

NATIONAL DEPARTMENT OF TRANSPORT

NTR 1: Part 2

National Technical Requirement 1: Pedestrian Crossings

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Version 6

Foreword

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Approval of the National Technical Requirement 1: Part 2

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Approval of the National Technical Requirement 1: Part 2 indicates an understanding of the purpose and content described in this deliverable. By signing this deliverable, each individual agrees with the content contained in this deliverable.

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Introduction

The development of NTR 1 has been commissioned by the Department of Transport, Public Transport Network Development Chief Directorate, Public Transport Branch. The primary objective of NTR 1 is a structured and standardised approach to address improved pedestrian safety, through a thorough understanding of the needs of pedestrians. The needs of motorised and non-motorised vehicles are acknowledged. However, the focus has purposely been shifted to recognising the needs of pedestrians as a significant component of the public transport system; whether walking from origin to destination, walking the first and last mile using public transport, and even walking the first and last mile to a private vehicle. These technical requirements will inform regulations which will be developed under the NLTA (Republic of South Africa, 2009) in due course.

The introduction of Regulation will follow a slow process. It is envisaged that the research supporting the development of NTR 1 to date will continue and that further refinement may be necessary or the inclusion of other layouts, which have not currently been included in the document. This process has been put in place to allow municipal (and provincial) officials, concerned with Roads and Transport, time to understand the different approach to providing for the needs of pedestrians, and to accommodate their feedback.

This first version of NTR 1 has included a significant amount of research targeting vulnerable pedestrians, particularly people who are blind or partially sighted. The purpose of this has been to enable the new layouts to accommodate their needs. Details of this work can be found at <https://drive.google.com/open?id=0B06QYwK6AXoxSkpjVG05bnRIVGM> including video footage of the testing.

This document (Part 2 of NTR 1) contains the technical component of the National Technical Requirement 1 for Pedestrian Crossings (NTR1), and is the product of the research reviews and consultation undertaken to inform these National Technical Requirements. The research and reviews have been documented in an overview research report (NTR 1: Part 1 Pedestrian Crossings) that should be read in conjunction with this second part.

NTR 1, *National Technical Requirements on the Design of Pedestrian Crossings*, recognises and references the NMT Facility Guidelines, published by the National Department of Transport in March 2015, the National Department of Transport's Position Paper on Tactile Ground Surface Indicators (NDoT, 2016a), as well as the regulatory requirements, as stipulated in the SANS 10400:S (2011). NTR 1 focuses on the specific technical requirements that inform the design of pedestrian crossings. Part 2 of NTR 1 has resulted from research conducted for NTR 1. The research undertaken in Part 1 NTR 1 informed the rationale and functional requirements for the testing for Part 2 NTR 1. The rationale recognises the value of

applying universal design principles to improve performance, functionality and safety of pedestrian crossings in South Africa.

Pedestrian crossings occur in both midblock and intersection configurations, and either of these may lead pedestrians and NMT users to public transport boarding points.

Pedestrians cross the road both in kerbside and median design configurations. Following desktop research, a series of onsite tests were conducted with stakeholders in Cape Town, Ekurhuleni and Tshwane respectively. The Ekurhuleni Metropolitan Municipality and the City of Tshwane offered a series of testing environments as the design methodology was refined. Specialists were also consulted with the research document (Part 1) and the configurations of the methodology were also discussed in detail with a broad range of stakeholders. All stakeholder information can be found in, or linked to, NTR 1: Part 1.

Tactile Walking Surface Indicators (TWSI, also known as TGSI - see terms and definitions) only form a small but integrated part of the entire NTR 1. However, it formed a comparatively large part of the onsite research due to problems encountered with the application of the SANS 784 (SABS Standards Division, 2008). SANS 784 is a voluntary standard, adopted by South Africa from the Australian and New Zealand standards, without consultation with the South African National Council for the Blind (SANCB). The SANS 784 (2008) was subsequently used as a base document to design guidelines for various local authorities, but without much consideration for contextual infrastructure, such as existing wider bell mouth radii, which lead to the overuse of tactile tiles. One such example is the document that was commonly referred to as the "Tshwane Guidelines" (which, from this point forward, will be referred to as GIBB's proposal drawings), which was a set of drawings on standard construction detail and design for intersection pedestrian crossings. The drawings by GIBB were never adopted by the City of Tshwane as guidelines¹, but were used to develop STD009 (City of Tshwane, 2016), a City endorsed document. STD009 was used by Tshwane in the design of pedestrian infrastructure along the IPTN, but without rational design or application, which lead to the overuse of TWSI (TGSI).

It was for reasons such as this that research on the design layout, as well as orientation aids commonly provided at pedestrian crossings, were investigated as part of the NTR 1. On site testing took place with groups and individual representatives from SANCB and Kaleidoscope (previously the Institute for the Blind).

An outcome of the stakeholder engagements was the urgent request for a clear set of planning policy guidelines, using the principles of Universal Design, for urban planning as a whole, not for pedestrian crossings alone.

¹ Letter by J J Mushwana, from the City of Tshwane addressed to A Gibberd of the National Department of Transport, stating that the further development of standard construction details are not being proceeded with (Dated: February 2011).



In order to make road space safer, more enjoyable and to enable more people to walk as a mode of transport, there is clearly a need to create a new approach to the design and use of the road space. Therefore, not only is it important to ensure that pedestrians can function efficiently and safely, if the needs of vulnerable pedestrians are not accommodated, the current dangerous road conditions will not change. If, however, nothing is done at the roadside to enable vehicles to maintain the appropriate speed limits, then the rate of pedestrian fatalities may actually increase after implementing improvements, such as the recommendations in this document, as pedestrians falsely think that they are safer when they are not. One such example would be the use of audible warnings at signalised pedestrian crossings, where the audible sound would indicate that pedestrians can start crossing the road, whilst vehicles are still moving over the crossing, such as at right turning intersections. It is important that implementation of NTR 1 is part of a wider awareness raising and advocacy campaign to ensure that these specifications are well understood by designers, implementing agencies and users. The adoption of NTR 1 must, therefore, be accompanied by workshops and training on the content on this document, in order to achieve their successful adoption and implementation.

This document recognises the work that was conducted prior to the commencement of NTR 1: Pedestrian Crossings, and which contributed to the findings. This included the South African Bureau of Standard's (SABS) working group for SANS 784, as well as other research projects and undertakings by the National Department of Transport, in the implementation of Integrated Public Transport Networks (IPTNS). The document recognises the input and feedback from key stakeholders, with specific recognition of the support provided by the SANCB and the other blind and partially sighted persons who have assisted with the evaluation of current tactile surface warning and guidance systems.

NTR 1, including its technical requirements, design processes and other recommendations, is particularly relevant to the 13 municipalities who are responsible for the IPTN's and who receive PTNG funding for compliance with Universal Access. In the context of IPTN's planning there are three primary technical parameters which are a funding requirement for an inclusive pedestrian environment, namely:

1. 1:15 gradient along ramps ²
2. 1:50 camber along paths of travel;
3. Maximum threshold of 5mm (NDoT, 2016a).

In addition to these, all the requirements and recommendations in this document require a minimum of a year's testing, before these technical requirements can be concluded. This process is necessary to inform the upgrading of the national standards and regulations and to ensure that the recommendations are supported and understood by the officials whose role it will be to enforce them. Finally, the process allows time for developers, designers and construction professionals to include these layouts in their designs voluntarily and to help promote safer walking environments.

² It is, however, noted that the maximum gradient for a ramp in the SANS 10400 Part S (2011) is 1:12. However, research into standards that accommodate children with disabilities in Australia in xxx (Amanda Gibberd to complete preceding section in text) found that a 1:15 ramp is far more inclusive. In addition, planning for a 1:15

1. Scope of Work

This technical component of the NTR 1: Pedestrian Crossings (Part 2), covers the following:

- Technical drawings, specifications and standard details on the design and layout of pedestrian crossings, in road-based public transport precincts, in road based public transport environments.
The technical drawings will apply to national, provincial and local authority roads in IPTN municipalities and detail suitable types of crossing in relation to the relevant road classes. These include designs relating to a range of different conditions for both dropped kerb or kerb cut and dropped intersection modalities, depending on the available sidewalk width.
- The technical drawings demonstrate the current thinking in the way in which tactile walking surface guidance and warning systems should be included in pedestrian crossings, and provide the limits for their use.
- These NTR 1's have been drafted with a view to ultimately be adopted for use by SABS technical committees on standards for the built environment.
- To inform the development of national standards and, ultimately, regulations by the National Department of Transport.

(National Department of Transport. *Terms of Reference for the Development of a National Technical Requirement (NTR 1) on the design of pedestrian crossings for all modes of road-based public transport*. Public Tender Document. 23 November 2015)

2. Terms and Definitions

For the purposes of this document, the following (terms and) definitions apply.

Accessibility – Enabling persons with different types of disabilities to live independently and to participate fully in all aspects of life, and the dismantling of barriers that hinder the effective enjoyment of all rights. (Republic of South Africa, 2016: 40)

Actuated pedestrian crossing signalling - Pedestrian signalling that is activated by the pedestrian at the traffic signal through a push button.

Automated pedestrian crossing signalling - Pedestrian signalling that is automatically included in the vehicular traffic signalling and does not require pedestrians to push a button at the traffic signal pole.

Bell Mouth - The curved area where two straight kerb edges of the sidewalk meet. The size of the curvature is defined as the radius and it is recommended that the radii be kept to a minimum to reduce vehicular traffic speed.

Block crossings or painted crossing – An area that is designated for pedestrians to use when crossing a roadway, painted white road marking paint, in

ramp allows contractors, including emerging contractors, a certain amount of leeway in executing a legally compliant gradient (which cannot be steeper than 1:12).



a configuration that is the width of the road and in section parallel to the vehicular road traffic which is 600mm wide with a 600mm gap.

Bollard – A post used to protect pedestrians at block crossings by preventing vehicle intrusions. Where there is a preference for the installation of a bollard or bollards, it is/they are to be located specifically as indicated in the technical drawings and not located where they would clutter sidewalks or the pedestrian crossing. Bollards should be limited to one centrally located, where required.

BRT – Bus Rapid Transit, a public transport system using dedicated lanes for buses and kerbside or median dedicated boarding areas.

Buffer strip - An area that is 300mm in width and runs parallel to the road and forms a strip between the road edge and the area that is safe for pedestrians to stand on the sidewalk. The buffer strip can be cast concrete, figure 1 or 3 kerbs (lying flat) or shallow v-channels to better assist with drainage. Shallow v-channels are installed for the continuity of the side drain/channel. Buffer strips are also referred to as gutters.

Dropped Intersection – A design configuration where the sidewalk, prior to the pedestrian crossing, is level with the road surface.

Functional Limitations – Restrictions in performing fundamental physical and mental actions used in daily life such as mobility (physical) or memory (mental). (WHO ICF).

Intersection - Wherever two or more roadways intersect or the pedestrian and NMT network intersects the roadway network.

IPTN: Integrated Public Transport Network - IPTN's include road (quality bus services, BRT, on demand services or any other service contracted to the municipality) and rail based transport, as well as NMT facilities, to form an integrated network of public transport services

Kerb cut - A design configuration where the sidewalk has a gradient, which leads directly to the start of the pedestrian crossing.

Kerb side bus stop - A bus stop designed for convenience of access for passengers, with the kerbs and the entrance level of the bus, offering level boarding (with a maximum gradient of 1:50).

Kerbside – The area next to a kerb on the roadside or on the sidewalk, in the space distinctly allocated for pedestrians.

Kerbside to median pedestrian crossing – A pedestrian crossing designed for the purpose of connecting a kerbside to a median island.

LOS – Level of Service.

Median – The median is the reserved area that separates opposing lanes of traffic on divided roads, such as divided highways and dual carriageways. The term also applies to divided roads other than highways, such as some major roads in urban or suburban areas.

Midblock – Located between two intersections which is then either from kerb to kerb or kerb to median island.

Mobility – The ability of movement of people or goods, including NMT users.

NMT – Non-Motorised Transport, transportation that does not rely on energy generated from an engine (NDoT, 2015). This document recognises

the importance of pedestrians and includes NMT users as all other users of the sidewalk who include people who use wheelchairs (motorised and manual), skateboarders, cyclists (could be leisure or sport-dependent on external factors), pushbikes, mothers with prams, etc.

NMT users – Any person that fulfils their travel demand through movement that is not powered by an engine, including pedestrians, manual wheelchair users, power wheelchair users and people making use of mobility scooters.

Pedestrian crossing – Facilities that accommodate the movement of pedestrians and or NMT users, across the road reserve.

Principles – Over-arching principles that help to guide practitioners' thinking and design process.

Public Transport – all modes of transport that serve the transportation needs of the general public.

Raised pedestrian crossings – Pedestrian crossings that are level with the height of the adjacent pedestrian pavement/kerbside/sidewalk.

Sidewalks – Facilities that accommodate NMT as the most basic mode of transportation of people (City of Johannesburg, 2010).

Signage – Graphic designs, as symbols, emblems, or words, used especially for identification or as a means of giving directions or warning (<http://www.dictionary.com/browse/signage>).

Signalised and Un-signalised Intersections – Intersections where there are either traffic signals to control vehicular traffic and pedestrian movement or at intersections where there are no traffic signals. Traffic signals can also be installed at midblock crossings to assist in the safe road crossing of pedestrians

Signalling – The control of a crossing using traffic lights, pedestrian signalling and/or audible signals and other similar technologies.

Stop lines – Lines indicating that drivers of a vehicle must stop and give way to other road users.

Stopping Sight Distance – The distance that allows for a driver to bring a vehicle safely to a stop taking into account the distance travelled during the driver's reaction period and the distance required to decelerate to 0km/h. (CSIR, 2000).

Targeted categories of passengers – “Persons with disabilities; and the elderly, pregnant women, scholars, young children and those who are limited in their movements by children” (National Land Transport Amendment Bill, 2016: 3).

Technical Requirements – A list of technical aspects that pedestrian crossings shall adhere to.

TWSI (also known as TGS³) – Tactile Walking Surface Indicators (Tactile Ground Surface Indicators), are raised tactile surface tiles and are, generally, available in two configurations; guidance (indicator) tiles and warning tiles. Tactile guidance (indicator) tiles are “used as a guide to a safe route, indicating direction to travel, which is laid in the direction of travel” (SABS Standards Division, 2007). Tactile warning

³ TWSI is the preferred international term as per ISO 21542 (2011) and TGS³ is the term currently in use in the SANS 784 (2011)



tiles are “used as a warning of a hazard and the need to stop, consider, investigate and wait before proceeding” (SABS Standards Division, 2007). As per the National Department of Transport’s directive (Position Paper on Tactile Ground Surface Indicators (TGSI’s), 2016:9) the previous configuration of the warning tile (bubble blocks) is no longer compliant and its use was discontinued in 2014.

Universal Design – “The design of products and environments to be useable by all people, to the greatest extent possible without the need for adaptation or specialised design.” (<http://ddadesign.com.au/accessible-design/>)

3. Test Methods

The information in this document is supported by onsite testing in various local (South African) Municipalities using existing and recently installed infrastructure and more prototype installations developed largely through the IPTN’s. The finding led to the technical requirements through testing design methodology, for which examples can be seen in a series of technical drawings contained in this NTR1: Part 2 Pedestrian Crossings.

The majority of the testing was conducted with people who are blind or partially sighted, on a range of applications informed by the SANS 784 (2008), and recent configurations recommended by the NDOT in information papers circulated in 2015 and 2016. The testing took place in various locations, in the City of Cape Town, City of Johannesburg and the City of Tshwane. The techniques for the methods that were employed varied slightly, depending on the confidence in the user’s ability to cross the road. The focus of the testing was to gain insight into the ability of blind pedestrians to safely, independently and efficiently:

- i. Detect TWSI’s (TGSI’s) along a path of travel,
- ii. Use existing tactile aids to detect the start of the road surface, prior to crossing the road, and
- iii. Use existing orientation aids to align themselves in the correct position to cross the road,
- iv. The use of audio and tactile signal indicators at signalised intersections.

The findings from the onsite tests, along with the principles of Universal Design, informed the design methodology (see NTR 1: Part 1 Pedestrian Crossings, version 6, 28 November 2016) and the technical requirements were then formulated based on further technical consultations with stakeholders and specialists in the field of road and NMT design, both in private consulting and local authorities.

All meeting notes, onsite test material and research documents that were used or collated during the formulation of NTR 1: Pedestrian Crossings can be found online in the following locations:

NTR 1 Meeting notes:

<https://drive.google.com/drive/folders/0B06QYwK6AXoxMmtkMWVBdDEyVzQ?usp=sharing>

NTR 1 TWSI (TGSI) and Orientation Site Testing Material

<https://drive.google.com/drive/folders/0B06QYwK6AXoxSkpjVG05bnRIVGM?usp=sharing>

NTR 1 Research Report Supporting Documents

<https://drive.google.com/drive/folders/0B06QYwK6AXoxcmhud3FjQjBnaUE?usp=sharing>

4. Technical Requirements

Road safety considerations for targeted categories of passengers, as defined in the National Land Transport Amendment Bill (Republic of South Africa, 2016: 3), who become pedestrians when accessing public transport, have to be taken into account. This refers to the planning of new roads, human settlements, public facilities, as well as during the time in which upgrading and maintenance of existing roads is undertaken. The application of Universal Design principles is fundamental to the provision of accessible and integrated pedestrian movement within the South African transport systems. Ensuring the provision of safe NMT facilities is fundamental to encouraging more sustainable travel mode choices and achieve cost-effective, efficient travel behaviour. Walking is a very efficient mode of transport that is often overlooked, due to the inadequate pedestrian facilities and concerns that pedestrians have with respect to their safety. Although the NTR 1 focuses on pedestrian safety, any design in the road space cannot be done in isolation, and needs to recognise the requirements for safe and efficient motorised and non-motorised movement. The important paradigm shift in this approach is the focus on pedestrians and NMT users, as opposed to the vehicle centric approach that has historically been applied.

Accessible and integrated pedestrian movement has to be safe, convenient and comfortable. In South Africa, some 33% of fatalities that occur on South African roads are pedestrian fatalities (NDoT, 2016). Therefore, improving pedestrian safety should be the primary focus and the critical component of enhancing the manner in which South Africans travel.

NTR 1 Pedestrian Crossings has been compiled through extensive desktop research, as well as consultations with stakeholders, and specialists. The stakeholders and specialists have included targeted categories of pedestrians, and local authority and private consulting engineers, who have extensive expertise in the field of road design and NMT facilities. The following Technical Requirements are currently recommendations for a period of testing at pedestrian crossings, specifically along the development of new IPTN routes, and should be retrofitted through maintenance programmes, upgrading of facilities and additional new infrastructure.



National Technical Requirements for Pedestrian Crossings:

1. Reduction of bell mouth radii to between 4 metres and 10 metres.
2. The location of the pedestrian crossing perpendicular to the direction of vehicular traffic. If, based on geometric design or severe negative impact on LOS for vehicles or pedestrians (and other NMT users), the crossing can be moved no further than the first 20 degrees into the bell mouth radius.
3. Road classification shall be reduced to be no more than a class 3 road.
4. Reduction of vehicular traffic lane widths to be between 2.8 metres and 3.4 metres.
5. Removal of slip lanes.
6. Gradients along the path of pedestrian and NMT travel shall not be steeper than a ratio 1:12 (8.33%) and is preferred to be a ratio of at least 1:15 (6.66%).
7. At the top of all gradients that allow pedestrians to get to the lowered road level, in order to cross the road, there shall be a landing of no less than 1.5 metres, which is clear of all obstructions to allow pedestrians through traffic.
8. Cambers along the path of pedestrian and NMT travel, as well as along pedestrian crossings, shall not be steeper than a ratio of 1:50 (2%).
9. Along paths of travel for pedestrians and NMT users, including over the pedestrian crossing, there shall be no thresholds that exceed a height differentiation of 5mm.
10. The L-shape configuration of the TWSI (TGSI). Where the stem of the L-shape shall be no less than 1.2 metres in length and consist of two 400mm wide guidance tiles which must be installed to intercept the path of travel along the sidewalk, and is only permissible to change direction at 45 degrees after the minimum length to reach the nearest verge, edge or boundary. The base of the L-shape shall be no less than 1.2 metres in width and consist of two 400mm wide warning tiles which must be installed perpendicular to the direction of vehicular traffic and perpendicular to the guidance tiles. No cutting of the basic L-shape TWSI (TGSI) warning tiles is permissible.
11. Other than the L-shape configuration, the continuation of the installation of only the two rows of TWSI (TGSI) warning tiles across the entire width of the pedestrian crossing, at the road edge, is the prerogative of the designer. No cutting of the basic L-shape TWSI (TGSI) warning tiles is permissible. In cases where the warning tiles, as installed at the base of the L-shape, are extended for the width of the pedestrian crossing, the extended section from the L-shape is less material to the principle of orientation to people who are blind. It can, therefore, be recommended that no more than one tile width of 400mm is cut on the curvature of the bell mouth. This should not occur within the fixed L-shape configuration and should be applied consistently with the 20 degree rule (see Figure 2).
12. The TWSI (TGSI) guidance tiles of the L-shape configuration shall lead users to the traffic signal pole, at signalised intersections, or to a bollard at un-signalised intersections, of which either shall be located at the base of the L-shape TWSI (TGSI) configuration, and preferred to be located furthest out of the intersection which is also on the vehicle stop approach side. If the location is compromised in this layout, the L-shape orientation could be reversed. In the case of retrofitting, where space constraints

prevent the minimum requirements for the L-shape TWSI (TGSI) configuration, it is recommended that the installation of the guidance tiles be omitted, but this can only be affected by a rational design.

13. At signalised pedestrian crossings, the vehicular stop lines shall be installed at least 1.5 metres from the pedestrian crossing.
14. At signalised pedestrian crossings the signal timing shall be decreased to be between 0.8 metres and 1 metre per second. This is due to the reduced speed with which pedestrians cross vehicular roads: previously timing was 1.2 metres per second.
15. At un-signalised pedestrian crossings at intersections, the vehicular stop lines shall be installed, based on the location of the cadastral, and rationalised to increase pedestrian desire lines and safety.
16. All pedestrian crossings are to be marked with painted block crossings and dropped sidewalk areas for pedestrian crossing areas (kerb cuts or dropped sections) shall be as wide as the painted pedestrian crossing.
17. Sidewalk widths shall have no less than 1.2 metres of clear, unobstructed width when required for pedestrian only areas. In shared space configurations, where cyclists and other NMT users are to be accommodated on the sidewalk for safety, sidewalk widths shall have no less than 3 metres of clear, unobstructed width.
18. Where four or less all-inclusive vehicular lanes (with widths based on NTR number 4 - as indicated above) are required to be crossed by pedestrians or NNMT users in a single phase of traffic signalling and where there is a median island, the walkthrough portion of the median shall have no obstructions, no TWSI's (TGSI's), shall have the same road finish and markings as the remainder of the pedestrian crossing and shall have straight-up kerbs designating the through section of the median.
19. Where four or more all-inclusive vehicular lanes are required to be crossed by pedestrians or NMT users, a double pedestrian signal is required to allow pedestrians to cross the road in two phases, and this configuration shall be a staggered median and have at least 900mm clear width along the entire median. Staggered medians must offer pedestrians a safe area of refuge and sufficient manoeuvring space.
20. In-line with the base of the L-shape configuration, on the staggered median island, a set of 1.2 metre wide with two rows of 400mm wide TWSI (TGSI) warning tiles is required. Where TWSI (TGSI) is installed on median islands it must be level with the road surface.
21. In areas where IPTN are being installed, there shall be a reduction in vehicular travelling speed and the methodologies in the NMT Facility Guidelines, by the National Department of Transport (2015) shall be employed.
22. In pedestrian only areas, such as the sidewalk, where clear and open space does offer the opportunity for vehicles to enter the pedestrian only space, sufficient barriers or preventative measures for vehicles shall be installed in a rational design without obstructing the movement of pedestrians. This might include policing, additional enforcement or other methods to change the behaviour of drivers.
23. At the transition between the road and the sidewalk, where pedestrians and NMT users are at the road level and at the pedestrian crossing, a buffer zone of 300mm directly in



front of the TWSI (TGSi) warning tiles shall be installed. This buffer shall comply with the gradient and threshold requirements.

24. The sidewalk shall have a surface finish that enhances the use and detection of TWSI (TGSi) and shall comply with the gradient and threshold requirements.

The process of applying the National Technical Requirements, as listed here, is suggested to be broken down into the following three step design process, which is illustrated in the diagram below, showing the hierarchy and structure of the design process.

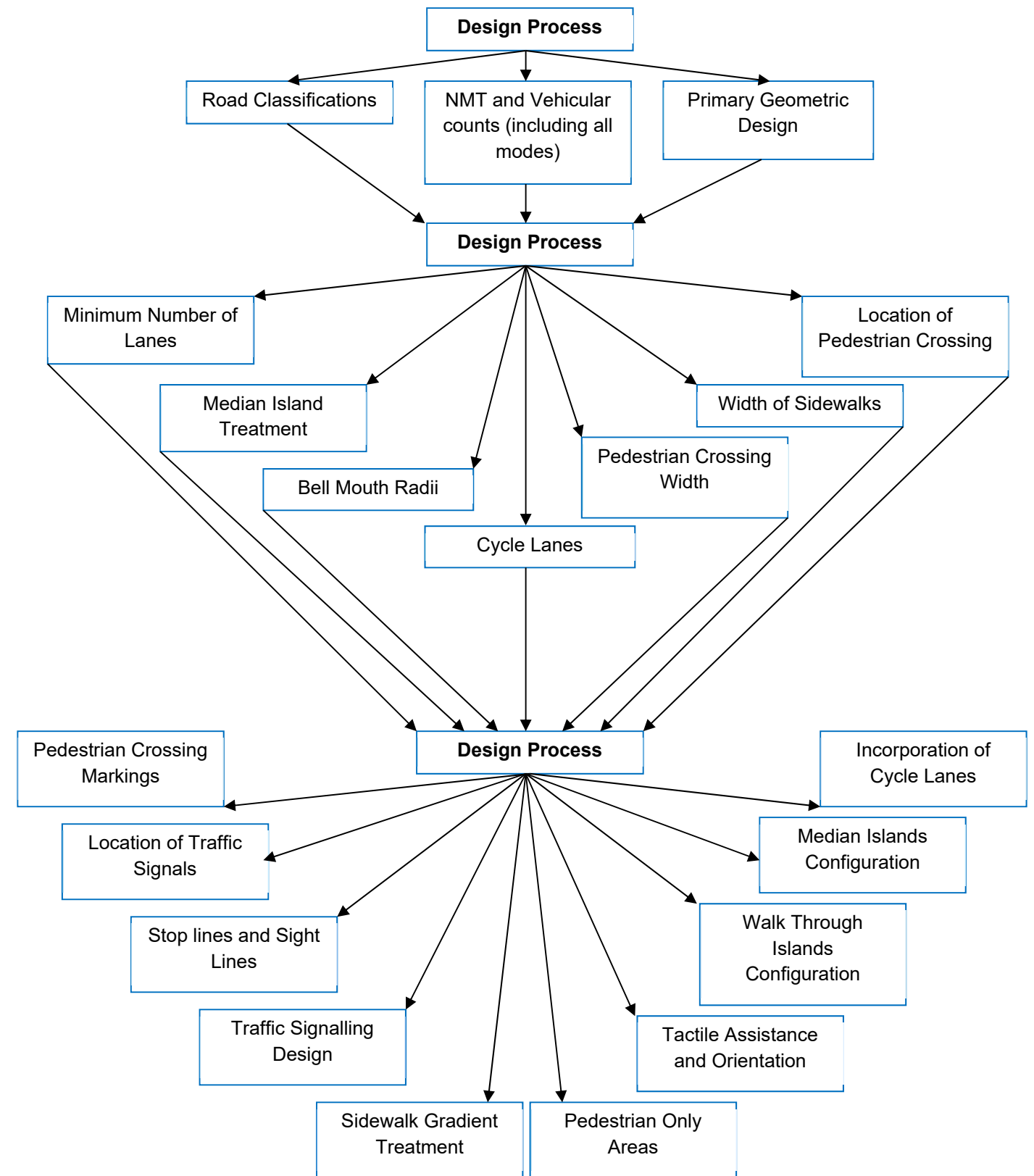


Figure 1: Flow diagram of design processes One, Two and Three as per the methodology of this NTR 1: Part 2 Pedestrian Crossings



4.1 Design Process One: Site Specific Research

At each intersection, road crossing or precinct where pedestrian crossings are to be installed, a detailed analysis of the immediate site or locality is required. This should be conducted based on the existing road network pedestrian and vehicle counts, as well as the proposed or predicted pedestrian and vehicular traffic flows. The potential and predicted increase in pedestrian and traffic demands will need to address the required Level of Service (LOS). The NTR 1: Part 1 has articulated the importance of including reliable statistics and data related to pedestrians and other NMT users, from the inception of the design process.

4.1.1. Road Classifications

Road classification and reclassification should be carefully analysed to determine if the road and surrounding area is safe for pedestrians and if it is appropriate to accommodate pedestrian crossings. During this assessment, a range of factors need to be considered, including catchment areas, NMT desire lines and vehicular speeds, to reduce conflicts, where possible, and increase the safety of pedestrians and other NMT users. Road classification will also define the number of lanes, as well as the minimum lane widths. The NTR 1 has largely been driven by the need to review pedestrian crossings around the development of new public transport systems. These road systems and the associated road classifications, where public transport routes are located, are required to accommodate safe and effective pedestrian infrastructure. It is possible to declassify a portion of a high order road around an intersection, trip attractor or stations. This primary design process will also determine where midblock crossings or intersections will be and whether they will require signalised control or if they can remain un-signalised

4.1.2. Vehicular Speed Reduction

Road classification on public transport networks should be reduced to the lowest classification possible and the operating speed should be reduced to the minimum viable speed to achieve the required vehicular LOS. This will ensure the reduction of the maximum speed which would have inherent benefits in following design processes two and three. It will also inform the reduction of the bell mouth and the vehicular lane widths. Both these significant factors assist in creating safer pedestrian and NMT facilities. Whilst there are other potential subliminal means of reducing vehicular speeds, lane widths and roadway throttling are also potential methods of speed reduction, which is clearly articulated in the NMT Facility Guidelines (NDoT, 2015: 94-108).

