

Traffic Signals Design Technical Directive and Guideline

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| Contact details | Department of Infrastructure, Planning and Logistics, Transport and Civil Services Division |
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| Acronyms | Full form |
|----------|---|
| ELV | Extra Low Voltage |
| EPROM | Electronic Programmable Read-Only Memory |
| ITS | Intelligent Transport System |
| LV | Low Voltage |
| NTG | Northern Territory Government |
| PROM | Programmable Read-Only Memory |
| SIDRA | SIDRA Solutions software produced by Akcelik and Associates |
| TSDR | Traffic Signals Design Report |
| UPS | Uninterrupted Power Supply |

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1. INTRODUCTION

This technical directive and guideline specifies requirements when designing, drafting and documenting the use of traffic signals on Northern Territory Government roads.

1.1. OBJECTIVE

This document aims to ensure that the traffic signal project safely and efficiently controls all traffic movements, is consistent with current standards and with normal operation of the traffic signal/road network.

1.2. PURPOSE

The technical directive and guideline has been developed to assist in designing traffic signals for use in the Northern Territory. The information contained in the various sections is intended to be used as a guide to good practice. Discretion and judgement should be exercised, taking into account all the factors that may influence the design of traffic signals at any particular site.

The brief makes reference to local policies, local standard drawings, current Australian Standards and Austroads Guidelines, and is intended to supplement and otherwise assist in their interpretation and application. For matters where Australian Standards and Austroads Guidelines are silent, then local policies and standards, as consulted with the Department shall prevail.

2. REFERENCES AND STANDARDS

Unless specified otherwise, all design must be undertaken in accordance with the following:

AS1742: Manual of Uniform Traffic Control Devices Parts 1 – 15

AS1100:401 Technical Drawings Part 401

AS2053: Conduits and fittings for electrical installation set

AS2144: Traffic signal lanterns

AS2276: Cables for traffic signal installation set

AS2339: Traffic signal posts and attachments

AS2353: Pedestrian push button assemblies

AS2703: Vehicle loop detector sensors

AS3000: Electrical installations

AS 61386: Conduit systems for cable management set

Austrroads Guide to Road Design Parts

Austrroads Guide to Traffic Management Parts

The Department's CS3400 series standard drawings apply to the design of traffic signals:

Refer <https://dipl.nt.gov.au/industry/technical-standards-guidelines-and-specifications/standard-drawings>

In the case of reconstruction of existing traffic signals, the Department will provide the Designer with copies of the "as constructed" or design drawings, cable installation drawings and cable connection chart for the existing installation, where available.

The traffic signal design shall be co-ordinated with the road works concept design and detailed design to ensure they are compatible and consistent.

3. DESIGN STEPS

The steps involved in the traffic signals design process are as depicted in the following figure.

Each design stage is followed by a review as noted in the following sections. The review at the 25% Concept Plan Stage may generate concept iterations prior to proceeding to the Preliminary Design.

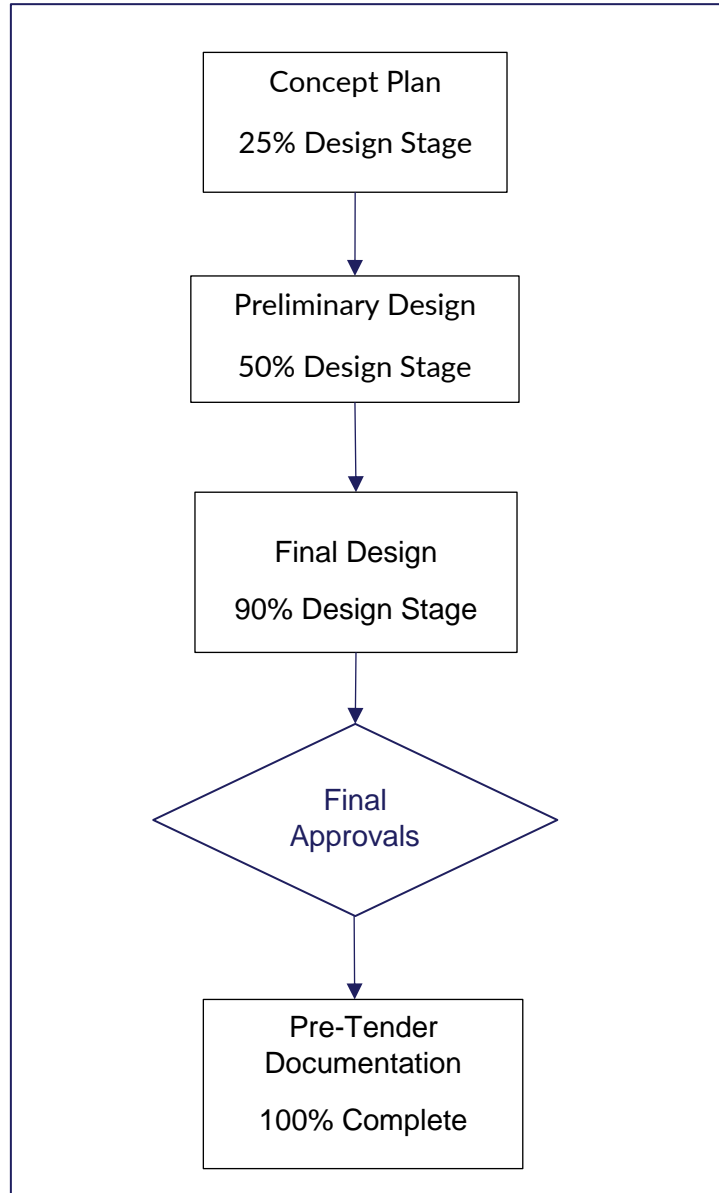


Figure 1. Traffic Signals Design Process

3.1. CONCEPT PLAN

A concept plan will show the road layout and all the existing or design features to be included in or likely to affect the traffic signal design.

Assumptions about inclusion and use of various features shall be clarified at this stage, for example:

- Aspect size (200mm/300mm)
- Use and location of overhead displays (mast arms)
- Innovative devices (CCTV, ITS facilities, etc)
- Use of red light cameras
- Use of Active Advance Warning Signs
- frangible columns (slip base/ vehicle impact absorbing)
- lighting technology

This work constitutes 25% of the design process and is assessed at a 25% Review.

