SAFE DIRECTION
Protecting Life & Property

RAMSHIELD GUARDRAIL

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RAMSHIELD®

Mash TL3 Compliant W-Beam Barrier

Product Manual

Ref: PM 020/03 Rev B

RAMSHIELD®

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Leading Safety

Successfully crash tested to MASH Test Level 3

Complies with AS/NZS 3845.1:2015 Road safety barrier systems and devices

Higher safe redirection capacity than public domain w-beam barrier designs

No debris from system on impact

Low Deflection

Lower deflection than cable barrier systems

Compatibility

Rail height is compatible with approved terminals and transitions

Standard 2.0m post spacing

Fast Assembly

Fewer parts than public domain w-beam barrier designs

Simple rail to post bolt alignment

Stiff driving post

Narrow Geometry

Narrower system width than any other approved w-beam barrier system

Motorcycle Friendly

Post is set lower than rail to eliminate snag point

No exposed edges on the post

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1.0 Introduction

RAMSHIELD® is the latest innovation and advancement in w-beam guardrail barrier designs. Developed by Safe Direction specifically for Australian conditions, RAMSHIELD® has been full-scale crash tested to MASH Test Level 3, providing a superior performance when compared to all existing Australian public domain guardrail barrier systems.

Providing a forgiving roadside environment reduces the consequences for vehicles leaving the safe, travelled way. Hazards such as trees, utility poles, culverts and embankments are often located adjacent to roadways and relocating them is often impractical. In these instances, shielding with a longitudinal safety barrier, such as RAMSHIELD® is the most appropriate solution.

W-beam barrier designs have developed over the years and are used to safely contain and re-direct errant vehicles away from nearby hazards. Safety barriers reduce the severity of run-off-the-road crashes and have made a significant contribution to the safety of our region's roads.

RAMSHIELD® has significantly advanced the containment level of w-beam guardrail by introducing patented technology into the behaviour of the post during impact. This results in a safer barrier design with fewer components allowing more metres of barrier to be deployed per public dollar to protect Australian motorists.

2.0 Specifications

Height to top of rail:	730mm
Height to top of installed post:	680mm
Post drive depth:	880mm
System width (narrowest on market):	180mm
Post spacing:	2.0m ctrs
System mass:	19kg/m
Dynamic deflection (MASH TL3):	1.56m
Compliance:	MASH Test Level 3 (156kJ)
	AS/NZS 3845.1:2015
	Exceeds NCHRP 350 TL3 (137kJ)
Material:	350Mpa yield steel
Finish:	Hot dip galvanised to AS/NZS 4680

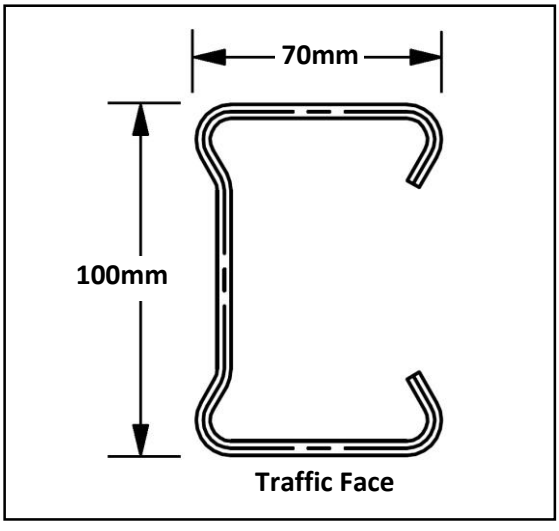

Figure 1: RAMSHIELD® Post Profile

3.0 How RAMSHIELD® Works

RAMSHIELD® achieves a controlled redirection of errant vehicles by releasing the rail from the post at an optimal load to retain rail height, limit dynamic deflection and to allow the post to collapse without tripping the vehicle.

The separation of the rail from the post is achieved by a release tab incorporated into the post. The tab is designed to pull forward and tear from the post and remains connected to the rail to ensure there is no debris from the system that may otherwise present as a danger to other motorists.

RAMSHIELD® uses standard state road specified w-beam guardrail and standard fasteners meaning there is very little risk of inadvertent use of non-compliant items.

The posts have been designed to collapse upon impact yielding proximate to the ground surface. This distinguishes RAMSHIELD® from heavier post systems which rely on the post rotating in the ground prior to collapse. The post collapsing near the ground surface ensures more reliable performance that is not as dependent on soil conditions. Moreover the collapse mechanism of the post makes RAMSHIELD® suitable for use in concreted mowing strips and/or deep asphalt applications which are problematic to the performance of heavier post systems.

The working mechanism of RAMSHIELD® is a patented concept designed and developed by Safe Direction. The concept is the latest innovation in guardrail design and sets a new benchmark in simplicity and performance.

Figure 2: Front View of RAMSHIELD® Post

Figure 3: Action of Release Tab

Figure 4: Controlled Release of Rail

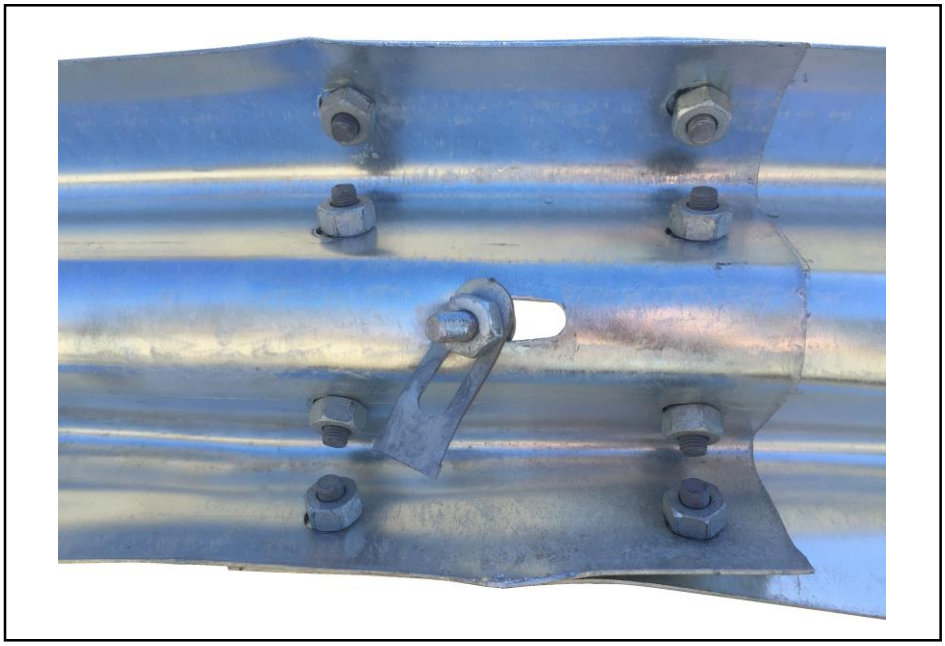

Figure 5: Detached Tab Attached to Rail

4.0 Crash Test Performance

RAMSHIELD® has been fully crash tested and evaluated according to the specifications for Test Level 3 (TL3) of the AASHTO Manual for Assessing Safety Hardware (MASH). The MASH specification is an update to and supersedes NCHRP Report 350 for the purposes of evaluating new safety hardware devices.