4.1.3. NMT and Vehicular Counts

Although current pedestrian counts may not indicate the true potential use of an area, specifically if there are little or no NMT facilities in place at the time of counts, it is essential to use the best information available to inform the development of safer pedestrian and NMT infrastructure. This data provides the foundation to predict the potential increase in the space required by pedestrian and NMT users. Vehicular modes, pedestrian LOS, as well as

pedestrian accident counts, are all primary information, in addition to other site specific research which will include existing desire lines and will all have direct design implications.

The counts for various modes of transport inform the current and predicted LOS (vehicles). Where LOS (vehicles) is less than required, the design of the facility can be adapted, so as to provide the required pedestrian LOS. For example, if the LOS (pedestrian) of a holding area for pedestrians at an intersection is inadequate, the redesign can create the required holding area; this approach should be applied to all other components of the NMT infrastructure associated with pedestrian crossings. The basis for these detailed calculations of the LOS for NMT facilities can be found in the Highway Capacity Manual (HCM); see, for example, the HCM (2000). Recent research into the walking speeds of South African pedestrians and the need to recognise the realistic walking speeds of elderly, blind and persons who experience other functional limitations that impact on their mobility, demand the review of pedestrian signal times for signalised intersections. Currently the pedestrian signal times are 1.2 metres per second, but in reference to NTR 1: Part 1 Pedestrian Crossings, it is recommended to be reduced to between 0.8 metres and 1 metre per second.

The required LOS (pedestrians) and UD requirements will differ from site to site, as would be expected; sites close to institutions that accommodate, either temporary or permanently vulnerable, NMT users, especially pedestrians that have sight or mobility functional limitations. This is specifically important for precincts that have institutions for blind or mobility impaired individuals, hospitals and schools. Pedestrian crossings in these areas should receive a higher LOS (pedestrian) and be afforded priority implementation or serial phase pedestrian signals. This would also include surrounding facilities and services that might attract or retain significant pedestrian activity, such as high density business and retail precincts. It is important to note that the basic L-shape TWSI (TGSi) configuration is still applicable to these areas, through rational design, and that the installation of long traversing strips of guidance tiles are not recommended along the length of pedestrian travel routes.

4.1.4. Primary Geometric Design

The vertical and horizontal alignment, as well as the lane widths and bell mouth radii, are fundamental criteria that impact on the potential to produce functional and safe pedestrian intersections. The geometric designs are further impacted on by road reserve widths and the required sight lines that inform the position of stop lines, especially for un-signalised intersections with pedestrian crossings. Basic geometric design at intersections, or midblock pedestrian crossings, should optimise safety and efficiency through simplifying designs for optimal pedestrian use, to foster the growth and expansion of NMT and, specifically, pedestrian movement. Bell mouth radii should be kept to a minimum and slip lanes should only be employed where absolutely essential to achieve appropriate performance (LOS for vehicles) from the intersection. Along public transport routes, a slip lane is only permissible if the operation of the intersection is significantly impacted on without it; other than this condition, slip lanes are to be removed as it has a negative effect on pedestrian movement. There has been a historic over-emphasis of vehicular traffic performance through intersections, over



functionality and safety of pedestrian crossings, therefore, it is imperative that geometric designs now address this imbalance.

4.1.5. Design Process One: Summary

The three areas of investigation in Design Process One of the methodology, that will determine the priority for upgrading to the design details specified in Design Processes Two and Three of the NTR1, are determined by the Road Classification. The LOS that is required for vehicular traffic should be balanced against, and equally important to, LOS for NMT and, more specifically, pedestrians. The number of lanes required for motorised vehicles and their expected speed will significantly impact on the ability of designers to achieve a functional and safe road space for pedestrians. Similarly, the primary geometry of an intersection will predetermine the bell mouth radii, location of pedestrian crossings and stop lines. This will impact on NMT paths of travel and these users' ability to navigate an accessible route. Maintenance, repairs, upgrading of infrastructure and new installations (green fields work), should all meet the technical requirements set out in the NTR1, as a priority. In this section the following four areas of prioritisation have been identified, starting with the highest priority:

- a) Areas related to or servicing public transport and public transport routes, as well as any areas of maintenance, upgrading, developments or green field work.
- b) Areas where accidents with pedestrians and NMT users occur.
- c) Special facilities – schools, higher education facilities, hospitals and other areas where high LOS (pedestrian) is required or expected (LOS according to the Highway Capacity Manual, 2010).
- d) Areas where complaints have been received about the safety of NMT facilities.

4.2 Design Process Two: Primary Design

Design Process Two focuses on reducing the priority afforded to vehicles and to provide increased priority to pedestrians. This process should focus on the more detailed parameters, which have been identified in the site specific Design Process One. Design Process Two also aims to minimise, through traffic and larger freight vehicles. This traffic cannot be removed from the design altogether; appropriate design can increase the difficulty with which these areas, which are predominantly for public transport, are navigated by larger freight and through traffic. This design process accommodates 12 metre buses for public transport, as well as fire engines and refuse collection vehicles. This design process, therefore, restricts large, articulated vehicles from entering high pedestrian density areas, which are services by public transport, and requires that these vehicles use straight routes and make use of depots.

4.2.1 Maximum Number of Lanes

A primary design parameter is to minimise the number of lanes that are required for efficient LOS for vehicles, considering road class, speed and pedestrian safety. It is essential to ensure that the combined road space is designed to optimise the space for the provision of NMT infrastructure, especially with respect to pedestrian crossings. The number of lanes determine the road crossing distance for pedestrians and will determine when a median island will be required, to provide an area of refuge for pedestrian safety. Four lanes, all inclusive (including bus lanes and all vehicular lanes, including turning lanes, irrespective of the direction of traffic flow) should be regarded as the maximum number of vehicular traffic lanes that a pedestrian can be required to cross in a single pedestrian signal and only two lanes for un-signalised pedestrian crossings. A median island with an adequate area of refuge should be provided once the total number of vehicle lanes exceeds these parameters or when the pedestrian is required to cross the road in multiple pedestrian signal phases. As mentioned in Design Process One, where possible, intersections should be designed to avoid or remove slip lanes, as these allow for the increase in vehicular speed and necessitate that pedestrians deviate from their path of travel in order to cross the road.

Based on the consultation with roadway design specialists, lane widths in areas where pedestrians are to be accommodated, should be no less than 3 metres and are not to exceed 3.5 metres. Although, in special situations, which are site specific, lane widths can be the absolute minimum of 2.8 metres. Ideally, lanes along pedestrian and NMT routes should be no wider than 3.2 metres.

Pedestrian bridges or underpasses may be considered in specific situations where the number of lanes are four or more, as well as where there are high density pedestrian counts and where the road class is three or higher, and the road class cannot be reduced to better accommodate pedestrians. Due to the overhead clearance height of roadway bridges, it is not feasible, in terms of space required and construction costs, to install ramps for pedestrian access and, therefore, overhead pedestrian bridges should be equipped with elevators to ensure universal access for all pedestrians and NMT users. As a result, it is important to note the additional costs in both installation and maintenance of pedestrian elevators, as these are required to be



operational at all times. In addition to this, pedestrian bridges need a rational design, signed off by a competent person. It is, therefore, recommended that an alternative, more accessible, long term solution be planned for, instead of overhead bridges.

4.2.2 Median Island Treatment

When the vehicular road width is less than four all-inclusive lanes (including bus lanes and all vehicular lanes, including turning lanes, irrespective of the direction of traffic flow) and there is an existing traffic island that pedestrians are expected to cross over under one signal, the traffic island should be as unobtrusive as possible to the pedestrian. These walk through islands should only be used under these conditions as detailed in Design Process Three. If there are four or less lanes and there is no existing traffic island, or no requirement to install a traffic island, pedestrian crossings are required to lead directly to the opposite sidewalk.

When the vehicular road width exceeds four all-inclusive lanes (including bus lanes and all vehicular lanes, including turning lanes, irrespective of the direction of traffic flow) and the pedestrians are expected to cross the vehicle road width under more than one signal, a staggered median island, with an area of refuge, should be provided. A staggered median island should have a clear and continuous, smooth and trafficable surface of absolutely no less than 0.9 metres in width, clear of all obstructions and installations, with a preferred clear width of 1.1 metres. The resultant width, including traffic signal poles, signage and kerbs, will be no less than 2.4 metres, all inclusive, measured from traffic facing kerb face to traffic facing kerb face. All such median islands are required to serve as an area of refuge for NMT users during a change in traffic signals. The area of refuge should be defined by the LOS (pedestrians) and the predicted peak pedestrian flows. Median islands that accommodate median trunk bus stations should have an overall width of no less than 4 metres, as this provides sufficient area of refuge and accommodates the minimum requirements for TWSI's (TGSIs), as detailed in Design Process Three.

4.2.3 Bell Mouth Radii

The size of bell mouth radii are directly related to the type of vehicles for which the roadway has been designed. Roadways should only accommodate vehicles appropriate to specific roadways and routes consistent with the approved road network design. Through the judicious use of geometric designs, larger vehicles should be encouraged to use alternative routes, especially where significant pedestrian movement is anticipated. Routes that service public transport should be regarded as high priority pedestrian routes. One of the significant mechanisms to discourage larger vehicles from using a specific route is the size of bell mouths. The size of bell mouth radii also influence the speed at which vehicles negotiate a traffic intersection. In addition to reducing speeds, smaller radii allow pedestrians to get closer to the intersection before they are then able to cross the road, reducing deviation from their path of travel. While 12 metre radii are allowed in terms of the NDoT, SARTSM, Volume 3, Section 5.2.9, for public transport environments, they should not exceed 10 metres and, preferably,

should be less than 8 metres. These criteria should be, specifically, applied along public transport routes and bell mouths with radii of 6 metres should be introduced, where possible.

4.2.4 Cycle Lanes

Design considerations for cycle lanes should be based on the site specific research, as outlined in Design Process One, and the NMT Guidelines published by the NDOT. This will determine the type of cycle lanes, if any, for incorporation along the route and through intersections and pedestrian crossings. Where arterial cycle lanes are provided it is recommended to have dedicated cycle lanes adjacent to vehicular traffic, where parking is not permitted. Feeder cycle routes should be included as mixed NMT facilities. The impact of cycle lanes on pedestrian crossings is important, as cyclists can be on the roadway and, therefore, generally are required to behave as vehicular traffic, whilst cyclists on mixed NMT facilities, predominately on the sidewalk, are required to generally behave as pedestrians. A clear understanding of the type of cyclist that has been anticipated on the route is essential to understand what type of cycle lane infrastructure is required. Where large volumes of commuting cyclists are anticipated, separated pedestrian, cycle and vehicle infrastructure should be provided. In these conditions intersections should be designed to avoid conflict between pedestrians and cyclists which will occur on mixed use infrastructure.

4.2.5 Location of Pedestrian Crossing

Due to the diversity of pedestrians catered for through NMT facilities, specifically along public transport routes, it is recommended that location of the pedestrian crossing is perpendicular to the sidewalk and kerb edge, as well as the passing vehicular traffic. This implies that the pedestrian crossing is installed as far out of the radius of the bell mouth as possible to assist with the correct orientation. This ninety degree orientation assists pedestrians who have visual functional limitations or who are blind, as well as offering pedestrians the shortest route when crossing the road, increasing pedestrian safety.

In extreme cases, where this cannot be achieved, the location of the pedestrian crossing should be according to the *first 20 degree rule*. This is, however, the last resort in terms of locating pedestrian crossings, and should only be installed in exceptional circumstances, such as areas around depots where the off-loading of larger freight vehicles to smaller vehicles, takes place. The *first 20 degree rule* dictates that the pedestrian crossings can only be located within the first 20 degrees of the bell mouth, on the outer edge of the intersection. The *20 degree rule* does deviate pedestrians and NMT users' desire lines to a small degree, but by allocating the area behind the curvature of the bell mouth to services, pedestrians will be encouraged to follow this path from one pedestrian crossing to the other. More clearly defined painted block markings for pedestrian crossings and crossings that provide the shortest route across the roadway will encourage pedestrians and NMT users to use the safe, protected and dedicated pedestrian areas.



It is acceptable to reposition the location of the pedestrian crossing marginally if in conflict with a manhole or the location of major services, but this is only applicable in cases where retrofitting is taking place. Optimally, this should not be displaced by more than a 1 metre from the preferred position.

4.2.6 Pedestrian Crossing Width

The minimum width of painted pedestrian crossings are required to be 2.4 metres wide (NDoT, 1998). As indicated in the example the below, where the minimum width of 2.4 metres is recommended to accommodate the other components of the pedestrian crossing, including the TWSI (TGSI) and orientation bollards. In the example, the crossing is widened in 1.2 metre increments up to a total of 4.8 metres wide, depending on the LOS, also determined in Design Process One. Where wider pedestrian crossings are justified, based on pedestrian volumes as required by Design Process One, especially along public transport routes, it is recommended that the crossing be no wider than 5 metres and must be painted for the entire width of the road surface, as detailed in NDoT, SARTSM, Volume 1, Section 7.2.4.2 and Volume 3, Section 4.6.8.



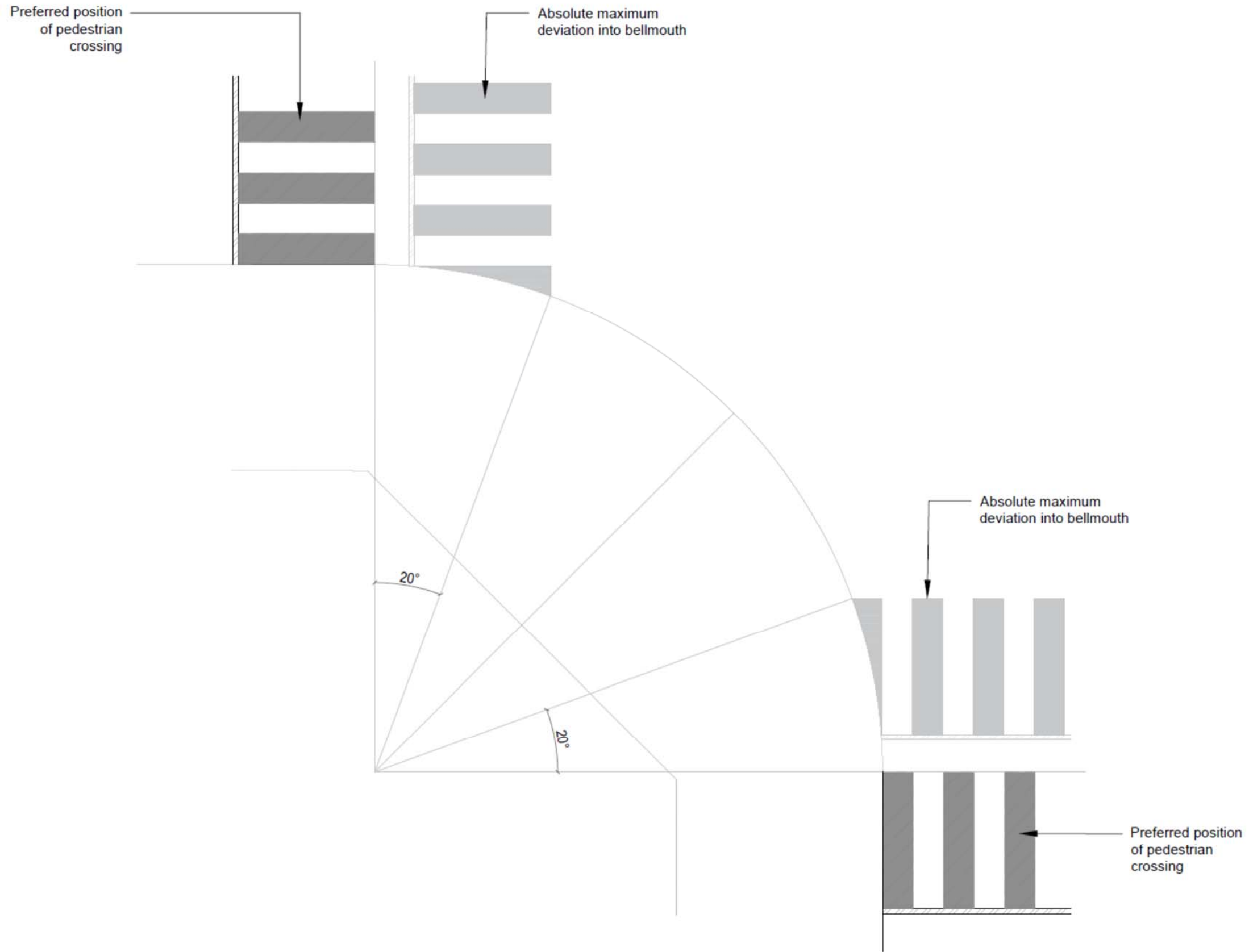


Figure 2: Technical Requirement - 20 Degree Rule. The location of the pedestrian crossing is preferred to be located out of the bell mouth radius but in cases where this is not possible, the location of the pedestrian crossing cannot be located further than 20 degrees from the start of the bell mouth curvature



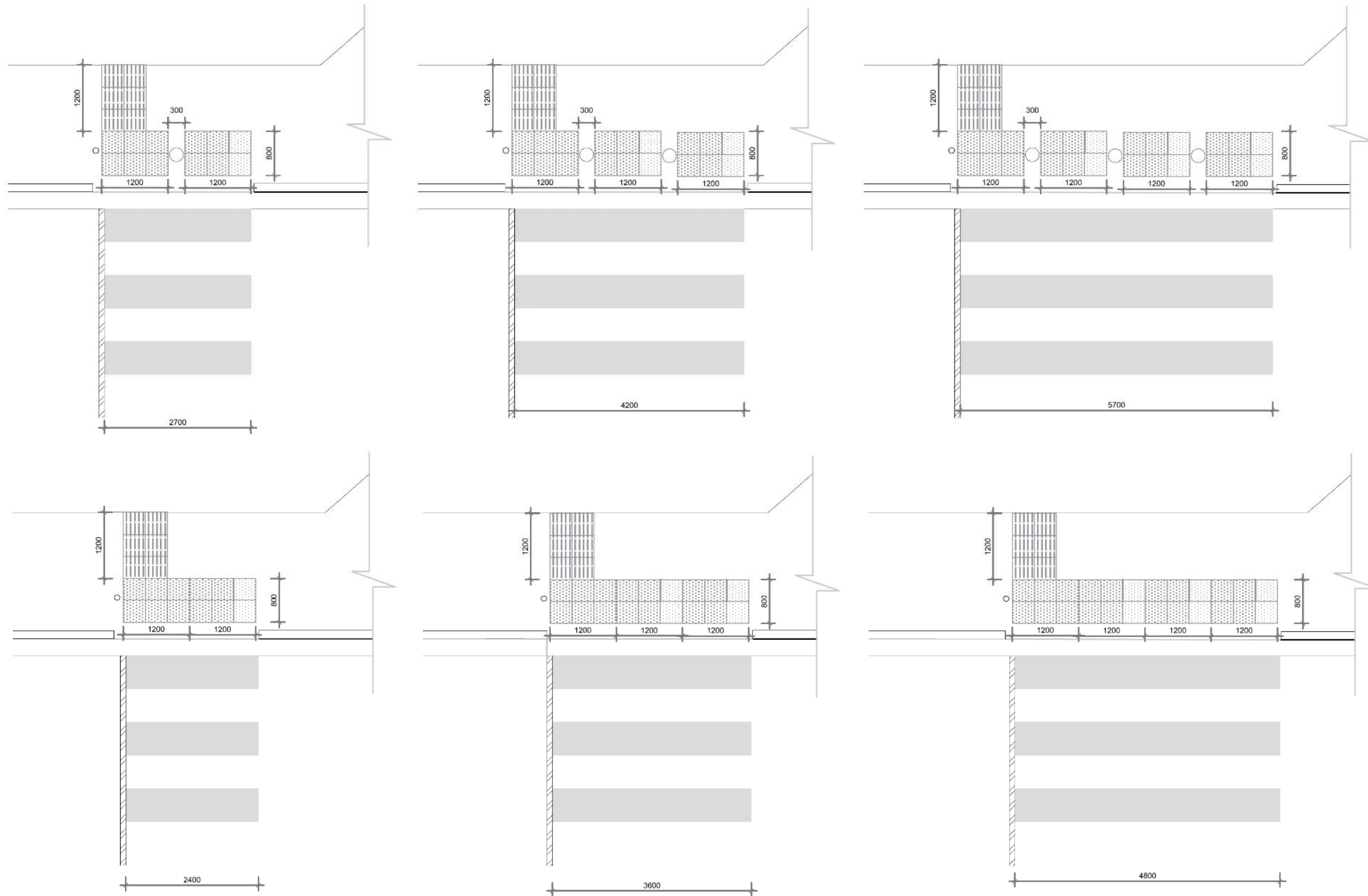


Figure 3: Series of images illustrating examples of incremental increases in the width of pedestrian crossings in areas where high volumes of pedestrians are present or expected at a signalised pedestrian crossing. The examples illustrate some design elements which can be multiplied when increasing a pedestrian crossing width, but includes the fixed location of the TWSI (TGSi) L-shape configuration, with the increasing width in the painted pedestrian block crossing marking - for the entire width of the crossing, with additional bollards - as required, fixed location of the traffic signal pole on the vehicular approach side of the crossing and the location of the rumble strip (optional), if required



4.2.7 Width of Sidewalks

Sidewalks are required to be of sufficient widths to accommodate the required accessible pedestrian gradients, at a ratio of 1:12 but preferred maximum of 1:15. Depending on the type of configuration used to provide the vertical transition to the roadway level and on the kerb height, the ramp length and required sidewalk space required to achieve this transition will be defined. A typical kerb set at 180mm above the roadway will dictate a ramp length of up to 2.2 metres at a maximum grade of 1:12 and 2.7 metres at a preferred gradient of 1:15. The preferred width of sidewalks is 3 metres with the minimum clear width of 1.5 metres to accommodate all types of pedestrians. A minimum passing distance around individual obstacles of 1.1 metres should be applied.

There are two options for achieving this required gradient along the sidewalk to get pedestrians to the road level before crossing the road. The first is a typical dropped kerb ramp, or kerb cut option, at 90 degrees to the direction of travel on the sidewalk. The second option is the dropping of the entire section of the sidewalk. In both cases the preferred gradient of 1:15 or 6.6%, with a maximum gradient of 1:12 or 8.3% and camber ratio 1:50 or 2%, should be provided as a level surface enabling neater drainage. Kerb cuts, with side slopes that exceed the maximum 1:12 gradient, cannot be regarded as trafficable surfaces and are potentially tripping hazards depending on the extent and gradient of the flare. The dropped kerb ramp option must align with the pedestrian crossing location and should have a clear passing width at the top of the ramp of 1.5 metres. Where the sidewalk is constrained the pedestrian has to wait on an inclined surface, which is not optimal for pedestrians with functional mobility limitations, such as parents with pushchairs and prams or walker and wheelchair users.

The dropped intersection option assumes the width of the sidewalk and is, therefore, the only option on a constrained sidewalk. The recommended width for sidewalks is 3.0 metres while the minimum width should not be less than 2.5 metres to accommodate standard signal poles and traffic signs. Although road reserve widths may dictate narrow sidewalk widths, the sidewalk width should never be reduced to less than 1.5 metres. The dropped intersection option allows the pedestrian to stand on a level waiting area and, through the use of a delineator barrier kerb, provides definition between the roadway and the sidewalk. This discourages all pedestrians from entering the roadway on the curvature of the bell mouth. The entire protected dropped intersection should have a 1:50 camber towards the road way to ensure that the dropped area remains drained. The dropped intersection necessitates the lowering of manhole covers, and other access panels on existing infrastructure, to the same level. This can increase the cost.

The decisions as to whether a dropped kerb or dropped intersection option can be applied will be dependent on the width of sidewalk. In certain cases additional sidewalk width can be acquired from the properties abutting the roadway, or by reclaiming sidewalk space taken to widen the road and by reducing the kerb radii. In the cases where sidewalks cannot be increased in width to accommodate the widths required by dropped kerbs or kerb cuts, the only compliant option is the dropped intersection.

The use of increased or flared sidewalk widths to throttle vehicle traffic and achieve vehicle speed reduction is promoted, with other possible throttling proposals, in the NMT Facility Guidelines.

Shelter and a pleasant walking environment is an important part of promoting NMT and can be served through planning of trees in the space for signage and utilities, located within the first 500mm from the kerb edge.

4.2.8 Design Process Two: Summary

The primary purpose of Design Process Two is to prioritise NMT safety, through speed reductions and, location of pedestrian crossings, enabling a safe transition for the pedestrian from the sidewalk level to the road level and back, to ensure that these systems are universally accessible to all pedestrians. In addition, Design Process Two addresses the need to manage driver behaviour, especially with respect to speed, and improve the visibility of pedestrians. Further, the design of pedestrian crossings so that pedestrians travel the shortest and most direct route across the roadway.



4.3 Design Process Three: Detailed Design

The detailed design of the pedestrian crossings should respond to the parameters and design decisions taken in Design Process One and Two. The optimal design will take into account all the interrelated components and dependencies that have been addressed in these processes. The following sections provide specific details that address these inter-relationships and provide solutions to optimise pedestrian movement and assist all NMT users to safely, independently and efficiently cross the roadway. As noted in the NTR 1: Part 1, the effectiveness of the TWSI (TGSi), as required by the broadly adopted SANS 784, has been questioned. Currently, research is being undertaken, with the assistance of IPTN Municipalities, to investigate the most appropriate and effective TWSI (TGSi) systems for use by people who are partially sighted or blind. Assessment is ongoing. Whilst there is a definitive agreement on an “L-shape” configuration, the final decision on certain aspects of the application of the TWSI (TGSi) guidance and warning tiles, is still subject to discussion. The current configuration of the TWSI’s (TGSi’s), as shown on the technical drawings, demonstrates all the tested options, at this stage, and further testing will continue.

Making pedestrian and NMT facilities attractive, encouraging walking and cycling, as well as developing a positive relationship between the members of the communities and their environment, is an important aspect to include in the design process, although it does not directly impact on pedestrian crossings. NTR 1: Part 1 Pedestrian Crossing, version 6 (2016).

4.3.1 Pedestrian Crossing Markings

National Department of Transport’s SADC RTSM, Volume 1, Section 6.2.5.2 notes that painted block pedestrian crossings can be used interchangeably with the more traditional “tram line” marking crossing lines, used both at signalised and un-signalised crossings. The increased visual impact of block crossing markings, as well as improved driver awareness of the significance and priority of the block pedestrian crossings, suggests that pedestrian safety will be enhanced by the universal use of block crossing markings at all pedestrian crossings. The more pronounced marking will also assist pedestrians to identify their demarcated crossing zone and will assist partially sighted pedestrians to identify the position of the crossing. In addition to this, the visibility of the “tram line” type markings degenerates faster with wear, as opposed to the larger block crossing markings. It must be stressed that where pedestrian crossings are installed without signalling, the appropriate road signage must accompany the painted block pedestrian crossing. This is also important at midblock pedestrian crossings where the pedestrian crossing is un-signalised. The additional painted road markings should be employed as per SADC RTSM (NDoT, 2012). To maximise the width of the first painted block on either side of the roadway, the painted block marking should be centralised and should always start with a painted block abutting the side channel/gutter.

4.3.2 Location of Traffic Signals

Particular to signalised intersections and midblock crossings with signalling, all primary traffic signals are to be located on the outer intersection edge of the pedestrian crossing. This implies that these signal poles are located furthest from the centre of the intersection. At midblock

crossings with single direction traffic, the signal pole should be on the opposite side to the approaching vehicle. The vehicular traffic signal should be installed at the vehicle approaching edge of the pedestrian crossing, once the crossing location has been identified (Design Process Two). This position should be directly in line with the outside edge of the pedestrian crossing. At bi-directional midblock crossings, the traffic signal can be located on either edge of the pedestrian crossings, but both signals should be on the same side of the pedestrian crossing. Single headed signal poles, with 500mm wide back plates, should be located 750mm from the vehicular traffic edge of the kerb on roadsides and can be installed at 350mm from the kerb line on median islands. The radius of bell mouths also impacts on the location of traffic signals; smaller bell mouths are therefore also preferred for the installation of traffic signals.

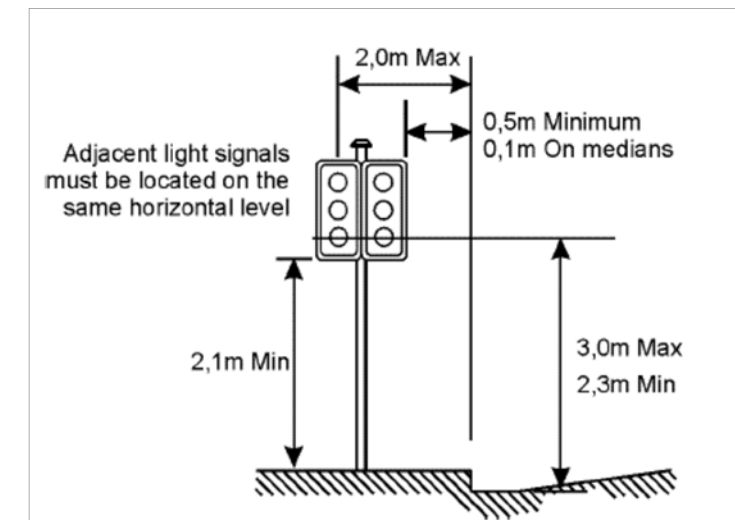


Figure 4: Indication of the location of a traffic signal pole from the edge of the kerb. Given that the width of the single headed traffic light is 500mm, the mounting pole is located in the middle, and the total distance that a single headed traffic light is required to be installed, from the edge of the kerb, is a total of 750mm. (SARTSM, Vol 3 Section 3.9.1.2 (b))

4.3.3 Traffic Signalling Design

Clearance times, through the intersection for vehicles and pedestrians, each have associated signal times which are interrelated and impact on the efficiency and LOS of an intersection for both pedestrians and vehicles. Dedicated pedestrian signal phasing is preferred along public transport routes with increased pedestrian density, as well as along routes where the top two orders of priority, according to Design Process One, have been identified. In lower volume pedestrian areas, actuated pedestrian crossing signalling could be installed, as is the case at most signalised midblock crossings. All light signalling for pedestrians should incorporate audio signals and, in cases where actuation is required, additional audio signals to assist in locating the actuator could be provided. Audio signals and push buttons should only be located on the signal pole aligned with the outer edge of the pedestrian crossings. In cases where pedestrians are required to cross the road in two phases of traffic signalling, with the appropriate waiting space and period on a median island, additional traffic signalling is required on the median, and where applicable, with actuators and audio signals. Dedicated pedestrian signal phases are better suited to high traffic volumes and pedestrian volumes, as it also allows for better traffic flow through congested areas and allows for pedestrian priority. Research shows that the current signal timing is not sufficient for South African pedestrians and that the

time per metre should be decreased to between 0.8 metre and 1 metre per second (refer to Figure 8, page 36 of the NTR 1: Part 1 Pedestrian Crossings). The total time allocated for pedestrian crossing signal phases is, therefore, dependent on the road width with an additional 0.7 seconds of green man in the pedestrian signalling phase, prior to the time assigned for the pedestrians to safely start crossing the road. Pedestrian signalling currently reads: green man (safe to start walking over the road), flashing red man (not safe to start walking over the road and people crossing already should hurry over the road) and then solid red man (stop and clear the road, and no road crossing for pedestrians). In practice, pedestrians assume that they can still enter the roadway on the flashing red man. A more intuitive system would be to provide a green walking man and a static red man, and this may be more easily understood by vehicle drivers, pedestrians and NMT users. However, this would need to be extensively tested before this recommendation could be implemented.

