

Technical Standard - TS085

Trenching and Installation of Underground Conduits and Cables Network (up to and including 33 kV)

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SA Power Networks

Empowering South Australia

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1. Introduction

This document specifies the minimum requirements for the trenching and installation of underground conduits and cables, operating up to and including 33 kV, which will form a part of SA Power Networks' electrical distribution network.

The specifications in this technical standard are applicable to all parties, whose activities are associated with trenching, trenchless techniques, and the installation of underground conduits and cables for all new installations, extensions, or alterations within SA Power Networks' electrical distribution network.

For the design and installation requirements of a 66 kV underground sub-transmission network, refer to TS110.

2. Definitions and Abbreviations

2.1 Definitions

Boring	Refers to activities of directional drilling (typically horizontal or vertical).
Cable System	The cable system includes components such as power cables, cable joints, cable terminations, cable accessories etc., which forms a part of SA Power Networks' infrastructure in connection with the electrical distribution network, and in particular forms the underground portion between the locations as specified.
Connection Point	As per Electricity (General) Regulations 2012: A connection point to a transmission or distribution network . The 'connection point' also has the same meaning as 'point of supply' defined in AS/NZS 3000. The point of supply established between the SA Power Networks and the customer.
Consumer Mains	The electrical cables/conductors, which are owned and maintained by the customer, connect the supply point to the main switchboard and form part of the customer installation.
Contractor	A contractor who is a suitably accredited installer (full or provisional) engaged by the customer and has satisfied SA Power Networks' terms and conditions (i.e. Construction Terms 3302) to undertake the civil and electrical installation works.
Customer	Is the customer as set out in the project-specific offer letter. A person who engages in the activity of purchasing electricity supplied through the distribution network to a connection point and is registered by AEMO as a customer under chapter 2 of the NER.
Customer's Agent	A contractor or designer engaged by the customer.
Designer	A person who is suitably accredited designer (full or provisional) engaged by the customer and has satisfied SA Power Networks' terms and conditions (i.e. Construction Terms 3302) to undertake the design work.
Distribution Network	The assets (e.g. poles, wires, underground cables, transformers, substations etc.) operated by SA Power Networks, which transports electricity to and from a customer's connection point.
Electrical Works	All cable laying, cable jointing, testing, and street lighting needed to service the customer, and any works needed to connect the customer to SA Power Networks' distribution network but does not include LV electricity reticulation beyond the point of supply; transformer, switching cubicle, and pillar/pit installation; and restoration works.
Excavation Depth	The vertical distance measured between the ground level and the deepest part of the excavation.

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Fire Hydrant (External)	As defined in AS 2419.1, a fitting installed in a fire main with a single-valve outlet or two-valve outlets for the connection of a fire hose(s). They are usually installed outside buildings.
Fire Hydrant (Internal)	As defined in AS 2419.1, an internal attack fire hydrant is located to provide fire hose coverage to a floor area not otherwise covered by an attack fire hydrant(s) located within a fire- isolated stair or adjacent to a non-fire-isolated stair.
Hazardous Area	An area in which an explosive gas atmosphere is or may be expected to be present in quantities such as that requiring special precautions for the construction, installation, and use of the equipment.
HV (High Voltage)	The HV is greater than 1000 Vac or 1500 Vdc, and up to 33,000 Vac.
Installation	It is an electrical installation unless the context is otherwise.
LV (Low Voltage)	The LV exceeds 50 Vac or 120 Vdc ripple-free but does not exceed 1000 Vac or 1500 Vdc.
Mains Side	The side of the street on which the LV distribution cables are installed.
Owner/Landowner	The owner/landowner is the person or an entity that is the registered proprietor/owner of the land, as recorded at the Land Titles Office (LTO). All easement agreements shall be with the owner/landowner.
Plan of Division	The customer's plan for the proposed division of the land into the residential allotments, public roads, reserves, and the like varied from time to time.
Power Line Environment Committee (PLEC)	The 'Power Line Environment Committee' is responsible for selecting sites where SA Power Networks' assets are to be underground for the community benefit.
Property	Either what is commonly described as a Torrens Title allotment, a Community Title Scheme or Land which is owned by the crown on which the owner/occupier has the right to the installation of an electricity supply. A property may include: a single parcel of freehold, leasehold, and/or public land, and/or land held under lease or license on which the customer or the controlling body has the right to install their electrical installation; any combination of contiguous land to which the customer or the controlling body has the right to install the electrical installation; and contiguous land and/or individual titles to which a corporate body, customer, or the controlling body has the right to install their own electrical installation.
Protective Barrier	Also known as Mechanical Protection, Mechanical Barrier and Protective Covering, which may be provided by installing anyone (1) of the following: concrete slabs; or continuous pour concrete slabs; or polymeric cable protection cover (RN 0202); or Bricks designed to protect electrical cables and may include a suitable conduit. So that the likelihood of injury to any person during any work is minimised.
Potholing	Also known as 'vacuum excavation', the potholing process involves using a vacuum or pressurised water to break up the soil and then remove the debris, creating a hole. The potholing is considered as a safe and non-destructive method for locating underground utilities, reducing the risk of damage compared to mechanical excavation.

