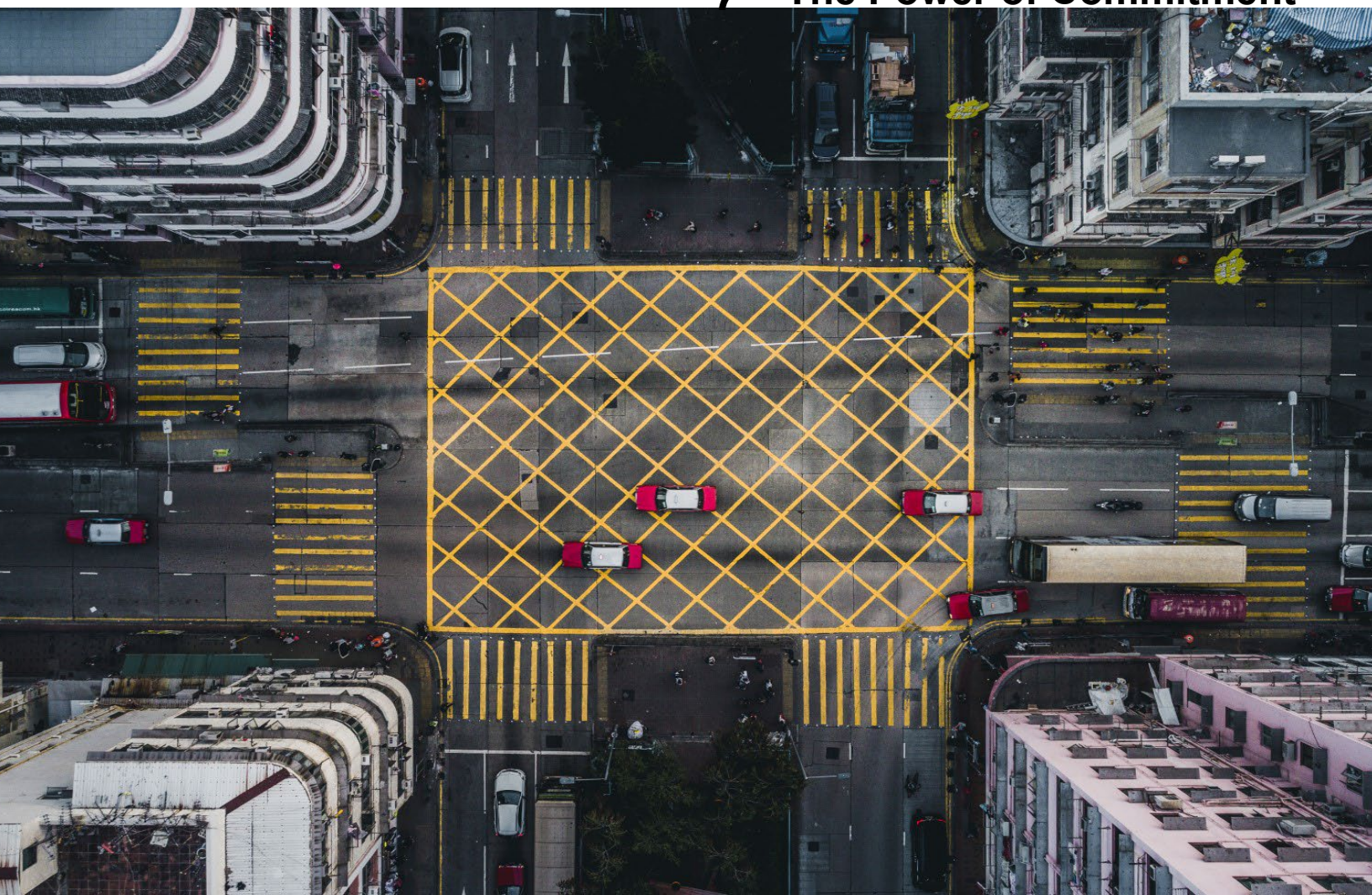
Derailment Protection Report

388 Cumberland Avenue, Hamilton, Ontario (Mile 56.60)

Biz Mechanical

June 27, 2025

→ The Power of Commitment



Project name		388 Cumberland Avenue, Hamilton, Ontario					
Document title		Derailment Protection Report | 388 Cumberland Avenue, Hamilton, Ontario (Mile 56.60)					
Project number		12657125					
File name		12657125-Derailment Protection Report-388 Cumberland Ave.docx					
Status Code	Revision	Author	Reviewer		Approved for issue		
			Name	Signature	Name	Signature	Date
S3	1st Submission	Corinne Ruthenberg	Steve Starcevic		Michael Mikhail		05/20/2025
S4	2nd Submission	Haoran Qi	Steve Starcevic		Michael Mikhail		06/27/2025

GHD
Contact: Steve Starcevic, Project Manager, Senior | GHD
100 Milverton Drive, Suite 404
Mississauga, Ontario L5R 3G2, Canada
T +1 647898-4940 | **E** michael.mikhail@ghd.com | **ghd.com**

Contents

Table index

Figure index

Appendices

Attachments

1. Introduction

Since 1980, railway companies have established a set of criteria for new developments adjacent to their respective rail corridors. Based on the adjacent railway track's function and volume of traffic, each track is compartmentalized into different classifications. With each railway classification, a stringent set of guidelines and regulations are applied to the development to safeguard against train derailment.

As per the existing site conditions, proposed site features and railway elements, the proposed development will be analyzed in accordance with the guidelines of the Railway Association of Canada (RAC), the Federation of Canadian Municipalities (FCM), Metrolinx Adjacent Development Guidelines, and AECOM's Submission Guidelines. Once the development has been analyzed, the necessary protection measures will be recommended accordingly.

1.1 Purpose of this report

This report has been prepared as supporting documentation for the development of the property at 338 Cumberland Avenue, in the City of Hamilton, Ontario. The report shall be supplemental to the documentation included for a Site Plan Amendment (SPA). The development of the subject site will consist of one (1) residential building.

1.2 Scope and limitations

This report: has been prepared by GHD for Biz Mechanical and may only be used and relied on by Biz Mechanical for the purpose agreed between GHD and Biz Mechanical as set out in section 1.1 of this report.

GHD otherwise disclaims responsibility to any person other than Biz Mechanical arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report (refer to section 3.0 of this report). GHD disclaims liability arising from any of the assumptions being incorrect.