It is advisable, when specifying the use of the audible warning signals at signalised pedestrian crossings, to obtain additional testing and vetting from users, particularly people who are blind. The viability of the audible warnings is dependent on driver behaviour, which currently does not support the safe use of these systems, as drivers disregard the priority given to pedestrians crossing with green signal priority (and even more so, on a right turning signal, where drivers are meant to yield to pedestrians who have right of way). This is especially the case where right turning vehicles disregard the pedestrian priority, and as blind pedestrians cannot see the oncoming risk, and assume that they have priority afforded by the audio signal. The use of demand driven signalling from pedestrian push buttons should be employed on intersections where a demand driven serial signals phase can be accommodated.

4.3.4 Stop Lines and Sight Lines

At signal controlled intersections or pedestrian crossings, sightlines are not as significant as the traffic un-signalised stop and yield configurations. Vehicle stop lines are then required to be installed between 0.9 metres and 3 metres from the approach edge of the pedestrian crossing. To enhance the safety of pedestrians, it is recommended that the vehicle stop line be located at least 1.5 metres from the vehicle approaching edge of the pedestrian crossing. At un-signalised crossings the vehicle stop lines should be located at least 1.5 metres from the pedestrian crossing, however, where sight lines are seriously compromised, they may be reduced to 1.0 metres. Sight lines must be calculated based on the location of the cadastral boundaries of properties abutting the road reserve. The reduction of the bell mouth radii, clearing or removal of obstructions in the road reserve, will enhance the sight lines, and the functionality of pedestrian crossings. For further research into this please refer to NTR 1: Part 1 Pedestrian Crossings, version 6, (2016).

4.3.5 Sidewalk Gradient Treatment

In order to achieve the required gradients and camber on sidewalks with the installation of compliant gradients, the following sidewalk space is required to get pedestrians to the road at road level at the ideal gradient ratio of 1:20, the preferred gradient ratio of 1:15 and the maximum gradient ratio of 1:12. The ideal and preferred gradients of 1:20 and 1:15 offers a better gradient on waiting surfaces at kerb cuts at the road edge and, due to the variation of

construction standards, the preferred gradient gives an acceptable tolerance for error (NDoT, 2016a).

Table 1: Required width of area where gradients for pedestrians, at the maximum and preferred gradient ratios, are to be installed. Table indicates the variable for different kerb heights

Kerb Height	Length of ramp @ 1:20 (ideal gradient)	Landing/Walkway	Total Width Required
120mm	2400mm	1500mm	3900mm
140mm	2800mm	1500mm	4300mm
150mm	3000mm	1500mm	4500mm
160mm	3200mm	1500mm	4700mm
180mm	3600mm	1500mm	5100mm
200mm	4000mm	1500mm	5500mm

Kerb Height	Length of ramp @ 1:15 (preferred gradient)	Landing/Walkway	Total Width Required
120mm	1800mm	1500mm	3300mm
140mm	2100mm	1500mm	3600mm
150mm	2250mm	1500mm	3750mm
160mm	2400mm	1500mm	3900mm
180mm	2700mm	1500mm	4200mm
200mm	3000mm	1500mm	4500mm

Kerb Height	Length of ramp @ 1:12 (maximum gradient)	Landing/Walkway	Total Width Required
120mm	1440mm	1500mm	2940mm
140mm	1680mm	1500mm	3180mm
150mm	1800mm	1500mm	3300mm
160mm	1920mm	1500mm	3420mm
180mm	2160mm	1500mm	3660mm
200mm	2400mm	1500mm	3900mm

Kerb heights in Table 1 are indicative; the length of the ramp is calculated on the required maximum gradient of 1:12 and the preferred gradient of 1:15; the landing space is the level area at the top of the gradient that is required as a walkway for passing pedestrians (where applicable), as well as providing a level area for wheelchair users before or after proceeding through the ramped area. The final column is the total space that is required on the sidewalk in order to accommodate a compliant ramp configuration with one landing.



With a dropped kerb, or kerb cut option, the lower landing is assumed to be in the roadway, while the upper landing space at the top duplicates the walkway. The total space required for the installation of the ramped surfaces has to be accommodated in the width of the sidewalk, because the ramped surface has to be in alignment with the pedestrian crossing.

The dropped intersection option uses the length of the sidewalk, in the direction of travel, to achieve the landings and the desired gradient. In this option there is more available space to run the preferred gradient of 1:15. A 180mm kerb requires 2.7 metres for the ramp, as the landing is formed by the sidewalk, and the waiting area at the edge of the pedestrian crossing is level. To prevent undulating walking surfaces in the area behind the bell mouth kerb, the entire area could be kept level with the road surface, until the adjacent pedestrian crossing is reached, and then the gradient leads up to the kerb height again. Drainage of the dropped area should be achieved by maintaining a 1:50 camber towards the roadway, and designing for kerb inlets and the use of v-channels and side channels should be considered.

It is important to maintain the standard drainage regime of side channels or gutters through the use of shallow v-channels which provide continuity across the dropped kerb or kerb cut. In the technical drawings responding to the design processes, the sidewalk slope of the 600mm v-channels has been used to create the 300mm buffer between the road edge and the start of the pedestrian only space. This buffer could be installed in various options, as long as the gradient of 12% is maintained to provide a safe vertical curve through the v-channel for wheelchair users.

With retrofit applications into existing infrastructure, dropped intersections have potential additional cost implications, due to the required adjustment of manholes, access panels and other certain reticulation, where there is no cost on new infrastructure or where material realignment occurs. In both configurations, certain services need to be relocated due to conflicting positions with the ramps and TWSI (TGSI). Ideally, these should be relocated out of the pedestrian's path of travel and located behind the curvature of the bell mouth with the required sidewalk width clear of obstructions (see 4.2.7 Width of Sidewalks).

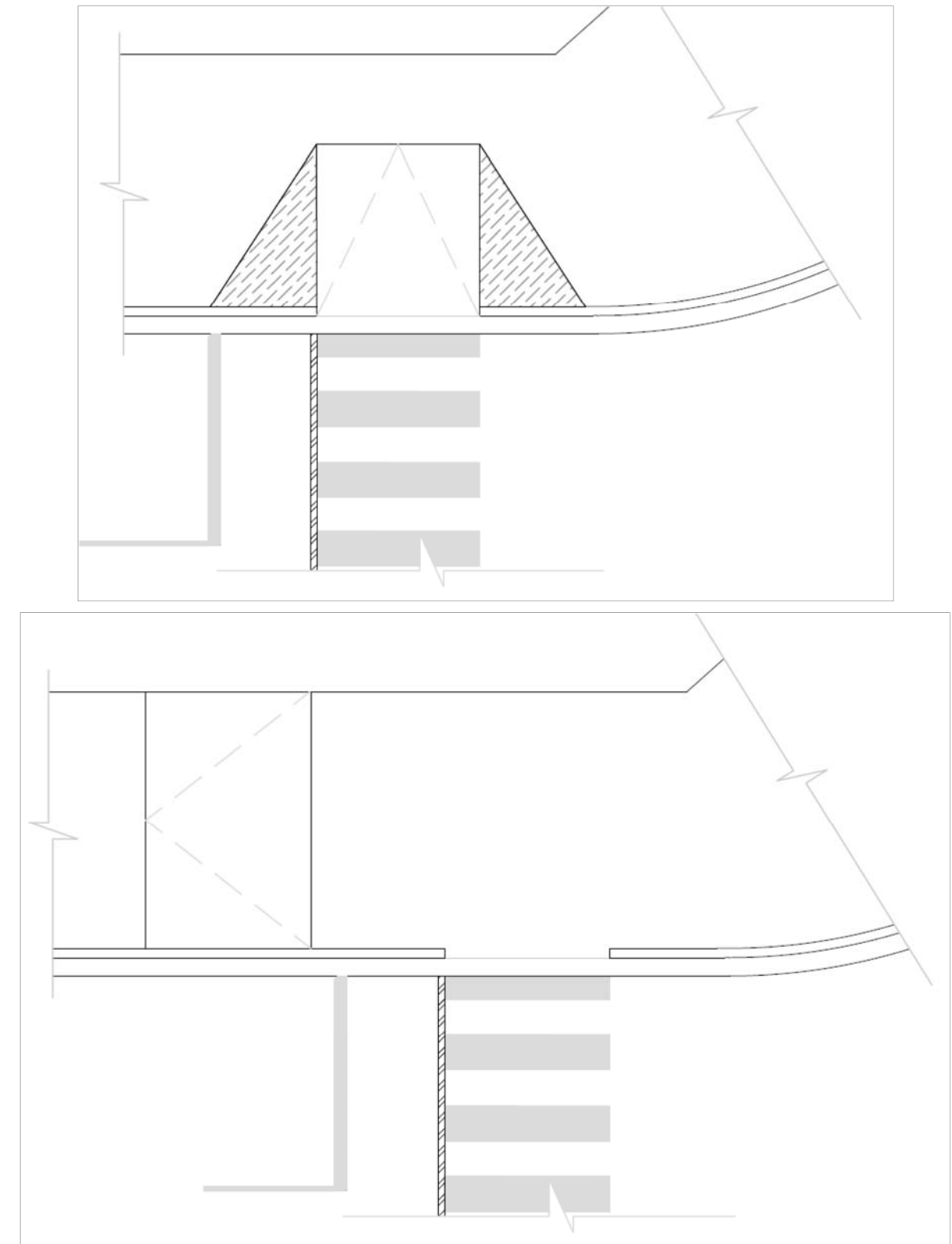


Figure 5: Basic design option layouts of required geometry for kerb cut and dropped intersection configurations, at a pedestrian crossing, before the TWSI (TGSI) are installed. Note the alignment out of the bell mouth radius, the direction of the gradient and the position of the rumble strip (if included) in the two configurations. It is to be noted that the shaded area, on the drawing of the kerb cut, is an un-trafficable surface due to the steep gradients that typically occur at these configurations.



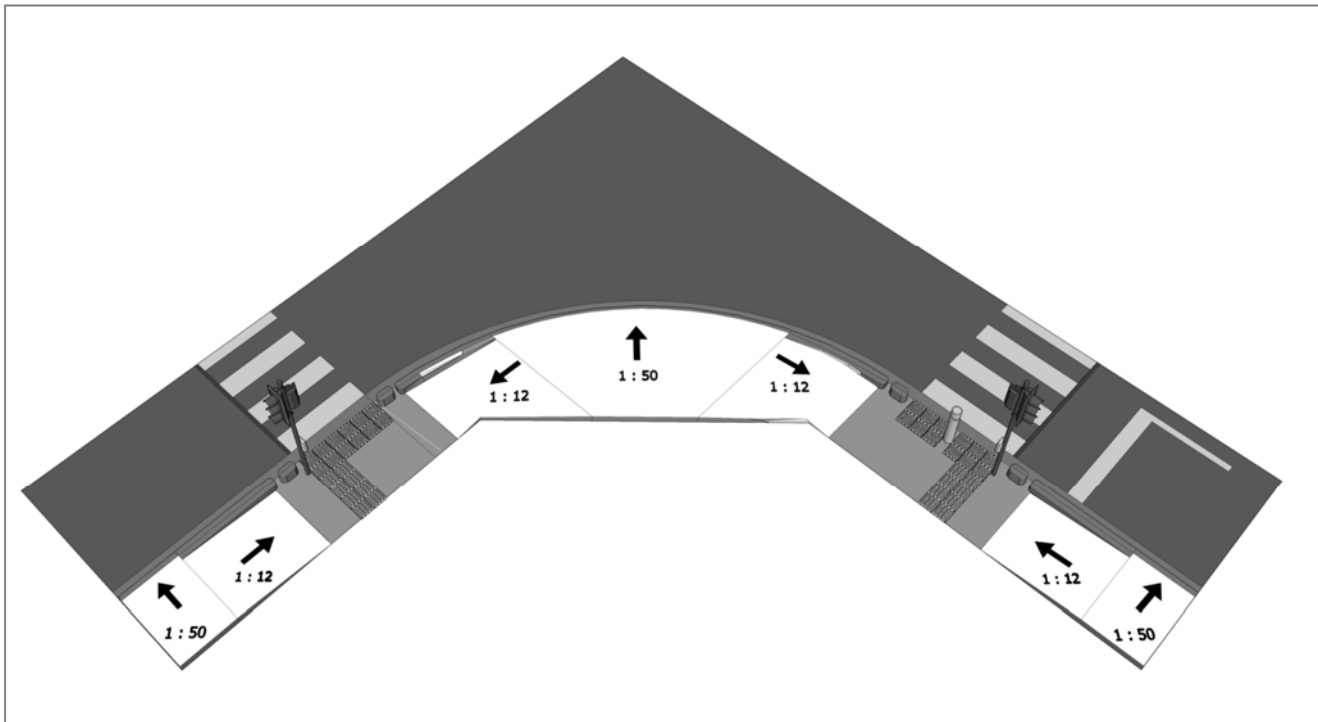
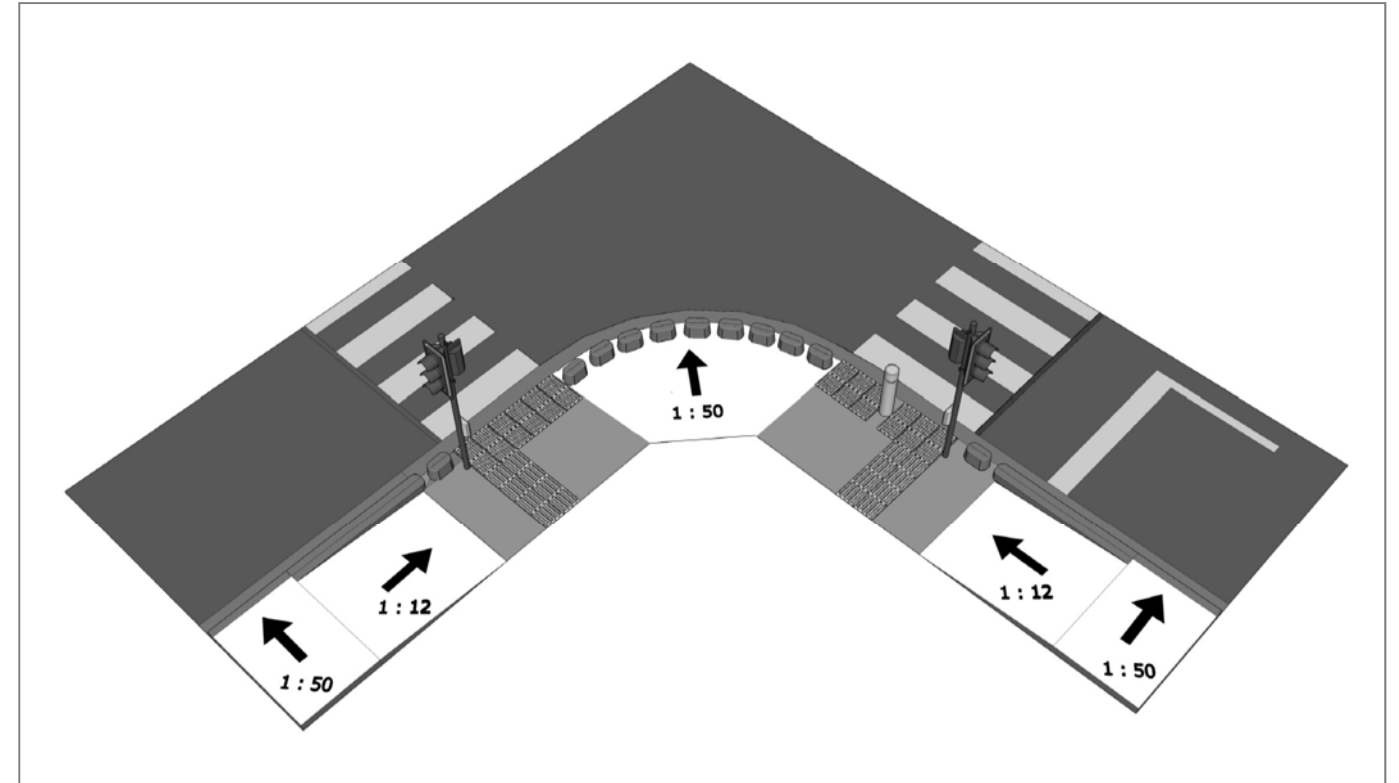
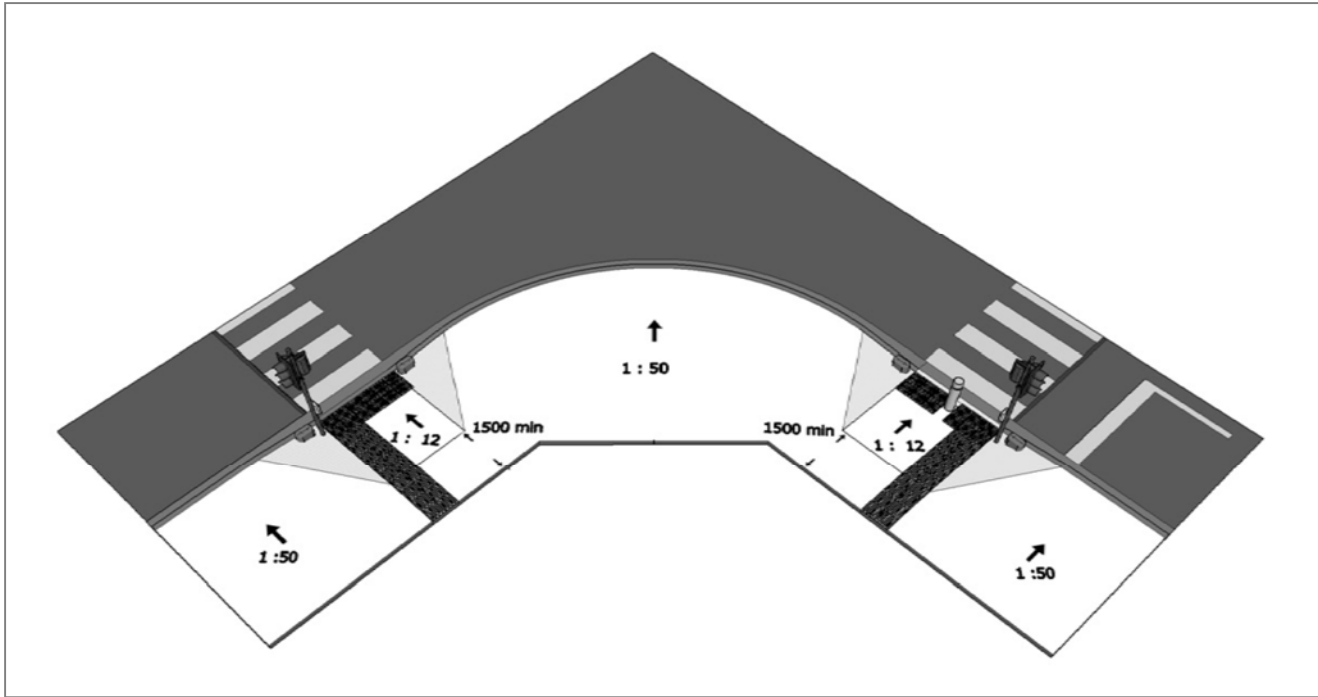


Figure 6: The illustrations of design configurations that would meet the technical recommendations, as set out in NTR1. First illustrated is the kerb cut configuration with the requirements for a landing at the top of the graded surface. Second illustrated is the dropped configuration with a raised area behind the bell mouth radii, to retain existing services. Last illustrated is the dropped configuration that extends for the entire intersection and makes use of higher delineator kerbs. All examples illustrate the configuration installations without bollards (the roadway approaching from the right) as well as illustrating the configurations with bollards in the preferred locations. Though optional, they prevent vehicle access to pedestrian only areas (see the next section below). All examples shall consider drainage. Note the fixed installation of the L-shape of TWSI (TGSI), the location of the traffic signal pole, preferred gradients, painted block pedestrian crossing and the rumble strip (if included)

4.3.6 Pedestrian Only Areas

In dropped kerbs or kerb cuts configurations and dropped intersection configurations, a ramp or opening in the kerb line, at least 2.4 metres wide, occurs. This creates a condition where drivers of vehicles can gain access, accidentally or intentionally, onto the sidewalk. An example of how this could be prevented, might be through the rational application of bollards, which should then be installed at 1.2 metre intervals in conjunction with delineator kerbs to prevent vehicular access. Alternative, preventative measures can be employed on the condition that the thoroughfare space for pedestrians is not less than 1.2 metres and not more than 1.5, as this will allow vehicle access. In addition, other measures could be employed, as indicated in requirement number 22.

In cases where bollards are preferred, it is recommended that smooth concrete surface bollards with a width of 250mm in diameter, and which are 1.2 metres in height, be used.





Figure 7: Bollards are largely installed to prevent vehicles from accessing and misusing pedestrian only areas. Bollards, and the installation thereof, are recommended but not listed as a technical requirement for NMT1 and, therefore, remain the prerogative of the designers/engineers or Municipality. If bollards are to be installed, it is recommended that they be installed according to the drawings in other parts of this NTR1 document



Figure 8: The misuse of kerb cut areas by vehicle drivers is common at both signalised and un-signalised intersections. Bollards, and the installation thereof, are recommended but not listed as a technical requirement for NMT1 and, therefore, remain the prerogative of the designers/engineers or Municipality. If bollards are to be installed it is recommended that they be installed according to the drawings in other parts of this NTR1 document

At the dropped intersection configuration it is important that the delineator kerbs are provided around the bell mouth radius. Currently, this can be achieved by placing two Figure 3 kerbs, or the standard road edge kerbs, in a back to back configuration. In the future, it is

recommended that a high profile bullnose delineator kerb, at least 300mm in height with rounded edges, be produced for this purpose, but until these are available as standard items, current installations have made use of standard Figure 3 kerbs in a back to back configuration. This provides definition and protection for pedestrians in the dropped pedestrian area. All kerbs installed at a dropped intersection configuration, in the area of the bell mouth radius, must allow spacing of 50mm between each kerb, to provide drainage from the 1:50 or 2% sloped surface. To improve visibility and increase awareness of the delineator kerb, for both pedestrians and drivers, it is recommended that they are painted with road paint in the conventional alternate black and white kerb markings. For further research into this please refer to NTR 1: Part 1 Pedestrian Crossings, version 6, (2016).

4.3.7 Tactile Assistance and Orientation

To assist a person who is partially sighted or blind to safely, independently and efficiently cross a road, there are several interventions that are required at pedestrian crossings. Upon approach to the pedestrian crossing, it is essential to provide Tactile Walking Surface Indicators (TWSI, also known as TGSIs - see terms and definitions) to guide them to safely cross the road. Directional guidance tiles, leading from the back edge of the sidewalk, should be laid across the side walk in the direction of the crossing in line with the outer edge of the block markings. To facilitate the detection of this guidance strip, the tiles should be laid in configurations that are 800mm wide. This width has been verified through testing of configurations that are 400mm, 600mm and 800mm wide. The guidance should link to an 800mm x 1200mm configuration of warning tiles, which extend at 90 degrees from the guidance strip in an "L" configuration. This panel of warning tiles should be aligned at 90 degrees to the direction of the pedestrian crossings and parallel to a straight kerb line. Where the pedestrian crossing is located within the first 20 degrees of the curvature of the bell mouth, it is essential that the warning tiles should still be aligned at 90 degrees to the pedestrian crossing, and not aligned to the curvature of the kerb line. The narrow space remaining in front of the double row of tactile warning tiles is to be filled with a level concrete surface to increase the detect-ability of the front edge of the warning tiles.

The length of the guidance strip should be the full width of the sidewalk and at least 1.2 metres in length. Should the adjacent property boundary be angled, the guidance strip can be cranked at 45 degrees to align with the boundary. Forty-five degree changes in direction have proved to be the most detectable change in direction of TWSI's (TGSIs), during onsite testing (NTR 1: Part 1 Pedestrian Crossings). Tactile warning tiles are also useful indicators for any pedestrians, or NMT users, as they provide a detectable surface under foot which provides a warning that the pedestrian is moving into a roadway or zone that is being used by vehicles. In view of this, an 800mm wide band of warning tiles should be provided across the entire width of the pedestrian crossing, where pedestrians enter the roadway. When pedestrian crossings are positioned within the context of the 20 degree rule, the additional set of warning tactile tiles could be installed in such a manner that they are cut to the shape of the bell mouth, but the L-shape configuration must remain uncut and perpendicular. This installation can occur with, and without, a bollard (or more as required for the width of the crossing). The set of warning tiles



should be installed for the width of the pedestrian crossing. Pedestrians wearing footwear with pronounced heels may experience certain discomfort when negotiating these warning tiles. The NTR 1: Pedestrian Crossings does not promote the use of tactile tiles anywhere, other than at pedestrian crossings, although there may be other applications beyond the research undertaken as with the NTR 1. Refer to Figure 3, which illustrates the incremental increase in width of the pedestrian crossing.

In the research that has been undertaken with blind users, it has been established that they require an additional orientation aid to assist them in walking directly over the pedestrian crossing, which depends on the various user preferences and abilities. The edge of the warning tiles against the side, or V channel, is detectable by some long cane users, but this has not proved to be universally detectable. The location of the traffic signal pole, at signalised traffic intersections or midblock crossings, serves as an important orientation aid and, together with an aligned bollard, installed 1.2 metres away at 90 degrees to the signal pole, this has been verified during the site based research. It is important that the signal pole, which is located 750mm from the edge of the road, be aligned with the outer edge of the pedestrian crossing. The position of the bollard, in this alignment, prevents vehicles from entering the pedestrian and NMT only area.

During site research the use of audible environmental information was very evident, as well as the TWSI (TGSi) aid users, with spatial and directional orientation. "Inserting more tiles into wide radii kerbs makes way-finding more confusing. The maximum kerb radii in a public transport environment is 10 metres." (NDoT, 2016a: 8) "The layout of tiles on wide radii will be the subject of a more in depth research study which the Working Group on TGSi will carry out" (NDoT, 2016a: 8) – this is in reference to the SABS SE5904 Working Group.

In addition to this, the research identified that it would be very useful if it was possible to provide a tactile strip across the road to guide partially sighted and blind pedestrians across the full width of the roadway. This will increase the speed at which these pedestrians are able to cross the roadway, as well as an increase in their confidence and ability to independently navigate pedestrian crossings. It is recommended that a rumble strip guidance line be installed across the outer edge of the pedestrian crossings, to assist long cane users to successfully cross the roadway.

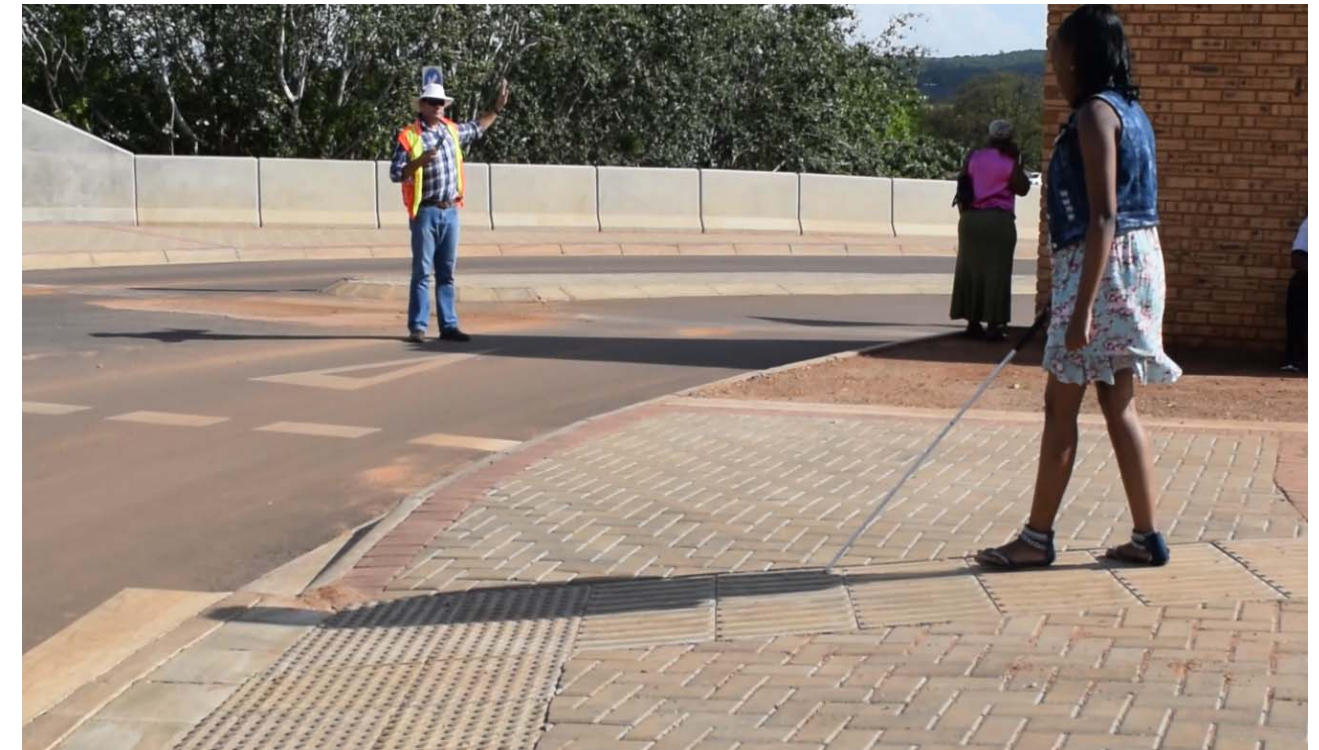


Figure 9: White cane user making use of the L-shape configuration to orientate herself to cross the road. Testing took place in Tshwane on the 17th Nov 2016



Figure 10: Recommended rumble strip that was installed for testing in Tshwane on 17th Nov 2016, served as a very useful assistive feature for people who are blind to enable them to cross the road successfully

4.3.8 Walk Through Islands Configuration

At traffic islands where pedestrians are expected to cross during their single road crossing phase, the island should have straight, regular kerbs, usually Figure 1 or 2 kerbs, demarcating the pedestrian crossings on either side. The surface finish of the walk through island should be the same material and texture as the road surface, with the continuous painted pedestrian block crossing markings running through the island. This continuity will ensure that pedestrians, especially those who are partially sighted or blind, who are not able to distinguish the island, and walk through pedestrian crossings without hesitation, cross the entire roadway in a single crossing sequence. In the GIBB proposal to Tshwane, the walk through median is also illustrated as a straight through walking area without any obstructions in the path of pedestrian travel (GIBB, 2011: TGSI 011), as these median islands do not offer a safe space to harbour pedestrians and NMT users safely, and should be regarded as a single and continuous path of travel.

