Department of Transport

Technical Guideline

Barrier design commentary

Road Design Note

RDN 06-16

February 2023

Abstract

This document provides commentary on the safety barrier design process, including product specific notes, design philosophies and common practices.

Key Information

This document is administered by Engineering, Department of Transport and Planning on behalf of Head, Transport for Victoria. This document must be read in conjunction with the DoT Supplement to AGRD Part 6.

Where information contained in this document cannot be followed, the designer, engineer or team may seek technical advice (from the Department of Transport and Planning or delegated Technical Advisor) and gain acceptance (if necessary) for a departure from this guideline.

1. Purpose

This Road Design Note (RDN) provides commentary on the ‘DoT Supplement to Austroads Guide to Road Design (AGRD): Part 6 – Roadside Design, Safety and Barriers’, including product specific notes and additional context.

1.1 Consolidation of barrier design documents

RDN 06-02, RDN 06-08 and RDN 06-15 were all developed to supplement the guidance in AGRD Part 6 with specific information on Wire Rope Safety Barriers, Steel Beam Guard Fence and the application of continuous safety barrier.

While each of these documents provided a comprehensive standalone document, they all contained significant overlap with each other and the Supplement to AGRD Part 6. As such, these RDNs have been reviewed to identify any duplicated information, and the relevant guidance has been consolidated and incorporated into the Supplement to AGRD Part 6 and this commentary. As a result, RDN 06-02, 06-08 and 06-15 have be withdrawn.

1.2 Current barrier design documents

To clarify the current relationship between safety barrier design documents, the following structure has been provided in Figure 1.

AGRD Part 6 and the DoT Supplement to AGRD Part 6 are the primary references for barrier design and design values. The Supplement will reference relevant material such as the Road Design Notes, Guideline Drawings and Accepted Products. These documents set the desirable design values for barrier design and the process to use when departing from these values.

RDN 06-16 supports the requirements in AGRD Part 6 and provides specific information on the various product types.

Guideline Drawings also support the requirements in AGRD Part 6 by providing a visual representation of certain barrier design concepts. Verification is required that the concepts are applicable to contexts being addressed when developing site specific solutions.

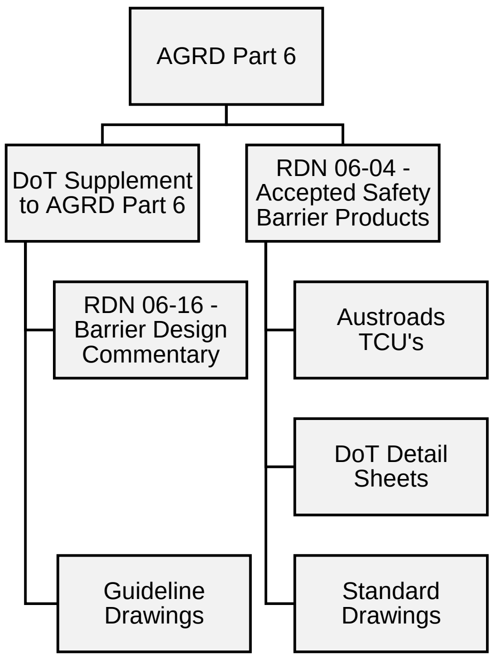


Figure 1 - Barrier Design Documents

RDN 06-04 provides a list of road safety devices that DoT has assessed and considers acceptable for use on the declared road network, subject to appropriate design and installation. This RDN contains general conditions of use relating to safety barriers, current safety barrier policies, and it also references the relevant Technical Conditions of Use for each product.

Austroads Technical Conditions of Use (TCUs) are the Austroads reference for product specific performance and design. These documents have been adopted directly by DoT to improve national harmonisation and are referenced throughout RDN 06-04 – Accepted safety barrier products.

DoT Detail Sheets are only provided in special circumstances, where DoT accepts a safety barrier product that has not been assessed by Austroads or where DoT has specific conditions or variants that cannot be contained within RDN 06-04.

Standard Drawings provide specific safety barrier details for construction, including the manufacture and installation details for several public domain systems

For barrier installation documents, refer to Section 4.

2. AGRD Part 6 – Section 5 and 6 – Barrier Fundamentals and Design

The following section is formatted to match Section 5 and 6 of the AGRD Part 6 (2022) and the DoT Supplement (v5.0). Sections with 'no commentary' have been omitted.

5.4 Barrier Configurations

5.4.1 Barrier System Components

Wire Rope Safety Barrier characteristics

WRSB systems generally consist of the following components:

- **Tensioned steel ropes -** to engage and contain the vehicle; and smoothly redirect the vehicle away from the hazard
- **Steel posts** - to support the ropes at the height required to engage a vehicle; and to provide lateral resistance on the ropes during an impact, thereby reducing deflection. (i.e. more posts provide a lower deflection)
- **Post foundations** - to support the posts during an impact without movement, allowing damaged posts to be easily replaced.
- **Anchor foundations -** to anchor the tensioned ropes, allowing redirection away from the hazard during an impact.
- **Delineator** – a retroreflective sticker attached to the post cap to alert drivers of the WRSB position.

The following limitations, benefits and comments are typical of WRSB systems:

- The minimum allowable curve radius for WRSB installations is 200m as this is the lowest radius at which the system was successfully tested. Horizontal curves place more lateral load on the post foundations.
- 100m radius curves may only be used at emergency stopping bays, refer Appendix E.
- The minimum allowable sag curve K value is 30. There is no K value limit for crest curves. Refer to AGRD Part 3 for the definition of K value.
- WRSB working widths increase when installed on curves and when the barrier is longer than 250m. Refer Section 5.3.15.6.
- Not compatible with continuous motorcycle protection.
- Minimum proximity to the batter hinge point is 1m, to ensure the post foundation is supported.
- Cannot be connected to other systems.

Guard fence characteristics

Guard fence systems generally consist of the following components:

- **Posts** (strong or weak) – absorb some of the crash energy upon impact through post rotation in the surrounding soil. The post shape and strength will differ between products and will have the greatest influence on whether a system is considered flexible or semi-rigid;

- **Blocks** (only used in Type B & G4) – positioned between the rail and post to minimise vehicle snagging and reduce the potential for vehicles to vault over the barrier, by maintaining rail height during the initial stages of impact. Flexible GF has no block;
- **Release mechanism** – a critical component of all GF systems, designed to release the w-beam or thrie-beam during an impact to maintain desirable contact with the impacting vehicle;
- **W-beam** – longitudinal steel sections in the shape of a 'W', spliced together that work in tension to contact and redirect the vehicle away from the hazard;
- **Thrie-beam** – longitudinal steel sections in the shape of a 'VVV', spliced together that work in tension to contact and redirect the vehicle away from the hazard;
- **End Terminals** – designed to anchor the GF system and introduce the necessary characteristics required for safe vehicle impact and redirection throughout the length of need section.
- **Delineator** – Flexible plastic bracket with retroreflective material to alert drivers of the position of the GF system. Fastened to the top of the beam with a single bolt. Refer Standard Section 708.11.

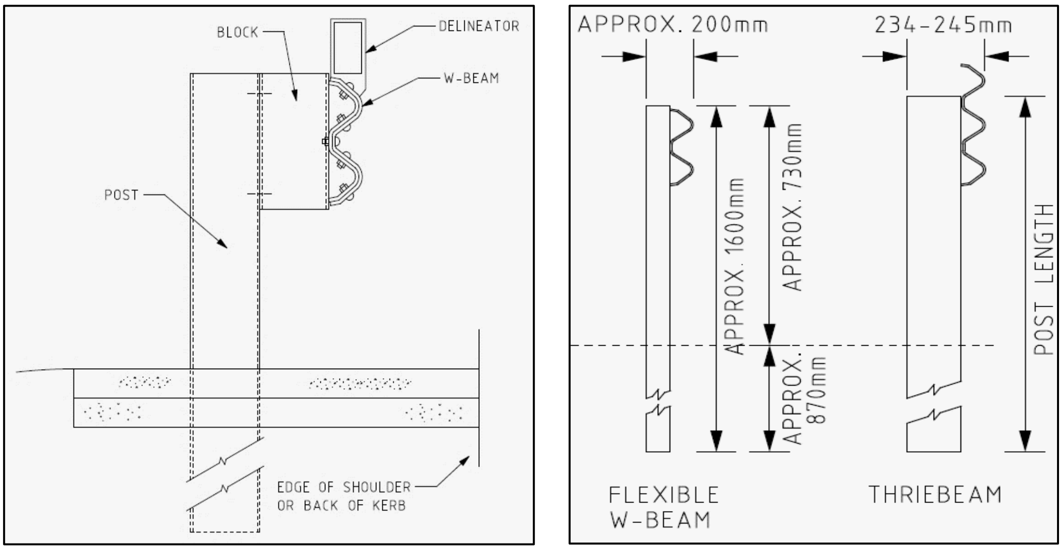


Figure 2 - Typical guard fence systems

The following limitations, benefits and comments are typical of guard fence (w-beam systems):

- Infield examples of GF have performed well on the outside of curves, even those of relatively small radius, as the concave shape supports the development of tension in the rail.
- Installations on the inside of curves can be more problematic, as the convex shape can mitigate development of tension in the rail. However, this is usually only a problem for very small radii, such as those on the corners of intersections. In this case, designers should allow extra clearance behind the barrier for deflection.
- There are no vertical alignment limitations for GF installations.
- Can be transition/connected to thrie-beam and Type F concrete safety barriers.
- Barrier length, curvature and temperature do not affect the working width values.
- Impact damage is localised and will not affect the entire barrier system.
- GF is compatible with continuous motorcycle protection.

Concrete barrier characteristics

Additional information on F-Shape concrete barriers can be found in the Detail Sheet for F-Shape concrete barrier.

5.14 Choosing an appropriate barrier system

Barrier selection examples

Barrier selection is not a prescriptive procedure and designers should recognise that there is unlikely to be a 'perfect' barrier system. Barrier selection should be based on the key components above.

However, to assist with understanding and decision making, Table 1 provides informative notes on the common barrier types with summaries of known benefits and risks.

These tables are intended for information only, and do not prescribe DoT's requirements.

Table 1: Generic strengths and weaknesses of longitudinal barrier types

Barrier flexibility (DD/IS)	**High (>0.008)**	**High (>0.008)**	**Moderate (0.004 to 0.008)**	**Zero (~0.000)**
Examples	***Wire rope safety barrier***	***Flexible W beam systems***	***Thriebeam***	***Permanent concrete barrier***
Containment capacity	Tested: MASH TL-3 to TL-4 Maximum: Added capacity is available in the cables with greater working width. Containment of larger trucks has occurred infield. Highest potential for breach. Rank: A-B	Tested: MASH TL-3 Maximum: Unknown additional capacity in the w-beam rail. Medium potential of breach Rank: B	Tested: MASH TL-4 Maximum: Little additional capacity in the w-beam. Release mechanism may tear rail during impact. Medium to Low potential of breach Rank: A	Tested: MASH TL-3 to TL-6+ Maximum: Significant capacity provided in the system. Lowest potential of breach Score: A+
Impact severity	Lowest occupant risk for passenger vehicle and truck occupants. Not tested for motorcyclists. Post cushions provide minor benefit for motorcyclists. Rank: A	Lowest occupant risk for passenger vehicle occupants. Not tested for truck impacts Rub rail provides known safety benefit for motorcyclists (EN1317.8). Narrow post provides minor benefit to peds and cyclists. Rank: A	Medium occupant risk for passenger vehicle and truck occupants Rub rail provides known benefit for motorcyclists (EN1317.8). Post caps provide minor benefit Rank: B	Highest occupant risk for passenger vehicle and truck occupants. Acceptable occupant risk for commercial vehicles (36T) Smooth surface provides minor benefit to motorcyclists and (not tested) Rank: B
Site suitability	Large working width required. Large performance variability due to cable tensions in the field. WRSB terminals do <u>not</u> 'absorb energy'. Should be offset from traffic lane. Rank: C	Large working width required. Little performance variability Terminals will 'absorb energy' and redirect. Gating behaviour observed. Rank: B	Medium to low working width required. Little performance variability Terminals will 'absorb energy' and redirect. Gating behaviour observed. Rank: B	Small working width required. No (negligible) performance variability Crash cushions will 'absorb energy' effectively and are fully redirected. Rank: A
Whole of life	Cables are likely to drop after impact and rope tension may be affected along the entire barrier. Low cost to install per metre. Low cost to repair per metre. Few tools needed. Requires 10-20 (avg) posts replaced per impact. Requires routine cable tensioning. Reliability Rank: B Maintainability Rank: B	Impact damage is localised and visible. Low cost to install per metre. Medium cost to repair per metre. Barrier repair requires special equipment. Requires 5-10 (avg) posts replaced per impact. Reliability Rank: B Maintainability Rank: A	Impact damage is localised and visible. Low cost to install per metre. Medium cost to repair per metre. Barrier repair requires special equipment. Requires 5-10 (avg) posts replaced per impact. Reliability Rank: B Maintainability Rank: B	Impact damage is rare, localised and visible. Barrier is durable to vehicle impacts. High cost to install per metre. High cost to repair per metre, although rare. Barrier repair requires special equipment Barrier is durable to vehicle impacts with no routine maintenance. Reliability Rank: A Maintainability Rank: A
Please note: The rank values provided in this table are based on general experience and observation of barrier performance. All barrier types have been assigned the same total in order to highlight the comparative strengths and weaknesses. These ranks may assist designers when tailoring a system to the site. All longitudinal barriers have demonstrated occupant risk values below the preferred threshold. The term low, medium and high described above is a comparative ranking, within the accepted levels. The rank values for 'Site Suitability' refer to the variety of sites and contexts that the barrier type is likely to suit. Higher ranks imply that the barrier type can be adjusted to suit more locations and contexts. While lower rank values imply the barrier type is suitable to fewer location, due to the space needed or installation constraints.				

V6.7 Select a barrier system and define its working width

V6.7.1.1 Working width factor of safety

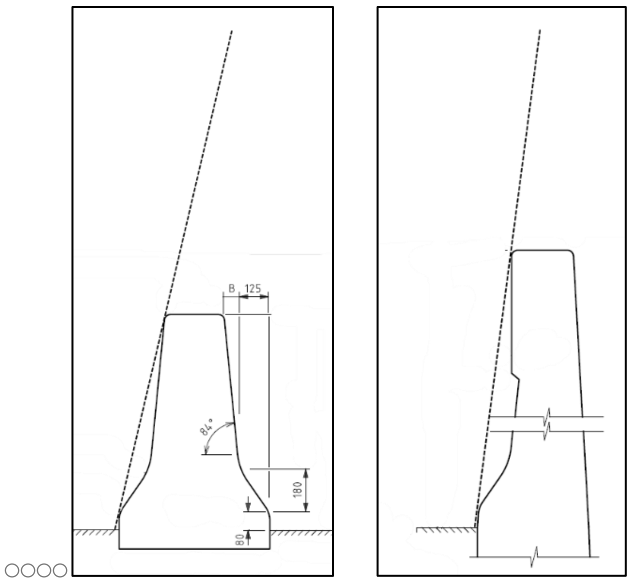
While product suppliers are not required to test beyond the chosen test level, it is generally recognised that if an errant vehicle were to impact a barrier with less lateral energy than tested, the vehicle is likely to be contained. As such, a factor of safety (FoS) concept was introduced into the Supplement to AGRD Part 6 (2019) to cater for heavier/over-capacity vehicles on the network. While this additional allowance does not deliver a higher test level, it provides additional clearance for heavier vehicles on the network and is recommended when protecting assets without a specific containment level selection process.

The FoS is additional to the crash tested performance and is used for above ground assets on greenfield projects, where the designer can influence the location of roadside assets and especially where an asset may collapse onto a road user. On brownfield projects, the FoS is often not practical and the tested working width may be adopted.

V6.7.1.3 Working widths for concrete barrier

For concrete barriers taller than 1300 mm, working width values should be determined using the ‘point of contact’ method. This method adopts a projected vehicle roll line that contacts the face of the barrier (kerb reveal to top corner) and extends to a height of 4.6 m above the pavement surface. This is method is shown in Figure 3.

Figure 3: Point of Contact method for F-shape concrete barriers



6.8.1 Offset from Traffic Lane

Barrier setback from kerb

In 2020, Troutbeck completed a review of DoT’s guidance relating to barrier-kerb offset values. The following information has been provided from this report.

> Barriers are evaluated using tests based on ‘worst practical’ conditions. The strength is tested with heavier vehicles and occupant protection with lighter vehicles. However, when testing the interaction of the vehicles and barriers, the impact angle becomes important and the critical angle will depend on the vehicle’s suspension characteristics and to a lesser degree the kerb profile. It is therefore important to evaluate the kerb barrier interaction using a range of impact conditions. It is not reasonable to use full scale testing to evaluate all probabilities.
>
> There is no easily recognised relationship between the kerb profile and the likely interaction. Flatter or steeper kerbs have approximately the same effect on the vehicle trajectories. The effect of kerb height on the trajectories is only noticeable when the front of the errant vehicle is within 0.5 m of the face of the barrier.

With the barrier behind the kerb, the vehicle’s trajectory is first affected by the kerb, which can then result in the vehicle not engaging with the barrier effectively. If the kerb was behind the barrier and the vehicle could engage with the barrier then the effect of the kerb could be reduced. Locating the barrier in front of the kerb is likely to result in a better outcome than with the barrier behind the kerb, although there is no testing that demonstrates this point and it is likely to introduce other installation and maintenance challenges.

The decision to use a kerb and a barrier needs to be aware of site drainage issues. In fact, the guidance should be more holistic and address drainage and safety together. The recommended guidance given below should be augmented with comments on drainage.

It is recommended that a non-proprietary G4 barrier be located either:

- With the face of the barrier no more than 0.2 m from the face of the top of the kerb.
- With the face of the barrier more than 7.0 m from the face of the kerb for roads with operating speeds above 85 km/h. This distance could be reduced to 6.0 m in constrained locations.
- With the face of the barrier more than 4.0 m from the face of the kerb for roads with operating speeds between 70 and 85 km/h.

It is recommended that flexible guard fence products and wire rope safety barriers be located either:

- be closer than 200 mm from the face of a kerb or further way than 7.0 m from the face of the kerb. It is noted that the 200 mm dimension may be problematic as the kerb generally has a flat section that would make it difficult to install a barrier so close to it.

Following this review, Table V6.8.4 has been significantly updated within v5.0 of the Supplement to AGRD Part 6. Most obviously, Table V6.8.4 changes the design domain for semi-rigid guard fence setback distances of 0.1m to 1.0m (from back of kerb), which limits the offset to traffic lane, when a kerb is installed on the edge line. In addition, it limits the default placement of underground drainage.

However, in recognition of the ongoing in-field performance of the historical setback range, DoT provides an Extended Design Domain (EDD) setback range for use in constrained urban situations. Refer the Supplement to AGRD Part 6.

These ranges help designers avoid underground services or achieve a barrier offset to traffic lane of 0.6m and 1.0m, in 70-80km/h and <70km/h environments respectively. However designers should not maximise the setback distance unless there is a justified reason (e.g. insufficient sight distance, underground services or high risk of nuisance impacts). Smaller setback distances minimise the potential vaulting risk, therefore designers must consider the site-specific risks of adopting a reduced barrier offset (refer Table V6.8.1b), before adopting the maximum setback value.

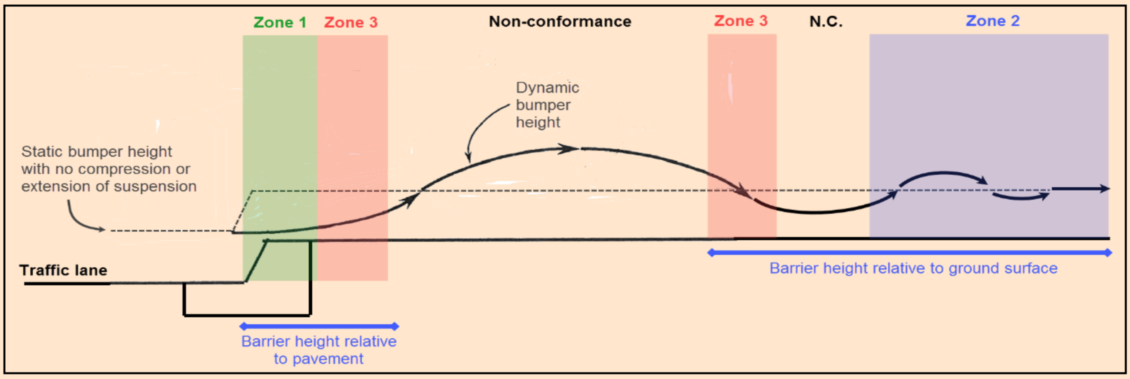
To assist designers, typical flow charts has been provided in Appendix G.

Historical barrier-kerb setback guidance (for comparison)

The following information on barrier-kerb interaction has been provided for reference and comparison only.

Historically, guidance included three acceptable ‘Offset Distance Zones’ as explained below. Following a thorough review of available literature (Troutbeck 2020), DoT has modified Zone 1 and 2, and has removed Zone 3 from its guidance. Refer updated barrier-kerb guidance above.

Figure 2A – Historic barrier-kerb setback guidance



Kerb type	Speed (km/h)	Barrier type	Zone Offset Distances		
			Zone 1	Zone 2	Zone 3
Barrier	> 80	GF & WRSB	Not recommended		
	70-80	GF & WRSB	0m	4m +	-
	< 80	GF & WRSB	0m	2.5m +	-
Semi-mountable	> 80	GF	0m	4m +	0 – 1m
		WRSB	0m	4m +	1.2 – 1.8m
	70-80	GF	0m	4m +	0 – 1m
		WRSB	0m	4m +	1.2 – 1.8m
	< 70	GF	0m	2.5m +	0 – 1m
		WRSB	0m	2.5m +	1.0 – 2.0m
Mountable	No restrictions				
Notes: Offsets are measured to back of kerb. This creates an offset of 300mm to line of kerb which reduces the likelihood of nuisance impacts. In low speed areas, such as car parks, there are no restrictions on the location of kerbs and barriers. Guard fence offsets are measured to the face of W-beam. WRSB offsets are measured to face of barrier post. Post foundations are typically 450mm-600mm in diameter, hence ‘Zone 1’ includes the foundation install at back of kerb.					

Zone 1: **Preferred**. The kerb’s ability to deviate the bumper height is diminished as the safety barrier is already engaged. Preferred offset is as close to back of kerb as possible.