3.2. PRELIMINARY DESIGN

A preliminary design for traffic signals shall:

- Be the result of critical review of concept options, taking account of the site, the Department's standard drawings, relevant Australian Standards and Austroads Guidelines.
- Be coordinated with any associated road works or other detailed design to ensure compatibility and consistency, and that control points are common to both designs.
- Have a critical review process to get the best design option.

Any major departure from initial geometry and/ or phasing decisions must be referred back to the investigation stage to ensure the concept remains the most suitable treatment before adoption as the preliminary design.

In addition to the site plan information, the preliminary traffic signal design must show:

- (a) The location of the:
 - Controller and source of supply.
 - Detectors.
 - Posts and signal faces for all connected devices.
 - All pavement marking.
- (b) Phasing diagrams.
- (c) ITS and/or any special operation feature, and a
- (d) Preliminary cost estimate.

This work constitutes 50% of the design and is assessed at a 50% Review.

3.3. FINAL DESIGN

The final design for traffic signals shall:

- Refine and finalise the agreed preliminary design taking account of the site, the Department's standard drawings, relevant Australian Standards and Austroads Guidelines.
- Be coordinated with any associated road works or other detailed design and shall ensure they are compatible and consistent, and that control points and design lines are common to both designs.
- Have a critical final internal review prior to presentation.
- Be fit for service and avoids any conflict with existing utilities, drainage, awnings, trees and roadside furniture.
- Ensure a design life of 20 years for all electrical equipment.
- Finalised cost estimate.

This work constitutes 90% of the design and is assessed at a 90% Review.

3.3.1. Construction Staging

Where construction staging affects the traffic signals, the drawings shall be prepared showing the complete signal design for each stage of the road works construction.

3.3.2. Specifications

The traffic signal design shall be in accordance with this brief, the Standard Specification for Roadworks and the Department's relevant standard drawings.

3.3.3. Traffic Signals Design Report (TSDR)

The TSDR is a collection of all documentation and decision outcomes associated with the traffic signals design and shall include, but not limited to:

- The Department's direction or agreement to adopt traffic signals as the preferred intersection treatment.
- Comprehensive traffic data to support the design solution, including but not limited to; recent traffic counts, traffic assignment, traffic crash records.
- Site photographs.
- Results of the initial investigation.
- A road safety audit in accordance with the Department's Road Safety Audit Technical Directive and Guideline.
- Description of the adopted signal system elements.
- Reference to all applicable standards and specifications.
- Details of design inputs.
- Details of design and default parameters adopted.
- Details of interfaces to existing or third party systems.
- Operational description, including phasing philosophy.
- Location of all equipment.
- Explanations for non-standard equipment locations.
- Controller input/output allocations.
- Signal group allocations.
- Detector input allocations.
- Power system, volt drop and fault loop impedance calculations.
- Details of all proposed equipment and construction materials.

- Appropriately detailed traffic signal hardware.
- Specification for supply and installation of traffic signals.
- Design, procurement, installation integration and commissioning program.
- Any associated road design plans or setting out details that are not shown on the design layout; and
- Confirmation that the traffic signal equipment will integrate with the Department's communications and traffic systems / software.

3.4. FINAL APPROVALS

Prior to completion of all the necessary documentation, drawings and traffic signals design report, the Designer shall seek approval from the relevant authorities for power, telecommunication and any telemetry connections.

3.5. PRE-TENDER DOCUMENTATION

The traffic signals design for the delivery of the project comprise the following:

- Plans
- Specification
- Traffic Signals Design Report
- Cost Estimate

On completion of the design, the abovementioned documents shall be provided in electronic format in both native (WORD, .dwg, .sip#) and pdf formats.

4. PROJECT DRAWINGS

Project drawings shall be compiled consistent with the requirements of the Department's NTG Technical Drawings Part 2 – Civil CADD Manual. The manual can be found at https://dipl.nt.gov.au/_data/assets/pdf_file/0017/430019/ntg-technical-drawings-part-2-civil-cadd-manual.pdf

4.1. PRELIMINARY DESIGN DRAWINGS

As preliminary content, the following signal drawings shall be created for each site and titled as follows:

Drawing Type A

XXXX REGION
PROJECT DESCRIPTION
INTERSECTION DETAILS ROADS A AND B
TRAFFIC SIGNAL LAYOUT (Refer Figure 2)

The drawing shall show:

- Traffic Signal Layout
- All associated services

Drawing Type B

XXXX REGION
PROJECT DESCRIPTION
INTERSECTION OF ROADS A AND B
TRAFFIC SIGNAL ELECTRICAL AND PHASING (Refer Figure 3)

The drawing shall show;

- Traffic Signal Phasing Plan
- Traffic signal layout with extraneous information removed.
- Reference Notes to any external equipment

4.2. FINAL DESIGN DRAWINGS

As a minimum requirement, the following signal drawings and associated content shall be created for each site and named as:

Drawing Type A

XXX REGION
PROJECT DESCRIPTION
INTERSECTION DETAILS ROADS A AND B
TRAFFIC SIGNAL LAYOUT (Refer Figure 2)

The drawing shall show:

- Traffic Signal Layout
- Traffic signal/ITS equipment
- Traffic Signal Conduits and Pits
- Underground/ Overhead services
- Line marking
- Legend for project specific symbols

Drawing Type B

XXXX REGION
PROJECT DESCRIPTION
INTERSECTION OF ROADS A AND B
TRAFFIC SIGNAL ELECTRICAL AND PHASING (Refer Figure 3)

The drawing shall show;

- Traffic Signal Phasing Plan
- Electrical connections
- Cable connection schedules, including the identification of spare cores;
- Civil layout with extraneous information removed.

The following signal drawing shall be provided by the designer when equipment in the design is remote from the intersection, such as Active Advance Warning Signs, or ITS facilities.

Drawing Type C

XXXX REGION
PROJECT DESCRIPTION
INTERSECTION OF ROADS A AND B
TRAFFIC SIGNAL OVERVIEW LAYOUT (Refer Figure 4)

The drawing shall show the traffic signal layout including all remote signal equipment, including;

- Traffic signal/ITS equipment
- Conduits and Pits;
- Underground/Overhead services
- Line marking

Note: The drawings can be rearranged so that C is the first in the set. In that instance, all traffic signal layout, general notes and project specific symbols are to be included in this drawing and removed from the other drawings. (Refer to the greyed content on Figure 4).

Where a site is being modified, the following drawings shall be provided.