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Road Reserve	A road reserve is a legally defined area within which roads, footpaths and other related features may be constructed for public transport. It is the total area between boundaries shown on a cadastral plan.
SCADA	Supervisory Control and Data Acquisition equipment used for the control, monitor, and telemetry of the HV substation site equipment.
The SA Power Network Project Manager	SA Power Networks' Network Project Manager, Network Project Officer, Network Service Officer, Customer Service Officer, Strategic Project Manager, or any Officer/Supervisor who is responsible for the management of a project.
Ventilation	As defined in AS/NZS 60079.10.1
Adequate Ventilation	An open-air situation with natural ventilation without stagnant areas, and where vapor is rapidly dispersed by wind and natural convection. Air velocity should rarely be less than 0.5 m/s but should frequently exceed 2 m/s.
Inadequate Ventilation	Natural ventilation is limited by topography, nearby structures, weather conditions. Artificial ventilation may be necessary for adequate ventilation.
Works Agreement	Agreement in accordance with SA Power Networks' construction terms (i.e. 3302: Construction Terms - Non-Contestable and Contestable).
Works	For the purposes of this document, "Works" refers to any activities associated with the design or construction requirements specified in this Standard. This definition is distinct from the term "Works" as defined in the Construction Terms 3302.

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2.2 Abbreviations

AS/NZS	Australia and New Zealand Standards published by Standards Australia
BYDA	Before You Dig Australia
CBD	Central Business District
CGF	Customer GelPort Fuse
CLER	Customer Lighting Equipment Rate
CMEN	Common Multiple Earthed Neutral System
CST	Common Service Trench, also known as 'Shared Service Trench'
DIT	Department of Infrastructure and Transport
EGPR	Electronic Ground Penetration Radar system
E-dwg	The SA Power Networks' Electronic Drawing
HD	Heavy Duty
HDD	Horizontal Directional Drilling
HV	High Voltage
kPag	Kilo Pascal Gauge Pressure Reading
LIP	Lubrication Injection Point
LV	Low Voltage
LVSC	Low Voltage Switching Cubicle
MEN	Multiple Earthed Neutral System
MD PVC	Medium Duty
MSDS	Material Safety Data Sheet
NAP	Network Access Permit
NICC	SA Power Networks' publications 'Network Information for Contractors and Customers'
TSM	SA Power Networks' Technical Standards Manager
OTR	The Office of the Technical Regulator
PLEC	Power Line Environment Committee
PM	SA Power Networks' Project Manager
RMU	Ring Main Unit
SCADA	Supervisory Control and Data Management
SDS	Safety Data Sheet
SWMS	Safe Work Method Statement
TMP	Traffic Management Plan
TNC	SA Power Networks' Telecommunications Network Control
TS	SA Power Networks' publications 'Technical Standards'
UPVC	Unplasticised Polyvinyl Chloride, also known as 'Rigid PVC'
WH&S	Work Health and Safety

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2.3 Terminology

Shall	Indicates mandatory requirements.
May or Should	Indicates a recommendation that is not mandatory but can be imposed as deemed appropriate by SA Power Networks.

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3. Relevant Rules, Regulations, Standards, and Codes

3.1 Standards and Codes

The following documents listed in this section provide additional information, however, this is not a conclusive list and other documentation may be required on a project-specific basis.

