



RAILWAY CROSSING CONTROL

IN WESTERN AUSTRALIA
POLICY AND GUIDELINES



Contents

Document Control	4
Amendments	4
Authorisation	4
Preface.....	5
1. Introduction.....	6
1.1 Purpose.....	6
1.2 Scope.....	6
1.3 ALCAM.....	6
1.4 Background.....	7
2. Terms of Reference.....	9
2.1 Strategy and Policy Railway Crossing Protection Sub-Committee.....	9
2.2 Operational Railway Crossing Protection Sub-Committee.....	10
3. Road and Rail Works.....	12
3.1 Interface Agreements	12
3.2 Costs.....	12
3.3 Activities	12
3.4 Road Works in The Vicinity of Railway Crossings.....	13
3.5 Rail Works in The Vicinity of Road Crossings.....	14
4. Levels of Control	16
4.1 Sight Distance Requirements	16
4.2 Maximum Road Speed Limit at Level Crossings.....	18
4.3 Other Safety Considerations.....	19
5. Give Way Signs (RX-1)	21
5.1 Sight Distance Requirements for Give Way Signs.....	21
5.3 Assessment for Give Way Signs On Side Road Crossings.....	21
6. STOP Signs (RX-2)	22
6.1 Sight Distance Requirements for Stop Signs.....	22
6.2 Angle Requirements for Stop Signs.....	22
7. Flashing lights (RX-5)	23
7.1 Warrant Due to Conflict Exposure	23
7.2 Visibility Requirements for Flashing Lights	23
7.3 Other Safety Considerations.....	24
7.4 Design and Operation of Active Flashing Light Signals	24
8. Boom Barriers (RX-5)	25
8.1 Warrant Due to Conflict Exposure	25
8.2 Other Safety Considerations.....	26
8.3 Operational Sequences and Timing.....	26

9. Active Advance Warning Assemblies (RX-11)	27
9.1 Location and Operational Timing	27
9.2 Sign Size Selection	28
10. Grade Separation	29
10.1 Warrants for Grade Separation.....	29
10.2 Determination of Exposure Level.....	29
10.3 Investigation	30
10.4 Funding	31
10.5 Additional Safety Considerations.....	31
11. Prioritising Level Crossings	32
11.1 Methodology.....	32
11.2 ALCAM Assessment Frequency	32
12. Level Crossings Status	33
12.1 Rail Line Status	33
12.2 Cessation of Railway Operations.....	33
12.3 New Level Crossings.....	34
13. Short Stacking and Queuing Hazards.....	35
13.1 Short Departure Stacking	35
13.2 Short Approach Stacking.....	36
13.3 Possible Treatments for Short Stacking.....	36
13.4 Queuing Hazards	36
14. Pedestrian Crossings	37
14.1 Sight Distance	37
14.2 Warrants.....	38
14.3 Other Safety Considerations.....	40
Appendix A – Definition of Notation and Terms	41
Acronyms	41
Definitions	43
Appendix B – Estimation of Vehicle Queue Lengths at Railway Crossings.....	44
Appendix C – Short Stacking Treatments	45
Appendix D – Standard Drawings.....	49
Figure 1 – Example Interface Demarcation	15
Figure 2 –Driver Eye Height	18
Figure 3 – Available Stacking Distance	35

Document Control

Owner	Metropolitan and Southern Regions Directorate
Custodian	Railway Crossing Branch
Document Number	D17#104381
Issue Date	11 April 2017
Review Frequency	2 Years

Amendments

Revision Number	Section / Page	Description of Key Changes	Revision Date
9000/01	All	Initial issue	6 May 2005
D14#241381	All	Full redraft, including removing duplication of AS 1742.7, new sections for pedestrian crossings and grade separation.	30 June 2015
D17#104381	All	Full document review, inclusion of rail line status definitions.	11 April 2017

Authorisation

This document is owned and controlled by the Executive Director Metropolitan and Southern Regions. The Level crossing Safety and Policy Coordinator is the delegated custodian. All comments and requests for changes should be submitted to the Level Crossing Safety and Policy Coordinator.

Authorised by
 Executive Director Metropolitan and Southern Regions

12 / 4 / 17

Preface

Main Roads WA and Local Governments directly manage more than 140 000 kilometres of public roads. This road network interfaces with approximately 8 100 kilometres of standard and narrow gauge railway track at some 1 400 public railway crossings throughout Western Australia. There are a similar number of non-public (private or occupational) rail crossings.

These Policy and Guidelines are authorised by the Executive Director Metropolitan and Southern Regions, Main Roads WA and have been prepared by Main Roads WA and endorsed by the Strategy and Policy Railway Crossing Protection Sub-Committee. Matters concerning policy were reviewed and recommended by the Strategy and Policy Railway Crossing Protection Sub-Committee, with the Operational Sub-Committee endorsing the technical content.

These policy and guidelines have been prepared to provide direction and guidance on the management, design and operation of railway crossings in Western Australia. This document, along with the roles of the two sub-committees have no statutory or other legal effect on existing State Acts and/or Regulations, including those pertaining to roads and railways.

Users of this document are encouraged to provide comments to:

Level Crossing Safety and Policy Coordinator

Main Roads WA

PO Box 6202

EAST PERTH WA 6892

Alternatively, an email can be sent to the following address: enquiries@mainroads.wa.gov.au (Attention: Level Crossing Safety and Policy Coordinator).

1. Introduction

1.1 Purpose

The purpose of this document is to detail the policies and guidelines for railway crossing control in Western Australia.

1.2 Scope

This policy and guidelines are to be applied to all railway crossings on public roads throughout Western Australia, and can be used as a reference for managing and assessing railway crossing control at railway crossings on non-public roads.

As per the *Road Traffic Act 1974* a road is defined as any highway, road or street open to, or used by, the public and includes every carriageway, footway, reservation, median strip and other traffic island thereon.

The use of the term 'public road' within this document is defined as a road that is owned by a local or state road authority. Most public roads have a road number and have an allocated road reserve. All crossings which do not fall into the definition of a public road are the responsibility of the road and rail owners to assess risk and implement appropriate controls. Similarly pedestrian facilities within public level crossings are within the brief of this document. However, pedestrian crossings and other access ways which are remote from level crossings are not covered within this document.

Reference will need to be made to other publications for information on standards and procedures relating to the technical design and emplacement of the various traffic control treatments and devices described in this document e.g. *Australian Standard Manual of Uniform Traffic Control Devices Part 7: Railway Crossings (AS 1742.7)*. In the event there is a conflict between this document and AS 1742.7. This document details requirements additional to AS 1742.7 and therefore takes precedence where discrepancies occur.

Section 297 of the *Road Traffic Code 2000* empowers the Commissioner of Main Roads with the responsibility for all traffic signs and traffic control signals on all roads (as defined under the *Road Traffic Act 1974*) within the State of Western Australia. This empowerment extends to any traffic signing, signalling devices or road markings installed at or on the approaches to railway level crossings on public roads. Where not specified in other technical standards or documentation approved by the Commissioner of Main Roads, all traffic control devices at railway crossings are to be installed in accordance with AS 1742.7.

Traffic control devices on a road that does not qualify as a 'road' under the *Road Traffic Act 1974* are not the responsibility of the Commissioner of Main Roads. However, it is within the brief of the Strategy and Policy Railway Crossing Protection Sub-Committee and Operational Railway Crossing Protection Sub-Committee to review policies and operational matters relating to the safety requirements for any railway level crossings on such roads.

1.3 ALCAM

Australian Level Crossing Assessment Model (ALCAM) is an assessment tool used to identify key potential risks at level crossings and to assist in the prioritisation of crossings for upgrades. The risk model is used to support a decision making process for both road and pedestrian level crossings and to

help determine the most appropriate treatments to improve safety.

Although it is a comprehensive tool for the assessment of level crossing hazards, ALCAM cannot be applied in isolation and does not preclude the need for sound engineering judgement. Any risk assessment and treatment also needs to consider other factors, including:

- Incident history
- Engineering experience (both rail and road)
- Local knowledge of driver or pedestrian behaviour
- Social and economic assessment
- Standards and international best practice

ALCAM does not provide warrants for upgrades or attempt to define a 'safe' or acceptable level of risk.

1.4 Background

In September 1964 following a spate of serious crashes at railway level crossings, the then Cabinet appointed an inter-departmental committee to review and make recommendations on the safety requirements for all level crossings in Western Australia.

The committee's findings, published in its 'Report on Railway Crossing Protection in Western Australia' in December 1968 and agreed to by Cabinet, included an outline of the criteria to be used for determining the levels of control required at railway level crossings and made a number of specific recommendations to ensure that safety requirements were maintained. These included the appointment of a standing committee to undertake further reviews of railway crossing control requirements. This standing committee, known as the Railway Crossing Protection Committee, continued to review policies and guidelines, publishing a further report on railway crossing protection in December 1980.

Since these times, the level of control in the network overall has improved and the rate of crashes occurring at railway crossings remains low. However, in 1991 it was recognised that factors such as the progressive increase in the number and size of road freight vehicles and the introduction of high speed passenger rail services in both the metropolitan and regional areas were demanding improved control requirements at railway crossings if safety was to be maintained. This prompted the Committee to agree to the draft 'Review of the Railway Crossing Protection Criteria' in November 1992 (revised edition in 1998), which, together with further consideration to factors effecting railway-crossing safety, forms the basis of this publication.

In January 1996, the Commissioners of Main Roads and Railways agreed to restructure the roles and composition of the Committee to allow for the separation of the strategic and policy areas of railway crossing control from the operational areas. A 'Strategy and Policy Sub-Committee' and an 'Operational Sub-Committee' were formed, reporting jointly to the Commissioners.

In December 2000, the Government-owned Westrail freight railway network was privatised, with WestNet Rail Pty Ltd appointed to manage and operate the track and signalling infrastructure under a lease agreement. In 2011 WestNet Rail Pty Ltd was taken over by Brookfield Rail Pty Ltd. The Western Australian Government Railways Commission (now known as Public Transport Authority) retained responsibility for managing the urban passenger railway network infrastructure. Although the majority of public rail crossings are owned by PTA or managed by Brookfield Rail, there are a number of other rail infrastructure owner / managers. These include but are not limited to: Pilbara Rail, BHP Billiton, Roy Hill, FMG, Hotham Valley Railway and Pemberton Tram Company.

In 2004 ALCAM was endorsed by the national Standing Council on Transport and Infrastructure (SCOTI) and was accepted nationally as a way to measure risk at railway level crossings.

In May 2010 the State Government integrated WA's three key transport agencies to form a central head of the Transport portfolio, consisting of the Department of Transport, Main Roads WA and the Public

Transport Authority. This position has the three titles of the Director General of the Department of Transport, Commissioner for Main Roads and Chief Executive Officer of the Public Transport Authority. There is now a Managing Director at Main Roads WA and a Managing Director at the Public Transport Authority.

In February 2011, the “*Rail Safety Act 2010*” was promulgated by the Western Australian Parliament. The Act addresses many issues and clearly defines responsibilities of the Road Manager and the Rail Infrastructure Manager. In 2015 the *Rail Safety Act 2010* was repealed and the *Rail Safety National Law (WA) Act 2015* was passed by the Legislative Assembly and is currently referred to a Legislative Council Committee.

In November 2015 the Office of Rail Safety was reformed in Western Australia, joining the Office of the National Rail Safety Regulator (ONRSR). Its office was established in Western Australia to ensure a national approach to rail safety in Australia.

In 2016 the national Transport and Infrastructure Senior Official's Committee (TISCO) gave unanimous support to the continued use and maintenance of LXM and the ALCAM model.

2. Terms of Reference

2.1 Strategy and Policy Railway Crossing Protection Sub-Committee

It is important that the various levels of railway crossing control are applied consistently throughout the State. To achieve this objective it is necessary to determine a strategic programme for funding the various major control activities such as new flashing lights or boom barrier installations, upgrading of existing facilities and development or trials of new techniques. It is necessary to react to changing circumstances and ensure that control programs are tailored to account for new technology and developments interstate and overseas.

Because of the low rate of crashes, control of railway level crossings is often perceived as having low safety benefits in direct comparison with other traffic engineering countermeasures. On low traffic volume roads, only low cost control can be justified at most crossings. If the benefits of higher levels of control are to be maximised, it is important they are installed at crossings where there is the highest risk of a collision. If lower cost control proves to be viable, and a more proactive approach to control becomes possible, then it is essential that there is an objective, sound method of risk assessment used to determine overall priorities for installation. There are questions to be addressed on the relative importance of control of road vehicles and rail vehicles, and there is a need to ensure timely and informed response to innovation and new technology. These and other issues are the province of the Strategy and Policy Railway Crossing Protection Sub-Committee.

The Strategy and Policy Railway Crossing Protection Sub-Committee's Terms of Reference are as follows.

Objective

- To provide a forum for discussion and review of the State's level crossing control by representatives of State and Local Government, private railways and road users.

Role of the Sub-Committee

Provide advice to the Managing Director of Main Roads and the Chief Executive Officer of the Public Transport Authority of Western Australia (PTA) with regard to:

- Setting and reviewing policy for the control of road and rail users at public road and non-public road crossings on all rail systems.
- Long term funding requirements for appropriate rail crossing control.
- Impacts of road-use policy changes.
- Considering and proposing new or emerging risk reduction treatments at level crossings.
- Discuss and review standards for level crossing controls.
- Discuss national and international developments in respect of railway control techniques and equipment.
- Discuss other contentious issues.

Membership

- Chair
 - Executive Director Metropolitan and Southern Regions, Main Roads WA
- Sub-Committee Representatives
 - Main Roads WA
 - Public Transport Authority of Western Australia

- Brookfield Rail Pty Ltd
- Western Australian Local Government Association
- Office of the National Rail Safety Regulator (Observer)
- Industry Sector Representatives
 - Private railway infrastructure owners/operators including:
 - Heavy Haul Freight, and
 - Tourist and Heritage
 - Occupational Crossing (Pastoral Grassers Association of WA)

Each organisation will nominate one member to represent their views and interests. Industry sector representatives will be nominated by the sub-committee to provide an industry perspective. If a member is unable to attend any meeting, that member may nominate a proxy representative.

Meetings

Meetings are to be held as required (generally two per year).

Support / Secretariat

Level Crossing Safety and Policy Coordinator, Main Roads WA will provide administrative support.

Agenda and Minutes

- All discussion topics and items are to be forwarded to the Level Crossing Safety and Policy Coordinator, Main Roads WA ten working days prior to the meeting for consideration as agenda items.
- The agenda and supporting papers will be distributed five working days prior to the meeting.
- Minutes will be taken and circulated to all members within ten working days of the meeting.

Reporting

Main Roads WA will draft proposed changes to the Railway Crossing Control in Western Australia Policy & Guidelines.

Sub-Committee members are encouraged to report on the meeting outcomes to their organisations.

2.2 Operational Railway Crossing Protection Sub-Committee

It is important that ongoing operational railway crossing control activities are discussed and resolved by those accountable for the safety and control of the road and rail networks. Where operational activities cannot be resolved between relevant parties; the Operational Railway Crossing Protection Sub-Committee provides a forum where the strategic operational and technical functions of railway crossing control can be addressed.

The Operational Railway Crossing Protection Sub-Committee's Terms of Reference are as follows.

Objective

To provide guidance on the day-to-day operational roles for all parties involved in the management of railway crossing control in WA.

Role of the Sub-Committee

To act as a point of coordination between Main Roads WA, Railway Infrastructure Managers, railway owners and operators, Road Managers and local government on operational matters. To monitor incident data, conduct audits and implement improvements. To provide advice to the Strategy and Policy Railway Crossing Protection Sub-Committee with regard to:

- Particular level crossing sites that require a coordinated resolution.
- Knowledge and lessons learnt from level crossings treatments.
- Implementation of the Railway Crossing Control in Western Australia Policy and Guidelines.
- Recommendations for changes to the Railway Crossing Control in Western Australia Policy and Guidelines.
- Undertake research and/or trials as necessary to develop enhancements to control levels.

Membership

- Chair
 - Level Crossing Safety and Policy Coordinator, Main Roads WA.
- Sub-Committee Representatives
 - Main Roads WA,
 - Public Transport Authority of Western Australia,
 - Brookfield Rail Pty Ltd, and
 - Western Australian Local Government Association.
- Industry Sector Representatives
 - Private railway infrastructure owners/operators including:
 - Heavy Haul Freight,
 - Tourist and Heritage, and
 - Mining industry.

Each organisation will nominate one member to represent their views and interests. Industry sector representatives will be nominated by the sub-committee to provide an industry perspective. If a member is unable to attend any meeting, that member may nominate a proxy representative.

Meetings

Meetings are to be held as required (generally three per year).

Support / Secretariat

Level Crossing Safety and Policy Coordinator, Main Roads WA will provide administrative support.

Agenda and Minutes

- All discussion topics and items are to be forwarded to the Level Crossing Safety & Policy Coordinator, Main Roads WA ten working days prior to the meeting for consideration as agenda items.
- The agenda and supporting papers will be distributed five working days prior to the meeting.
- Minutes will be taken and circulated to all members within ten working days of the meeting.

Reporting

Sub-committee members are encouraged to report on the meeting outcomes to their organisations.

3. Road and Rail Works

3.1 Interface Agreements

The *Rail Safety National Law (Act) 2015* (the Act) identifies the responsibility of Rail Infrastructure Managers and Road Managers to manage risk on their network. The Act requires Rail Infrastructure Managers and Road Managers to enter into Interface Agreements for the purpose of managing risks associated with rail crossings on public roads in Western Australia. Refer to individual Interface Agreements for specific asset managers responsibilities.

In WA all Interface Agreements for public level crossings include the following parties:

- Main Roads WA as the regulatory authority,
- Rail Infrastructure Manager, and
- Road Manager (Main Roads WA or Local Government for public roads).

3.2 Costs

Funds for public railway crossing control are provided by the State Government as road funds and are administered through Main Roads WA.

Where not otherwise subject to separate agreements and conditions, responsibilities for meeting the costs for railway crossing control are as follows:

- At existing railway crossings on public roads, the cost of improving railway crossing control, including pedestrian facilities at public road level crossings, is to be met by Main Roads WA.
- Costs associated with maintaining and operating control devices on public roads at State owned railways (e.g. PTA and Brookfield Rail managed railway crossings) are to be equally shared between Main Roads WA and the Rail Infrastructure Manager. Generally on Federal or privately owned rail lines, the cost associated with this function is met by the Rail Infrastructure Manager.
- The costs for installing, improving or modifying railway crossing control, including pedestrian facilities, required as a result of specific network improvement (i.e. road, rail, land-use improvements or land developments) are to be met by the Road Manager or Rail Infrastructure Manager or by the developer, as appropriate. The costs are to include maintenance requirements extending five years beyond the completion of the development, new construction or upgrade.
- Where removal of vegetation and/or other visibility obstructions is required to provide adequate sight distances for drivers approaching a public road crossing, the Road Manager is to meet the costs of removal within the road reserve (including any negotiations with private property owners if required), and the Rail Infrastructure Manager is to meet the cost of removal within the railway reserve.
- All costs associated with controlling crossings not located on public roads are to be met as agreed between the Road Manager and Rail Infrastructure Manager.

3.3 Activities

Where not otherwise subject to separate agreements and subject to the approval of the Commissioner of Main Roads where appropriate, operational responsibilities for railway crossings are as follows.

Main Roads WA

- Install and maintain the appropriate regulatory signs, warning signs, road markings and Active Advance Warning Assembly panels on public road approaches to level crossings - excludes signage affixed to railway hardware.

Road Manager

- Maintain the road approaches up to three metres (3m) either side from the outside running rail.
- Arrange, undertake and maintain any vegetation clearing and/or removal of other physical obstructions on Roads to provide requisite driver visibility sightlines on the approaches to Level Crossings (including any negotiations with private property owners if required).
- Notify the Rail Infrastructure Manager of any road works planned, either of a temporary or permanent nature, in the vicinity of a crossing. (See “Roadworks in the Vicinity of Railway Crossings” below).
- Notify the Rail Infrastructure Manager of any change in land use adjacent to an interface or any change in crossing use.
- Report to Main Roads WA any damaged and unserviceable line marking and signage associated with a crossing identified during inspection of the local road network in accordance with normal maintenance regimes.

Rail Infrastructure Manager

- Arrange and coordinate application designs for the installation of flashing lights, boom barriers, warning bells and Active Advance Warning Assembly control devices.
- Maintain and install flashing lights, boom barriers, warning bells and Active Advance Warning Assembly control devices.
- Undertake and maintain any vegetation clearing and/or removal of other physical obstructions within the rail reserve to provide adequate visibility on the approaches to level crossings.
- Maintain the roadway within three metres (3m) of the outside running rails (in accordance with the Interface Agreement, if one exists).
- At pedestrian crossings, install and maintain flashing lights, warning bells, pedestrian mazes, gates and crossing paths (excludes approach paths) as applicable, including any signage affixed to these devices.

Reciprocal Action for All Parties

- Notify each other party of changes to usage of an Interface of which a party is aware, such as changes to traffic volumes.

3.4 Road Works in The Vicinity of Railway Crossings

Road and other service related works being undertaken in the vicinity of railway level crossings could have adverse impacts on the level of safety at the crossings.

Some examples of where a potential reduction in safety may occur at rail crossings while works are in progress and/or as a consequence of completed works include widening of a carriageway without providing for additional clearances to railway crossing control equipment and other railway infrastructure; road realignments or modifications requiring adjustment to the focal alignment or repositioning of flashlight signals; and visibility obstructions due to the placement of road side furniture, bus shelters, etc.

Road Managers are responsible for advising the appropriate Rail Infrastructure Manager of planned work within the road reserve, either of a temporary or permanent nature, in the vicinity of railway crossings. In the case of an emergency notification shall be provided to the Rail Authority as early as practically possible. As a general guide, the table below shows the minimum distances from the railway, within which any road or other works should not proceed without prior notification to the Rail

Infrastructure Manager.