Drawing Type D

XXXX REGION
PROJECT DESCRIPTION
INTERSECTION OF ROAD A AND ROAD B
TRAFFIC SIGNAL CONSTRUCTION

The drawing shall be;

- Similar to drawing types A, B and C above and reflect the modified site overlaid over the existing site and infrastructure. All existing elements are to be displayed in a greyed-out format.
- Construction notes

4.3. SYMBOLS

Symbols on the drawings shall be consistent with Australian Standard, 1100, Technical Drawings Part 401 (AS1100.401) and standard drawing CS3404.

The Department's specific symbols are in addition to those in AS1100.401 and are also incorporated in standard drawing CS3404. These can be referenced in lieu of providing legends on any of the traffic signals drawings.

<https://dipl.nt.gov.au/industry/technical-standards-guidelines-and-specifications/standard-drawings>

5. HARDWARE REQUIREMENTS

5.1. APPROVED PRODUCTS

All products shall be compliant to the Australian Standards and proposed product types are to be submitted to the Department for acceptance for application.

5.2. UNINTERRUPTED POWER SUPPLY (UPS)

The inclusion of a UPS shall be subject to prior consultation with the Department. The UPS should be included in the design where one or more of the following conditions apply:

- At 4 way multilane intersections;
- Where there is high pedestrian use
- Where CCTV or other ITS applications are/will be installed.

UPS must have the capacity to operate over a period of not less than 4 hours.

Where an external UPS system is to be installed it should be located adjacent to the controller on a common foundation.

5.3. TRAFFIC SIGNALS FACES

The number and location of signal faces shall be determined by best practice in consideration of the localised site conditions, vehicle paths and vehicle overhangs.

5.3.1. Overhead signals

These displays have high installation and maintenance costs, but they are required where:

- Stopping sight distance to the post-mounted signal face is inadequate, for geometry or obstruction reasons, or
- Where the roadway is too wide for kerb mounted signal faces to fall within driver's line of sight, or
- Where the Department directs, in response to traffic characteristics and/or experience with driver compliance and behaviour.

5.4. LANTERNS

Traffic signal lanterns shall be installed with relevant accessories as shown in the standard drawings, the Department's Standard Specification for Roadworks or as otherwise specified in this brief.

Mounting heights and minimum clearance to vehicle lanterns shall be as shown on the Department's Standard Drawings, Standard Specification for Roadworks, and Australian Standards.

5.5. CONTROLLER

The traffic signal controller (controller) cabinet shall be located to allow easy access for maintenance personnel and their vehicles. The controller cabinet shall be positioned with the door facing away from the intersection but with a line of sight to the traffic signals to allow the controller and traffic signals to be viewed concurrently by a service technician. An optimal location should be near external services supplies (i.e. power and telecommunication). Designers should coordinate with external service suppliers to identify points of entry into the traffic signal system. Controllers should be located on higher ground or away from drains at the site to avoid issues with drainage.

Footpaths should not be obstructed by the open door of the controller or any service technician working on the controller.

Where ITS equipment is to be utilised, a top-hat cabinet installed on top of the controller cabinet is preferred. However, if there is substantial auxiliary equipment, an adjacent cabinet may be used subject to the Department's approval.

5.6. JUNCTION PITS

Junction pits shall be located at least 3.5m from the edge of any traffic lane and not be located in pedestrian areas or table drains. Where 3.5m clearance cannot be achieved, such as in a traffic island or median, the pits should be located to provide equal clearance in all directions. Pits should not be located in the road traffic lanes or shoulder.

5.7. TRAFFIC SIGNALS POST

Where possible, traffic signals posts shall be installed at no less than 1.5m from the edge of the traffic lane. Offsets less than 1.5m are to be agreed to by the Department.

The location of traffic signals posts must take into account site constraints such as services and roadside furniture. Location must ensure clear sightlines to the signals by approaching drivers and ensure they are clear of areas where they may be struck by vehicles manoeuvres, vehicle overhangs, or where long vehicles may need to mount the kerb while negotiating a turn.

Where a pedestrian button is to be mounted on a post, the post should be positioned so that people using mobility devices do not need to be on the wheelchair ramp to activate the push button. Where an effective compromise position cannot be achieved, a separate pedestrian push button post shall be installed. Posts shall not be placed within drains, pedestrian or cycle pathways or crossing areas and placement of the posts shall comply with the requirements of the Disability Discrimination Act

Combination posts comprising road lighting and or mast arms may be used in situations where it is not possible to position them separately. Where a site is specified to be ELV operation and low voltage (LV) road lighting is used, appropriate electrical segregation must be maintained between the two systems.

Where combination posts are incorporated into the traffic signals design, then consideration must be given to a separate source for energy supply for the street lighting. The use of this design option must not compromise the design of either the street lighting or the traffic signals.

Approval from both the energy supplier and the Department must be received prior to this treatment being accepted.

5.8. SIGNS

When regulatory signs are to be provided for part time regulation of some movements at intersections, a symbolic LED sign (e.g. no left turn/no right turn) must be provided at the stop line post and a secondary (or tertiary) post.

Sign equipment must be approved by relevant authorities. If advance signage are to be considered, it shall be in consultation with the Department.

5.9. VEHICLE DETECTORS

Inductive loops (loops) utilised for vehicle detection must be the symmetripole type.

Loops must be included in non-controlled lanes e.g. left turn slip lanes, and connected to the controller.

Where queue detectors are recommended in the Traffic Signals Design Report, the final position of the detectors on the road is to be determined in consultation with the Department.

5.10. PEDESTRIAN AND BICYCLE DETECTORS

All pedestrian movements shall be demand actuated by pedestrian push buttons with audio tactile units. Pedestrian push buttons must be:

- a) Oriented so that the face of the push button is in line with or parallel to the crosswalk marking;
- b) Incorporate arrow legends (in the tactile display) on all pedestrian push buttons;
- c) Correctly oriented to guide visually impaired pedestrians in the same direction indicated by cross walk markings;
- d) Provided on median traffic islands.

Special type push buttons, for example, cyclist or horse rider shall not have the audio tactile component and shall be located at heights suited for the defined user, without having to dismount.

The following is to be included when requested and specified by the Department:

- a) Microwave or radar pedestrian sensors; Incorporate microwave pedestrian sensors where pedestrian displays are controlling marked foot crossings 15m and longer.

Designers shall liaise with the Department regarding performance specification of these detectors. Details of the agreed sensors shall be included in the TSDR.

- b) The provision of cycle push buttons on side road approaches and at locations where extended clearance is required.