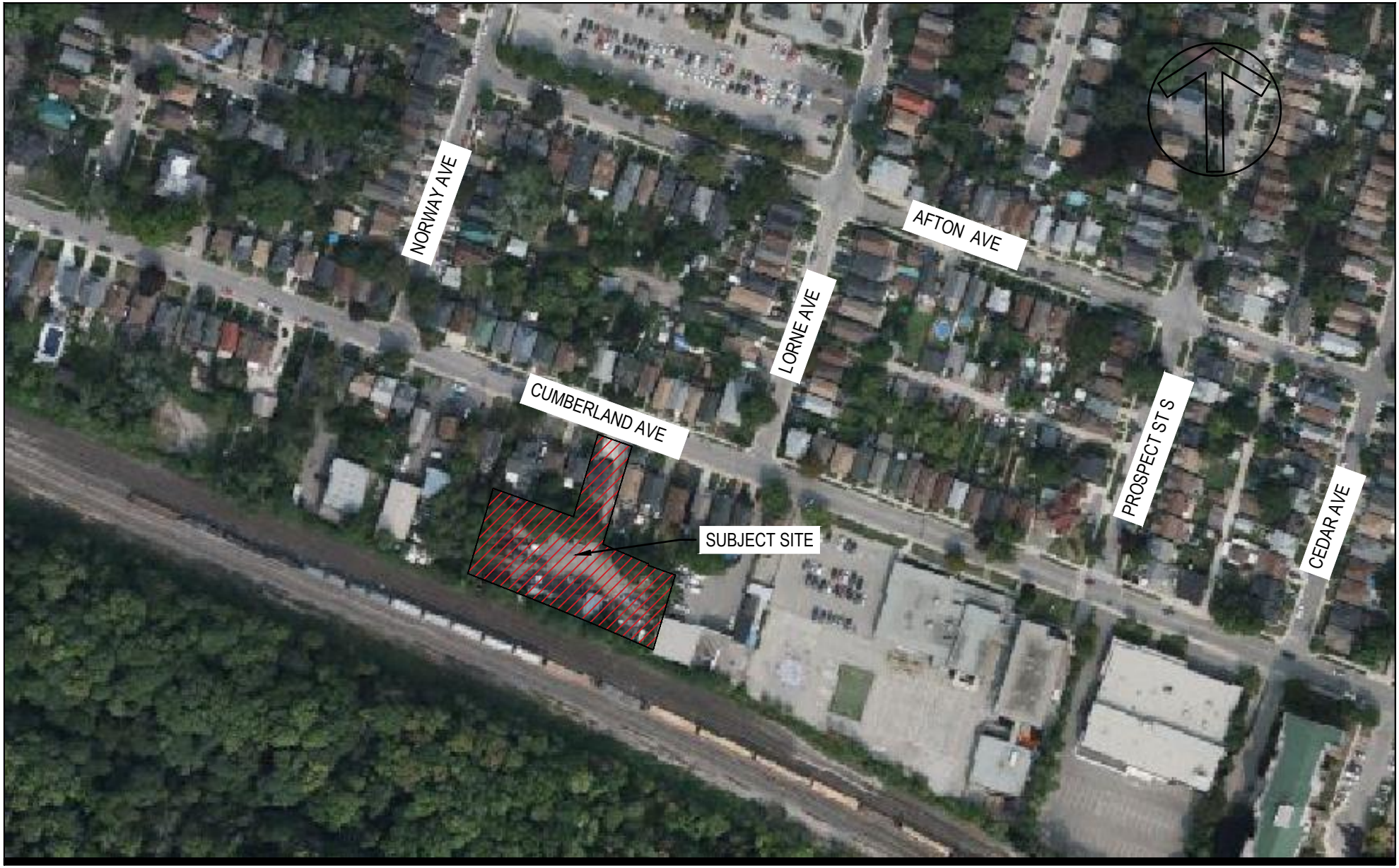
Accessibility of documents

If this report is required to be accessible in any other format, this can be provided by GHD upon request and at an additional cost if necessary.

1.3 Background

The subject site is located within the City of Hamilton, Ontario, on Cumberland Avenue; situated between Norway Avenue and Lorne Avenue (see ***Figure 1*** for details). The proposed development is approximately 0.31 ha in area. Bordering the subject site to the east and west are industrial developments. There are residential properties north of the subject site. Adjoining the south limit of subject site is the rail corridor which is presently owned and operated by Canadian Pacific Kansas City (CPKC).

The subject site is located within 300 meters of the CPKC Hamilton Subdivision. Within this corridor there are six (6) tracks, located at mile 56.60 of the CPKC Hamilton Subdivision. The closest railway track to the subject property is approximately 5.0m away from the subject site's property line. CPKC no longer issues volume data; therefore, this report does not include any train volume information related to the railway track. The current track design speed on this rail corridor for the CPKC Rail service is conservatively estimated to be 60 mph (96.6 km/h), and the track classification is a rail yard.



GHD

Key Plan

DESCRIPTION

Project No. 12657125
Date 4/25/2025

Figure 1

Filename: Drawing1.dwg
Plot Date: 24 April 2025 2:11 PM

1.4 Development Concept

Biz Mechanical is proposing to develop the site at 338 Cumberland Avenue to one (1) three (3) storey residential building. The residential building is proposing a combination of one (1) bedroom units, and three (3) bedroom units. On the first storey there will also be indoor amenities proposed. Furthermore, the development will also include an at-grade parking lot at the south end of the site (see ***Appendix A*** for development details).

2. Derailment Protection and Setback

2.1 Derailment Protection Criteria

The Federation of Canadian Municipalities (FCM) criteria for derailment protection is based on the classification on the track to which the development is adjacent. The track classification indicates the specific design requirements of the derailment protection measure and the setback distance from the property line to the proposed building.

If the development is to be used in conjunction with an earth berm, the minimum setbacks are dependent on the classification of the track. Typically, a proposed development designated for sensitive use occupancy requires a 2.5-meter-high berm (minimum) with a 30-meter setback. Exceptions to the aforementioned setback requirements can be permitted by the railway company with a maximum reduction up to 5.0 meters to the setback distance (i.e. 25 meters). However, a reciprocal increase in the height of the berm (minimum berm height of 3.0 meters) is required to accommodate the reduction in setback distance. Berm height is taken relative to the grade along the property line of the railway corridor.

Although an earth berm would provide adequate derailment protection, the use of a crash wall would be an approved equivalent. However, standard crash wall heights and thicknesses cannot be recommended due to varying site conditions, setback distances and crash wall designs. In order to design the crash wall, the criteria set out in the FCM/RAC Guidelines, Metrolinx, and AECOM's memorandum are to be referenced. Based on this criterion, one of two methods may be used to engineer the crash wall. These methods are as follows:

– Method 1 (Minimum Point Load)
  - The wall may be designed for a minimum point load of 600 kip (2700 kN) applied horizontally and normal to the face at any point along the wall.
    – The point load shall be applied at a height of 6 feet (1.8 m) above the top of rail for walls up to 25 feet (7.6 m) from the centerline of track, or a height of 6 feet (1.8 m) above the groundline for walls farther than 25 feet (7.6 m) from the centerline of the track.
    – This method may be applied where track speeds do not exceed 50 mph (80 km/hr) for freight or 70 mph (112 km/hr) for passenger trains; where speeds exceed these limits, Method 2 shall be used.
– Method 2 (Energy balance approach)
  - An energy balance approach considering collision by glancing blow and single car rotation my be used to determine the design load. The following four (4) cases must be considered:
    – *Freight Train Load Case 1* – Glancing Blow: nine cars weighing 143 tons (129,700 kg) each, impacting the wall at an angle Θ_G. The angle of impact will be a function of track curvature, and for tangent track may be taken as 3.5 degrees.
    – *Freight Train Load Case 2* – Single Car Impact: single weighing 143 tons (129,700 kg) impacting the wall as it undergoes rotation about its center. The angle of rotation at impact is:

$$\Theta_f = \text{asin}\left(\frac{d_{CL}}{8.5}\right) \qquad \text{[Equation 1]}$$

Where;

DCL is the distance from the cash wall to the centerline of track in meters. The closest existing or future track is to be used. Where dCL is greater than 8.5 m, this load case need not be considered.

– Passenger Train Load Case 3 – Glancing Blow eight (8) cars weighing 74 tons (67,120 kg) each impacting the wall at an angle, ΘG. The angle of impact will be function of track curvature, and for tangent track may be taken as 3.5 degrees.
– Passenger Train Load Case 4 – Single Car Impact: single car weighing 74 tons (67,120 kg) impacting the wall as it undergoes rotation about its center. The angle of rotation at impact is:

$$\Theta f = \text{asin}\left(\frac{d_{CL}}{13}\right) \qquad \text{[Equation 2]}$$

Where DCL is greater than 13 m, this load case need not be considered.

– In all of the above cases, the following parameters are to be considered:
  - Speed of derailed units impacting the wall must be equivalent to the track speed.
  - Height of the application of impact force must be applied at 3 feet above the ground.
– For energy dissipation assume:
  - Plastic deformation of individual cars, due to direct impact, are applied at a maximum of 1 foot.
  - Compression of linkages of three (3) locomotives and six (6) cars consist of a maximum of 5 feet.
  - Deflection of the wall is to be determined by the designer. The design must incorporate horizontal and vertical continuity to distribute the impact loads from the derailed train.

AECOM's memorandum dated March 25, 2013 and AECOM's Crash Wall Guidelines Revision 2, dated July 29, 2014 (see copy of both in ***Appendix B***) also defines structural assessment criteria presented above.

2.2 Proposed Setback

In order to provide an additional level of protection, building setbacks are used in conjunction with protection features to further safeguard against the possibility of train derailment. Building setbacks are typically measured from the mutual property line of the rail corridor and the proposed development to the nearest building façade dedicated for sensitive use areas within the site. These setbacks are intended to provide a dissipation buffer for several different factors such as rail-oriented emissions, noise, vibrations and ultimately velocity reduction in the event of a train derailment. Although an extensively long buffer would be preferred, it is not always feasible or practical to implement due to site conditions and constraints. Therefore, each site must undergo an assessment to evaluate a suitable protection feature and setback distance to safeguard the development.

Typically, when a protection feature (earth berm or crash wall) satisfies the vertical requirements, reviewing agencies can authorize a reduction in horizontal setback limits. However, in practice, setback reductions are applied differently depending on the type of protection: for earth berms, setbacks are measured strictly in horizontal terms based on specific height-to-distance ratios (see **Section 2.1** for details), whereas crash walls may allow the horizontal and vertical components to be combined to meet the minimum total setback requirement (Guidelines for new Development in Proximity to Railway Operations – Prepared for the FCM and the RAC, May 2013). When a proposed development is in close proximity to a rail corridor, and its principal derailment protection feature is a crash wall, a combination of horizontal, and vertical or protection feature setbacks (whichever setback is greater), are proposed provided to satisfy this criterion (see ***Figure 2***). Although the adjacent railway corridor does not operate as principal mainline track, for the purposes of this derailment protection assessment, it is being treated as a principal mainline. This approach reflects the fact that, from a derailment safety standpoint, the operational characteristics of the rail corridor align more closely with those of a mainline in terms of potential derailment risk. The FCM/RAC setback guidelines for rail yards are primarily driven by considerations of occupant comfort related to noise and vibration, rather than derailment safety. Accordingly, this assessment emphasizes the safety dimension and applies principal mainline criteria to support a reasoned and defensible basis for the proposed sensitive land use. Therefore, a combination of horizontal and vertical

setbacks will be used to adhere to the required minimum total setback. Additionally, in accordance with the aforementioned guideline, it is permissible to develop within the setback limits, so as long as the area is developed as a 'low-occupancy' region and there are no principal congregation areas.