MASH is also the basis of testing procedures for road safety systems as stated in *AS/NZS 3845.1: 2015 Road Safety Barrier System and Devices.*

The MASH TL3 crash test matrix requires the following impacts;

- 2270kg pick-up travelling at 100km/h and 25°, and
- 1100kg car travelling at 100km/h and 25°.

In addition, RAMSHIELD® has been crash tested with a Commodore to reflect Australian driving conditions as follows;

- 1700kg car travelling at 110km/h and 25°.

This impact was performed adjacent to a 2H:1V embankment representing a 'worst practical condition' for a roadside barrier impact.

5.0 Clearance to Hazards

When shielding roadside hazards, the barrier system shall be positioned with sufficient clearance behind the barrier to allow for the expected dynamic deflection of the barrier during impact.

The amount of barrier deflection is dependent upon the Impact Severity (IS), which is a factor of vehicle mass, vehicle speed and the angle of impact.

$IS = ½ M (V \sin \theta)^2$

Where;

IS = the impact severity in joules (J),

M = the test inertial mass of the vehicle in kg ,

V = the impact speed in metres/second (m/s) , and

θ = the impact angle in degrees.

The 1.56m deflection result obtained during MASH TL3 crash testing with the 2270kg pick-up truck travelling at 100km/h and 25 degrees has a calculated Impact Severity of 156kJ.

This impact condition represents the extremes of real-life parameters and therefore a site evaluation is recommended to normalise the deflection according to design vehicle, design speed and roadway geometry.

A 2000kg vehicle is often regarded as the design vehicle for the calculation of deflection by Australian State Road Agencies.

Table 1 provides dynamic deflection values for various speeds and angles of impacts for a 2000kg design vehicle at the standard post spacing of 2.0m.

The deflections in Table 1 may be reduced through a reduction in post spacing. Please consult with Safe Direction for guidelines.

Table 1: RAMSHIELD® Dynamic Deflection Values – 2000kg Design Vehicle

Design Speed (km/h)	Dynamic Deflection (m) – 2000kg Design Vehicle			
	10° Impact Angle	15° Impact Angle	20° Impact Angle	25° Impact Angle
50	0.1	0.1	0.2	0.3
60	0.1	0.2	0.3	0.5
70	0.1	0.3	0.4	0.7
80	0.2	0.3	0.6	0.9
90	0.2	0.4	0.7	1.1
100	0.2	0.5	0.9	1.4
110	0.3	0.6	1.1	1.7

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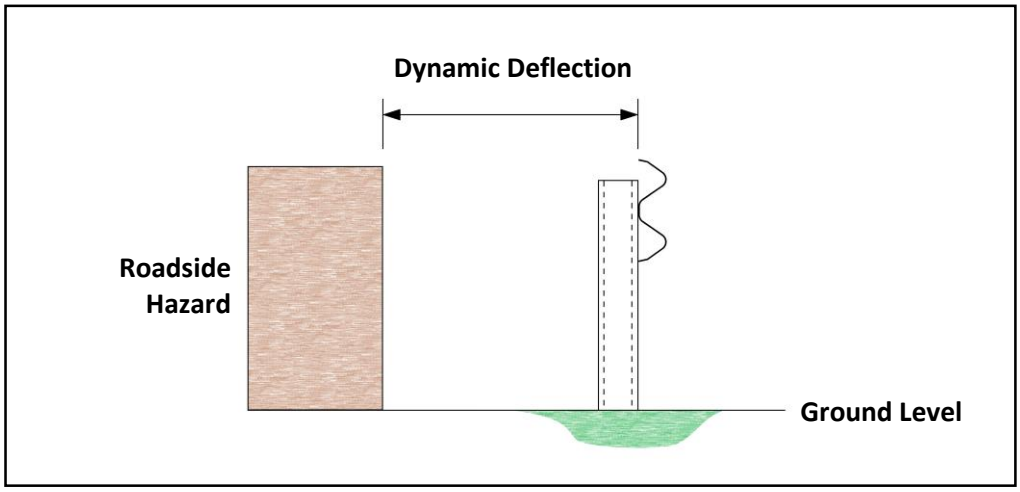

Figure 6: Clearance to Fixed Roadside Hazards

6.0 Set Out

6.1 Advance Grading

It is recommended that the area in advance of RAMSHIELD® be limited to a grading of 10H:1V to ensure that the vehicle's suspension is neither extended nor compressed at the moment of impact with the barrier.

6.2 Adjacent to Batter Slope

State Road Agency Guidelines provide recommended distances for the installation of guardrail barriers adjacent to an embankment slope. These distances are typically in the range of 400mm to 600mm measured from the rear of the post to the embankment rounding point.

Where possible, the guidelines published by State Road Agencies should be followed for the installation of RAMSHIELD®.

RAMSHIELD® has been successfully evaluated when installed 200mm (measured for the back of the post) to the rounding point of a 2H:1V embankment slope. This impact was performed with a 1700kg Commodore travelling at 110km/h and 25 degrees. The energy of this impact (142kJ) exceeds NCHRP Report 350 TL3 (137kJ).

6.3 End Terminals

End terminals are the specially designed end pieces located at the leading and trailing end of the w-beam guardrail system.

End terminals are designed to anchor the w-beam guardrail system and introduce the necessary tensile and flexural strength required for safe vehicle containment and re-direction throughout the length-of-need section.

Some guardrail end terminals also provide the additional feature of reducing the severity of an impact near or at the end of the system.

It is a requirement that all w-beam guardrail systems, including RAMSHIELD® be appropriately anchored at the leading and trailing end of the installation.

If the system is installed on an undivided roadway, it is recommended that a crashworthy end terminal such as the SKT-SP, FLEAT-SP or similarly approved NCHRP Report 350 TL3 compliant terminal be installed on both the leading and trailing end of the system.

If the system is installed on a divided roadway, a departure terminal may be considered for the trailing end of the system.

Guidelines for departure terminal configurations and their allowable use are contained within State Road Agency publications.

RAMSHIELD® posts are not to be used for the assembly of end terminals. End Terminals are to be installed following proprietor or State Road Agency guidelines.

Refer to Safe Direction drawings GR-WB-064, 067 & 068.