Cycle Push button faces are to be parallel to the kerb. In-ground loop detection in cycle lanes must be provided between marked vehicle lanes

5.11. AUXILIARY EQUIPMENT

This includes; closed circuit television video surveillance (CCTV), ITS, communications and other equipment when specified by the Department.

The arrangement for housing of auxiliary equipment is specified in Section 6.4.

ITS, communications and auxiliary equipment shall be separately designed showing both mechanical installation and electrical layout and operation.

This detail must be included in the TSDR.

5.12. RED LIGHT CAMERA

Red-light camera equipment shall be included when specified by the Department.

5.13. LEVEL CROSSINGS

Level crossings are considered to be adjacent to traffic signals where the traffic signals conflict with the level crossing flashing assembly (wigwags) or where queued traffic at one site may back-up to the other. Interlocking systems must be provided between adjacent level crossing and traffic signal sites through ducting and a hard-wired connection. This hardwire interlocking is a requirement to force traffic signals to a clearance and safe state operation before the level crossing closes to permit the passage of a train.

This detail must be documented in the Traffic Signal Design Report.

5.14. ACTIVE ADVANCE WARNING SIGNS (AAWS)

The Department of Infrastructure Planning and Logistics acknowledge Main Roads Western Australia for the technical content of this AAWS guide.

To the extent permitted by law, the Department of Infrastructure Planning and Logistics, its employees, agents, authors and contributors are not liable for any loss resulting from any action taken or reliance made on the information under Section 5.14 and related subsections in this document.

5.14.1. General

Active advance warning signs (as opposed to passive advanced warning signs) are used in various situations to attract attention and in doing so, to warn of a situation ahead that may be unexpected. The intention is to provide drivers with early information to enable them to react and avoid and/or reduce the risk. The signs generally take the form of twin alternating flashing lights as an integral part of a warning sign positioned in advance of a traffic signal installation. Other arrangements of such warning signs may be used where emergency vehicles enter the road network.

The primary function of active advance warning signs with the message “Prepare to Stop” is to warn motorists that there is a high possibility that they will be required to stop at the intersection (or crossing). The use of these signs should be limited to maximise effectiveness and also prevent driver complacency to the message.

5.14.2. Warrant/ Criteria

AAWS should only be used when traffic engineering studies have considered such aspects as traffic speed, traffic volumes, heavy truck use, visibility and crash patterns, and indicate that the use of these signs may be of benefit.

AAWS on the approaches to the traffic signals should be considered if the following applies:

- The road is an arterial and
- The road is a truck route and
- Traffic signals on the road have separation greater than 500m and
- The posted speed is equal to or greater than 80 km/h

Or

- The traffic signals are located where drivers have been exposed to many kilometres of high speed driving.

5.14.3. Size

Where possible, AAWS shall be based on Australian Standard warning sign size C on both sides of the carriageway or road. Other sizes may be considered in accordance with the following table:

| Size | Condition of Use |
|------|--|
| D | 100km/h speed limit or above, or at lower speed limits where sight distance is an issue |
| C | Up to and including 90 km/h speed limit |
| B | Shall only be used for speed limits of 70 km/h or less and only where it is impractical to use a C or D size due to space restrictions |
| A | Shall only be used in combination with a B, C or D size sign where it is impractical to provide a matching size sign due to space restrictions |

5.14.4. Display

The sign shall use LED lanterns.

5.14.5. Longitudinal Location and Timing

5.14.5.1. Location

AAWS are installed sufficiently in advance of a signalised intersection such that drivers, upon seeing the signs activate, can comfortably come to a stop at the stop line at the intersection. The distance is the sum of the distances travelled during reaction time and braking distance.

Reaction time is dependent on a number of factors including how alert drivers are and the visual cues provided. In general drivers are more alert in built up areas where higher levels of interaction occur than in rural (higher speed) areas. In general drivers will be more alert to traffic signals as these provide an active light output at all times.

The **reaction time** (R_t) of 2.0 sec is recommended for use in calculating AAWS distance, where speed (v) is 70 km/h or greater.

The following coefficient of friction (as detailed in AUSTRROADS Road Design Guidelines) are recommended for use in calculating AAWS distances:

| Speed (v) (km/h) | Coefficient of friction (f) (for trucks on wet sealed road surface) |
|-------------------------|--|
| 60 | 0.29 |
| 70 | 0.29 |
| 80 | 0.29 |
| 90 | 0.29 |
| 100 | 0.28 |
| 110 | 0.26 |

The distance to position AAWS in advance of traffic signals is given by the following formula:

$$S = v * R_t + v^2/2g(f + G) \text{ metres}$$

where:

S= Traffic signal distance (m)

v= posted speed limit, expressed in metres per second (m/s)

R_t = reaction time (s)

g= gravitational acceleration of 9.8m/s²

f= coefficient of friction (wet surface)

G= grade (decimal)

This is the sum of the distance travelled during reaction time and during deceleration

5.14.5.2. Timing

The time that the signals begin to flash is calculated so that the driver travelling at the posted speed limit, who passes the signal before they begin to flash, has sufficient time to clear the stop line at the traffic signals, prior to the traffic signals changing from Green to Yellow.

$$t = (S + 22)/v \text{ seconds}$$

Where:

t = time (s) required for the AAWS before a change from 'Green' at the traffic signals

S= Traffic signal distance (m)

v= posted speed limit, expressed in metres per second (m/s)

22 = a distance constant (m) based on international practice.

The 22m constant is added to account for the probability that the flashing sign may be out of direct vision at close range even though the sign has not been passed; i.e. the sign may start flashing when the vehicle is within 22m of the sign and the driver may not notice its operation.

The sign, once activated, shall remain flashing for the duration of the downstream Red light at the traffic signals. The sign shall flash alternately and at a 1Hz frequency.

6. DESIGN ELEMENTS

The following design elements provide detail to the traffic signal standard drawings.

6.1. EXTERNAL SERVICES

Power, communication and other external services shall be designed to the approval of the appropriate controlling authority (hold point). The point of entry shall be identified on the drawing including any authority reference number for the connection point. Size and type of conduit and cable required by the authority shall be identified in the symbol legend and documented in the Traffic Signal Design Report.

Where supply services are not adjacent to the traffic signal controller and need to cross a road the traffic signal ring main conduits shall not be used and a separate conduit shall be detailed for the service.