Zone 2: **Preferred**. The barrier is sufficiently far away that for most bumper trajectory paths, the vehicle has returned to the ground and collides with the barrier at the expected bumper bar height.

Zone 3: **Tolerable**. While the vehicle has commenced or not quite completed the vaulting process, the height and dynamic behaviour of the vehicle bumper is in conjunction with the safety barrier tolerable collision zone. This may vary between barrier types given the mechanism of engagement.

N.C.: **Non-conformance**. The zone between the preferred and tolerable limits. In this zone, there is an unacceptable risk that a run-off road vehicle will collide with and breach the barrier. Rise of the bumper may cause it to ramp or vault the barrier while lowering of a bumper may cause it to underrun the barrier. For these reasons a safety barrier should not be installed in this “Non-conformance” zone

6.8.8 Flaring of barrier and terminal

Flaring is often used to adjust the barrier offset to protect hazards or roadside features closer to the road.

However, flaring can also be used to maximise the protected area when there is insufficient length before the first hazard. While safety barriers work best during a glancing impact, the Manual for Assessing Safety Hardware (MASH) requires physical crash testing up to 25 degrees. This is based on an upper percentile of run-off-road departure angles across the whole network.

Although flaring may increase the impact angle and thus the impact severity during a crash, the likelihood for vehicles to exceed the 25-degree impact angle cannot be accurately predicted, and in certain situations it may be more beneficial to flare the barrier and capture a greater percentile of errant vehicle. I.e. those errant vehicles that leave the road at an earlier location.

Designers should acknowledge that flaring will increase the impact severity but also provide other benefits like a greater protected area. A short risk identification and assessment should be completed to understand which risks are higher based on the context. For example, at lower operating speeds (<70km/h), the nominal impact severity is already lower than testing, therefore a barrier flare may be acceptable.

The following figure shows that the point of need could be achieved with a flare.

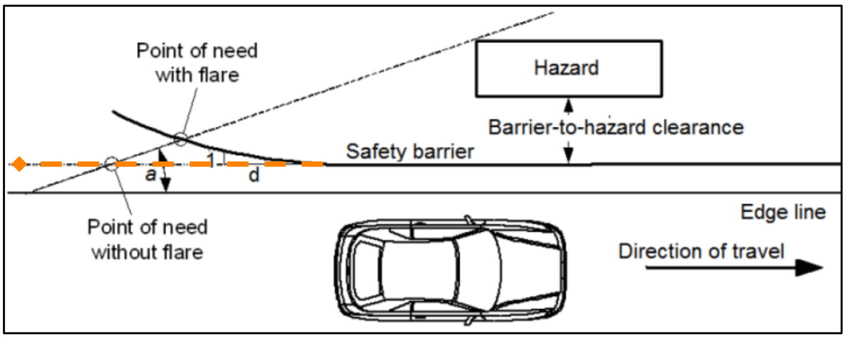


Figure 4 – Point of Need with and without flare

6.8.9 Barriers in Constrained Locations

Using a higher containment level barrier to reduce working width

Vehicle roll is the lateral distance between the deflected face of a road safety barrier and the maximum extent of the vehicle body during impact. Significant roll is measured during the TL-4, TL-5 and TL-6 crash tests and is already included within the accepted working width value. As a result, the published working width values will often increase with higher Test Levels. While the safety barrier may be taller, the impact vehicle is also taller and a greater vehicle roll/sway will occur.

If a specific containment level is needed (e.g. TL-4) and the published working width for a matching product (i.e. TL-4) cannot be achieved, then the designer should intuitively consider a taller and/or more rigid barrier to reduce the working width/roll allowance. However, this often requires the designer to select a barrier that has been crash tested to a higher level, and there is often uncertainty about which working width value to use. For example, in the case of a concrete barrier, although the designer should consider using an 1100mm high TL-5 concrete barrier instead of a 920mm TL-4 barrier height, it is typical practice for the designer to use the published TL-5 working width value which is then greater than the original TL-4 system.

For this reason, it is acceptable in some cases to select a higher test level product (e.g. taller concrete barrier) and use the working width for the test level required. For MASH TL-4 products, the barrier is also crash tested to the MASH TL-3 conditions and therefore both working width values are provided for use.

For concrete barriers, Table 2 may be used to determine working width.

Table 2: Working widths for F-shape concrete barriers

Concrete barrier height (mm)	Test Level 3		Test Level 4		Test Level 5	
	2200 kg Pick-up truck Vehicle height = 2.0 m		10000 kg Rigid truck Vehicle height = 3.6 m		36000 kg semi-trailer Vehicle height = 4.1 m	
	Cabin (mm)	Truck box (mm)	Cabin (mm)	Truck box (mm)	Cabin (mm)	Truck box (mm)
820	650[1]	no box	Not achievable		Not achievable	
920	500	no box	1380[4]	2300	Not achievable	
1100	System width[2]	no box	1320[4]	2200	1440[4]	2400
1300			900[4]	1500[3]	900[4]	1500
>1300			Use point of contact method[5]			

Notes:

This is a nominal value based in an intrusion of 450 mm plus the need to allow 200 mm for the width of the foot and sloping sides of the barrier. Rosenbaugh et al (2018) recorded a working width of 504 mm in a vertical barrier.

This impact results in zero intrusion, and the working width is equal to the system width.

The assumed body roll for the TL-4 vehicle is the same as for the TL-5 vehicle

The height of the cabin in the tests being 2.7 m high, therefore the working widths for the cabin are 60% of those for the box.

The point of contact method assumes a straight line along the barrier face (i.e. toe of barrier to top edge) and extended to the necessary height (typically 4.6m). Refer Table 4 and Figure 3.

Table 3: Working widths for F-shape concrete barriers with sway protection

Concrete barrier height (mm)	Test Level 3		Test Level 4		Test Level 5	
	Cabin (mm)	Truck box (mm)	Cabin (mm)	Truck box (mm)	Cabin (mm)	Truck box (mm)
1100	System width[1]	no box	1300[2]	2170[3]	1420[2]	2370[3]
1300			Use point of contact method[4]			
> 1300			Use point of contact method[4]			

Notes:

This impact results in zero intrusion, and the working width is equal to the system width.

The height of the cabin in the tests being 2.7 m high, therefore the working widths for the cabin are 60% of those for the box.

Concrete barriers with ‘sway protection’ will have a top edge (face) that is 30mm closer to traffic than the traditional F-shape. As such, these values have been reduced by 30mm.

The point of contact method assumes a straight line along the barrier face (i.e. toe of barrier to top edge) and extended to a height of 4.6m. Refer Table 4 and Figure 3.

Table 4: Working widths for F-shape concrete barriers (>1300mm)

Concrete barrier height (mm)	1300	1500	1550	1700	1800	1900	2000	2100
F-Shape profile	Table 2	825	815	785	765	750	735	725
F-Shape profile with sway protection	618	535	515	470	440	415	395	375

Working widths are based on the ‘point of contact’ method, which assumes a straight line along the barrier face (kerb reveal to top corner), extended to a height of 4.6m. These values have been rounded up. Working width is measured from the toe of the barrier.

Sway protection is a modification to the barrier profile to reduce the amount of vehicle roll above and beyond the barrier. Refer above for additional guidance.

6.9.1 Determine the Length of Need (Step 7)

Using GD6111 and GD6112

GD6111 and GD6112 provide a range of common LoN values calculated using the run-out-length method detailed in AGRD Part 6.

To use these tables, the designer must know the protected width (i.e. the distance from the edge of traffic lane to back of hazard), the design speed, and the barrier offset. While these drawings provide a range of typical values, rounded up, designers may use the run-out-method in AGRD Part 6 to obtain a more accurate LoN value.

GD6111 Table B and GD6112 provide an adjustment factor for lower AADT volumes, which is embedded within the Lr values provided in AGRD Part 6.

While the barrier offset values in Table A extend beyond the recommended 4-6m barrier offset, these higher values can be used when calculating LoN from the opposite direction (‘A Opposite’).

6.13 Detailed installation refinements (Step 11)

V6.13.5 Post depths on narrow verges

When GF is used to shield embankments and the full width of dynamic deflection cannot be provided, consideration needs to (in addition to performance) be given to the provision of adequate ground support as, over time, softening of the verge may occur. Adequate post support is critical to ensure the barrier system will perform as intended.

If posts are placed closer to the hinge point than the minimum support width, it is recommended that the post embedment depth is increased to provide sufficient lateral support in semi-rigid systems.

For strong post guard fence products, a 500mm minimum clearance from the rear of the post to the embankment hinge point is the absolute minimum, although this may vary due to soil conditions, batter slope and post depth.

Note some proprietary barrier suppliers have crash tested and/or analysed the performance of their proprietary systems at a clearance of less than 500mm from the batter hinge point. 500mm is the minimum clearance and anything less than this should only be implemented in a constrained location with risk assessment and design exception. Documented evidence should be sought from the supplier to support any option assessment and decision making.

In general, an additional post embedment depth of 1000/a mm should be provided for strong post GF, where the embankment is aH:1V (refer Figure 8), limited to a maximum slope 2:1. 2.4m posts (600mm additional depth) are commonly used on narrow verges.

For proprietary systems, information and advice should be sought from the System Suppler.

Adoption of increased embedment depth as above should only be adopted on existing roads with constrained formation widths. Adequate formation width should be provided on all Greenfields projects and high risk retrofit projects.

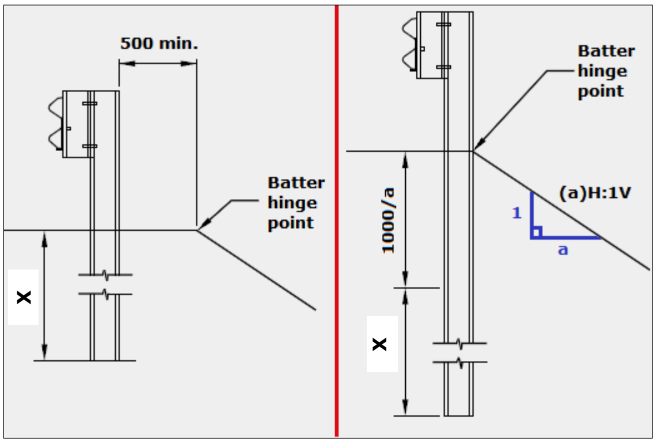


Figure 5: Post depths on narrow verges

V6.13.6 Post foundations for WRSB

Adequate ground support must be provided to the posts and anchors to enable the barrier system to perform as designed.

WRSB posts must be located in concrete ground sockets in accordance with the supplier's specification. While it is always recommended that a geotechnical investigation is completed, the default post footing sizes may be used in accordance with RDN 06-04 unless a geotechnical investigation has been undertaken and an alternative size has been approved by the supplier.

Where the run-off road risk associated with heavy vehicles is particularly high, consideration may be given to larger post foundations than specified. Although larger foundations are not required for performance, it has been observed that impacts from heavy vehicles can cause the concrete foundations to pull out of the ground. This decision could be considered on a benefit/cost ratio for the project.

6.19 Barriers across drainage structures and to avoid underground conflicts

Where drainage or underground services are required at the barrier location, it is important that the drainage design and services strategy is coordinated with the barrier design. Items affected may include the location and depth of pipes/conduits and location of pits. Installations of barrier along the inverts of table drains should be avoided for maintenance, durability and barrier performance reasons.

Where barriers are required across culverts or other underground services, the following options may be considered:

Ground beam / shallow foundation

Several proprietary barrier systems have accepted surface mount posts which can be installed on a shallow concrete foundation. These variants must be installed in accordance with all supplier requirements and should be constrained to the area of need only, and not the entire length of barrier. Any modifications to the accepted foundation design will need proof engineering and approval by the System Supplier.

The provision of a Type-B GF ground beam requires structural design and proof engineering by a prequalified design consultant and approval by the Superintendent.

Attaching surface mount posts directly to a culvert structure is also possible but requires structural advice and approval by the Superintendent.

Post omission

Where necessary, a single GF or Thrie-beam post can be omitted to avoid a lateral underground asset, resulting in an isolated post spacing of up to 4-5m.

The omission of more than one post requires acceptance by the Department of Transport.

Several proprietary barrier systems have accepted configurations with post spans of 6m (i.e. the omission of two posts). Refer RDN 06-04 and product specific TCUs. These variants must be installed in accordance with all supplier requirements and should be constrained to the area of need only.

Post omission within Type B GF must also be nested to provide additional strength. Nesting of the w-beam is designed to increase lateral stiffness to compensate for the missing post and provide continuity of stiffness for vehicles, thereby minimising pocketing.

The recommended Type B post omission treatment is to nest and splice two layers of w-beam together in a 'running bond' configuration shown below (Figure 6). The length of nested GF should extend at least one w-beam length either side of the omitted post and should not be used in conjunction with reduced post spacing.

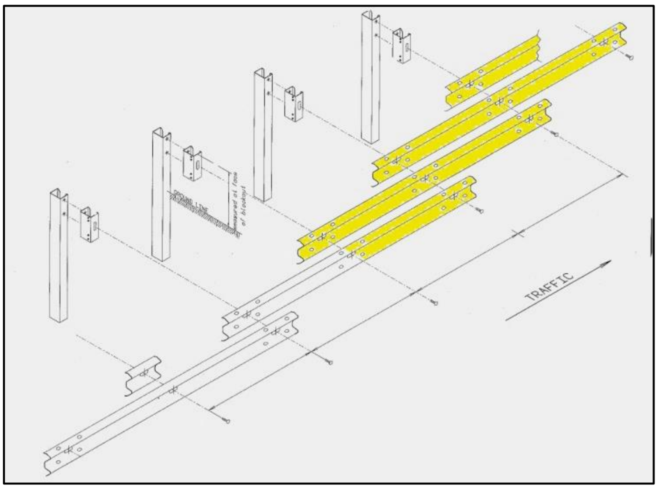


Figure 6 - Nested guard fence rail

If factory drilled nested w-beam sections are not available, the additional holes required for bolting of the nested w-beam should only be formed by drilling. No holes shall be formed or enlarged using oxy-acetylene equipment (“gas-axe”) or similar flame cutting methods. Once formed, the holes should be filed to remove any rough edges and painted with a single pack zinc-rich primer that meets AS/NZS 3750.9. Source NZTA TM-2003: Nesting of semi-rigid guardrail.

Combinations of nesting and reduced post spacing should only be used as per technical advice to avoid pocketing.

Nesting of flexible GF will not provide measurable performance benefits and should not be used.

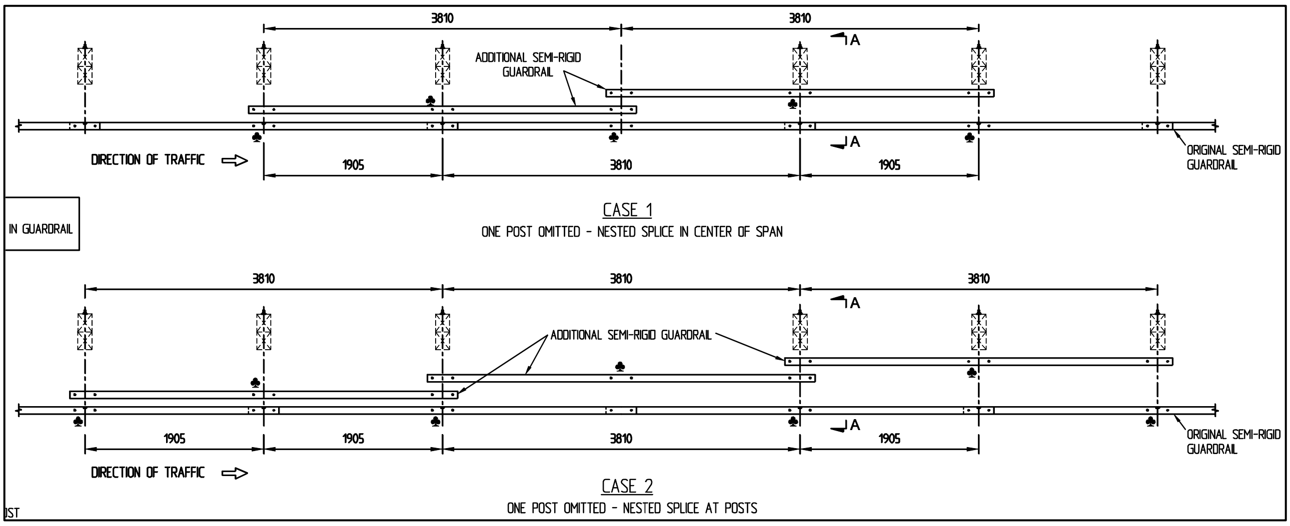


Figure 7 - Post omission configuration

Twin block outs

Where isolated individual (i.e. single) GF posts cannot be installed due to underground services, twin blockouts are acceptable on Type B to allow the post to be setback further from the w-beam. More than two stacked blockouts has the potential to lift the w-beam as the post rotates back during an impact and therefore should not be installed.

6.21 Fauna Crossings

On our roads, many animal species die per annum including some species of environmental significance. Fauna crossings may range from providing culverts, bridges, gaps within the barrier or rub rail, or fencing to restrict or corral fauna to an appropriate crossing point. A generic treatment on one project may not suit other locations or fauna, therefore, a specific treatment particularly suited to the local fauna and environment will need to be determined.

In general, wildlife should be discouraged from accessing roadways (other than low-speed and low-traffic volume roads) to minimise roadkill. Gaps in continuous WRSB and flexible W-Beam are not recommended. This advice is to be reviewed periodically by fauna experts, as more information becomes available on wildlife behaviour in roadsides with continuous barrier.

Safety barriers with motorcyclist rub-rail may obstruct the movement of wombats, echidnas, possums and other animals that are too large to squeeze under the rub rails. Where these species habitat nearby areas, gaps in the rub rail should be considered to allow animals to escape from the road.

When roads divide habitats and/or small populations of wildlife, expert fauna advice should be provided to assess the risk from reduced animal movement.

6.24 Additional Barrier Design Considerations

6.24.4 System Height

System height upgrades

Over the past decade, some products have increased in height to meet the newer crash test protocols. As such, some product (e.g. Type B) have attachments to increase the height (upgrade) of existing barrier installations without needing to re-install the system.

Where existing Type B installations are below standard height, lifting of the w-beam can be achieved with proprietary Abraham Blocks (Refer Figure 8.

Some proprietary GF products can also be lifted retrospectively to be compliant with installation height requirements. Please refer to product manuals to see the accepted lifting components that can be used.

Figure 8: Abraham block

6.24.10 Bullnose treatments for medians and short radius treatments for intersections

A short radius curve treatment aims to redirect a vehicle where possible or absorb the energy of a vehicle impacting at a high angle. To achieve this, it requires frangible (timber) posts to break away, allowing the GF to wrap around the front of a vehicle and bring it to a stop. High angle impacts will deflect significantly allowing the vehicle to travel into a run-out area behind the barrier, refer Figure 9. The required run out area is clearly shown on the standard drawings and shall be provided.

Figure 9: Short radius curve deflection

Without a run-out area or breakaway posts, the vehicle will essentially be hitting a very stiff system at high speed and at a high angle, resulting in the vehicle to either under-ride the w-beam causing a large amount of occupant ride-down forces, or vault over the barrier into whatever hazard may be behind. In addition, double nesting shall not be provided as this would make the system even more rigid.

Following investigation into the work done by the FHWA (USA), short radius treatments have been successfully crash tested to NCHRP350 Test Level 2: 70km/h and are largely ineffective at higher speeds. Impact speeds above this can cause the vehicle to override or under-ride the barrier and could become more severe for the occupant than the hazard.

V6.24.13 Help phone bays

The retention, installation or upgrading of help phones should be avoided due to the availability of mobile phones and other methods of incident detection. However, the DoT Help Phones Policy (2016) recognises that in high-risk locations (e.g. lack of cellular coverage), the retention, installation or upgrading of help phones may be considered.

Where continuous barrier is proposed adjacent to a help phone bay, that is to be retained, the barrier must be flared and aligned behind the bay/phone to allow for normal access.

TC-2024 and TC-2025 detail the standard help phone bays installed on the Victorian network, both of which should be treated with a similar barrier alignment; smaller curve radii could be used for flexible w-beam systems.

Where existing kerb is present, it is desirable that a kerb-barrier offset value that complies with the Supplement to AGRD Part 6 is adopted, however, this may not always be achievable, and an alternative offset may be required for the short bay length. Where possible, a mountable kerb could be installed to limit the effects on barrier performance.

6.24.9 Maintenance of barriers

Maintenance strips

The decision to install a safety barrier maintenance strip, concrete or otherwise, should be based on the benefit that it will provide. This decision should be made during the design development stage, before installation, as it will depend on the context, local maintenance needs and feedback from local stakeholders.

For lengths of continuous barrier in rural locations, the use of maintenance strips is generally not economical unless a specific need has been identified for a short section of the overall route.

In urban environments, maintenance strips are highly likely to assist with local maintenance practices and should be considered for use.

Before adopting a concrete maintenance strip, designers should consider current practices (including mowing equipment) and other maintenance solutions (such as controlled grasses) that could mitigate the need for a maintenance strip.

Types of maintenance strips

The most common type of maintenance strip in Victoria, is the concrete maintenance strip shown on SD3503.

Other maintenance strip types, such as geotextile fabrics, are available for use although they have not been widely implemented in Victoria. Where other maintenance strip types will provide benefit, they must be evaluated carefully prior to use, to minimise the potential for a long-term maintenance burden.

3. Typical design philosophies

When considering site constraints and context, it is extremely rare for two locations to be identical. Site-specific context will influence which design elements are most important, and also which design elements may be compromised.

This section provides a general design philosophy (approach) when designing barrier. Ideally, the barrier installation would meet all the desirable design values provided in the Supplement to AGRD Part 6, such as offsets to hazards, kerbs and traffic lanes. However, where site constraints do not permit, the designer may need to create a typical design philosophy (i.e. order of preference) to assist with decision making.

The following design philosophies provide a typical starting point, and therefore must be used in conjunction with the Supplement to AGRD Part 6 and must be validated by the designer. All design decisions must be documented.