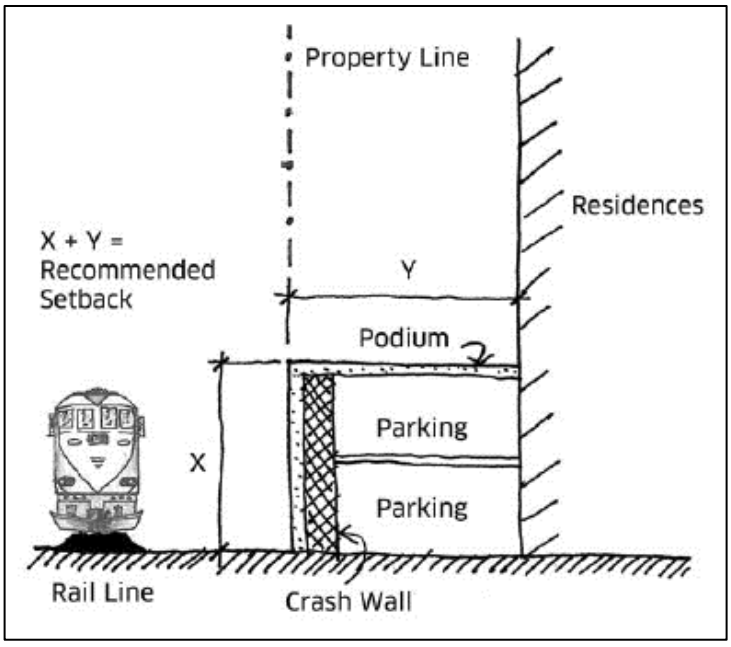


Figure 2 Incorporating a Crash wall into a Development (J.E. Coultler Associates Limited, May 2013)

In order to further understand the setback limits throughout the subject site, ***Table 1*** has been prepared to provide additional clarity. Since the rail safety setback is acceptable to be measured from the operational rail corridor's property line, the *Proposed Track Setback*[1] defines the minimum horizontal setback distance from the operational rail corridor's property line to the centerline of the closest existing track. Although this setback distance is not accounted for in the required setback limits, this supplemental information is helpful because it provides additional levels of safety when the existing track is setback further from the subject property line. The *Minimum Horizontal Setback*[2] defines the minimum horizontal distance from the subject site's property line to the building façade. The *Vertical Setback*[3] defines the vertical height of each floor of the proposed development, above the ground floor. The *Proposed Protection Feature Setback*[4] is defined as the vertical height of the proposed crash walls. The *Minimum Total Setback*[5] is defined by the combination of the *Minimum Horizontal Setback*[2], and the *Vertical Setback*[3], and the *Proposed Protection Feature Setback*[4]. It is also to be noted that the aforementioned setback criteria were measured as the worst-case condition (the closest points).

Table 1 Proposed Setback Distances

Residential Building Level	Existing Track Setback[1] (m)	Minimum Horizontal Setback[2] (m)	Vertical Setback[3] (m)	Proposed Protection Feature Setback[4] (m)	Minimum Total Setback[5] (m)
Ground Floor	5.0	20.0	0.0	5.0	25.0
2nd Storey and Above	5.0	20.0	3.0	5.0	25.0

In the post-development condition, the subject site's nearest point of a 'high-occupancy' region for the residential building is on the ground floor at the building's southwest corner. Additionally, since the site's proposed principal derailment protection feature is a 5.0m high crash wall (see **Section 2.3** for details), the *Minimum Total Setback*[5] is taken as the combination of *Minimum Horizontal Setback*[2] and the *Proposed Protection Feature Setback*[4] which equates to a *Minimum Total Setback*[5] of 25.0m.

The *Minimum Total Setback*[5] for the subject site is justified for a number of reasons. Firstly, considering that if a train were to derail at a 3.5-degree (°) angle relative to the centerline of a potential future track (installed 4m from the property line to the centerline of the potential future track), the derailed train would likely never impact the proposed derailment protection feature or the proposed sensitive use buildings (please see **Section 2.3** for details). Secondly, due to the track switches and the horizontal alignment of the tracks (track curvature) within the corridor, it is likely that trains are traveling at reduced speeds, relative to the assumed principal mainline track speeds of 60mph.

2.3 Proposed Derailment Protection Feature

Typically, when proposed residential uses are proposed adjacent to a rail corridor, at a minimum, a 2.5m high earth berm in conjunction with a 30m setback is required. For the subject site, a 78.1m long crash wall is being proposed as the principal derailment protection feature, which will span along the subject site from the west property line to the east property line. Two (2) 6m long return crash walls are also proposed to protect the sensitive uses from the site's western and eastern flanks.

Typically, a crash wall would require to be a minimum of 2.135m high above top of rail grade, however the proposed crash wall and return crash walls for the project site to be 5.0m high (above top of rail grade). The crash wall height was increased in order to adhere to minimum total setback criteria (see **Section 2.2** for details). Additionally, the crash wall and return crash walls are to be a minimum of 760mm thick (see Derailment Protection Plan and Sections, **DP-1** and **DP-2**, for details). The proposed crash wall and return crash walls are to be coated with anti-graffiti spray. Lastly, the crash wall and return crash wall will be completely independent of any of the proposed sensitive use structures within the development.

Furthermore, the amenity area is not considered a sensitive use area; it is a passive space (low occupancy) therefore, it does not require derailment protection. However, the crash walls are proposed to protect future development/expansion of sensitive uses on the subject site, while also providing additional protection to the proposed residential building currently proposed.

As discussed in **Section 2.2**, since the sensitive use building is adequately setback, if a train were to derail at an angle of 3.5°, relative to the centerline of a potential future track (installed 4m from the property line to the centerline of the proposed track), the train will likely not impact the development. Based on physics principles, the stopping distance of a projectile can be approximated through the consideration of several factors. By utilizing the velocity of the derailed train car, coefficient of friction, and acceleration due to gravity, the stopping distance of a derailed train can be determined. The calculations to determine the stopping distance have been prepared and have been conservatively estimated. The velocity of the derailed train is equal to the maximum track design speed, which is 60 mph. Based on the fact that if a train were to derail in accordance with a maximum design track speed of 60 mph (96.6 km/h), then the maximum stopping distance of the train would be approximately 147 m. The stopping distance is conservatively assumed using hard, flat, and frozen ground with little frictional resistance and no obstructions to attenuate the locomotives momentum. When a derailed train (travelling the maximum track design speed) comes to rest after a derailment, the derailed train would have stopped at approximately 5.0 meters north of the subject site's property line (18.9 m from the proposed residential building). Additionally, due to the track switches and the horizontal alignment of the tracks (track curvature) within the corridor, it is likely that trains are traveling at reduced speeds, relative to the assumed principal mainline track speeds of 60mph.

Therefore, as per the AECOM guidelines and basic trigonometry principles, if a train were to derail at a 3.5° angle relative to the centerline of the proposed future track, the derailed train would likely never impact the proposed development's property line.

Furthermore, for a train to derail and hit the proposed building, it would need to rotate more than 9.3° around the centerline of the potential future track. This means the train would have to alter its trajectory significantly off its normal path. The physical forces required to cause such a rotation are immense and unlikely to occur under normal operating conditions.

2.4 Life Cycle and Operations

In order to ensure that the derailment protection feature(s) continuously operate as per the intended design, scheduled inspection will be required on an ongoing basis to determine the adequacy of said item(s). Although a majority (if not all) of the design features are 'set-it-and-forget it' items, it is prudent to investigate any deficiencies that may occur due to weathering, erosion, fatigue, and/or human interference. Based on the aforementioned, ***Table 2*** has been prepared as a rough approximation in terms of life cycle, inspection frequency and maintenance requirements.

Table 2: Protection Feature Operations

Item	Life Expectancy (years)	Required Inspection Frequency	Maintenance/Inspection Requirements
Crash Walls	100+	Biannually	– Inspect for over excessive wall batter. – Analyze walls for crumbling, structural fractures, and warping.