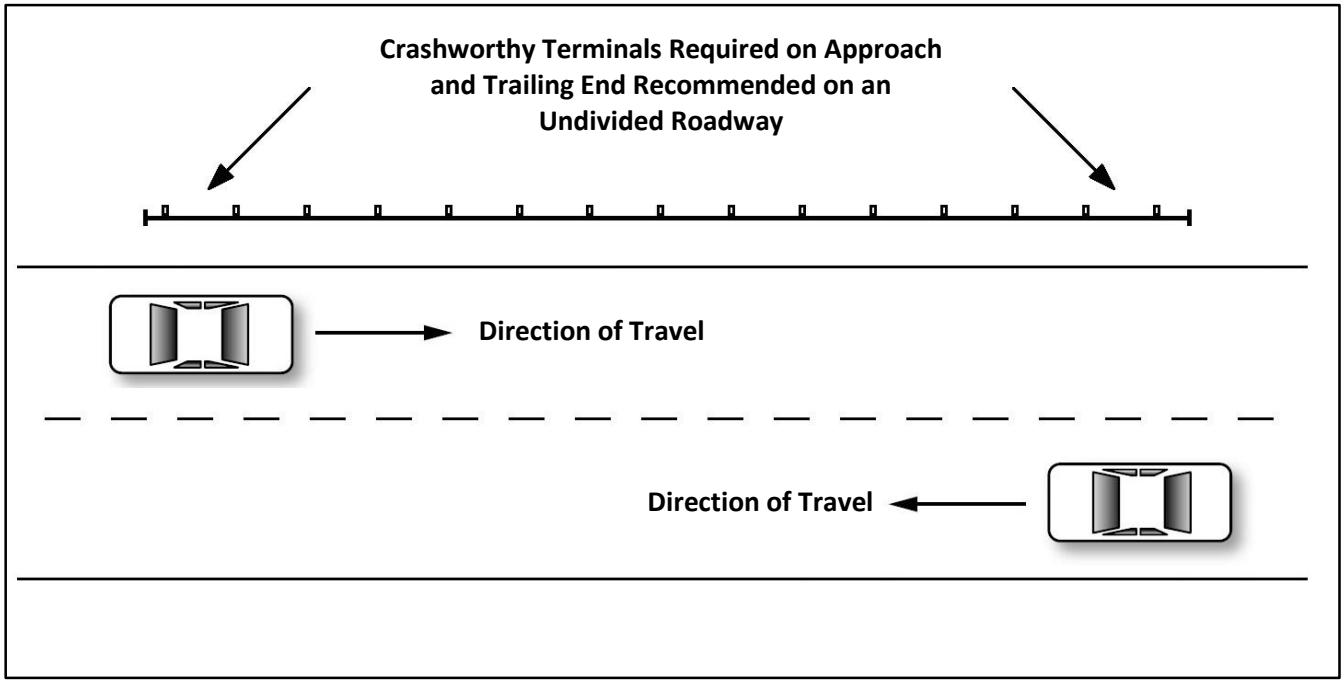

Figure 7: End Terminal Protection

6.4 The Point-of-Need

RAMSHIELD® is designed to safely contain and re-direct errant vehicles away from roadside hazards. The point-of-need is the location where the barrier system becomes re-directive.

The point-of-need is typically dependent upon the terminal selected to anchor the RAMSHIELD® system. For terminals such as the SKT-SP and FLEAT-SP the point-of-need location is terminal post 3, a distance of 3.81m downstream from the start of the system.

It is necessary that the point-of-need location is appropriately aligned with the hazard that is being shielded. Figure 8 provides an example.

6.5 Transition to Rigid Barriers

Since the stiffness properties vary between a semi-rigid and rigid barrier, a specially designed transition is required when connecting RAMSHIELD® to a rigid barrier.

A transition gradually increases the lateral stiffness of the w-beam guardrail barrier and reduces the potential for vehicle pocketing at a connection with a rigid barrier, such as concrete.

RAMSHIELD® posts are not to be used for the assembly of the transition.

Transition designs are contained within state road agency guidelines and vary from state to state. Transitions often incorporate the use of thrie-beam (triple corrugation rail) and/or a reduction in post spacing.

Refer to Safe Direction drawings GR-WB-065 & 066.

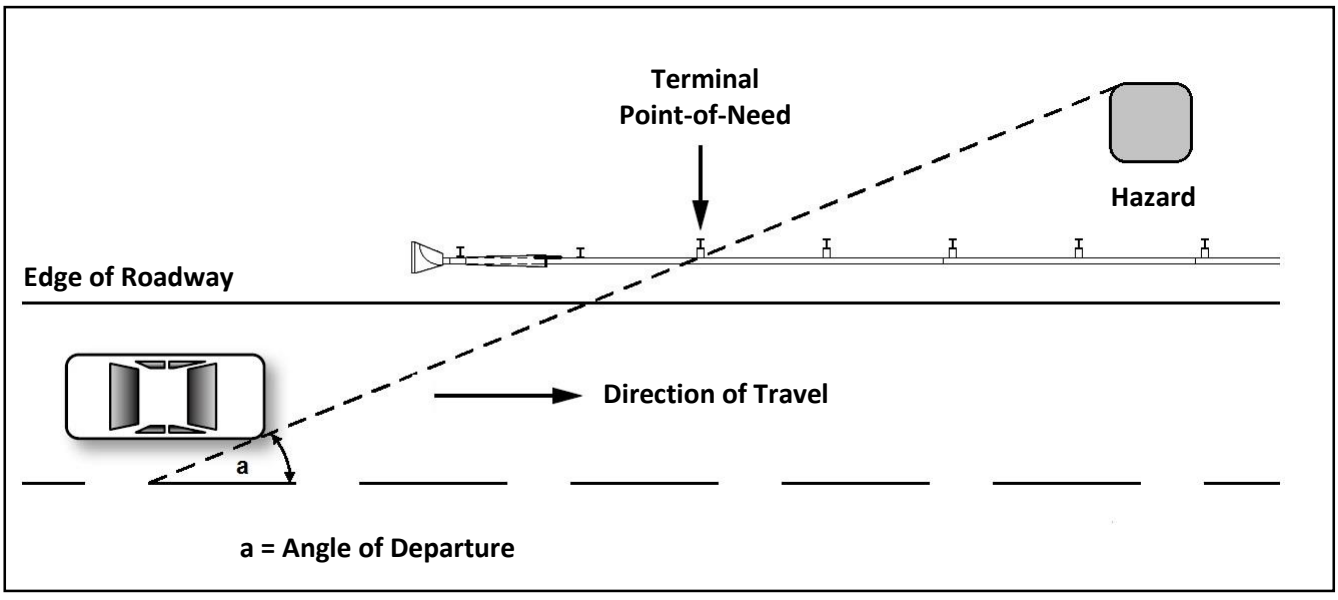

Figure 8: Positioning of Terminal Point-of-Need to Adequately Shield a Roadside Hazard

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Figure 9: SKT End Terminal

Figure 10: Bridge Approach Transition

Figure 11: Departure Terminal

6.6 Kerbs

Placing kerbs in front of w-beam guardrail on high-speed roads is not recommended. As an alternative, a mountable type kerb in front of the barrier or subsurface grated drainage should be considered.

On lower speed roads that often require a kerb, it is recommended that the location of the barrier be 200mm from the face of kerb. This reduces nuisance impacts and minimises the potential for vehicle launching.

6.7 Placement in Concrete, Rock or Deep Lift Asphalt

The performance of RAMSHIELD® differs from traditional w-beam barrier designs. Traditional posts will absorb some crash energy through post rotation in the surrounding soil prior to fully yielding. Setting these posts in concrete or installing in deep lift asphalt or rock may compromise the performance of the system.

A RAMSHIELD® post yields in stiff soils by bending near ground level. This yielding behaviour is suitable for installations in rock, mowing strips or deep lift asphalt.

6.8 Installation on Curves

W-beam guardrail barriers perform well on the outside of curves, even those of relatively small radius, as the concave shape (in plan view) supports the development of tension in the w-beam rail.

In the field, straight sections of w-beam can be used to form a radius of 45m or greater. When a radius of less than 45m is required, the w-beam rails are required to be factory curved. For ordering purposes, the orientation of curvature (i.e. concave or convex) and the radius is required by the manufacturer.

6.9 Modifications or Attachments

In order to predict the performance of RAMSHIELD® when impacted by an errant vehicle, the product shall be installed in a configuration that has been subjected to rigorous crash testing analysis and engineering evaluation.