Typical design philosophy options for shielding hazards

1. Locate the barrier at 4.0m – 6.0m from the traffic lane.
2. Reduce the barrier offset from the traffic lane to minimum.
3. If for a short section, adopt a reduced post spacing for a sufficient length to protect the hazard
4. If WRSB, consider shortening the barrier length to avoid additional working width factors.
5. If WRSB, consider a stiffer barrier system such as guard fence, before reducing the offset to the traffic lane below minimum.
6. Reduce the barrier offset from the traffic lane to absolute minimum
7. Consider the use of alternative terminal products that may provide for a greater length of redirection within the length of terminal.
8. Consider the use of a rigid barrier system.
9. Reconsider removal or relocation of the hazard.
10. Undertake an appropriate risk assessment to justify the net benefit for safety barrier vs not installing a safety barrier.

Typical design philosophy options for shielding fill batters

1. Provide a 10:1 traversable surface behind the barrier equal to dynamic deflection;
2. Provide a 6:1 traversable surface behind the barrier equal to dynamic deflection;
3. Consider a reduced post spacing to lower dynamic deflection (will increase barrier impact severity);
4. Consider an alternate barrier type to suit available offset to hinge point (will change barrier impact severity & performance);
5. If WRSB, consider a batter overhang (BO). Vmin = 1.0m and BOmax = 1.3m, where batter slope is no steeper than 4:1 (greater verge widths are preferred);
6. If WRSB, consider an increased concrete post footing size to provide Vmin ≤ 1.0m and BOmax ≤ 1.3m, where the batter slope is no steeper than 4:1.
7. If WRSB, consider a Design Exception with careful consideration of risk. Absolute minimum BOmax ≤1.3m where batter slope is no steeper than 2:1. (NB: risk must be carefully managed and an alternate barrier type is strongly recommended);
8. If GF, consider a Design Exception with careful consideration of risk. Some systems have been tested with reduced offsets to hinge point. 500mm absolute minimum.
9. Alternate barrier type required.

4. Barrier installation

In order to install an effective barrier on site, the designer needs to provide sufficient information on the detailed design so that the installer does not need to create solutions on site, or second guess due to lack of information.

The Australian Standard defines this role as the Installation Designer, therefore it is important that the designer understands barrier installation requirements and is aware of solutions for common site constraints.

4.1 Documents for barrier installation

To clarify the current relationship between safety barrier installation documents, the following structure has been provided in Figure 10.

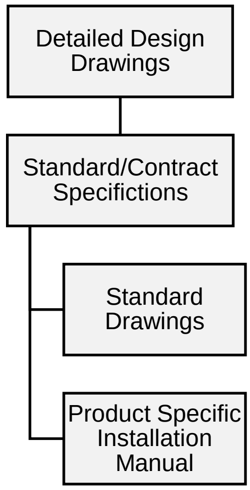


Figure 10 - Barrier installation documents

Detailed Design Drawings – These drawings provide the final barrier design values (such as barrier length, location, and type) as determined during the barrier design process. These drawings will contain key decisions and any compromised solutions or values.

Standard Specifications – These documents provide requirements for the supply and/or installation of concrete safety barrier, steel beam guard fence (Section 708) and wire rope safety barrier (Section 711) systems and associated works.

Standard Drawings – These documents are the primary reference for manufacture and installation of public domain products.

Product Installation Manuals – These documents are the primary reference for final installation of proprietary products. They include component details and assembly requirements. It should be noted that while some product manuals contain design information (such as working width, offset to traffic lanes and product variants), these values and variants may not be accepted by DoT and installers should not be making or overriding key design decisions.

4.2 Quality assurance

Certificate of Compliance

Due to the increasing complexity of proprietary safety barriers and terminals to install, and the lack of an installer accreditation scheme, DoT requires that all proprietary systems receive a Certificate of Compliance (CoC) by the System Supplier after installation. The CoC provides assurance that the product has been assembled and installed in accordance with the product installation manual.

The CoC DOES NOT require the System Supplier to review, evaluate or “sign-off” the detailed design of the safety barrier system, such as barrier offset, barrier-to-hazard clearance, barrier flare, barrier selection etc. Safety barrier selection and design is an intricate process that requires the application of engineering judgement and risk assessment. Where the site is constrained, the designer must use relevant design guidance (e.g. AGRD Part 6), make appropriate decisions and document those decisions in a Design Report. The CoC does not validate or assure the design process.

Austroads Safety Hardware Training & Accreditation Scheme

The Austroads Safety Hardware Training and Accreditation Scheme (ASHTAS) has been developed to ensure the people who design, install, and maintain road safety barriers on Australia’s and New Zealand’s road network are appropriately trained.

Austroads has partnered with Lantra (UK) to develop a national accreditation scheme that will require the certification of all people engaged in the design, installation, and maintenance of any road safety barrier system used in New Zealand or Australia. Austroads intends that the training courses run under the ASHTAS program will eventually cover a wider range of road safety hardware, essentially products covered by AS/NZS 3845 Part 1:2015 and Part 2:2017.

Victoria has committed to implementing the scheme in coordination with Austroads. More details will be provided to industry as the scheme is progressively implemented in Victoria.

5. Work zone safety barrier systems

Unanchored temporary barrier systems (free-standing temporary) must develop sufficient mass for the barrier to perform and deflect as intended. Impacts within the development length may cause the barrier to deflect further than specified, hence an anchored system or a system with shorter leading development length are preferred in constrained locations.

Where the leading development length cannot be achieved before the hazard/work zone, designers should consult with the product supplier and mitigate the risk through additional controls such as reducing the posted speed.

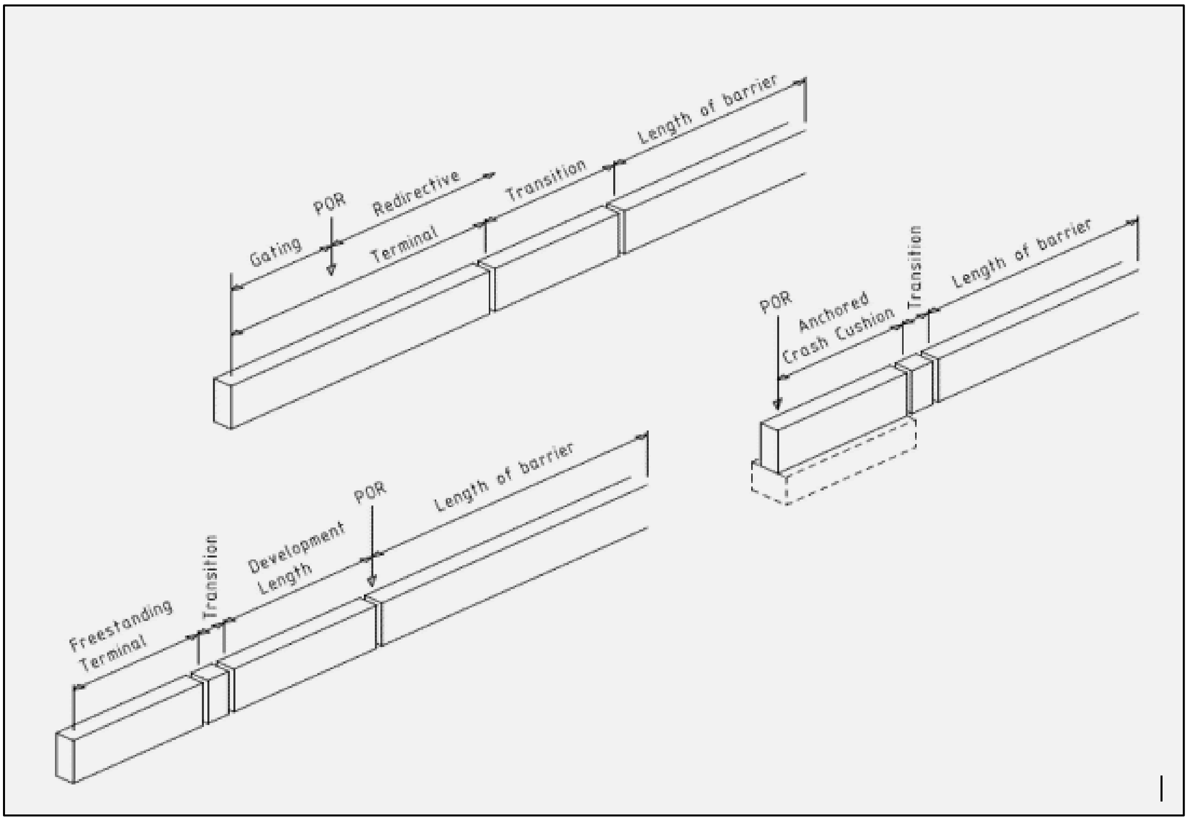


Figure 11: Typical terminal configurations

Table 5: Indicative working width (m) for concept/feasibility design

Temporary barrier		
Barrier Type	**Test Level**	**Working width**
Plastic (Freestanding)	TL-3	2.0 – 4.1 m
Steel (Freestanding)	TL-3 TL-4	1.9 – 2.6 m 3.0 – 3.7 m
Steel (Pinned)	TL-3 TL-4	0.8 – 2.0 m 2.2 – 3.0 m
Concrete (freestanding)	TL-3	1.2 – 2.2 m

6. References

1. AS/NZS 3845.1:2015 – Road safety barrier systems
2. AS/NZS 3845.2:2017 – Rod safety devices
3. Austroads Guide to Road Design – Part 6 (2022)
4. DoT Supplement to Austroads Guide to Road Design – Part 6 (2023)
5. Road Design Note 06-04 – Accepted Safety Barrier Products
6. Standard Section 708 – Guard fence installation
7. Standard Section 711 – WRSB installation
8. An explanatory model for quantification of road safety barrier impact risk, Burbridge 2020

7. Appendices

APPENDIX A	Wire Rope Safety Barrier deflection calculation
APPENDIX B	Procedure to determine the length of redirection of a WRSB
APPENDIX C	WRSB worked example
APPENDIX D	Emergency Stopping Bay (ESB)
APPENDIX E	Continuous safety barrier summary sheet
APPENDIX F	Typical barrier drawings

8. Revision History

Version	Date	Clause	Description of Change
1.0	August 2021	All	First version - This document consolidates guidance from RDN 06-02, RDN 06-08 and RDN 06-15, as well as other DoT internal documents. This document provides additional commentary on • Working widths for concrete barrier • Barrier setback distances from kerb
2.0	February 2023	Various	• RDN restructured to align with the Supplement to AGRD Part 6 (v5.0). • All duplicated information has been removed and located within the Supplement to AGRD Part 6. • Minor clarifications and edits.

9. Contact Details

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Appendix A - Wire Rope Safety Barrier deflection calculation factors

Please note, this appendix has been moved from 'RDN 06-02 – The use of wire rope safety barriers (2016)' and is largely unchanged. This appendix will be reviewed in a future edition of the document.

The universal deflection values provided in Table A1 are based on the NCHRP 350 crash test protocol and are now superseded. As such, designers should refer to the product specific values contained within relevant Austroads TCUs.

DoT is currently reviewing the need to re-establish universal WRSB deflection and working width values.

The tables below contain the standard barrier design deflections (Dstd) and correction factors (Fl, Fc) required to calculate the maximum barrier deflection (Dmax) . (Dmax = Dstd x Fl x Fc)

A.2 Dstd –Standard barrier design deflections at accepted post spacings

"Working width" or "dynamic deflection" shall be adopted, from Table A1 below, as the required standard barrier design deflection.

Table A1: D_{std} – Standard barrier design deflections[1,2]

Post spacing class	Reduced	Standard
Post spacing	2.0 m	3.0 m
Working Width standard (4-12 Test)	1.9 m	2.3 m
Dynamic Deflection standard (4-11 Test)	1.5 m	1.8 m

Notes:

1. Values based on straight barriers, up to 250m long between anchors.
2. Values based on barriers with concrete post footings.
3. Design deflections are based on NCHRP Report 350 Test Designations 4-11 and 4-12. See selection of 'dynamic deflection' or 'working width' for Dstd below.

A.3 Selection of "Dynamic deflection" or "working width" for Dstd

The selection of either "working width" or "dynamic deflection" as standard barrier design deflection Dstd, is dependent on the type of hazard being shielded. This can be simplified into two cases;

Case 1 – Where the hazard can be impacted by the vehicle roll allowance (e.g. pole or tree), "working width" shall be used. This is the preferred case for all situations.

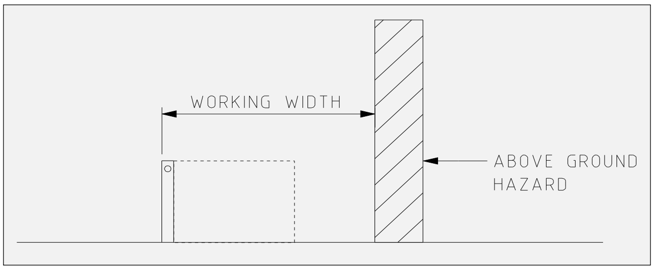


Figure A1: Case 1 hazard

Case 2 - Where the hazard is low enough that it does not interfere with the vehicle roll allowance beyond the barrier (e.g. batter), "dynamic deflection" is considered sufficient.

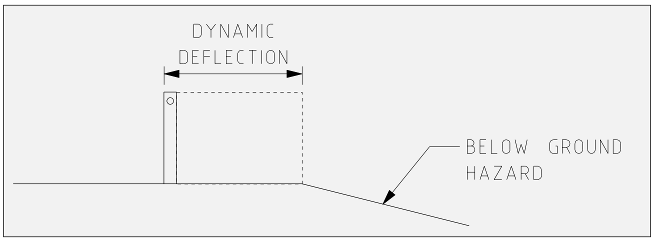


Figure A2: Case 2 hazard

For these two cases, the “working width” and “dynamic deflection” values, quoted in Table A1 above, have been based on the results measured during NCHRP 350 crash test designation 4-12 and 4-11, respectively, which are considered a severe case for each hazard type.

As discussed in Section 2, each accepted WRSB system must demonstrate satisfactory crash testing in accordance with NCHRP report 350 to at least Test Level 4. This includes passing the following NCHRP 350 test designations:

4-10: 820 kg car at 100km/h and 20 degrees

4-11: 2,000 kg pickup at 100km/h and 25 degrees

4-12: 8,000 kg truck at 80km/h and 15 degrees

As a simplistic overview; the 820 kg vehicle impact ensures a low riding vehicle is captured by the barrier and the occupant ride down is acceptable. The 2,000 kg vehicle impact represents a worst case, high energy impact, generally resulting in the greatest dynamic deflection. And the 8,000 kg vehicle impact demonstrates containment for a higher centre of gravity vehicle, generally resulting in a larger working width than dynamic deflection due to the vehicle roll allowance beyond the barrier. As such, the WRSB “dynamic deflection” values are based on the 4-11 crash test where no vehicle roll and the greatest overall dynamic deflection was demonstrated, while the WRSB “working width” values are based on the 4-12 crash test, which resulted in a lesser dynamic deflection (than 4-11) but a greater overall working width beyond the barrier. Refer product crash test results for performance details.

Fl – Barrier length correction factors

The Fl to be adopted should be selected from Table A2 below.

Table A2: Length correction factors (Fl)

Rope length (m)[1]	Correction factor Fl
0 - 250	1.0
251 - 350	1.1
351 – 500[2]	1.15
> 500[2]	1.2

Notes:

1. Rope length is the total length of wire rope between anchor connections. (i.e. including terminals).

2. Deflection will continually increase as the wire rope length increases. Maximum barrier length shall be 1km. Fc – Barrier curvature correction factors

The Fc to be adopted should be selected from Table A3 below for all installations except those where impacts are only possible on the concave side of the curved alignment. For installations where impacts are only possible on the concave side, an Fc of 1.0 shall be adopted irrespective of curve radius.

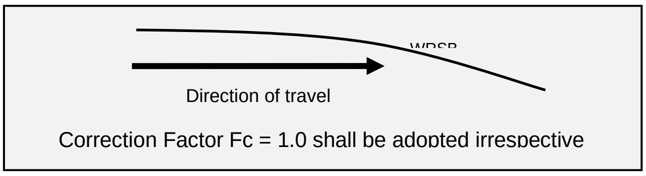
Table A3: Curvature correction factors (F_c)

Barrier radius (m)	Correction Factor Fc
200 - 400	1.5
401 - 500	1.4
501 - 600	1.3
601 - 800	1.2
801 - 1500	1.1
> 1500	1.0

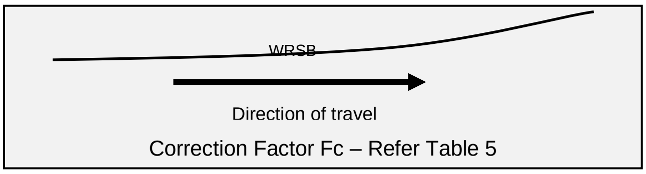
Notes:

1. Where the barrier alignment is straight, adopt Fc = 1.0

Concave side



Convex side



A.4 Non-conforming or system specific designs

If the requirements cannot be met, a non-conforming or system specific design may be considered in accordance with the Superintendent, only after the use of a stiffer system of similar containment has been considered. The use of a non-conforming or system specific design can be advantageous over a lower containment barrier, such as guard fence, as the extra containment of a TL-4 system means protection for a larger range of vehicle types, especially if the impact energy is expected to be less than tested.

Non-conforming design

Where site conditions prevent the use of “working width” with case 1 hazard types, “dynamic deflection” may be considered for above ground hazards where a documented non-conforming design report has been completed, endorsed by a delegated Department of Transport and Planning officer and approved by the Superintendent.

This non-conforming design report shall demonstrate that the expected vehicle impact conditions on-site are reduced from the crash tested conditions. Including but not limited to a:

- small future vehicle fleet mix,
- reduced operating speed,
- lesser likely impact angle, and
- low probability of an impact.

By demonstrating that the 4-12 impact condition (8,000 kg truck at 80km/h and 15 degrees) is not expected on site; the deflection recorded during crash testing may not be expected and the “dynamic deflection” standard may be used as an absolute minimum case; ‘case 3’ below.

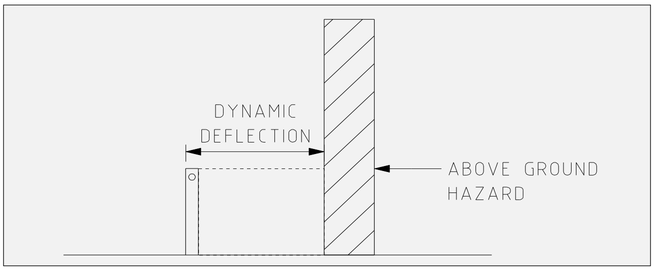


Figure A3: Case 3 hazard

The documented non-conforming design report for case 3 shall be endorsed by a delegated Department of Transport and Planning officer and approved by the Superintendent and submitted to the final barrier supplier for review.

System specific design

Alternatively, where a specific product is known (e.g. an existing installation), the system supplier may be sought for advice and guidance of a specific systems performance. The system specific design may use data from the specific product crash testing as provided and approved by the product owner. System specific designs shall be:

- supported with evidence from the supplier,
- documented with correspondence from the owner,
- specified on the safety barrier design drawings,
- certified by a DoT prequalified designer, and
- approved by the Superintendent.

Any alterations made to the system specific design shall be endorsed by the original designer and supplier, and approved by the Superintendent. Approved suppliers of each WRSB system can be found in RDN 06-04.

All system specific designs shall use an accepted post spacing, specified in Table A1 (2.0m and 3.0m), with the exception of retro fit or context sensitive design exceptions. The use of alternate post spacing that have been crash tested shall be endorsed by a delegated Department of Transport and Planning officer, and approved by the Superintendent.

Appendix B - Procedure to determine the length of redirection of a WRSB

Please note, this appendix has been moved from 'RDN 06-02 – The use of wire rope safety barriers (2016)' and is largely unchanged.

Since the publication of RDN 06-02, the Department of Transport (now the Department of Transport and Planning) no longer adopts the clearzone methodology for assessing the area which is to be free of hazards and instead uses the "area of interest method" (see DoT Supplement to AGRD Part 6 Section 1.9.4). Examples provided in this section based on the clearzone method are for information only.

This appendix will be reviewed in a future edition of the document.

This procedure describes how to determine the minimum WRSB length of redirection (LOR) required to shield a hazard. A hazard in this context is defined as an obstacle or feature located on the roadside that may result in a higher severity accident when impacted by a vehicle than would be expected from a vehicle impacting the barrier. Refer to DoT Supplement to AGRD Part 6 - Section 6.0 for discussion of hazards.

As a simplistic approach, the two main principles include:

- Using an accepted method to determine the required point of need for a hazard. The required point of need is the first point at which a road safety barrier is required to prevent an errant vehicle from striking the hazard. Barriers closer to the hazard are shorter in length. DoT preferred method is the "Run-Out Length method" specified in AGRD Part 6 Section 6.14.3. Refer also SD 3521 and 3573.
- Selecting a barrier product that can provide the redirective capabilities required between points of need; the minimum barrier length of redirection. Aligning the barriers POR with the required point of need will provide this minimum length of adequate protection.

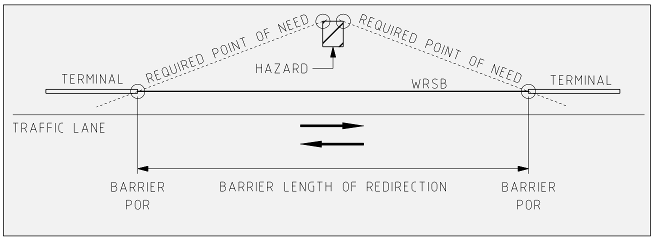


Figure 9: Required point of redirection

The barrier POR location and configuration of the terminal is different for each WRSB product and should be confirmed with the supplier when the POR is critical. Where the POR is not critical, 12m from the beginning of the barrier may be assumed.

Reference should be made to Standard Drawing SD 3521 and 3573 in using this procedure.

1. One-way traffic

1.1 Locate the WRSB as close to the hazard as possible according to the instructions in Sections 4 and 5 of this RDN.

1.2 Determine the operating speed of the road alignment and the one-way AADT (approach volume). Refer to AGRD Part 3 - Section 3.0

1.3 Determine the width of the clear zone by referring to VRS Part 6 - Section 4.2 using the speed and volume from Step 1.2. The width of the clear zone is measured from the edge of the traffic lane nearest to the hazard.

1.4 Referring to Standard Drawing SD 3521 determine the distance "A" from the edge of the traffic lane to the WRSB and the protected width "B" from the traffic lane to the outermost point on the hazard.

1.5 Determine the minimum point of need (i.e."Z" length) from Table B of Standard Drawing SD 3521. (multiply the "Z" value by the future AADT correction factor also in Table B of SD 3521)

1.6 Locate the barrier POR at the calculated point of need. Length of redirection (LOR) = Z (approach) + length of hazard.