2.5 Rail Corridor Security

To safeguard against trespassing, the rail corridor will typically be cordoned off with a high security fence along the property line. The requirements of high security fence is that the fence must be 2.43 m in height (minimum) and possess non cut and non climb fabric (see ***Appendix C*** for details). The proposed conditions at the subject site adhere to the minimum security height by providing a 5m high crash wall (exceeding the 2.43m minimum height). As discussed in **Section 2.3**, the proposed wall extends from the western property line to the eastern property line, complete with two (2) 6m long return crash walls. Therefore, the site adheres to Metrolinx fencing and trespassing requirements by providing a 5.0m security height. (see Derailment Protection Plan **DP-1** for more details).

2.6 Risk Assessment

As outlined in the 2013 CFM Guidelines, the individual risks for the proposed development must be identified and evaluated. Each risk shall outline mitigation measures which are proposed or planned to address these risks. Such risks may include injury, loss of life and/or damage to public or private infrastructure.

Table 3 (See ***Appendix D*** for details) summarizes potential risk generated from developing 338 Cumberland Avenue adjacent to a rail corridor.

3. Conclusions and Summary

- The subject site consists of one (1) three (3) storey residential building.
- The site will satisfy setback criteria by providing a minimum total setback of 25.0 m
- The site will provide a 71.8m long crash wall and two (2) 6m long return crash walls along the property line. The crash wall and return crash walls are to be 0.76 m thick (minimum) and 5.0 m high (above top of rail). The proposed crash wall and return crash walls are to be coated with anti graffiti spray. Lastly, the crash walls will be completely independent of any of the proposed sensitive use structures within the development.
- If a train were to derail at an angle of 3.5°, relative to the centerline of a potential future track installed 4 m south of the property line, the train will likely not impact the derailment protection feature.

Prepared by:

Checked by:

Haoran Qi
Engineer in Training, Land Development
+1 905 429-5058
Haoran.Qi@ghd.com

*Seal does not include review and design of structural elements. Final design to be confirmed by Structural Engineer of Record

Steve Starcevic, P.Eng.
Engineering Design Organization, Civil Team Lead
416-904-4677
Stephan.starcevic@ghd.com

Appendices

Appendix A

Site Plan

CUMBERLAND AVENUE

SCALE 1:400

URBAN PROTECTED RESIDENTIAL - ONE AND TWO FAMILY DWELLINGS, ETC. "D/S-476"

EXISTING 2 STOREY SINGLE DETACHED DWELLING

EXISTING SINGLE DETACHED DWELLING

EXISTING SINGLE DETACHED DWELLING

EXISTING SINGLE DETACHED DWELLING

GARAGE

GARAGE

RESTRICTED LIGHT INDUSTRIAL DISTRICT "JJ"

N70°34'10"W 43.638

N16°33'50"E 38.638

2.06

7.50

14.073

R6

R6

N70°34'10"W

4.59

4.59

1.98

34.662

1.80

1.47

PROPOSED STACKED TOWNHOUSE
12-24 UNITS
341.99 m² (3,681 ft²)

BOLLARD LOCATION

6.00

N16°33'50"E 20.00

9

5.80 TYP.

2.80 TYP.

21.28

6.00

1.50

3.30

N68°27'40"W 25.277

R9

EXISTING SINGLE DETACHED DWELLING

EXISTING SINGLE DETACHED DWELLING

EXISTING 2 STOREY SINGLE DETACHED DWELLING

EXISTING 2 STOREY SINGLE DETACHED DWELLING

N16°33'50"E 38.638

1.50

GARAGE

URBAN PROTECTED RESIDENTIAL - ONE AND TWO FAMILY DWELLINGS, ETC. "D/S-476"

N66°48'10"W 19.513

0.634

N16°33'50"E

N70°34'10"W 11.125

RESTRICTED LIGHT INDUSTRIAL DISTRICT "JJ"

AMENITY AREA

BOLLARD LOCATION

9

5.80 TYP.

2.80 TYP.

6.00

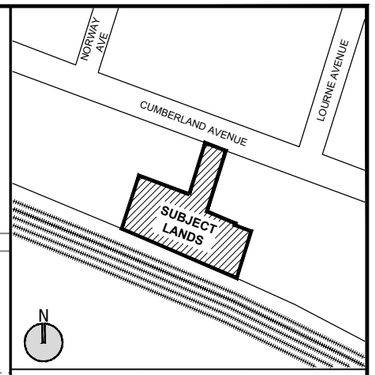
1.50

30.480

EXISTING 1 STOREY LIGHT INDUSTRIAL

WASTE PICKUP

R=1193.292
A=52.894
C=52.890
N67°11'35"W



KEY MAP - N.T.S.

SCALE 1:400

METRES

0 5 10 15 20

LEGEND

SUBJECT LANDS

PROPOSED BUILDING

NOT FOR CONSTRUCTION
ISSUED FOR REVIEW & COMMENTS ONLY

NOTES:

ALL DIMENSIONS SHOWN ON THIS PLAN ARE IN METRES AND CAN BE CONVERTED TO FEET BY DIVIDING BY 0.3048.

DESIGN BY: S. ERICKSON	CHECKED BY: M. JOHNSTON
DRAWN BY: S. ERICKSON	DATE: APRIL 21, 2025

est. 2014
URBAN SOLUTIONS
PLANNING & LAND DEVELOPMENT
3 STUDEBAKER PLACE, SUITE 1
HAMILTON, ON L8L 0C8
905-546-1087 - urbansolutions.info

PROJECT:

338 & 338 ½
CUMBERLAND AVENUE
CITY OF HAMILTON

CLIENT:

2115616 ONTARIO INC.

TITLE:

CONCEPT PLAN

U/S FILE NUMBER:	SHEET NUMBER:
349-20	1

C:\Users\LucasTaibi\Urban Solutions\Active Projects - Documents\349-20 - 338 Cumberland Avenue\2 - Drawings\1 - UrbanSolutions\Concept Plan\2025\349-20 - Concept Plan - 2025-04-21.dwg

Appendix B

AECOM Guidelines

Submission Guidelines for Crash Walls

Crash walls may be required for the protection of overhead structures, and in some cases the Railway may consider a crash wall as an alternative to an earthen berm for the protection of structures or facilities adjacent to the track. When proposing or designing such a structure, the following components should be in the submission. Where there is a discrepancy between the requirements here and those provided by the client Railway or AREMA, the more stringent shall govern.

1. Covering Letter

- Summary of items enclosed,
- Location and date of previous, approved, similar designs by this designer, if any,
- Where the crash wall is proposed as an alternative to an earthen berm: alternative materials / configurations considered and benefits of this design,
- A Location or Key Plan. This will be used to identify the mileage and subdivision, the classification of the rail line, and the maximum speed for freight and passenger rail traffic, all obtained from AECOM Canada for CP and CN-owned corridors or from GO Transit for GO-owned corridors.
- Name, phone, fax and e-mail address of your contact.

2. Geotechnical Report - (2 copies)

- Soil properties used in design, and how determined,
- Borehole logs including location plan, if required to support these properties,
- Narrative report describing soil and ground water conditions, if required as above.

3. Design of Crash Walls

- One of the following methods may be chosen, or an alternative design load may be selected and if it can be justified by the engineer responsible for the design. The simplified approach of Method 1 may be used in most cases. Method 2 may be used to optimize the design, or where factors such as distance from the track to the wall, track speeds, side slopes along the track, consequences of collision or others may justify a different load.
- **Method 1**: The wall may be designed for a minimum point load of 600 kip (2700 kN) applied horizontally and normal to the face at any point along the wall
    - The point load shall be applied at a height of 6 feet (1.8 m) *above the top of rail* for walls up to 25 feet (7.6 m) from the centerline of track, or a height of 6 feet (1.8 m) *above the groundline* for walls farther than 25 feet (7.6 m) from the centerline of track.

  - This method may be applied where track speeds do not exceed 50 mph (80 km/hr) for freight or 70 mph (112 km/hr) for passenger trains; where speeds exceed these limits, Method 2 shall be used.

- **Method 2**: an energy balance approach considering collision by glancing blow and single car rotation may be used to determine the design load. The following four cases must be considered:

  - Freight Train Load Case 1 - Glancing Blow: nine cars weighing 143 tons (129 700 kg) each, impacting the wall at an angle, θ_G. The angle of impact will be a function of track curvature, and for tangent track may be taken as 3.5 degrees.