Please Note: It is the responsibility of the customer/customer's agent to ensure that you have complied with all applicable SA Legislative Regulations (under Acts), ESCOSA/ENA/AEMC/IEC documentations, relevant AS/NZS standards, and SA Power Networks' publications and have ensured their current publications, before implementing them.

Standards Australia Publications

AS/CA S009	2020	Installation requirements for customer cabling; (Telecommunications Wiring Rules)
AS 1074	1989	Steel tubes and tubular for ordinary service
AS 1141.11.1	2020	Methods for sampling and testing aggregates; Part 11.1: Particle size distribution sieving
AS 1289.3.3.1	2009	Methods of testing soils for engineering; Part 3.3.1: Soil classification tests: calculation of the plasticity index of soil
AS 1319	1994	Safety signs in the occupational environment
AS 1345	1995	Identification of the contents of the pipes, conduits, and ducts
AS/NZS 1477	2017	PVC conduits and fittings for pressure applications
AS/NZS 2032	2006	Installation of PVC conduit systems
AS/NZS 2033	2024	Design and Installation of polyolefin pipe systems
AS 2067	2016	Substations and high voltage installations exceeding 1 kV a.c.
AS 2419.1	2021	Fire hydrant installations: System design, installation, and commissioning
AS/NZS 2648.1	1995	Underground marking tape: Non-detectable tape
AS/NZS 2885.1	2018	Pipelines - gas and liquid petroleum: Design and construction
AS/NZS 3000	2018	Electrical Installations (known as the Australian/New Zealand Wiring Rules)
AS/NZS 3500 (series)	-	Plumbing and drainage (Parts 0-4)
AS 3798	2007	Guidelines on earthworks for commercial and residential development
AS/NZS 3845.1	2015	Road safety barrier systems and devices: Road safety-barrier systems
AS/NZS 4026	2008	Electric cables - For underground residential distribution systems
AS/NZS 4130	2018	Polyethylene (PE) pipes for pressure applications
AS/NZS 4645.2	2018	Gas distribution networks: Steel pipe systems
AS/NZS 4645.3	2018	Gas distribution networks: Plastic pipe systems
AS 4678	2002	Earth-retaining structures
AS 4799	2000	Installation of underground utility services and pipelines within railway boundaries
AS/NZS 4853	2012	Electrical hazards on metallic pipelines
AS 5577	2013	Electricity network safety management systems

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AS/NZS ISO 14001	2016	Environmental management systems - Requirements with guidance for use
AS 60038	2022	Standard voltages
AS 60068.1	2023	Environmental testing: General and guidance
AS 61386	2015	Conduit systems for cable management
AS/NZS 60079.14	2022	Explosive atmospheres; Part 14: Design selection, erection and initial inspection

International Standards Publications:

ASTM STP1331	1998	Design and application of controlled low-strength materials (Flowable Fill)
ISO 21307	2017	Plastic conduits and fittings: Butt-fusion jointing procedures for the polyethylene (PE) piping systems
ISO 31000	2018	Risk management set: Principles and guidelines

SA Power Networks' Publications

Manuals	
Manual 14	Safety, Reliability, Maintenance, and Technical Management Plan
Manual 32	Service and Installation Rules
Network Information for Customers and Contractors	
NICC401	Network Design and Installation by an External Contractor
NICC404	Working in the vicinity of SA Power Networks' Infrastructure: Network Permit Process (NAP)
NICC802	Mk7 Padmount Transformers - General Information for Customers & Contractors
Technical Standards	
TS099	Distribution and Transmission CAD Drafting Standards
TS100	Electrical Design Standards for the Underground Distribution Cable Network (up to and including 33 kV)
TS101	Public Lighting Design and Installation
TS102	Easement Standards for SA Power Networks' Infrastructure
TS105	Testing Standards for the Underground and Overhead Distribution Powerline Network (up to and including 33 kV)
TS105A (Forms)	Standard Forms for SA Power Networks' Underground and Overhead Electricity Distribution and Transmission Cable Network
TS109	Earthing of SA Power Networks' Distribution Network
TS117	Design and Construction near Railway and Tram Lines
Relevant E-Drawing Series including Manual No. 40: Civil Construction Manual	

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3.2 Legislation and Regulations

This section provides a list of relevant legislation and regulations applicable to the design, manufacture, installation, testing and commissioning, and operations and maintenance of all plant and equipment for electrical distribution network.