Speed Limit	Distance from Level Crossing
< 70 km/h	150 m
70 – 90 km/h	200 m
> 90 km/h	300 m

Depending on the nature of the proposed works, the risk to rail safety posed by the road works and if a Traffic Management Plan is required; or the works are likely to result in realignment of a road section or intersection impacting on the railway crossing; or the works will significantly affect the existing traffic flow through a railway crossing then the Rail Infrastructure Manager shall be notified a minimum of two (2) weeks prior to the commencement of the works. Notification may need to be accompanied by a traffic management plan(s), design plan(s).

Refer to the *Traffic Management for Works on Roads Code of Practice* (Main Roads WA)

The Rail Infrastructure Manager may determine that a Safety Management Plan (SMP) is also required for road works which impact on the safe operation of the railway. An SMP shall be prepared by the Road Manager and submitted to the Rail Infrastructure Manager for approval. The Rail Infrastructure Manager will liaise with the Road Manager to assist in developing the SMP. Prior to commencement of the road works the SMP shall be submitted for approval to the Rail Infrastructure Manager within a timeframe set by the Rail Infrastructure Manager.

Track Access Permit Requirements

Track Access Permits (TAP) are required when working within the railway reserve. TAP accreditation is undertaken to ensure those working within the rail reserve are aware of hazards and safe working procedures specific to the rail environment. Accreditation is gained by passing the relevant mandatory health assessment applicable to the level of accreditation sought and successfully completing applicable training module (s). Successful candidates are issued with the relevant level of TAP.

TAPs are intended for people who work in the rail industry not for one-off visitors or workers doing specialist activities. For brief works, specialists or one-off visitors, written exemptions to the requirement for TAPs can be sought from the Rail Infrastructure Manager provided that alternate safe working procedures or supervision by appropriately accredited rail safety workers are put in place as per the relevant Rail Infrastructure Manager rules. For specific TAP requirements refer to the relevant Rail Infrastructure Manager.

3.5 Rail Works in The Vicinity of Road Crossings

Any party undertaking rail work which may impact on the safety of road users shall prepare a Traffic Management Plan (TMP). This TMP shall provide a means of planning and implementing how road users will be safely and efficiently guided through, past or around the affected site; provide for the safety of workers; and ensure the road network performance is not unduly impacted, for the duration of the works. These TMPs must be prepared in accordance with the *Traffic Management for Works on Roads Code of Practice* (Main Roads WA). TMPs are prepared by appropriately accredited people in advance of the works being conducted and must be approved for implementation by the road authority a minimum of two (2) weeks prior to the works.

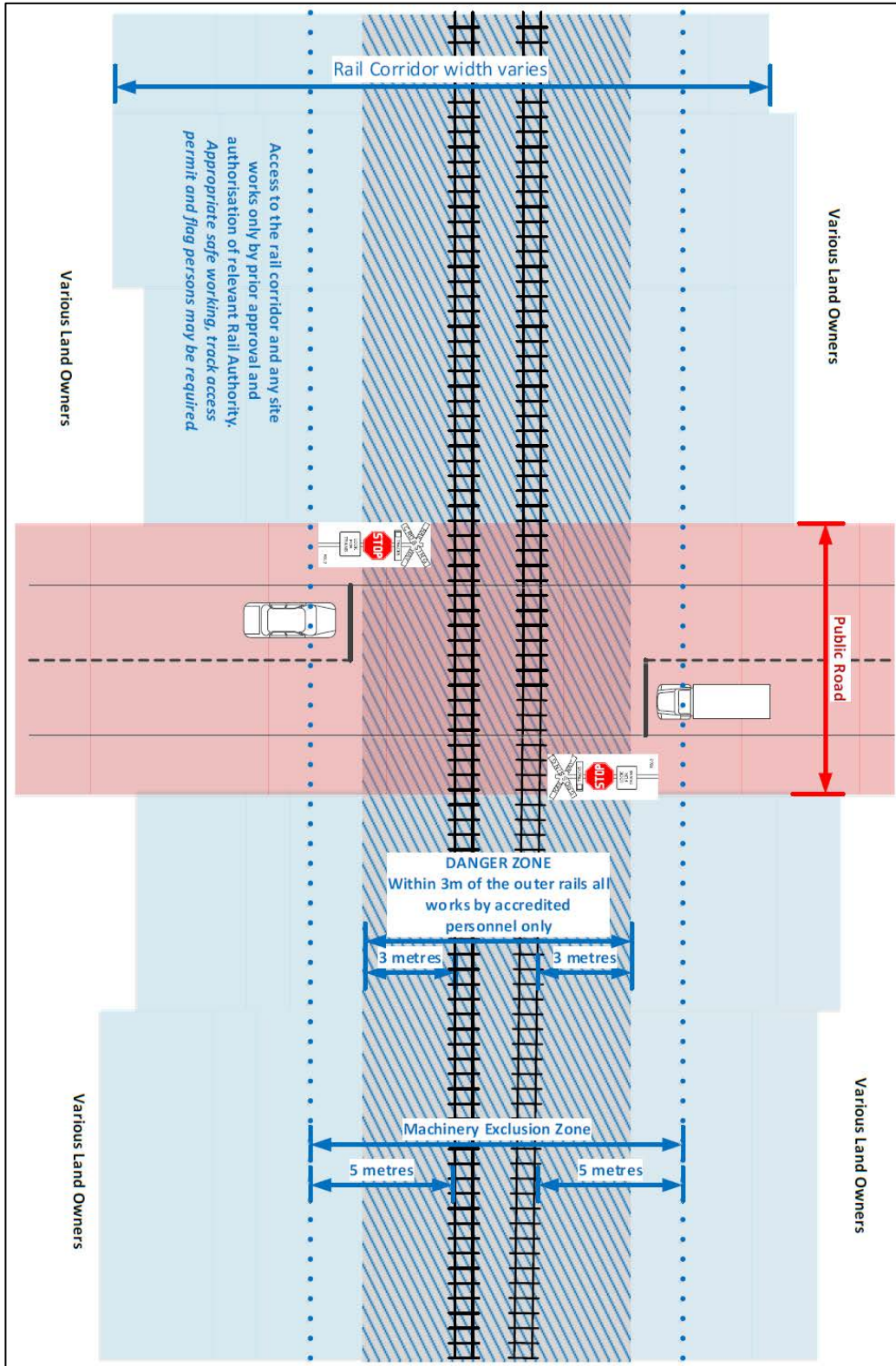


Figure 1 – Example Interface Demarcation

4. Levels of Control

There are five levels of control used at operational level crossings in this State. In ascending order, they are:

- Give Way Signs.
- Stop Signs.
- Flashing Lights.
- Boom Barriers.
- Grade Separation.

The four levels of 'at-grade' control fall into two groups: *passive devices* i.e. Give Way Signs and Stop Signs; and *active devices* i.e. Flashing Lights and Boom Barriers. In making an assessment as to the appropriate level of control for any particular railway crossing, the basic philosophy is to provide an adequate level of safety with the minimum amount of disruption to road or rail traffic and at the lowest cost. Often these requirements conflict as evidenced by the fact that Flashing Lights provide less disruption to road traffic than Stop Signs, however at a much greater cost.

Examples of each type of control are shown in AS 1742.7; which also details the layout of the standard signs and road markings associated with each type of control.

Additional treatment may be required to prompt drivers of the potential hazards ahead, such as:

- Reduced Speed Zones,
- Passive Advanced Warning Signs,
- Active Advanced Flashing Warning Assemblies.

The process of determining the appropriate level of control for any railway crossing entails systematically checking the adequacy of each level of control, starting with Give Way Sign control and working down the five levels of control until an adequate level is determined. This is done in accordance with AS 1742.7, along with the criteria set out in Sections 5 to 10 of this document, considering safety and risk flags highlighted by the ALCAM and using appropriate safety consideration. The full range of variables should be used in the detailed assessment process, which will often require calculations to be performed in conjunction with an on-site investigation of the crossing.

It is important that records be kept of the control installed at each railway crossing. Main Roads WA maintains a record of the type of control installed at all crossings on all railway lines in Western Australia using the ALCAM and its associated database. Those organisations upgrading the levels of control are responsible for advising Main Roads WA when the works are completed.

4.1 Sight Distance Requirements

Sighting requirements must be measured in accordance with AS 1742.7. Sight distance requirements for each type of control can be determined from AS 1742.7 or entering relevant data into ALCAM. When using either method consideration of the following should be taken into account.

S₁ Calculation

The driver of a vehicle approaching a railway crossing needs to be able to see the crossing controls at a sufficient distance from the crossing that would allow time to stop the vehicle if required. The required S₁ sight distance is measured from the nearest rail.

S₁ calculation including factors and coefficients can be found in AS 1742.7 and are supplemented by the following;

Reaction Time

Total Perception Reaction Time, R_t, is used for calculating stopping sight distances for vehicles approaching an intersection is generally taken as 2.5 seconds. Although a motorist can be alerted to the presence of the railway crossing by the installation of signs, R_t is principally comprised of the time a driver needs to look both left and right in order to search for any approaching trains and then, if a train is seen, appreciate the need to stop. An additional 0.5 seconds of reaction time is added for each of the following conditions if they apply on the approach to the crossing:

- Drivers do not expect to encounter a train due to low train volumes i.e. less than 2 trains per day or train movements are subject to significant seasonal variation.
- High-speed road in a rural environment.
- The conditions of the road on the approach to the crossing result in the motorist concentrating more on physically driving the vehicle than looking for trains e.g. sharp bends, narrow pavements, poor road surfaces, etc.

85th Percentile Vehicle Speed

In locations where there are a high number of vehicles moving significantly below the 85th percentile speed of the road, there may be a need to calculate equivalent S₁ and S₂, and the subsequent angle requirements. These assessments will be based on the 15th percentile and 85th percentile speed.

The 85th percentile vehicle speed is the speed in kilometres/hour at which 85 percent of vehicles are travelling at or below. Where speed data information is not available the road speed limit plus 10% may be used.

Curved Approaches

Vehicles traversing curves have a reduced braking ability, compared to vehicles traveling in a straight line due to the available friction supplied by the tyres. The S₁ distance must follow the curvature in the road as it represents the distance travelled by the approaching road vehicle.

S₂ Calculation

A motorist reaching the S₁ position who cannot see any trains should be able to proceed without changing speed, and clear the crossing in advance of any approaching train that may have been just out of view. To incorporate a comfortable safety margin the vehicle needs to be clear of the crossing at least 5 seconds prior to the arrival of the train. The distance down the track, S₂, at which a motorist at S₁ needs to be able to see an approaching train is measured from the centre of the road carriageway along the track. S₂ calculation including factors and coefficients can be found in AS 1742.7.

Adequate visibility is defined as being a driver's ability to view at least two thirds of the frontage area, including any warning or headlight/s, of the approaching locomotive from a driver's eye height.

Austrroads Guide to Road Safety recommends using a driver eye height of 1.10 metres above the road surface level.

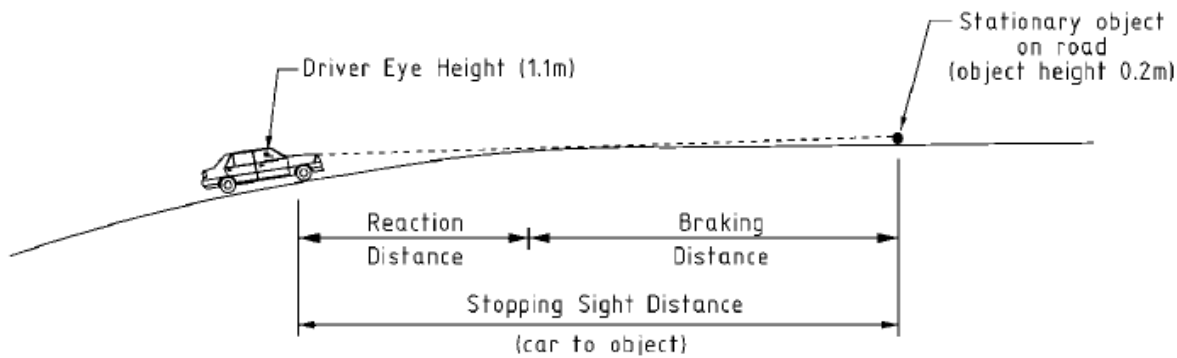


Figure 2 – Driver Eye Height

It is not necessary to completely remove all obstacles within the sight triangles. Isolated obstructions such as trees can be retained so long as any blanketing effect upon visibility is removed and drivers are able to readily detect the presence of an approaching train within the distance S_2 from the crossing.

4.2 Maximum Road Speed Limit at Level Crossings

Road users and train occupants are exposed to risk at level crossings due to the possibility of a collision. Road users are required to stop or give way to all rail traffic at level crossings. The most significant variable in the distance required for a road vehicle to stop is its velocity (or speed). Therefore reducing road speeds to a maximum of 80km/h at level crossings decreases the likelihood of vehicles being unable to stop at level crossings. Studies have shown that road user compliance with a reduction in speed at level crossings is good. There is an additional benefit of reducing road speeds given level crossings are typically rougher than the road surface either side of the level crossing.

A maximum speed limit of 80km/h is applied to level crossings in Western Australia to decrease the risk at railway level crossings. Further detail can be found in the “Policy and Application Guidelines for Speed Zoning” on the Main Roads WA website: <https://www.mainroads.wa.gov.au>

Speed zoning the road at 80km/h is not applicable on unsealed roads or approaching level crossings:

- within 300 metres of a road terminating; or
- where the crossing is under Stop Sign control.

In both of the above scenarios drivers are required to stop; therefore posting a speed limit of 80km/h would encourage higher speeds and decrease the safety of the crossing.

To be able to speed zone a section of road there are a number of road design factors to be satisfied such as the design speed, seal width (greater than 5.5 metres) and length of seal.

At all crossings speed zoned at 80 km/h, ‘X RAIL’ line marking shall be installed as per AS 1742.7. It should be noted the ‘X RAIL’ uses the letter height of 3 m for ‘X’ and 2.5 m for ‘RAIL’, with the ‘X’ being installed prior to the ‘RAIL’ line marking.

4.3 Other Safety Considerations

Some additional considerations for improving safety at level crossings are outlined below.

Whistle Boards

Where there is the likelihood of pedestrian movements at or other extraneous activity at or near a railway crossing that does not have audible warning bells associated with the road crossing, warning can be provided by the sounding of the approaching train's siren or horn at a distance determined by the relevant Rail Infrastructure Manager.

Street Lighting

The installation of suitable street lighting can reduce the problem of trains already on the crossing not being visible to approaching drivers at night. This particularly applies where night time shunting activities occur. It is desirable that the lighting include illumination on both sides of the railway a short distance either side of the crossing.

Queuing

Adjacent intersections and their controls should take into account the need to accommodate any vehicle queuing which may occur without impeding traffic movement over the railway crossing. Also, the layout of the intersection must allow for the longest length of vehicle permitted to use the crossing to stop at the intersection if required, without impinging upon the railway crossing safety clearance area. Refer to Section 13.

Width Markers

'Railway Crossing' boards along with the associated width markers (RX-9 Assembly) provide additional warning to drivers of the approaching railway crossing, and also highlight the position of the crossing. The width markers provide vertical delineation of the width of crossing, and thus offer safe guidance past potential roadside hazards associated with railway crossings such as flashing light masts, boom arm equipment, exposed rails, sleepers, etc. In all cases, Railway Crossing boards should not obstruct visibility from nearby intersecting roads or driveways.

Width Markers should be erected on the line of the vertical obstruction in conjunction with the signs RAILWAY (G9-32) and CROSSING (G9-33). Where there are kerbs or footways, the width markers should be erected so that they indicate the width of the pavement. In this context the pavement is the trafficable road surface whether constructed gravel formation or sealed road surface.

Where the pavement width narrows over a railway crossing Road Narrows signs (W4-3) should be used where a reduction of the pavement width may constitute a hazard. Specific conditions for its use are;

- where the width of any lane is reduced by 600 mm or more in the direction of travel, or
- The pavement width is reduced to 5.5 m or less.

Note: Narrowing the pavement width may involve a reduction in width of a single carriageway, with or without a reduction in the number of lanes.



W4-3

The Road Narrows sign (W4-3) shall be installed in advance to the lateral transition of the edge of the pavement, as per AS 1742.2.

Rumble strips

Rumble strips can be effective at warning drivers of a hazard. Rumble strips in advance of railway crossings can be used in areas prone to driver fatigue or where a rail crossing is not expected.

Seal Road Approaches

On unsealed roads, sealing the approaches to the level crossing will reduce dust and improve visibility of the crossing. This also will improve the maintenance life of level crossing assets. Refer to *Main Roads WA Design Guides* for minimum length of seal.

Site Monitoring and CCTV

At locations prone to vandalism or noncompliance with the *Road Traffic Code 2000*, Closed Circuit Television (CCTV) can be installed to assist law enforcement. Prior arrangement with the WA Police is required where prosecution will be sought, to ensure the image quality and other specific requirements are met.

5. Give Way Signs (RX-1)

A railway crossing protected by Give Way Signs works on the principle that sufficient visibility is provided to the driver of a road vehicle approaching the crossing to enable them to see an approaching train in time to stop if necessary before reaching the crossing and allow the train to pass. This level of control generally applies to crossings where train and/or vehicle volumes are relatively low.

The following conditions should be met before Give Way signs are considered to be an adequate level of control:

- Western Australian practice is to have no Give Way control on multi-track level crossings or on level crossings adjacent to sidings.
- There must be clear visibility available on the road approaches to the crossing, at least equal to the minimum distance necessary for a driver to see an approaching train and be able to stop safely prior to reaching the crossing. Refer to S_1 and S_2 calculation given in AS 1742.7.
- Vehicles giving way to a passing train must stop at the Give Way hold line; therefore the minimum clear visibility available at the stopped position at the crossing must be at least equal to the minimum distance necessary that applies to Stop Sign control crossings. Refer to S_3 calculation given in AS 1742.7.
- The level of train and vehicle activity should be below that warranting active control to be installed.

5.1 Sight Distance Requirements for Give Way Signs

Sight distance requirements for Give Way Signs can be determined from AS 1742.7 and are supplemented by section 4.1.

In addition to having clear visibility between the vehicle at S_1 and the train at S_2 , drivers cannot be expected to turn their heads through too great an angle in order to see the train. Maximum angle requirements are set out in AS 1742.7.

Due to the maximum viewing angles as a vehicle approaches a crossing, the driver's ability to check for an approaching train reduces. The S_1 sighting distance uses the 85th percentile road vehicle speed; however, for slow moving vehicles and fast moving trains the equivalent S_1 and S_2 may result in viewing angles outside of the maximum range. Where a road speed is considered variable, equivalent S_1 and S_2 calculations and angle requirements should be checked for the 15th percentile road vehicle speed.

5.3 Assessment for Give Way Signs On Side Road Crossings

Many railway lines throughout the State have roads running close by and parallel to the tracks. While travelling along such roads motorists may be unaware of a train travelling just behind the vehicle in the same direction. The speed of a vehicle turning from a parallel road into a side road is often variable. For this situation the equivalent S_2 position are always based upon the 85th percentile vehicle speed as measured at the tangent point of the intersection. (This is based upon there being no increase in vehicle speeds after drivers reach this point.)

While the driver may be aware of the existence of the crossing before turning into the side road, the driver's concentration is primarily directed to the turning manoeuvre and other possible conflicting traffic, therefore it is not until such time as this manoeuvre has been completed that a driver is in a position to safely check for approaching trains. S_2 may be measured from a position 2.5 seconds after completing the turning manoeuvre.

6. STOP Signs (RX-2)

A railway crossing controlled by Stop Signs works on the principle that visibility restrictions on the road approaches to the crossing, either by virtue of the crossing geometry or adjacent development / vegetation, are such that a motorist is not able to make an appropriate decision on proceeding over the crossing without first stopping on the approach side to assess the conditions. However, there is sufficient visibility from the stopped position to an approaching train to enable the driver to decide whether the distance to the train is such that it will not be a collision threat and it is safe to cross or if they must wait until the train has passed. Similar to Give Way sign control, this level of control generally applies at locations where train and/or vehicle volumes are relatively light.

The following conditions are to be satisfied before Stop Sign control may be considered to be an adequate level of control:

- Stop Signs are not appropriate where the train speed is in excess of 100 km/h due to the difficulties faced by a motorist to view and perceive the rate of approach of a high-speed train over long distances. However, it is not expected that this condition would apply to non-public crossings where drivers would generally be familiar with the conditions and exercise a greater level of caution when negotiating these crossings.
- The extent of clear visibility either actually available or that could be made available by clearing works to a motorist at the stopped position at the crossing must be at least equal to the minimum level necessary as determined from consideration of train speeds over the crossing, vehicle length and acceleration, grade and surface of the road, and geometry of the crossing. Refer to S_3 calculation given in AS 1742.7.
- The clear visibility required must be available through a range of angles that does not require excessive rotation of the drivers head when stopped at the crossing or that may be obscured by parts of the vehicle. Refer to AS 1742.7 for angle requirements.
- The level of train and vehicle activity should be below that warranting active control to be installed.

6.1 Sight Distance Requirements for Stop Signs

In addition to the S_1 Sighting requirement to the crossing controls, for Stop Sign controlled crossings, motorists need to be able to see any approaching train that represents a potential conflict, while stopped at the hold line. In the absence of a hold line the sight distance shall be measured as the control sign (generally 3.5 m from the outside edge of the rail).

The minimum distance down the track, S_3 , at which a motorist stopped at the hold line, needs to be able to see an approaching train is measured from the centre of the crossing. The S_3 calculation including factors and coefficients can be found in AS 1742.7.

Adequate visibility is defined as being a driver's ability to view at least two thirds of the frontage area, inclusive of any warning or headlight/s, of the approaching locomotive (assumed to be 2.4 m above the rail from a driver eye height of 1.1 metres above the road surface).

The sight triangles should be clear of any obstructions to ensure drivers are able to readily detect the presence of an approaching train within the distance S_3 from the crossing.

6.2 Angle Requirements for Stop Signs

In addition to needing clear visibility of trains at a distance of S_3 , drivers cannot be expected to turn their heads through too great an angle in order to see the train. Maximum angles are set out in AS 1742.7.