Modifications and/or attachments to the system that are not covered in this Product Manual are not to be undertaken without the consent of Safe Direction.

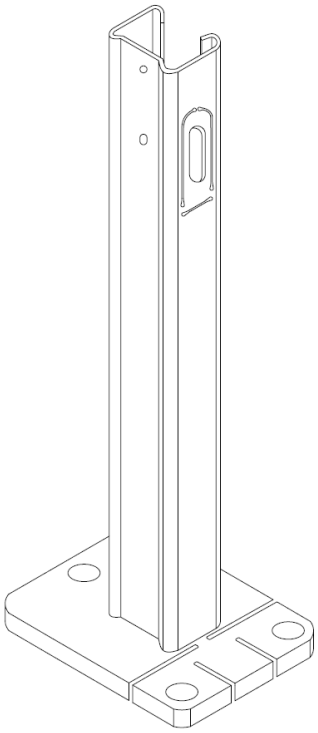
6.10 Post on Base Plate

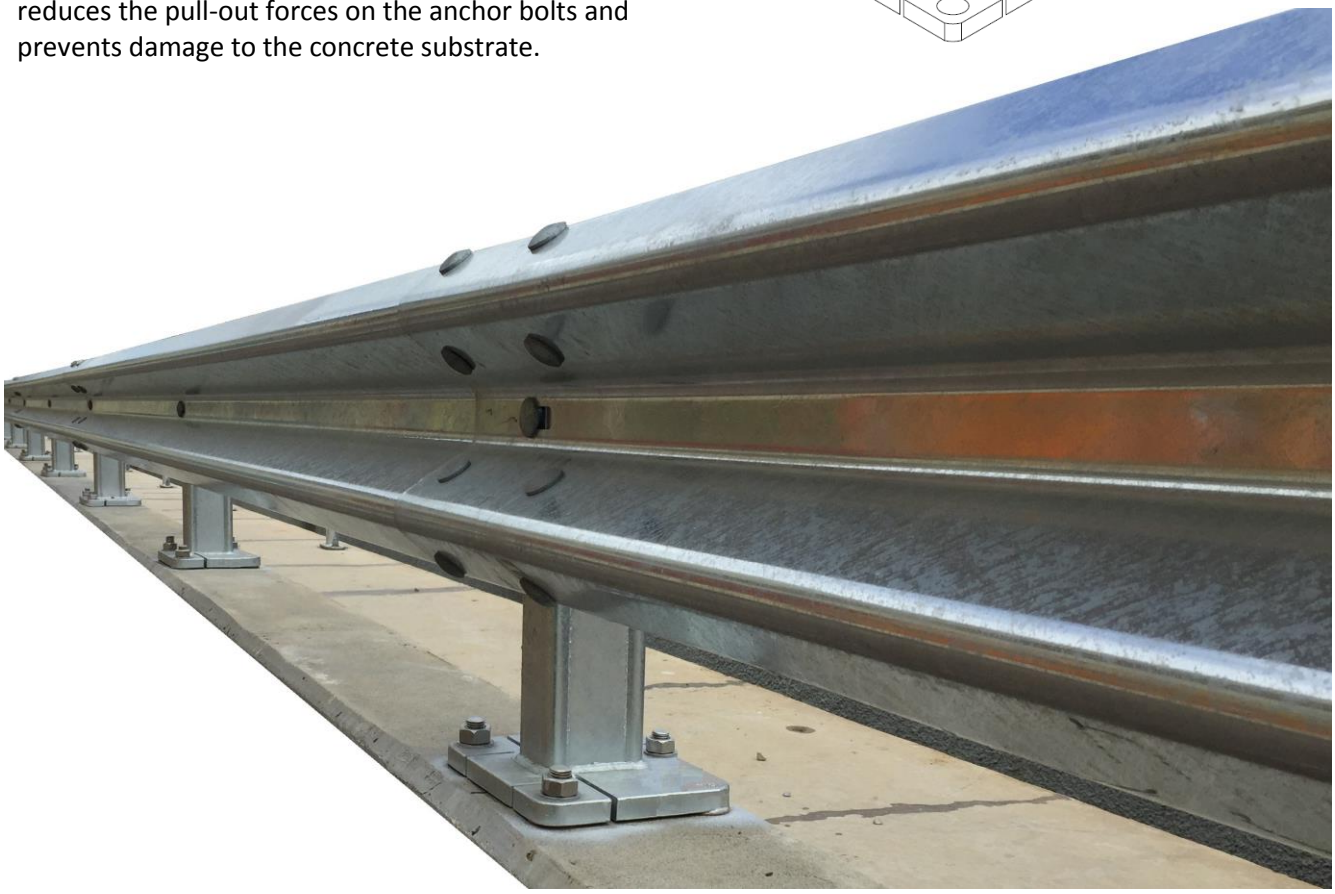
The bending behaviour of the RAMSHIELD® post has been engineered for installation on a base plate.

The post on base plate design replicates the yielding behaviour of an in-ground post.

The RAMSHIELD® base plate incorporates cuts into the plate that provide tear lines in the plate itself that are designed to activate when a vehicle directly impacts with the post. This design feature more closely mimics the behaviour of an in-ground post and reduces potential for a colliding vehicle to snag on the post.

This yielding behaviour is also an important design consideration for asset owners as the bending of the post combined with deformation of the base plate reduces the pull-out forces on the anchor bolts and prevents damage to the concrete substrate.





6.11 Shy Line Offset

Drivers tend to reduce speed or laterally move their vehicles away from a road safety barrier if it is within close proximity to the edge of the travelled way.

The distance from the edge of the travelled way beyond which a safety barrier will not be perceived as an immediate hazard by the typical driver is known as the shy line offset. Recommendations for the shy line offset are contained in Table 2.

Table 2: Shy Line Offset

Design Speed (km/h)	Shy Line Offset (m)
50	1.1
60	1.4
70	1.7
80	2.0
90	2.2
100	2.4
110	2.8

Source: Austroads Design Guide 6.4

6.12 Flaring

Motorists are less likely to perceive roadside barriers to be a hazard if the barrier is introduced gradually to the roadside environment through the use of a 'flare'. Consequently, some end treatments for w-beam guardrail barriers such as the FLEAT-SP are designed to be flared away from the approaching traffic. The flare rate is the ratio of the length of the flared part of the barrier (measured parallel to the road) to the barrier offset.

Flaring the safety barrier system provides the following benefits;

- The end terminals can be positioned further from the travelled path reducing the potential for a head-on impact;
- The shy line effects where a hazard is close to the travelled path is minimised; and
- Flaring provides a gradual transition to a major hazard close to the roadway (such as a bridge parapet or railing).

The maximum flare rates that should be used on an approach to a road safety barrier are shown in Table 3. Following the guidelines of Table 3 ensures that the flare does not significantly increase the opportunity for high-angle impacts with the barrier.