In the event of any inconsistency between legislation and regulations and these technical requirements, the legislation and regulations shall prevail.

- Electricity Act 1996 and Electricity (General) Regulations 2012
- Work Health and Safety Act 2012 and Work Health and Safety Regulations 2012
- Environment Protection Act 1993 and Environment Protection Regulations 2009
- Electricity Corporations (Restructuring and Disposal) Act and Regulations of 1999

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4. General

A trench containing SA Power Networks' cables, and the associated conduits shall be in accordance with the approved design drawings and be positioned in the straightest possible alignment.

The trench containing the electrical works is a component of the asset inspection process and shall meet the requirements of this standard and those set out in the contract. SA Power Networks' Asset Compliance Officer may inspect the trench at any time.

Any deviations from the approved design drawing, will require approval from an SA Power Networks' Project Manager.

5. Separation requirements

5.1 Separation Between Services

The minimum separation requirements between SA Power Networks' assets and other utilities' assets are stipulated in Table 1 (parallel vertical separation), Table 2 (parallel horizontal separation), and Table 3 (vertical crossing separation).

Refer to:

- **Appendices C to H** for the separation requirements for various trenching arrangements.
- **Appendix I** for the typical road-crossing arrangement.
- **Appendix J** for the reduced depth of cover trenching within the footpath.

The following notes apply to Tables 1, 2, and 3:

(1) All separation distances are from the exterior surface of the conduit/cable, not from the centrelines or inner walls.

(2) The clearances stated are SA Power Networks' minimum requirements based on AS/NZS 3500.3 and AS/NZS 3000, however additional separations may be stipulated by other utilities, relevant councils, and/or DIT.

(3) SA Water separation requirements may be in excess of those stipulated by SA Power Networks. Where this is the case, the customer or their agent shall seek as exemption from SA Water.

  (a) Design separation shall consider SA Water separation requirements as outlined in their document TS0136: 'Pipework Access and Protection' (Document ID SAWS-ENG-0136).'

  (b) For SA Water's asset, contact their customer care centre on 1300 729 283 or email sawateralterations@sawater.com.au , for advice.

(4) APA Group separation requirements may be in excess of those stipulated by SA Power Networks. Where this is the case, the customer or their agent shall seek as exemption from APA.

  (a) Design separation shall consider APA Group separation requirements as outlined in their document 400-STD-AM-0001: 'Guidelines for Works Near Existing Gas Assets'.

  (b) Note that excavations near buried gas utilities may require additional site attendance from APA personnel. This shall be confirmed prior to any excavations.

  (c) For APA Group's asset, contact their locations team (permits office) on (07) 3215 6700, or email permitsqld@apa.com.au or contact APA's team (08) 8115 4500, for advice.

(5) For clearances to metallic gas or water pipelines, an engineering assessment shall be conducted to consider earth potential rise (EPR) and low-frequency induction (LFI) in accordance with AS/NZS 4853: 'Electrical hazards on metallic pipelines'. Additionally, engineering assessments shall consider the derating effects imparted by the services such that there is sufficient separation to not negatively impact the performance of either cable.

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5.1.1 Parallel vertical separation to other utility services

The parallel vertical minimum separations defined below in Table 1 shall be maintained.