7. Flashing lights (RX-5)

Flashing Lights are an active form of control at a railway crossing that alert the vehicle driver of an approaching train and their need to stop. If any of the following conditions apply at a railway crossing, consideration should be given to the installation of Flashing Lights:

- The geometric requirements for passive control cannot be met.
 - The volumes and speeds of trains and vehicles create a potential conflict at a level that justifies the installation of Flashing Lights.
 - The replacement of Stop Signs with Flashing Lights may be shown to have a cost benefit.
 - The road is of a classification that drivers would generally expect to have priority travel i.e. a declared highway or main road.
 - Heavy vehicle routes i.e. maintenance costs caused by constant heavy vehicle start-up at Stop Signs
- Meeting any of the above conditions does not automatically lead to the installation of Flashing Lights. Additionally on major roads or within town sites, provision of active control devices is encouraged and should be considered.

7.1 Warrant Due to Conflict Exposure

The potential conflict at a railway crossing is influenced by the level of conflict between trains and vehicles. The conflict is normally expressed as the product of the number of trains and vehicles using the crossing. Given that potential conflicts can also be influenced by the speed at which trains and vehicles approach a crossing, it is appropriate to assume that crossings having the same level of conflict but different train and vehicle speeds, also have different levels of potential conflict. To account for these differences, it is necessary to apply weighting factors to the level of conflict based on the speed of trains and vehicles to establish the weighted conflict at a crossing in order to assess its level of potential conflict.

When assessing the installation of flashing lights the weighted conflict, C_w is derived as follows:

$$C_w = \frac{V_t}{60} * N_t * \frac{V_v}{60} * AADT$$

The weighted conflict (C_w) is the product of the average annual daily traffic (AADT), and the average number of train movements per week (N_t), with weighting factors applied for 85th percentile vehicle approach speeds (V_v), and maximum train speeds (V_t), that vary from a base speed of 60km/h. For existing crossings controlled by Stop Signs, the value of V_v is always taken as 60 km/h.

If C_w is greater than 14 000, consideration should be given to the installation of Flashing Lights.

7.2 Visibility Requirements for Flashing Lights

The operating flashing light signals should be clearly visible to approaching motorists from a distance of at least equal to the stopping sight distance (SSD) applicable for the section of road for the largest vehicle type.

Since the crossing may also generate a queue of vehicles, it is important that an approaching motorist can also see the end of the queue from a distance of at least equal to the SSD from wherever the end of the queue may be.

The required minimum driver visibility distance to the flashing light signals, S_{vf} , is therefore made up of the following components:

- S_1 can be calculated from AS 1742.7; and
- The average maximum length of any queue of vehicles, L_q , which may have formed from the stop line following commencement of the lights flashing.

S_{vf} can then be calculated as follows:

$$S_{vf} = S_1 + L_q$$

The length of vehicle queues that can form at a crossing is influenced by a number of factors including arrival rates, the type of traffic flow (i.e. random, bunched or platooned), number of lanes, vehicle types, crossing closure times, etc. Appendix B can be used as a guide for estimating values for L_q in the absence of measured data or observations to determine the average maximum vehicle queue length. Should the required visibility distance, S_{vf} , not be available, one or a combination of the following measures should be considered:

- Geometric modifications to the road alignment;
- Reduce speed of approaching road vehicles;
- Remove obstructions such as vegetation, embankments, structures;
- Modifications to the flashing light signal displays such as additional, taller or offset masts; or
- Active Advance Warning Assemblies (Refer to Section 9).

7.3 Other Safety Considerations

The ability of a driver to view flashing lights can be adversely effected by various traffic and environmental conditions.

- Rectangular back boards must be installed and consideration should be given to installing overhead cantilever flashing light displays to address visibility obstructions caused by:
 - Traffic congestion on multi-lane roads, where slow moving or queued vehicles in one lane can obstruct visibility for drivers in an adjacent lane.
 - Large vehicles regularly stopping at nearby side roads or driveways and blocking sight lines.
 - Distractions in the form of other signal displays and illuminated signs and devices.
 - Sight lines regularly obstructed by kerbside or verge parking.
- On unsealed roads there is the possibility of dust obscuring the signals. Therefore, the installation of Flashing Lights on unsealed road crossings should be accompanied by the sealing of the road approaches either side of the railway.
- On routes approved for use by 'oversize' vehicles, investigations should be undertaken to determine if any particular safety requirements need to be incorporated into the operation of the Flashing Lights e.g. longer pre-warning times and sight distances to the signals, allowance for greater safe stopping distances by installing Active Advance Warning Assemblies or an oversized vehicle by-pass may be required. Refer to Appendix D for Main Roads standard drawing.

7.4 Design and Operation of Active Flashing Light Signals

Design and operational requirements for flashing light protection are outlined in *Railway Infrastructure: Railway Level Crossings (AS 7658)* and supplemented by the relevant Rail Infrastructure Manager's design documents.

8. Boom Barriers (RX-5)

Boom Barriers are installed to supplement the level of control provided by Flashing Lights. They are an active control device providing a visual barrier between the movement of vehicles and trains, typically comprising of a boom spanning from the left hand kerb to:

- Right hand kerb or edge of one way roadway,
- Edge of physical median island or centre of island depicted only by road marking, or
- Dividing line or centre of roadway.

The boom includes red and white bands as well as three red lamps as per AS 1742.7.

The effectiveness of this barrier in improving safety is particularly realised at crossings subject to heavy and often congested vehicle flows.

If any of the following conditions apply at a railway crossing then consideration should be given to the installation of Boom Barriers:

- The volumes and speeds of trains and vehicles create a potential conflict at a level that justifies the installation of Boom Barriers.
- The crossing is located on a railway with multiple through tracks and it is possible for more than one train to approach the crossing at the same time. This is to prevent drivers falsely anticipating the crossing is safe after the passage of one train and proceeding to cross by anticipating a light change.

Meeting any of the above conditions does not automatically lead to the installation of Boom Barriers. Additionally on major roads, within regional townsites, provision of active control devices is encouraged and should be considered.

8.1 Warrant Due to Conflict Exposure

The method for determining the weighted conflict, C_{wb} , and hence the level of potential conflict at a crossing controlled by Boom Barriers uses the following formula.

The level of exposure at a railway level crossing, C_{wb} is based on two factors:

- Weighted conflict (C_w) - The product of the average annual daily traffic (AADT), and the average number of train movements per week (N_t), with weighting factors applied for 85th percentile vehicle approach speeds (V_v) in km/h, and maximum train speeds (V_t) in km/h.
- Heavy vehicle factor (H_v) - Is based on the percentage of heavy vehicles (P_v), as a whole number (Note: 5% as the default value). This is multiplied by a road grade factor (G_r), as a whole number. P_v must be adjusted where there are road trains (Austroads class 10 and above). The class 10-12 vehicles are multiplied by a factor of 1.5. Take for example a crossing has a total of 30% heavy vehicles with 10% of all vehicles being class 10 and above. The adjusted P_v is $(20 + 10 \times 1.5) = 35$. G_r is the steepest incline within 400 metres of the crossing (averaged over 100m).

The exposure level is derived from the following formula:

$$C_{wb} = C_w * H_v$$

Where:

$$C_w = \frac{V_t}{60} * N_t * \frac{V_v}{60} * AADT$$

And:

$$H_v = \frac{[1 + (P_v/5)]}{2} * \left[1 + \frac{Gr}{10} \right]$$

If C_{wb} is greater than 700,000, consideration should be given to the installation of Boom Barriers.

If Stop Signs exist at the crossing, the vehicle speed needs to be estimated as if Flashing Lights were installed.

8.2 Other Safety Considerations

In conjunction with the installation of Boom Barriers in urban areas, particularly at multiple track crossings, it is desirable that suitably designed traffic islands be installed to provide a barrier between opposing carriageway approaches. The islands assist in preventing motorists from driving around the ends of the boom arms to bypass delays which can be caused by the approach of a second train, and also serve to highlight the location of the crossing.

Interconnection between active control devices (such as boom barriers) and road traffic signals is required where a car may be trapped within a level crossing due to traffic lights and a lowered boom barrier.

8.3 Operational Sequences and Timing

Recommended operational sequence and timing for active control containing boom barriers are contained within AS 7658 and supplemented by the relevant Rail Infrastructure Manager's design documents.

9. Active Advance Warning Assemblies (RX-11)

Active Advance Warning Assemblies (AAWA) are installed to supplement the level of control provided by Flashing Lights and Boom Barriers. They are an active warning device incorporating the message 'Prepare to Stop', and provide visual advance warning to motorists that there is a requirement to stop for the flashing light signals at the railway crossing ahead.

The effectiveness of this advance warning in improving safety is particularly realised on high speed road approaches where the required visibility to the flashing lights cannot be attained by normal measures. Heavy vehicles, particularly road trains derive significant benefit from the AAWA.

The decision to install AAWA should be based upon sound traffic engineering judgement which includes consideration to factors such as traffic speeds, traffic volumes, heavy vehicle composition, road geometry, visibility and vehicle crash history.

To ensure some uniformity in vehicle operating speeds, the road should conform to the requirements for speed zoning. At least one of the following minimum conditions would be met:

- The road is a designated heavy vehicle route or a specified road train route.
- The railway crossing has a known history of vehicle crashes, which cannot reasonably be alleviated by other warning signs or devices.
- Available driver sight distance to the primary flashing lights at the railway crossing is below that specified in Section 9.1 and the available sight distance cannot be reasonably increased by other measures.
- Driver visibility of the operating railway crossing flashing lights can at times be severely reduced by sun-glare, either as a consequence of the sun shining directly on the signal lenses or due to the sun shining directly into the driver's line of vision.

9.1 Location and Operational Timing

The AAWA signs should be located sufficiently in advance of the railway crossing to enable drivers travelling at the 85th percentile speed for the particular road to safely and comfortably stop at the stop line after viewing the AAWA commence operation. The Longitudinal Location of AAWA provided in AS 1742.7 uses an average coefficient of deceleration of 0.29 on a wet sealed road surface.

Speed (km/h)	Longitudinal Location of AAWA (B-Double)								
	Average Approach Grade (%)								
	-8%	-6%	-4%	-2%	0%	2%	4%	6%	8%
60	109	103	98	94	91	87	85	82	80
70	140	132	126	120	115	111	107	104	101
80	176	165	156	149	142	137	132	128	124
90	214	201	190	181	172	165	159	154	149

The following table is provided for larger road vehicle braking characteristics.

Longitudinal Location of AAWA (Triple Road Train and AAB Quad)									
Speed (km/h)	Average Approach Grade (%)								
	-8%	-6%	-4%	-2%	0%	2%	4%	6%	8%
60	160	143	130	120	113	106	101	96	92
70	209	186	169	156	145	136	129	123	118
80	266	236	213	196	182	170	161	152	146
90	328	290	262	240	222	207	195	185	176

Note: the above values have been derived using a Coefficient of Deceleration of 0.20 on sealed roads from *Austrroads Guidelines* for RAVs Categories 9-10.

Refer to AS 1742.7 for the length of time in seconds, T, which the advance signals flash before the railway crossing flashing lights begin to operate. To allow for major obstacles and other physical features, which may affect the on-site location of the AAWA, a 5% tolerance can be applied to the values of S without the need to recalculate the length of time, T. For AAWA sign installation outside of this 5% tolerance, a new value for T, must be determined and applied. Vehicles traveling at slower speeds may pass the AAWA signs prior to them activating and still be able to sight the control or queue in time to stop.

9.2 Sign Size Selection

AAWA comprise of a standard diamond shaped railway level crossing flashing light ahead sign on a yellow rectangular background. Refer to Appendix D for Main Roads standard drawing. Sign size selection is related to the posted speed limit of the road and applied as follows:

- Type C sign shall be used on roads where the posted speed limit is 80km/h.
- Type B sign shall be used on roads where the posted speed limit is below 80 km/h, OR where it is impractical to provide sufficient space for a Type C.

Sign Type	Sign Width	Sign Height	Diamond Size	Text Size
B	1100	1600	750 x 750	120 DM
C	1350	1950	900 x 900	160 DM

10. Grade Separation

Grade separation using a bridge or an underpass offers the safest but most expensive treatment at a rail crossing. Justification of the high expenditure involved with grade separation is required before replacing an existing level crossing or constructing a new grade separated crossing.

10.1 Warrants for Grade Separation

Grade separation shall be pursued in the following scenarios:

- Where the current or anticipated exposure level is greater than 5 million for rail and road interfaces.
- Railway crossings on all freeways and controlled access highways.
- Where new crossings are proposed within the current or proposed Perth urban passenger rail network which results in an increase in the total number of level crossings.
- Where the Road Manager determines that a proposed crossing location presents an intolerable risk to road users and / or network efficiency (this will generally be due to factors such as road and rail geometry and alignment which are not fully encapsulated by the exposure level formula).
- Where there is a dual track crossing proposed on a highway or high volume road of strategic importance to the State.

Note: Where the crossing is an existing public rail and public road interface that exceeds the 5 million exposure level, further investigation into project cost, traffic impacts, pedestrian activity, safety risks, ALCAM scores, recorded crashes, incidents, and project feasibility should be used to adjust grade separation priorities prior to seeking government funding.

There may be certain scenarios where the 5 million exposure level is reached, however grade separation may not be an appropriate treatment. Refer to Section 10.3.

10.2 Determination of Exposure Level

The level of exposure at a railway level crossing, C_{wgr} is based on three factors:

- Weighted conflict (C_w) - The product of the average annual daily traffic (AADT), and the average number of train movements per week (N_t), with weighting factors applied for 85th percentile vehicle approach speeds (V_v) in km/h, and maximum train speeds (V_t) in km/h.
- Heavy vehicle factor (H_v) - Is based on the percentage of heavy vehicles (P_v), as a whole number, (Note: 5% as the default value) This is multiplied by a road grade factor (G_r), as a whole number. P_v must be adjusted where there are road trains (Austroads class 10 and above). The class 10-12 vehicles are multiplied by a factor of 1.5. Take for example a crossing has a total of 30% heavy vehicles with 10% of all vehicles being class 10 and above. The adjusted P_v is $(20 + 10 \times 1.5) = 35$. G_r is the steepest incline within 400 metres of the crossing (averaged over 100m).
- Vehicle delay factor (D_v) - Determined from the length of the longest train (L_{tl}) in metres, and the maximum speed of the longest train (V_{tl}) in km/h that travels over the crossing.

The exposure level is derived from the following formula:

$$C_{wgr} = C_w * H_v * D_v$$

Where:

$$C_w = \frac{V_t}{60} * N_t * \frac{V_v}{60} * AADT$$

And:

$$H_v = \frac{\left[1 + \left(\frac{P_v}{5}\right)\right]}{2} * \left[1 + \frac{Gr}{10}\right]$$

Note: percentages are expressed as whole numbers for the purpose of the equation.

And:

$$D_v = \frac{\left[1 + \frac{\left(21 + 3.6L_{tl} / 0.9V_{tl}\right)}{25}\right]}{2}$$

Note: Unless subject to shunting operations, $0.9 V_{tl}$ can be assumed to be representative of the slowest train speed through a crossing.

10.3 Investigation

In certain scenarios where the exposure level is exceeded, grade separation may be deemed inappropriate. These particular locations will only be considered where the below criteria are met for level crossings:

- Where the warrant for grade separation will only be exceeded for a relatively short period of time in relation to the design life of a bridge or underpass; and
- The vast majority of road users are not ordinary members of the public (i.e. from one company) and therefore the exposure can be managed by other means.

These particular scenarios will generally only occur on Local Government or private roads as a result of activities such as mining projects with limited mine life. Additional controls will need to be put in place to ensure safety and efficiency is not compromised. These controls may include:

- additional overtaking lanes,
- additional seal lengths,
- inductions for road drivers from the mining company using the road,
- staggered departure times for controlled vehicles including GPS tracking,
- CCTV at the crossing,
- radio messaging to heavy vehicles through the two way radio, or
- recourse for drivers that disobey the induction.

These level crossings will be subject to reassessment for grade separation if the additional controls fail to mitigate the risk.

These level crossings must have the highest level of active control and advanced warning installed.

Where there are existing level crossings on the public rail network and the exposure level is exceeded, grade separation may be cost prohibitive in the short to medium term. In some instances grade separations will not be able to be contained within existing reservations and may impact on landowners and businesses or require significant cost implications to mitigate impacts. In such cases, investigations into other measures to reduce traffic impacts and improve safety should be investigated and implemented where appropriate.

10.4 Funding

For private railways, existing private rail/public road crossing, grade separation must be funded by the rail owner. The costs are to include maintenance requirements extending five years beyond the completion of the development, new construction or upgrading.

For public railway crossings, any grade separation which is required as a result of specific road, rail or land-use improvements or development, must be funded by the Road Manager or Rail Infrastructure Manager or the developer, as appropriate.

10.5 Additional Safety Considerations

Consideration of the following grade separation safety issues is required:

- Protection of people and property from objects or material falling, suspended or thrown from one level to another;
- Protection of traffic on either the upper or lower facility from any consequences of incidents such as road crashes or train derailments on the other facility;
- Provision of safe clearances or low clearance warning for road traffic under railway structures gantries on approaches to be installed;
- Provision of safe clearances for railway traffic under railway, road or other facility structures; and
- Protection from contact with live electrical equipment.

Refer to AS 5100.1 and Main Roads WA Structures Engineering Design Manual for bridge design specification and general principles.

11. Prioritising Level Crossings

Whilst there are a number of crash prediction models available to determine relative hazard and hence priorities for upgrading control levels, these are largely based upon or compared to some historical measure of crash occurrences. Crashes at railway crossings in Western Australia are widely dispersed. Given the diversity of the road and railway network and the continuing changes occurring in the transportation area, the ranking or prioritising of control requirements based upon previous or predicted crash levels is not considered an effective method of identifying or forecasting hazards at railway crossings in this State. Nevertheless a crossing having a continuing history of train-vehicle crashes or near misses obviously demands attention. There are other factors including social and economic considerations, which can also influence the priority given to the upgrading of control.

After having established from previous sections that upgrading of control from passive control to active control or from Flashing Lights to Boom Barriers is warranted, it is often a requirement that the installation be incorporated into a funding program. In many cases there are more installations identified as meeting the warrants at any one time that budget allocations can fund. In these circumstances it is necessary to establish priorities for the works to determine which installations should be programmed ahead of others.

11.1 Methodology

The accepted method of prioritising warranted Flashing Light and Boom Barriers installations is to consider the degree to which the warrants are exceeded or the geometric requirements are deficient, as well as any other peripheral safety hazards associated with a crossing. These additional hazards can arise from the particular geometric layout of the crossing and its approaches, operational and physical aspects of the site, as well as any environmental factors, which should be taken into account. The following should be noted in respect to the prioritising crossing upgrades:

- ALCAM risk score.
- Flags generated by the ALCAM or failings in the crossings layout/control in relation to AS 1742.7.
- The exposure level of the crossings in question.
- Crossings should only be compared with the same proposed level of control i.e. a crossing to be provided with Flashing Lights should not be scored against a crossing that is proposed to be upgraded to Boom Barriers.

11.2 ALCAM Assessment Frequency

Road Managers and Rail Infrastructure Managers undertake routine inspections of their assets and notify each other of changes to usage of an Interface of which a party is aware as per their Interface Agreement. In order to have confidence in level crossing asset data, regular ALCAM assessments are required; however due to the number of crossings in Western Australia it is impractical to reassess them all on a regular basis. Level crossings in the rapidly changing metro areas should be resurveyed more frequently than level crossings in rural areas which are not as likely to change over time. Therefore, it is recommended that Level Crossings should be assessed at intervals no longer than:

- 5 years for Open lines; and
- 10 years for crossings on dormant or disused lines.

If a crossing is required to be ALCAM assessed prior to its reassessment date, due to a change in the crossing control or specific land development in the area, the proponent will pay for the reassessment.

12. Level Crossings Status

Level crossings can be closed and removed subject to agreement between the Rail Infrastructure Manager and the Road Manager, typically Main Roads WA or the Local Government.

The authority to approve the removal of or to change level crossing controls on the public road network remains the responsibility of the Executive Director Metropolitan and Southern Regions, Main Roads WA as the regulatory authority for all public crossings.

12.1 Rail Line Status

The following terms and definitions are used to determine a hierarchy of control.

Open

Train and maintenance services are being run (either regular or seasonal).

Dormant

A railway line with rail infrastructure that remains in place which under current network operations does not carry routine freight or passenger rail traffic but which does regularly carry machines, vehicles and equipment for railway maintenance and/or inspection.

Disused

A railway line with rail infrastructure that remains in place which under current network operations no rail traffic is expected but which may carry machines, vehicles and equipment for minimal railway maintenance and/or inspection.

Closed

Line is permanently out of service, with crossing related infrastructure completely removed, ideally with the tracks removed or bund installed.

Rail Infrastructure Managers may have different definitions for the status of lines on their network i.e. operational, non-operational, active, seasonal, not-in-use, inactive, discontinued, etc. Ensure definitions of status are understood when dealing with other organisations.

12.2 Cessation of Railway Operations

From time to time train movements on a particular rail line cease either permanently, or temporarily. To ensure railway crossing control devices are effective they should only be installed in situations where they are required; otherwise motorists can become complacent and may ignore them. On railway lines which will have no rail movement for the foreseeable future, consideration should be given to removing the regulatory level crossing signage and disabling active controls, and replacing them with "Railway Crossing Not In Use" (G9-74) signage. Where necessary, additional appropriate warning signs (e.g. 'hump', 'dip', 'rough surface', etc.) should be erected at the time of removing the railway crossing signs. Speed limits on the approaching road shall not be increased and any vehicle restriction must remain in place (i.e. restriction on vehicle lengths/weights, restrictions for stacking).

Permanent closure of a rail line in Western Australia requires an act of State Parliament before it can be removed from the network.