2. Two-way traffic

2.1 For the near-side traffic, determine point of need (i.e.“Z” length) on the approach end of the near-side traffic by repeating Steps 1.1 to 1.5 above.

2.2 For the far-side traffic, determine the point of need (i.e.“Z” length) on the approach end of the far-side traffic by repeating Steps 1.2 to 1.5 above, noting that the width of the clear zone and the distances “A” and “B” are measured from the centreline of the carriageway as shown in SD 3521.

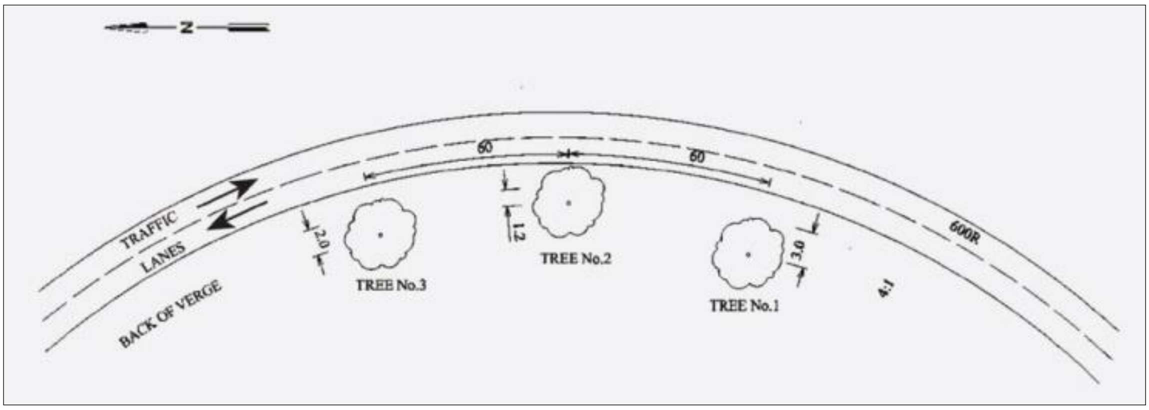
2.3 Locate the barrier POR at the calculated points of need, providing a barrier LOR for the required length. Length of redirection = Z for the near-side traffic + length of hazard + Z for the far-side traffic.

Appendix C – Worked WRSB example

Please note, this appendix has been moved from 'RDN 06-02 – The use of wire rope safety barriers (2016)' and is largely unchanged.

Since the publication of RDN 06-02, the Department of Transport (now the Department of Transport and Planning) no longer adopts the clearzone methodology for assessing the area which is to be free of hazards and instead uses the "area of interest method" (see DoT Supplement to AGRD Part 6 Section 1.9.4). Examples provided in this section based on the clearzone method are for information only.

This appendix will be reviewed in a future edition of the document.



Design input	
Alignment	700m radius curve
Traffic volume	7,000 vehicles/day (2 ways)
Speed limit	100km/h
Cross section	2 lane 2 way highway in fill, 3.5m lanes, 2.5m shoulders, 1.5m verge, 4:1 batters, 4m wide (i.e. 1m high)
Hazard	Trees at 1.6m, 2.0m and 3.0m offset from back of verge on inside of curve (refer diagram)

Step 1: Identify hazards warranting protection

Determine clear zone width (VRS Part 6 - Section 4.0)
Speed limit = 100 km/h, Operating Speed = 110 km/h (AGRD Part 3 - Section 3.0)
One way traffic volume = 3,500 vehicles/day
Basic clear zone width = 8m (VRS Part 6 – Figure V4.1)

4:1 fill batter slopes are considered partially recoverable where errant vehicles may travel further than on a flatter slope; Effective clear zone (ECZ) width (VRS Part 6 - Section 4.2.2.3)

For northbound traffic, 8m basic clear zone width extends over full width of batter. From VRS Part 6 - Figure V4.2, only half of the batter width can be included in the effective clear zone, so ECZ = 8 + 2 = 10m.

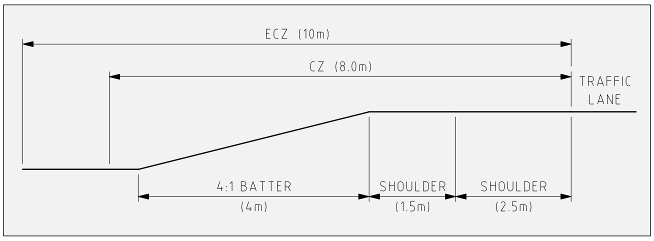


Figure 10: Effective clear zone

For southbound traffic, 1m of basic clear zone width extends over 4:1 batter. From VRS Part 6 - Figure V4.2, this clear zone width over the 4:1 batter is doubled, so ECZ = 7 + 2x1 = 9m.

- For northbound traffic, trees 1, 2 and 3 are within the ECZ, so protection is required.
- For southbound traffic, only trees 2 and 3 are within the ECZ and require protection.

Step 2: Determine barrier length of redirection

For northbound traffic, tree 1 will control the length of barrier required. For southbound traffic, tree 3 will control the length of barrier required.

Refer to Standard Drawing SD 3521 – Safety Barrier (Line B) Alignment Details

Northbound traffic

Tree 1 is offset 6.5m from the edge of traffic lane. Assuming a trunk width of 0.5m, adopt protected width B = 7m.

WRSB offset from traffic lane (A):

- Desirable offset = 4m (see Section 4.2.2)
- Minimum offset = 3m

At 4m offset from traffic lane, WRSB would be located on the 4:1 batter hinge point. This position is not acceptable, unless the system proposed has been successfully crash tested in this configuration (refer Section 4.2.4(b)). If the desirable offset is not possible, then WRSB should be located as far as possible from the traffic lane. As some verge width is likely to be required behind the barrier to meet design deflection requirements, try WRSB at 3m offset from traffic lane.

From Table B of SD 3521, at 110 km/h with A = 3.0m and B = 7m, Z = 65m.

AADT = 3,500 v/d, therefore Z = 55m (65 x 0.81)

Southbound traffic

Tree 3 is offset 9m from the centreline of the road, which is the edge of the closest southbound traffic lane.

From Table B of SD 3521, at 110km/h with A = 6.5m and B = 9m, Z = 35m

AADT = 3,500 v/d, therefore Z = 30m (35 x 0.81)

Total length

Total Length of Redirection:

= Z for Tree 1 + Distance between Trees 1 & 3 + Z for Tree 3.

= 55 + 120 + 30

= 205m

Barrier length:

= 205 + terminals (12m where not specified)

= 229m

Step 3: Determine barrier location and configuration

Having determined a length of redirection for the barrier at an offset of 3m from the traffic lane, the next step is to confirm that this offset is appropriate, and then determine the required post and anchor spacing. The aim of the design should be to maximise the offset of the barrier from the traffic lane and maximise the post and anchor spacing.

For the 3m offset from the traffic lane to be appropriate, the offsets required to hazards as described in Sections 4.2.3 and 4.2.4 respectively must be met.

Offsets to hazard (see Section 4.2.4)

The required offset between WRSB and hazard will be either “working width” for case 1 hazards or “dynamic deflection” for case 2 hazards. In this instance Tree 2 will act as a case 1 hazard and the batter will act as a case 2 hazard.

Tree 2 – Case 1 hazard

Given WRSB offset is 2.6m from Tree 2, working backwards to find allowable Dstd;

Dmax = Dstd x Fl x Fc

Dmax = 2.6m,

Fl = 1.0, from Appendix B, Table 4, for barrier length

= 229m,

Fc = 1.2, from Appendix B, Table 5, for 700m radius curve where convex side impacts may occur.

2.6 = Dstd x 1.0 x 1.2,

Dstd = 2.17m

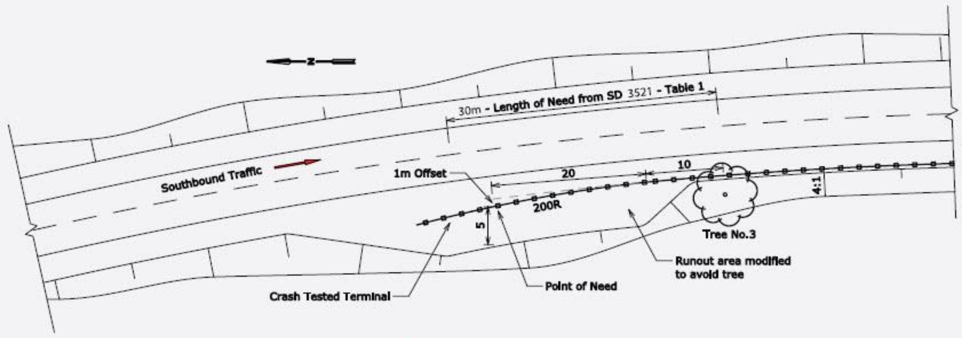


Figure D1 - Acceptable Layout for Northern Terminal & Runout Area

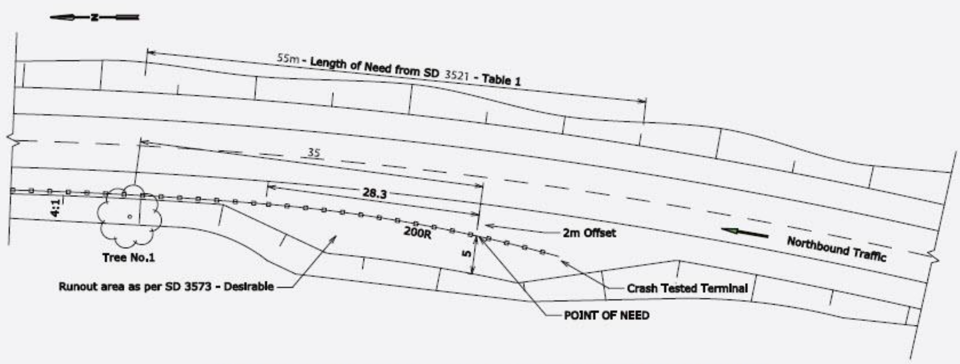


Figure D2 - Preferred Layout for Southern Terminal & Runout Area

From Appendix A, Table A1, a “working width” standard for design deflection with a reduced post spacing is required to achieve Dstd = 2.17m (1.9m).

Fill Batter – Case 2 hazard

Given WRSB offset is 1 m from top of batter, the desirable verge width should be Dmax. working backwards to find allowable Dstd;

Dmax = Dstd x Fl x Fc

1.0 = Dstd x 1.0 x 1.2,

Dstd = 0.84m

From Appendix A, Table A1, a design deflection with either post spacing will not achieve Dstd = 0.84m. If widening of the verge is not practicable, then the minimum verge width required can be Vmin.

Vmin = Dmax – 1.3m (see 4.2.4(b))

1.0m = Dmax – 1.3;

Dmax = 2.3m

Dmax = Dstd x Fl x Fc

2.3m = Dstd x 1.0 x 1.2,

Dstd = 1.91m

From Appendix B, Table 3, a "dynamic deflection" standard for design deflection with a standard post spacing is required to achieve Dstd = 1.91m (1.8m).

Minimum constraint for the site is Tree 2, which requires reduced post spacing. Since the adoption of the larger post spacing would be preferable, and can be achieved for the case 2 batter hazard, it is possible to use a standard post spacing with a minimum length of reduced post spacing.

From Section 4.3.3, the minimum length of reduced post spacing is 30m. As the hazard can be approached from only one direction, the reduced post spacing should extend for 20m on the approach side of the tree, and 20m on the departure.

Having determined that WRSB can be located at 3m offset from the traffic lane and meets the clearance requirements to hazards and batters, confirmation is required from the barrier supplier that adequate support is available for the posts and anchors at this particular site.

Step 4 End treatments and runout areas

Both ends of the WRSB require crash tested terminals regardless if they are approach or departure. See Section 4.3.6.

Alternative treatments for the termination of WRSB are shown on standard drawing SD 3573. The highest standard treatment that can be accommodated at the site should be adopted. This may require earthworks to widen the verge in the vicinity of the terminal.

Treatments for the southern and northern terminals at this site are shown in Figures D1 and D2. The basis for these layouts is as follows:

Northern terminal – Figure D1

The desirable treatment would include a widening of the verge to provide a flat runout area behind the WRSB terminal and a flaring of the WRSB on a 200m radius curve prior to the terminal to offset the point of redirection a further 2m from the traffic lane and direct the terminal away from approaching traffic.

However, in this case, as the length of redirection is relatively short at 30m, the adoption of this treatment, together with the 20m shortening of the length of redirection would result in Tree No.3 being located within 10m of the start of the terminal flaring (refer SD 3573), which is unacceptable.

This problem could be avoided by forgoing the shortening of the length of redirection available from offsetting the point of redirection by 2m, but an acceptable alternative would be to adopt a smaller flare, in this case a 1m offset, which still provides some shortening of the length of redirection without compromising the hazard free zone required beyond the terminal. This is the treatment shown in Figure D1 below.

Southern terminal – Figure D2

At this site there are no constraints preventing the adoption of the desirable flared terminal treatment shown on SD 3573. This treatment should be adopted where possible.

Straight terminal option – verge widening requirements

If the assessment of site constraints concluded that flared terminal treatments were not practicable then a straight terminal treatment as per SD 3573 could be adopted. Note that even the minimum straight terminal treatment shown in SD 3573 would require some verge widening in this case. This verge widening is important given the potential for WRSB terminals to destabilise vehicles in end on impacts.

Appendix D - Stopping refuge bay layout

Figure E1 below shows the preferred layout for stopping refuge bays within WRSB installations more than 500m long at offsets to traffic lanes of less than 4.0m.

WRSB Offset to Traffic Lane 'A' (m)	100 R Curve Arc Length 'B' (m)
1	20
2	15
3	10

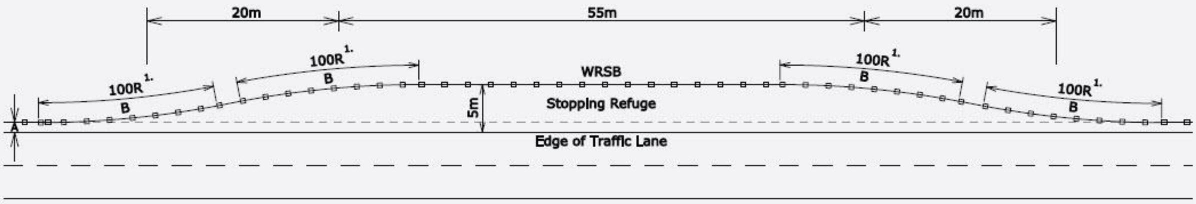


Figure E1 - Preferred Layout for Stopping Refuge Bay

Notes: 1.

100m radius curves are acceptable in this instance only to limit the size of the refuge bay. Class A post spacings will be required in these areas. Unyielding hazards should not be located within 5m of 100m radius curve sections where impacts on the convex side of the curve are possible.

Appendix E – Continuous safety barrier summary sheet

The following summary is unchanged from 'RDN 06-15 – Continuous safety barrier for High Speed Roads (v1.0)' and may be outdated.

While RDN 06-15 has been withdrawn, this list may be useful to some designers. This list does not take precedence over any other guidance, it merely acts as a summary.

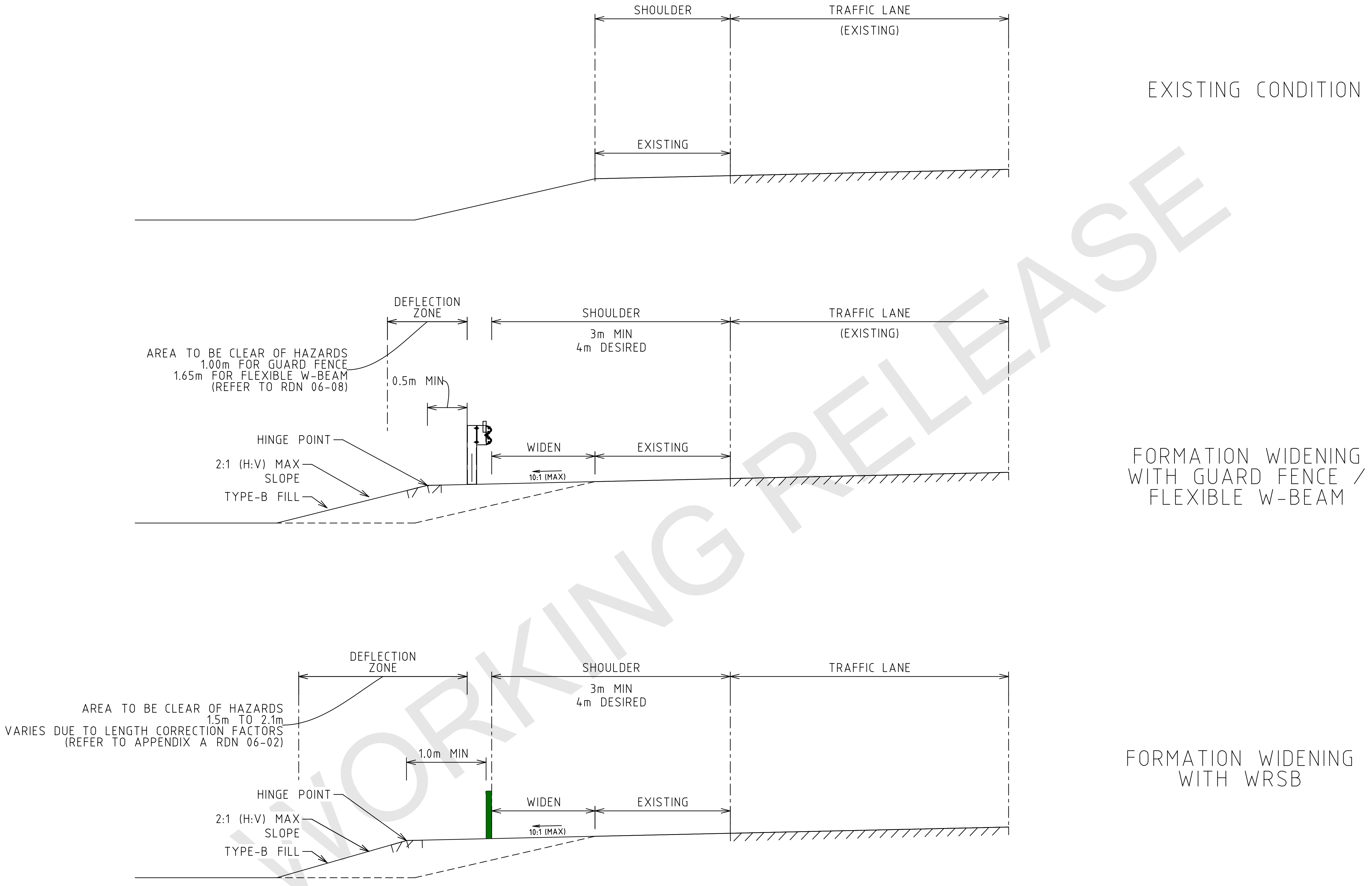
- Continuous safety barrier should be treated like a longitudinal component of the road, with an **intent to shield all roadside elements** as effectively as possible; including all hazards within the 'area of interest' (not only within the clear zone), areas of flat terrain that may cause roll-over, and cut embankments irrespective of grade
- Attractive roadsides strengthen a sense of place and give travellers a more rewarding experience. **Continuous lengths of similar barrier types and designs are desirable** to draw focus on the natural landscape
- **WRSB and flexible GF systems should be used** where possible, as these barrier types have the lowest impact severity and greatest potential to reduce occupant injury.
- Table 1 provides common brownfield (retrofit) scenarios and the preferred safety barrier type.
- **MASH products should be installed** where possible to future proof the serviceability of the asset.
- Every effort should be made to achieve the **desirable offset of 4.0-6.0 metres** as it allows broken down vehicles to pull over clear of traffic lanes and provides space for maintenance vehicles. An offset closest to this range is preferred.
- Greater offsets allowed in certain locations, e.g. ESBs
- **Median barrier offsets between 2.0m-3.0m should be avoided** to discourage vehicles from pulling over into a narrow shoulder.
- Where a divided carriageway has two or less lanes in one direction, median barrier offsets may be less than minimum when a barrier offset 3.0m or greater is provided on the verge.
- Projects should **consider mitigation measures for lengths of reduced barrier offset**; speed reduction, localised pull over opportunities, increased sight lines, advisory signing
- Safety barrier should be overlapped to maintain a continuous barrier system.
- **Maximum safety barrier length is typically 1km for WRSB**, longer lengths may be used where the risk of nuisance impacts is low; desirable offset, straight alignment, ATLM. Maximum length of Flexible GF not defined.
- Provision for stopping considers non-discretionary and elective stopping to allow safe pull over in the event of an emergency or voluntary stop, e.g. Emergency Stopping Bay.
- **Bays are provided at least every 1km-4km**. The precise frequency should be determined with consideration of; a route plan, minimising the cost of earthworks required, providing adequate sightlines, and targeting high risk stopping sites.
- **Help Phone Bays can be removed** unless poor cellular coverage is identified.
- **Provide adequate access for emergency services** where possible. Contact local service to agree/determine locations of access points.
- **Traditional length of need process not critical**; rather commence the barrier at the earliest location possible and identify potential unprotected areas.
- **Run-out area requirements to be provided** at critical and appropriate locations along the proposal.
- **Barrier must be offset or flared to 3.0m near a side road** or property access to provide sight lines. Otherwise, individual risk assessment is required.
- **Barriers offset to hinge point (6:1 or flatter) should be more than dynamic deflection**. Where this requires considerable earthworks, absolute minimum is 1.0m for WRSB and 0.5m for flexible and semi-rigid GF.
- **Replace all MELT, BCTA, BCTB & FLEXFENCE Standard terminals** with a G.R.E.A.T, T.T. or Flex fence TL-3 terminal.
- **Upgrade existing guard fence (<686mm)** using Abraham Blocks or Replace with a more forgiving system.
- **Consider raising the height of existing guard fence (<720mm)** using Abraham Blocks or consider replacing with a more forgiving system.
- **Consider replacing Sentryline II (releasing) terminals** with a Sentryline III (non-releasing) terminal when the barrier offset is < 3m and barrier length is 500m and greater.
- Assess the performance requirements of existing 3-rope WRSB systems and upgrade where cost effective;
- System specific designs may be considered when the proprietary product is known
- P**rovide flexible GF and rub-rail on high risk motorcycle routes**; crash history, high volume, tight curves.
- Fauna crossings to be considered in consultation with Urban Design.
- **Medians less than 10m**, single barrier run can be used. **Medians greater than 10m**; two barrier runs required unless the median is free of hazards, the batter is 10:1 and a second barrier run is catered for in the future.
- **Entry and exit ramps should be treated**, however, the main carriageway must take priority. Must allow for vehicles to pass a broken-down vehicle.
- **Speed management treatments** (e.g. speed limits and speed calming) **may be needed through townships** or on roads with high frequency of side roads, access points and median access
- **Unprotected areas must be assessed and treated** where possible. Exposed hazards within the clear zone must be removed to eliminate the risk of injury (preferred), relocated behind the barrier, or relocated beyond the clear zone (least preferred) as per *AGRD Part 6, Section 4*.
- **Sealing in front of barrier not required** unless considered a local high-risk location.
- **Audio tactile line marking to be installed in-front of barrier** to mitigate the likelihood of impact.
- **Road Safety Audit and Safe System Assessment to be conducted** at various stages of the project.
- Safety barrier maintenance strips only considered were treatment offers whole-of-life benefit.
- **Maintenance and service authority access points to be strategically located** to support maintenance activities.