6.2. TRAFFIC SIGNALS POSTS

Posts shall be labelled with a number in a hexagon symbol adjacent to the post symbol (refer Figure 2 and standard drawing CS3404) in an anticlockwise direction from the controller.

6.3. LANTERNS

Lanterns shall be labelled with a capital letter for each independently controlled signal group display. (As illustrated on Figure 2).

6.4. JUNCTION PITS

Junction pits shall be labelled by a capital letter in the junction pit symbol in an anticlockwise direction from the controller (refer Figure 2 and standard drawing CS3404). Where the site has been modified any deleted junction pits labels shall not be reused and existing labels shall not be revised.

6.5. VEHICLE DETECTORS

Vehicle detectors shall be numbered anticlockwise from the controller in the following sequence.

| Detector Type |
|--|
| Stop Line |
| Advanced |
| Slip Lane |
| Pedestrians (as per signal group allocation) |
| Red Runner count |
| Auxiliary equipment |

6.6. SIGNAL GROUPS

Signal groups shall be numbered with the following convention as a guide;

| Movement Type | Signal Group |
|---|--------------|
| Arterial Road Inbound (As directed) | 1 |
| Arterial Road Outbound (As directed) | 2 |
| Arterial Road Inbound Right Turn | 3 |
| Arterial Road Outbound Right Turn | 4 |
| Side Road 1 | 5 |
| Side Road 2 | 6 |
| Side Road 1 Right Turn | 7 |
| Side Road 2 Right Turn | 8 |
| Arterial Road Inbound Left Turn | 9 |
| Arterial Road Outbound Left Turn | 10 |
| Side Road 1 Left Turn | 11 |
| Side Road 2 Left Turn | 12 |
| Arterial Road Inbound Advanced Warning | 13 |
| Arterial Road Outbound Advanced Warning | 14 |
| Pedestrian Arterial Inbound | 15 |
| Pedestrian Arterial Outbound | 16 |
| Pedestrian Side Road 1 | 17 |
| Pedestrian Side Road 2 | 18 |
| Auxiliary Equipment | 19 |

Signal group numbers shall always be consecutive unless a future development will introduce a nominated movement in which case the signal group number should be set aside for this development.

If a nominated movement is not going to be used, then the signal group numbers should be adjusted down.

Signal group references shall be shown in the lanes behind the detector symbol.

6.7. PEDESTRIAN CROSSINGS

Pedestrian crossing shall be labelled with their pedestrian reference number and signal group e.g. PED2 (SG16).

Pedestrians that cross multilane arterials and that have an appropriate median area should be designed as 2 separate pedestrian movements with a staggered pedestrian path through the median.

Pedestrian crossings of multiple carriageways should be of the protected type. Vehicle turn movements should be included in the design to provide protection. See also the Traffic Signal Timings and Personality (PROM) section of this document regarding programming requirements.

6.8. SHARED CROSSINGS

Potential conflict between cyclists, pedestrians and other users shall be minimised through appropriate design.

6.9. MEDIANS

Traffic signal hardware that is to be positioned in medians and traffic islands must maintain adequate clearance to traffic lanes (refer to section 5.7). Where design constraints restrict the available clearance, then alternative signal hardware and mounting configurations may be considered and submitted to the Department for approval.

Traffic island and median minimum sizes, inclusive of lengths and widths are to be applied consistent with Austroads Guide to Road Design: Part 4A Unsignalised and Signalised Intersections to ensure adequate clearance is provided for infrastructure and crossing application requirements.

Where two-stage signalised crossings are used, the median shall be a minimum of 2.4m wide to allow for pedestrian storage.

6.10. TURN POCKETS

Turn pockets shall be designed for the 98th percentile of peak flow storage. Deceleration and lateral shift requirements are separate from this storage. Turn pocket lengths shall be designed to minimise any potential interaction between queued and moving traffic in the turn lane and queued and moving traffic in the adjacent through lane.

6.11. DIAMOND TURNS

The design shall provide sufficient clearance for diamond turns (i.e. opposing right turns operating concurrently). Where the civil design provides insufficient width for a diamond turn, options to either; physically prevent one of the turns or separating the turns through appropriate signal phasing shall be considered during preliminary design.

6.12. FILTER RIGHT AND U TURN

Use of filtered right turns and U turn movements are to be addressed during preliminary design.

6.13. LEFT TURN ON RED

Left Turn on Red shall not be used.

6.14. BICYCLES

The needs of on-road cyclists shall be considered in the design of signalised intersections in urban environments. Continuity through intersection is a key design issue for cyclists. Short lengths of bicycle lanes may be considered in association with advanced stop lines and bicycle storage areas.

Where it is not feasible to provide separate on-road facilities, the design should allow for the mixing of vehicle and bicycle traffic for at least 50 m on all approaches to an intersection.

Effective automatic detection specific for bicycles is still evolving. Where detection of bicycles is desired a special push-button facility shall be used. The button shall be mounted differently to the buttons used by pedestrians and it shall be clearly marked or identified as being for cyclists' use only.

Special bicycle detection shall only be provided where there is a risk that bicycles will be left waiting against a red signal for a long period of time. In practice, bicycles are rarely left stranded at the stop line as there are usually sufficient vehicles to lodge the call for the phase. This shall be addressed during preliminary design.

Where an off-road bicycle route crosses a main road, exclusive traffic signals should be provided if warranted, however the use of a combine bicycle with pedestrians at a mid-block pedestrian crossing should be considered.

6.15. BUS AND SPECIAL VEHICLE FACILITIES

6.15.1. Bus Priority

Bus priority shall only be included when specified by the Department.

Bus priority shall only be provided where the design includes an exclusive bus lane at the intersection. Other design guides will provide details about appropriate engineering design for such exclusive lanes, and will typically include issues such as; frequency, placement and spacing of BUS ONLY and arrow pavement marking, line marking for the exclusive lane, length of exclusive lane, access to adjacent properties. Where bus priority is to be included in the intersection operation it shall be controlled by white B symbol lanterns as a separate signal group, with specific logic in the intersection operation.

6.15.2. Emergency Vehicle

When traffic signals are close to the operation of emergency responders such as; fire station, ambulance station, police station or a hospital, it may be necessary to make special provisions to ensure that emergency service vehicles are not blocked by stationary vehicles when trying to exit in an emergency.

This can be achieved using traffic management treatments such as:

6.15.2.1. Pavement Markings

Relocating the stop line may be appropriate where the emergency vehicle egress is at the intersection. If the resultant position of the stop line is "unnatural" from the motorist's point of view, extra facilities such as signs (e.g. STOP HERE ON RED SIGNAL R6-6) and a wider 600 mm stop line may be necessary.