On rail lines where train movements are seasonal or temporarily suspended, consideration of alternate

method to combat complacency should be considered i.e. media campaigns alerting local people to changes in rail movements. Therefore Disused and Closed crossings that still have the railway tracks left in place, may require the Level Crossing control to be removed (Give Way and Stop Signs removed with Flash Lights deactivated). In addition W7-8 or W7-9 with "Railway Crossing Not in Use" (G9-74) signs will be installed to warn motorists of the uneven surface the railway tracks over the road cause.

12.3 New Level Crossings

Approval of additional level crossings on the public road network is by agreement between the Road Manager and Rail Infrastructure Manager. The level of control remains the responsibility of the Executive Director Road Network Services, Main Roads WA as the regulatory authority.

The introduction of new road level crossings for the purpose of residential development is not supported by State Government. The Public Transport Authority does not permit an increase in the net number of level crossings on the public rail network. Other options must be considered prior to applying for new level crossings, these may include: Grade Separation, realignment or relocation of existing rail level crossings.

Where a new road level crossing is required on a public road and all alternate options have been considered, the crossing will need to be proven to have significant benefits to the State e.g. town bypass for a new heavy vehicle route. The project will be investigated by Main Roads WA and the relevant Rail Infrastructure Managers.

It is the responsibility of the Applicant (usually a project manager from the Local Government or new rail manager applying for a new level crossing) to manage communications between all stakeholders, obtain the required approvals and arrange for ALCAM and Rail Safety Reports to be undertaken.

For the introduction of new level crossings as a result of a new rail project, the applicant (usually a project manager from the rail manager), as part of the Change Advice process, must apply to ONRSR. There are many other agencies which must be involved and the Office of National Rail Safety Regulator can provide further information on the process. It should be noted the ONRSR does not support the construction of new railway crossings and strongly encourages governments and industry to commit to a firm policy of 'no new railway crossings'. Investment in early planning to avoid the creation of railway crossings has long-term safety benefits.

When a public level crossing is first ALCAM assessed, it will be issued an ALCAM Crossing Number by Main Roads WA as a universal identifier. The ALCAM Crossing Number may be different to an organisations asset tracking number.

13. Short Stacking and Queuing Hazards

Some railway crossings are prone to vehicles stopping on the railway tracks due to factors involving short storage or stacking distances between the crossing and a nearby intersection, and/or traffic congestion which results in vehicle queues extending back over the crossing. Also, the crossing itself may contribute to queues extending back into nearby intersections.

There are hazards associated with these situations and it is necessary to identify and implement suitable treatments to eliminate or reduce this hazard.

13.1 Short Departure Stacking

Short departure stacking occurs when part of a vehicle, which is legally permitted to use the road, remains on the crossing while stopped at an intersection to give way to traffic on a priority road located beyond the crossing. These conditions typically arise at crossings on side roads where the priority road is a main route running parallel and close to the rail track. Another short departure stacking situation is where a vehicle remains on the crossing while attempting to turn right into a side road and is blocked by opposing vehicles. The normal vehicle stopping position at a priority road intersection is generally indicated by a holding line. In the absence of a hold line, the stopping position can be assessed on site from the edge of the through road. The available stacking distance is measured 3 m from the nearest rail to where a vehicle is expected to stop. This is taken as either 2 m from the edge of the through road or 1 m from the hold line, whichever results in the shortest stacking distance.

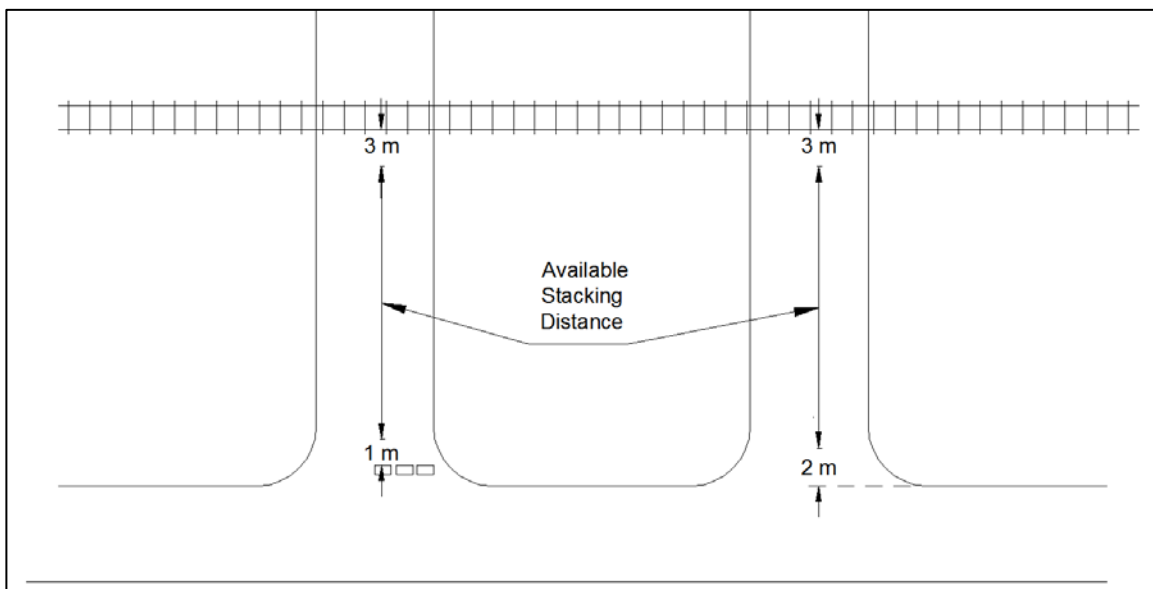


Figure 3 – Available Stacking Distance

The longest 'as-of-right' vehicle legally allowed to use the road, L, is 19 metres, which provides for a semi-trailer. Generally on major routes and in many rural areas, vehicles exceeding this length are permitted.

Main Roads WA's Heavy Vehicle Services should be consulted for up-to-date information on the maximum vehicle length that applies to a particular crossing. The Heavy Vehicle Services page on the Main Roads WA website: <https://www.mainroads.wa.gov.au> for more information.

13.2 Short Approach Stacking

Short approach stacking occurs when a vehicle, which is legally permitted to use the road, is unable to fully clear a priority road of an intersection when stopping at an adjacent railway crossing.

Short approach stacking is also evident when the length of queued vehicles forming at a railway crossing regularly extends back into an adjacent intersection. As well as obstructing traffic flows, these situations pose potential hazards for vehicles at the intersection. On the approach to the crossing, the stopping position is normally indicated by a holding line or in the absence of a line, assumed to be 3.5 metres back from the nearest rail.

13.3 Possible Treatments for Short Stacking

A range of possible treatments for short stacking at railway crossings is shown in Appendix C, which is intended to be used as a checklist to identify possible treatments to a particular crossing with a short stacking problem. These treatments should not be considered exhaustive and there may be other solutions that are not shown here. In many situations, a combination of treatments may be applicable.

The preferred treatment cannot always be implemented immediately due to timing, financial and other constraints. In these cases, an interim treatment should be considered as a first stage to reduce the risk of a collision occurring at the crossing.

13.4 Queuing Hazards

Railway crossings which are regularly subject to traffic congestion have the potential for vehicles to be stationary on the tracks.

The *Road Traffic Code 2000* makes it an offence to enter a railway crossing if the vehicle cannot be immediately driven clear of the crossing. Observations show that in many instances vehicles stopping on the track during traffic congestion may not be occurring deliberately but rather is caused by the driver's inability to anticipate the forming of a queue ahead.

Particularly at multi-track or skew angle crossings, this problem is compounded by drivers being unable to accurately perceive the extent or limits of the crossing zone beyond the tracks.

To alleviate these conditions, an appropriate minimum delineation of the crossing zone in which vehicles should not enter unless they can proceed immediately to the other side of the crossing is required. This delineation is achieved by the installation of yellow cross hatch markings within the area of the crossing zone, supplemented with 'KEEP CLEAR' signs installed on the approach and departure limits of the zone. Reference should also be made to Main Roads WA Drawings 9731-1096-1 and 9731-2493 for the standard signing and road marking design details. It is clear that the markings and signs alone will not eliminate the problem and that continuing education and enforcement programs will be required to ensure the effectiveness of these measures.

14. Pedestrian Crossings

At level crossings where facilities are to be provided for pedestrians to cross the tracks, an appropriate treatment selected from the hierarchy of controls set out below is required. The treatment shall provide for all pedestrians including cyclists, people with disabilities, including ambulant, vision and hearing impairment. There are six levels of control used in normal circumstances for pedestrians at railway crossings in this State. In ascending order, they are:

- Passively Signed Crossing.
- Pedestrian Maze Crossing.
- Adjacent Active Control.
- Actively Signed Crossing (with or without maze).
- Gated Maze Crossing.
- Grade Separation (Underpass or Overpass).

In making an assessment as to an appropriate level of control for any particular railway crossing, the basic philosophy is to provide an adequate level of safety with the minimum amount of disruption to pedestrian movements and at the lowest cost.

Note: Warrants for the installation and level of control for pedestrian crossings that are remote to level crossings (i.e. at a midblock pedestrian crossing) are determined by the rail and adjacent land owners. It is recommended that devices should be installed in accordance with AS 1742.7 as a minimum and this section can be taken as a guide.

Note: Pedestrian and train volumes shall be calculated based on yearly averages and should be seasonally adjusted.

14.1 Sight Distance

At pedestrian railway crossings the required minimum sight distance (SD) in metres for a person to see an oncoming train shall be calculated as follows:

$$SD = \frac{V_t}{3.6} * \left(\frac{d}{V_p} + MS \right)$$

V_t is the maximum speed of trains in km/h.

d is the pedestrian crossing distance in metres measured between pedestrian holding lines/locations if they exist, or 1.5 m from the outside edge of rail on each side. At crossings with train speeds greater than 80 km/h the total distance shall be extended by 1 m.

V_p is the pedestrian walking speed, usually taken to be 1.0 m/s. On crossings where there is likely to be significant use by high risk pedestrians (people with ambulant disabilities, using perambulators, school aged children or the elderly) the walking speed shall be reduced to 0.8 m/s.

MS is a margin of safety of 2, as a minimum. It is required to increase the margin of safety, where the pedestrian crossing is narrow, uneven, on a grade or where 'platoons' of pedestrians are present.

14.2 Warrants

Safety requirements of pedestrian movements will have to be assessed at each site individually. There are many design and geographical issues with retrofitting new pedestrian crossings at existing level crossings. While pedestrian control requirements are listed below, they are not all inclusive, as other factors may affect the appropriate level of control required. Typical arrangements are included in AS 1742.7.

Level 1 – Passively Signed Crossings

Is a formalised path with signs as per AS 1742.7 it is generally the simplest and cheapest option, passively signed crossings are considered to provide the lowest level of protection. Level 1 is only recommended where the location meets sight distance requirements, is a single track line and all of the following conditions apply:

- Low pedestrian volumes (less than 50 pedestrians per day),
- Low train volumes (less than 30 trains per week), and
- Low train speeds (less than 80km/h).

At Level 1 pedestrian crossings adjacent to a kerbed road vehicular crossings the general arrangement is to provide additional width on the roadway to include a path within the shoulder, with a clear width of 1200 mm, defined by tactile ground surface indicators (TGSI) and pedestrian holding markings, and install “Look For Train” signs (W7-14-5). Unkerbed road approaches require a path to be positioned at a minimum of 2500mm from the road edge as per AS 1742.7

Level 2 – Pedestrian Maze Crossing

Is a formalised path which includes pedestrian mazes on both approaches to the crossing. The general arrangement requires a defined footway with an enclosed maze which shall be designed so that pedestrians are forced to make at least one 180 degree turn when walking through the maze. This results in the pedestrian looking alternatively in the up and down direction of the railway line increasing likelihood of sighting oncoming trains that may approach the level crossing from either direction. Pedestrian maze crossings are recommended where the location meets sight distance requirements is a single track line and any of the following conditions are not exceeded:

- Moderate pedestrian volumes (between 50 and 100 pedestrians per day),
- Moderate train volumes (between 30 and 50 trains per week), or
- High train speeds (greater than 80km/h).

See AS 1742.7 for general maze layouts and dimensions. The width shall be sufficient to allow wheel chairs and mobility scooters (gophers) sufficient room to negotiate through the maze. The treatment also includes the provision of “Look For Trains” signs (W7-14-5).

Level 3 – Adjacent Active Control

Where the site distance requirements are not met, passively protected crossings with or without mazes (as detailed above) which are adjacent to vehicular roads which have active controls are considered to have a higher level of protection in the following circumstances:

- Where audible warning from the adjacent crossing sounds continuously during the approach of an oncoming train and until such time as the train has passed and is no longer a collision threat; and

- Where the flashing lights from the vehicle crossing are visible to approaching pedestrians and can provide warning of the need to wait until the train has cleared before commencing crossing.

Signage requirement for pedestrian crossing (with or without mazes) with active control for vehicular traffic only are outlined in AS 1742.7

Level 4 – Actively Signed Crossing

Actively signed crossings provide additional control to crossings with poor sight distance. Actively signed crossings are recommended where the following conditions apply:

- Insufficient sight distance (refer to Section 14.1),
- Two or more operational tracks,
- Moderate to high pedestrian volumes (50 or more pedestrians per day), and
- Moderate to high train volumes (30 or more trains per week).

The general arrangement requires a defined footway with a clear width of 1800 mm. A control point including a hold line, TGSI, a red symbolic standing pedestrian signal assembly (RX-12), associated alarms or bells and “Do Not Cross While Lights Are Displaying or Alarm Sounding” signs (W7-14-6). Refer to AS 1742.7 for general arrangements.

Level 5 – Gated Maze Crossing

Gated maze crossings are considered the highest level of at-grade protection and are typically the most expensive at-grade crossing to install. Gated maze crossings are recommended where any of the following conditions apply:

- High pedestrian volumes (100 or more pedestrians per day),
- High train volumes (50 or more trains per week), or
- Volume factor greater than 500 ($N_p \times N_t > 500$).

Note: where N_p is the number of people per day and N_t is the number of trains per day.

The general arrangement requires a defined footway with an enclosed maze as required in Level 2; and the installation of a pedestrian gate that is remotely controlled and lockable (activated by the presence of an approaching train). The treatment also includes the provision of red symbolic standing pedestrian signal assembly (RX-12), associated alarms or bells, and “Do Not Cross While Lights Are Displaying or Alarm Sounding” signs (W7-14-6).

Level 6 – Grade Separation

Grade separation is considered the ultimate pedestrian treatment. If appropriately designed it removes all conflict between pedestrians and trains. Additionally pedestrian delays as a result of train movements are eliminated. Therefore the following should be included in assessment for grade separation:

- Total closure times for a pedestrian level crossing, and
- How motivated pedestrians are to disobey level crossing control (e.g. proximity to train station).

While all grade separation treatments must be individually designed and assessed, the following should be considered for pedestrian grade separation:

- Protection of people and property from objects or material falling, suspended or thrown from one level to another;

- Protection from contact with live electrical equipment;
- Perceived safety of pedestrians (due to crime) using the crossing (particularly for underpasses); and
- Additional lighting requirements.

14.3 Other Safety Considerations

In addition to the levels of pedestrian control, some safety items should be considered:

- Location may meet sight distance requirements as a single track line; however a siding or additional track may be located within the required length of sighting distance. Where this occurs active control should be considered to acknowledge that a train on one line may mask another train approaching on the other line.
- Rationalisation of pedestrian crossings should be carried out where multiple crossings are located in close succession.
- Corral fencing along the edge of the approach footways or along the rail reserve shall be provided to guide pedestrians to the designated pedestrian crossing where it is likely that pedestrians will short-cut the crossing.
- One or more active warning devices shall be provided at a pedestrian crossing location where pedestrians would not have time to cross the tracks safely before the arrival of a previously unseen train.
- A sign should be installed to indicate an alternate crossing option when the crossing has a history of being temporarily blocked by shunting operations.
- In areas subject to large amounts of visual and audible distraction, this may include pedestrians using mobile devices, a physical barrier may be required to direct the attention away from the distraction and promote observation of the rail tracks.

Appendix A – Definition of Notation and Terms

Acronyms

AADT	Annual average daily vehicle traffic
AAWA	Active Advance Warning Assembly
ALCAM	Australian Level Crossing Assessment Model
BCR	Benefit cost ratio
C_w	Weighted conflict
C_{wb}	Weighted conflict for Boom Barriers
C_{wgr}	Weighted conflict for Grade Separations
CCTV	Closed Circuit Television
D	Deceleration rate
d	Pedestrian crossing distance in metres
D_v	Vehicle delay factor
G	The approach grade of the road to a level crossing
H_v	Heavy vehicle factor
L	Length of the longest vehicle, legally allowed to use the road
L_{tl}	Length of the longest train
L_q	Length of vehicle queue formed on the approach to a level crossing
L_s	The length of vehicle stacking distance between the rail and an adjacent priority road.
M	The average annual maintenance cost
MS	Margin of Safety
N_p	The average number of pedestrians a day
N_t	The average number of trains per week
P_v	Percentage of heavy vehicles
PTA	Public Transport Authority of Western Australia
R_t	Reaction time of a driver
S	The distance from the crossing the warning signs are located in advance of the holding line
S_1	The minimum distance from the crossing, measured along the road, at which a motorist needs to be able to see the crossing controls

S_2	The minimum distance from the crossing, measured along the rail, at which a motorist needs to be able to see an approaching train from the S_1 position
S_3	The minimum distance from the crossing, measured along the rail, at which a motorist needs to be able to see an approaching train
S_{vf}	The minimum distance from the crossing, measured along the road, at which a motorist needs to be able to see an activated set of Flashing Lights
SD	Sight Distance
SL	Service life
SMP	Safety Management Plan
SSD	Stopping Sight Distance
T	Length of time in seconds
TGSI	Tactile Ground Surface Indicators
TMP	Traffic Management Plan
V_p	The average walking speed of a pedestrian
V_t	The maximum train speed
V_{tl}	The maximum speed of the longest train
V_v	The 85 th percentile speed of vehicles approaching a railway crossing

Definitions

For the purpose of this document, the definitions below apply.


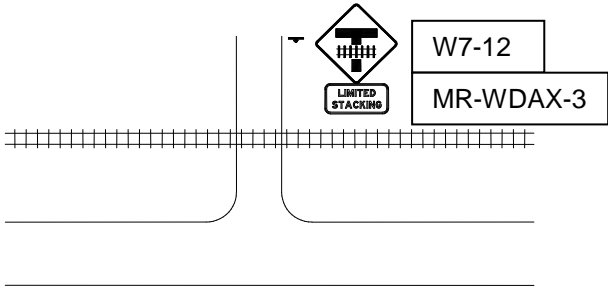
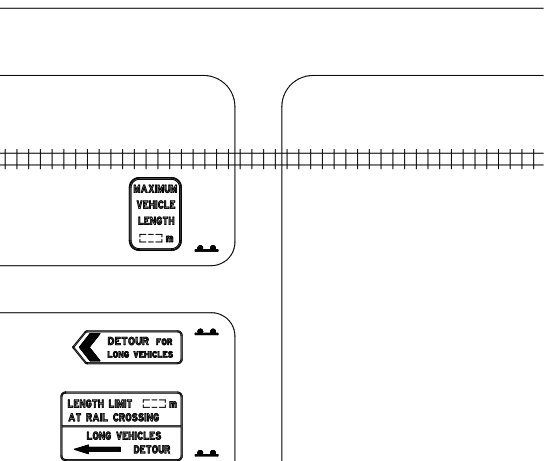
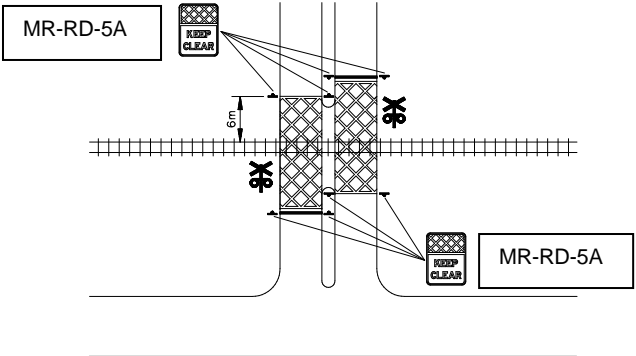
Act	<i>Rail Safety National Law (WA) Act 2015</i> (as amended from time to time).
At Grade	A crossing where a road or footpath crosses a rail line at the same level.
Carriageway	The trafficable surface of a road, ordinarily used for vehicular traffic.
Corrective Action Report	A report or similar that details specific actions designed to reinstate or maintain safety at a crossing and which identifies the entity responsible for the actions.
Danger Zone	The area encompassing the rail lines and extending 3 metres horizontally either side from the outer rails, including any distance above or below this area.
Footpath	An area that is open to the public that is designated for, or has as one of its main uses, use by pedestrians. This includes, but is not limited to, a shared path, dual use path and bicycle path.
Incident	An occurrence at or affecting an Interface, which has the potential to adversely impact or has resulted in an adverse impact to the safety of persons or infrastructure or Road or train operations.
Interface	The location where a rail line intersects or interacts with a road or footpath and includes level crossings, pedestrian crossings and mid-block crossings.
Level Crossing	An area where a road and a railway meet at substantially the same level, whether or not there is a “level crossing” sign on the road at all or any of the entrances to the area.
Mid-block Crossing	An area where a footpath crosses a railway not adjacent to a level crossing that includes a carriageway.
Operational Responsibilities	A party’s responsibilities for undertaking physical works (whether on behalf of another party or not) and is the authority responsible for that relative asset. Note: operational responsibility is not associated with cost liability.
Pedestrian Crossing	An area where a footpath crosses a railway adjacent to a level crossing that includes a carriageway.
Public Road	A road owned by a Local or State road authority.
Rail Infrastructure Manager	An organisation responsible for managing the safe operation of a railway. This is often separate to the rail owner.
Road	Any highway, road or street open to, or used by, the public and includes every carriageway, footway, reservation, median strip and traffic island thereon.
Road Manager	Is an organisation responsible for managing and maintaining a roadway. This is usually Main Roads WA or a Local Government.
Safety Management Plan	Is a document required for works which may impact on the safe operation of the railway.