Appendix F – Typical barrier drawings

Typical barrier drawings have been provided from 'RDN 06-15 – Continuous safety barrier for high-speed roads (v1.0)'. While these drawings are not a standard or minimum requirement, they may be adopted by projects when the layout is suitable for site.

Please contact StandardsManagementRD@roads.vic.gov.au if you have additional drawings that may be included.

Number	Page	Description	Comments
782001	45	Formation widening – Guard fence and WRSB	Distance between barrier and hinge point shown is a minimum and does not cater for dynamic deflection (desirable).
782002	46	Cut embankment – No Kerb	Distance between barrier and cut batter is 2.5m minimum to allow for typical maintenance practices.
782003	47	Cut embankment – With Kerb	
782004	48	Table drain relocation (FILL)	
782005	49	Table drain relocation (CUT)	Need to consider maintenance practices.
782006	50	Emergency services – Median Barrier Access - 90 Degrees PoN overlap	
782007	51	Maintenance access – 10 Degrees PoN overlap	To be used after consideration of 90 and 25-degree PoN overlap. Refer Supplement to AGRD Part 6, Section V5.4.3
782008	52	Maintenance access – 25 Degrees PoN overlap	To be used after consideration of 90-degree PoN overlap. Refer Supplement to AGRD Part 6, Section V5.4.3
782009	53	Maintenance access – 90 Degrees PoN overlap	Refer Supplement to AGRD Part 6, Section V5.4.3
782010	54	Side road access – Barrier layout	
782011	55	Stopping refuge bay - Wire rope safety barrier	
782012	56	Access on bridge departure – 90 Degrees PoN overlap	
782013	57	Emergency services – Vehicle Median Turn Area	Sight lines are critical. Likely earthworks to achieve barrier offsets and maximum barrier length.
782014	58	Combined - Refuge Bay & Median Access	Refer Supplement to AGRD Part 6, Section 5.4.
782015	59	WRSB – Departure overlap detail (no access)	
782016	60	GF – Departure overlap detail (no access)	
782017	61	WRSB – Approach overlap detail (no access)	
782018	62	GF – Approach overlap detail (no access)	



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GENERAL NOTES

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SCALE OF METRES
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SAFE SYSTEM BARRIER FORMATION WIDENING GUARD FENCE / WIRE ROPE

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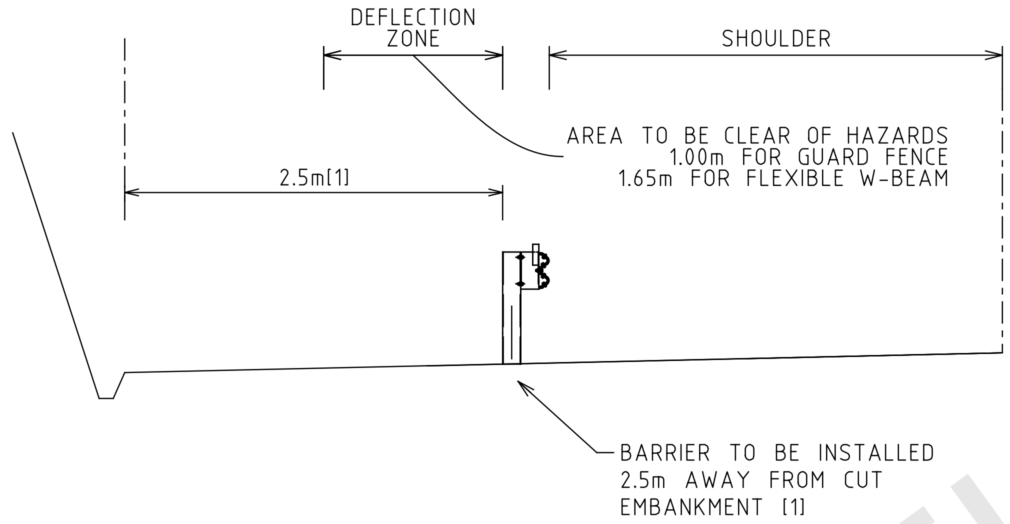
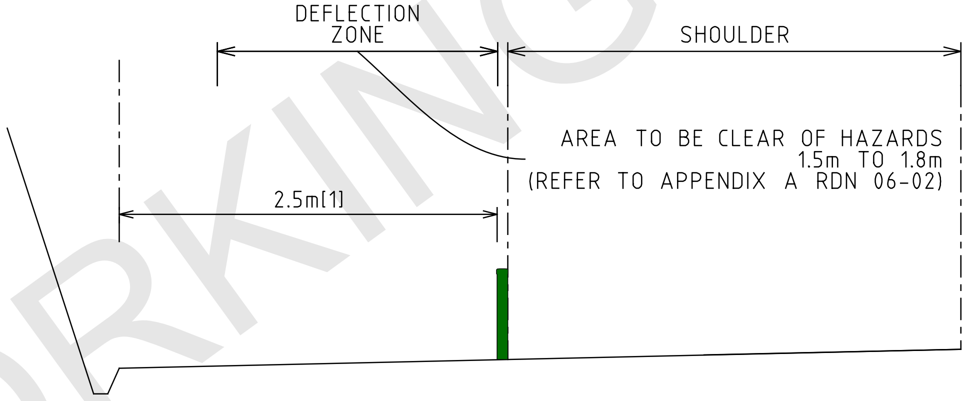


CUT EMBANKMENT
GUARD FENCE / FLEXIBLE
W-BEAM



CUT EMBANKMENT
WITH WRSB

[1] OFFSET THE BARRIER 2.5m FROM THE EMBANKMENT WHERE POSSIBLE TO ALLOW FOR MAINTENANCE VEHILCE ACCESS BEHIND THE BARRIER, OTHERWISE ENSURE THE EMBANKMENT IS OUTSIDE THE DEFLECTION ZONE.

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SAFE SYSTEM BARRIER
CUT EMBANKMENT
NO KERB

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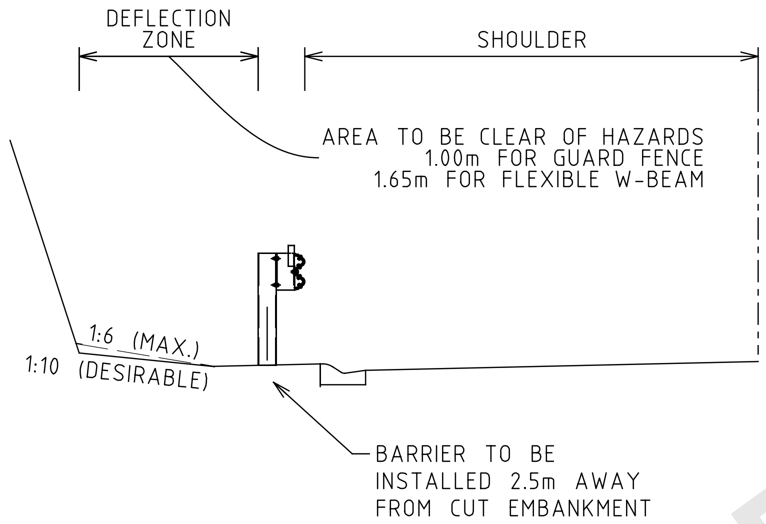
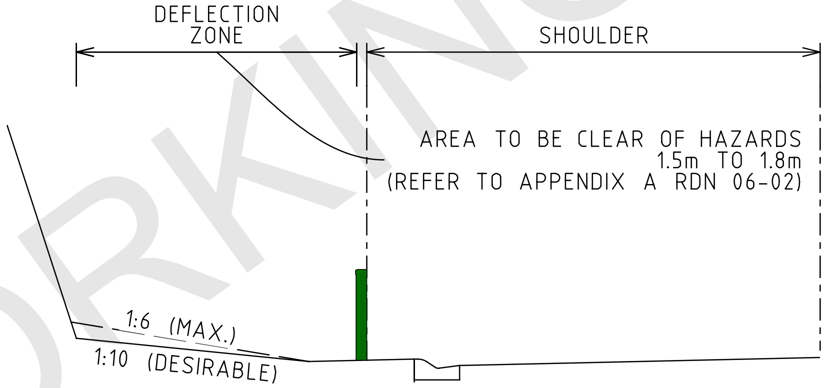


CUT EMBANKMENT
GUARD FENCE / FLEXIBLE
W-BEAM



CUT EMBANKMENT
WITH WRSB

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**SAFE SYSTEM BARRIER
CUT EMBANKMENT
WITH KERB**

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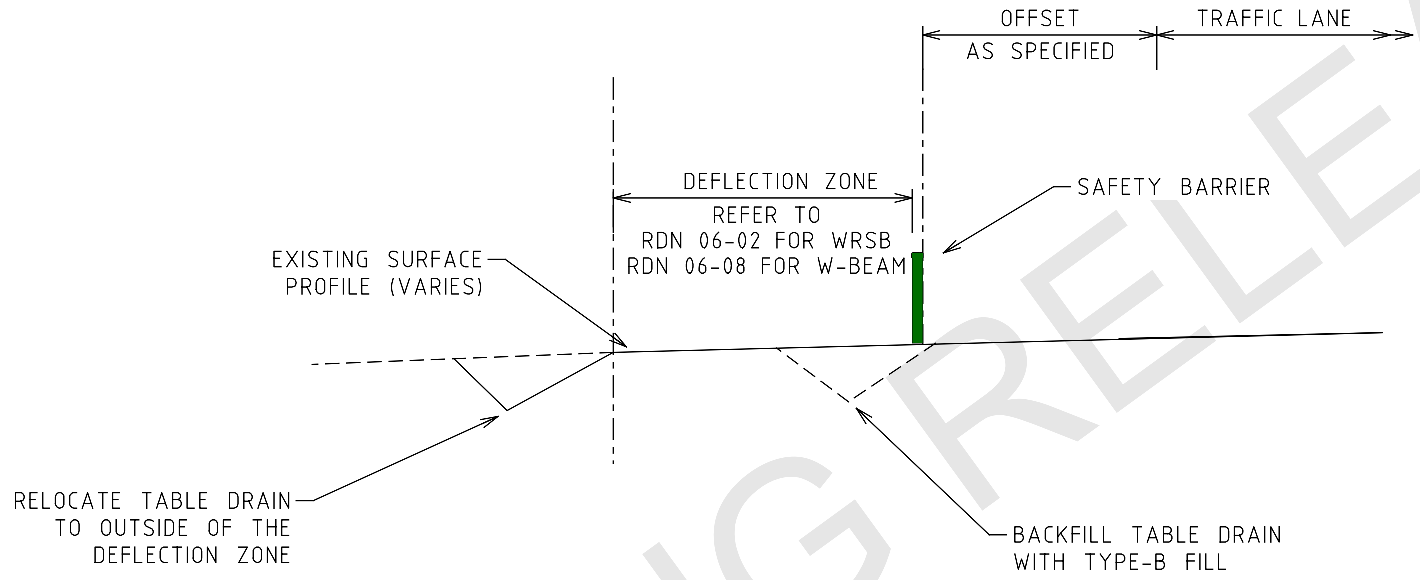

TYPICAL SECTION - TABLE DRAIN RELOCATION (FILL)

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SAFE BARRIER SYSTEMS
TABLE DRAIN RELOCATION
(FILL)

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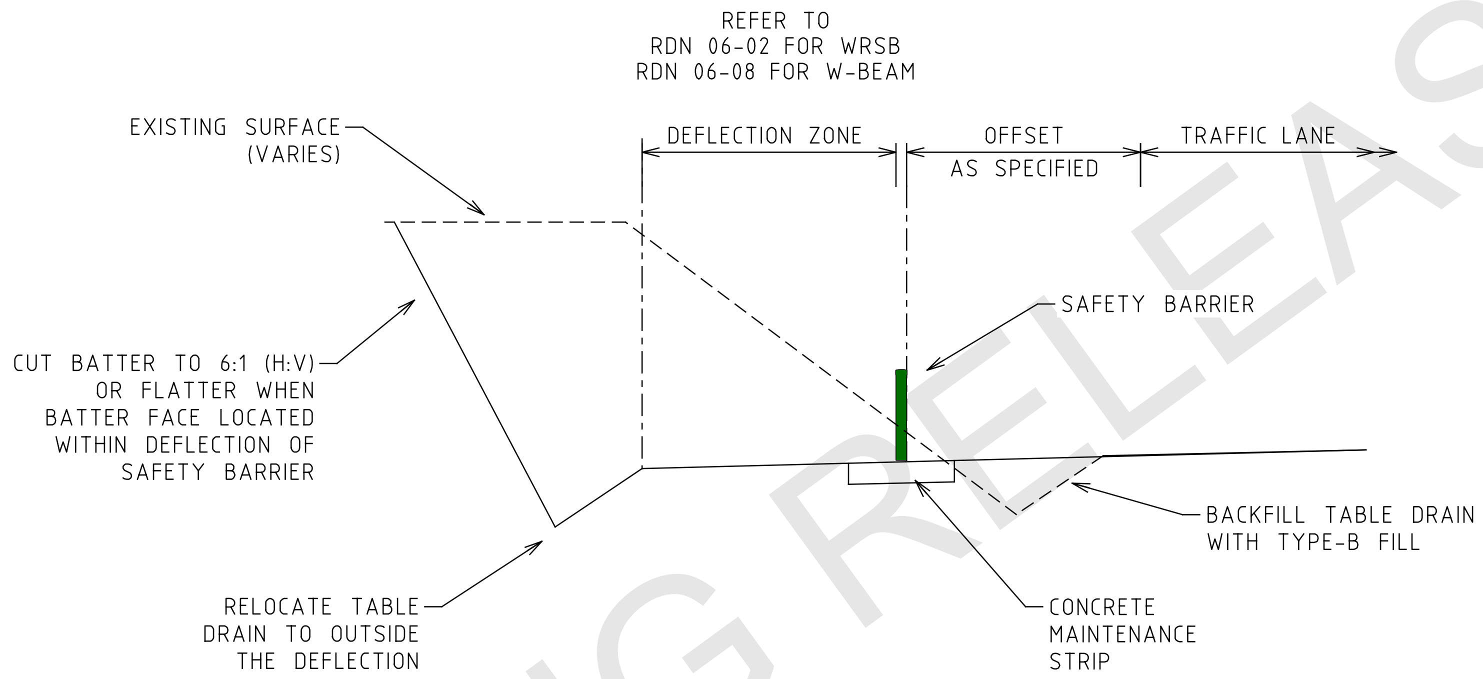

TYPICAL SECTION - TABLE DRAIN RELOCATION (CUT)

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SAFE SYSTEM BARRIER
TABLE DRAIN RELOCATION
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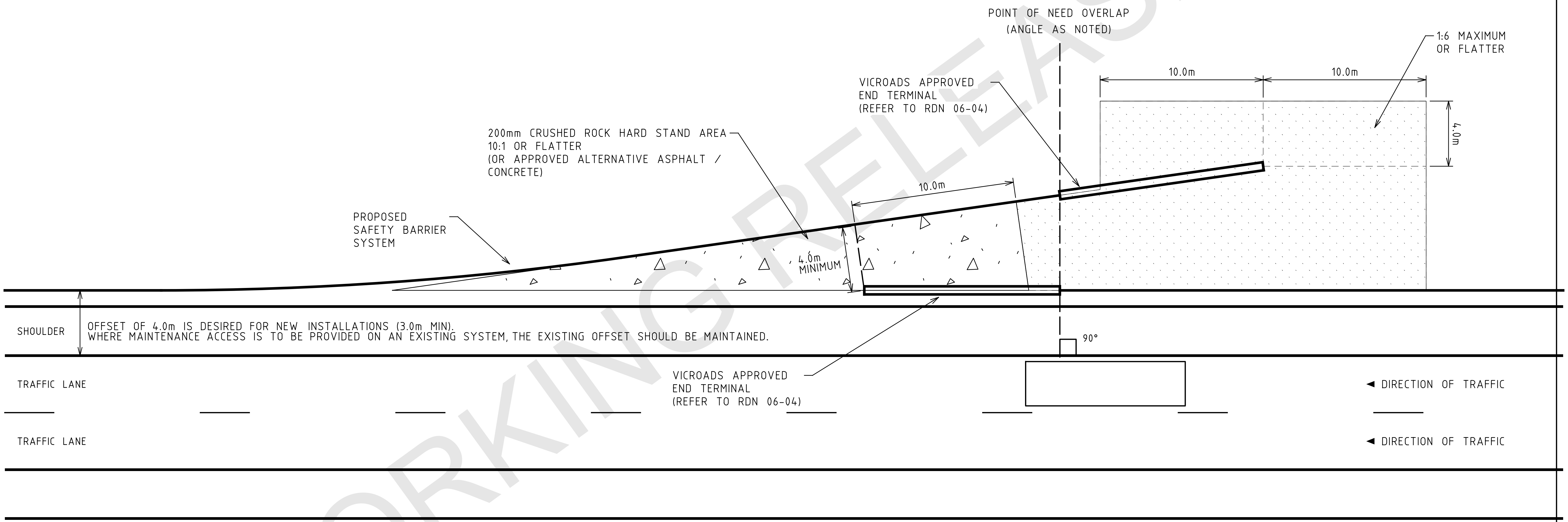
NOTES
1. WHERE SITE CONDITIONS DIFFER FROM THIS TYPICAL LAYOUT, AS A MINIMUM, ENSURE THAT A GAP OF 4.0m IS PROVIDED BETWEEN THE TWO BARRIER SYSTEMS. FURTHERMORE, IT IS DESIRABLE TO ACHIEVE THE ANGLE OF PON OVERLAP AS NOTED ON THE PLAN.
2. WHERE THE SHOULDER IN THE FAST LANE IS LESS THAN 3m, TRAFFIC MANAGEMENT SHOULD BE IMPLEMENTED TO ALLOW MAINTENANCE VEHICLE ACCESS INTO THE MEDIAN.



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SAFE SYSTEM BARRIER
EMERGENCY SERVICES OPERATION & MAINTENANCE ACCESS
MEDIAN BARRIER ACCESS

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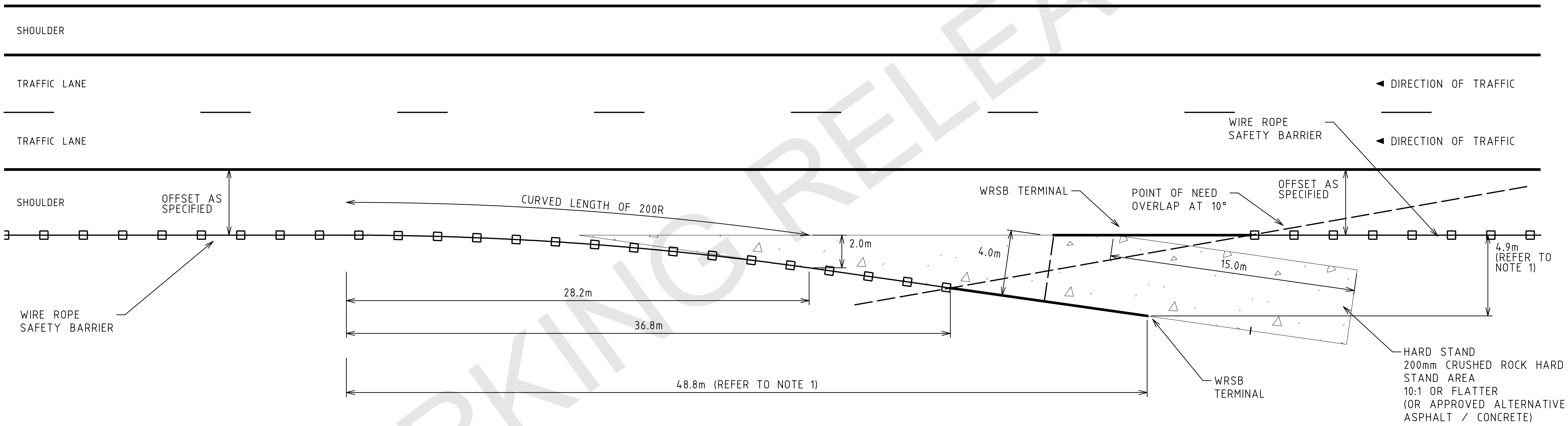

NOTES
1. BASED ON A 12m WRSB TERMINAL.