  - Freight Train Load Case 2 - Single Car Impact: single car weighing 143 tons (129 700 kg) impacting the wall as it undergoes rotation about its center. The angle of rotation at impact is:

    $$\theta_f = \text{asin}\left(\frac{d_{CL}}{8.5}\right) \quad [1]$$

    where d_{CL} is the distance from the crash wall to the centerline of track in m. The closest existing or future track is to be used. Where d_{CL} is greater than 8.5 m, this load case need not be considered.

  - Passenger Train Load Case 3 - Glancing Blow: eight cars weighing 74 tons (67120 kg) each impacting the wall at an angle, θ_G. The angle of impact will be a function of track curvature, and for tangent track may be taken as 3.5 degrees.

  - Passenger Train Load Case 4 - Single Car Impact: single car weighing 74 tons (67120 kg) impacting the wall as it undergoes rotation about its center. The angle of rotation at impact is:

    $$\theta_f = asin\left(\frac{d_{CL}}{13}\right) \quad [2]$$

    Where d_{CL} is greater than 13 m, this load case need not be considered.

  - The analysis should reflect the specified track speeds for passenger and/or freight trains applicable within the subject corridor.

  - To assist in designing the structure for the above load cases, use:

    - For the glancing blow load cases, the speed of derailed equipment impacting the wall is reduced from the track speed, v_o, to

      $$v_G = \sqrt{v_o^2 + 2a\left(\frac{d_{CL}-1.625}{\sin\theta_G}\right)} \text{ [m/s]} \quad [3]$$

      Where d_{CL} is the distance from the crash wall to the centerline of track in m.

      v_o is the track speed in m/s

      θ_G is the angle of impact

a is the acceleration in m/s, calculated as $-9.8(.25 + \mathrm{G})$

G is the grade in decimal unit of the groundline in the direction of travel defined by the angle of impact relative to the centerline of track; calculated as $\frac{Groundline\ at\ wall - Base\ of\ Rail}{d_{CL}/_{sin\theta_G}}$.

- For the single car load cases, the speed of derailed equipment impacting the wall is

$$v_A = \frac{2.3\theta_f}{\sqrt{1-cos\,\theta_f}}\left[\frac{m}{s}\right] for\ freight\ cars \quad [4]$$

$$v_A = \frac{2.9\theta_f}{\sqrt{1-cos\,\theta_f}}\left[\frac{m}{s}\right] for\ passenger\ cars \quad [5]$$

Where θ_f is the angle of impact, in radians, defined in [1] and [2].

- For energy dissipation, assume:
  - Contact with the wall stops all movement in the direction perpendicular to the wall, but not along its length
  - Plastic deformation of individual car due to direct impact is 1 foot (.3048 m) maximum,
  - Total compression of linkages and equipment of the 8 or 9 car consist is 10 feet (3.048 m) maximum,
  - Deflection of wall is considered negligible in equations [6] to [9]. Where the designer wishes to include it, those equations may be modified.
  - In lieu of more rigorous analysis, these energy balance equations may be used to determine the design load perpendicular to the wall. The design load acts along the given length of wall.
    - For the glancing blow load cases

$$F_G = \frac{\frac{1}{2}m(v_G \sin\theta_G)^2}{d_G} \quad [6]$$

And the load is considered to act along the length l_G in m:

$$l_G = \frac{3.048}{\cos\theta_G} \quad [7]$$

Where m is the mass of the derailed cars in kg.

v_G is the impact speed in m/s, defined in [3]

$\theta_G$is the angle of impact

d_G is the deformation of the consist in the direction of the applied force, and $d_G = 3.048 \sin \theta_G$, in m

- For the single car impact

$$F_A = \frac{\frac{1}{2} m (v_A \cos \theta_f)^2}{d_A} \quad [8]$$

And the load is considered to act along the length l_A in m:

$$l_A = \frac{.3048}{\sin \theta_f} \quad [9]$$

Where m is the mass of the derailed cars in kg.

v_A is the impact speed in m/s, defined in [4] or [5]

θ_f is the angle of rotation at impact defined in [1] or [2]

d_A is the deformation of the consist in the direction of the applied force, and $d_A = .3048 \cos \theta_f$, in m

Where the influence areas of two sequential cars in an accordion style of derailment overlap, the wall must be designed for the simultaneous impact of both cars.

- Regardless of the method selected, the following guidelines must be followed:
    - The minimum thickness for walls up to 25 feet (7.6 m) from the centerline of track shall be 2'-6" (.760 m); minimum thickness for walls farther than 25 feet (7.6 m) from the centerline of track shall be 18 inches (.45 m).
    - Crash walls less than 12 feet (3.6 m) from the centerline of track shall be a minimum of 12 feet (3.6 m) above the top of rail. Crash walls between 12 feet (3.6 m) and 25 feet (7.6 m) from the centerline of track shall be a minimum of 7 feet (2.135 m) *above the top of rail*. Crash walls greater than 25 feet (7.6 m) from the centerline of track shall be a minimum of 7 feet (2.135 m) *above the adjacent groundline*.
    - The face of the crash wall shall be smooth and continuous, and shall extend a minimum of 6 inches (0.15 m) beyond the face of the structure (such as a building column or bridge pier) parallel to the track.
    - The design must incorporate horizontal and vertical continuity to distribute the loads from the derailed train.
    - The wall must be of solid, heavy construction, and separate precast blocks or stones will not be permitted.

4. Drawings - (2 hard copies as well as .pdf format)

- Site plan clearly showing property line, location of wall structure, centerline and elevation of nearest rail track,
- Layout and structural details of proposed structure, including all material notes and specs and construction procedures/phasing. All drawings signed and sealed by a professional engineer registered in the province having jurisdiction at the project location.
- Extent and treatment of any temporary excavations on railway property.

5. Cheque

- A cheque payable to AECOM will be required for the cost of this review. Please contact AECOM for current pricing. Cost will take into consideration number of submissions, site visits, meetings, and alternative or unusually complex designs.

6. Post-Construction Certificate - (1 copy)

- Engineer's certificate of completion describing actual construction, and certifying that the structure was built as per approved drawings,
- Copy of as-built drawings, as part of the engineer's certification of completion.

Access to Railway Operating Rights-of-Way

Permits **MUST** be obtained before entering into any Railway Operating right-of-way.

Some or all of the following may also be required: - proper railway flagging protection, cable locates, liability insurance, release of liability, safety training.

AECOM Canada Ltd. will provide guidance as to the proper process to be followed in this regard. Fees will be established based on the nature and extent of the work being proposed.

Communication for Submissions

All correspondence during the review process should be directed to AECOM Canada Ltd.

Upon completion of our review, a confidential report on our findings will be made to the railway company, who will subsequently contact the applicant.

The applicant will be notified when the report has been submitted to the railway.

Liability and Responsibility

The review will be undertaken with the understanding that neither the railway nor AECOM Canada Ltd. shall have any responsibility nor liability whatsoever for the design or adequacy of the crash wall, notwithstanding that any plans or specifications may have been reviewed by the railway nor AECOM Canada Ltd. No such review shall be deemed to limit the applicant's full responsibility for the design and construction adequacy of the works.

AECOM Canada Ltd.

Mississauga, Ont.

July 2005 Revised July 29, 2014

Appendix C

Rail Corridor High Security Fence

METROLINX

Fencing and Gates Specification

Section 32 31 19

Revision 0
Date: July 2022

Fencing and Gates Specification

Section 32 31 19

Publication Date: July 2022

Amendment Record Sheet

Amendment in Clause No.	Date of Amendment	Description of Changes

LIST OF CONTENT

1. GENERAL

1.1. DESCRIPTION OF WORK

1.1.1. This Section 32 31 19 – Fencing and Gates, specifies the Contractor requirements for fencing, gates and associated fittings and hardware for the Work.

1.2. RELATED SECTIONS

1.2.1.	Division 1 – General Requirements	Section 01 11 00 – 01 91 13

1.3. REFERENCE DOCUMENTS

1.3.1. The Contractor shall perform Work in accordance with GO Transit, Design Requirements Manual (DRM), latest version.

1.3.2. The Contractor shall perform Work in accordance with Metrolinx Fencing and Anti-Trespassing Requirements, latest version.

1.3.3. The Contractor shall perform Work in accordance with National Building Code of Canada (NRCC 51690), latest edition.

1.3.4. The Contractor shall perform Work in accordance with Canadian Standards Association (CSA), latest version including:

a) CAN/CSA G164-M92 (R2003), latest revision, Hot Dip Galvanizing of Irregularly Shaped Articles;

b) CAN/CSA - A23.1, latest revision, Concrete Materials and Methods of Concrete Construction; and

c) CAN/CSA – A23.5-98, latest revision, Supplementary Cementing Materials.