6.15.2.2. Signage and Extra Signals

Installing warning signs and flashing lights shall be considered when the exit from the emergency service facility is more than approximately 10 m from the intersection and relocation of the stop line would require an unusually long inter-green period. These flashing lights are operated from the depot to allow safe egress of the emergency service vehicles. The use of signs and/or pavement marking to warn motorists not to queue across the driveway should be included. Civil and electrical detail of this must be included in the intersection design.

6.15.2.3. Additional Signal Phases

Adding a special emergency service phase shall be considered where the phase is warranted based on:

- Conflict between emergency service vehicles and passing traffic. This will consider, but not be limited to; the speed limit on the adjacent road, the classification of passing vehicles, and the characteristics of passing traffic flow.
- Possibility of queued vehicles blocking the exit from the emergency service facility
- Delays to emergency service vehicles if the emergency service phase is not provided

The emergency service phase shall clear any queued vehicles within the path of the emergency service.

6.16. TURN MOVEMENTS

All turning paths must cater for the specified Design Vehicle.

Right turn lanes and left turn lanes must be designed with turn bays to remove through lane interaction and short queue effects.

The Traffic Signals Design Report shall explain how the Design Vehicle has affected turn movement provisions in the design.

6.17. HEAVY VEHICLES

The TSDR must clearly show how heavy vehicles and buses have been accommodated in design flows and signal timings.

6.18. TRAFFIC SIGNALS TIMINGS AND PERSONALITY

6.18.1.1. Traffic Signal Personality Guidelines

A summary template for all design inputs in the creation of the traffic signal personality must be included in the TSDR and also be provided separately to the Department. A certificate verifying the functionality of personality Programmable Read-Only Memory (PROM) modules shall be submitted to the Department prior to the commencement of testing of any traffic signal installation.

When required as part of the design of an Electronic Programmable Read-Only Memory (EPROM), Personality Card or XPM Dongle, a copy of the software shall be prepared to the Department's requirements to be installed directly into the Personality Module or Logic Processor card, as required. The EPROM window is to be covered by a purpose made foil backed label to provide protection from the effect of light and for use as device identification. A label is also to be placed on the cover of the Personality Module. Both labels shall provide the following information for the EPROM or Personality Cards/EPROM Labels

- a) Intersection Site Number (i.e. LM).
- b) Intersection Revision Letter.
- c) Checksum of personality in Hexadecimal format.
- d) Date EPROM or Personality Card was programmed.

6.18.1.2. Time Setting Guidelines

Green (seconds)

| Movement Type | Min | Max |
|-------------------|-----|-----|
| Arterial | 10 | 40 |
| Side Road | 6-8 | 30 |
| Right Turn Pocket | 5 | 20 |

Yellow and Red

Use time settings as per formulas in Austroads, Guide to Traffic Management Part 10 – Traffic Control and Communication Devices. Use the following values in the equation.

Reaction time 1.50 sec

Deceleration 3.00 m/s

Approach Timer Times (seconds)

| Timer | 1 Lane | 2 Lanes | 3 or more Lanes |
|---------|--------|---------|-----------------|
| Gap | 3 | 3 | 3 |
| Headway | 1.2 | 1 | 0.8 |
| Waste | 10 | 10 | 10 |

Pedestrian

Use time settings as per formulas in Austroads, Guide to Traffic Management Part 9 – Traffic Operations. Use the following value in the equation, consistent with Appendix E of the Austroads Guide.

Pedestrian speed 1.2 m/s and 1.4 m/s

Walk times: 5 Seconds (min)

6.19. PAVEMENT MARKINGS

Refer to the Department's standard drawings and Australian Standards.

7. DOCUMENT DELIVERABLES

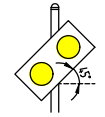
The following records shall be provided to the Department at project completion:

- Drawings described in Section 4 Project Drawings
 - The final drawings are to be provided in “pdf” and “dwg” formats
- The Traffic Signals Design Report (TSDR) as described in Section 3.3.3, inclusive of all appendices.
 - The TSDR is to be provided in “WORD” and in “pdf” formats.

Figure 2. Drawing Type A

NOTE:

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH SHEET 2 OF 3 AND 3 OF 3
2. STOP LINES SHALL BE SET OUT AS PER PROJECT LINE MARKING PLAN.
3. NO PITS TO BE LOCATED WITHIN THE ROAD SURFACE WITHOUT SUPERINTENDENT APPROVAL.
4. REFER TO STANDARD DRAWING CS34.04 FOR TRAFFIC SYMBOLS.
5. PEDESTRIAN FOOTING AND TRAFFIC SIGNAL CONTROLLER LOCATIONS ARE TO BE FINALISED ON SIT IN CONJUNCTION WITH THE SUPERINTENDENT - HOLD POINT.
6. REFER TO STANDARD DRAWING CS34.04 FOR TRAFFIC SYMBOLS.
7. LANTERN TO BE MOUNTED USING 45° AS A BRACKET FOR FLASHING YELLOW PEDESTRIAN OPERATION, SHOWN AS BELOW.
- 8.
- 9.
- 10.
- 11.