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SAFE SYSTEM BARRIER
MAINTENANCE ACCESS
10 DEGREE POINT OF NEED OVERLAP

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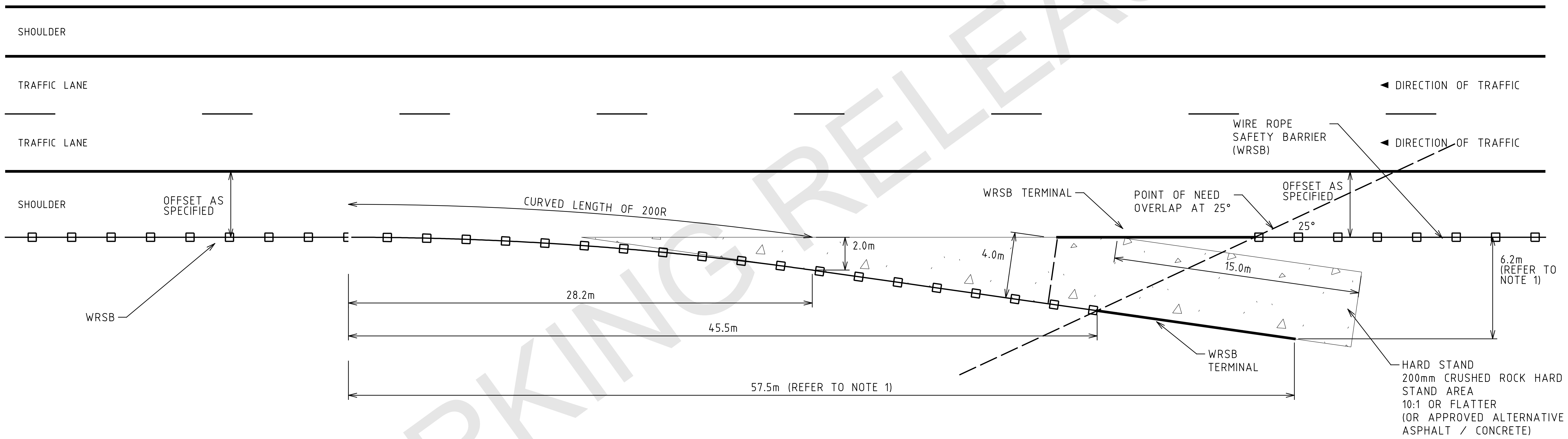

NOTES
1. BASED ON A 12m WRSB TERMINAL.

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SCALE OF METRES
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SAFE SYSTEM BARRIER
EMERGENCY SERVICES OPERATION & MAINTENANCE ACCESS
25 DEGREE POINT OF NEED OVERLAP

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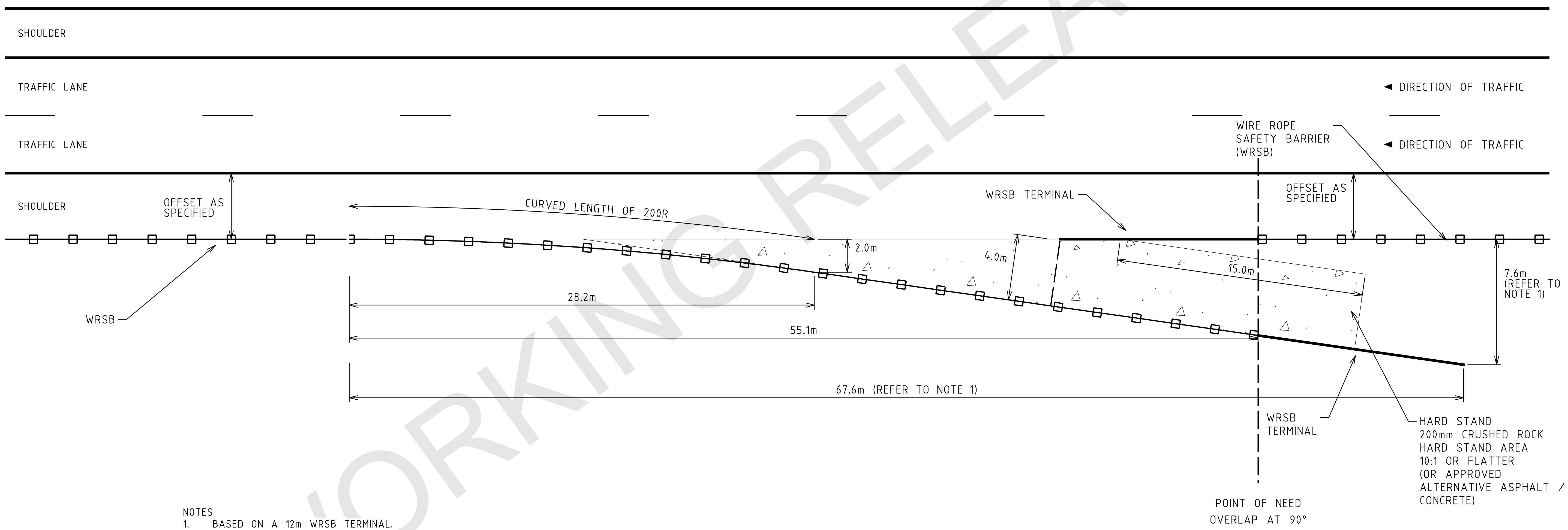

NOTES
1. BASED ON A 12m WRSB TERMINAL.

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SAFE SYSTEM BARRIER
EMERGENCY SERVICES OPERATION & MAINTENANCE ACCESS
90 DEGREE POINT OF NEED OVERLAP

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X	X	X	782009	A

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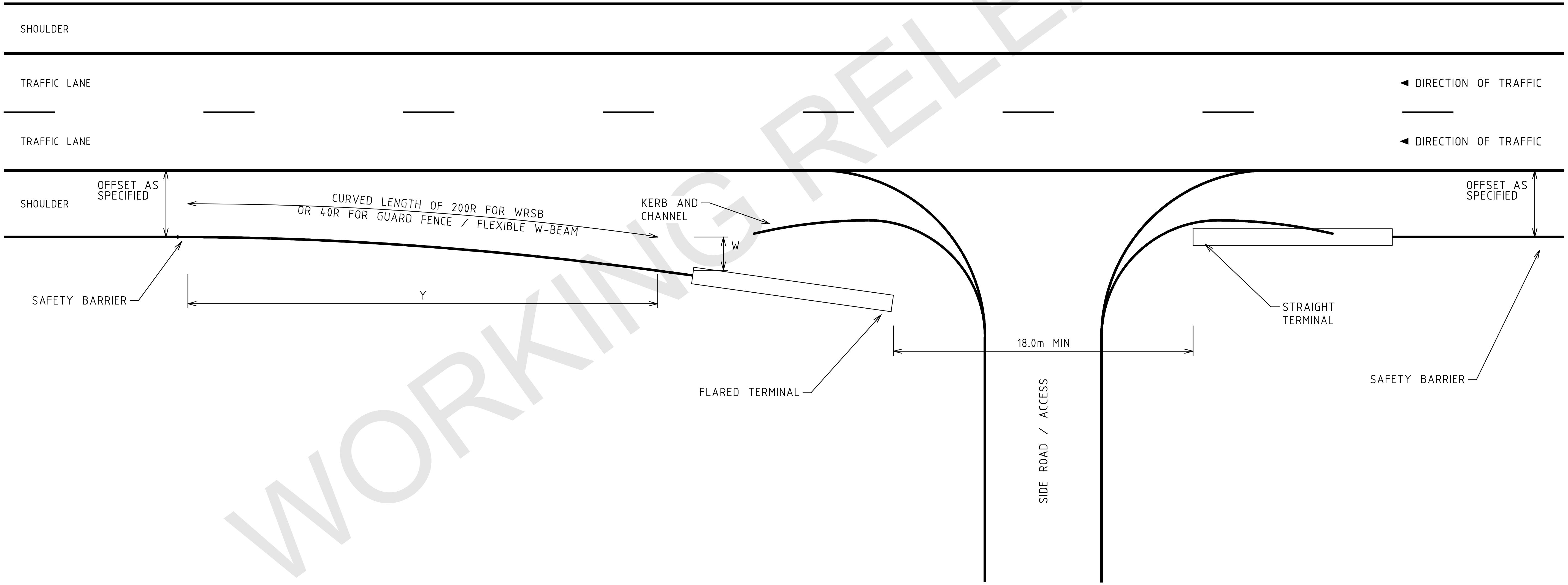
TERMINAL OFFSET 'W' (m)	LONGITUDINAL LENGTH 'Y' (m)
1.0	20.0
1.5	24.4
2.0 (MAX)	28.2

REFER TO VICROADS SD 3573

NOTES

1. SAFETY BARRIER SHOULD EXTEND AS CLOSE TO THE SIDE ROAD / ACCESS AS PRACTICABLE.



ISSUE	APP'D	DATE	AMENDMENT
E	.	.	.
D	.	.	.
C	.	.	.
B	.	.	.
A	.	.	.

GENERAL NOTES

TRAFFICWORKS
166030-FLP-10

DESIGNED TRAFFICWORKS MAY'17
APPROVED VICROADS MAY'17
CAT: -
PROJ: -
FILE: -

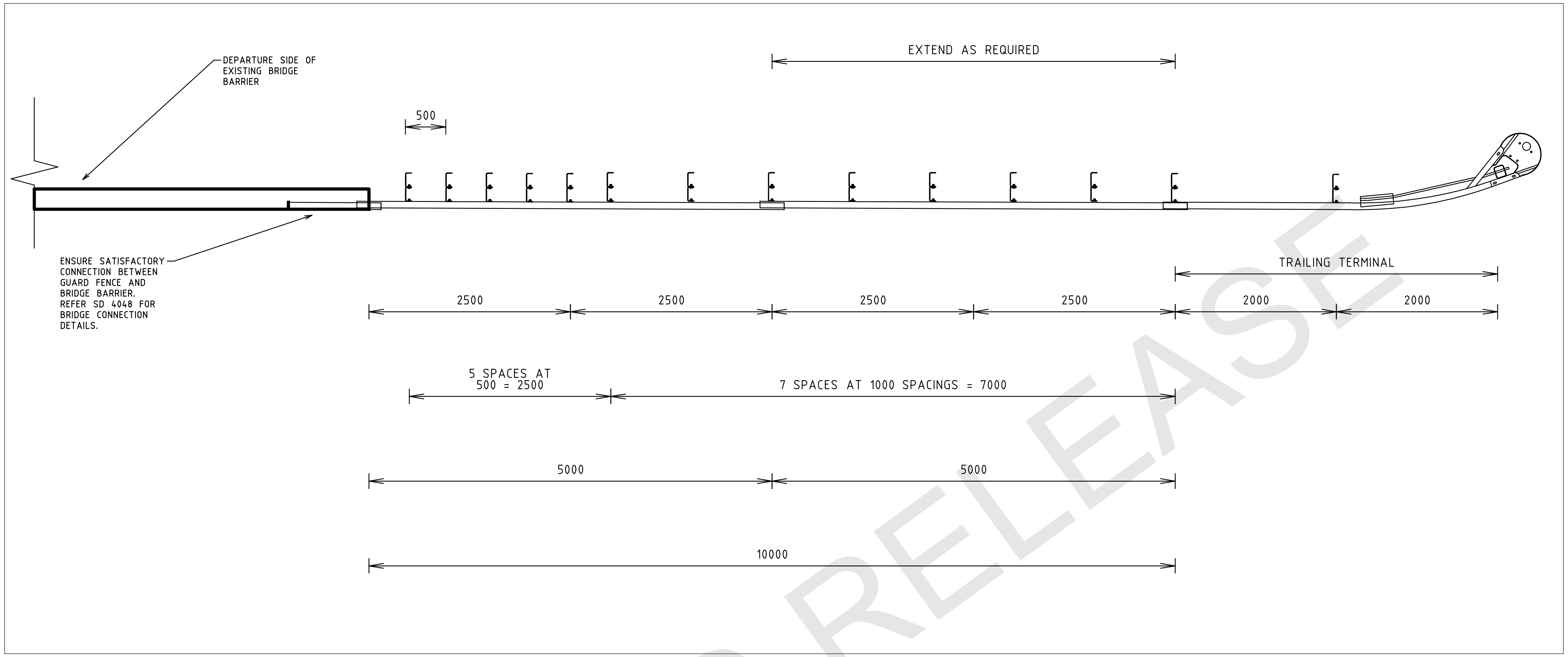
vicroads

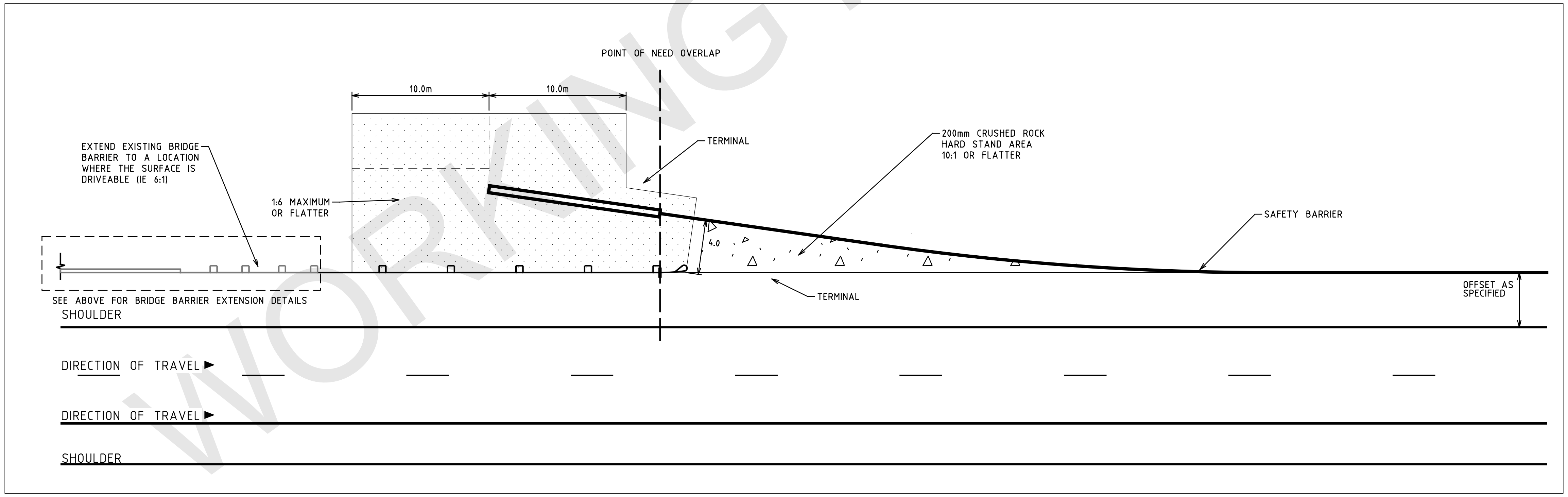
SCALE OF METRES
HOR 0 NTS
VER 0

SAFE SYSTEM BARRIER
PROPERTY / SIDE ROAD ACCESS
BARRIER LAYOUT

FILE NO.	CONTRACT NO.	SHEET NO.	DRAWING NO.	ISSUE
X	X	X	782010	A

13-Jun-17 3:50:16 PM Default 166030-FLP-10.dgn





BARRIER TO BE EXTENDED TO ENSURE THAT THE MAINTENANCE ACCESS LOCATION IS WITHIN A DRIVEABLE SURFACE.

ISSUE	APP'D	DATE	AMENDMENT
E	.	.	.
D	.	.	.
C	.	.	.
B	.	.	.
A	.	.	.

GENERAL NOTES

TRAFFICWORKS
166030-FLP-11

DESIGNED TRAFFICWORKS MAY'17
APPROVED VICROADS MAY'17
CAT: -
PROJ: -
FILE: -

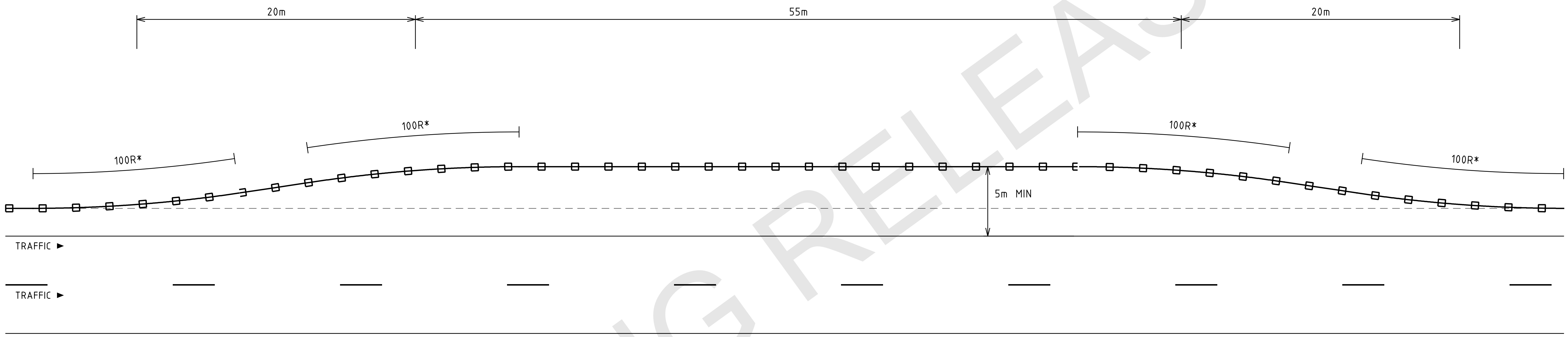
SCALE OF METRES
HOR 0 NTS
VER 0

vicroads

SAFE SYSTEM BARRIER ACCESS ON BRIDGE DEPARTURE PON OVERLAP

FILE NO.	CONTRACT NO.	SHEET NO.	DRAWING NO.	ISSUE
X	X	X	782012	A

13-Jun-17 3:50:17 PM Default 166030-FLP-11.dgn



PREFERRED LAYOUT FOR STOPPING REFUGE BAY

*NOTES:

1. 100m RADIUS CURVES ARE ACCEPTABLE IN THIS INSTANCE ONLY TO LIMIT THE SIZE OF THE REFUGE BAY.
2. REDUCED POST SPACINGS WILL BE REQUIRED IN THESE AREAS.
3. UNYIELDING HAZARDS SHOULD NOT BE LOCATED WITHIN 5m OF 100m RADIUS CURVE SECTIONS WHERE IMPACTS ON THE CONVEX SIDE OF THE CURVE ARE POSSIBLE.

WRSB OFFSET TO TRAFFIC LANE 'A' (m)	100 R CURVE ARC LENGTH 'B' (m)
1	20
2	15
3	10

REFER TO APPENDIX E RDN 06-02

ISSUE	APP'D	DATE	AMENDMENT
E	.	.	.
D	.	.	.
C	.	.	.
B	.	.	.
A	.	.	.

GENERAL NOTES

TRAFFICWORKS
166030-FLP-12

DESIGNED TRAFFICWORKS MAY'17
APPROVED VICROADS MAY'17
CAT: -
PROJ: -
FILE: -

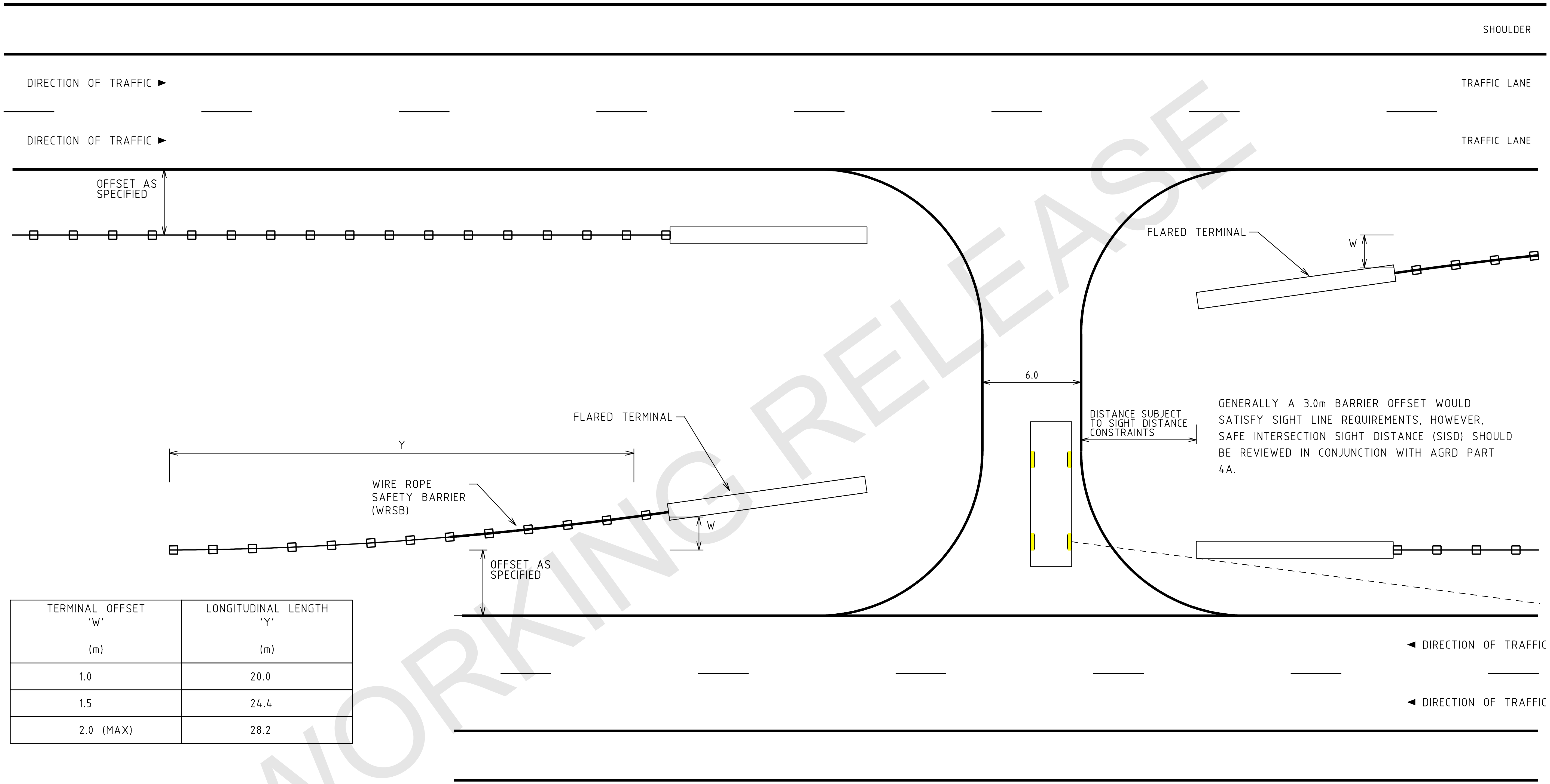
vicroads

SCALE OF METRES
HOR 0 NTS
VER 0

SAFE SYSTEM BARRIER
LAYOUT FOR STOPPING REFUGE BAY
WIRE ROPE SAFETY BARRIER

FILE NO.	CONTRACT NO.	SHEET NO.	DRAWING NO.	ISSUE
X	X	X	782011	A

13-Jun-17 3:50:17 PM Default 166030-FLP-12.dgn



TERMINAL OFFSET 'W' (m)	LONGITUDINAL LENGTH 'Y' (m)
1.0	20.0
1.5	24.4
2.0 (MAX)	28.2

NOTES

1. SAFETY BARRIER SHOULD EXTEND AS CLOSE TO THE SIDE ROAD / ACCESS AS PRACTICABLE.

ISSUE	APP'D	DATE	AMENDMENT
E	.	.	.
D	.	.	.
C	.	.	.
B	.	.	.
A	.	.	.