Table 3: Flare Rate

Design Speed (km/h)	Flare Rate (within Shy Line Offset)	Flare Rate (outside Shy Line Offset)
50	13:1	7:1
60	16:1	8:1
70	18:1	10:1
80	21:1	11:1
90	24:1	12:1
100	26:1	14:1
110	30:1	15:1

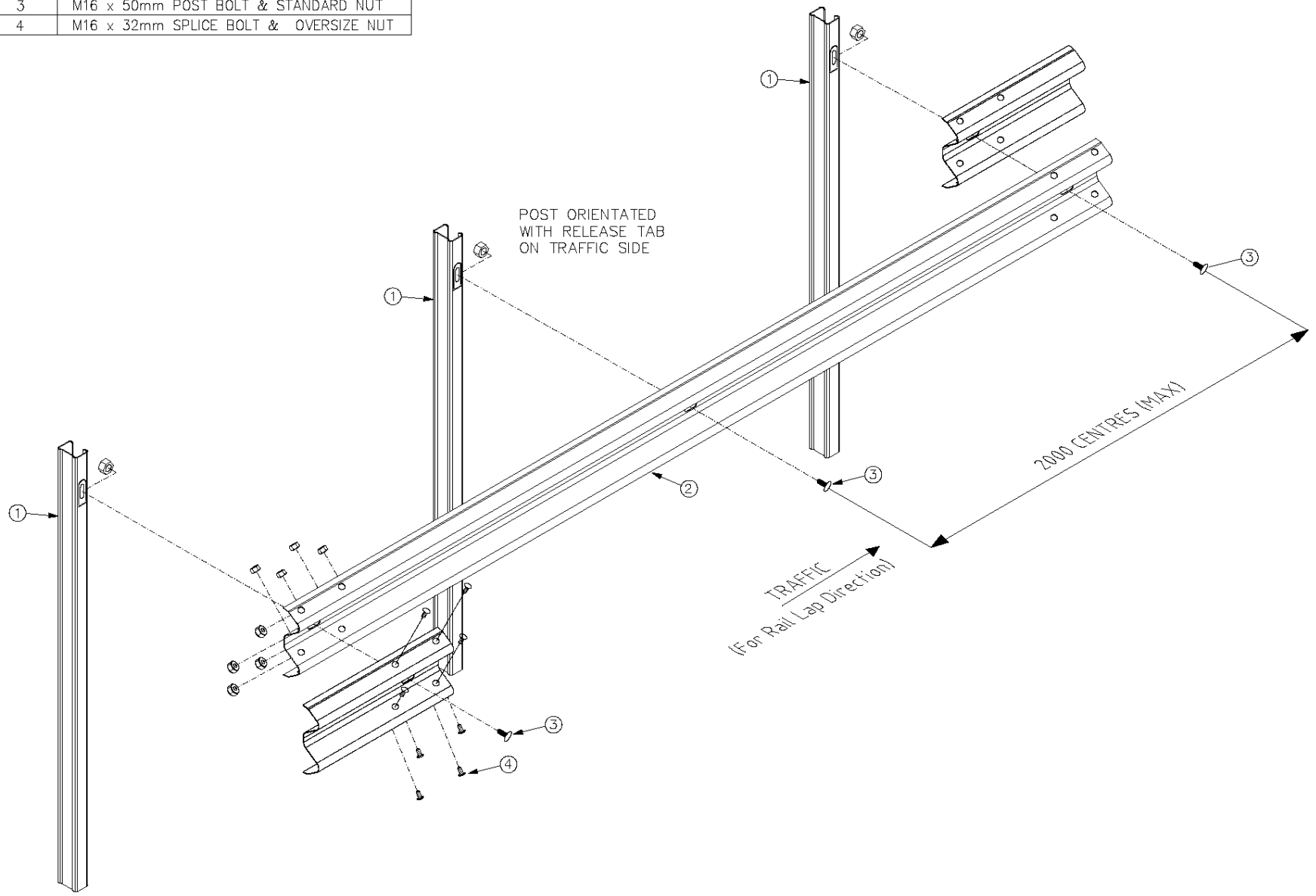
Source: Austroads Design Guide Table 6.5

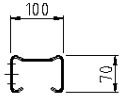
The flare rate for end terminals such as the FLEAT-SP may vary from those contained in Table 3. Please refer to specific Product Guides for allowable flare rates for end terminals.

7.0 Designers Checklist

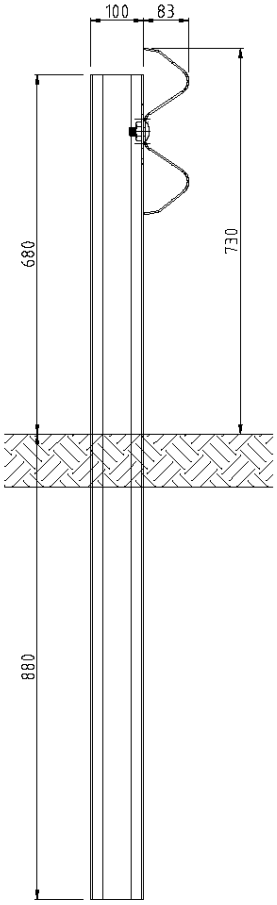
- Calculate the beginning length-of-need required to shield the roadside hazard.
- Ensure a crash-worthy terminal such as the SKT-SP, FLEAT-SP or similarly approved NCHRP Report 350 TL3 compliant terminal is located on the leading end of the system.
- If the roadway in undivided, most state road agencies require a crashworthy terminal on the trailing end of the barrier system.
- Determine the expected dynamic deflection of the system as shown in Table 1. Ensure fixed object hazards are located outside of the deflection zone.
- Ensure appropriate grading is provided in advance of RAMSHIELD®.
- Provide appropriate clearance to embankment batter slope as described in Section 6.2.
- Consider locating the barrier outside the shy line offset in accordance with Table 2.
- Consider providing a flare throughout the system in accordance with Table 3.
- On high-speed roads, provide a shallow gutter or subsurface grated drainage as an alternative to a kerb.

BILL OF MATERIALS	
ITEM	DESCRIPTION
1	RAMSHIELD POST
2	W-BEAM GUARDRAIL
3	M16 x 50mm POST BOLT & STANDARD NUT
4	M16 x 32mm SPLICE BOLT & OVERSIZE NUT