Appendix B – Estimation of Vehicle Queue Lengths at Railway Crossings

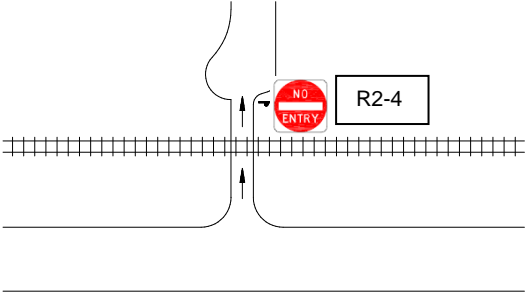
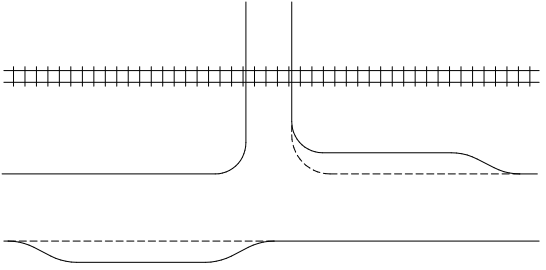
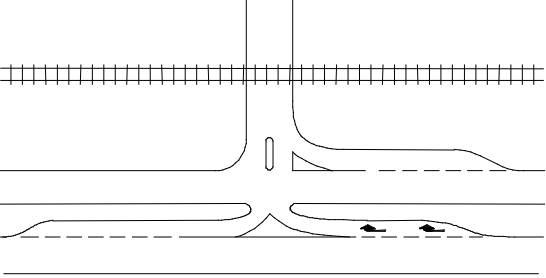
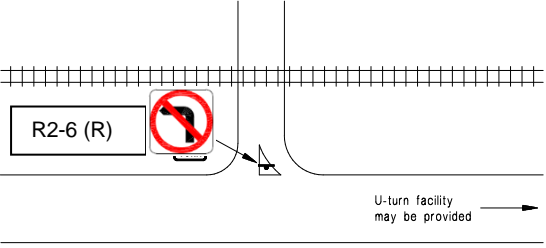
Annual Average Daily Traffic (AADT)	Crossing Closure Times (Minutes)									
	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
0 – 2 000	7	14	21	28	35	42	49	56	63	70
2 001 – 4 000	14	28	42	56	70	84	98	113	127	141
4 001 – 6 000	21	42	63	84	106	127	148	169	190	211
6 001 – 8 000	28	56	84	113	141	169	197	225	253	281
8 001 – 10 000	35	70	106	141	176	211	246	281		
10 001 – 12 000	42	84	127	169	211	253	295			
12 001 – 14 000	49	98	148	197	246	295				
14 001 – 16 000	56	113	169	225	281					
16 001 – 18 000	63	127	190	253						
18 001 – 20 000	70	141	211	281						

To Note: Values based upon random arrivals on a single lane approach to a typical crossing. A 7% heavy vehicle composition has been assumed.

Appendix C – Short Stacking Treatments

Short Term Solutions	
<p>1.1 Advisory Signs</p> 	
<p>1.2 Regulatory Signs</p>	
<p>1.3 KEEP CLEAR Signs and Yellow Cross Hatching</p> <p>Refer to Main Roads WA standard drawing 9731-2493</p>	

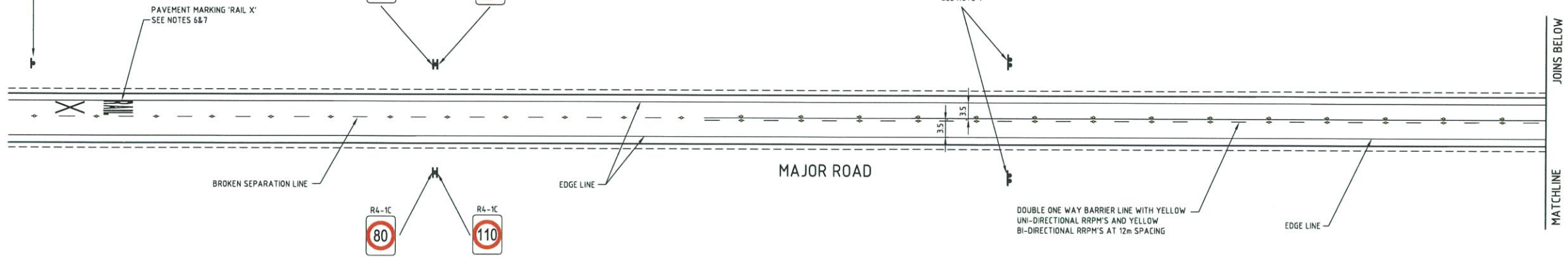
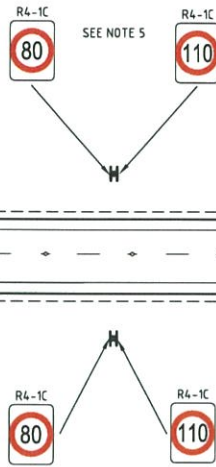
Medium Term Solutions	
<p>2.1 Change Road Priority</p>	
<p>2.2 Traffic Signals</p> <p>Note: For very short stacking distances, the stop line and signal display on the departure side of the crossing may be relocated to the approach side of the crossing.</p>	
<p>2.3 Signal Facing Driver Entering Intersection</p>	
<p>2.4 Flashing Lights Beside Through Road</p>	

<p>2.5 Partial Closure</p>	
<p>2.6 Escape Facilities</p>	
<p>2.7 Acceleration Lanes</p>	
<p>2.8 Right Turn Prohibition</p>	

Long Term Solutions	
<p>3.1 Realign Road away from Railway</p>	
<p>3.2 Grade Separation</p>	
<p>3.3 Realign Railway Away From Road</p>	

Note: This is not intended to be an all-inclusive list of solutions and individual locations will require further assessment before installation.

Appendix D – Standard Drawings

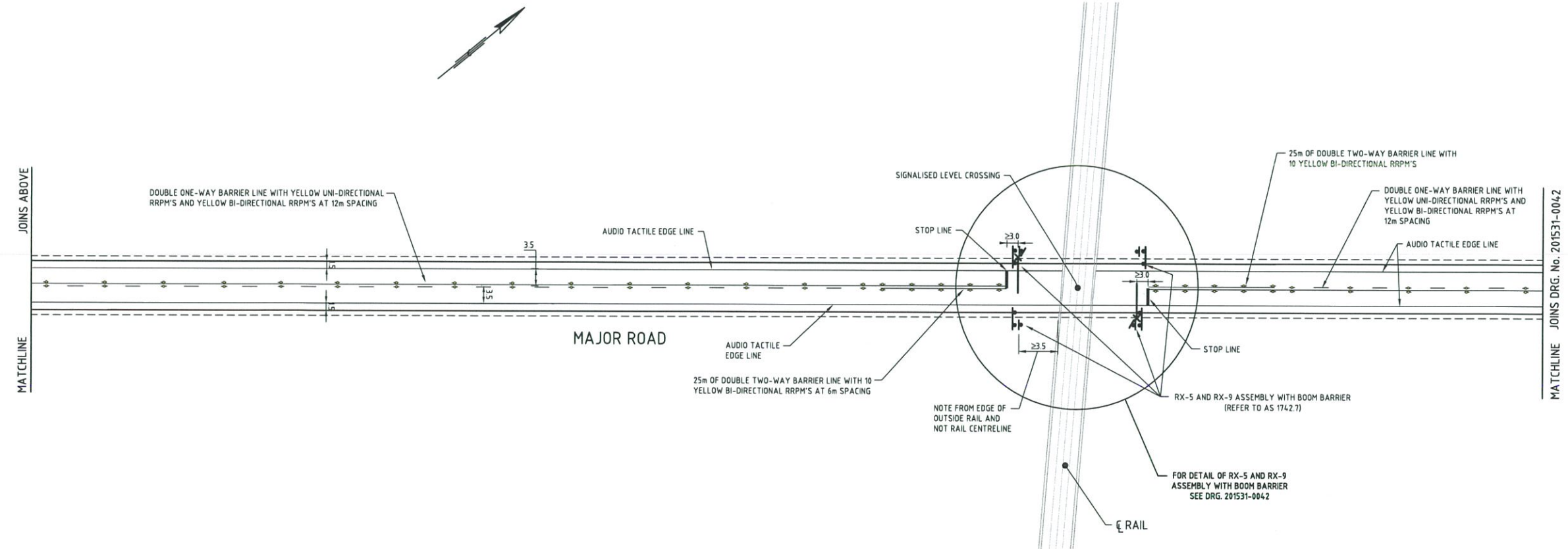


AMENDMENTS		
No.	DESCRIPTION	APPROVED & DATE
1	PAVEMENT MARKING 'RAIL X' RELOCATED, NOTE 7 ADDED.	<i>[Signature]</i> 21/6/16

- NOTES**
- THIS DRAWING TO BE READ IN CONJUNCTION WITH MAIN ROADS WA SPECIFICATIONS.
 - PAVEMENT MARKING AND SIGNING TO BE IN ACCORDANCE WITH A.S. 1742.7 AND MAIN ROADS WA STANDARD DRAWINGS.
 - AUDIO TACTILE RUMBLE STRIPS MAY BE INSTALLED ON AREAS PRONE TO DRIVER FATIGUE OR WHERE A RAIL CROSSING IS NOT EXPECTED. REFER MAIN ROADS DRAWING 201531-0039.
 - AAWA LOCATION AND TIMINGS SHALL BE IN ACCORDANCE WITH A.S. 1742.7. THE LOCATION MUST CONSIDER THE STOPPING SITE DISTANCE REQUIRED FOR MAXIMUM VEHICLE TYPES.
 - THE 80 km/h SPEED ZONE IS TYPICALLY 300-400m PRIOR TO THE RAIL CROSSING. REFER TO MAIN ROADS "POLICY AND APPLICATION GUIDELINES FOR SPEED ZONING".
 - 'X RAIL' PAVEMENT MARKING SHALL BE INSTALLED AS PER A.S. 1742.7. 'X RAIL' USES THE LETTER HEIGHTS OF 3m FOR 'X' AND 2.5m FOR 'RAIL'. UNDER SPECIAL CIRCUMSTANCES THE LARGER 'X RAIL' MARKING MAY BE USED.
 - 'RAIL X' MARKING MAY BE INSTALLED ADJACENT TO AAWA WHERE ADDITIONAL REINFORCEMENT IS REQUIRED.

LEGEND

---	REFERENCE LINE
====	KERB TYPE SM-2140
----	NEW SEALED SHOULDER
----	NEW EDGE LINE
----	NEW EDGE LINE WITH AUDIO-TACTILE
====	NEW DOUBLE TWO WAY BARRIER LINE
====	NEW DOUBLE ONE WAY BARRIER LINE
----	NEW BROKEN LANE LINE
----	NEW CONTINUITY LINE
▲	NEW ONE POST SIGN
▲▲	NEW TWO POST SIGN
◊	NEW WHITE UNIDIRECTIONAL RRP
◆	NEW YELLOW BIDIRECTIONAL RRP
◄	NEW YELLOW UNIDIRECTIONAL RRP
■	PROPOSED GUIDE POSTS
----	EXISTING SEALED SHOULDER
----	EXISTING DRIVEWAY
▲	EXISTING ONE POST SIGN
▲▲	EXISTING TWO POST SIGN
X	BOOM GATE ASSEMBLIES



mainroads
WESTERN AUSTRALIA

PLANNING AND TECHNICAL SERVICES DIRECTORATE
ROAD AND TRAFFIC ENGINEERING BRANCH

WATERLOO CRESCENT EAST PERTH 6004
Telephone (08) 9323 4111 Fax (08) 9323 4430

FILE NUMBER	
DESIGNED / DRAWN	J.VOKE 13.5.15
VERIFIED	R.KOORENGEVEL 12.2.16
APPROVED	D.LANDMARK 12.2.16

GUIDELINE DRAWING

RAILWAY CROSSING
PAVEMENT MARKING & SIGNING
SHEET 1 OF 2

LOCAL AUTHORITY
MRWA DRAWING NUMBER
201531-0041-1

75
70
65
60
55
50
45
40
35
30
25
20
15
10
5m
0

SCALE 1:500

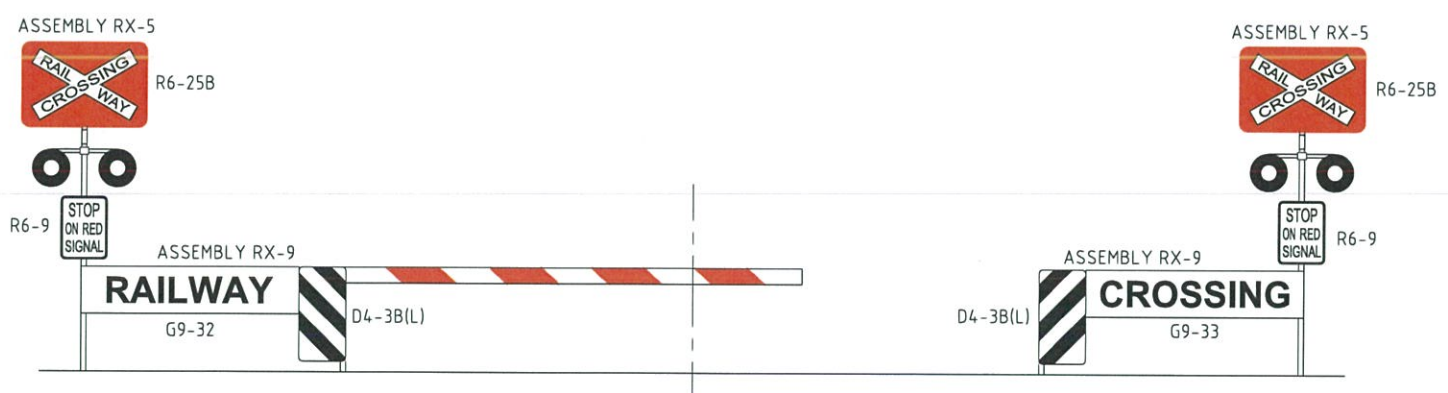
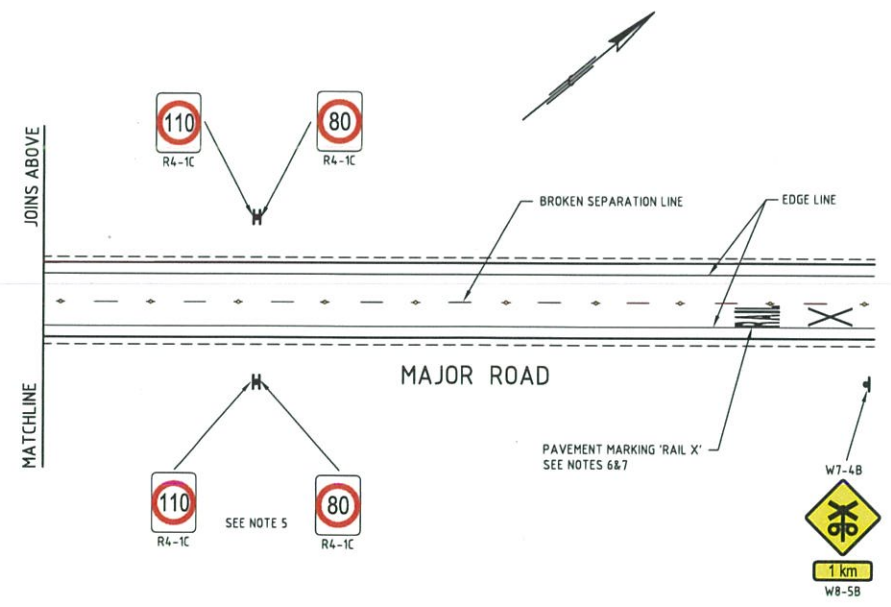
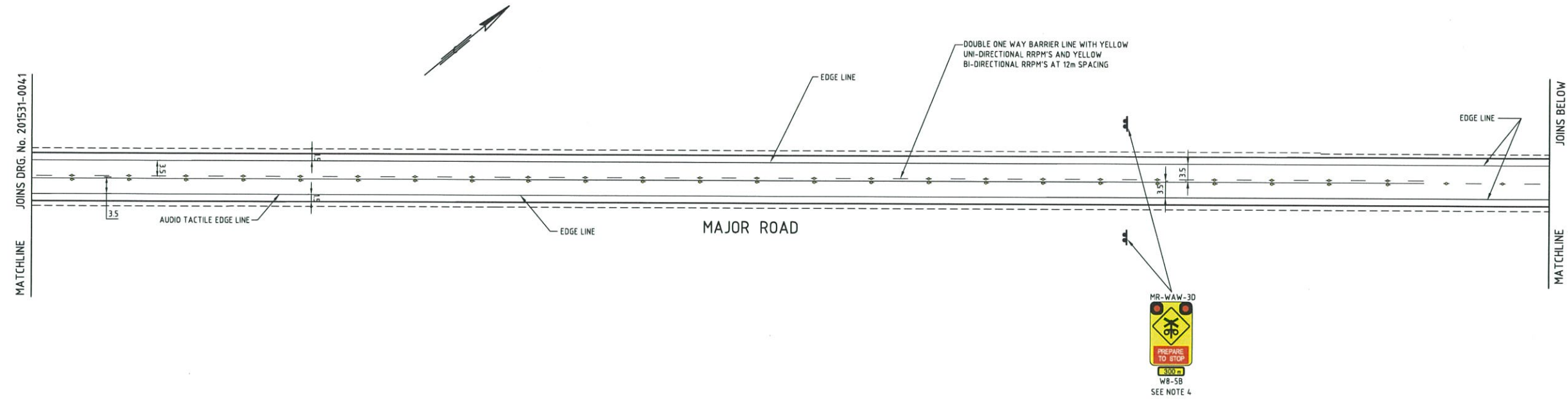
A
1

AMENDMENTS		
No.	DESCRIPTION	APPROVED & DATE
1	PAVEMENT MARKING 'RAIL X' RELOCATED, NOTE 7 ADDED.	<i>Rhodes</i> 2/14/16

- NOTES**
- THIS DRAWING TO BE READ IN CONJUNCTION WITH MAIN ROADS WA SPECIFICATIONS.
 - PAVEMENT MARKING AND SIGNING TO BE IN ACCORDANCE WITH A.S. 1742.7 AND MAIN ROADS WA STANDARD DRAWINGS.
 - AUDIO TACTILE RUMBLE STRIPS MAY BE INSTALLED ON AREAS PRONE TO DRIVER FATIGUE OR WHERE A RAIL CROSSING IS NOT EXPECTED. REFER MAIN ROADS DRAWING 201531-0039.
 - AAWA LOCATION AND TIMINGS SHALL BE IN ACCORDANCE WITH A.S. 1742.7. THE LOCATION MUST CONSIDER THE STOPPING SITE DISTANCE REQUIRED FOR MAXIMUM VEHICLE TYPES.
 - THE 80 km/h SPEED ZONE IS TYPICALLY 300-400m PRIOR TO THE RAIL CROSSING. REFER TO MAIN ROADS "POLICY AND APPLICATION GUIDELINES FOR SPEED ZONING".
 - 'X RAIL' PAVEMENT MARKING SHALL BE INSTALLED AS PER A.S. 1742.7. 'X RAIL' USES THE LETTER HEIGHTS OF 3m FOR 'X' AND 2.5m FOR 'RAIL'. UNDER SPECIAL CIRCUMSTANCES THE LARGER 'X RAIL' MARKING MAY BE USED.
 - 'RAIL X' MARKING MAY BE INSTALLED ADJACENT TO AAWA WHERE ADDITIONAL REINFORCEMENT IS REQUIRED.