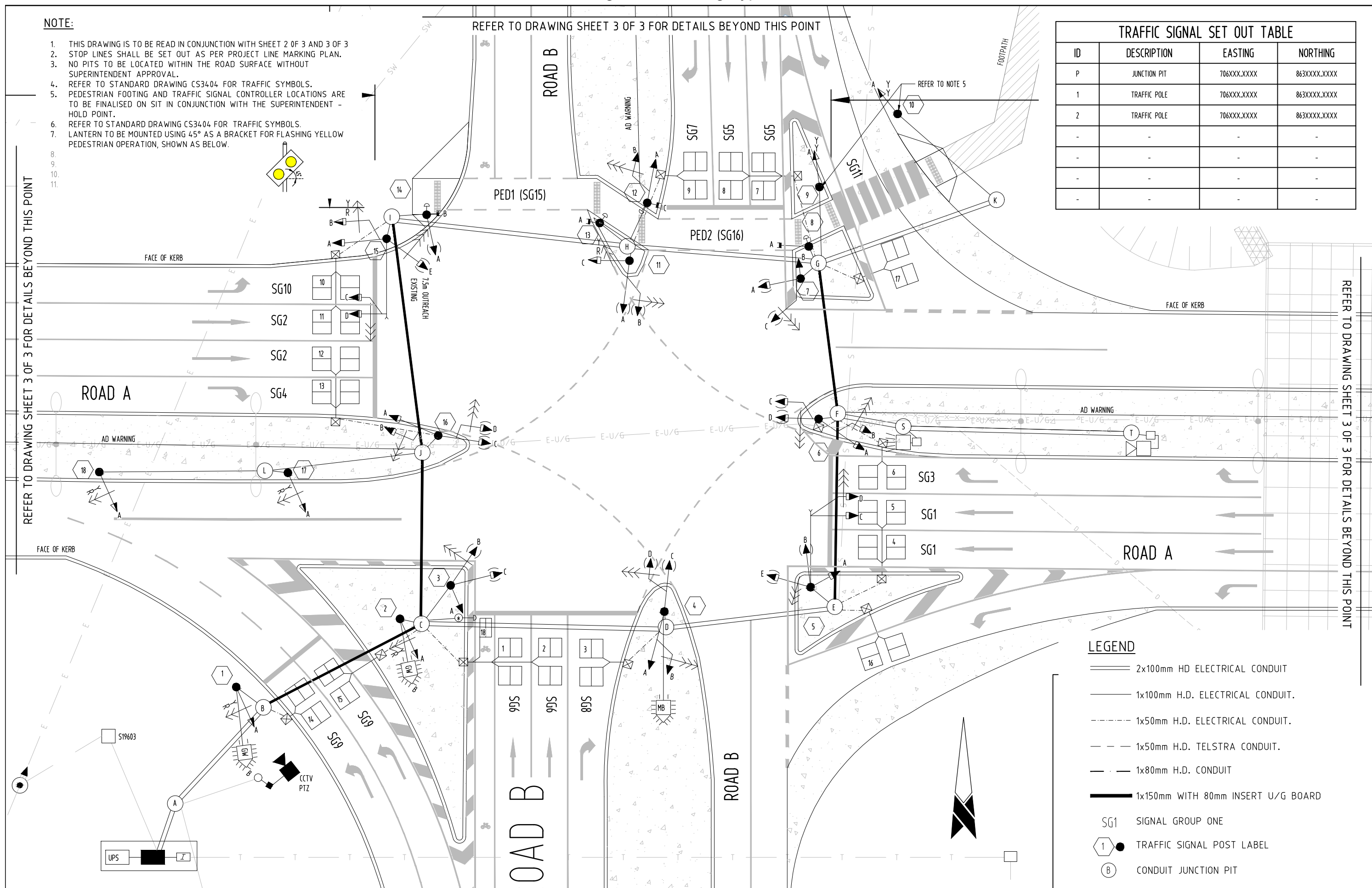


REFER TO DRAWING SHEET 3 OF 3 FOR DETAILS BEYOND THIS POINT

| TRAFFIC SIGNAL SET OUT TABLE | | | |
|------------------------------|--------------|-------------|--------------|
| ID | DESCRIPTION | EASTING | NORTHING |
| P | JUNCTION PIT | 706XXX.XXXX | 863XXXX.XXXX |
| 1 | TRAFFIC POLE | 706XXX.XXXX | 863XXXX.XXXX |
| 2 | TRAFFIC POLE | 706XXX.XXXX | 863XXXX.XXXX |
| - | - | - | - |
| - | - | - | - |
| - | - | - | - |
| - | - | - | - |

REFER TO DRAWING SHEET 3 OF 3 FOR DETAILS BEYOND THIS POINT

REFER TO DRAWING SHEET 3 OF 3 FOR DETAILS BEYOND THIS POINT



LEGEND

- 2x100mm HD ELECTRICAL CONDUIT
- 1x100mm H.D. ELECTRICAL CONDUIT.
- 1x50mm H.D. ELECTRICAL CONDUIT.
- 1x50mm H.D. TELSTRA CONDUIT.
- 1x80mm H.D. CONDUIT
- 1x150mm WITH 80mm INSERT U/G BOARD
- SG1 SIGNAL GROUP ONE
- TRAFFIC SIGNAL POST LABEL
- CONDUIT JUNCTION PIT

WARNING
 BEWARE OF UNDERGROUND SERVICES.
 THE LOCATIONS OF UNDERGROUND SERVICES ARE APPROXIMATE ONLY AND THEIR EXACT POSITION SHOULD BE PROVEN ON SITE. NO GUARANTEE IS GIVEN THAT ALL EXISTING SERVICES ARE SHOWN.

| | |
|----------------------------|----------------------|
| DRAWN | CHECKED |
| DATE DESIGNED | DATE CHECKED |
| DATE DESIGN PROJECT LEADER | DATE PROJECT OFFICER |
| DATE | DATE |



XXXX REGION
 PROJECT DESCRIPTION
EXAMPLE LAYOUT
 INTERSECTION DETAILS OF ROADS A AND B
 TRAFFIC SIGNAL LAYOUT

| No. | DESCRIPTION | DATE | NAME | DEPT/COMPANY |
|------------|----------------|----------|-------|--------------|
| 0 | EXAMPLE LAYOUT | JAN 2020 | S.SHI | EES/DIPL |
| AMENDMENTS | | | | |

| | | | | | |
|----------|-----------|-----------|-------------|--------|------------|
| FILE No. | ASSET No. | SHEET No. | DRAWING No. | AMEND. | SHEET SIZE |
| - | LXXXX | 1 OF 3 | - | - | A1 |