POST PLAN



POST ELEVATION

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SAFE DIRECTION

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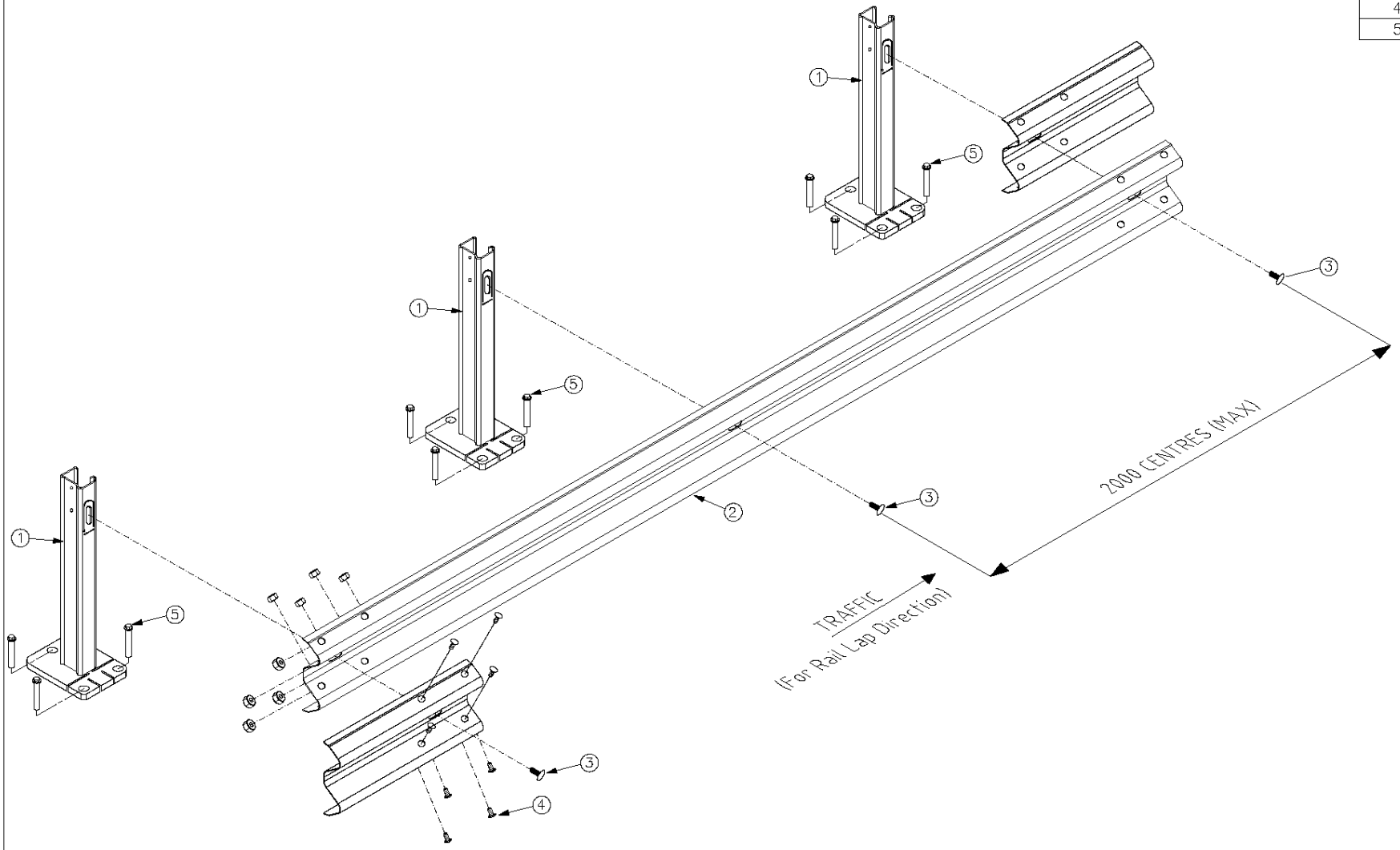
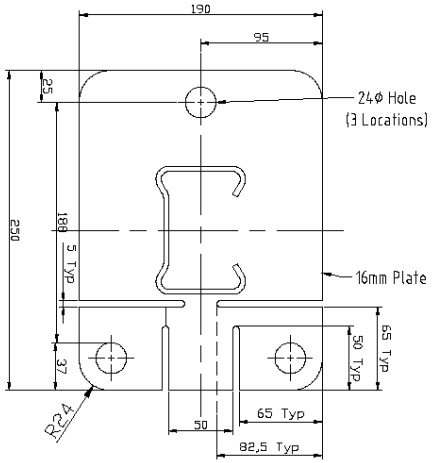
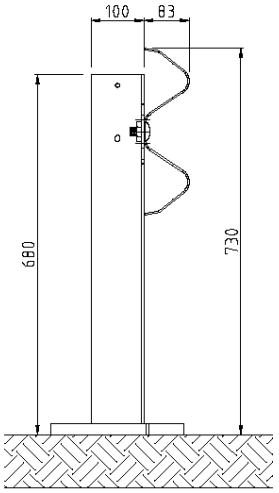
		CHECKED	H. WALLACE	SCALE	NTS
		APPROVED	T. COLQUHOUN		

BILL OF MATERIALS	
ITEM	DESCRIPTION
1	680mm RAMSHIELD POST ON BASEPLATE
2	W-BEAM GUARDRAIL
3	M16 x 50mm POST BOLT & NUT
4	M16 x 32mm SPLICE BOLT & NUT
5	M20 ANCHOR BOLT





POST PLAN



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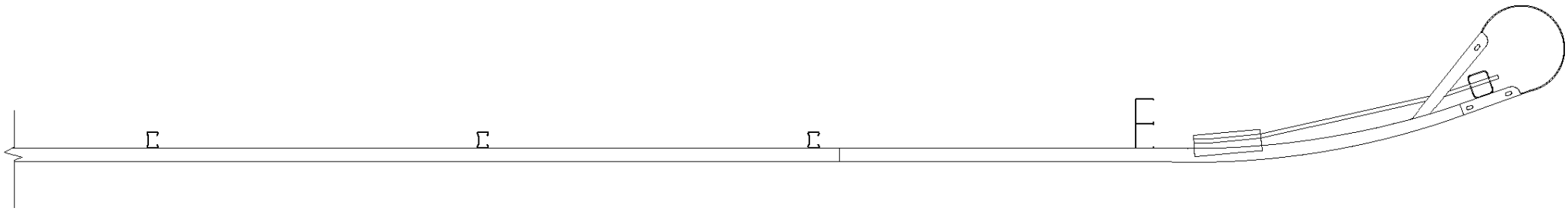
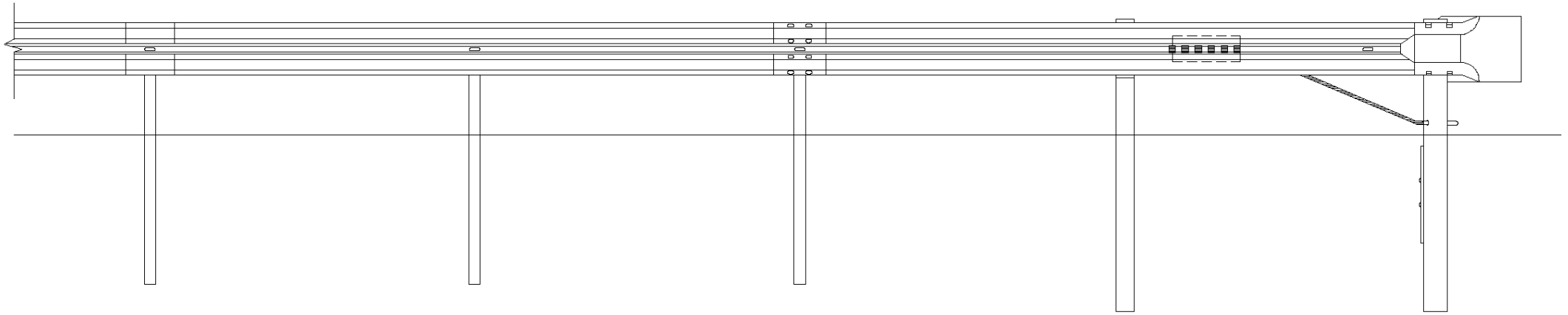
APPROVED	T. COLQUHOUN		



PLAN VIEW



ELEVATION VIEW

NOTE: FOR TRAILING TERMINAL SPECIFICATIONS
PLEASE READ IN ACCORDANCE WITH:
NSW – MD.R132.G03.A.2
QLD – SD1474
VIC – SD3544
SA – S-4050
WA – 200331-0011-5