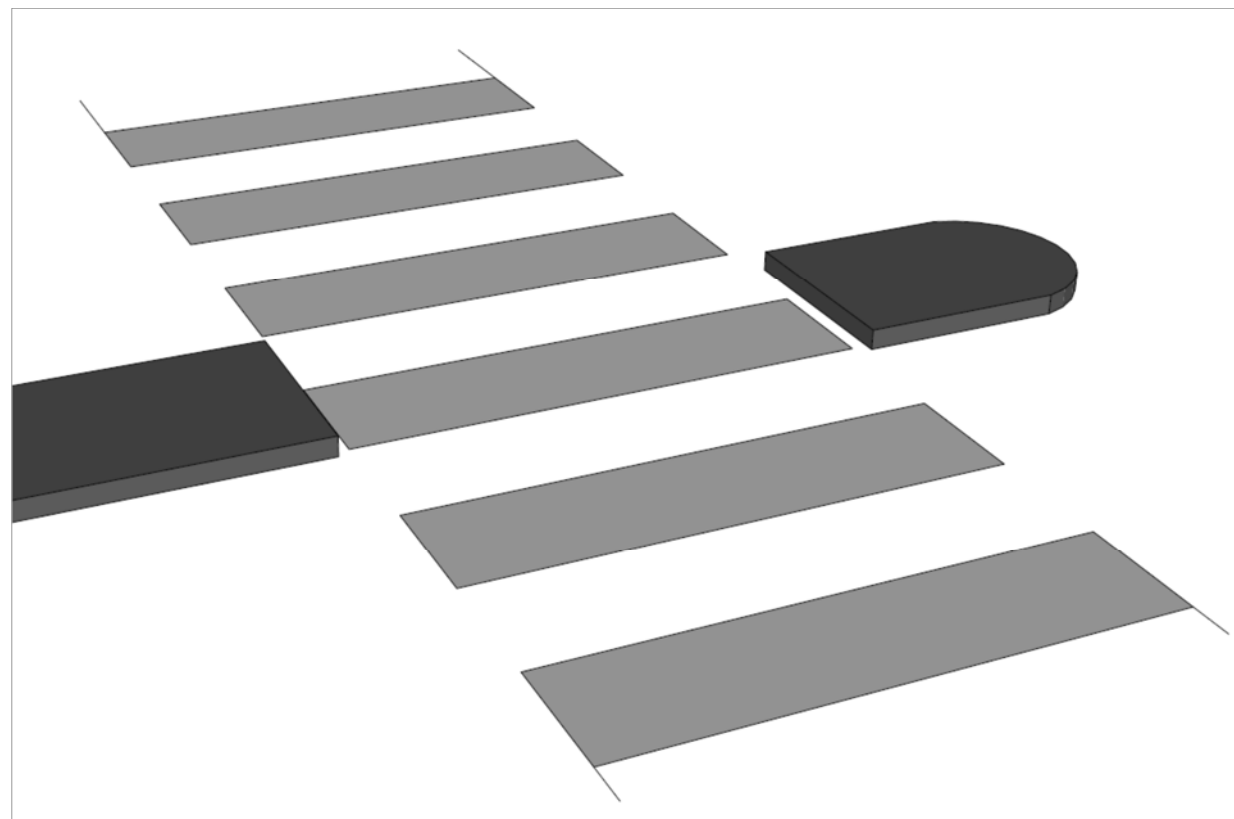


Figure 11: Illustration of a walk through island, where the section through the island is the same surface as the road surface, as well as having the continued pedestrian block crossing markings and the pedestrian crossing is demarcated with the same kerb configuration as the remainder of the island

4.3.9 Median and Slip Lane Island Configurations

Median islands offer pedestrians safety whilst crossing roads with more than four, all-inclusive lanes, and the pedestrian path should be provided at road level with a maximum camber of ratio of 1:50 or 2%. The road level crossing is required as there is, generally, insufficient space to accommodate ramps at a gradient of 1:15 or 6.6% in the space available. The effective clear walkway width of 1.1 metre should be maintained throughout the median island, when passing individual obstacles. The pedestrian block crossings must be staggered to obviate pedestrians

confusing the median islands with walk through islands. The dropped walking area, along the stagger of the median island, should be protected with upright delineator kerbs on either side. The stagger is preferred to be to the right when crossing from the vehicle approaching side, as this assists with vehicle stacking through intersections as well as allowing for better vision of pedestrians crossing for oncoming vehicular traffic. Signalling that is installed at the intersection should also be installed at the median, and should be either actuated, or automatic, pedestrian signalling.

In cases where the slip lane must be provided or remain, and cannot be removed through the design process, a slip lane island should be constructed to comply with the requirements of median islands. Signalling should be installed to assist pedestrians through the intersection safely. The pedestrian crossing location should be as close as possible to the centre of the island.

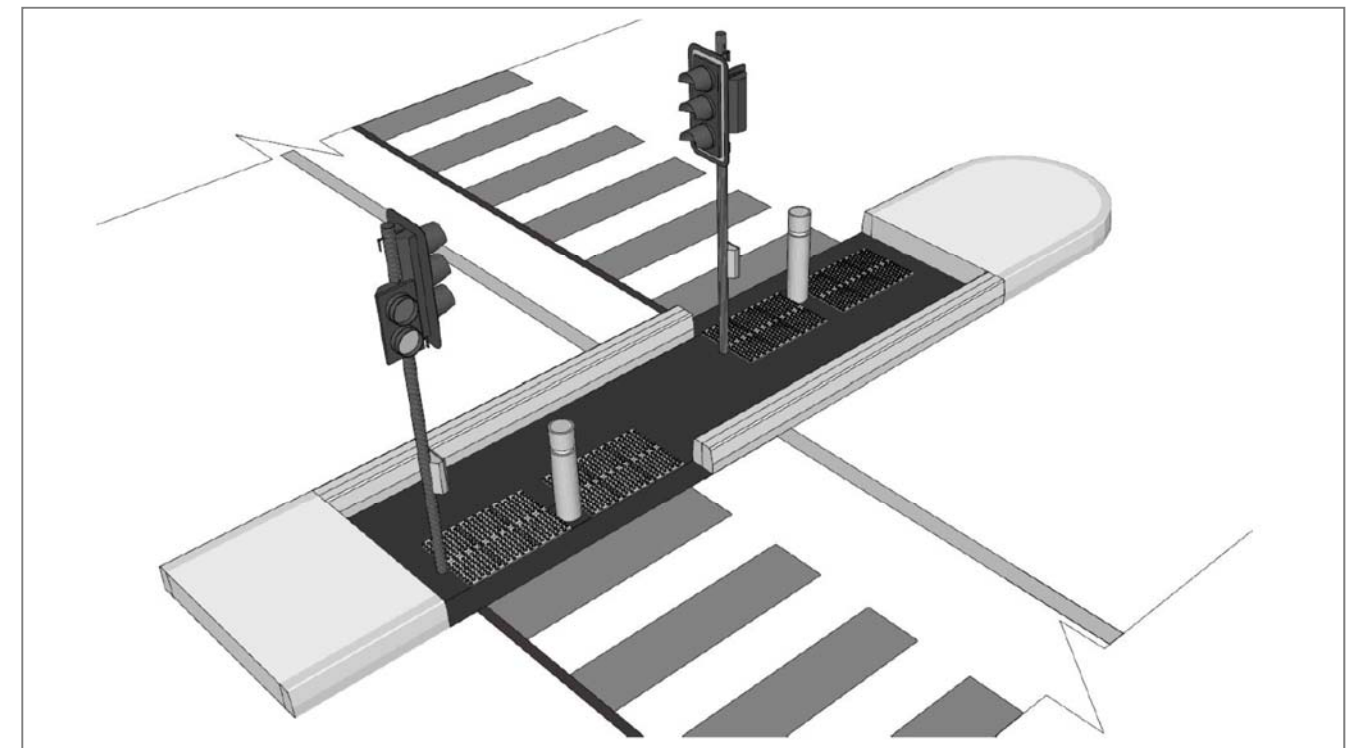


Figure 12: Illustration of a staggered median island as an example of a stagger to the right. According to the technical requirements, is the location of the traffic signal, painted pedestrian block crossing, rumble strip (if included) and dropped area for walking surface to be at least 1.1 metres clear of all obstructions.

4.3.10 Incorporation of Cycle Lanes

Along cycle feeder routes, where shared space for cyclists is incorporated, cyclists are required to behave as pedestrians at intersections and at pedestrian crossings. Mixed NMT facilities are required to have the appropriate signage, which should not pose an obstruction or reduce the overall path of travel for pedestrians, and other NMT users, and should be a minimum of 3 metres wide. Users of a mixed use NMT facility could include young children on pedal bicycles, skateboarders, people on rollerblades, families with push chairs and prams and people with

mobility aids, such as wheelchairs, walkers or white canes. On most main cycle arterials, cyclists are accommodated on the road surface, with a dedicated and clearly distinguishable lane with appropriate markings for safety. These cycle lanes can be supported by bicycle boxes, where the stop line is set 2 metres from the outer edge of the pedestrian crossings. Cycle lanes should not exceed 1.2 metres in width, to prevent the use of these lanes by motorists, and it also promotes a condition for cyclists to ride in single file to further increase their own safety. Colour differentiations on the surfaces of cycle lanes are better comprehended by cyclists and motorists alike. Tactile surfaces, specifically guidance or directional tiles, create problems for all cyclists. For further information on cycle lanes, and their incorporation into the road space, please refer to the NMT Facility Guidelines (NDoT, 2015).

4.3.11 Additional Public Transport Recommendations

It is recommended that all bus stops for any public transport networks are located downstream of the intersection, to ensure that the location of pedestrian crossings can occur behind the bus while halted at the bus stop. This provides increased visibility through the intersection by other vehicle drivers, as well as any other NMT users, and allows pedestrians to cross the road behind the buses, increasing safety for pedestrians. It is also recommended that the walking distance from the bus stop, or station to the pedestrian crossing, be minimised to enable pedestrians and NMT users to travel the shortest distance possible to access public transport services.

On IPTN trunk routes the need for barriers should be provided to prevent pedestrians from crossing roads in unsafe areas, or under unsafe conditions, especially adjacent to or behind the trunk route bus stations, which should be carefully assessed. Along feeder routes, bus stops should be located as close as possible to pedestrian crossings at intersections or midblock crossings to allow pedestrians to make use of the nearest pedestrian crossing and avoid pedestrians J-walking across roadways. Stations located on the median should be orientated so that the entrance provides the most direct access from the intersection and the most logical path of travel for pedestrians and NMT users. In-lane bus stops are preferred on feeder routes, especially when parking is provided adjacent to the traffic/bus lane. This configuration takes up at least one parking space and is then accessible from the traffic/bus lane and it, subsequently, prevents motorists/taxis from parking at the bus stop, as well as being more easily monitored.

4.3.12 Design Process Three Summary

The design of safe pedestrian crossings is to the benefit of all NMT users, including targeted categories of pedestrians. The design of these facilitates, with an emphasis on pedestrian priority, attempts to address poor driver behaviour by placing an increased awareness of the NMT users. The application of this methodology allows for the design of a system, which encourages uniform and consistent NMT infrastructure, resulting in not only more consistent NMT infrastructure, but also promotes more consistent and predictable pedestrian and vehicle driver behaviour. While it is recommended to provide audible pedestrian crossing signals, it must be stressed that these installations do not guarantee the safety of partially sighted and

blind pedestrians, due to reckless driver behaviour. It must also be stressed that, only through increased policing of poor driver behaviour, will it be possible to materially increase pedestrian safety. This can, however, be assisted by more effective and functional design of pedestrian crossings, recognising the need for co-ordination and standardisation and increased pedestrian and driver awareness programmes.

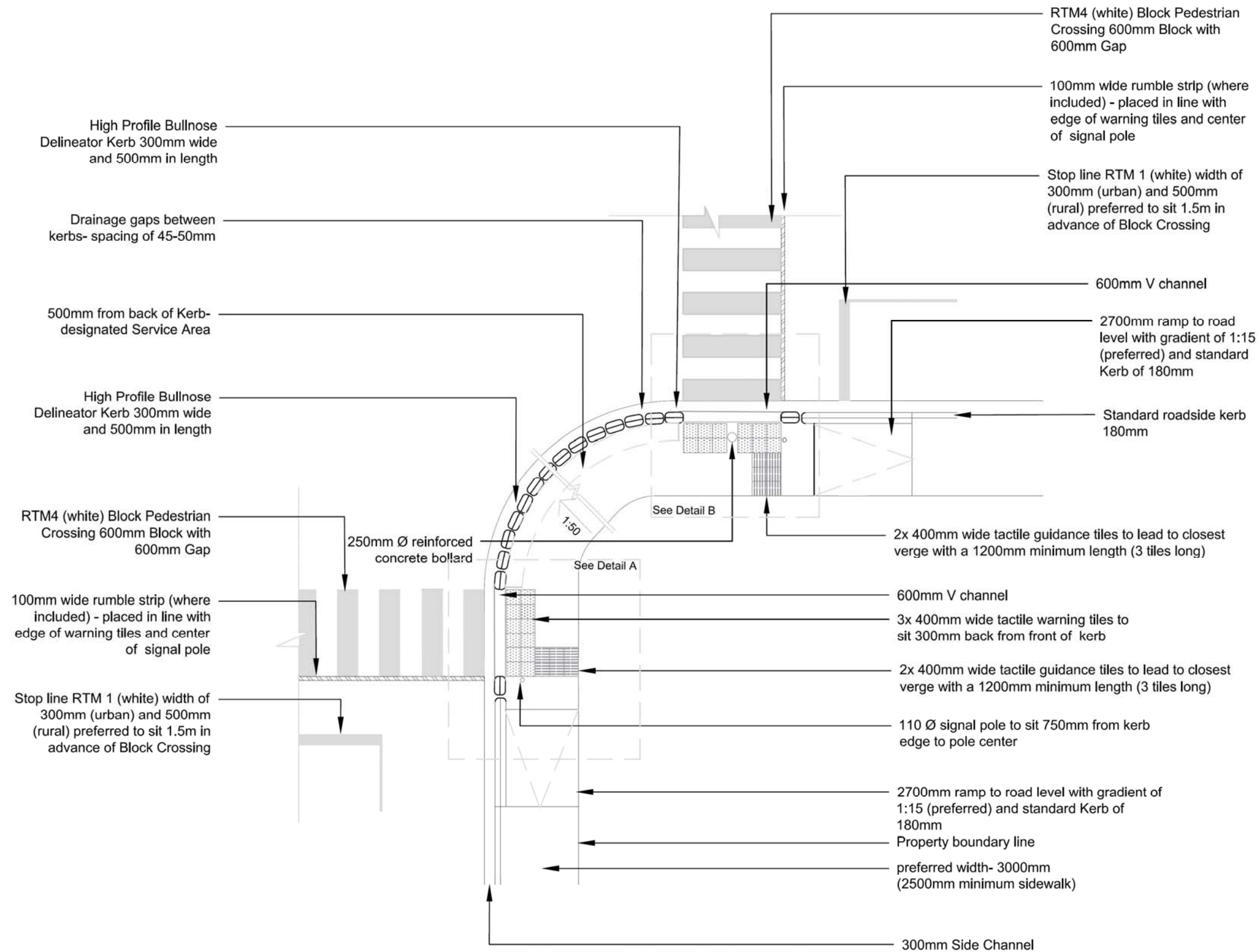
4.4 Additional General Recommendations

- Onsite training and monitoring of engineers, to ensure quality and compliance with drawings, is required.
- Road engineering and landscaping design must be documented in detailed drawings and must specify the exact location and co-ordination of all amenities to ensure adherence to the design methodology.
- All furniture is to be located in the designated service areas, as indicated in the drawings, to prevent cluttered pedestrian access areas.
- Road marking paint, specifically for pedestrian crossings, should be specified in tender requirements to prevent fading; good quality Cold Liquid Plastic is recommended.
- The surfaces along sidewalks are required to be smooth, stable and slip resistant. It is highly recommended that, along NMT routes, no bevelled edged pavers, cobble stones or uneven floor surface finishes, with raised or chamfered edges, be used. All pavers should be installed to be level with an even surface, where no steps exceeding 5mm occur. Preferred surface finishes include wire-cut clay pavers, wood-floated concrete and tarmacadam.
- All road and sidewalk maintenance or new installations must maintain the same quality of surface and infrastructure that was originally designed and constructed. This should be carefully monitored, especially when underground services are being installed or maintained.



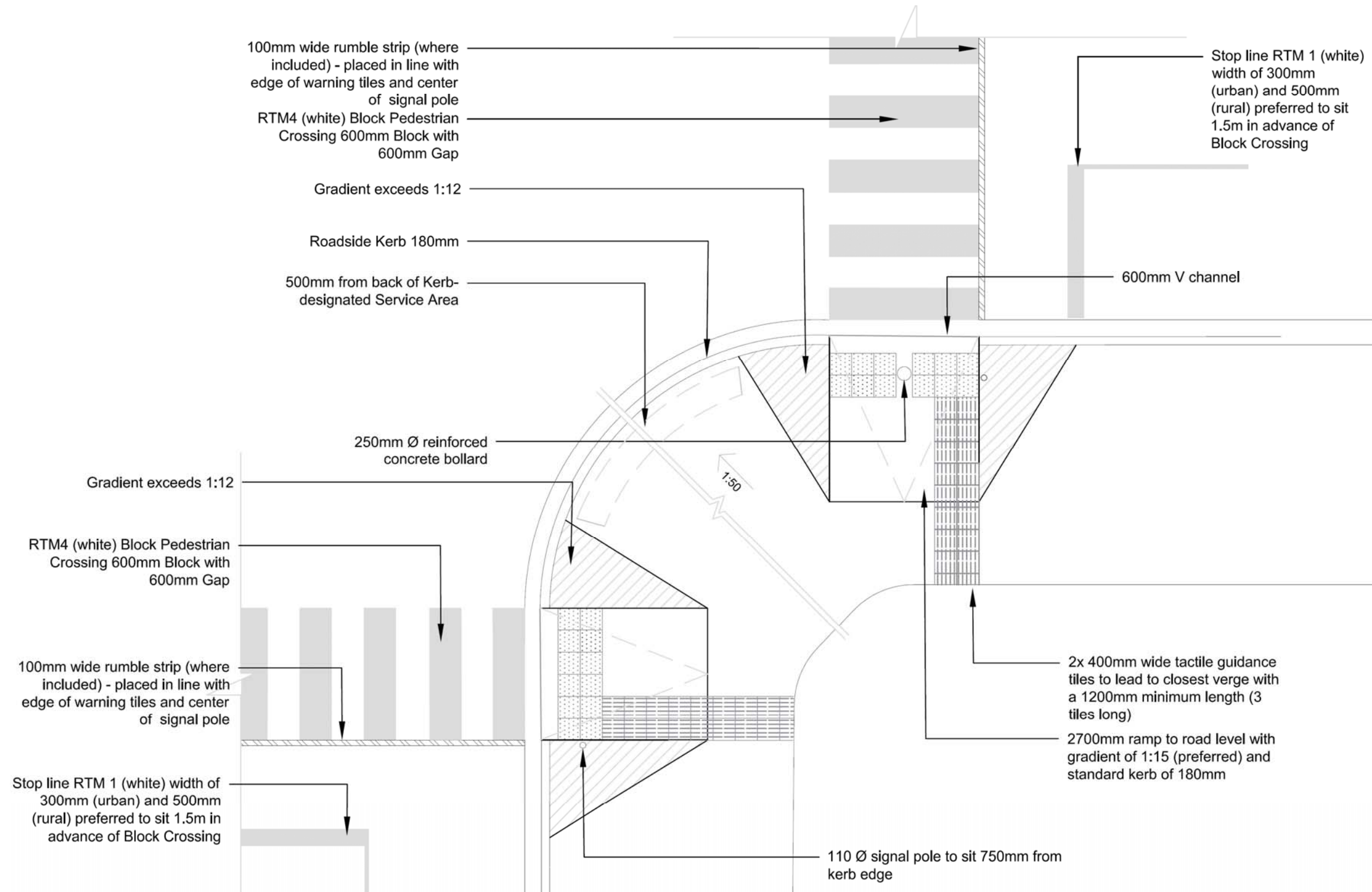
Figure 13: Large concrete pavers used in NMT areas in Sandton, Johannesburg. Pavers without bevelled edges offer a smoother surface for all users and are, therefore, more universally accessible and the preferred option for aiding in the detection of TWSI (TGSi) as well.





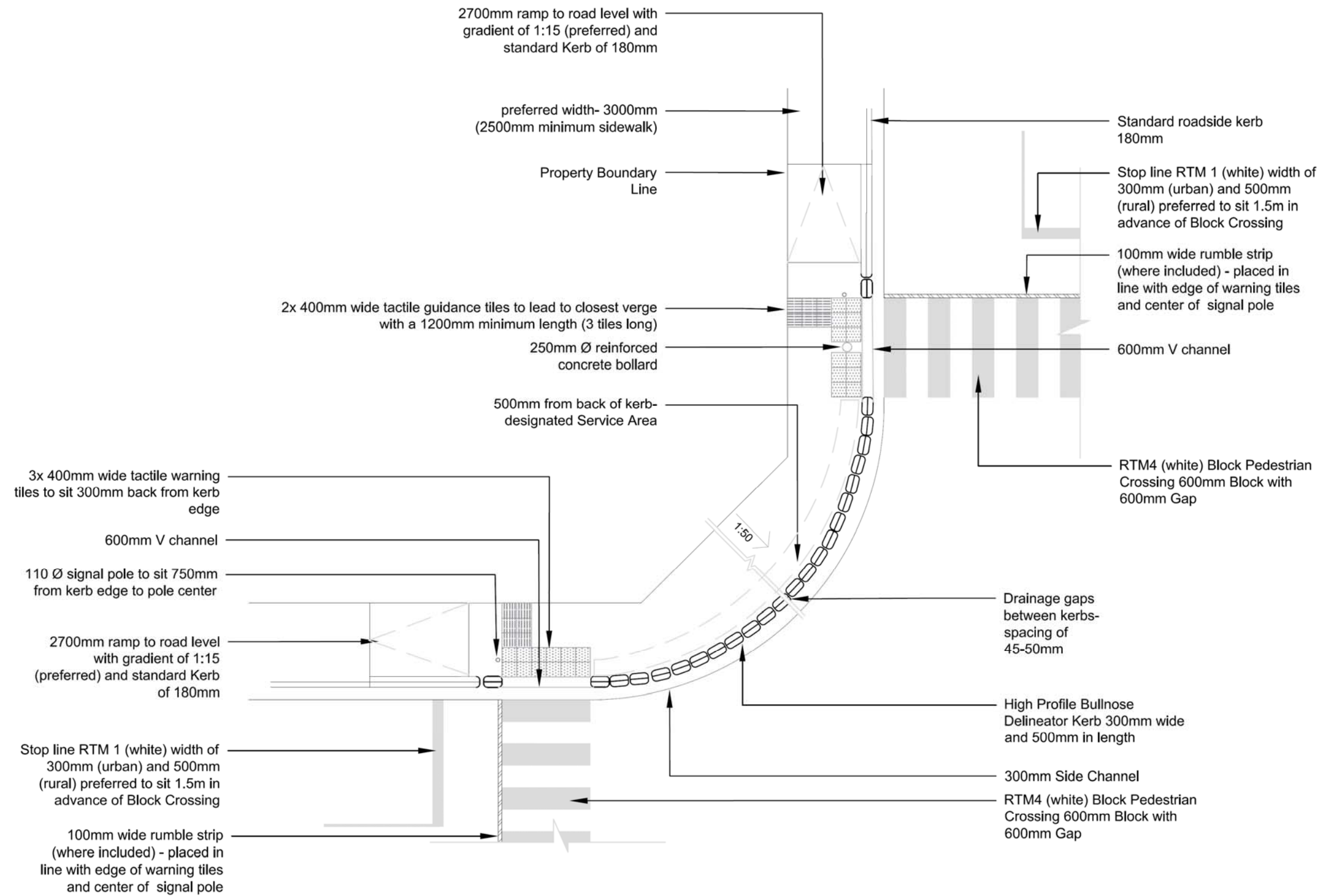
Technical Drawing 1: Dropped configuration, with a 5 metre radius bell mouth, signalised intersection with pedestrian crossings located perpendicular to vehicular direction. Sidewalks are the minimum width to accommodate the minimum L-shape TWSI (TGSI) layout- if there is insufficient space to accommodate the minimum of 1200mm of TWSI (TGSI) it is recommended that no guidance tiles be installed. Note the location and positioning of traffic signal pole, the orientation of the L-shape TWSI (TGSI) in relation to the pedestrian crossing, the rumble strip (if included) and painted block pedestrian crossing. This example illustrates the configuration installation without bollards (the roadway approaching from the bottom), as well as illustrating the configurations with bollards in the preferred locations (roadway approaching from the right). This example makes use of the installation of bollards and the second set of TWSI (TGSI) which consists of only the warning tiles, as well as the example of the entire width of the pedestrian crossing being installed with warning tiles, without the bollard. This dropped intersection illustrates the whole area behind the bell mouth being dropped, with the installation of the high delineator kerbs. (It is also to be noted that the V-channel is also referred to as the gutter)





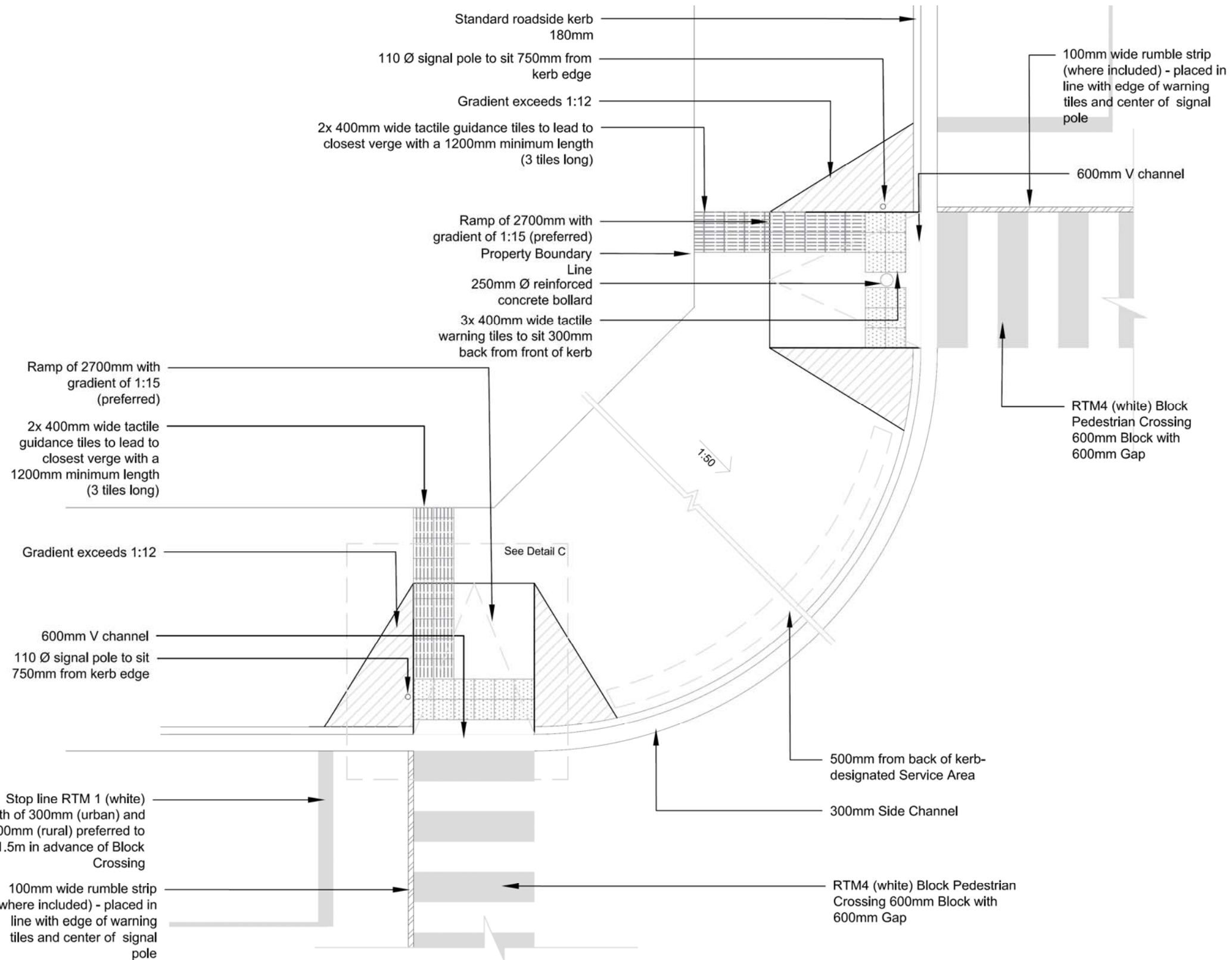
Technical Drawing 2: Kerb cut configuration with a 5 metre radius bell mouth, signalised intersection with pedestrian crossings located perpendicular to vehicular direction. Sidewalks are the minimum width to accommodate the minimum L-shape TWSI (TGSi) layout and the required landing space at the top of the graded surface. Note the location and positioning of traffic signal pole, the orientation of the L-shape TWSI (TGSi), the rumble strip (if included) and painted block pedestrian crossing. This example illustrates the configuration installation without bollards (the roadway approaching from the bottom), as well as illustrating the configurations with bollards in the preferred locations (roadway approaching from the right). This example makes use of the installation of bollards and the second set of TWSI (TGSi), which consists of only the warning tiles, as well as the example of the entire width of the pedestrian crossing being installed with warning tiles without the bollard. (It is also to be noted that the V-channel is also referred to as the gutter)