LEGEND

---	REFERENCE LINE
=====	KERB TYPE SM-2(40)
----	NEW SEALED SHOULDER
----	NEW EDGE LINE
----	NEW EDGE LINE WITH AUDIO-TACTILE
----	NEW DOUBLE TWO WAY BARRIER LINE
----	NEW DOUBLE ONE WAY BARRIER LINE
----	NEW BROKEN LANE LINE
----	NEW CONTINUITY LINE
▲	NEW ONE POST SIGN
▲▲	NEW TWO POST SIGN
◊	NEW WHITE UNIDIRECTIONAL RRPM
◊	NEW YELLOW BIDIRECTIONAL RRPM
◊	NEW YELLOW UNIDIRECTIONAL RRPM
■	PROPOSED GUIDE POSTS
----	EXISTING SEALED SHOULDER
----	EXISTING DRIVEWAY
▲	EXISTING ONE POST SIGN
▲▲	EXISTING TWO POST SIGN
X	BOOM GATE ASSEMBLIES



DETAIL OF RX-5 AND RX-9 ASSEMBLY WITH BOOM BARRIER

mainroads
WESTERN AUSTRALIA

PLANNING AND TECHNICAL SERVICES DIRECTORATE
ROAD AND TRAFFIC ENGINEERING BRANCH

WATERLOO CRESCENT EAST PERTH 6004
Telephone (08) 9323 4111 Fax (08) 9323 4430

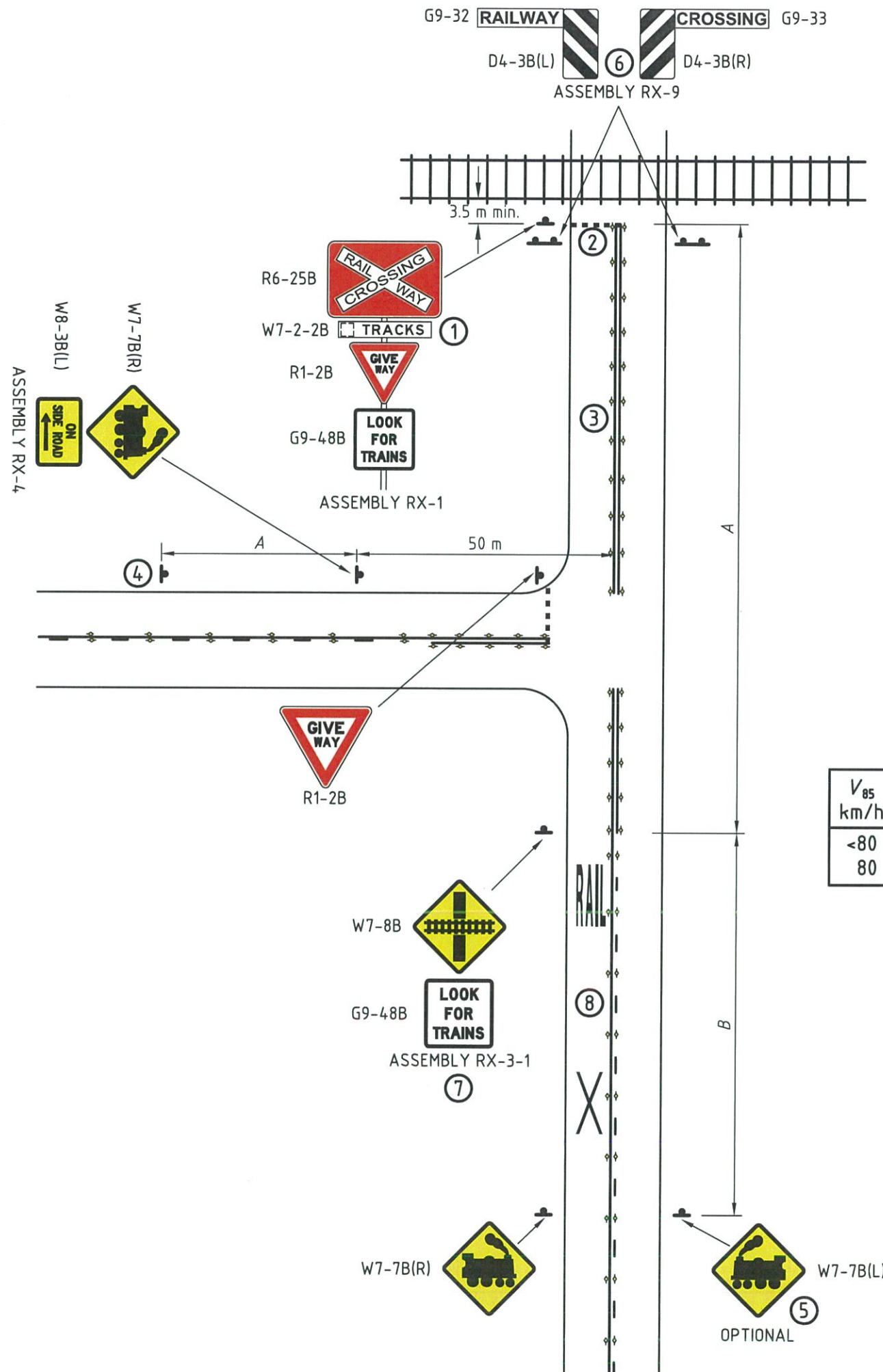
FILE NUMBER	
DESIGNED / DRAWN	J.VOKE 13.5.15
VERIFIED	R.KOORENGVEL 12.2.16
APPROVED	D.LANDMARK 12.2.16

GUIDELINE DRAWING

RAILWAY CROSSING
PAVEMENT MARKING & SIGNING
SHEET 2 OF 2

LOCAL AUTHORITY
MRWA DRAWING NUMBER
201531-0042-1





AMENDMENTS		
No.	DESCRIPTION	APPROVED & DATE

- NOTES**
- IF MORE THAN ONE TRACK, THE TRACKS SIGN, W7-2-2B, IS ADDED TO THE ASSEMBLY.
 - GIVE WAY LINES ARE REQUIRED ON SEALED ROADS AT CROSSINGS CONTROLLED BY GIVE WAY SIGNS.
 - THE DOUBLE TWO WAY BARRIER LINE EXTENDS FROM THE CROSSING TO THE INTERSECTION.
 - IF THE INTERSECTION ITSELF REQUIRES AN INTERSECTION WARNING SIGN IN ACCORDANCE WITH AS 1742.2 IT WILL BE PLACED AT THIS POSITION. THE CROSSING ON SIDE ROAD DIAGRAMMATIC SIGN IS REQUIRED ONLY IF THE INTERSECTION ITSELF REQUIRES AN INTERSECTION WARNING SIGN IN ACCORDANCE WITH AS 1742.2.
 - THE RIGHT-HAND SIDE SIGN, W7-7B(L), IS FOR OPTIONAL USE ON HIGH VOLUME ROADS OR A CURVE ON THE APPROACH TO THE LEVEL CROSSING.
 - RX-9 ASSEMBLY MAY BE REQUIRED AT NARROW CROSSINGS.
 - ALTERNATIVE RAIL CROSSING AHEAD ROAD APPROACH SIGNS MAY BE INSTALLED, EG: W7-9B(L) OR W7-17B(L).
 - 'X RAIL' PAVEMENT MARKING SHALL BE INSTALLED AS PER A.S. 1742.7. 'X RAIL' USES THE LETTER HEIGHTS OF 3m FOR 'X' AND 2.5m FOR 'RAIL'.

PLANNING AND TECHNICAL SERVICES
 ROAD AND TRAFFIC ENGINEERING
 WATERLOO CRESCENT EAST PERTH WA 6004
 Telephone (08) 9323 4111 Fax (08) 9323 4449

FILE NUMBER 67-08-4F

DESIGNED / DRAWN J. VOKE 21/12/16

VERIFIED *[Signature]* 20/1/17

APPROVED *[Signature]* 7/2/17

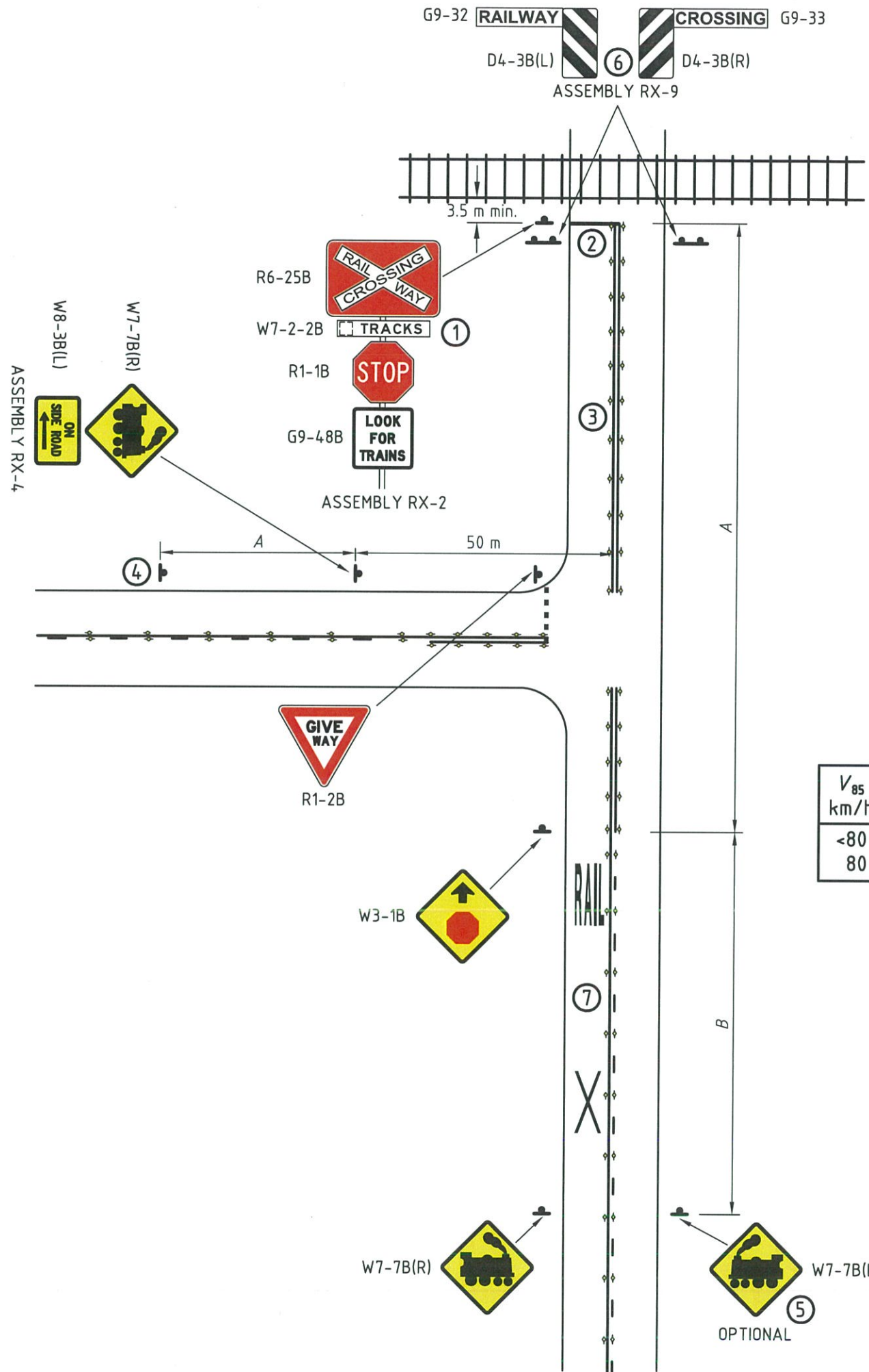
GUIDELINE DRAWING

**RURAL RAILWAY CROSSING
PAVEMENT MARKING AND SIGNING
GIVE WAY CONTROL**

LOCAL AUTHORITY
DRAWING NUMBER AMEND.

201631-0091

SCALE
MICROFILM DATE
A3



AMENDMENTS

No.	DESCRIPTION	APPROVED & DATE

NOTES

1. IF MORE THAN ONE TRACK, THE TRACKS SIGN, W7-2-2B, IS ADDED TO THE ASSEMBLY.
2. STOP LINES ARE REQUIRED ON SEALED ROADS AT CROSSINGS CONTROLLED BY STOP SIGNS.
3. THE DOUBLE TWO WAY BARRIER LINE EXTENDS FROM THE CROSSING TO THE INTERSECTION.
4. IF THE INTERSECTION ITSELF REQUIRES AN INTERSECTION WARNING SIGN IN ACCORDANCE WITH AS 1742.2 IT WILL BE PLACED AT THIS POSITION. THE CROSSING ON SIDE ROAD DIAGMMATIC SIGN IS REQUIRED ONLY IF THE INTERSECTION ITSELF REQUIRES AN INTERSECTION WARNING SIGN IN ACCORDANCE WITH AS 1742.2.
5. THE RIGHT-HAND SIDE SIGN, W7-7B(L), IS FOR OPTIONAL USE ON HIGH VOLUME ROADS OR A CURVE ON THE APPROACH TO THE LEVEL CROSSING.
6. RX-9 ASSEMBLY MAY BE REQUIRED AT NARROW CROSSINGS.
7. 'X RAIL' PAVEMENT MARKING SHALL BE INSTALLED AS PER A.S. 1742.7. 'X RAIL' USES THE LETTER HEIGHTS OF 3m FOR 'X' AND 2.5m FOR 'RAIL'.

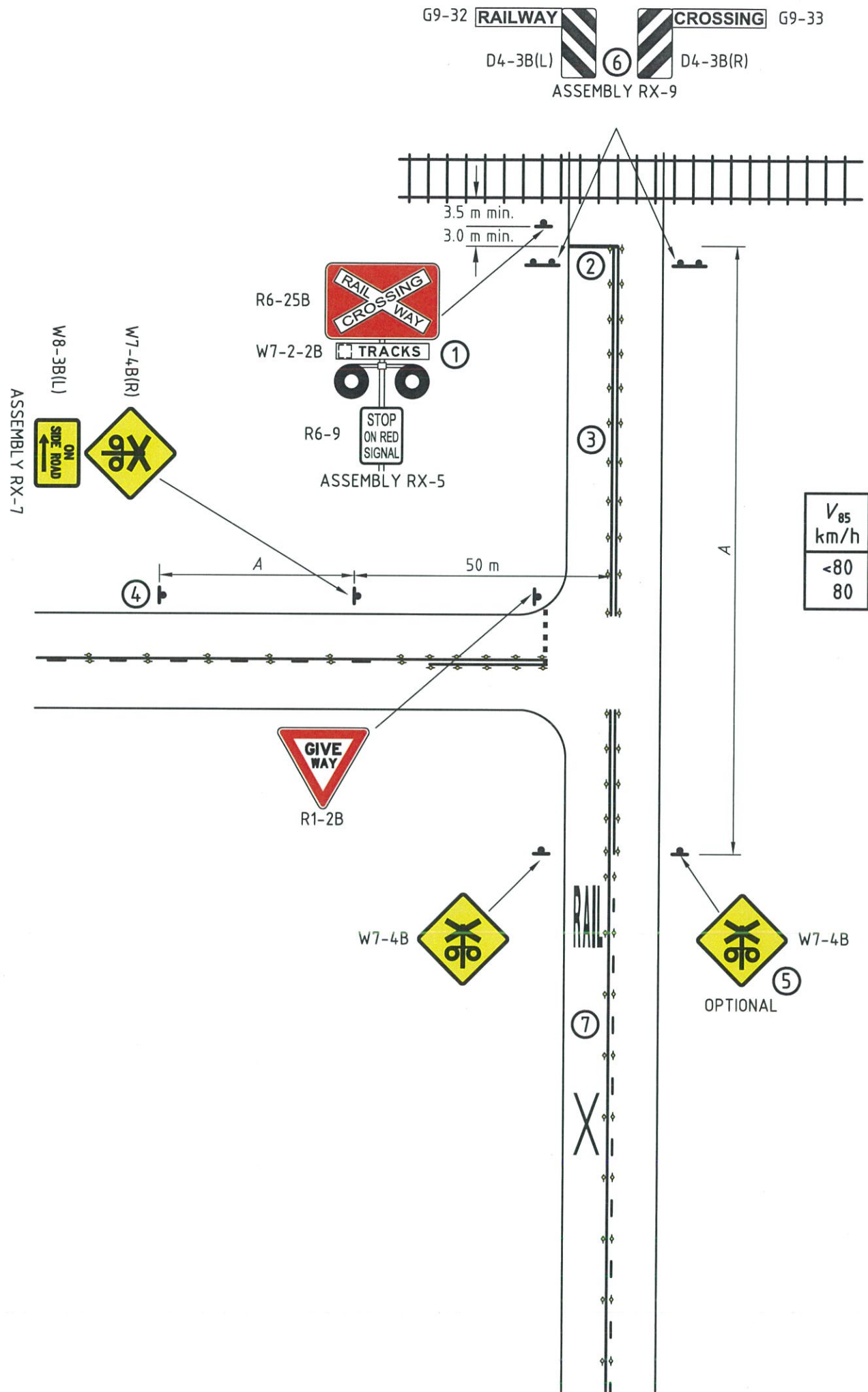
PLANNING AND TECHNICAL SERVICES
 ROAD AND TRAFFIC ENGINEERING
 WATERLOO CRESCENT EAST PERTH WA 6004
 Telephone (08) 9323 4111 Fax (08) 9323 4449

FILE NUMBER 67-08-4F
 DESIGNED / DRAWN J. VOKE 21/12/16
 VERIFIED *[Signature]* 20/1/17
 APPROVED *[Signature]* 9/2/17

GUIDELINE DRAWING
 RURAL RAILWAY CROSSING
 PAVEMENT MARKING AND SIGNING
 STOP CONTROL

LOCAL AUTHORITY
 DRAWING NUMBER 201631-0092 AMEND.

SCALE A3



AMENDMENTS		
No.	DESCRIPTION	APPROVED & DATE

- NOTES**
- IF MORE THAN ONE TRACK, THE TRACKS SIGN, W7-2-2B, IS ADDED TO THE ASSEMBLY.
 - STOP LINES ARE REQUIRED ON SEALED ROADS AT CROSSINGS CONTROLLED BY FLASHING LIGHTS.
 - THE DOUBLE TWO WAY BARRIER LINE EXTENDS FROM THE CROSSING TO THE INTERSECTION.
 - IF THE INTERSECTION ITSELF REQUIRES AN INTERSECTION WARNING SIGN IN ACCORDANCE WITH AS 1742.2 IT WILL BE PLACED AT THIS POSITION. THE CROSSING ON SIDE ROAD DIAGRAMMATIC SIGN IS REQUIRED ONLY IF THE INTERSECTION ITSELF REQUIRES AN INTERSECTION WARNING SIGN IN ACCORDANCE WITH AS 1742.2.
 - THE RIGHT-HAND SIDE SIGN, W7-4B, IS FOR OPTIONAL USE ON HIGH VOLUME ROADS OR A CURVE ON THE APPROACH TO THE LEVEL CROSSING.
 - RX-9 ASSEMBLY MAY BE REQUIRED AT NARROW CROSSINGS.
 - 'X RAIL' PAVEMENT MARKING SHALL BE INSTALLED AS PER A.S. 1742.7. 'X RAIL' USES THE LETTER HEIGHTS OF 3m FOR 'X' AND 2.5m FOR 'RAIL'.



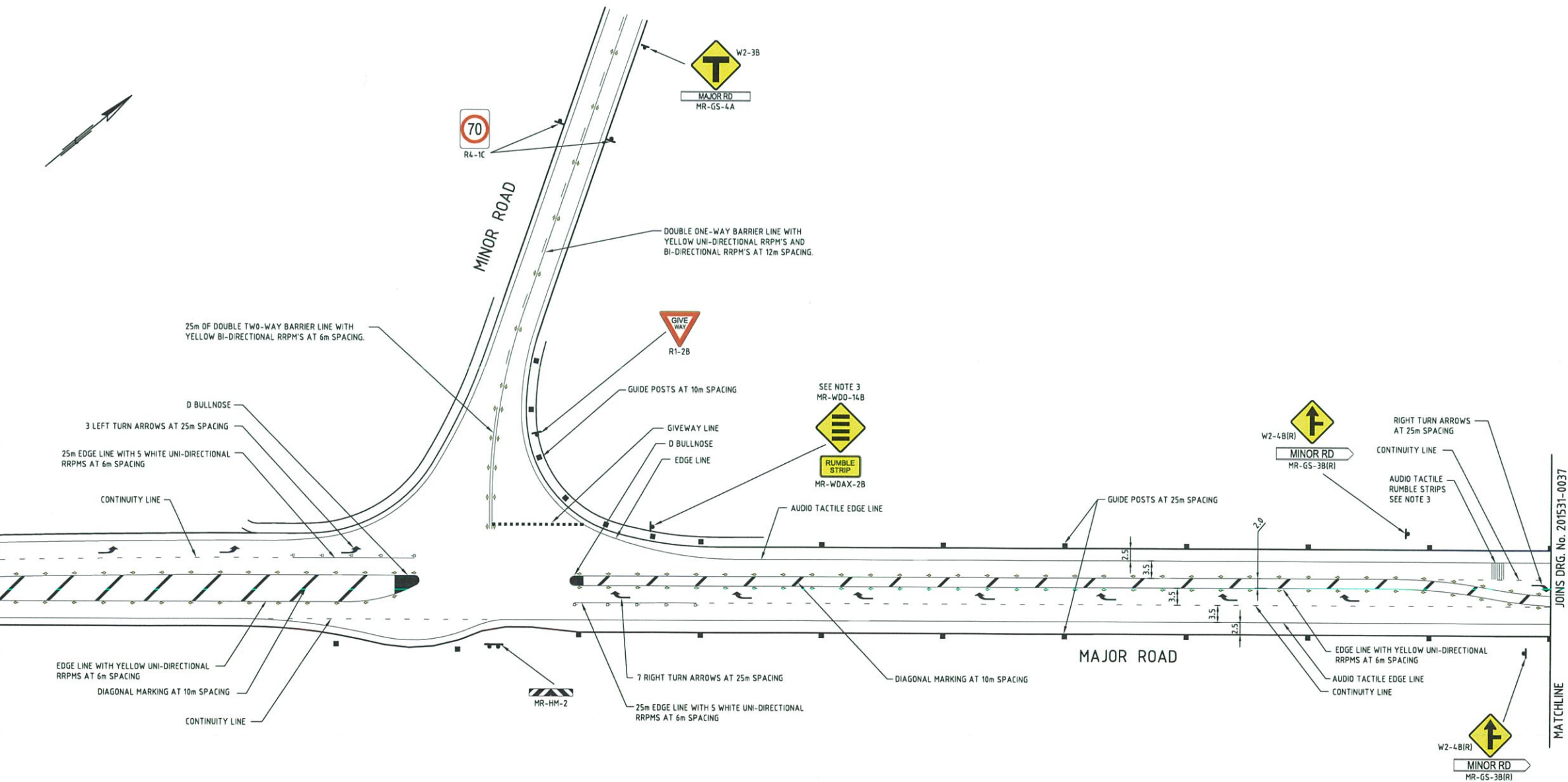
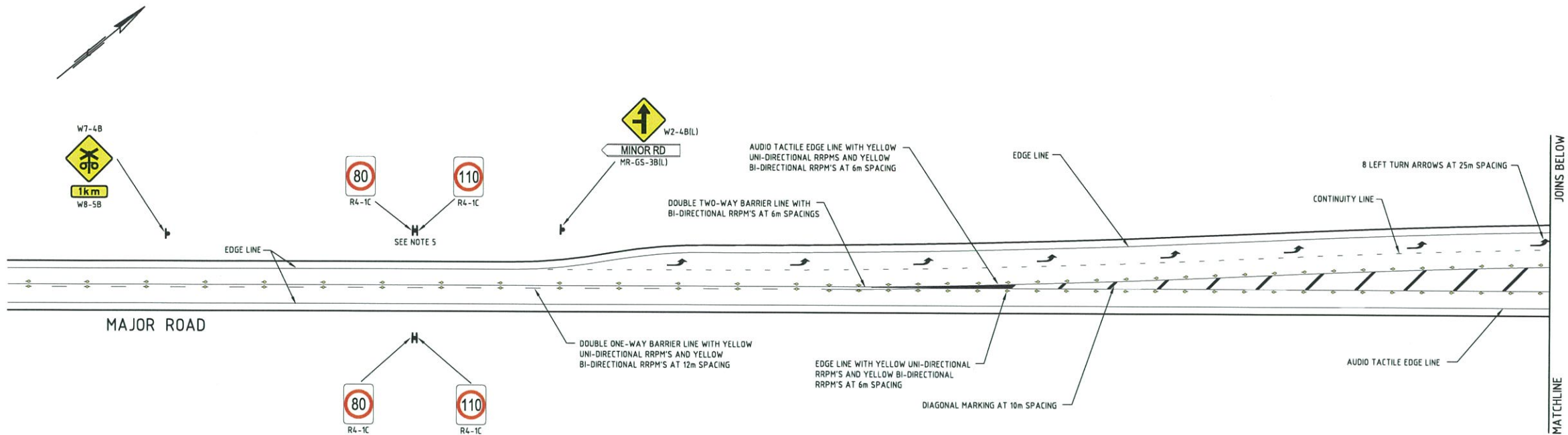

 PLANNING AND TECHNICAL SERVICES
 ROAD AND TRAFFIC ENGINEERING
 WATERLOO CRESCENT EAST PERTH WA 6004
 Telephone (08) 9323 4111 Fax (08) 9323 4449

FILE NUMBER	67-08-4F
DESIGNED / DRAWN	J. VOKE 21/12/16
VERIFIED	<i>[Signature]</i> 20/1/17
APPROVED	<i>[Signature]</i> 7/2/17

GUIDELINE DRAWING
 RURAL RAILWAY CROSSING
 PAVEMENT MARKING AND SIGNING
 FLASHING LIGHTS CONTROL

LOCAL AUTHORITY
 DRAWING NUMBER 201631-0093 AMEND.

