts as a strut). - No expansion joints required. - Long-term durability	- Slightly longer duration of site construction compared to other options. - Requires falsework below bridge (can be accommodated at this site).
Concrete Deck on Prestressed Concrete Girders (I-girders or box girders)	- Falsework below bridge is not required. - Slightly shorter duration of site construction compared to other options.	- Less efficient for bridges with high abutments. - Expansion joints can be eliminated via integral or semi-integral abutments, but at a higher construction cost compared to a rigid frame structure.
Concrete Deck on Steel Girders (I-girders or box girders)	- Falsework below bridge is not required. - Slightly shorter duration of site construction compared to other options.	MTO Structural Manual does not permit I-girders for this exposure condition. Structure depth is insufficient for steel box girders.

Considering that this bridge will require relatively high abutments and access below the bridge is available for falsework, the most appropriate and cost-effective structure type for this site is a reinforced concrete rigid frame structure on spread footings. This structure type will provide optimal long-term durability (no expansion joints or bearings, which are a common source of rehabilitation and maintenance needs).

To simplify construction, the abutments walls will be built without a curvature while satisfying the minimum clearance requirements for the curved ramp alignment. The resulting span length is 20.5 m (measured along the new roadway alignment), with the abutments at a skew angle of approximately 42° to the new roadway alignment. The structure is proposed to be 'overbuilt' so that the skew angle will be reduced to 30°. Considering the overbuilt geometry, the span length is effectively reduced to approximately 17.6 m (i.e. measured along edge of structure). MSE retaining walls are proposed at the four corners of the bridge.

Due to the relatively wide MUP and buffer areas, and vertical clearance restrictions, it is proposed to slope the outer portions of the bridge towards the roadway, including the deck soffit. This moves the location of minimum vertical clearance to below the separation barriers rather than at the outer edge of the bridge. The MUP and buffer areas will drain through drainage holes in the separation barriers, and the overbuilt areas on the outside of the structure will drain off the ends of the bridge.

7. CONSTRUCTION STAGING

The new structures will be built to the north of the existing ramp, in order to allow for the ramp to remain operational during construction.

8. GEOTECHNICAL RECOMMENDATIONS

A Draft Geotechnical Site Investigation was prepared in July 2024 by GEMTEC Consulting Engineers and Scientists Limited. Based on the report, the soils at the site consist of fill materials underlain by native interlayered sand and sandy silt, and (predominantly) silty clay and organic silty clay deposits, all underlain by a silty sand till deposit. At the time of completion of drilling, the boreholes were noted to be dry; however, this condition is not expected to be a stabilized groundwater condition and the groundwater levels are expected to fluctuate. The following options are feasible for the foundations of the proposed new bridge:

8.1 Shallow Foundations

Shallow foundations (i.e. spread footings) are suitable for the abutments. For footings founded directly on the properly prepared and inspected native subgrade, a factored ULS resistance of 300 kPa and a factored serviceability geotechnical reaction of 150 kPa may be used for design. Alternatively, if properly placed and compacted OPSS 1010 Granular A or unshrinkable fill is used as engineered fill below the footings (1.5 m thick), a factored ULS resistance of 400 kPa and a factored serviceability geotechnical reaction of 500 kPa may be used for design.

The preferred design includes spread footings founded on a 1.5 m thick Granular A pad.

8.2 Deep Foundations

Recommendations for driven steel H-piles are also included in the report. For HP310x110 piles driven to practical refusal at about Elevation 187 m, a factored geotechnical axial resistance at ULS of 1400 kN may be used for design, and the SLS reactions will not govern. Pile foundations are not included in the preferred design since spread footings are expected to be more economical at this site.

9. CONSTRUCTION COST

The preliminary estimated construction cost for the new bridge and retaining walls is summarized as follows. These costs are exclusive of HST.

Bridge:	\$	7,500,000
Retaining Walls:	\$	<u>1,200,000</u>
Total:	\$	8,700,000

It should also be noted that the cost for retaining walls only includes retaining walls located in the direct vicinity of the bridge. Additional costs would be expected for retaining walls which continue further north of the bridge.

10. MISCELLANEOUS

10.1 Design Codes and Standards

The design of the new structures will be in accordance with the following documents (the applicable version at the time of the detailed design):

- Canadian Highway Bridge Design Code CSA S6
- MTO Structural Manual
- MTO RSS Design Guidelines
- Ontario Provincial Standard Specifications

10.2 Drainage

Deck drains are not required on the bridge. Catch basins will need to be provided at the bridge approaches and drainage holes will be present in the separation barriers between the lanes and MUPs.

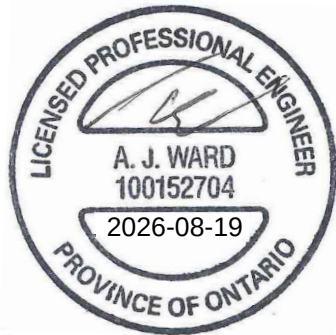
10.3 Barriers and Railing Systems

MUP bicycle barriers as per MTO Structural Standard Drawing SS110-22 will be built at the east and west sides of the bridge, with railings satisfying bicycle height requirements (1.37 m height). In addition, TL-4 MUP separation barrier (parapet) walls per SS110-110 will be built between the roadway and MUP on both sides of the road.

10.4 Approach Slabs

Approach slabs as per MTO Structural Standard Drawing SS105-15 will be built at both abutments. It is proposed that the width of these approach slabs be limited to the roadway width at this bridge.

Prepared by:



Andrew Ward, P.Eng.
Principal Bridge Engineer

Reviewed by:



William Van Ruyven, P.Eng., PMP
Vice President | Bridges & Structures Lead, Canada

APPENDIX A

Preliminary General Arrangement Drawing