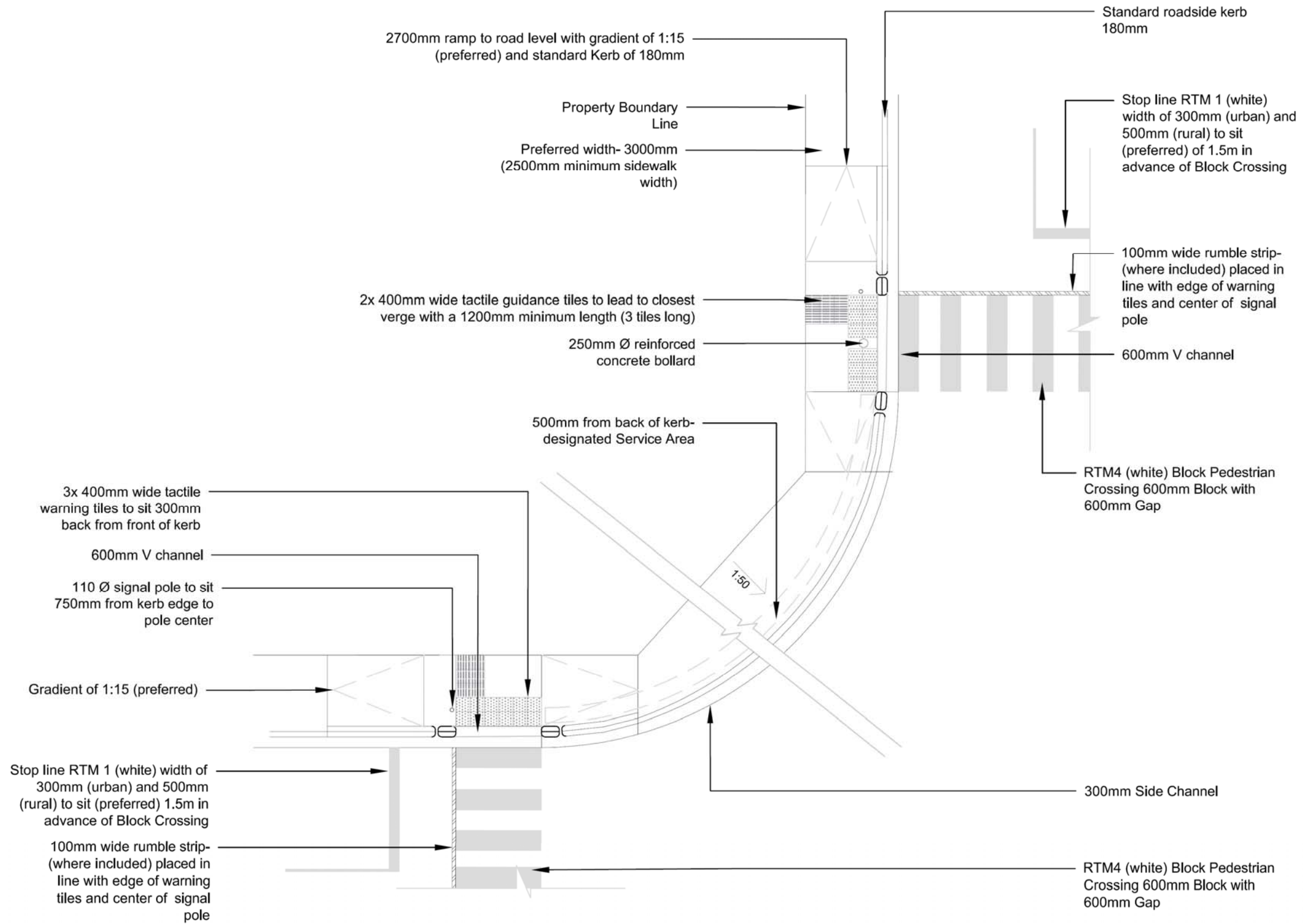
Technical Drawing 3: Dropped configuration with an 8 metre radius bell mouth, signalised intersection with pedestrian crossings located perpendicular to vehicular direction. Sidewalks are the minimum width to accommodate the minimum L-shape configuration. Note the location and positioning of traffic signal pole, the orientation of the L-shape TWSI (TGSI), in relation to the pedestrian crossing, the rumble strip (if included) and painted block pedestrian crossing. This example illustrates the configuration installation without bollards (the roadway approaching from the left), as well as illustrating the configurations with bollards in the preferred locations (roadway approaching from the top). This example makes use of the installation of bollards and the second set of TWSI (TGSI) which consists of only the warning tiles, as well as the example of the entire width of the pedestrian crossing being installed with warning tiles without the bollard. This also illustrates the entire section behind the bell mouth being dropped, with the installation of the high delineator kerbs. (It is also to be noted that the V-channel is also referred to as the gutter)





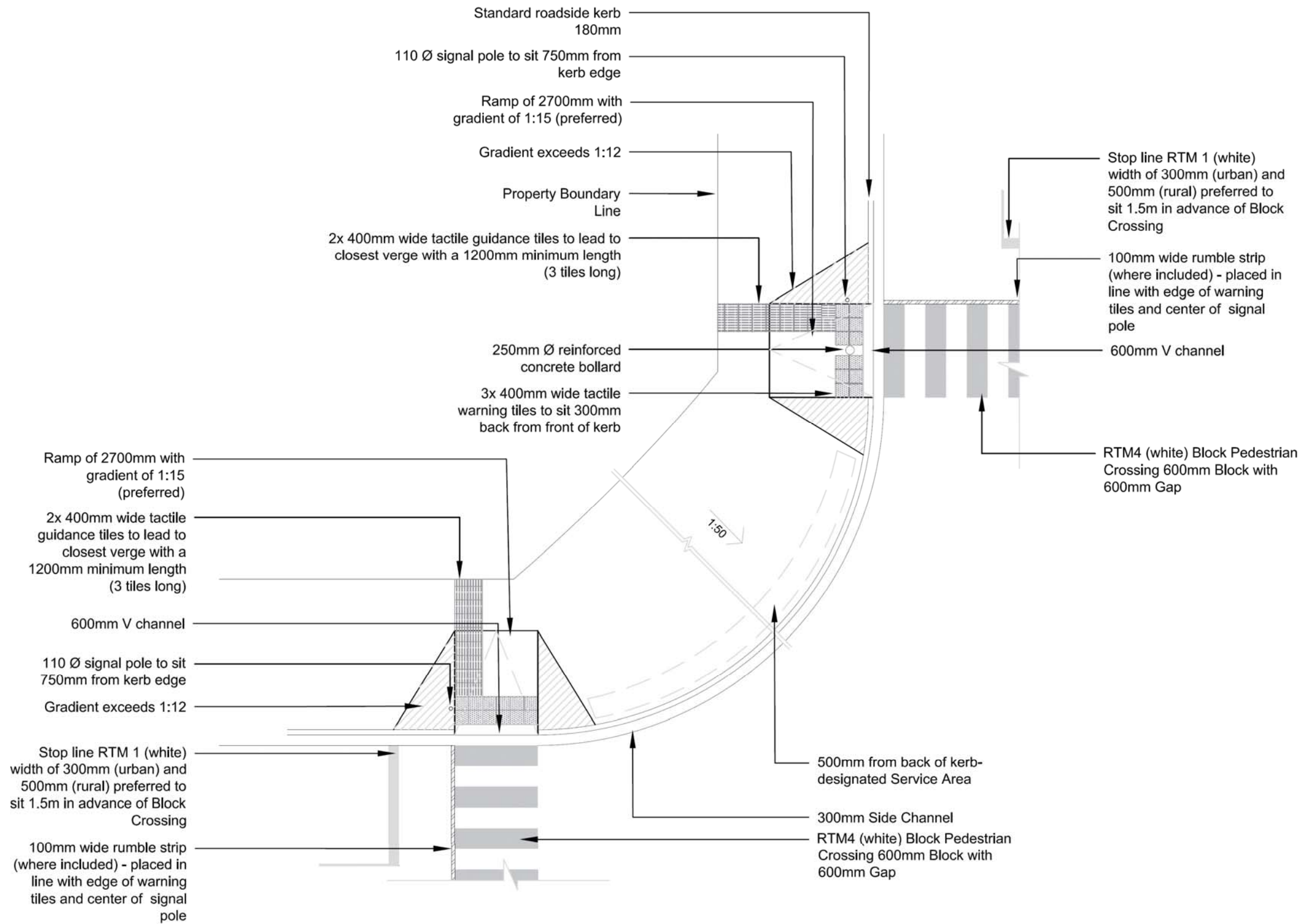
Technical Drawing 4: Kerb cut configuration with an 8 metre radius bell mouth, signalised intersection with pedestrian crossings located perpendicular to vehicular direction. Sidewalks are the minimum width to accommodate the minimum L-shape configuration and the required landing space at the top of the graded surface. Note the location and positioning of traffic signal pole, the orientation of the L-shape TWSI (TGSi), the rumble strip (if included) and painted block pedestrian crossing. This example illustrates the configuration installation without bollards (the roadway approaching from the left), as well as illustrating the configurations with bollards in the preferred locations (roadway approaching from the top). This example makes use of the installation of bollards and the second set of TWSI (TGSi) which consists of only the warning tiles, as well as the example of the entire width of the pedestrian crossing being installed with warning tiles without the bollard. (It is also to be notes that the V-channel is also referred to as the gutter)





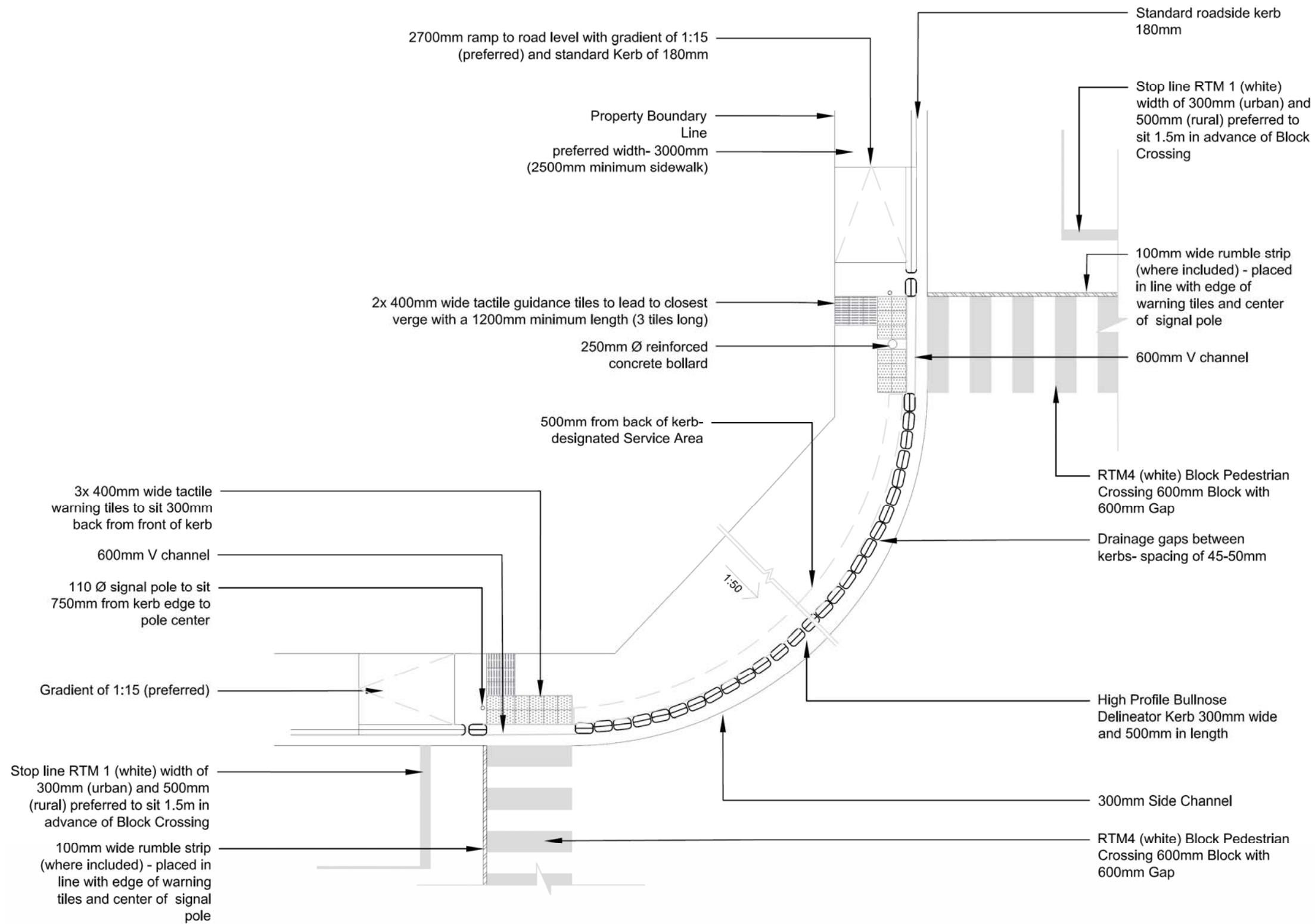
Technical Drawing 5: Dropped configuration with a 10 metre radius bell mouth, signalled intersection with pedestrian crossings located perpendicular to vehicular direction. This example illustrates the raising of the section behind the bell mouth again to be level with the kerb height, which could be applicable when the relocation or lowering of services behind the bell mouth is problematic. In comparison with Technical Drawing 1, this illustrates the rationale for reducing bell mouth radii. Note the location and positioning of traffic signal pole, the orientation of the L-shape TWSI (TGSI) in relation to the pedestrian crossing, the rumble strip (if included) and painted block pedestrian crossing. This example illustrates the configuration installation without bollards (the roadway approaching from the left), as well as illustrating the configurations with bollards in the preferred locations (roadway approaching from the top). This example makes use of the installation of bollards and the second set of TWSI (TGSI), which consists of only the warning tiles, as well as the example of the entire width of the pedestrian crossing being installed with warning tiles without the bollard. This also illustrates the entire section behind the bell mouth being dropped, with the installation of the high delineator kerbs. (It is also to be notes that the V-channel is also referred to as the gutter)





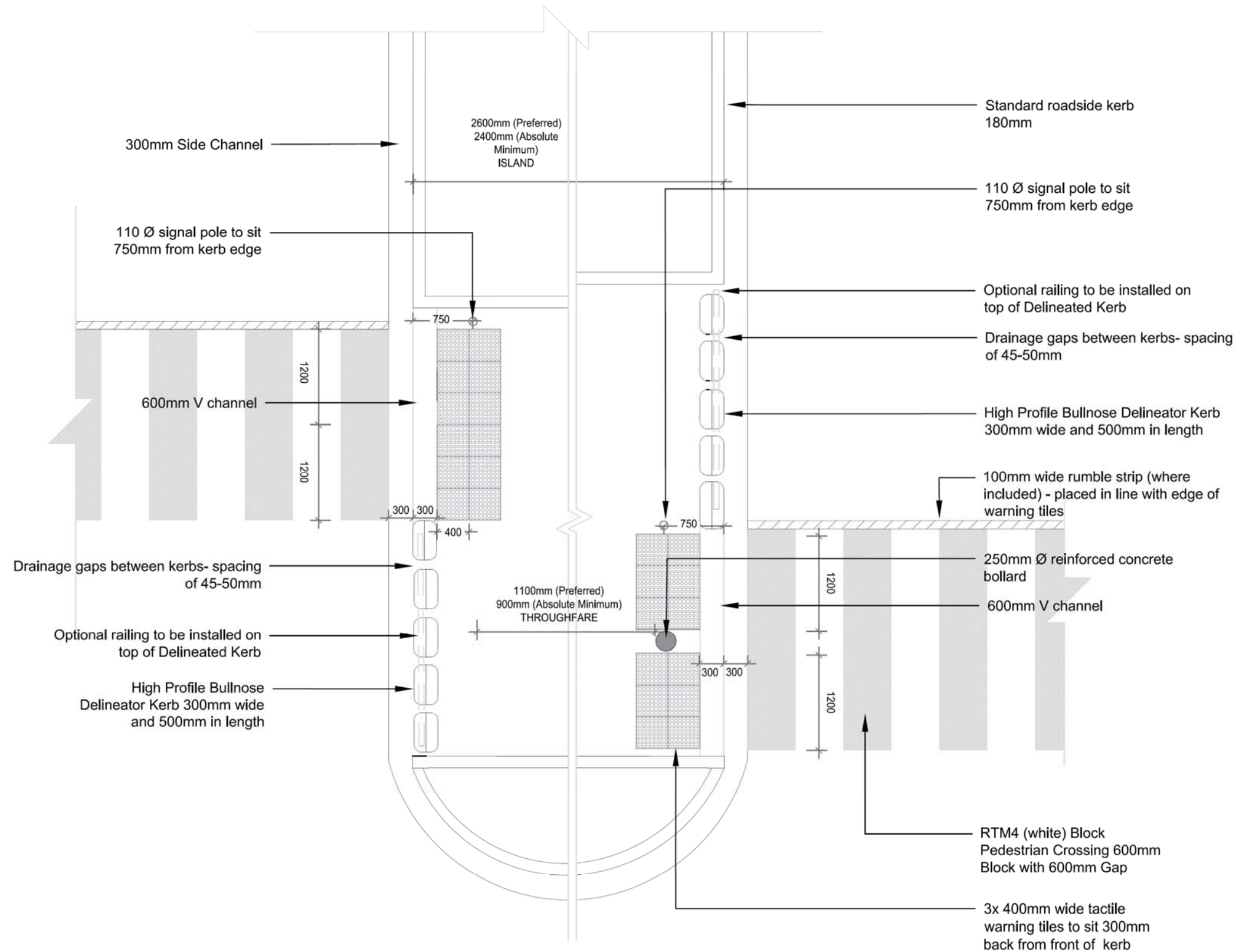
Technical Drawing 6: Kerb cut configuration with a 10 metre radius bell mouth, signalised intersection with pedestrian crossings located perpendicular to vehicular direction. In comparison with Technical Drawing 2, this illustrates the rationale for reducing bell mouth radii. Note the location and positioning of traffic signal pole, the orientation of the L-shape TWSI (TGSi) in relation to the pedestrian crossing, the rumble strip (if included) and painted block pedestrian crossing. This example illustrates the configuration installation without bollards (the roadway approaching from the left), as well as illustrating the configurations with bollards in the preferred locations (roadway approaching from the top). This example makes use of the installation of bollards and the second set of TWSI (TGSi), which consists of only the warning tiles, as well as the example of the entire width of the pedestrian crossing being installed with warning tiles without the bollard. This also illustrates the entire section behind the bell mouth being dropped, with the installation of the high delineator kerbs. (It is also to be noted that the V-channel is also referred to as the gutter)





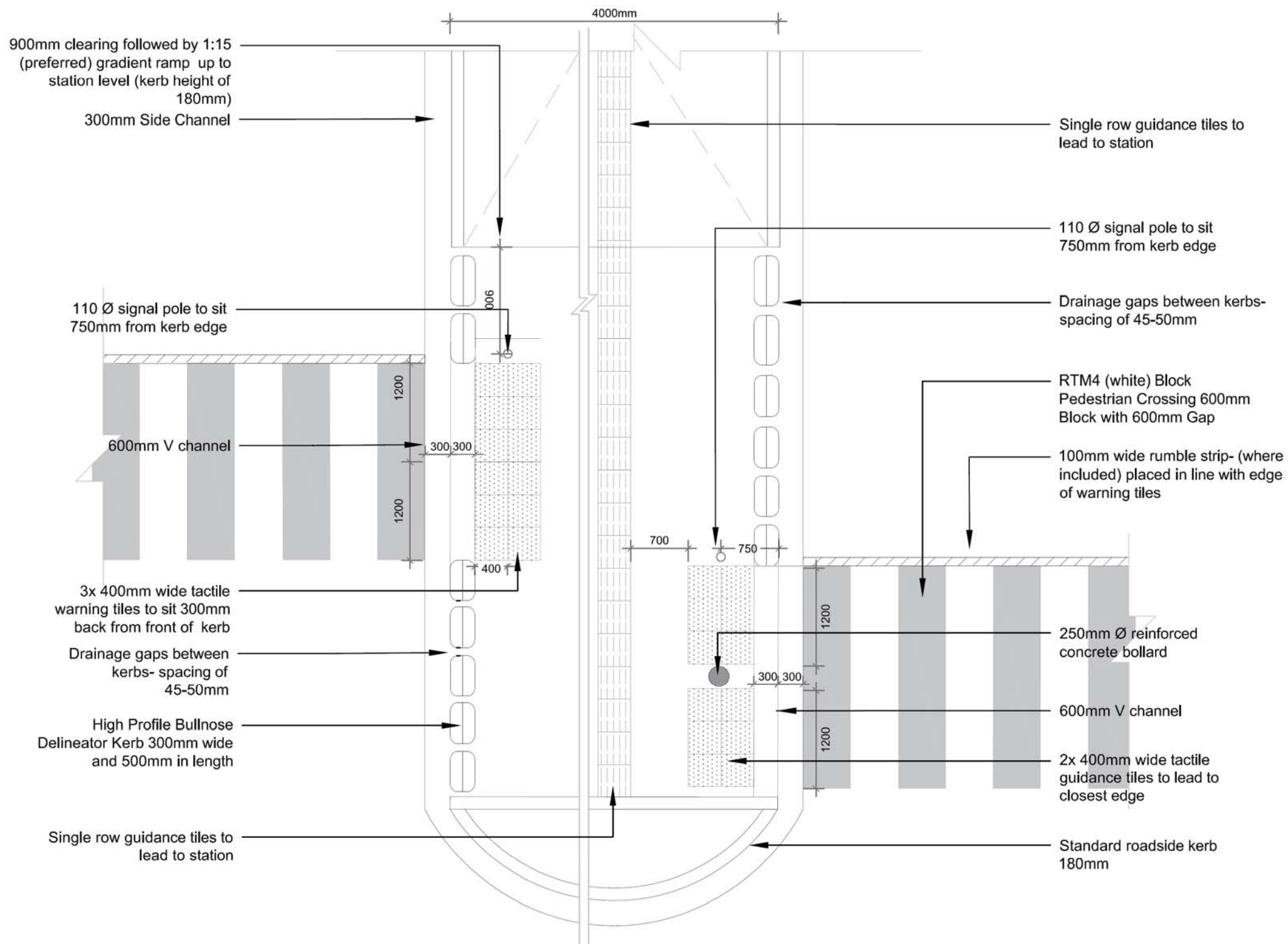
Technical Drawing 7: Dropped configuration with a 10 metre radius bell mouth, signalised intersection with pedestrian crossings located perpendicular to vehicular direction. This example illustrates the section behind the bell mouth also being lowered in the case where there are no problems with the installation of services or drainage. In comparison with Technical Drawing 1, this illustrates the rationale for reducing bell mouth radii. Note the location and positioning of traffic signal pole, the orientation of the L-shape TWSI (TGSi) in relation to the pedestrian crossing, the rumble strip (if included) and painted block pedestrian crossing. This example illustrates the configuration installation without bollards (the roadway approaching from the left), as well as illustrating the configurations with bollards in the preferred locations (roadway approaching from the top). This example makes use of the installation of bollards and the second set of TWSI (TGSi), which consists of only the warning tiles, as well as the example of the entire width of the pedestrian crossing being installed with warning tiles without the bollard. This also illustrates the entire section behind the bell mouth being dropped, with the installation of the high delineator kerbs. (It is also to be noted that the V-channel is also referred to as the gutter)





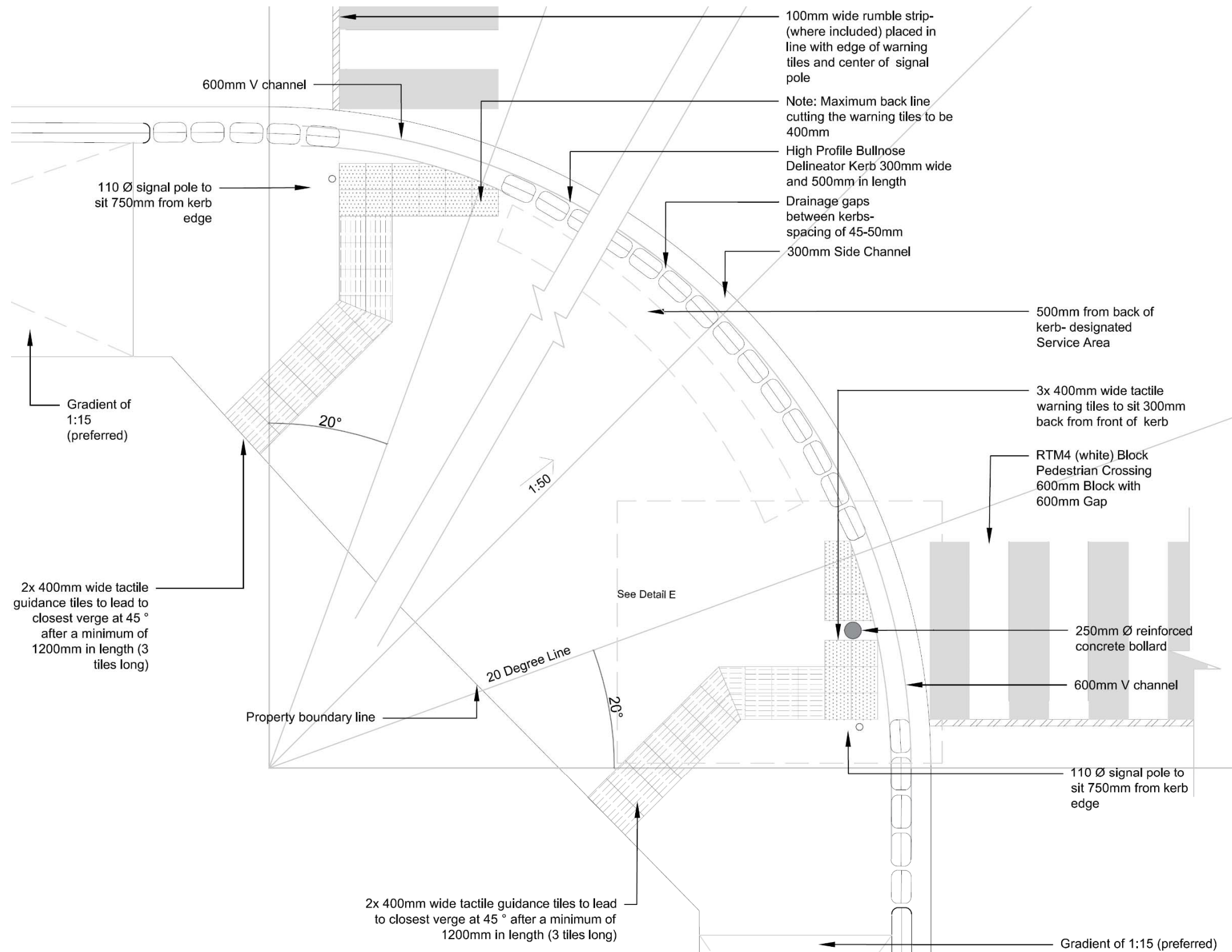
Technical Drawing 9: Dropped configuration Median Island at signalised crossing to offer pedestrians an area of refuge during a double signal phase crossing. Note, in this drawing example, the location of the traffic signal poles and their relation to the rumble strip (if included), painted block pedestrian crossing, as well as direction of the stagger to the median. This example illustrates the configuration installation without bollards (the pedestrians approaching from the left), as well as illustrating the configurations with bollards in the preferred locations (pedestrians approaching from the right). This example makes use of the installation of a bollard and the second set of TWSI (TGSI), which consists of only the warning tiles, as well as the example of the entire width of the pedestrian crossing being installed with warning tiles without the bollard. (It is also to be noted that the V-channel is also referred to as the gutter). This example makes use of the installation of the high delineator kerbs





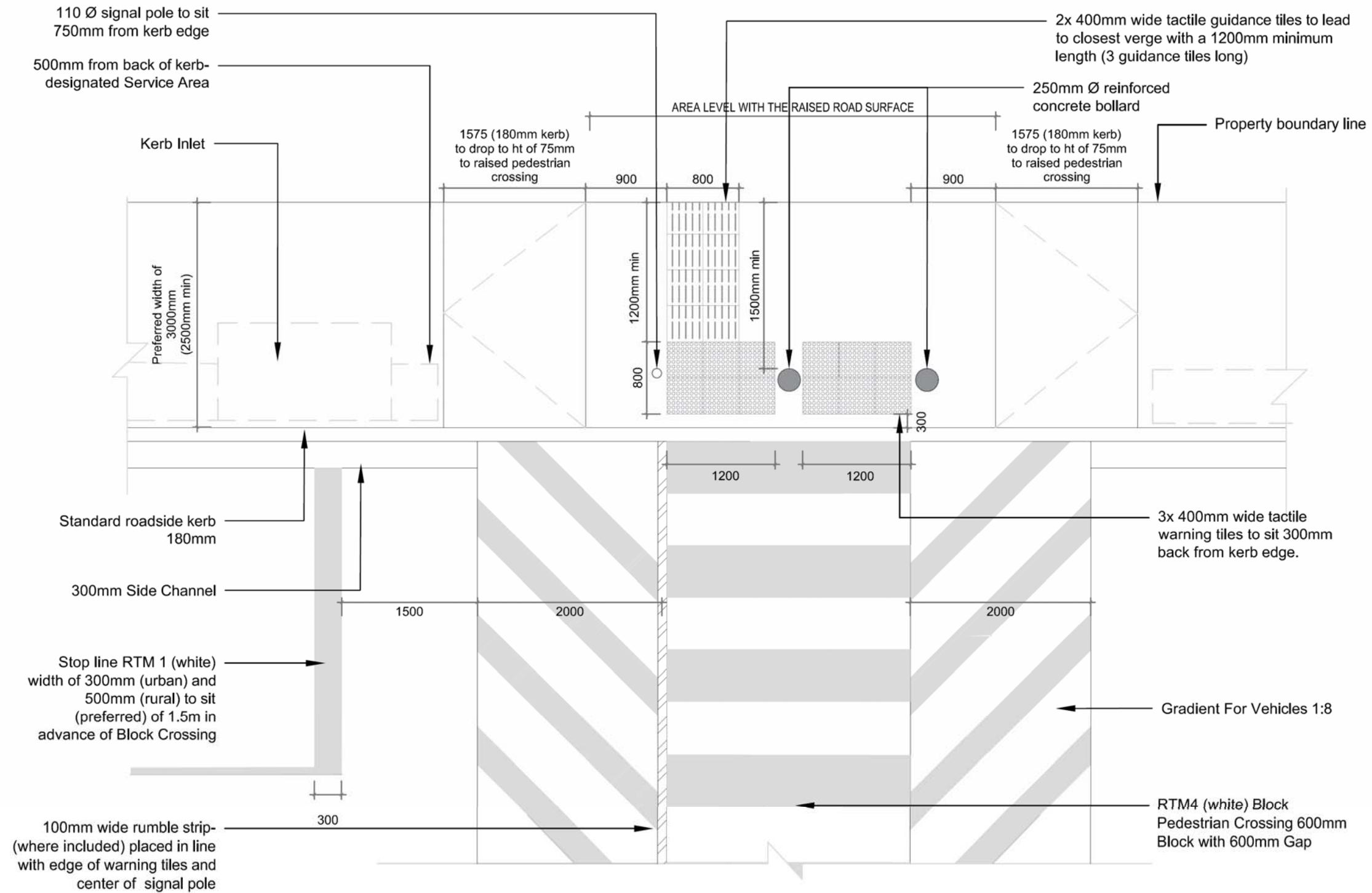
Technical Drawing 10: Dropped configuration Median Island for an IPTN Trunk station access, at signalised crossing, to offer pedestrians either an area of refuge during a double signal phase crossing, or access to the station. Median island configuration remains the same, with the addition of TWSI (TGSi) guidance to offer guidance into the station. This configuration of the TWSI (TGSi) leading to the station is an example, based on other tests that were conducted and the subsequent findings. This example illustrates the configuration installation without bollards (the pedestrians approaching from the left), as well as illustrating the configurations with bollards in the preferred locations (pedestrians approaching from the right). This example makes use of the installation of a bollard and the second set of TWSI (TGSi), which consists of only the warning tiles, as well as the example of the entire width of the pedestrian crossing being installed with warning tiles without the bollard. (It is also to be notes that the V-channel is also referred to as the gutter). This example makes use of the installation of the high delineator kerbs