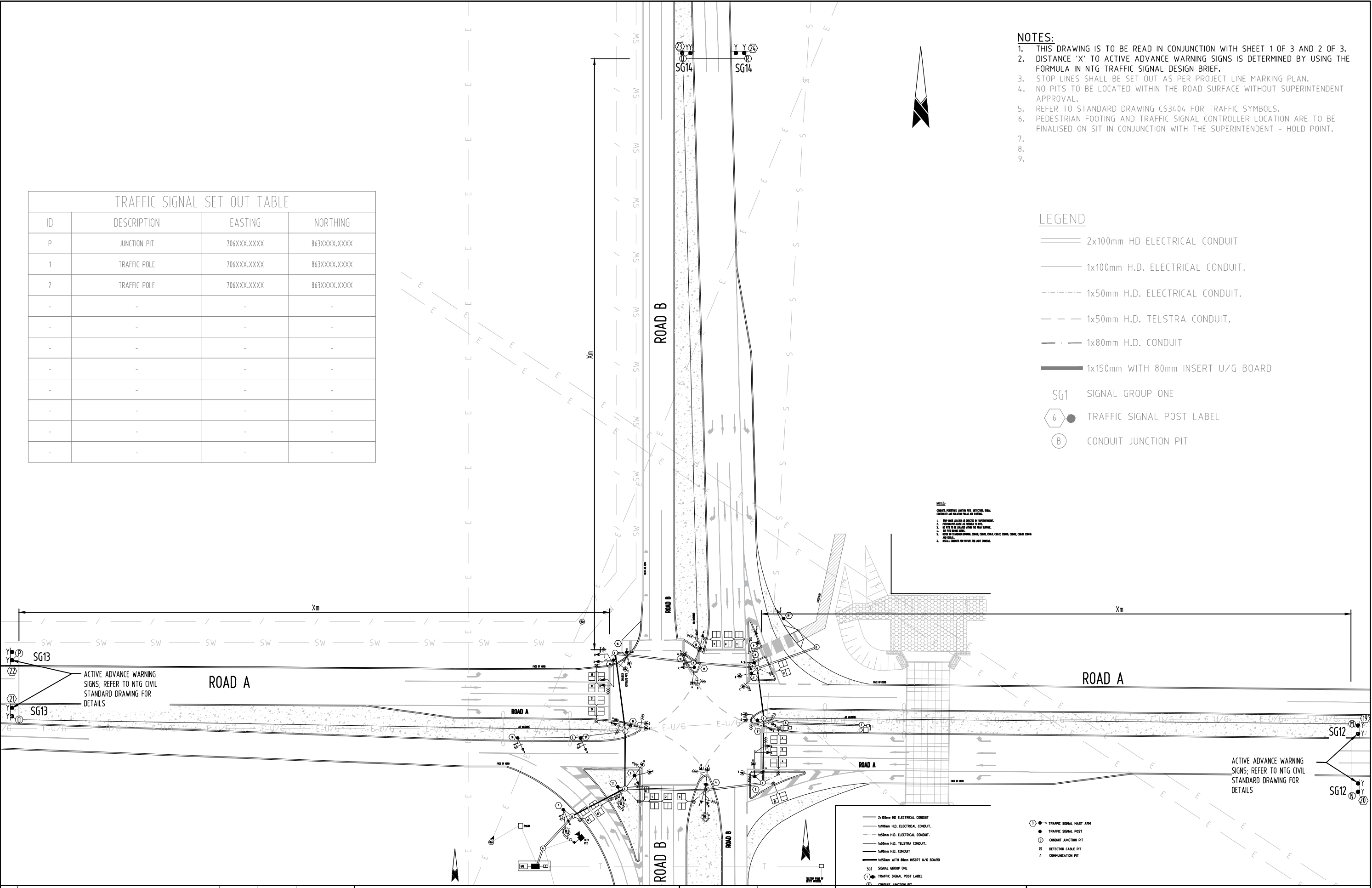
Figure 4. Drawing Type C

AMED_0 RELEASED 14/01/2020

| TRAFFIC SIGNAL SET OUT TABLE | | | |
|------------------------------|--------------|-------------|-------------|
| ID | DESCRIPTION | EASTING | NORTHING |
| P | JUNCTION PIT | 706XXX.XXXX | 863XXX.XXXX |
| 1 | TRAFFIC POLE | 706XXX.XXXX | 863XXX.XXXX |
| 2 | TRAFFIC POLE | 706XXX.XXXX | 863XXX.XXXX |
| - | - | - | - |
| - | - | - | - |
| - | - | - | - |
| - | - | - | - |
| - | - | - | - |
| - | - | - | - |
| - | - | - | - |
| - | - | - | - |
| - | - | - | - |

- NOTES:**
- THIS DRAWING IS TO BE READ IN CONJUNCTION WITH SHEET 1 OF 3 AND 2 OF 3.
 - DISTANCE 'X' TO ACTIVE ADVANCE WARNING SIGNS IS DETERMINED BY USING THE FORMULA IN NTG TRAFFIC SIGNAL DESIGN BRIEF.
 - STOP LINES SHALL BE SET OUT AS PER PROJECT LINE MARKING PLAN.
 - NO PITS TO BE LOCATED WITHIN THE ROAD SURFACE WITHOUT SUPERINTENDENT APPROVAL.
 - REFER TO STANDARD DRAWING CS3404 FOR TRAFFIC SYMBOLS.
 - PEDESTRIAN FOOTING AND TRAFFIC SIGNAL CONTROLLER LOCATION ARE TO BE FINALISED ON SIT IN CONJUNCTION WITH THE SUPERINTENDENT - HOLD POINT.
 -
 -
 -

- LEGEND**
- 2x100mm HD ELECTRICAL CONDUIT
 - 1x100mm H.D. ELECTRICAL CONDUIT.
 - 1x50mm H.D. ELECTRICAL CONDUIT.
 - 1x50mm H.D. TELSTRA CONDUIT.
 - 1x80mm H.D. CONDUIT
 - 1x150mm WITH 80mm INSERT U/G BOARD
 - SG1 SIGNAL GROUP ONE
 - TRAFFIC SIGNAL POST LABEL
 - (B) CONDUIT JUNCTION PIT



| No. | DESCRIPTION | DATE | NAME | DEPT./COMPANY |
|------------|----------------|----------|--------|---------------|
| 0 | EXAMPLE LAYOUT | JAN 2020 | S.SHI. | EES/DIPL |
| AMENDMENTS | | | | |

WARNING
 BEWARE OF UNDERGROUND SERVICES.
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| | |
|-----------------------|-----------------|
| DRAWN | CHECKED |
| DATE | DATE |
| DESIGNED | CHECKED |
| DATE | DATE |
| DESIGN PROJECT LEADER | PROJECT OFFICER |
| DATE | DATE |



| | | | | |
|--------------------------------|-----------|------------|-------------|--------|
| XXXX REGION | | | | |
| PROJECT DESCRIPTION | | | | |
| EXAMPLE LAYOUT | | | | |
| INTERSECTION OF ROADS A AND B | | | | |
| TRAFFIC SIGNAL OVERVIEW LAYOUT | | | | |
| FILE No. | ASSET No. | SHEET No. | DRAWING No. | AMEND. |
| - | LXXXX | 3 OF 3 | - | 0 |
| | | SHEET SIZE | | |
| | | A1 | | |