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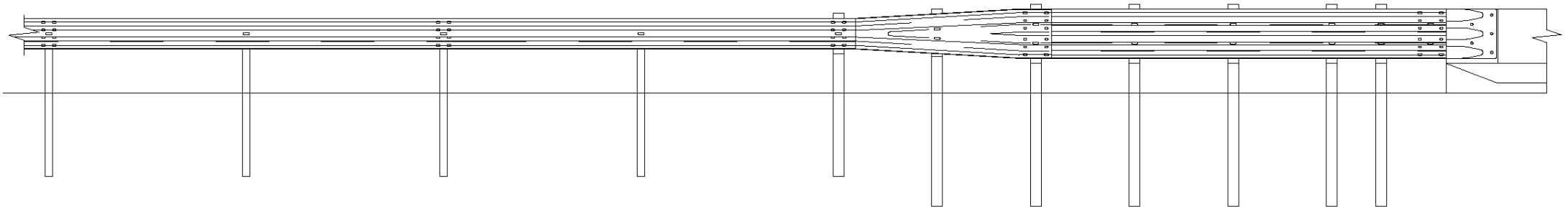
PLAN VIEW



ELEVATION VIEW

NOTE: FOR BRIDGE APPROACH SPECIFICATIONS PLEASE READ IN ACCORDANCE WITH:
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QLD – SD1475
VIC – SD4071
SA – S-4050.37
WA – 200331-021-3

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SAFE DIRECTION

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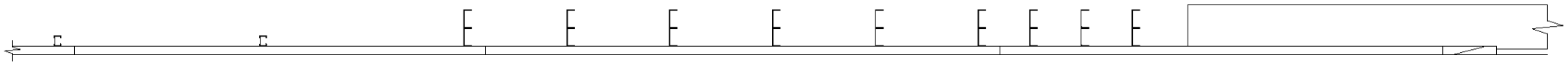

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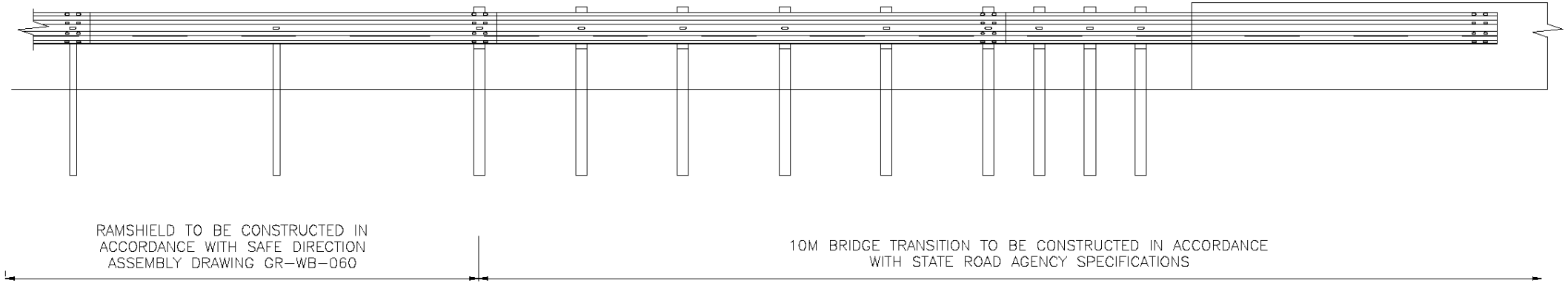

ELEVATION VIEW

NOTE: FOR BRIDGE APPROACH SPECIFICATIONS PLEASE READ IN ACCORDANCE WITH: VIC – SD4071

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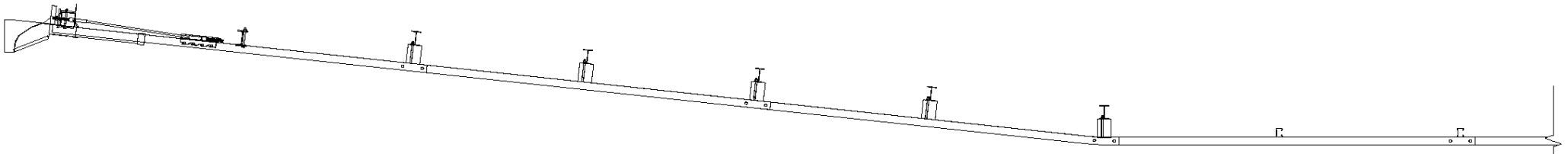
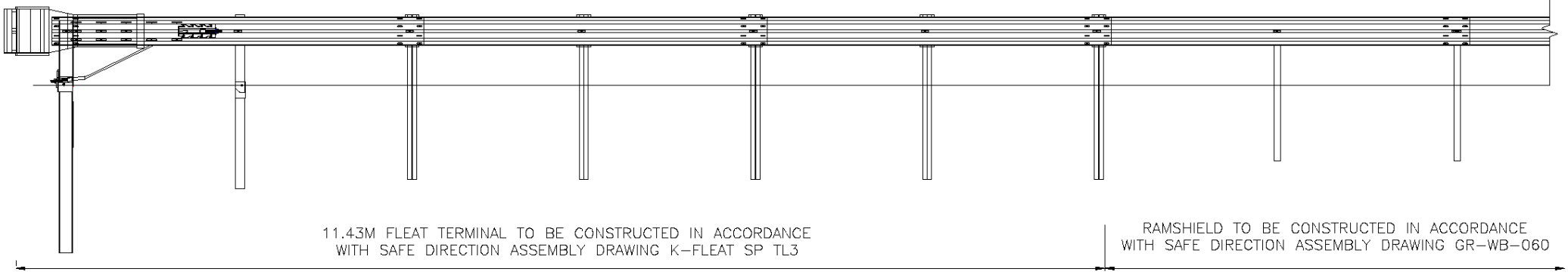
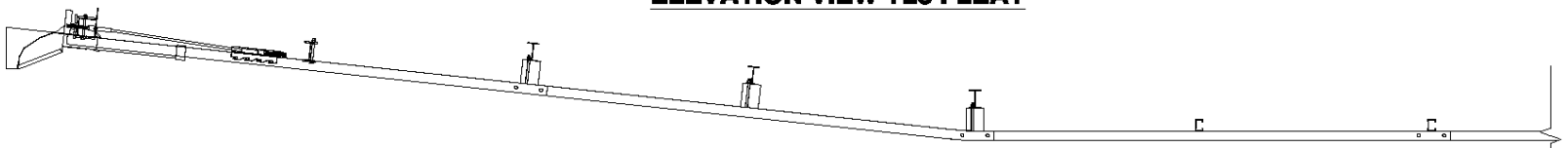