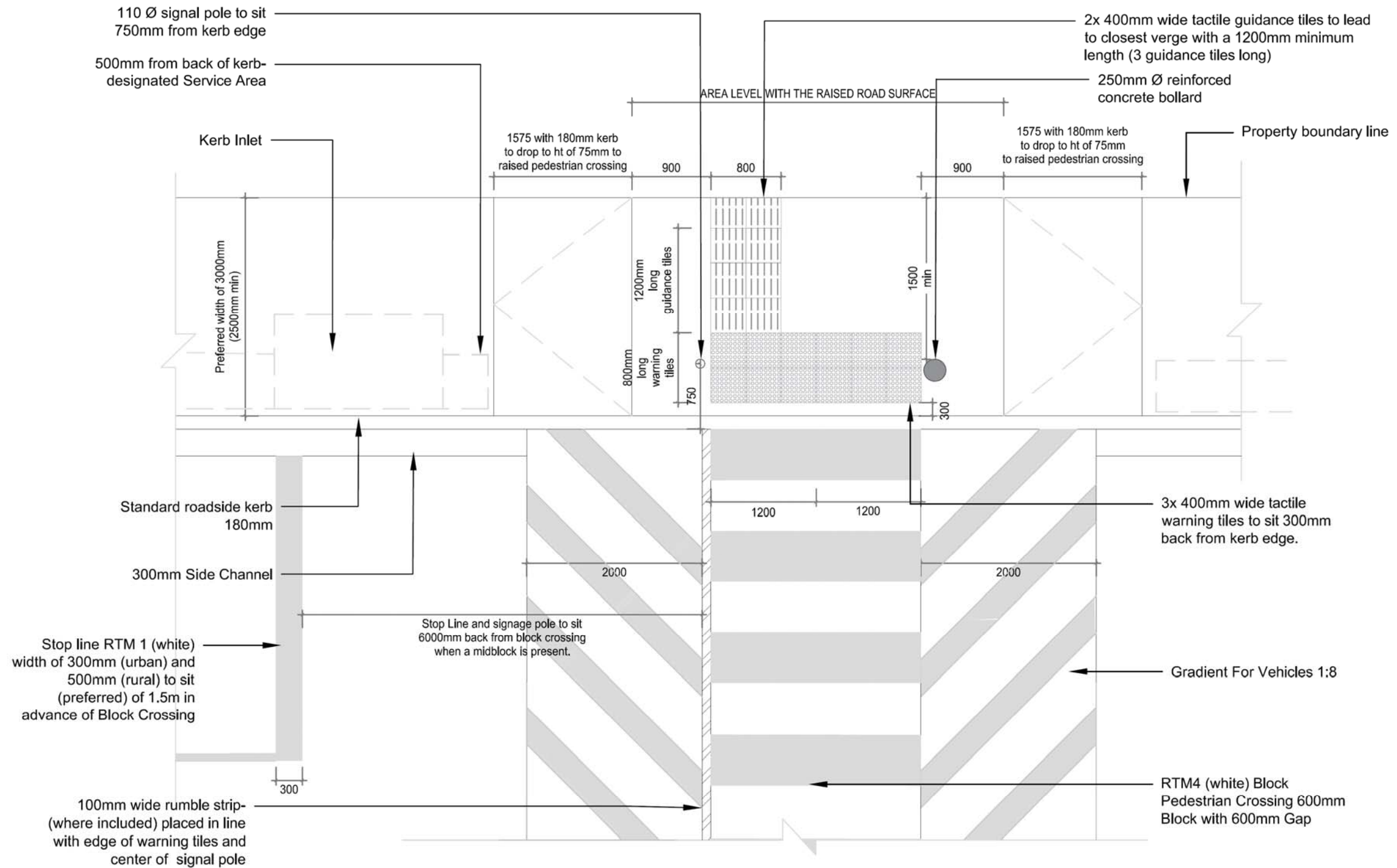
Technical Drawing 11: Dropped configuration with a 5 metre radius bell mouth, signalised intersection with the pedestrian crossings located according to the *first 20 degree rule*. Note the removal of additional set of warning TWSI (TGSi), but the L-shape configuration remains in place and perpendicular to the direction of vehicular traffic. Drawing includes details on the L-shape configuration, traffic signal location, pedestrian crossing located perpendicular to vehicular traffic, rumble strip (if included) location, installation of high profile bullnose delineator kerbs with drainage gap and service area location behind the kerbs at the bell mouth. This example illustrates the configuration installation without bollards (the roadway approaching from the left), as well as illustrating the configurations with bollards in the preferred locations (pedestrians approaching from the bottom). This example makes use of the installation of a bollard and without the second set of TWSI (TGSi), as well as the example of the entire width of the pedestrian crossing being installed with warning tiles without the bollard, where the warning tiles (outside of the L-shape configuration) are cut to fit the curvature of the bell mouth. (It is also to be notes that the V-channel is also referred to as the gutter). This example makes use of the installation of the high delineator kerbs





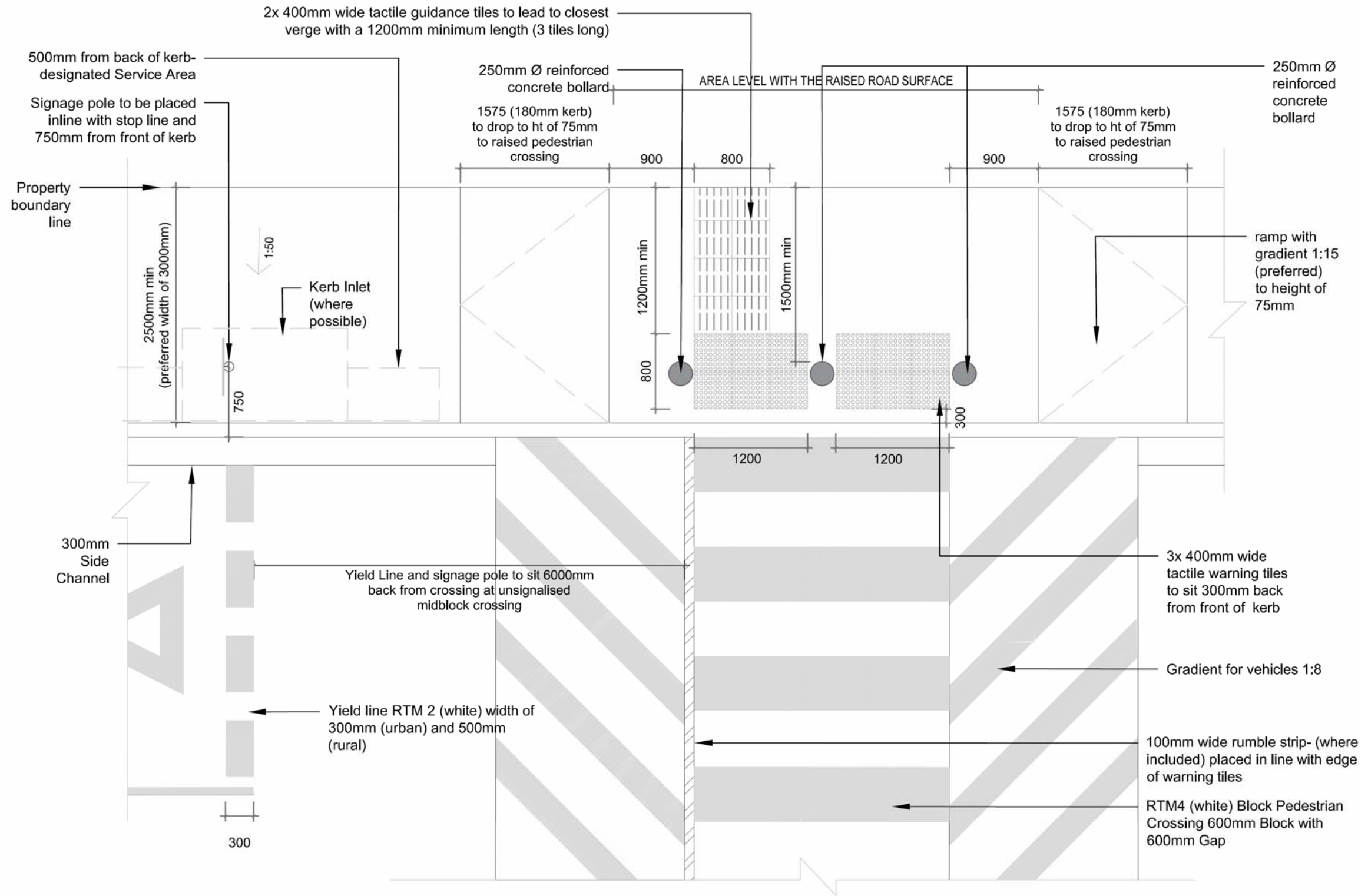
Technical Drawing 12: Raised midblock, signalised pedestrian crossing with bollards. Configuration is installed to accommodate the difference in height of the raised traffic calming measure and the sidewalk height, dependent on the kerb height. Design accommodates the minimum L-shape TWSI (TGSI) configuration with additional length in the guidance tiles to the closest verge, or boundary, to allow for the minimum 1.5 metres clear passing space along the sidewalk. Note the location and positioning of traffic signal pole, the orientation of the TWSI (TGSI), the rumble strip (if included) and painted block pedestrian crossing. For drainage, note the location of the kerb inlet, which best solves issues around drainage in this configuration, as well as the optional installation of a bollard at the end of the warning tiles to maintain the pedestrian only area. This example illustrates the installation position of bollards in this configuration, should they be preferred to be installed





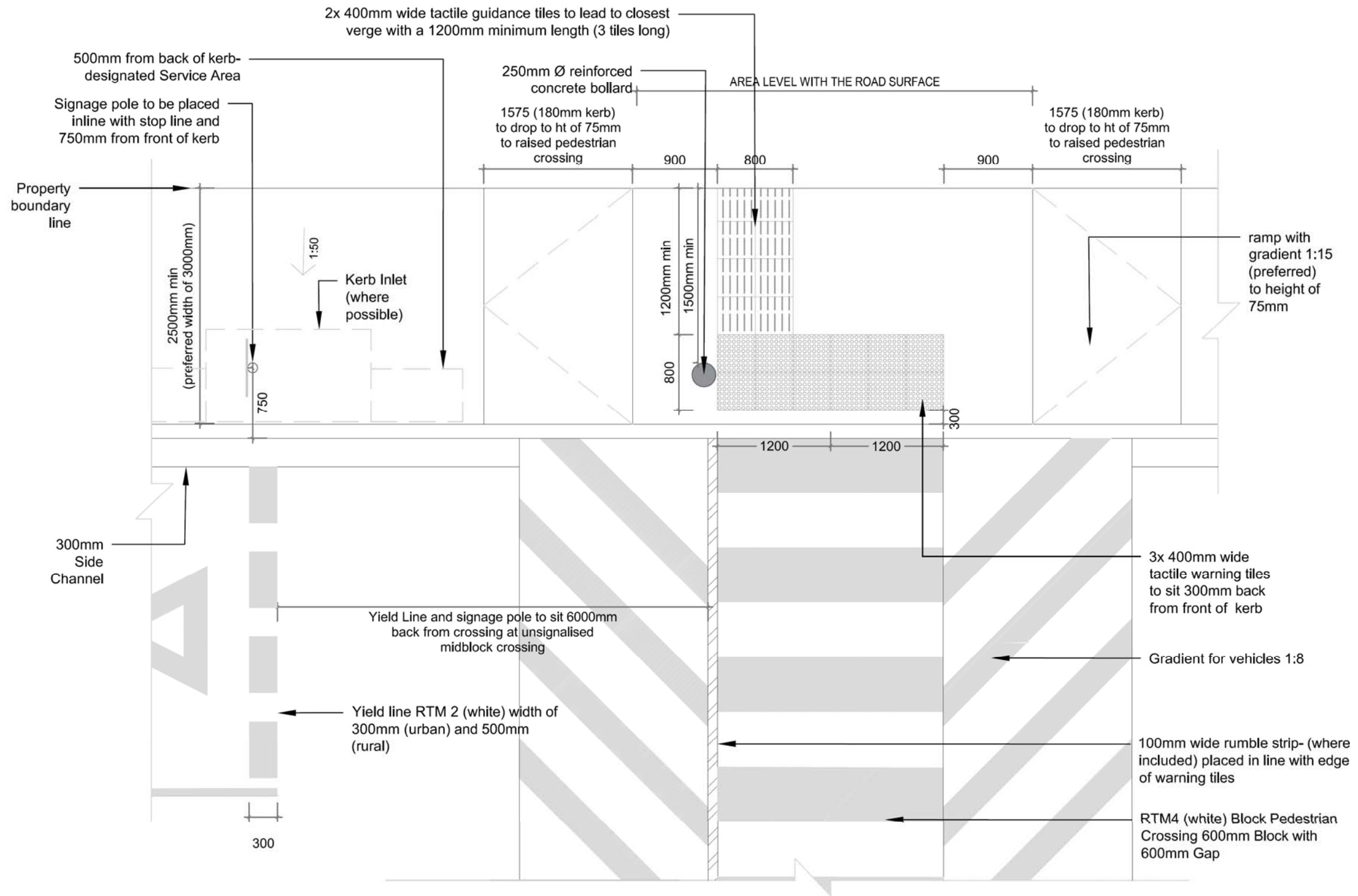
Technical Drawing 13: Raised midblock, signalled pedestrian crossing without bollards. Configuration is installed to accommodate the difference in height of the raised traffic calming measure and the sidewalk height, dependent on the kerb height. Design accommodates the minimum L-shape TWSI (TGSI) configuration with additional length in the guidance tiles to the closest verge, or boundary, to allow for the minimum 1.5 metres clear passing space along the sidewalk. Note the location and positioning of traffic signal pole, the orientation of the TWSI (TGSI), the rumble strip (if included) and painted block pedestrian crossing. For drainage, note the location of the kerb inlet, which best solves issues around drainage in this configuration.





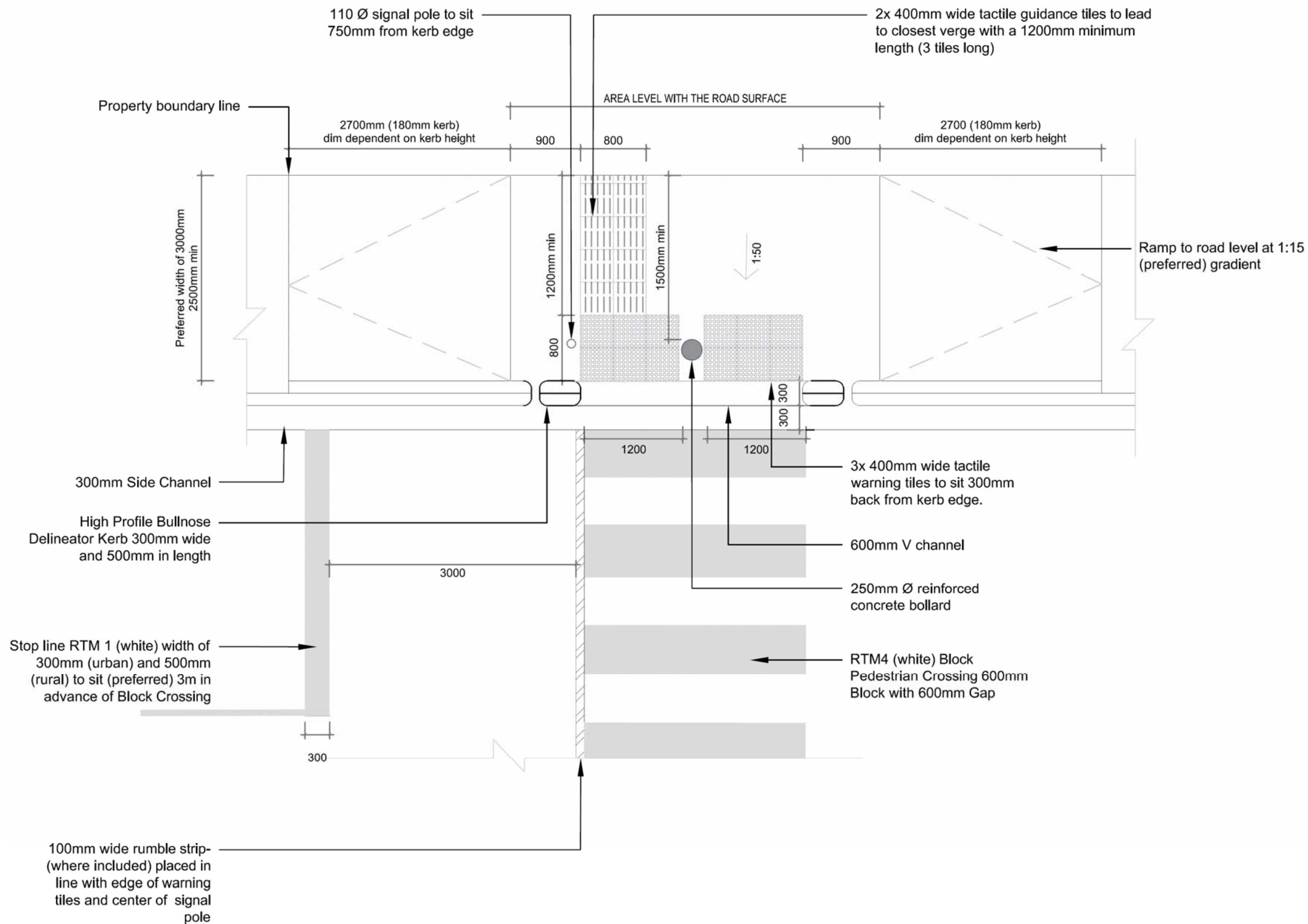
Technical Drawing 14: Raised midblock, un-signalised pedestrian crossing. Design accommodates the minimum L-shape TWSI (TGSi) configuration, with additional length in the guidance tiles to the closest verge or boundary, to allow for the minimum 1.5 metres clear passing space along the sidewalk. Note the orientation of the L-shape TWSI (TGSi), the rumble strip (if included) and painted block pedestrian crossing, as well as the change in detail where the traffic signal was previously replaced, which is replaced with a bollard for orientation and safety purposes, and additional bollards are installed for the protection of the pedestrian only area. This example also makes use of the additional set of warning TWSI (TGSi) tiles adjacent to the L-shape TWSI (TGSi), separated by bollards to maintain the pedestrian only area





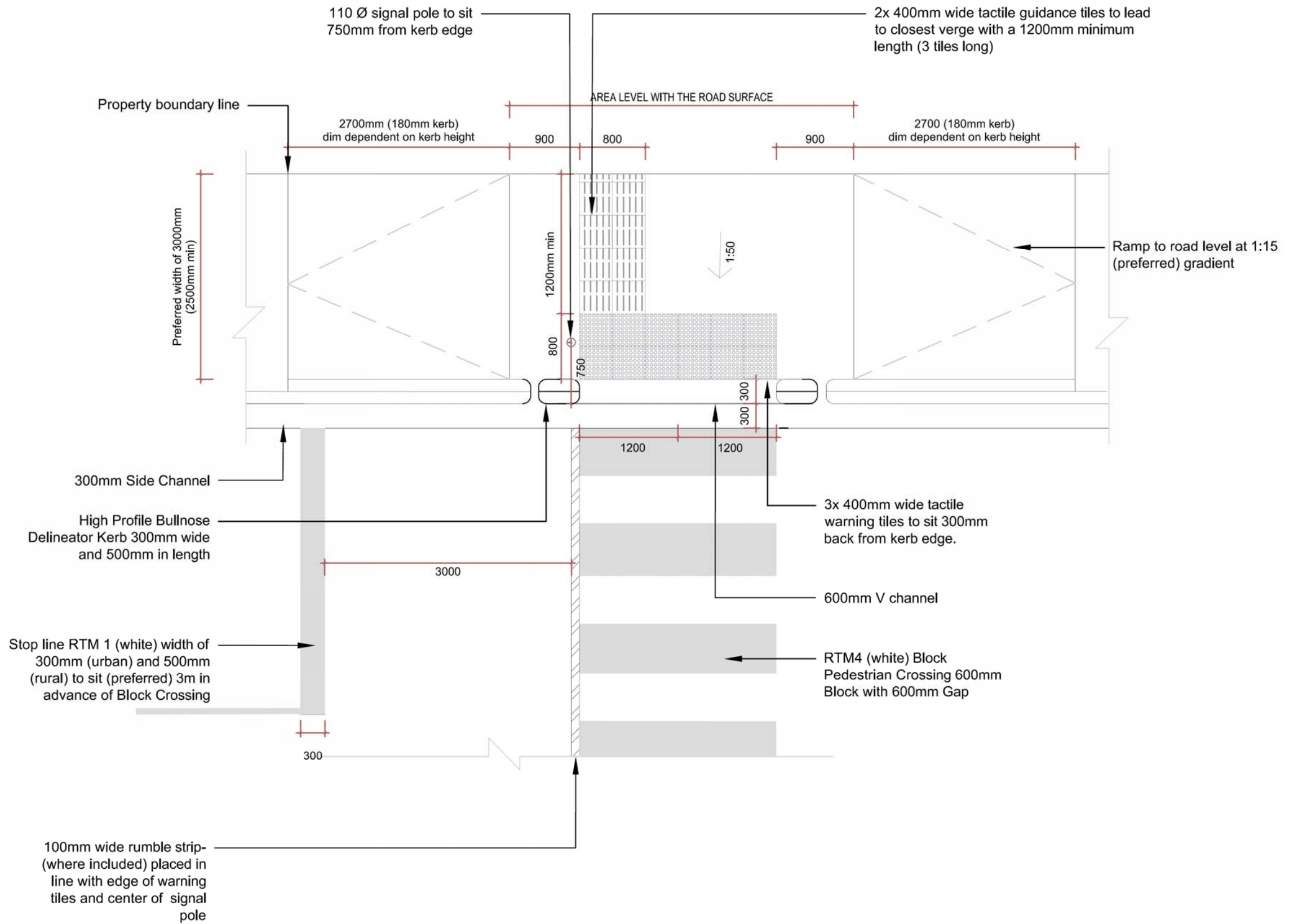
Technical Drawing 15: Raised midblock, un-signalised pedestrian crossing. Design accommodates the minimum L-shape TWSI (TGSI) configuration with additional length in the guidance tiles to the closest verge, or boundary, to allow for the minimum 1.5 metres clear passing space along the sidewalk. Note the orientation of the L-shape TWSI (TGSI), the rumble strip (if included) and painted block pedestrian crossing as well as the change in detail where the traffic signal was previously replaced, which is replaced with a bollard for orientation and safety purposes, and additional bollards are installed for the protection of the pedestrian only area. This example also makes use of the extension of the warning TWSI (TGSI) tiles adjacent to the L-shape TWSI (TGSI), without additional bollards





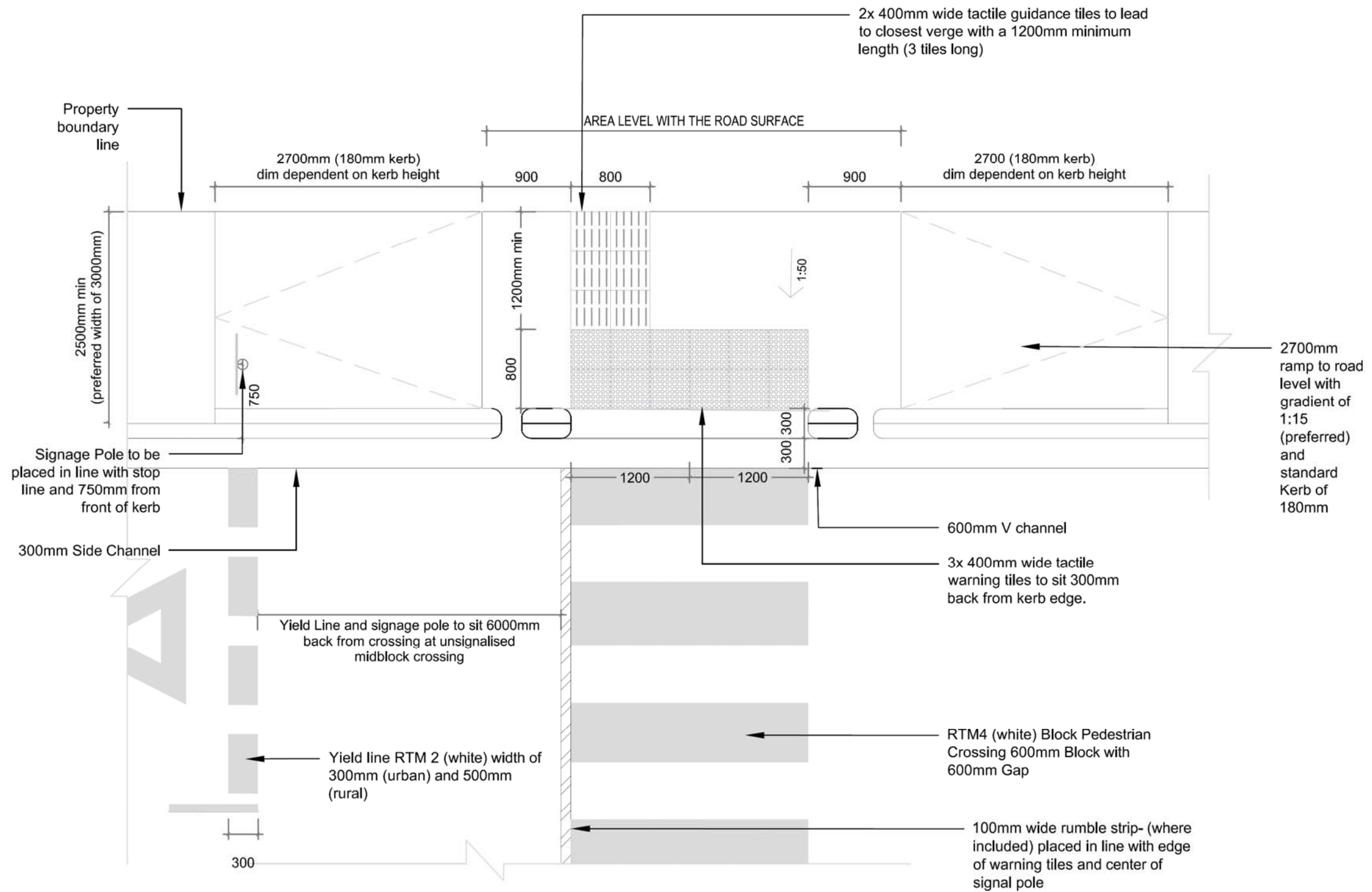
Technical Drawing 16: Dropped midblock, signalised pedestrian crossing. Design accommodates the minimum L-shape TWSI (TGSI) configuration with additional length in the guidance tiles to the closest verge, or boundary, to allow for the minimum 1.5 metres clear passing space along the sidewalk. Note the location and positioning of traffic signal pole, the orientation of the TWSI (TGSI), the rumble strip (if included) and painted block pedestrian crossing. This example makes use of the installation of a bollard and makes use of the installation of the additional set of warning tiles