SCALE
 MICROFILM DATE
 A3



AMENDMENTS		
No.	DATE	DESCRIPTION

- NOTES**
- THIS DRAWING TO BE READ IN CONJUNCTION WITH MAIN ROADS WA SPECIFICATIONS.
 - PAVEMENT MARKING AND SIGNING TO BE IN ACCORDANCE WITH A.S. 1742.7 AND MAIN ROADS WA STANDARD DRAWINGS.
 - AUDIO TACTILE RUMBLE STRIPS MAY BE INSTALLED ON AREAS PRONE TO DRIVE FATIGUE OR WHERE A RAIL CROSSING IS NOT EXPECTED. REFER MAIN ROADS DRAWING 201531-0039.
 - AAWA LOCATION AND TIMINGS SHALL BE IN ACCORDANCE WITH A.S. 1742.7. THE LOCATION MUST CONSIDER THE STOPPING SITE DISTANCE REQUIRED FOR MAXIMUM VEHICLE TYPES.
 - THE 80 km/h SPEED ZONE IS TYPICALLY 300-400m PRIOR TO THE RAIL CROSSING. REFER TO MAIN ROADS "POLICY AND APPLICATION GUIDELINES FOR SPEED ZONING".

LEGEND

---	REFERENCE LINE
---	KERB TYPE SM-2(40)
---	NEW SEALED SHOULDER
---	NEW EDGE LINE
---	NEW EDGE LINE WITH AUDIO-TACTILE
---	NEW DOUBLE TWO WAY BARRIER LINE
---	NEW DOUBLE ONE WAY BARRIER LINE
---	NEW BROKEN LANE LINE
---	NEW CONTINUITY LINE
---	NEW GIVEWAY LINE
---	NEW PAVEMENT ARROW
---	NEW ONE POST SIGN
---	NEW TWO POST SIGN
---	NEW WHITE UNIDIRECTIONAL RRPMS
---	NEW YELLOW BIDIRECTIONAL RRPMS
---	NEW YELLOW UNIDIRECTIONAL RRPMS
---	PROPOSED GUIDE POSTS
---	EXISTING SEALED SHOULDER
---	EXISTING DRIVEWAY
---	EXISTING ONE POST SIGN
---	EXISTING TWO POST SIGN
---	BOOM GATE ASSEMBLIES

mainroads
 WESTERN AUSTRALIA
 TECHNOLOGY AND ENVIRONMENT DIRECTORATE
 ROAD AND TRAFFIC ENGINEERING
 WATERLOO CRESCENT EAST PERTH 6004
 Telephone (08) 93230411 Fax (08) 93234449

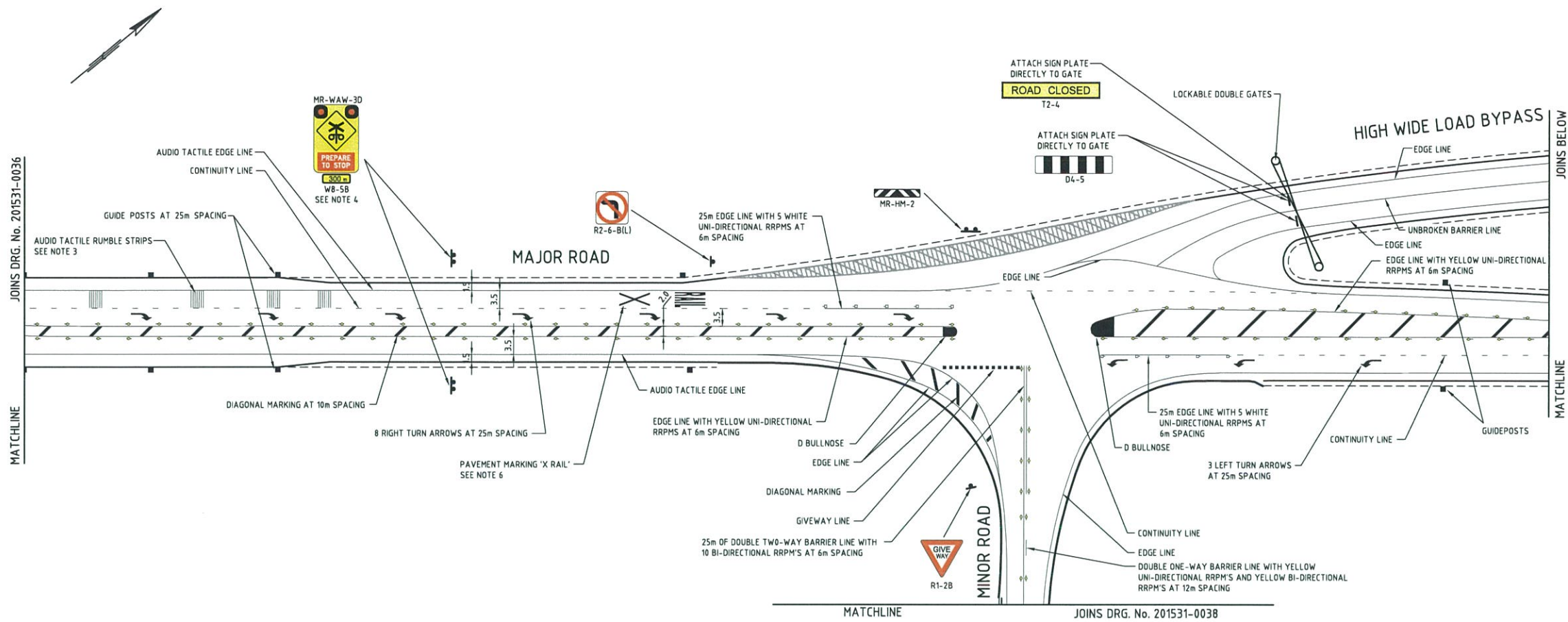
FILE NUMBER	
DESIGNED / DRAWN	J.VOKE 23.3.15
VERIFIED	<i>[Signature]</i> 12/2/16
APPROVED	<i>[Signature]</i> 12/2/16
GUIDELINE DRAWING	

**RAILWAY CROSSING & SIDE TRACK
 PAVEMENT MARKING & SIGNING**
 SHEET 1 OF 3

LOCAL AUTHORITY
 DRAWING NUMBER **201531-0036** AMENDMENT



MICROFILM DATE
A 1

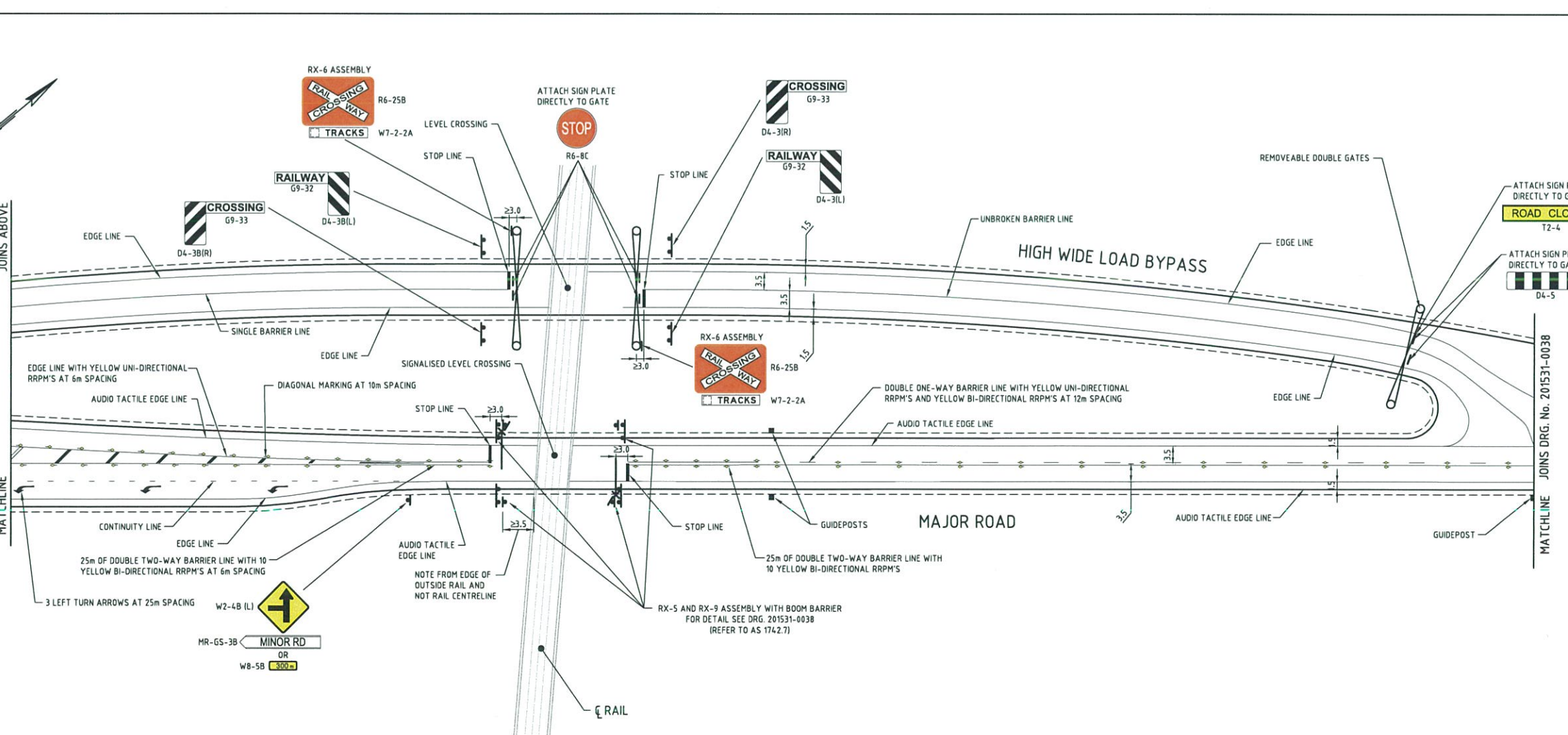


AMENDMENTS		
No.	DATE	DESCRIPTION

- NOTES**
- THIS DRAWING TO BE READ IN CONJUNCTION WITH MAIN ROADS WA SPECIFICATIONS.
 - PAVEMENT MARKING AND SIGNING TO BE IN ACCORDANCE WITH A.S. 1742.7 AND MAIN ROADS WA STANDARD DRAWINGS.
 - AUDIO TACTILE RUMBLE STRIPS MAY BE INSTALLED ON AREAS PRONE TO DRIVER FATIGUE OR WHERE A RAIL CROSSING IS NOT EXPECTED. REFER MAIN ROADS DRAWING 201531-0039.
 - AAWA LOCATION AND TIMINGS SHALL BE IN ACCORDANCE WITH A.S. 1742.7. THE LOCATION MUST CONSIDER THE STOPPING SITE DISTANCE REQUIRED FOR MAXIMUM VEHICLE TYPES.
 - THE 80 km/h SPEED ZONE IS TYPICALLY 300-400m PRIOR TO THE RAIL CROSSING. REFER TO MAIN ROADS "POLICY AND APPLICATION GUIDELINES FOR SPEED ZONING".
 - 'X RAIL' PAVEMENT MARKING SHALL BE INSTALLED AS PER A.S. 1742.7. 'X RAIL' USES THE LETTER HEIGHTS OF 3m FOR 'X' AND 2.5m FOR 'RAIL'.
 - A 10m HIGH WIDE CORRIDOR TO BE MAINTAINED ON THE HIGH WIDE BYPASS.

LEGEND

---	REFERENCE LINE
---	KERB TYPE SM-214(0)
---	NEW SEALED SHOULDER
---	NEW EDGE LINE
---	NEW EDGE LINE WITH AUDIO-TACTILE
---	NEW DOUBLE TWO WAY BARRIER LINE
---	NEW DOUBLE ONE WAY BARRIER LINE
---	NEW BROKEN LANE LINE
---	NEW CONTINUITY LINE
---	NEW GIVEWAY LINE
---	NEW PAVEMENT ARROW
---	NEW ONE POST SIGN
---	NEW TWO POST SIGN
---	NEW WHITE UNI-DIRECTIONAL RRPMS
---	NEW YELLOW BI-DIRECTIONAL RRPMS
---	NEW YELLOW UNI-DIRECTIONAL RRPMS
---	PROPOSED GUIDE POSTS
---	EXISTING SEALED SHOULDER
---	EXISTING DRIVEWAY
---	EXISTING ONE POST SIGN
---	EXISTING TWO POST SIGN
---	BOOM GATE ASSEMBLIES



Government of Western Australia

 TECHNOLOGY AND ENVIRONMENT DIRECTORATE

 ROAD AND TRAFFIC ENGINEERING

 WATERLOO CRESCENT Telephone (08) 93230411 EAST PERTH 6004 Fax (08) 9323 4449

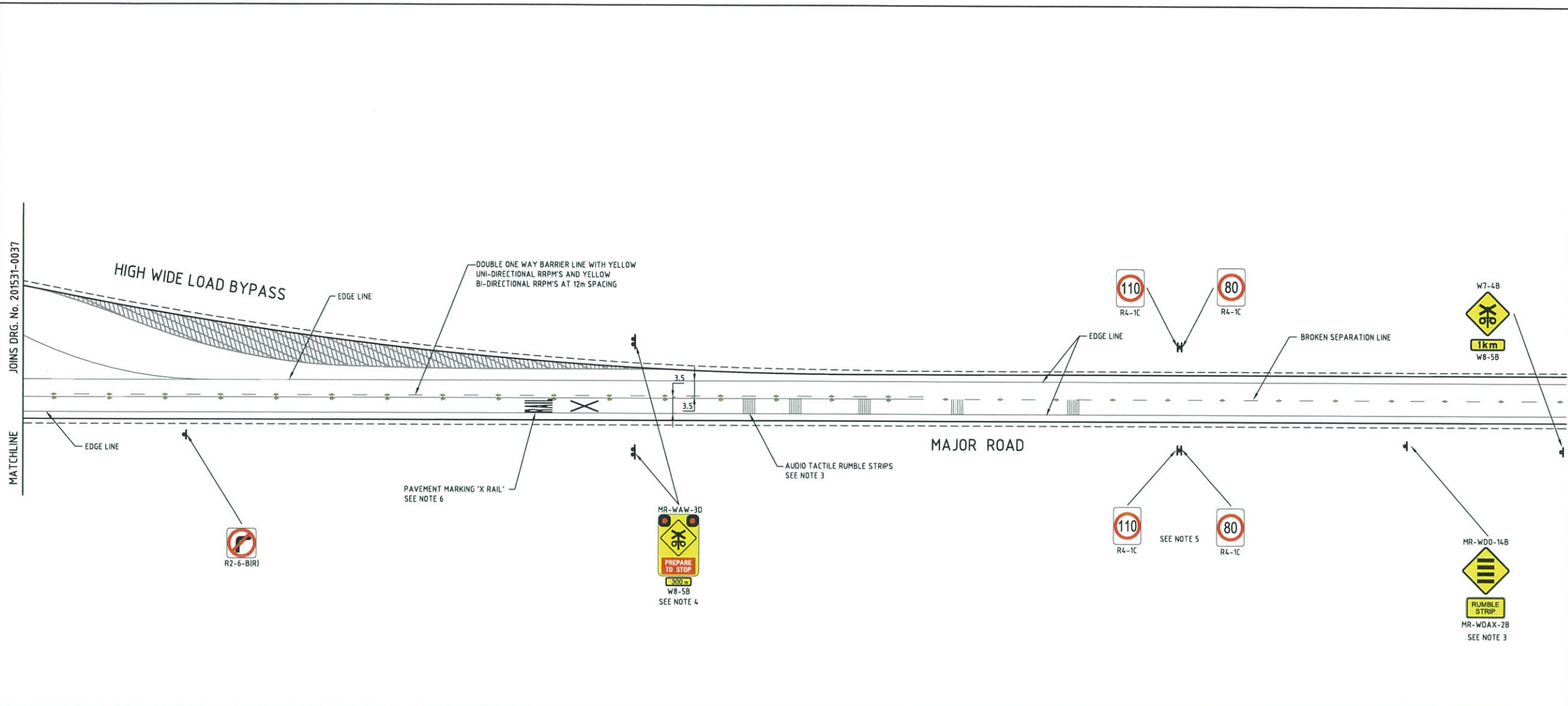
FILE NUMBER	
DESIGNED / DRAWN	J.VOKE 23.3.15
VERIFIED	<i>[Signature]</i> 22/2/16
APPROVED	<i>[Signature]</i> 22/2/16

RAILWAY CROSSING & SIDE TRACK PAVEMENT MARKING & SIGNING
 SHEET 2 OF 3

LOCAL AUTHORITY
 DRAWING NUMBER
201531-0037

SCALE 1:500

MICROFILM DATE
A 1

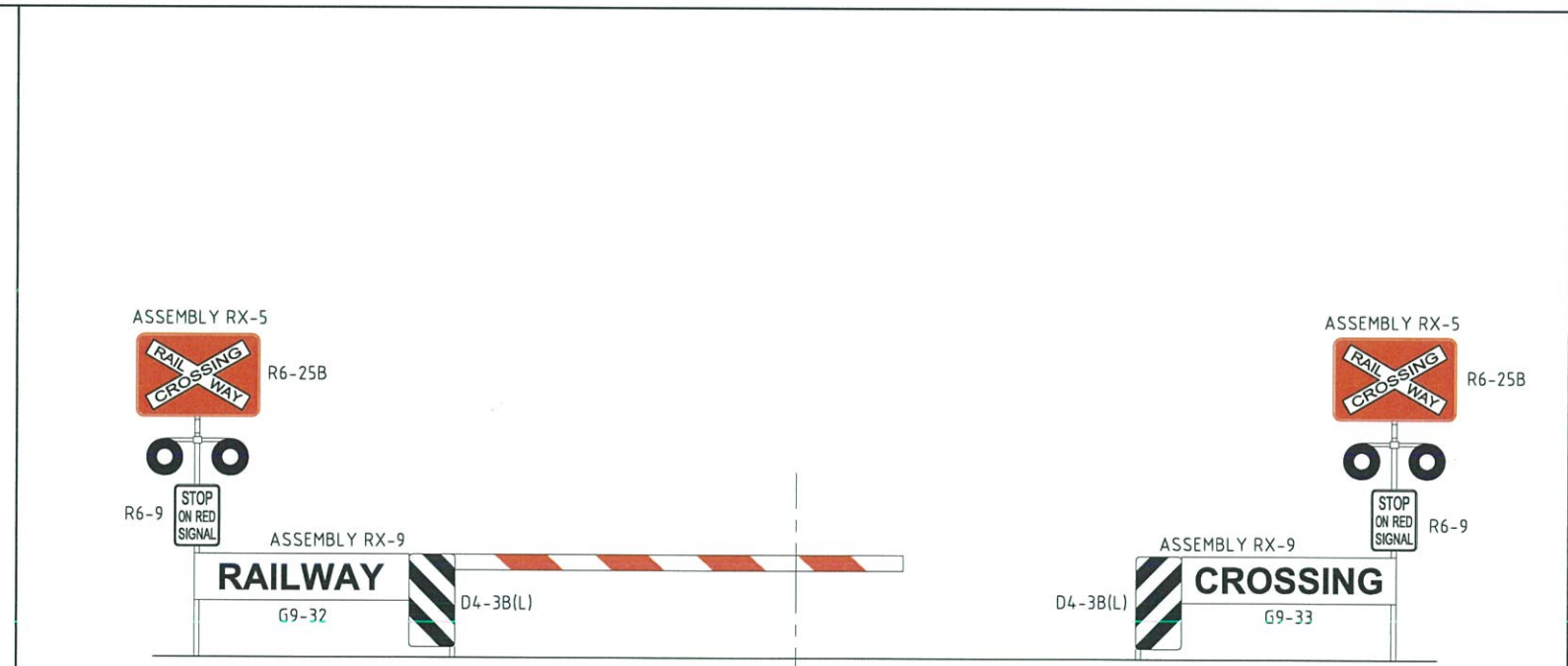
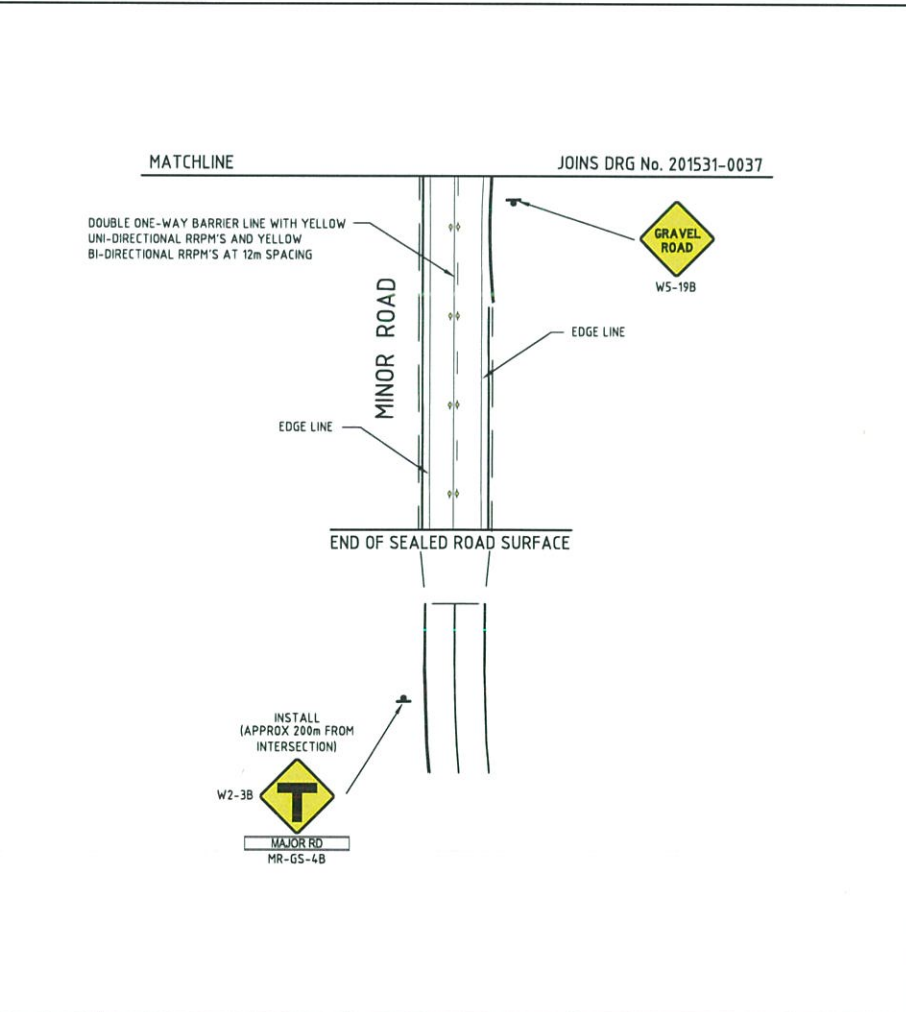