1.3.5. The Contractor shall perform Work in accordance with Ontario Provincial Standard Specification (OPSS), latest version including:

a) OPSS.PROV 772, latest revision, Material Specifications for Chain-Link Fence Components;

b) OPSS.PROV 1540, latest revision, Material Specifications for Standard Highway Fence Components;

c) OPSS.PROV 1541, latest revision, Construction Specification for Chain Link Fence Components; and

d) OPSS 1601, latest revision, Material Specifications for Wood, Preservative Treatment and Shop Fabrication.

1.3.6. The Contractor shall perform Work in accordance with Ontario Provincial Standard Drawing (OPSD):

a) OPSD 900.03, latest revision, Fence, Chain link Component – Gate;

b) OPSD 972.101, latest revision, Fence, Chain Link Component – Barbed Wire;

c) OPSD 972.101, latest revision, Fence, Chain Link Component – Roadway; and

d) OPSD 991.1320, latest revision, Expanded Metal Anti-Glare Screen, Installation – Chain Link Fence.

1.3.7. The Contractor shall perform Work in accordance with Canadian General Standards Board (CGSB) specifications:

a) CGSB – 1.181, latest version, Ready-Mixed Organic Zinc-Rich Coating

b) CGSB-138.1-96, latest revision, Fabric for Chain Link Fence;

c) CGSB-138.2-96, latest revision, Steel Framework for Chain Link Fence; and

d) CGSB-138.4-96, latest revision, Gate for Chain Link Fence.

1.4. QUALITY CONTROL

1.4.1. The Contractor shall conduct Work of this Section 32 31 19 – Fencing and Gates in accordance with Section 01 45 00 – Quality Control.

1.4.2. The Contractor shall ensure the Manufacturer is responsible to plan, establish, implement and maintain their own quality control program to ensure all materials and products meet the requirements of the specifications.

1.4.3. The Contractor shall ensure the Manufacturer meets the applicable requirements of the Contract Conditions and has a minimum of five years of experience manufacturing decorative metal fences and gates of the type specified. The Contractor shall ensure the Manufacturer provides test reports showing compliance with specified performance characteristics, and on-Site technical representation to advise on installation.

1.4.4. The Contractor shall ensure that the installer has past experience in performing the Work of this Section 32 31 19 – Fencing and Gates and is specialized in installations of a similar size and nature. The Contractor shall submit to Metrolinx, the installer's current certificate of approval by the Manufacturer as proof of compliance.

1.4.5. The Contractor shall arrange with the Manufacturer's representative, installer's representative, and the Consultant to inspect substrates, and to review installation procedures two Business Days in advance of installation.

1.4.6. The Contractor shall ensure fencing layout is completed by a surveyor, registered and licensed to practice in the Province of Ontario.

1.4.7. The Contractor shall keep records of inspection work by the Manufacture and shall make records available to Metrolinx during the performance of the Contract.

1.5. SUBMITTALS

1.5.1. The following submittals are in addition to the requirements of Section 01 33 00 - Submittal Procedures.

1.5.2. The Contractor shall submit copies of the Manufacturer's product data for Metrolinx review in accordance with Section 01 33 00 – Submittal Procedures indicating:

a) performance criteria, compliance with appropriate reference standard, characteristics, limitations; and

b) product transportation, storage, handling and installation requirements.

1.5.3. The Contractor shall submit Shop Drawings for Metrolinx review in accordance with Section 01 33 00 - Submittal Procedures indicating:

a) layout for the fence to suit the finished grade along the rail corridor;

b) transition panels to be utilized at the locations where the grade differences exist;

c) adjacent construction, elevations and details, dimensions gauges, finishes and relationship to adjacent construction;

d) profile drawings showing the fence elevation;

e) fence fabric details;

f) foundation design for posts demonstrating that foundations are located in a manner to minimize impacts and conflicts with existing surface features and underground / overhead utilities; both during the installation and permanent conditions;

g) methods of fastenings, accessory items required, gate details, structural header design and design computations, isolation details and other pertinent data and information; and

h) for custom fences and gates, guide rails, and appurtenances, indicating lateral strength, anchoring details to concrete foundation, dimensions, gauges, tensile and yield strength of members and welds, post settings and picket interspaces.

1.5.4. The Contractor shall ensure Shop Drawings are stamped and signed by a professional engineer licensed to practice in the Province of Ontario, having experience in design of fence and gates specified in this Section 32 31 19 – Fencing and Gates. The Contractor shall confirm experience on the Shop Drawings.

1.5.5. The Contractor shall submit the following samples upon request by Metrolinx for review in accordance with Section 01 33 00 - Submittal Procedures:

a) mock-up – one sample size typical panel complete with posts and exclusion fence; to demonstrate the fence finish and joint details.

2. PRODUCTS

2.1. GENERAL

2.1.1. The Contractor shall ensure detailed fencing specifications are in accordance with Metrolinx Fencing and Anti-Trespassing Requirements and shall comply with the Drawings.

2.1.2. The Contractor shall ensure custom metal fences, gates, guide rails, appurtenances, and their foundations are designed and certified by a professional engineer licensed to practice in the Province of Ontario to resist lateral loads of 2.2 kN/m and vertical loads of 1.5 kN/m.

2.1.3. The Contractor shall submit the Manufacturer's information in support of the manufacturing process and test results upon request by Metrolinx.

2.2. POST AND WIRE FENCING

2.2.1. The Contractor shall provide post and wire fencing in accordance with Metrolinx Fencing and Anti-Trespassing Requirements and as shown on the Drawings.

2.3. CHAIN LINK FENCE

2.3.1. The Contractor shall provide chain link fence and fence fabric in accordance with Metrolinx Fencing and Anti-Trespassing Requirements and as shown on the Drawings.

2.3.2. The Contractor shall ensure all new fences are fitted with a top rail.

2.3.3. The Contractor shall ensure the grounding rod is 16 mm diameter copperwell rod, 3.0 metres long.

2.3.4. The Contractor shall ensure the posts, braces and rails conform to CAN/CGSB-138.2, black vinyl coated galvanized steel pipe.

2.3.5. The Contractor shall use concrete for footing construction as designated on the Drawings.

2.3.6. The Contractor shall ensure fittings and hardware conform to the following criteria:

a) fittings and hardware shall be galvanized steel;

b) all mechanical fasteners to be sealed with thread-locking fluid as a means of vandal proofing the fastening system;

c) post caps to provide waterproof fit, to fasten securely over posts and to carry top rail;

d) overhang tops to provide waterproof fit, to hold top rails and an outward projection to hold; barbed wire overhang; and

e) turnbuckles are drop forged and the overall length of turnbuckles is approximately 300 mm, with ends in the closed position. The Contractor shall ensure bolt diameter is approximately 10 mm and capable of taking up a minimum of 150 mm slack.

2.3.7. Where anti-climb fencing is requested by Metrolinx, the Contractor shall provide projection with clips or recesses to hold three strands of barbed wire spaced 100 mm apart. The Contractor shall ensure projection of approximately 300 mm long to project from fence at 45° above horizontal.

2.3.8. The Contractor shall ensure finishes are as follows:

a) colour is Jet Black (RAL9005);

b) post is hot dip galvanized, marine fusion bond coated; and

c) mesh is pre-galvanized, marine fusion bond coated with “alugalv” coating for extra protection coated.

2.3.9. The Contractor shall ensure finishes of vinyl coated chain link fences are as follows:

a) finish on fabric, and ties to be factory applied vinyl coating, industrial grade, black in colour; and

b) finish on pipe components, hardware and fittings to be black polyester powder coating or black jacket extruded polyethylene coated, industrial grade.

2.3.10. Where indicated by Metrolinx the Contractor shall install additional chain link fabric on existing chain link fencing to form a double layer of fabric on either side of the fence posts. The Contractor shall ensure:

1) a uniform 1 ½" diamond pattern is used for this fabric; and

2) all other material specifications are as per OPSS 772.

2.4. EXPANDED METAL MESH (SECURITY MESH)

2.4.1. The Contractor shall provide expanded metal mesh fencing in accordance with Metrolinx Fencing and Anti-Trespassing Requirements and as shown on the Drawings.

2.4.2. The Contractor shall ensure the top line of the expanded metal mesh retrofit does not exceed 1" in elevation from the top cross member of the existing fence.

2.5. GATES

2.5.1. The Contractor shall supply gates in accordance with Metrolinx Fencing and Anti-Trespassing Requirements and as shown on the Drawings and matching the fencing material and colour of the adjacent fence.

2.5.2. The Contractor shall ensure gates meet the most current version of OPSS 541 and OPSD 900.03. The following gate types will be required as directed by Metrolinx:

a) Pedestrian gate – Chain Link and High Security (1.0 metre);

b) Single Swing gate – Chain Link and High Security (4.5metre);

c) Double Swing gate – Chain Link and High Security (9.0 metre);

d) Single Sliding gate – Chain Link and High Security (4.5 metre); and

e) Double Sliding gate – Chain Link and High Security (9.0 metre).