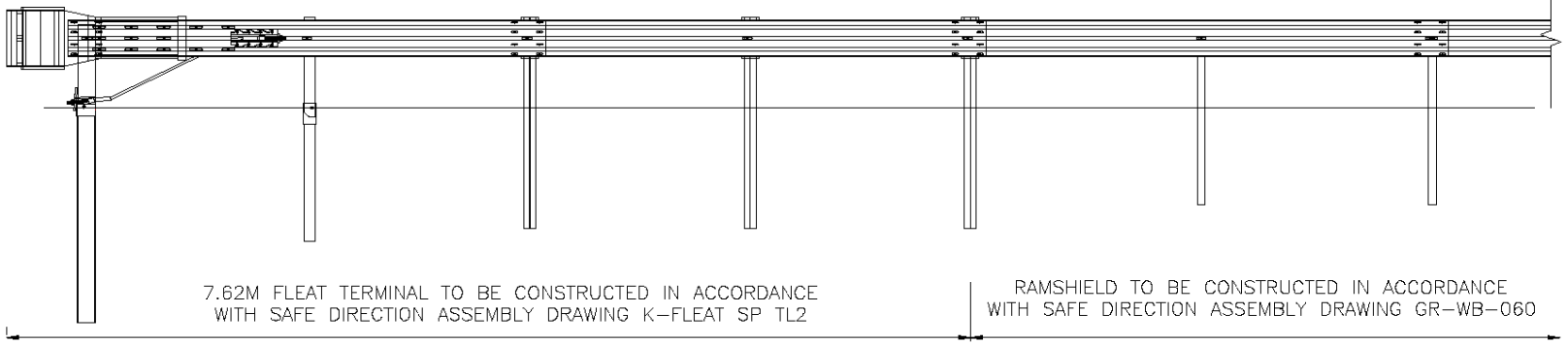
PLAN VIEW TL3 FLEAT



ELEVATION VIEW TL3 FLEAT



PLAN VIEW TL2 FLEAT



ELEVATION VIEW TL2 FLEAT

REVISIONS

REV	DATE	DESCRIPTION	DRAWN	APPRD.
A	02.11.15	INITIAL ISSUE	MS	TC

REVISIONS

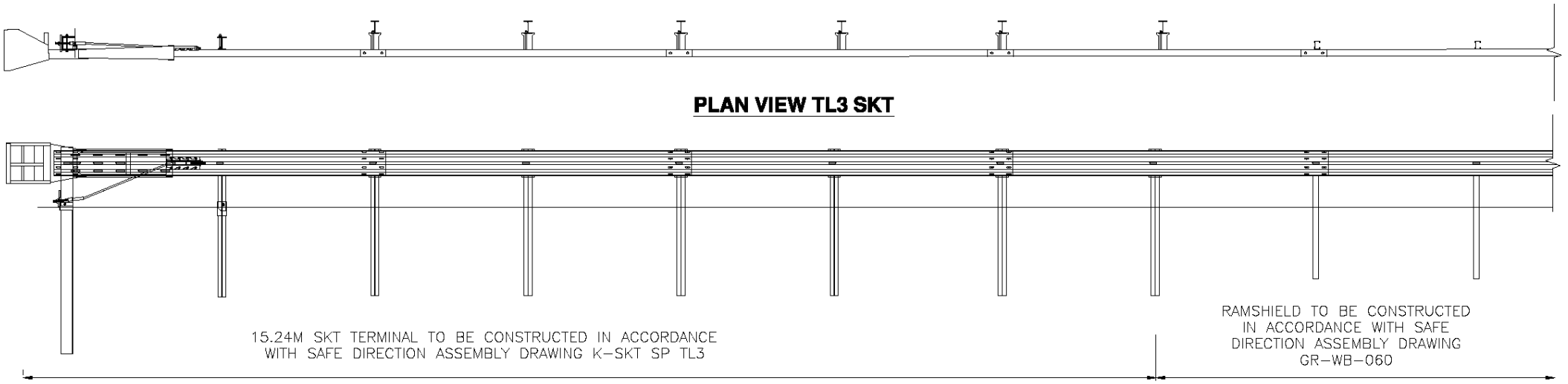
REV	DATE	DESCRIPTION	DRAWN	APPRD.

SAFE DIRECTION

DRAWING DESCRIPTION: RAMSHIELD ASSEMBLY CONNECTION TO FLEAT

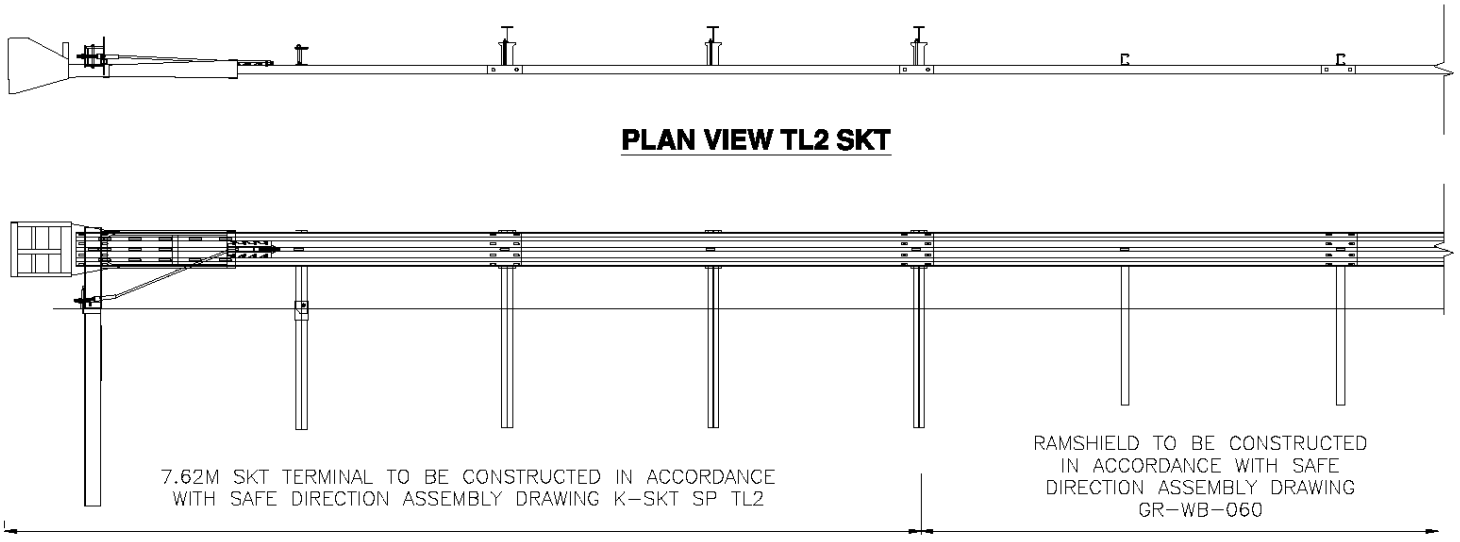
DRAWING REFERENCE: GR-WB-067

DRAWN BY	M. SEAL	DIMENSIONS	mm
CHECKED	H. WALLACE	SCALE	NTS
APPROVED	T. COLQUHOUN		



PLAN VIEW TL3 SKT

ELEVATION VIEW TL3 SKT



PLAN VIEW TL2 SKT

ELEVATION VIEW TL2 SKT

REVISIONS						REVISIONS					
A	02.11.15	INITIAL ISSUE	MS	TC							
REV	DATE	DESCRIPTION	DRAWN	APPRD.		REV	DATE	DESCRIPTION	DRAWN	APPRD.	

SAFE DIRECTION

DRAWING DESCRIPTION: **RAMSHIELD ASSEMBLY CONNECTION TO SKT**

DRAWING REFERENCE: **GR-WB-068**

DRAWN BY	M. SEAL	DIMENSIONS	mm
CHECKED	H. WALLACE	SCALE	NTS
APPROVED	T. COLQUHOUN		

RAMSHIELD®

MASH TL3 Compliant W-Beam Barrier

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