GENERAL NOTES

TRAFFICWORKS

166030-FLP-13

DESIGNED TRAFFICWORKS MAY'17

APPROVED VICROADS MAY'17

CAT: -
PROJ: -
FILE: -

vicroads

SCALE OF METRES
HOR 0 NTS
VER 0

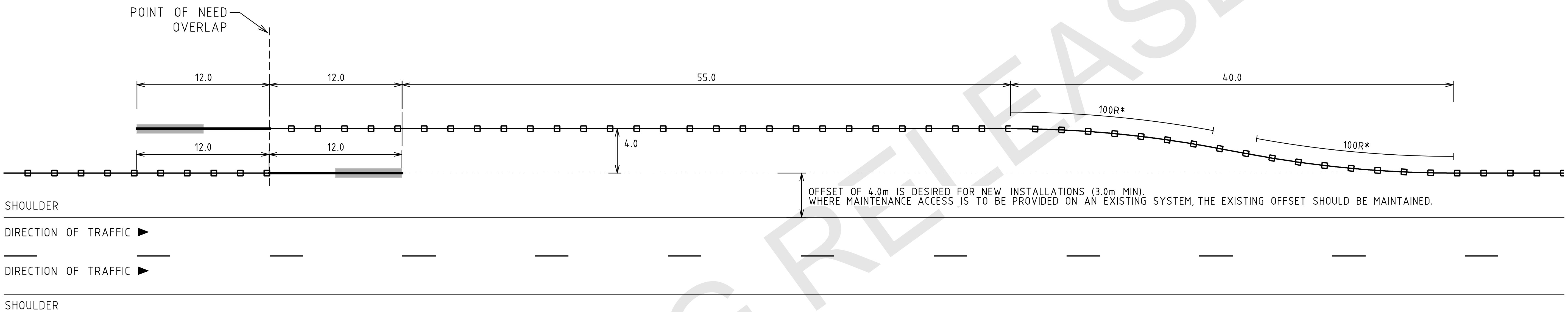
SAFE SYSTEM BARRIER EMERGENCY SERVICES / VICROADS VEHICLE MEDIAN TURN AREA

FILE NO.	CONTRACT NO.	SHEET NO.	DRAWING NO.	ISSUE
X	X	X	782013	A

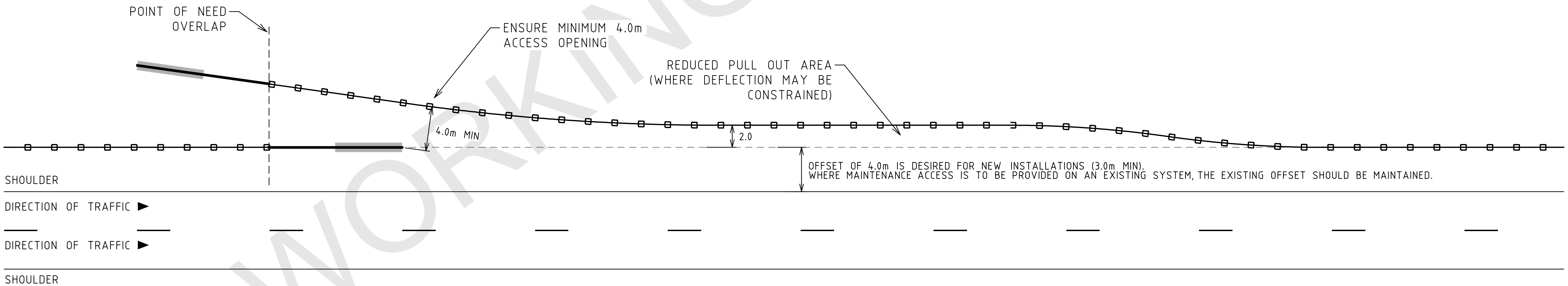
13-Jun-17 3:50:18 PM Default 166030-FLP-13.dgn

*NOTES:

1. 100m RADIUS CURVES ARE ACCEPTABLE (WITH REDUCED POST SPACINGS) IN THIS INSTANCE ONLY TO LIMIT THE SIZE OF THE REFUGE BAY.
2. REDUCED POST SPACINGS WILL BE REQUIRED IN THESE AREAS.
3. UNYIELDING HAZARDS SHOULD NOT BE LOCATED WITHIN 5m OF 100m RADIUS CURVE SECTIONS WHERE IMPACTS ON THE CONVEX SIDE OF THE CURVE ARE POSSIBLE.



PREFERRED LAYOUT FOR STOPPING REFUGE BAY



ALTERNATIVE LAYOUT FOR STOPPING REFUGE BAY

ISSUE	APP'D	DATE	AMENDMENT
E	.	.	.
D	.	.	.
C	.	.	.
B	.	.	.
A	.	.	.

GENERAL NOTES

TRAFFICWORKS
166030-FLP-14

DESIGNED: TRAFFICWORKS MAY'17
APPROVED: VICROADS MAY'17
CAT: -
PROJ: -
FILE: -

vicroads

SCALE OF METRES
HOR 0 NTS
VER 0

SAFE SYSTEM BARRIER
COMBINED REFUGE BAY & EMERGENCY ACCESS

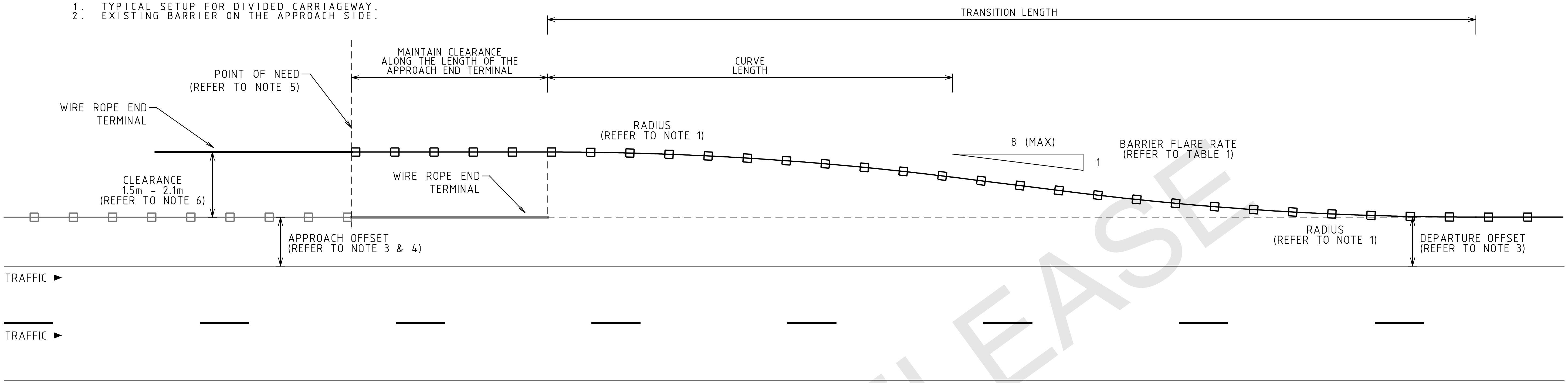
FILE NO.	CONTRACT NO.	SHEET NO.	DRAWING NO.	ISSUE
X	X	X	782014	A

13-Jun-17 3:50:18 PM Default 166030-FLP-14.dgn

WIRE ROPE SAFETY BARRIER
DEPARTURE OVERLAP TREATMENT

CONDITIONS FOR USE

1. TYPICAL SETUP FOR DIVIDED CARRIAGEWAY.
2. EXISTING BARRIER ON THE APPROACH SIDE.



NOTES

REFER TO AGRD PART 6 FOR REQUIRED FLARE RATES OF SAFETY BARRIER.

TABLE 1

DESIGN SPEED	SHY LINE OFFSET (m)	FLARE RATE	
		WITHIN SHY LINE OFFSET	OUTSIDE SHY LINE OFFSET
80	2.0	21:1	11:1
90	2.2	24:1	12:1
100	2.4	26:1	14:1
110	2.8	30:1	15:1

MAXIMUM FLARE RATE OF 8:1 WHERE TRANSITION IS TO BE MINIMISED AND NOT EXPOSED TO THE TRAFFIC (REFER TO SD 4071).

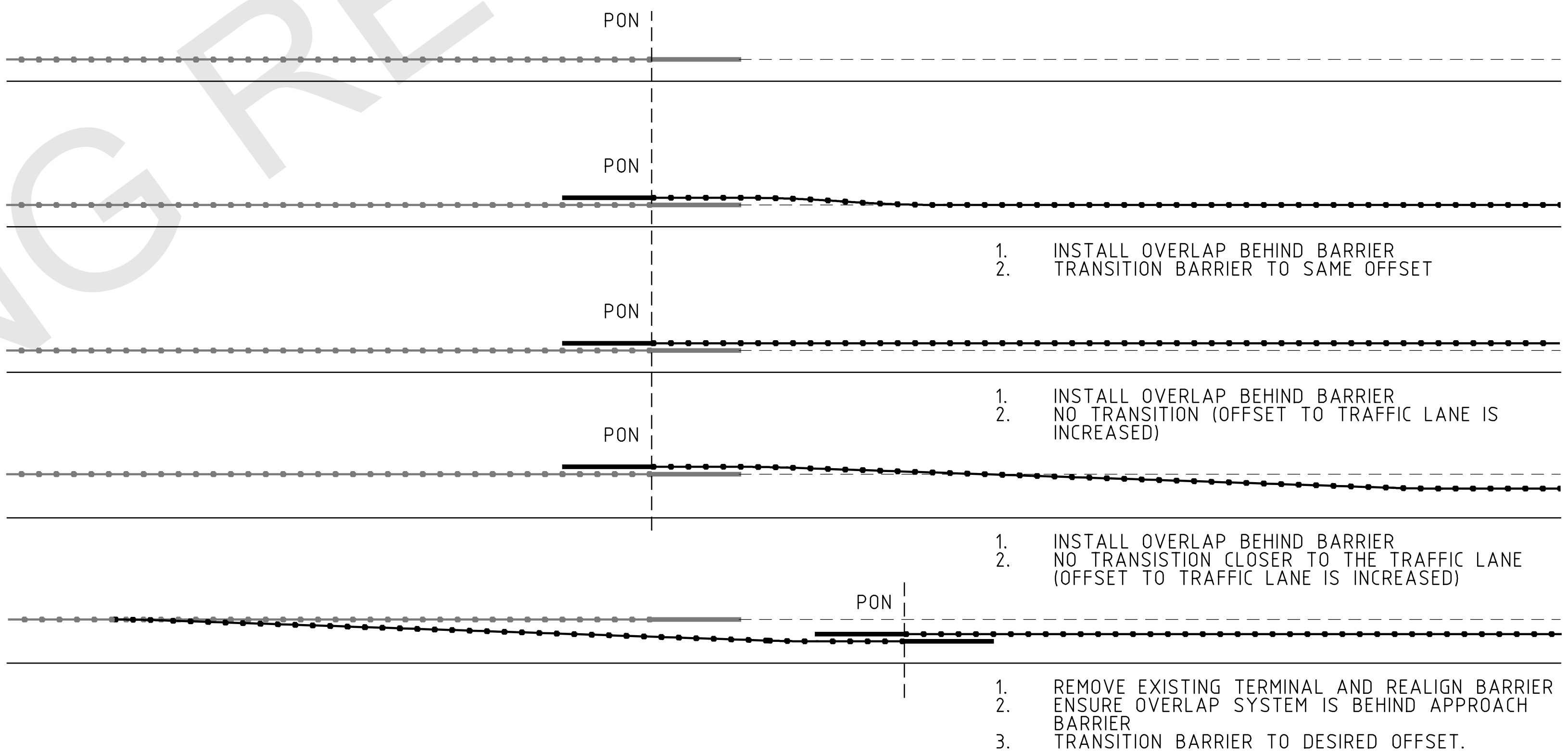
NOTES

1. DESIRABLE RADIUS OF 200m FOR WIRE ROPE SAFETY BARRIER IS TO BE USED. WHERE TRANSITION LENGTH IS TO BE MINIMISED, A RADIUS OF 100m MAY BE CONSIDERED (REFER TO RDN 06-02, FIGURE E1 NOTE 1)
2. WHERE THE OVERLAP IS TO BE RETROFITTED ONTO AN EXISTING BARRIER SYSTEM, THE EXISTING OFFSET TO THE TRAFFIC LANE SHOULD BE MAINTAINED TO KEEP A CONSISTENT BARRIER LINE.
3. THE DESIRABLE OFFSET OF THE BARRIER FROM THE TRAFFIC LANE IS 4.0m (3.0m MINIMUM).
4. WHERE THE PROPOSED OFFSET IS LESS THAN 3.0m, APPROVAL SHOULD BE SOUGHT FROM THE SUPERINTENDENT.
5. IT IS DESIRABLE TO HAVE THE POINT OF NEED OVERLAP BETWEEN THE TWO BARRIER SYSTEMS TO ENSURE CONTINUOUS PROTECTION ALONG THE ALIGNMENT.
6. THE DEFLECTION OF THE APPROACH BARRIER WILL DETERMINE THE CLEARANCE OF THE OVERLAPS BETWEEN THE TWO SYSTEMS; THIS ENSURES THAT THE PERFORMANCE OF THE BARRIER IN FRONT IS NOT IMPACTED BY THE BARRIER BEHIND IT (REFER TO APPENDIX A RDN 06-02).

DESIGN PHILOSOPHY

1. INSTALL OVERLAP BEHIND EXISTING BARRIER
2. DETERMINE REQUIRED CLEARANCE BETWEEN BARRIER SYSTEMS
3. DETERMINE PROPOSED OFFSET FROM THE TRAFFIC LANE
4. TRANSITION TO PROPOSED OFFSET (3.0m DESIRED - MAINTAIN EXISTING OFFSET)

TYPICAL LAYOUTS



ISSUE	APP'D	DATE	AMENDMENT
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D	.	.	.
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B	.	.	.
A	.	.	.

GENERAL NOTES

TRAFFICWORKS
166030-FLP-15

DESIGNED TRAFFICWORKS MAY'17
APPROVED VICROADS MAY'17
CAT: -
PROJ: -
FILE: -

vicroads

SCALE OF METRES
HOR 0 NTS
VER 0

SAFE SYSTEM BARRIER
WIRE ROPE SAFETY BARRIER
DEPARTURE OVERLAP DETAIL

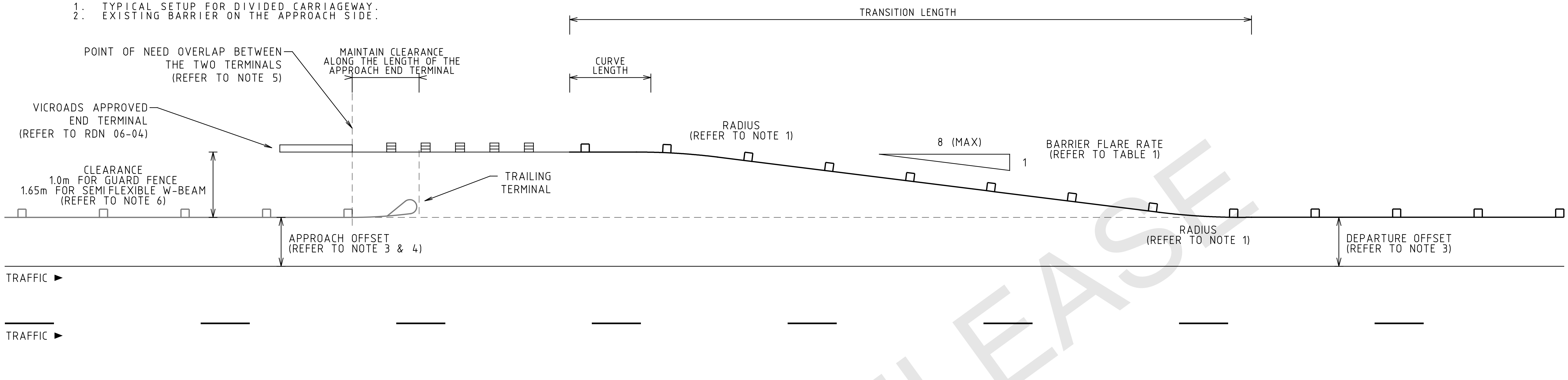
FILE NO.	CONTRACT NO.	SHEET NO.	DRAWING NO.	ISSUE
X	X	X	782015	A

13-Jun-17 3:50:19 PM Default 166030-FLP-15.dgn

GUARD FENCE / FLEXIBLE W-BEAM DEPARTURE OVERLAP TREATMENT

CONDITIONS FOR USE

1. TYPICAL SETUP FOR DIVIDED CARRIAGEWAY.
2. EXISTING BARRIER ON THE APPROACH SIDE.



NOTES

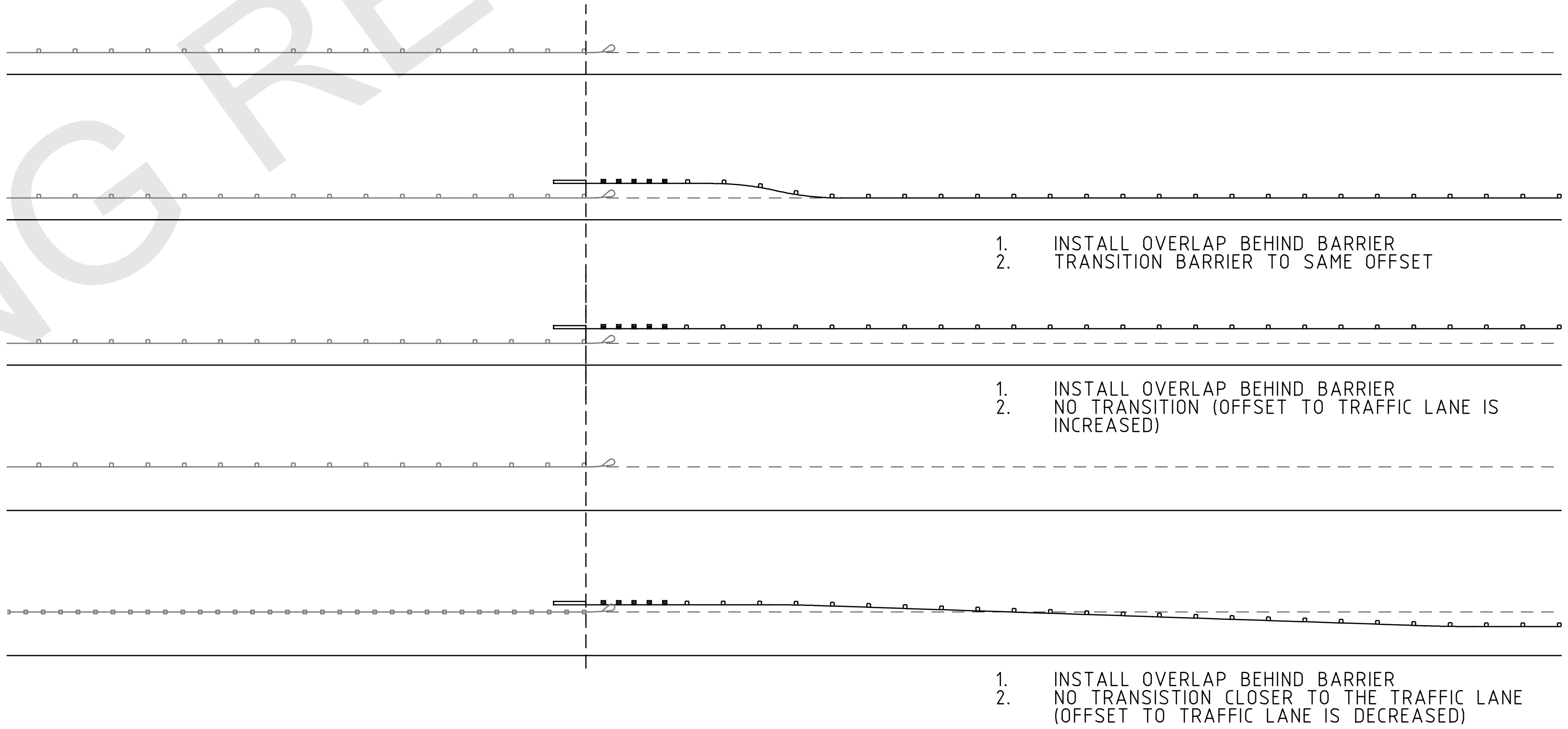
REFER TO AGRD PART 6 FOR REQUIRED FLARE RATES OF SAFETY BARRIER.

TABLE 1

DESIGN SPEED	SHY LINE OFFSET (m)	FLARE RATE	
		WITHIN SHY LINE OFFSET	OUTSIDE SHY LINE OFFSET
80	2.0	21:1	14:1
90	2.2	24:1	16:1
100	2.4	26:1	18:1
110	2.8	30:1	20:1

MAXIMUM FLARE RATE OF 8:1 WHERE TRANSITION IS TO BE MINIMISED AND NOT EXPOSED TO THE TRAFFIC (REFER TO SD 4071).

TYPICAL LAYOUTS



NOTES

1. GUARD FENCE / FLEXIBLE W-BEAM TO BE INSTALLED ON A 40m RADIUS OR TO MANUFACTURER REQUIREMENTS.
2. WHERE THE OVERLAP IS TO BE RETROFITTED ONTO AN EXISTING BARRIER SYSTEM, THE EXISTING OFFSET TO THE TRAFFIC LANE SHOULD BE MAINTAINED TO KEEP A CONSISTENT BARRIER LINE.
3. THE DESIRABLE OFFSET OF THE BARRIER FROM THE TRAFFIC LANE IS 4.0m (3.0m MINIMUM).
4. WHERE THE PROPOSED OFFSET IS LESS THAN 3.0m, APPROVAL SHOULD BE SOUGHT FROM THE SUPERINTENDENT.
5. IT IS DESIRABLE TO HAVE A 90° OVERLAP FOR THE POINT OF NEED OF THE TWO BARRIER SYSTEMS TO ENSURE CONTINUOUS PROTECTION ALONG THE ALIGNMENT.
6. THE DEFLECTION OF THE APPROACH BARRIER WILL DETERMINE THE CLEARANCE OF THE OVERLAPS BETWEEN THE TWO SYSTEMS; THIS ENSURES THAT THE PERFORMANCE OF THE BARRIER IN FRONT IS NOT IMPACTED BY THE BARRIER BEHIND IT.