AMENDMENTS			
No.	DATE	DESCRIPTION	APPROVED

- NOTES**
- THIS DRAWING TO BE READ IN CONJUNCTION WITH MAIN ROADS WA SPECIFICATIONS.
 - PAVEMENT MARKING AND SIGNING TO BE IN ACCORDANCE WITH A.S. 1742.7 AND MAIN ROADS WA STANDARD DRAWINGS.
 - AUDIO TACTILE RUMBLE STRIPS MAY BE INSTALLED ON AREAS PRONE TO DRIVER FATIGUE OR WHERE A RAIL CROSSING IS NOT EXPECTED. REFER MAIN ROADS DRAWING 201531-0039.
 - AAWA LOCATION AND TIMINGS SHALL BE IN ACCORDANCE WITH A.S. 1742.7. THE LOCATION MUST CONSIDER THE STOPPING SITE DISTANCE REQUIRED FOR MAXIMUM VEHICLE TYPES.
 - THE 80 km/h SPEED ZONE IS TYPICALLY 300-400m PRIOR TO THE RAIL CROSSING. REFER TO MAIN ROADS "POLICY AND APPLICATION GUIDELINES FOR SPEED ZONING".
 - 'X RAIL' PAVEMENT MARKING SHALL BE INSTALLED AS PER A.S. 1742.7. 'X RAIL' USES THE LETTER HEIGHTS OF 3m FOR 'X' AND 2.5m FOR 'RAIL'.
 - SIDE TRACK MUST BE PROVIDED WHEN THERE ARE NO VIABLE ALTERNATIVE ROUTES. WHEN IN OPERATION TRAFFIC MUST BE APPROPRIATELY MANAGED.

LEGEND

—	REFERENCE LINE
—	KERB TYPE SM-2(40)
---	NEW SEALED SHOULDER
---	NEW EDGE LINE
---	NEW EDGE LINE WITH AUDIO-TACTILE
---	NEW DOUBLE TWO WAY BARRIER LINE
---	NEW DOUBLE ONE WAY BARRIER LINE
---	NEW BROKEN LANE LINE
---	NEW CONTINUITY LINE
---	NEW GIVEWAY LINE
---	NEW PAVEMENT ARROW
---	NEW ONE POST SIGN
---	NEW TWO POST SIGN
---	NEW WHITE UNIDIRECTIONAL RRPMS
---	NEW YELLOW BIDIRECTIONAL RRPMS
---	NEW YELLOW UNIDIRECTIONAL RRPMS
---	PROPOSED GUIDE POSTS
---	EXISTING SEALED SHOULDER
---	EXISTING DRIVEWAY
---	EXISTING ONE POST SIGN
---	EXISTING TWO POST SIGN
---	BOOM GATE ASSEMBLIES



DETAIL OF RX-5 AND RX-9 ASSEMBLY WITH BOOM BARRIER

Government of Western Australia

 TECHNOLOGY AND ENVIRONMENT DIRECTORATE

 ROAD AND TRAFFIC ENGINEERING

 WATERLOO CRESCENT EAST PERTH 6004

 Telephone (08) 932304111 Fax (08) 9323 4449

FILE NUMBER: _____

 DESIGNED / DRAWN: J.VOKE 23.3.15

 VERIFIED: *[Signature]* 12/2/16

 APPROVED: *[Signature]* 12/2/16

 GUIDELINE DRAWING

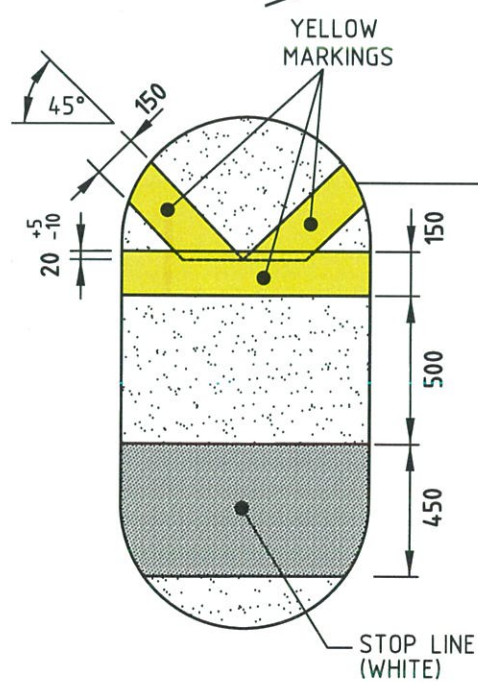
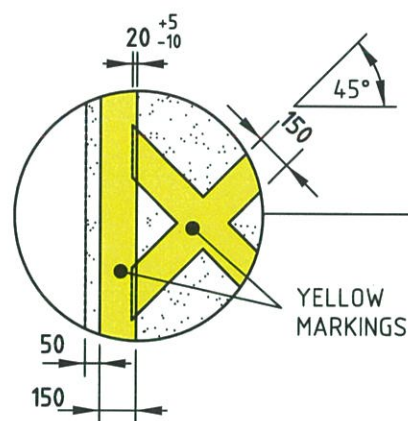
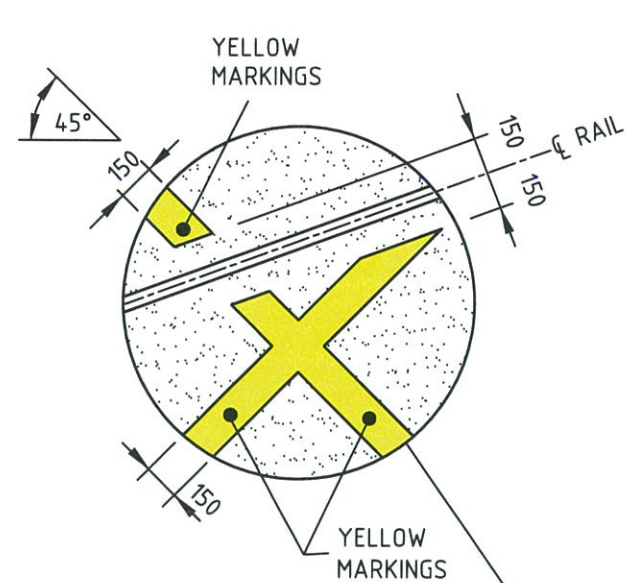
RAILWAY CROSSING & SIDE TRACK

 PAVEMENT MARKING & SIGNING

 SHEET 3 OF 3

LOCAL AUTHORITY: _____

 DRAWING NUMBER: **201531-0038**



SEE NOTES 7 & 8

6.0m MIN.
SEE NOTES 4 & 5

FLASHING LIGHTS, WITHOUT BOOM BARRIERS.
(TO BE LOCATED BY RAIL AUTHORITY)

6.0m MIN.
SEE NOTES 4 & 5

300 MIN
500 MAX
SEE NOTE 3

1.0m TO 1.2m
SEE NOTE 2

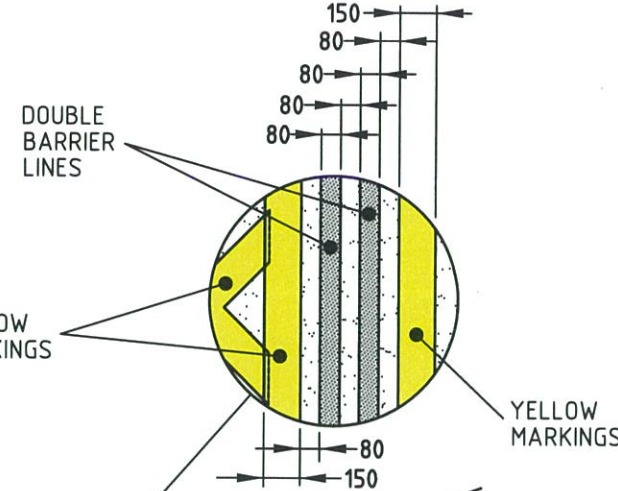
STOP LINE

€ OF LAYOUT SYMMETRY

FACE OF KERB OR
EDGE OF SEAL

SEE NOTES 7 & 8

VERGE
FACE OF KERB
OR EDGE OF SEAL
ROAD SURFACE



AMENDMENTS		
No.	DESCRIPTION	APPROVED & DATE
1	COLOUR ADDED. <i>R. Keenan 3/5/12</i>	

- NOTES**
- REFER TO DRG No. 9731-1096 FOR DETAILS OF 'KEEP CLEAR' SIGN.
 - HEIGHT OF 'KEEP CLEAR' SIGN TO BE BETWEEN 1.0m AND 1.2m (AS MEASURED BETWEEN ROAD SURFACE LEVEL AND TOP OF SIGN).
 - LATERAL CLEARANCE OF 'KEEP CLEAR' SIGN NOT TO EXCEED 0.5m, NOR TO BE LESS THAN 0.3m (AS MEASURED BETWEEN EDGE OF ROAD AND NEAREST EDGE OF SIGN).
 - START CROSSHATCH LAYOUT AT THE STOP LINE, SYMMETRICAL TO THE CENTRE OF THE CARRIAGEWAY AND FINISH WITH FULL OR HALF DIAMONDS ONCE PAST THE 6.0m CLEARANCE POINT OF THE RAIL TRACK.
 - FOR CROSSINGS WITH SHORT DEPARTURE STACKING DISTANCE, THE LENGTH OF HATCHING BEYOND THE CROSSING CAN BE REDUCED TO A RANGE OF 3.0m TO 6.0m TO ACCOMMODATE WHOLE VEHICLE UNITS.
 - THE RAIL AUTHORITY SHALL BE CONTACTED PRIOR TO CROSS-HATCH MARKINGS BEING INSTALLED.
 - ALL DOUBLE BARRIER LINES TO BE PRECEDED BY TWO MODULES OF BROKEN SEPARATION LINE (24m). REFER TO DRAWING NO. 200331-184.
 - IN URBAN AREAS, DOUBLE BARRIER LINE MAY BE REPLACED BY A SINGLE UNBROKEN SEPARATION LINE (120mm WIDE).
 - WHERE QUEUING IS A PROBLEM IN ONE DIRECTION ONLY, THE BOX MARKING SHALL BE PLACED ON THAT SIDE OF THE PAVEMENT ONLY.

Government of Western Australia
mainroads WESTERN AUSTRALIA
 TECHNOLOGY AND ENVIRONMENT
 ROAD AND TRAFFIC ENGINEERING
 WATERLOO CRESCENT EAST PERTH 6004
 Telephone (08) 9323 4111 Fax (08) 9323 4449

DESIGNED / DRAWN	J. VOKE	4/7/07
VERIFIED	D. LANDMARK	23.1.12
APPROVED	R. GROVE	23.1.12

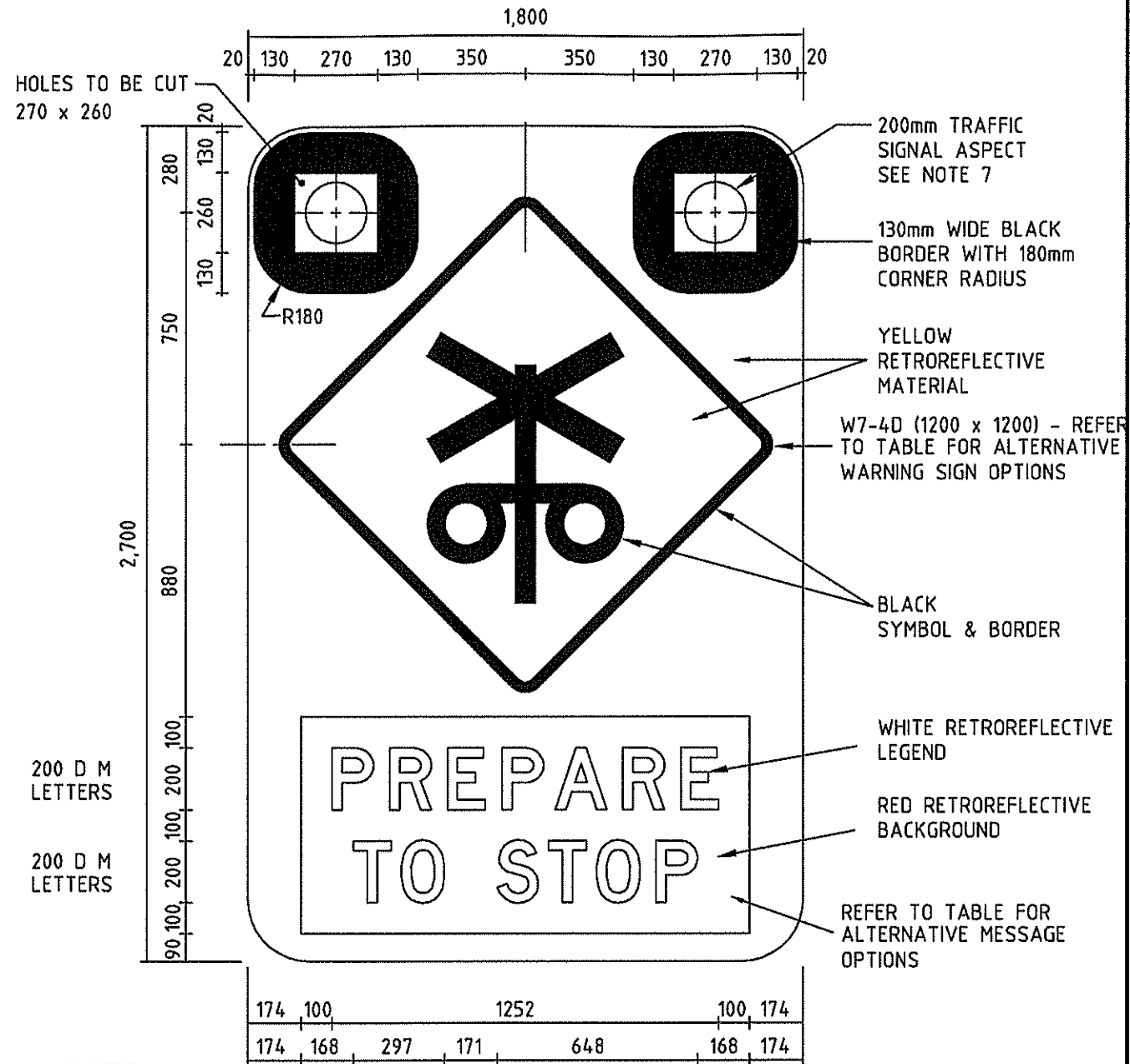
STANDARD DRAWING
 RAILWAY LEVEL CROSSING
 LAYOUT OF YELLOW CROSS HATCH MARKINGS
 AND KEEP CLEAR SIGNS AT CROSSINGS
 WITHOUT BOOM BARRIERS

LOCAL AUTHORITY	DRAWING NUMBER	AMEND
	200731-0040-1	

SCALE 1:250
 MICROFILM DATE

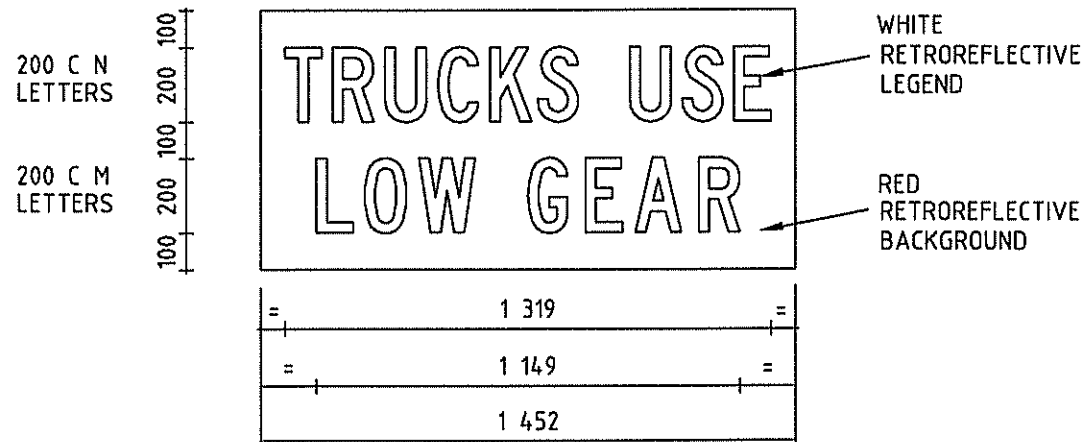
A 3

MAIN ROADS SIGNS INDEX No.	DESCRIPTION	WARNING SIGN INSERT	MESSAGE INSERT
MR-WAW-1D	SIGNALS AHEAD PREPARE TO STOP	W3-3D	PREPARE TO STOP
MR-WAW-3D (Illustrated)	LEVEL CROSSING AHEAD PREPARE TO STOP	W7-4D	PREPARE TO STOP
MR-WAW-6D	STOCK CROSSING AHEAD (GENERIC) PREPARE TO STOP	W5-38D	PREPARE TO STOP
MR-WAW-7D	STOCK CROSSING AHEAD (COWS ONLY) PREPARE TO STOP	MR-WD0-16D	PREPARE TO STOP
MR-WAW-8D	TRUCKS CROSSING / ENTERING PREPARE TO STOP	W5-22D	PREPARE TO STOP
MR-WAW-9D	EMERGENCY VEHICLES ENTERING PREPARE TO STOP	MR-WD0-11D	PREPARE TO STOP
MR-WAW-10D	STEEP DESCENT TRUCKS USE LOW GEAR	W5-39D	TRUCKS USE LOW GEAR



NOTES:

- DIMENSIONS: MEASUREMENTS IN mm. CORNER RADIUS = 200. BORDER = NONE. MAIN SIGN PANEL AREA = 4.86 SQM.
- COLOURS: AS INDICATED ON THE DRAWING.
- RETROREFLECTIVE CLASS OF MATERIAL: CLASS 1 EXCEPT CLASS 1W FLUORESCENT YELLOW FOR MR-WAW-3D
- GRAFFITI PROTECTION: TO BE SPECIFIED BY THE DESIGNER IN ACCORDANCE WITH MAIN ROADS GUIDELINES.
- MATERIALS: ALL SIGN MATERIALS AND MANUFACTURE TO BE IN ACCORDANCE WITH MAIN ROADS SPECIFICATION 601.
- POSTS & STIFFENERS: REFER TO DRAWING No. 200431-0092. FACE DETAILS.
- REFER TO DRAWING No. 200431-0100 FOR ELECTRICAL INSTALLATION DETAILS.
- THIS DRAWING SUPERSEDES DRAWING Nos. 200231-051 & 9431-1046 FOR SIGN FACE DETAILS.



AMENDMENTS		
No.	DESCRIPTION	APPROVED & DATE
1	RETROREFLECTIVE MATERIAL CLASS 1W ADDED IN NOTE 3, AND WA GOVT. LOGO UPDATED IN TITLE.	18.12.13

PLANNING AND TECHNICAL SERVICES DIRECTORATE
 ROAD AND TRAFFIC ENGINEERING
 WATERLOO CRESCENT EAST PERTH 6004
 Telephone (08) 9323 4111 Fax (08) 9323 4449

FILE NUMBER	67-08-4F
DESIGNED / DRAWN	N.PANGGABEAN 14.10.04
VERIFIED	D.LANDMARK 5.11.04
APPROVED	D.SULLIVAN 9.11.04

WARNING SIGN
 ADVANCE WARNING FLASHING SIGNS
 MR-WAW-1D, 3D, 6D, 7D, 8D, 9D, 10D
 LOCAL AUTHORITY
 DRAWING NUMBER
200431-0088-1

SCALE 1:15 0 25mm 50 75 100 125 150 175 200 225 250 275 300 325 350 375 400 425 450 475 500 525 550 575 600 625 650 675 700 725 750 775 800 825 850 875 900 925 950 975 1000
 MEMORIAL DATE A 3