Table 1: Parallel vertical separation

Service types		From SA Power Networks' LV Mains Distance (mm) (Refer to Note 1)	From SA Power Networks' HV ≤ 33 kV Mains Distance (mm) (Refer to Note 1)
Telecommunications Assets e.g Third party, Telstra, Optus, NBN		300 (Refer to Note 2) 100 mm separation is permissible, if a polymeric cable protection cover (RN 0202) is installed in the middle as a protective barrier.	450 (Refer to Note 2) 300 mm separation is permissible, if a polymeric cable protection cover (RN 0202) is installed in the middle as a protective barrier.
Gas Service Pipeline (Plastic)		250 (Refer to Note 4)	
Gas Service Pipeline (Steel)		300 (Refer to Notes 4 & 5)	
Gas Transmission or Distribution Mains (Steel) Distribution Pressure (≤ 1050 kPag) Asset, and/or Transmission Pressure (> 1050 kPag) Asset		1000	1000 (Refer to Notes 4 & 5) Engineering assessments are required If running more than 100 m in parallel.
Gas Distribution Mains - (Other than Steel) Distribution Pressure (≤ 1050 kPag)		300 (Refer to Note 4)	
Gas Transmission Mains - (Other than Steel) Transmission Pressure (> 1050 kPag)		Not Permissible (Refer to Note 4)	
Water Main and Water Connection	Pipe Diameter ≤ 65mm	600 (Refer to Note 3) 100 mm separation is permissible, if the polymeric cable protection cover (RN 0202) is installed in the middle as a protective barrier.	
	Pipe Diameter > 65mm	600 (Refer to Note 3 & 5) 300 mm separation is permissible, if the polymeric cable protection cover (RN 0202) is installed in the middle as a protective barrier.	
Sewer Mains (Pressure, vacuum etc.)	Pipe Diameter ≤ 300mm	225 (Refer to Note 3)	
	Pipe Diameter > 300mm	300 (Refer to Note 3)	
Stormwater		600 (Refer to Note 2) 100 mm separation is permissible, if the polymeric cable protection cover (RN 0202) is installed in the middle as a protective barrier.	
Third-party LV Assets E.g LV Consumer Mains, LV Electrical Installation Cables, Cathodic Protection Cables		300 (Refer to Note 2) 100 mm separation is permissible, if a polymeric cable protection cover (RN 0202) is installed in the middle as a protective barrier.	450 (Refer to Note 2) 300 mm separation is permissible, if a polymeric cable protection cover (RN 0202) is installed in the middle as a protective barrier.
Third-party HV Assets		Engineering assessments are required. (Refer to Note 5)	

Refer to the notes in Section 5.1.

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5.1.2 Parallel horizontal separation to other utility services

The parallel horizontal minimum separations defined below in Table 2 shall be maintained.

Table 2: Parallel horizontal separation

Service types		From SA Power Networks' LV Mains Distance (mm) (Refer to Note 1)	From SA Power Networks' HV ≤ 33 kV Mains Distance (mm) (Refer to Note 1)
Telecommunications Asset eg. Third party, Telstar, Otus, and NBN.		300 (Refer to Note 2)	450 (Refer to Note 2)
Gas Service Pipeline (Plastic)		250 (Refer to Note 4)	
Gas Service Pipeline (Steel)		300 (Refer to Note 4 & 5)	
Gas Transmission or Distribution Mains (Steel) Transmission Pressure (> 1050 kPag) Asset, or Distribution Pressure (≤ 1050 kPag) Asset		1000	1000 Engineering assessments are required If running more than 100 m in parallel. (Refer to Notes 4 & 5)
Gas Distribution Mains (Other than Steel) Distribution Pressure (≤ 1050 kPag)		300 (Refer to Note 4)	
Gas Transmission Mains (Other than Steel) Transmission Pressure (> 1050 kPag)		Not Permissible (Refer to Note 4)	
Water Main and Water Connection	Pipe Diameter ≤ 65mm	1150 (Refer to Note 3)	
	Pipe Diameter > 65mm	1150 (Refer to Note 3 & 5)	
Sewer Mains (Pressure, vacuum etc.)	Pipe Diameter ≤ 300mm	500 (Refer to Note 3)	
	Pipe Diameter > 300mm	1000 (Refer to Note 3)	
Stormwater		600 (Refer to Note 2)	
Third-party LV assets: LV Consumer Mains, LV Electrical Installation Cables, Cathodic Protection Cables		300 (Refer to Note 2)	450 (Refer to Note 2)
Third-party HV Assets		Engineering assessments are required. (Refer to Note 5)	

Refer to the notes in Section 5.1.

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5.1.3 Vertical crossing separation to other utility services

The vertical crossing separations defined below in Table 3 shall be maintained where SA Power Networks' cables and conduits are to be installed crossing at angles 90°± 15° (preferred) but not less than 45° to the other utility services.