DESIGN PHILOSOPHY

1. INSTALL OVERLAP BEHIND EXISTING BARRIER
2. DETERMINE REQUIRED CLEARANCE BETWEEN BARRIER SYSTEMS
3. DETERMINE PROPOSED OFFSET FROM THE TRAFFIC LANE
4. TRANSITION TO PROPOSED OFFSET (3.0m DESIRED - MAINTAIN EXISTING OFFSET)

ISSUE	APP'D	DATE	AMENDMENT
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GENERAL NOTES

TRAFFICWORKS

166030-FLP-16

DESIGNED TRAFFICWORKS MAY'17

APPROVED VICROADS MAY'17

CAT: -

PROJ: -

FILE: -

vicroads

SCALE OF METRES HOR 0 NTS VER 0

SAFE SYSTEM BARRIER
GUARD FENCE
DEPARTURE OVERLAP DETAIL

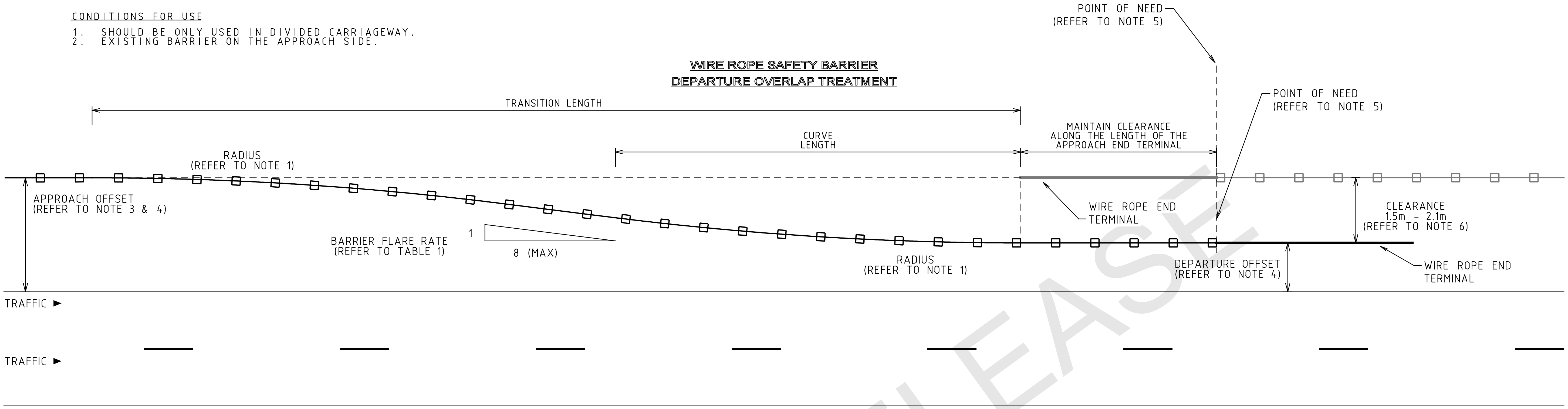
FILE NO.	CONTRACT NO.	SHEET NO.	DRAWING NO.	ISSUE
X	X	X	782016	A

13-Jun-17 3:50:19 PM Default 166030-FLP-16.dgn

CONDITIONS FOR USE

1. SHOULD BE ONLY USED IN DIVIDED CARRIAGEWAY.
2. EXISTING BARRIER ON THE APPROACH SIDE.

WIRE ROPE SAFETY BARRIER DEPARTURE OVERLAP TREATMENT



NOTES

REFER TO AGRD PART 6 FOR REQUIRED FLARE RATES OF SAFETY BARRIER.

TABLE 1

DESIGN SPEED	SHY LINE OFFSET (m)	FLARE RATE	
		WITHIN SHY LINE OFFSET	OUTSIDE SHY LINE OFFSET
80	2.0	21:1	11:1
90	2.2	24:1	12:1
100	2.4	26:1	14:1
110	2.8	30:1	15:1

MAXIMUM FLARE RATE OF 8:1 WHERE TRANSITION IS TO BE MINIMISED AND THE NOT EXPOSED TO THE TRAFFIC (REFER TO SD 4071).

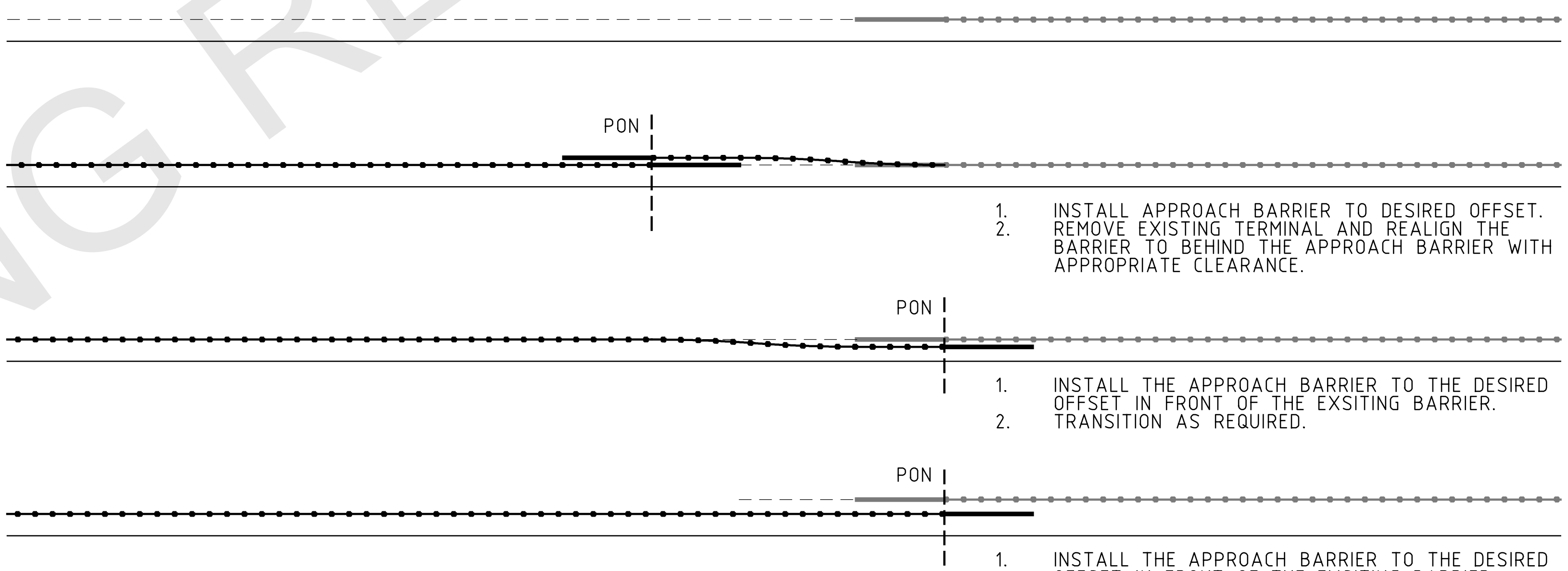
NOTES

1. DESIRABLE RADIUS OF 200m FOR WIRE ROPE SAFETY BARRIER IS TO BE USED. WHERE TRANSITION LENGTH IS TO BE MINIMISED, A RADIUS OF 100m MAY BE CONSIDERED (REFER TO RDN 06-02, FIGURE. E1 NOTE 1)
2. WHERE THE OVERLAP IS TO BE RETROFITTED ONTO AN EXISTING BARRIER SYSTEM, THE EXISTING OFFSET TO THE TRAFFIC LANE SHOULD BE MAINTAINED TO KEEP A CONSISTENT BARRIER LINE.
3. THE DESIRABLE OFFSET OF THE BARRIER FROM THE TRAFFIC LANE IS 4.0m (3.0m MINIMUM).
4. WHERE THE PROPOSED OFFSET IS LESS THAN 3.0m, APPROVAL SHOULD BE SOUGHT FROM THE SUPERINTENDENT.
5. IT IS DESIRABLE TO HAVE TO POINT OF NEED OVERLAP BETWEEN THE TWO BARRIER SYSTEMS TO ENSURE CONTINUOUS PROTECTION ALONG THE ALIGNMENT.
6. THE DEFLECTION OF THE APPROACH BARRIER WILL DETERMINE THE CLEARANCE OF THE OVERLAPS BETWEEN THE TWO SYSTEMS; THIS ENSURES THAT THE PERFORMANCE OF THE BARRIER IN FRONT IS NOT IMPACTED BY THE BARRIER BEHIND IT (REFER TO APPENDIX A RDN 06-02).

DESIGN PHILOSOPHY

1. INSTALL OVERLAP BEHIND EXISTING BARRIER
2. DETERMINE REQUIRED CLEARANCE BETWEEN BARRIER SYSTEMS
3. DETERMINE PROPOSED OFFSET FROM THE TRAFFIC LANE
4. TRANSITION TO PROPOSED OFFSET (3.0m DESIRED - MAINTAIN EXISTING OFFSET)

TYPICAL LAYOUTS



1. INSTALL APPROACH BARRIER TO DESIRED OFFSET.
2. REMOVE EXISTING TERMINAL AND REALIGN THE BARRIER TO BEHIND THE APPROACH BARRIER WITH APPROPRIATE CLEARANCE.

1. INSTALL THE APPROACH BARRIER TO THE DESIRED OFFSET IN FRONT OF THE EXSITING BARRIER.
2. TRANSITION AS REQUIRED.

1. INSTALL THE APPROACH BARRIER TO THE DESIRED OFFSET IN FRONT OF THE EXSITING BARRIER.
2. NO TRANSITION (OFFSET TO TRAFFIC LANE IS REDUCED)

ISSUE	APP'D	DATE	AMENDMENT
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A	.	.	.

GENERAL NOTES

TRAFFICWORKS
166030-FLP-17

DESIGNED TRAFFICWORKS MAY'17
APPROVED VICROADS MAY'17
CAT: -
PROJ: -
FILE: -

vicroads

SCALE OF METRES
HOR 0 NTS
VER 0

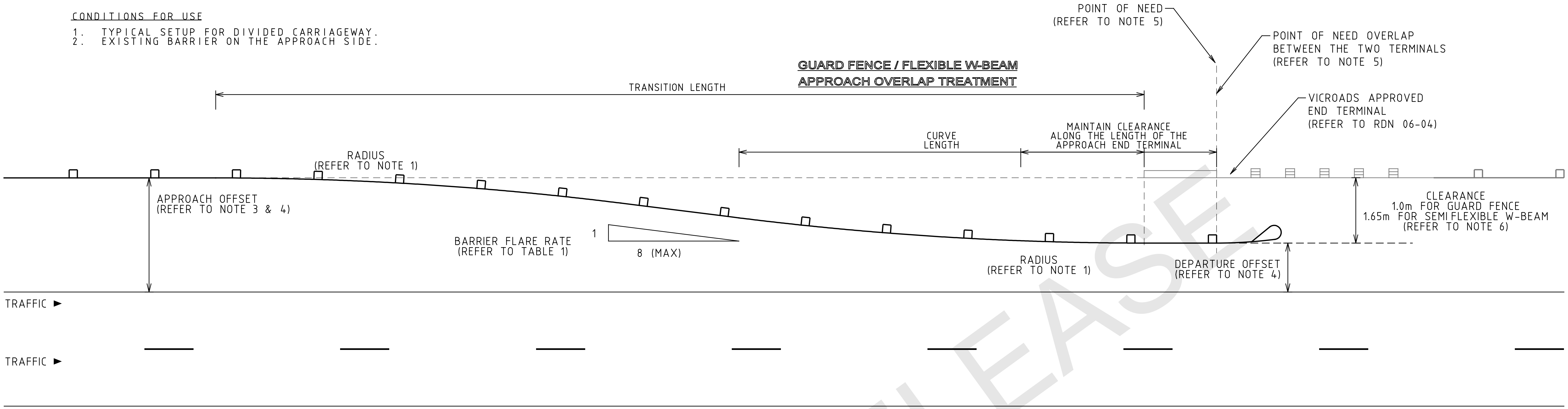
SAFE SYSTEM BARRIER
WIRE ROPE SAFETY BARRIER
APPROACH OVERLAP DETAIL

FILE NO.	CONTRACT NO.	SHEET NO.	DRAWING NO.	ISSUE
X	X	X	782017	A

13-Jun-17 3:50:20 PM Default 166030-FLP-17.dgn

CONDITIONS FOR USE

1. TYPICAL SETUP FOR DIVIDED CARRIAGEWAY.
2. EXISTING BARRIER ON THE APPROACH SIDE.



NOTES

REFER TO AGRD PART 6 FOR REQUIRED FLARE RATES OF SAFETY BARRIER.

TABLE 1

DESIGN SPEED	SHY LINE OFFSET (m)	FLARE RATE	
		WITHIN SHY LINE OFFSET	OUTSIDE SHY LINE OFFSET
80	2.0	21:1	14:1
90	2.2	24:1	16:1
100	2.4	26:1	18:1
110	2.8	30:1	20:1

MAXIMUM FLARE RATE OF 8:1 WHERE TRANSITION IS TO BE MINIMISED AND NOT EXPOSED TO THE TRAFFIC (REFER TO SD 4071).

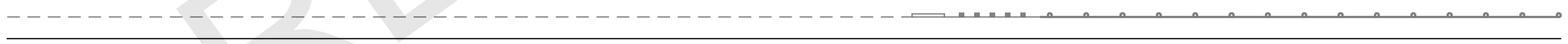
NOTES

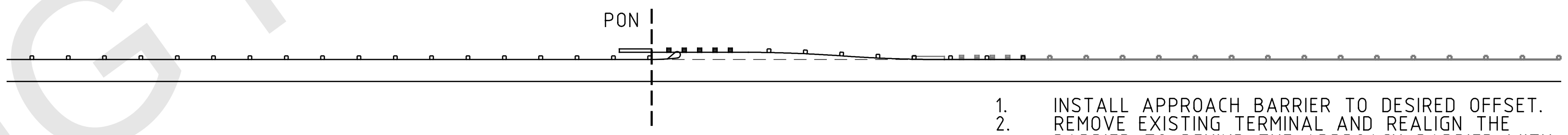
1. GUARD FENCE TO BE INSTALLED ON A 40m RADIUS OR TO MANUFACTURER REQUIREMENTS.
2. WHERE THE OVERLAP IS TO BE RETROFITTED ONTO AN EXISTING BARRIER SYSTEM, THE EXISTING OFFSET TO THE TRAFFIC LANE SHOULD BE MAINTAINED TO KEEP A CONSISTENT BARRIER LINE.
3. THE DESIRABLE OFFSET OF THE BARRIER FROM THE TRAFFIC LANE IS 4.0m (3.0m MINIMUM).
4. WHERE THE PROPOSED OFFSET IS LESS THAN 3.0m, APPROVAL SHOULD BE SOUGHT FROM THE SUPERINTENDENT.
5. IT IS DESIRABLE TO HAVE A 90° OVERLAP FOR THE POINT OF NEED OF THE TWO BARRIER SYSTEMS TO ENSURE CONTINUOUS PROTECTION ALONG THE ALIGNMENT.
6. THE DEFLECTION OF THE APPROACH BARRIER WILL DETERMINE THE CLEARANCE OF THE OVERLAPS BETWEEN THE TWO SYSTEMS; THIS ENSURES THAT THE PERFORMANCE OF THE BARRIER IN FRONT IS NOT IMPACTED BY THE BARRIER BEHIND IT.

DESIGN PHILOSOPHY

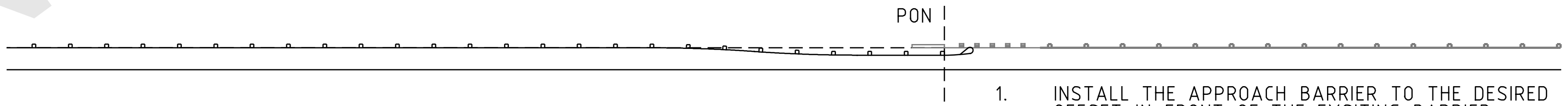
1. INSTALL OVERLAP BEHIND EXISTING BARRIER
2. DETERMINE REQUIRED CLEARANCE BETWEEN BARRIER SYSTEMS
3. DETERMINE PROPOSED OFFSET FROM THE TRAFFIC LANE
4. TRANSITION TO PROPOSED OFFSET (3.0m DESIRED - MAINTAIN EXISTING OFFSET)

TYPICAL LAYOUTS

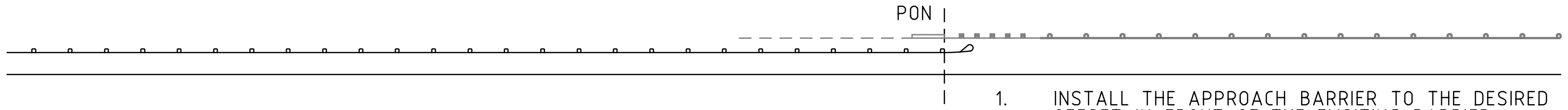




1. INSTALL APPROACH BARRIER TO DESIRED OFFSET.
2. REMOVE EXISTING TERMINAL AND REALIGN THE BARRIER TO BEHIND THE APPROACH BARRIER WITH APPROPRIATE CLEARANCE.



1. INSTALL THE APPROACH BARRIER TO THE DESIRED OFFSET IN FRONT OF THE EXSITING BARRIER.
2. TRANSITION AS REQUIRED.



1. INSTALL THE APPROACH BARRIER TO THE DESIRED OFFSET IN FRONT OF THE EXSITING BARRIER.
2. NO TRANSITION (OFFSET TO TRAFFIC LANE IS REDUCED)

ISSUE	APP'D	DATE	AMENDMENT
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B	.	.	.
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GENERAL NOTES

TRAFFICWORKS

166030-FLP-18

DESIGNED TRAFFICWORKS MAY'17

APPROVED VICROADS MAY'17

CAT: -

PROJ: -

FILE: -

vicroads

SCALE OF METRES HOR 0 NTS VER 0

SAFE SYSTEM BARRIER
GUARD FENCE / FLEXIBLE W-BEAM
APPROACH OVERLAP DETAIL

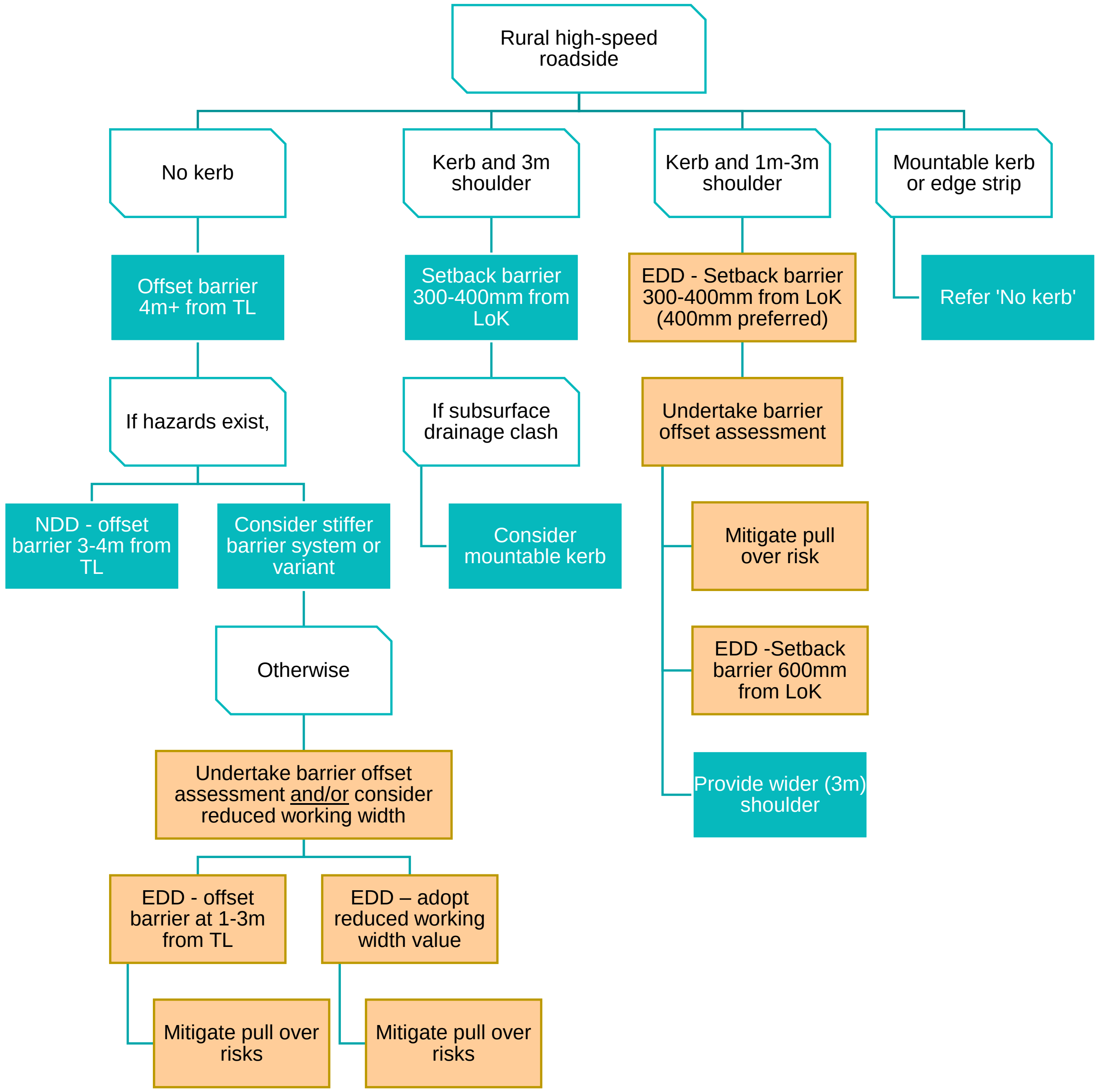
FILE NO.	CONTRACT NO.	SHEET NO.	DRAWING NO.	ISSUE
X	X	X	782018	A

13-Jun-17 3:50:20 PM Default 166030-FLP-18.dgn

Appendix G – Barrier offset options flowcharts

These flow charts are informative only, and are based on the guidance in the Supplement to AGRD Part 6. They provide support to designers, and therefore should not be used without first checking if they are suitable for the site. All design decisions must be documented.

Options flow chart – Lateral position of barrier for rural roads



Options flow chart – Lateral position of barrier for urban roads