2.5.3. The Contractor shall ensure material standards for chain link fence and gates are per OPSS 772.

2.5.4. The Contractor shall construct gates from galvanized steel pipe frames and braces.

2.5.5. The Contractor shall supply all gates with galvanized malleable iron hinges, latch and latch catch, and shall ensure the gates are capable of opening approximately

180 degrees. Gate latches shall be suitable for the use of Abloy Protec 2 High Security Lock system.

2.5.6. The Contractor shall ensure gates are supplied completely assembled, including the fabric. Gate fabrics shall be similar to the adjacent fence fabric.

2.6. HIGH SECURITY FENCING

2.6.1. The Contractor shall provide high security fencing in accordance with Metrolinx Fencing and Anti-Trespassing Requirements and as shown on the Drawings.

2.6.2. Contractor shall ensure high security fencing is in accordance with the following:

a) mesh shall be galvanized with an exterior finish coating capable of withstanding typical climate variances within Southern Ontario:

1) colour is Jet Black (RAL9005); and

2) fences greater than 305 metres in length shall be divided into maximum 305 metre sections with insulated inserts.

2.7. HIGH SECURITY GATES

2.7.1. The Contractor shall provide gates of type matching high security fencing system in accordance with the following:

a) 1000 mm wide pedestrian swing gate mesh a minimum 4 mm diameter high tensile wire, with aperture sizes (openings) 76.2 x 12.7 mm centers or smaller. Gate heights shall match fence heights as shown on Drawings;

b) two at 3000 mm wide vehicular double swing gate, a minimum 4 mm diameter high tensile wire, with aperture sizes (openings) 76.2 x 12.7 mm centers or smaller – swinging away from corridor and designed to prevent accidental movement of the gate towards the corridor;

c) provide non-lift barrel type hinges to permit gate to fully open and close, mechanical drop latch locking device, and automatic heavy-duty hydraulic gate closer as recommended by security gate Manufacturer; and

d) mesh to be galvanized with an exterior finish coating capable of withstanding typical climate variances within Southern Ontario:

1) colour is Jet Black (RAL9005).

3. EXECUTION

3.1. GRADING

3.1.1. The Contractor shall remove debris and correct ground undulations along fence line to obtain smooth uniform gradient between posts.

3.1.2. The Contractor shall provide clearance between bottom of fence and ground surface of 30 mm to 50 mm.

3.1.3. The Contractor shall restore grade to as appropriate to match existing or design condition and ensure there are consistent clearances not exceeding 50 mm below bottom of fence.

3.1.4. The Contractor shall ensure drainage is not altered.

3.1.5. The Contractor shall ensure access gate locations have grading on both sides of the gate, to allow for easy access (no grade difference between Metrolinx property and adjacent property).

3.2. LINE POST AND TERMINAL POST INSTALLATION

3.2.1. The Contractor shall install line posts and terminal posts as shown on the Drawings and in conformance with OPSD 972.130.

3.2.2. The Contractor shall maintain equal horizontal distances for posts. All posts shall be placed in a vertical position and set accurately in accordance with the Drawings.

3.2.3. The Contractor shall cut posts to the required height above the ground to present a smooth and uniform profile.

3.3. CHAIN LINK FENCE INSTALLATION

3.3.1. The Contractor shall erect metal fencing in accordance with locations and details indicated on the Shop Drawings including:

a) fence posts, rails and pickets;

b) gates;

c) metal posts to be anchored to concrete base wall;

d) overhang tops and caps;

e) anchors; and

f) all fabrication of fence panels and attachment to metal posts.

3.3.2. The Contractor shall ensure concrete mixes and materials are in accordance CAN/CSA-A23.1 and adhere to the following:

a) nominal coarse aggregate size: 20 mm;

b) compressive strength: 20 MPA at minimum 28 days; and

c) air entrained (5 - 8 %).

3.3.3. The Contractor shall provide terminal posts, bracing, and other required elements where existing adjacent property fences tie-in and abut to new fences.

3.3.4. The Contractor shall space line posts 3.0 metres apart, measured parallel to ground surface.

3.3.5. The Contractor shall space straining posts at equal intervals of 20 metres if distance between end or corner posts on straight continuous lengths of fence over reasonably smooth grade is greater than 40 metres.

3.3.6. The Contractor shall install corner post where change in alignment exceeds 10°.

3.3.7. The Contractor shall install end posts at end of fence and at buildings.

3.3.8. The Contractor shall install gate posts on both sides of gate openings.

3.3.9. The Contractor shall embed posts into concrete to a minimum depth of 1370 mm, extend concrete 50 mm above ground level and slope to drain away from posts. The Contractor shall brace to hold posts in plumb position and true to alignment and elevation until concrete has set.

3.3.10. The Contractor shall install top rail between posts and fasten securely to posts and secure waterproof caps and overhang tops.

3.3.11. The Contractor shall install bottom tension wire, stretch tightly and fasten securely to end, comer, gate and straining posts with turnbuckles and tension bar bands.

3.4. HIGH SECURITY FENCE INSTALLATION

3.4.1. The Contractor shall utilize installation methods in accordance with the Manufacturer's recommendations and the Shop Drawings.

3.4.2. The Contractor shall install fence posts in accordance with locations and details indicated on the Shop Drawings.

3.4.3. The Contractor shall install posts anchored to concrete bases in accordance with the Shop Drawings.

3.4.4. The Contractor shall ensure posts are plumb within a tolerance of 6 mm in 3.0 metres.

3.4.5. The Contractor shall install fence panels, including, anchorage, in accordance with the Shop Drawings.

3.4.6. The Contractor shall provide terminal posts, bracing, and other required elements in accordance with the Shop Drawings where existing adjacent property fences tie-in and abut to new fences.

3.5. FENCE FABRICS

3.5.1. The Contractor shall not install fence fabric until the footings have cured for a minimum period of seven calendar days.

3.5.2. The Contractor shall ensure fence fabric is stretched tight to tension recommended by Manufacturer and fasten to end, comer, gate and straining posts with tension bar secured to post with tension bar bands spaced at 300 mm intervals. The Contractor shall install the knuckled selvedge at bottom and twisted selvedge. The Contractor shall ensure longitudinal axis of the diamond configuration shall be perpendicular to the slope of the pipe rail.

3.5.3. The Contractor shall place the fabric on the side of the post nearest the railway, with the barbed edge at the top.

3.5.4. The Contractor shall secure fabric to top rails, line posts and bottom tension wire with tie wires at 450 mm intervals. The Contractor shall give tie wires a minimum of two twists.

3.6. BRACING

3.6.1. The Contractor shall install brace between end and gate posts and nearest line post, placed diagonally. The Contractor shall install braces on both sides of fence corner and straining posts in similar manner.

3.6.2. The Contractor shall secure the end fittings for pipe braces by a 6 mm bolt placed through the brace and fitting at both ends.

3.7. GROUNDING

3.7.1. The Contractor shall install grounding rods as indicated on the Drawings and in accordance with Metrolinx Fencing and Anti-Trespassing Requirements.

3.7.2. For electrified territory requirements please refer to Electrification Enabling Works Standards and Related Traction Power Standards and Specifications.

3.8. INSTALLATION OF GATES

3.8.1. The Contractor shall utilize installation methods in accordance with the Manufacturer's recommendations and the Shop Drawings.

3.8.2. The Contractor shall install gates in accordance with the following requirements:

a) install gates in locations as indicated on the Drawings and in accordance with Metrolinx Fencing and Anti-Trespassing Requirements;

b) level ground between gate posts and set gate bottom approximately 100 mm above ground surface; and

c) determine position of steel gate track:

1) cast steel gate track in concrete as directed by Metrolinx; and

2) dome concrete above ground level to shed water.

3.8.3. The Contractor shall install posts anchored to concrete bases in accordance with the Shop Drawings.

3.8.4. plumb within a tolerance of 6 mm in 3.0 metres.

3.8.5. The Contractor shall install gate panels, including, anchorage, in accordance with the Shop Drawings.

3.8.6. The Contractor shall ensure all gates to swing in the opposite direction of the railway tracks, or as directed by Metrolinx. The Contractor shall install gate stops where the gate has the potential to swing within the train envelope.

3.8.7. The Contractor shall ensure swing gates meet the following requirements:

a) all connections and joints shall be welded to form rigid frames or assembled with corner fittings; and

b) hinges shall not twist or turn under the action of the gate, shall be so arranged that a closed gate cannot be lifted off the hinges to obtain entry.