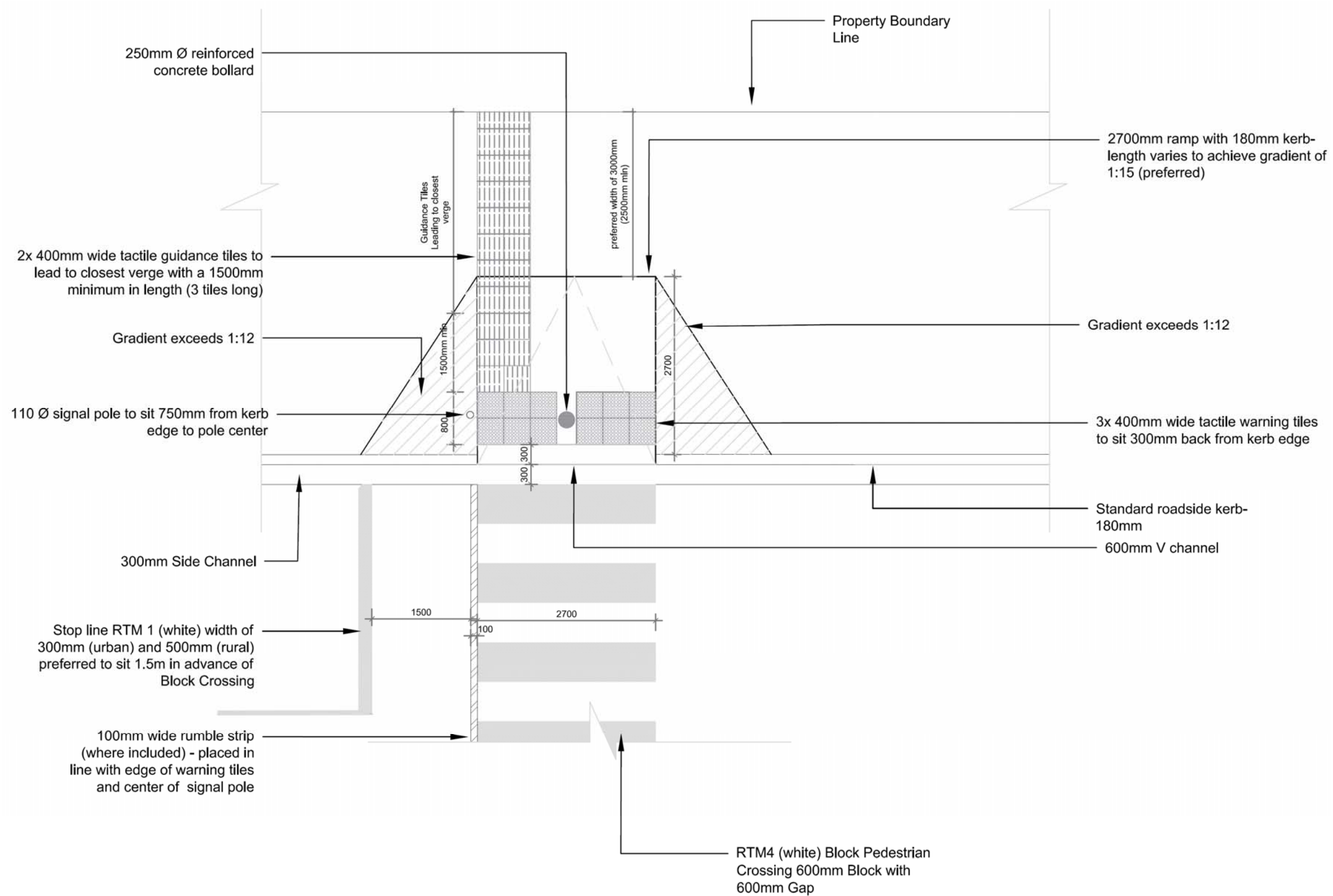
Technical Drawing 17: Dropped midblock, signalised pedestrian crossing. Design accommodates the minimum L-shape TWSI (TGSi) configuration with additional length in the guidance tiles to the closest verge, or boundary, to allow for the minimum 1.5 metres clear passing space along the sidewalk. Note the location and positioning of traffic signal pole, the orientation of the TWSI (TGSi), the rumble strip (if included) and painted block pedestrian crossing. This example makes use of the installation without a bollard and makes use of the installation of the full pedestrian crossing width in warning tiles





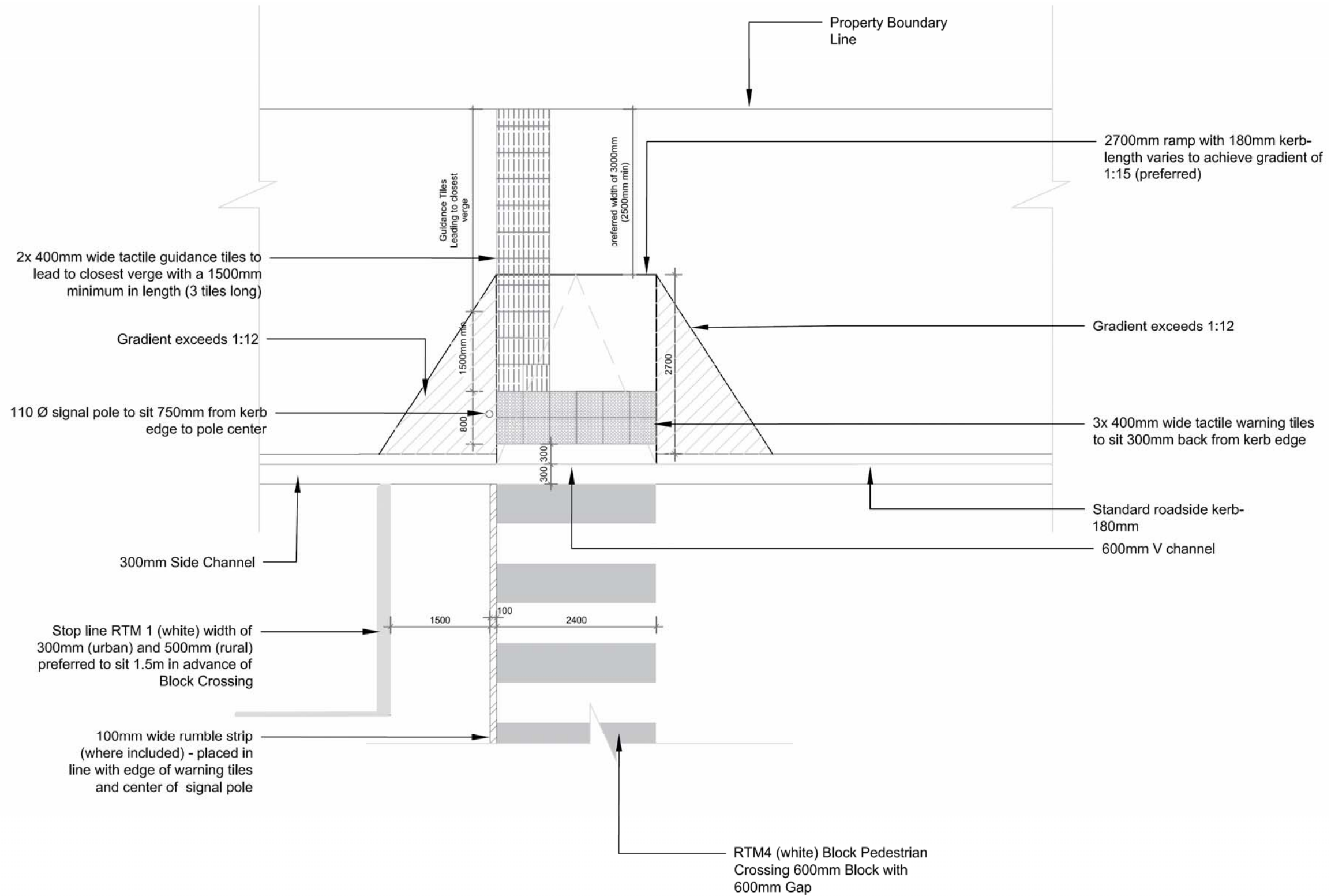
Technical Drawing 19: Dropped midblock, un-signalised pedestrian crossing. Design accommodates the minimum L-shape TWSI (TGSi) configuration with additional length in the guidance tiles to the closest verge, or boundary, to allow for the minimum 1.5 metres clear passing space along the sidewalk. Note the orientation of the TWSI (TGSi), the rumble strip (if included) and painted block pedestrian crossing. This example makes use of the installation without a bollard and makes use of the installation of the full pedestrian crossing width in warning tiles





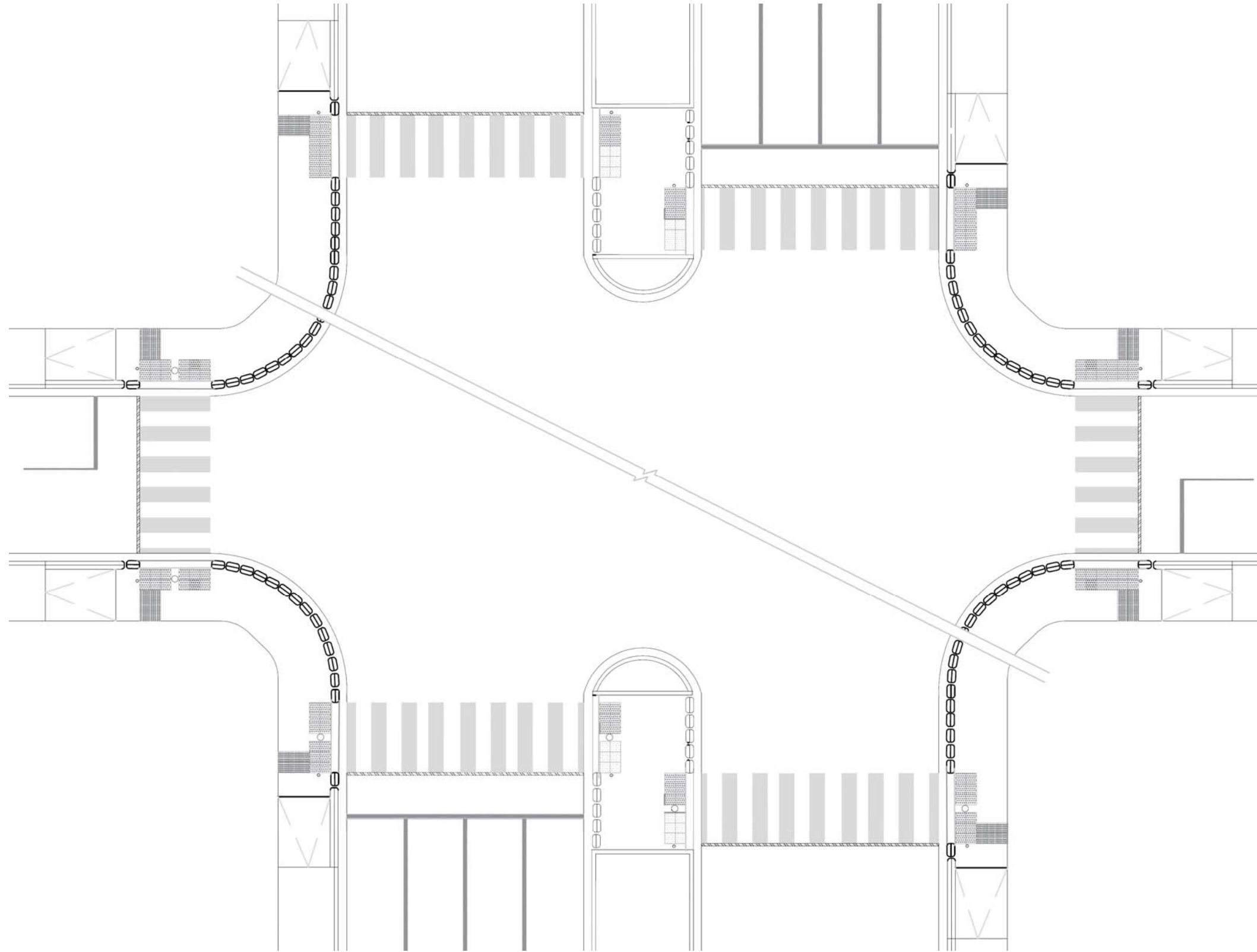
Technical Drawing 20: Kerb cut midblock, signalised pedestrian crossing. Design accommodates the minimum L-shape TWSI (TGSi) configuration with additional length in the guidance tiles to the closest verge, or boundary, to allow for the minimum 1.5 metres clear passing space along the sidewalk, after the gradient. Note the location and positioning of traffic signal pole, the orientation of the L-shape TWSI (TGSi), the rumble strip (if included) and painted block pedestrian crossing. This example makes use of the bollard, and the additional set of warning tiles adjacent to it, for the protection of the pedestrian only area, as well as the additional set of warning TWSI tiles adjacent to the L-shape TWSI (TGSi).





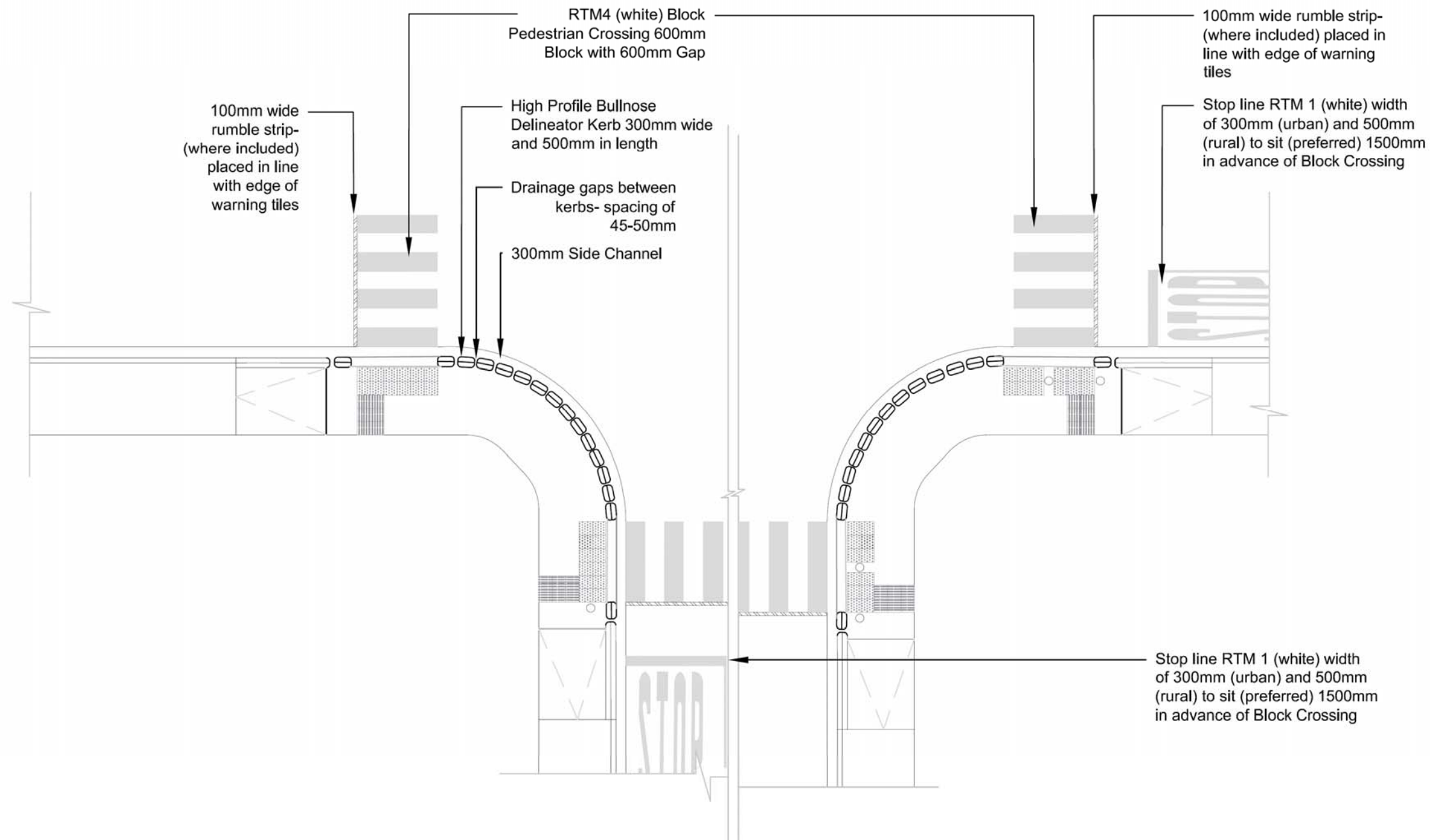
Technical Drawing 21: Kerb cut midblock, signalised pedestrian crossing. Design accommodates the minimum L-shape TWSI (TGIS) configuration with additional length in the guidance tiles to the closest verge, or boundary, to allow for the minimum 1.5 meters clear passing space along the sidewalk, after the gradient. Note the location and positioning of traffic signal pole, the orientation of the L-shape TWSI (TGIS), the rumble strip (if included) and painted block pedestrian crossing. This example makes use of the configuration without the bollard and makes use of the installation of the full pedestrian crossing width in warning tiles





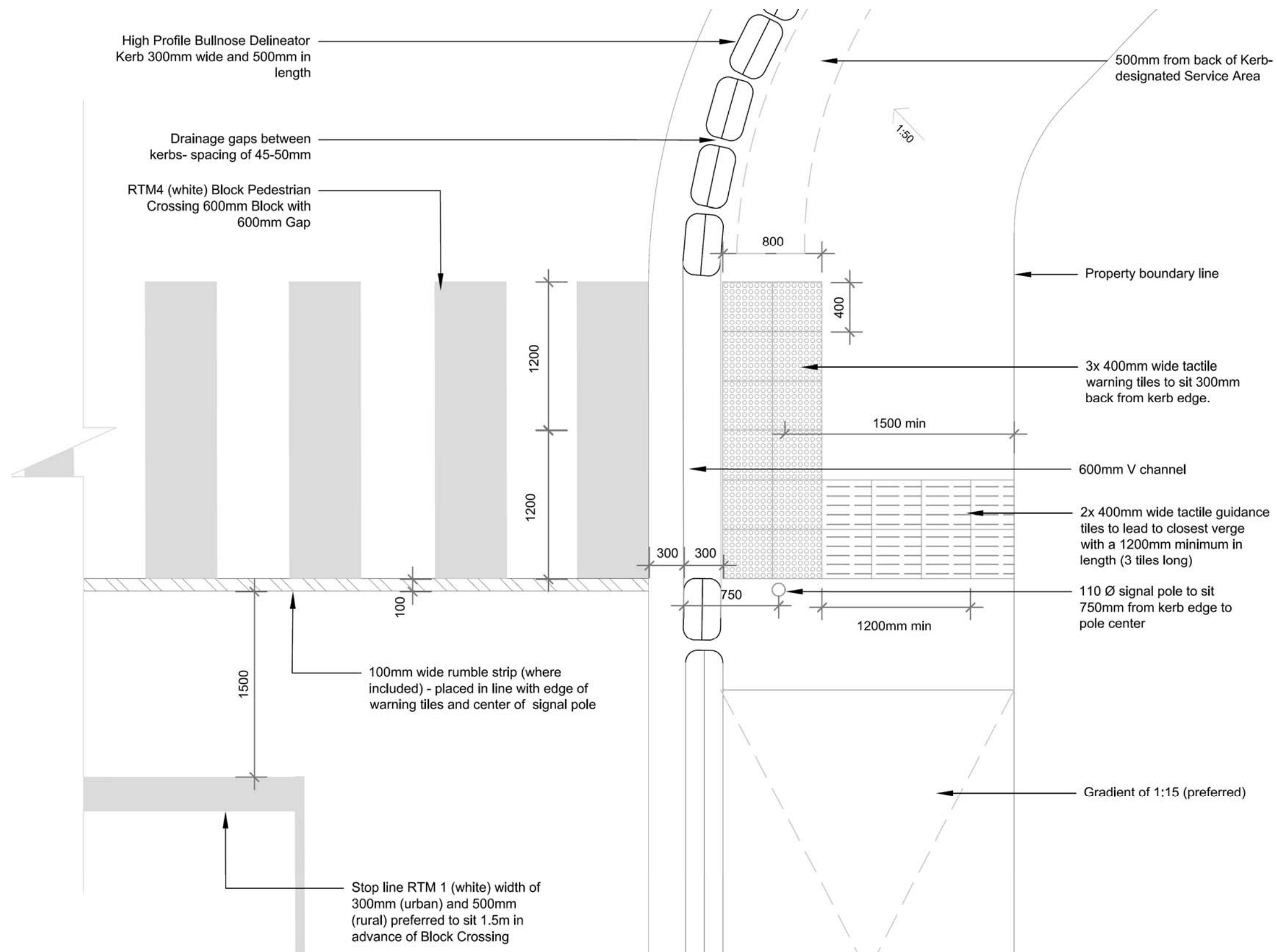
Technical Drawing 22: Full schematic illustration of signalised, dropped configuration intersections, with median areas of refuge, where pedestrian crossings are all installed perpendicular to the direction of vehicular traffic. This drawing also illustrates the stacking space for vehicles upon the exit of the intersection, for assisted optimisation of LOS, with the orientation of the pedestrian stagger to the right on the median islands. It is important to note that the direction of the stagger on the median is not a technical requirement. This example illustrates the configuration installation without bollards (the roadway on the top half of the drawing), as well as illustrating the configurations with bollards in the preferred locations (the roadway on the bottom half of the drawing). This example makes use of the installation of a bollard with the second set of TWSI (TGSi), as well as the example of the entire width of the pedestrian crossing being installed with warning tiles without the bollards. (It is also to be noted that the V-channel is also referred to as the gutter). This example makes use of the installation of the high delineator kerbs.





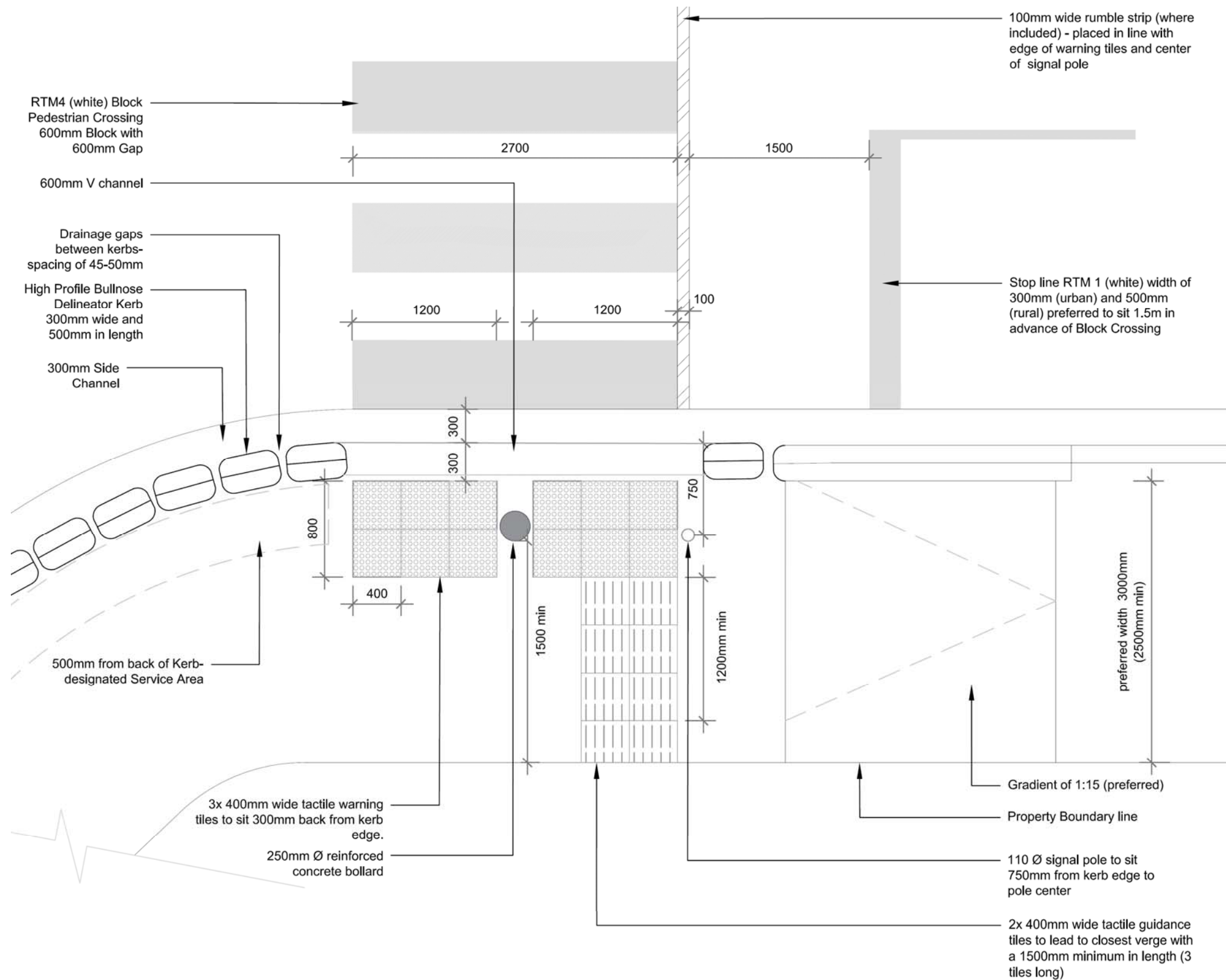
Technical Drawing 23: Dropped configuration, un-signalised pedestrian crossing of an intersection. Design accommodates the minimum L-shape TWSI (TGSI) configuration with additional length in the guidance tiles to the closest verge, or boundary, to allow for the minimum 1.5 metres clear passing space along the sidewalk. Note the orientation of the L-shape TWSI (TGSI) in relation to the pedestrian crossing, the rumble strip (if included) and painted block pedestrian crossings. Stop lines located prior to pedestrian crossing, with sufficient space to creep after allowing pedestrians to cross the road safely. This example illustrates the configuration installation without bollards (the roadway on the left hand side of the drawing), as well as illustrating the configurations with bollards in the preferred locations (the roadway on the right hand side of the drawing). This example makes use of the installation of a bollard with the second set of TWSI (TGSI), as well as the example of the entire width of the pedestrian crossing being installed with warning tiles without the bollards. (It is also to be noted that the V-channel is also referred to as the gutter). This example makes use of the installation of the high delineator kerbs





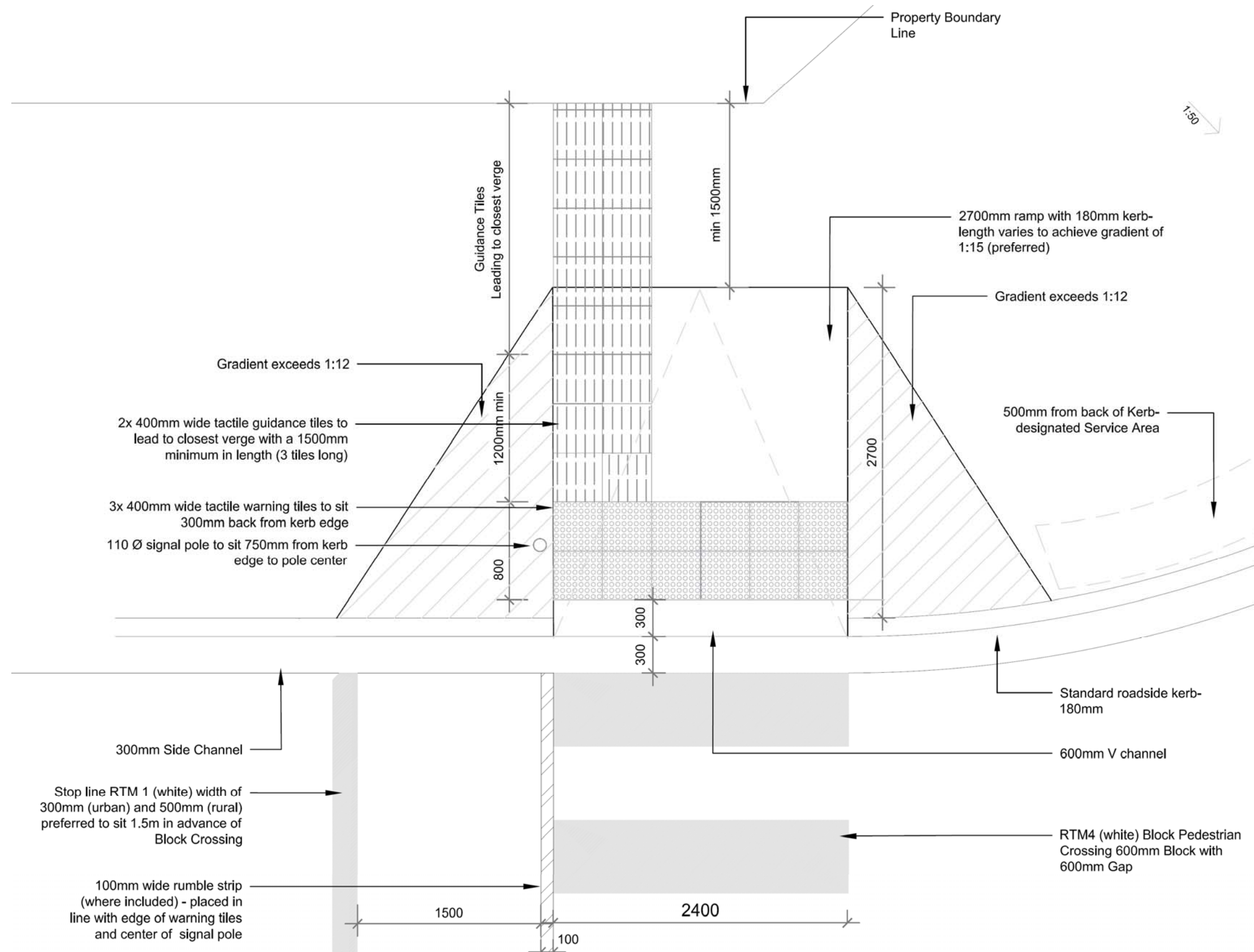
Technical Drawing 24: Detail A. Drawing shows details of required elements of a well-designed, dropped configuration, pedestrian crossing at a signalised intersection, including: basic L-shape TWSI (TGS) layout with an extension of the warning tiles to cover the extent of the pedestrian crossing, traffic signal location, pedestrian crossing located perpendicular to vehicular traffic at a 5 metre bell mouth, rumble strip (if included) location, service area allocation behind the kerbs at the bell mouth, preferred stop line distance of 1.5 metres from the pedestrian crossing, as well as compliant gradients along the path of pedestrian travel. This example makes use of the high profile bullnose delineator kerbs with drainage gaps