3.9. TOUCH UP

3.9.1. The Contractor shall lightly sand the surface to remove all rust and loose material.

3.9.2. The Contractor shall clean the surface with a solvent such as paint thinner to remove any remaining contaminants which might hinder proper paint adhesion.

3.9.3. The Contractor shall apply one coat of exterior metal primer and three topcoats with exterior grade enamel paint of type compatible with existing coating.

3.9.4. The Contractor shall ensure colour matches existing.

3.10. AS-BUILT DRAWINGS

3.10.1. Upon completion of the Work, the Contractor shall perform a topographical survey for all fences, confirming the location, length and elevations. The Contractor shall provide CAD files for the topographical survey to Metrolinx.

3.10.2. The Contractor shall prepare As-Built Drawings based on the topographical survey.

END OF SECTION

Appendix D

Risk Matrix

Prepared by (name & company):	GHD
Site:	338 Cumberland Avenue, Hamilton, Ontario
Adjacent Rail Corridor:	Canadian Pacific Kansas City Rail Corridor - Hamilton Subdivision
Date:	Friday, June 27, 2025
Revision:	1

General Notes

1) The railway corridor is a rail yard.

2) Crash walls design only intended to restrain physical forces of train derailment. Crash walls provides little or no protection against explosion, fire, or releases of hazardous goods. Emergency forces may decide evacuation is required in this event.

#	Frequency	Severity
1	Improbable	Negligible
2	Remote	Marginal
3	Occasional	Serious
4	Probable	Critical
5	Frequent	Catastrophic

	Initial Risk						Current (Residual) Risk					
Ref	**Hazard**	**Consequence**	**Frequency**	**Severity**	**Initial Risk**	**Risk Classification**	**Safeguard/ Mitigation Measure** (Describe the measure put in place which results in a reduction in likelihood and/or severity of the hazard)	**Assumptions/Comments** (Provide additional information relevant to the assessment of the revised ratings for Frequency and severity, as relevant)	**Frequency**	**Severity**	**Current Rank**	**Risk Classification**
1	Derailment of freight train carrying flammable or hazardous materials.	On collision with proposed berm/wall on site, rail cars with flammable/hazardous materials cause explosion ignite, explode or are released adjacent to the building causing injuries and/or fatalities to occupants.	3	3	9	Tolerable	A crash wall is in place to protect the proposed building. Appropriate setback is also provided.	1) Dangerous good trains operate at reduced mainline speeds compared to other freight trains. 2) The proposed crash wall and return crash walls will absorb the derailed train energy and minimize forces of the derailed cars as well as help protect inhabitants on board when impacting the walls. 3) The proposed setback will provide separation from the smoke, fire, and debris.	3	2	6	Tolerable
2	Derailment of freight or passenger train at speed greater than maximum line speed with berm/crash wall in place.	Collision of freight or passenger train with berm/crash wall. The Berm/Crash wall deflects more than design allowance. The Berm/Wall and connecting sacrificial structures experience more damage than design expectation.	3	3	9	Tolerable	The site is setback over 25.0m. The crash bollards are a stand alone structure that will protect the proposed building.	The combination of setback and the fact that crash walls are stand alone and not connected to any other structures provides a suitable protection system. Based on the Hamilton Subdivsion incident data from 1983 until present, no injuries have been sustained for speeding, to date.	3	2	6	Tolerable
3	Derailment of freight train	Transfer of derailment loads/forces to the auxiliary and principal building structures causes moderate to significant damage and possible collapse.	3	3	9	Tolerable	Firstly, the site will be safeguarded with a derailment protection feature (crash wall and return crash walls) that is to mitigate and/or minimize significant damage to the building structure. Secondly, the crash bollards and return crash bollards are independent of any structural feature supporting the building. This will mitigate any transfer of loads to structural elements of the building. Lastly, the site is also providing an appropriate minimum total setback. Assuming the train is going at the maximum speed of 60 mph at a derailment angle of 3.5 degrees, the train is not anticipated to collide with the proposed building.	See comments in item 1.The severity from pre-development to post-development conditions is reduced since the derailment protection features and setbacks are established, which will reduce risks of adverse impacts to the site.	3	2	6	Tolerable
4	Energy of derailed train deflected back from the crash wall/walls into rail cars.	Transfer of forces caused by sudden deceleration results in higher risk of equipment rupture and/or sparking, potentially causing fire or explosion.	3	3	9	Tolerable	See item 3 mitigation measures.	See comments in item 1.	3	2	6	Tolerable
5	Derailment of freight train into corners of proposed development property or berm/crash wall/walls.	Derailed freight cars or passenger cars enter the site from an angle (i.e. either from east or west approaches), bypassing the protection along the property line, and colliding with buildings on the site or hitting the corner of the crash wall/walls.	3	3	9	Tolerable	See item 3 mitigation measures.	See comments in item 1.	3	2	6	Tolerable
6	Top level of sea-can (double stack intermodal) freight car becomes airborne in a derailment.	Airborne freight car over sails the crash wall/walls and collides with the building.	3	3	9	Tolerable	The crash walls are set 5.0m higher than the adjacent grade elevation. Furthermore, the proposed building with sensitive occupancy is offset 25.0 meters from the property line, which helps mitigate any airborne freight cars being launched into the site.	The height of the protection feature is 5.0m above top of rail grades, which would deter double stacks of freight cars from overtopping the protection feature. The development is also setback from the crash wall, so damage to the building is unlikely and/or minimal. Lastly, double stack freight cars are also locked in place during the loading phase. If the locks are rigid during impact, the double stack shipment would act as a single unit.	3	2	6	Tolerable
7	Trespassing onto railroad	Interference with railway operations, vandalism, and danger to the trespasser(s) from moving trains.	3	5	15	Intolerable	The proposed crash wall and return crash walls are proposed to be 5m above top of rail and 2.43m minimum height, respectively. The Crash wall(s) act as a security feature to prevent trespassing from the subject site to the rail corridor.	No access from the site to the rail corridor is possible in the future condition, as the development will be providing a crash wall that separates the property from the rail corridor and exceeds the minimum security height of 2.43m.	1	5	5	Tolerable

Table A - Risk Classification Matrix

			SEVERITY				
			Catastrophic	Critical	Serious	Marginal	Negligible
			5	4	3	2	1
FREQUENCY	Frequent	5	25	20	15	10	5
	Probable	4	20	16	12	8	4
	Occasional	3	15	12	9	6	3
	Remote	2	10	8	6	4	2
	Improbable	1	5	4	3	2	1

Table B - Risk Category & Mitigation Strategy

Risk (Frequency x Severity)		Risk Category	Mitigation Strategy
Low	1 to 4	Broadly Acceptable	Risk is acceptable. No further mitigation required.
Medium	4 to 10	Tolerable	Risk is considered tolerable if agreed that the risk is reduced to a level considered ALARP*
High	10 to 25	Intolerable	Risk shall be eliminated/reduced.

**As low as reasonably practicable.*

Table C - Definition of Safety Hazard Severity Criteria

Hazard Rating		Consequence to Personnel or General Public	Consequence to the Environment	Consequence to the Rail System and Operation
1	Negligible	Non-reportable injury	None	Monetary loss less than $10k.
2	Marginal	Single minor injury	Reversible minor environmental impact	Minor operational delays Dangerous goods involved without release of product; Monetary loss between $10 k and $100 k.
3	Serious	Single permanent partial or temporary total disabling injury; Multiple minor injuries.	Reversible moderate environmental impact	Significant system loss, severely restricting operations; Dangerous goods release not resulting in evacuation; Monetary loss between $100 k and $1 million.
4	Critical	Single fatality; Single instances of permanent total disability; Multiple instances of permanent partial or temporary total disabling injuries.	Reversible significant environmental impact	Major loss of system / sub-system resulting in not being able to continue operations; Dangerous goods release resulting in evacuation; Monetary loss between $1 million and $10 million.
5	Catastrophic	Multiple fatalities; Multiple instances of permanent total disability	Irreversible significant environmental impact	Total loss of services; Dangerous goods release resulting in major evacuation; Monetary loss esceeding $10million.

Table D - Definition of Hazard Frequency Criteria

Rating		Qualitative Interpretation	Interpreted for Lifecycle
1	**Improbable**	Unlikely to occur, but possible. It can be assumed the event is unlikely to occur.	100 years to 1000 years
2	**Remote**	Likely to occur sometime in the rail system lifecycle. It can reasonably be expected to occur several times.	10 years to 100 years
3	**Occasional**	Likely to occur several times. The event can be expected to occur several times.	Yearly to every 10 years
4	**Probable**	Will occur several times. The event can be expected to occur frequently.	Monthly to yearly
5	**Frequent**	The event will be continually experienced	Daily to monthly

ghd.com

The Power of Commitment