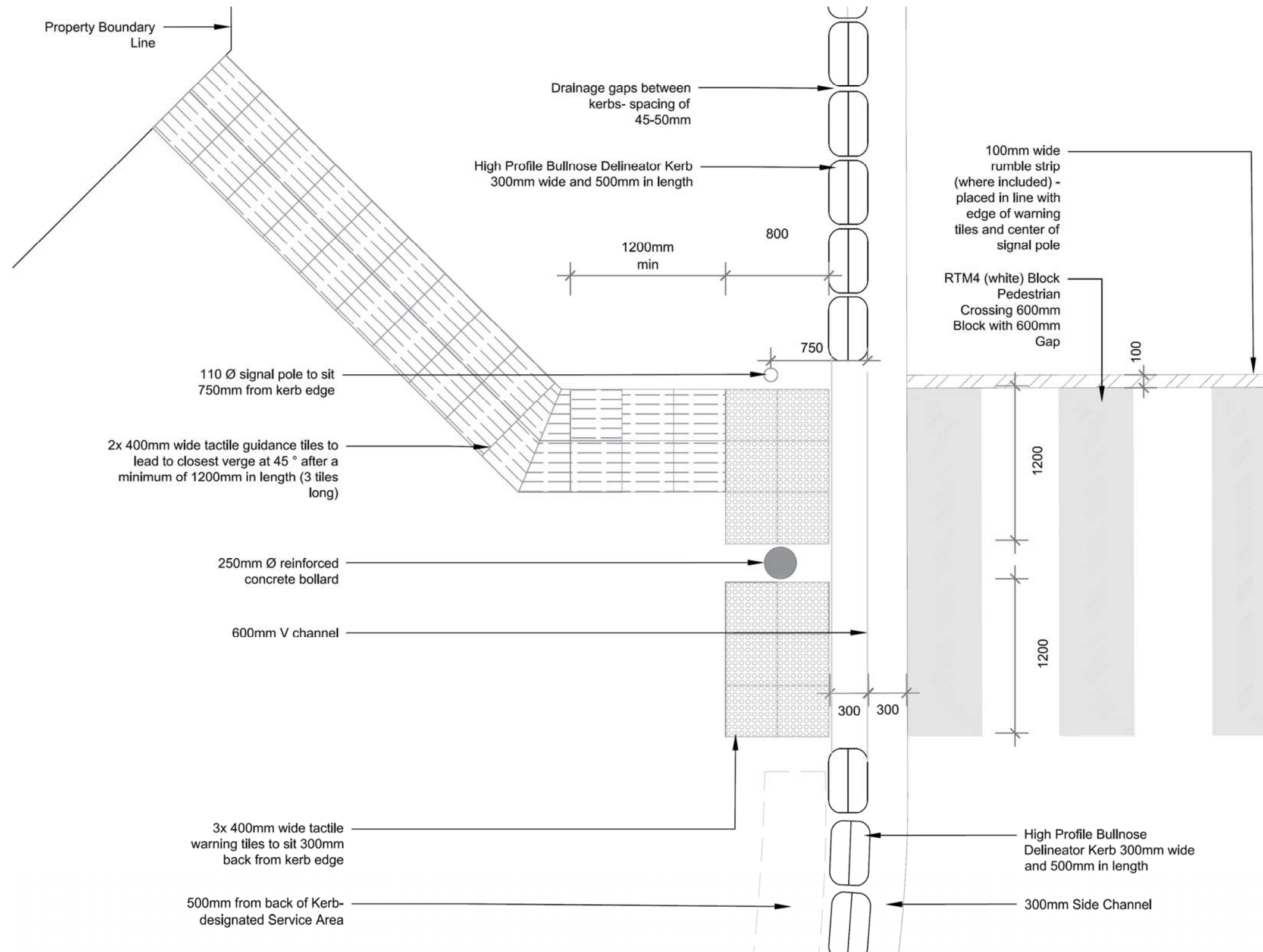
Technical Drawing 25: Detail B. Drawing shows details of required elements of a well-designed, dropped configuration, pedestrian crossing at a signalised intersection, including: basic L-shape TWSI (TGSi) layout, traffic signal location, pedestrian crossing located perpendicular to vehicular traffic at a 5 metre bell mouth, rumble strip (if included) location, service area allocation behind the kerbs at the bell mouth, preferred stop line distance of 1.5 metres from the pedestrian crossing, as well as compliant gradients along the path of pedestrian travel. This example makes use of the bollard for the protection of the pedestrian only area, as well as the additional set of warning TWSI (TGSi) tiles adjacent to the L-shape TWSI (TGSi), and the installation of high profile bullnose delineator kerbs with drainage gaps





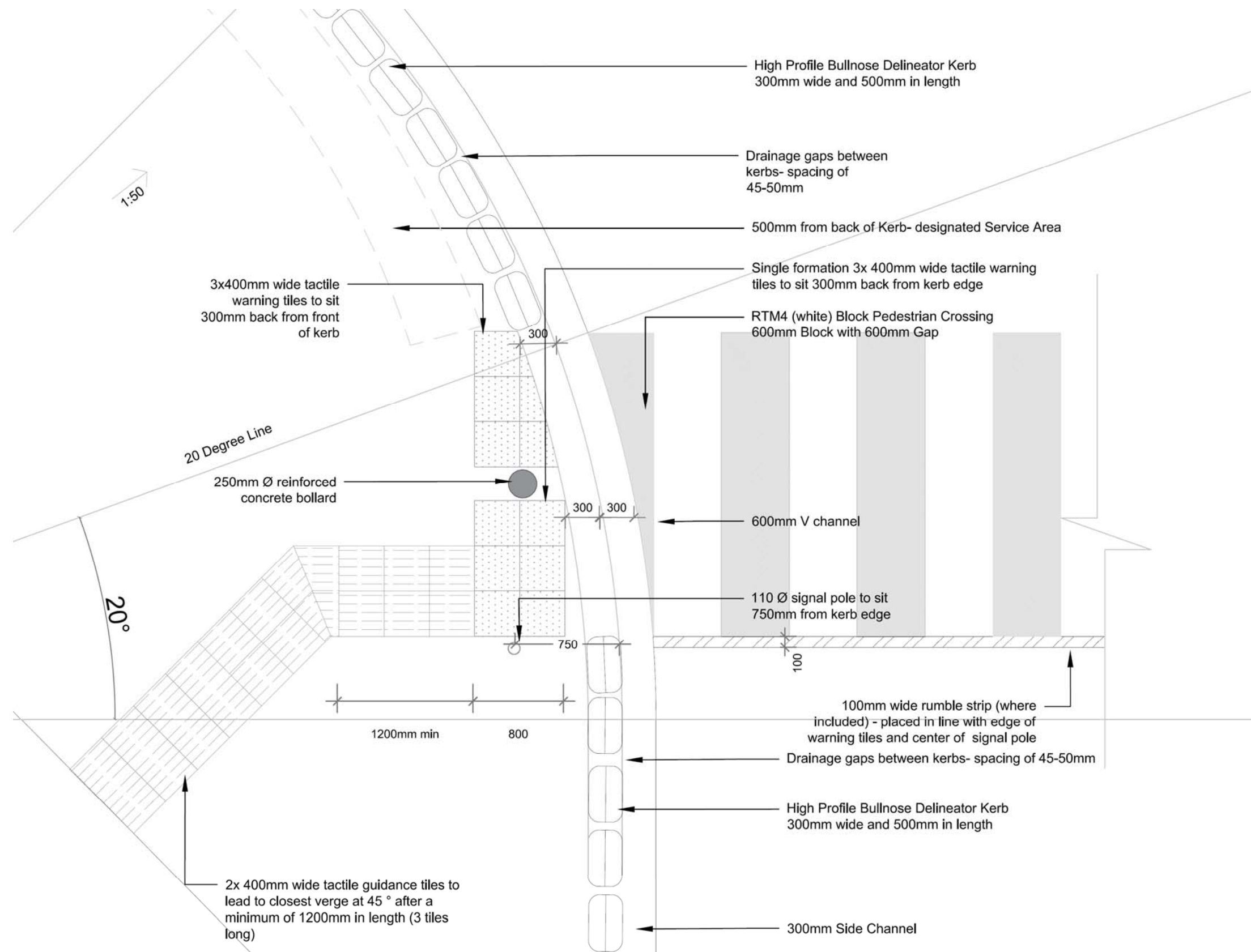
Technical Drawing 26: Detail C. Drawing shows details of required elements of a well-designed, kerb cut configuration, pedestrian crossing at a signalised intersection, including: basic L-shape TWSI (TGSi) layout, traffic signal location, pedestrian crossing located perpendicular to vehicular traffic at a 5 metre bell mouth, rumble strip (if included) location, service area location behind the kerbs at the bell mouth, preferred stop line distance of 1.5 metres from the pedestrian crossing, as well as compliant gradients along the path of pedestrian travel. This example makes use of the warning TWSI (TGSi) tiles installed to cover the width of the pedestrian crossing without a bollard





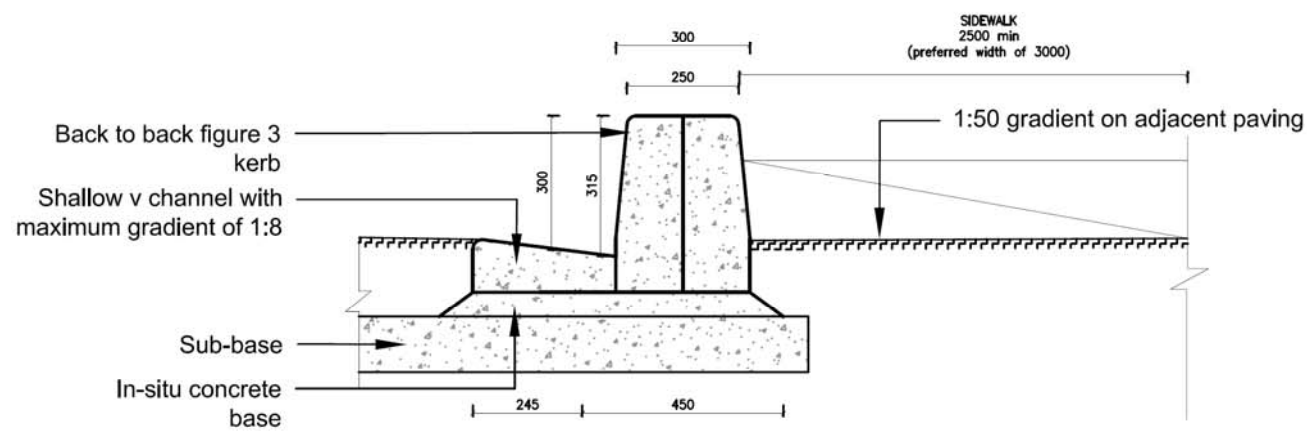
Technical Drawing 27: Detail D. Drawing shows details of required elements of a well-designed, dropped configuration, pedestrian crossing at a signalised intersection, where the TWSI (TGSi) route is extended to meet the nearest verge, or boundary, only after the 1.2 metre minimum guidance tile section and at an angle of 45 degrees. Detail also includes: traffic signal location, pedestrian crossing located perpendicular to vehicular traffic, rumble strip (if included) location, service area location behind the kerbs at the bell mouth, as well as compliant gradients along the path of pedestrian travel. This example makes use of the bollard for the protection of the pedestrian only area, as well as the additional set of warning TWSI (TGSi) tiles adjacent to the L-shape TWSI (TGSi) and the installation of high profile bullnose delineator kerbs with drainage gaps



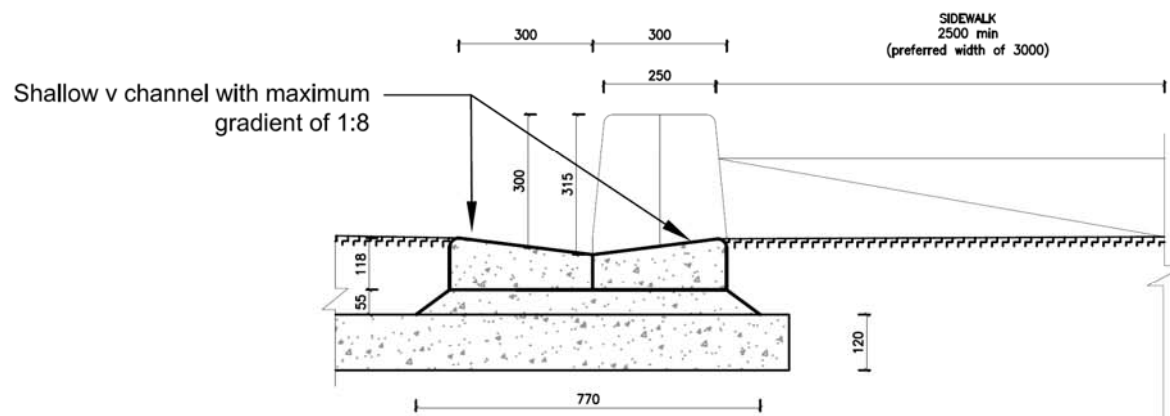


Technical Drawing 28: Detail E. Drawing shows details of required elements of a well-designed, dropped configuration, pedestrian crossing at a signalised intersection, where the TWSI (TGSi) route is extended to meet the nearest verge, or boundary, only after the 1.2 metre minimum guidance tile section and at an angle of 45 degrees. Note the installation of TWSI (TGSi) warning tiles and that the L-shape configuration remains in place and perpendicular to the direction of vehicular traffic. Drawing includes details on the L-shape configuration, traffic signal location, pedestrian crossing located perpendicular to vehicular traffic, rumble strip (if included) location and service area location behind the kerbs at the bell mouth. This example makes use of the bollard for the protection of the pedestrian only area, as well as the installation of high profile bullnose delineator kerbs with drainage gaps

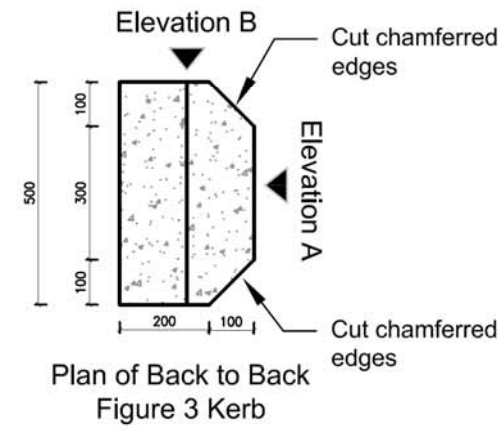




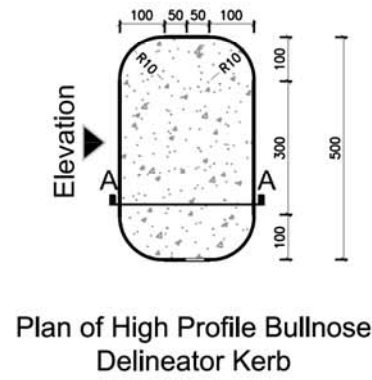
Cross Section of Back to Back Figure 3 Kerb



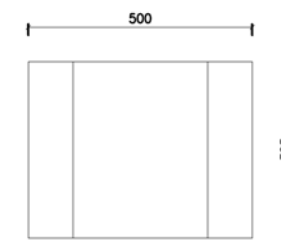
Section of 600mm V Channel



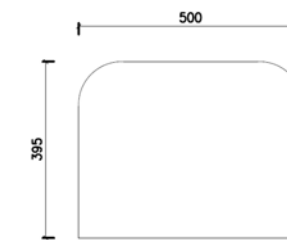
Plan of Back to Back Figure 3 Kerb



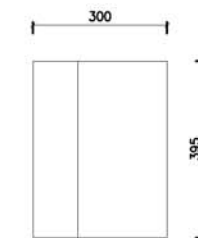
Plan of High Profile Bullnose Delineator Kerb



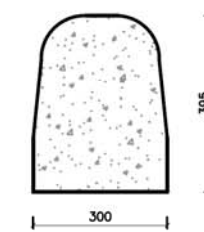
Elevation A of Back to Back Figure 3 Kerb



Elevation of High Profile Bullnose Delineator Kerb



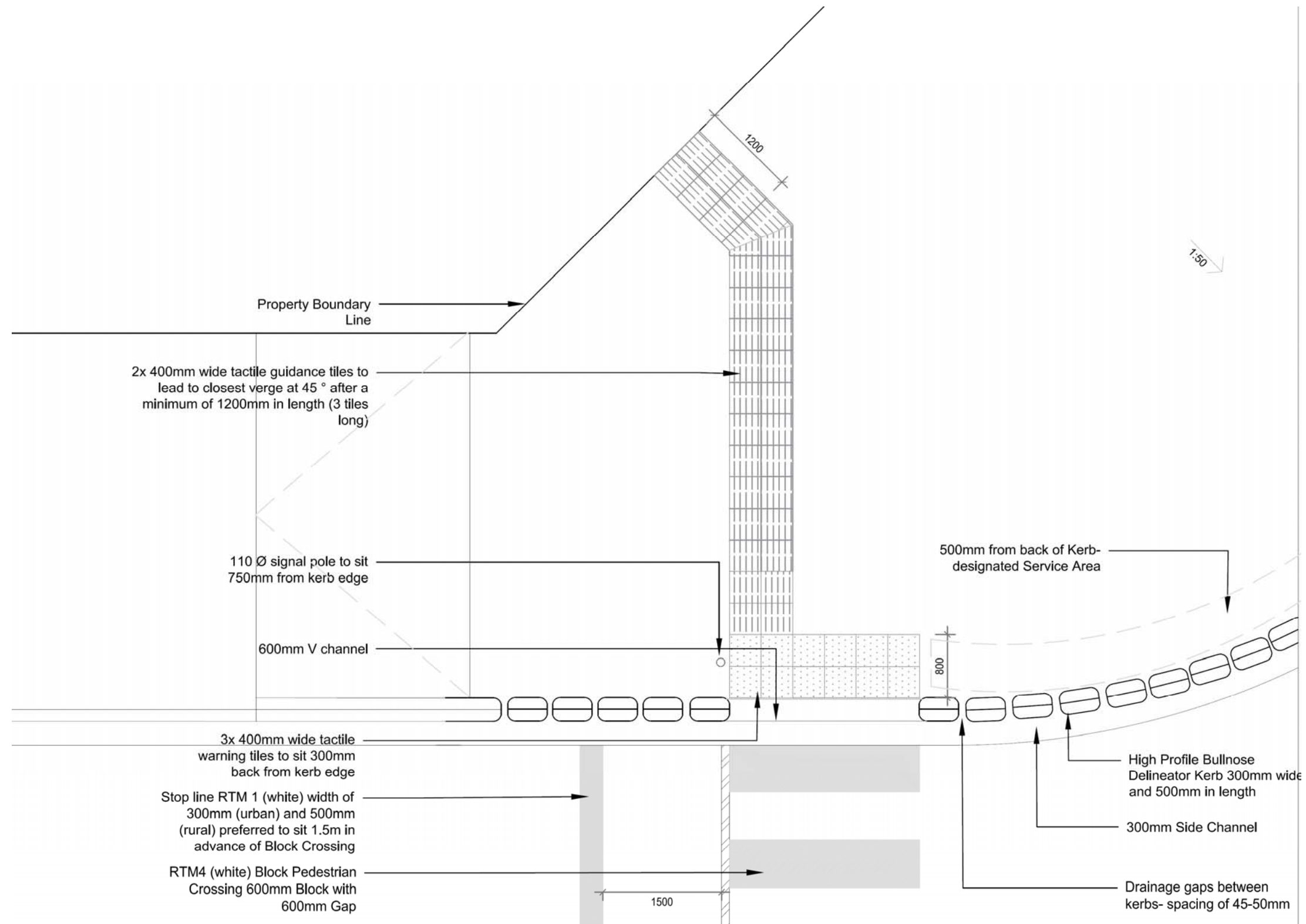
Elevation B of Back to Back Figure 3 Kerb



Section AA of High Profile Bullnose Delineator Kerb

Technical Drawing 29: Detail F. Details on kerb design and v-channel installation for the recommendations in this document





Technical Drawing 30: Detail G. Drawing shows details of required elements of a well-designed, dropped configuration, pedestrian crossing at a signalised intersection, where the TWSI (TGSi) route is extended to meet the nearest verge, or boundary, only after the 1.2 metre minimum guidance tile section from the verge at 45 degrees. Note the continued installation of the TWSI (TGSi) warning tiles for the width of the pedestrian crossing, but the L-shape configuration remains in place and perpendicular to the direction of vehicular traffic. Drawing includes details on the L-shape configuration, traffic signal location, pedestrian crossing located perpendicular to vehicular traffic, rumble strip (if included) location and service area location behind the kerbs at the bell mouth. This example does not make use of a bollard but is based on the installation of high profile bullnose delineator kerbs with drainage gaps



4.5 Check List

In order to assist with the design processes throughout this methodology, the following check list has been compiled to facilitate the development of pedestrian and NMT prioritising facilities.

Item	
Design Process One: Site Specific Research	
Road Classification	Yes
Public Transport Route – freight and through traffic minimised	
Determined Class of Road – lowest class possible	
For entire road, alternatively for 500m either side of the intersection or station:	
• Vehicle speed - minimised	
• Number of lanes - minimised	
• Width of lanes - minimised	
Signalised intersections - provided	
Un-signalised intersections - provided	
NMT and Vehicular Counts	Yes
Pedestrian counts (and/or predictions) and modes - completed	
Vehicular counts (and/or predictions) and modes - completed	
• LOS for Pedestrians and NMT users - optimised	
• LOS for Vehicles – rationalised	
Primary Geometric Design	Yes
Vertical gradients – at preferred 1:15 or compliant at 1:12	
Horizontal gradients – compliant at 1:50	
Gradient requirements for drainage – compliant	
Road reserve widths - optimised for pedestrians	
Initial sight line requirements - optimised for pedestrians	
Bell mouth radii - reduced	
Removal of slip lanes	
Design Process Two: Primary Design	
Minimum number of lanes	Yes
Based on LOS for all vehicles - reduction in vehicular traffic signal phasing	
More than four lanes and high order road - accessible overhead bridge	
Median Island Treatment	Yes
All-inclusive lanes, four or less	
• Signalised: single phase pedestrian crossing for all lanes - provided	
• Un-signalised: traffic calming measures at crossing - provided	
All-inclusive lanes, four or more	
• Signalised: median island location, two phase pedestrian signal for crossing – provided	
• Minimum median width of 2.4 metres - provided	
• Staggered median - provided	
• Additional traffic signal pole indicating pedestrian phase on median - provided	
Bell Mouth Radii	Yes
Bell mouth radii - reduced	

Cycle Lane	Yes
Arterial cycle route	
• Sufficient road reserve – provided	
• Road markings – provided	
• Signage - provided	
Mixed NMT	
• Sufficient sidewalk reserve (minimum of 3 metres clear of utility reserve) – provided	
• Sidewalk markings – provided	
• Signage - provided	
Location of Pedestrian Crossing	Yes
Crossing perpendicular to traffic and out of the curvature of the bell mouth – provided	
Located within the <i>20 degree rule</i> – provided	
Crossing to cover the shortest distance possible over the road – provided	
Location of signal pole at the approaching edge of the pedestrian crossing – provided	
Pedestrian Crossing Width	Yes
Minimum of 2 metres – compliant	
Pedestrian count dependent, increase pedestrian crossing width - provided	
Width of Sidewalk	Yes
Less than 2 metres=increase sidewalk width - provided	
2-3 metres=dropped intersection - provided	
3-4 metres=kerb cut or dropped intersection - provided	
4 metres and bigger= kerb cut or dropped intersection - provided	
Design Process Three: Detailed Design	
Pedestrian Crossing Markings	Yes
All crossings to be painted block pedestrian crossings - compliant	
Location of Traffic Signals	Yes
Traffic signals for pedestrian actuation to be located on the approach edge of the pedestrian crossing marking - provided	
Traffic signal poles to be located to aid in orientation of blind pedestrians - provided	
Midblock crossing, approach side location may vary - provided	
Traffic signal poles to be located 750mm from the kerb edge - compliant	
Stop Lines and Sight Lines	Yes
Initial calculations for un-signalised intersections based on cadastral - compliant	
Signalised crossing= stop line at least 1.5 metres from pedestrian crossing - provided	
Un-signalised=stop line at least 1.5 metres from pedestrian crossing and sufficient space for vehicles to creep over the crossing to increase vehicular visibility - provided	
Traffic Signal Design	Yes
Total width of crossing in one pedestrian signal phase measured - completed	
Timing for pedestrian phase (width/0.8= total seconds for single pedestrian phase) - completed	
Signal timing	
• LOS for Pedestrians and NMT users – optimised	



• LOS for Vehicles – rationalised	
Fixed pedestrian phase in signalling= no actuator - provided	
Actuated pedestrian phase in signalling=actuator – provided	
All pedestrian signals to include audible signals – provided	
All pedestrian signals to include visual signals – provided	
Additional caution time for pedestrians at right turning vehicular signals - provided	
Sidewalk Gradient Treatment	Yes
All ramps to road level at a maximum ratio of 1:12 (preferred 1:15) - compliant	
All cambers at a maximum ratio of 1:50 - compliant	
Kerb cuts	
• 1.5 metre landing at top of ramp for passing pedestrians - compliant	
Dropped intersection	
• Road level throughout bell mouth - provided	
Pedestrian Only Areas	Yes
Access areas from road wider than 1.2 metres to have vehicular barrier installed to prevent access through kerb cut or dropped intersection - provided	
At dropped intersection raised kerbs to be installed - provided	
Tactile Assistance and Orientation	Yes
L-shape configuration of TWSI (TGSI) installed perpendicular to the direction of vehicular traffic	
• Stem of L to be in guidance tiles - provided	
• Stem of L to be at least 1.2 metres in length - provided	
• Stem of L to be at 0.8 metres wide from side of approach - provided	
• Where change in direction is required, only after 1.2 metres from base of L and only at an angle of 45 degrees to the nearest verge – provided where applicable	
• Base of the L to be in warning tiles - provided	
• Base of L to be at least 0.8 metres in length - provided	
• Base of L to be 1.2 metres in width from side of approach - provided	
• Base of L to be fitted with two vertical orientation aids (signalised intersection=traffic signal or un-signalised intersection= bollard) - provided	
• Rational design in conjunction with universal access specialist	
Rumble strip (if included) located in line with traffic signal pole and further away from the intersection	
Walk Through Island Configuration	Yes
Straight-up kerb edge around through crossing - provided	
Walking surface same as adjacent road surface - provided	
Continued painted pedestrian block crossing - compliant	
Median Island Configuration	Yes
Dropped median to be level with road surface - provided	
Effective clear width minimum of 0.9 metres (preferred 1.1 metres) - compliant	
Stagger to the right - provided	
Installation of base of L shape TWSI (TGSI) (only warning tiles) - provided	
Orientation aids (traffic signal or bollard) - provided	
Additional pedestrian signal as required (actuated) - provided	
Rumble strip (if included) located in line with traffic signal pole and further away from the intersection - provided	

Slip lane that has to remain in place, treated as median island - provided	
Additional Public Transport Recommendations	Yes
All bus stops for any public transport networks are located downstream of the intersection - provided	
The location of pedestrian crossings can occur behind the bus - provided	
The walking distance from the bus stop or station to the pedestrian crossing be minimised - provided	
IPTN trunk routes sufficient barriers to prevent pedestrians from crossing roads in unsafe areas or under unsafe conditions - provided	
Stations located on the median to be orientated so that the entrance provides the most direct access from the intersection and the most logical path of travel for pedestrians and NMT users - provided	
In-lane feeder stops are preferred - provided	
Additional General Recommendations	Yes
Road marking paint specifically for pedestrian crossings should be specified in tender requirements to prevent fading; good quality Cold Liquid Plastic is recommended – done	
Onsite training and monitoring of engineers to ensure quality and compliance with drawings is required - done	
Road engineering and landscaping design must be documented in detailed drawings and must specify the exact location and co-ordination of all amenities to ensure adherence to the design methodology - done	
All furniture is to be located in the designated service areas, as indicated in the drawings, to prevent cluttered pedestrian access areas - done	
All road and sidewalk maintenance or new installations must maintain the same quality of surface and infrastructure that was originally designed and constructed. This should be carefully monitored especially when underground services are being installed or maintained - done	
The surfaces along sidewalks are preferred to be smooth, stable and slip resistant. It is highly recommended that along NMT routes, no bevelled edged pavers, cobble stones or uneven floor surface finishes with raised or chamfered edges be used. All pavers to be installed to be level with an even surface, where no steps exceeding 5mm occur. Preferred surface finishes include wire-cut clay pavers, wood-floated concrete and tarmacadam – done	



5. Safety Requirements

Sign off of layouts used from this document is required by the responsible official for universal access. It is envisaged that this official will have a comprehensive understanding and intimate knowledge of Road Safety Audits, roads engineering and a Universal Design. Although the NTR 1 takes cognisance of international precedents, such as the Dutch's Sustainable Safety Approach, the Australian's Safe Systems and the Swedish Vision Zero, local conditions affect the application of best practice. An important component of the Sustainable Safety Approach, for example, is the development of forgiving road environment that allows for driver error, and in view of this, bollards are avoided. Although this approach is commendable, the South African road context does require the use of forceful street furniture that assists driver behaviour and minimises the enforcement process. This may include the need for bollards at the entrance and exit of cycle paths, to avoid the abuse of them by motorised vehicles.



Figure 14: Bollards at Cycle Path to avoid abuse by motorised vehicles. Source: <http://www.juca.org.za/?paged=8>

6. Quality Control Measures

Sign off of layouts used from this document is required by the responsible official for universal access. It is envisaged that this official will have a comprehensive understanding and intimate knowledge of Road Safety Audits, roads engineering and a Universal Design. It is feasible for the municipality to out-source some of this skills base until internal capacity has been consolidated.

7. Enforcement

It is acknowledged that South African Traffic Law Enforcement and South African Police Services are not effectively achieving compliance and addressing bad pedestrian and driver behaviour. The NTR 1 strives to minimise the level of law enforcement and, instead, focuses on self-enforcing systems design, which is designed into the recommendations. South Africa is not yet in a position where regulations can be used in conjunction with design solutions, as mentioned with respect to international precedents (Dutch, Australian and Swedish). These technical requirements form the start of a paradigm shift around pedestrian and NMT safety and, through systems design and design solutions, the promotion of self-enforcement.

8. Areas that Require Additional Research and Testing

Other areas also contribute to the safety of the pedestrian and NMT environments, which could not be covered extensively enough in NTR1. These areas require additional research and feedback into the NTR1: Pedestrian Crossings:

- The use and application of pedestrian signals, particularly audible and visible warnings and investigation into the efficient and effective use of the systems.
- Traffic signal pole audible locators for North/South and East/West crossing directions.
- TWSI (TGSi): the effective use of warnings tiles.
- TWSI (TGSi): colour contrast.
- TWSI (TGSi): for universal access and the efficiency of installations across the entire width of the pedestrian crossing.
- TWSI (TGSi): design configuration when leading users to a bus stop or station.
- The single rumble strip across the road at pedestrian crossings to assist people who are blind. Although this has been tested, alternative methods need to be tested to identify the most functional solution in terms of maintenance, vehicular noise levels and user efficiency.

9. Document Progress Process

The document, in its current format, is a proposal as it has not undergone committee approval as required by the Department of Transport. The final layouts included in this document must be tested in situ under the supervision of the National Department of Transport for one to two years, with the support of the 13 municipalities who are responsible for the development of the IPTN's and as required by the PTNG funding conditions.



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⁴ Some supporting documents are available in the shared folder in this location
<https://drive.google.com/drive/folders/0B06QYwK6AXoxcmhud3FjQjBnaUE?usp=sharing>

or in National Department of Transport (NDoT), National Technical Requirement 1: Part 1 Pedestrian Crossings, Version 6 (2016)