Table 3: Vertical crossing separation

Service types		**From SA Power Networks' LV Mains Distance (mm)** (Refer to Note 1)	**From SA Power Networks' HV ≤ 33 kV Mains Distance (mm)** (Refer to Note 1)
Telecommunications Asset e.g Third party, Telstra, Optus, NBN		300 (Refer to Note 2) 100 mm separation is permissible, if a polymeric cable protection cover (RN 0202) is installed in the middle as a protective barrier.	450 (Refer to Note 2) 300 mm separation is permissible, if a polymeric cable protection cover (RN 0202) is installed in the middle as a protective barrier.
Gas Service Pipeline (Plastic)		150 (Refer to Note 4)	
Gas Service Pipeline (Steel)		300 (Refer to Note 4)	
Gas Transmission Mains (> 1050 kPag) Any installation that crosses the gas asset		500 (Refer to Note 4)	
Water Main and Water Connection	Pipe Diameter ≤ 65mm	600 (Refer to Note 3) 100 mm separation is permissible, if the polymeric cable protection cover (RN 0202) is installed in the middle as a protective barrier.	
	Pipe Diameter > 65mm	600 (Refer to Note 3) 300 mm separation is permissible, if the polymeric cable protection cover (RN 0202) is installed in the middle as a protective barrier.	
Sewer Mains (Pressure, vacuum etc.)	Pipe Diameter ≤ 300mm	225 (Refer to Note 3)	
	Pipe Diameter > 300mm	300 (Refer to Note 3)	
Stormwater		600 (Refer to Note 2) 100 mm separation is permissible, if a polymeric cable protection cover (RN 0202) is installed in the middle as a protective barrier.	
Third-party LV assets: LV Consumer Mains, LV Electrical Installation Cables, Cathodic Protection Cables		300 (Refer to Note 2) 100 mm separation is permissible, if a polymeric cable protection cover (RN 0202) is installed in the middle as a protective barrier.	450 (Refer to Note 2) 300 mm separation is permissible, if a polymeric cable protection cover (RN 0202) is installed in the middle as a protective barrier.
Third-party HV Asset (Greater than 66 kV)		Engineering assessments are required. (Refer to Note 5)	

Refer to the notes in Section 5.1.

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5.2 Buildings and Structural Clearances

5.2.1 Underground Powerlines

The Electricity (General) Regulations 2012 requires separation of buildings and/or structures from underground powerlines operating:

(1) At a voltage of 33 kV or less, a minimum of 2.0 m.
(2) At voltages greater than 33 kV, a minimum of 3.0 m.

5.2.2 From LV Equipment

The separation between LV service pits/pillars from building and/or structure shall be a minimum of 1.2 m. Refer to Manual 32: Service and Installation Rules for more details.

5.2.3 Poles to Existing 3rd Party Utilities

For separation requirements for SA Power Network's owned poles to 3rd party underground utilities, refer to TS107 (overhead distribution poles) and TS101 (public lighting).

5.3 Other Separation Requirements

5.3.1 Between Earthing Systems

Refer to TS109 for details of separations between earthing systems.

5.3.2 Within Railway and Tram Corridors

Refer to TS117, for more details.

5.3.3 Between Fire Hydrant Systems and Electrical Equipment

HV equipment (e.g. padmount transformer, switching cubicle) shall not be installed within 10 m of a fire hydrant located outside a building. Refer to AS 2419.1, for further details.
LV equipment (e.g. LV switching cubicle, service pillars and service/junction pits) shall not be installed within 2.0 m of a fire hydrant located outside of a building without consultation with the SA Metropolitan Fire Service (MFS). Visit their website https://www.mfs.sa.gov.au/, for more details.
For clearance of fire hydrants within buildings, refer to the National Construction Code (NCC).

5.3.4 Petrol/LPG Dispensing Station and Electrical Equipment

The parallel horizontal separation between the petrol/LPG dispensing station and the electrical equipment where adequate ventilation is available shall be a minimum of 4.0 m.
Where ventilation is inadequate, a minimum separation of 8.0 m is required. Refer to AS/NZS 60079.10.1 Appendix B, for more details.

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5.3.5 Between Bulk Flammable Liquid Storage Tanks and Electrical Equipment

The horizontal separation between the bulk flammable liquid storage tank (e.g. LPG, diesel, petrol, flammable storage tanks) and the electrical system is stated in Table 4. Refer to AS/NZS 60079.10.1 Appendix B, for further details on hazardous area classifications.

Table 4: Storage tank capacity vs horizontal separation

Storage Tank Capacity, Kilolitres (kL)	Horizontal Separation (m)
2	4
4	5
7	6
10	7
25	8
50	9
200	12
≥ 500	15

5.3.6 Vicinity of a 19 kV SWER Transformer Pole

A 19 kV single wire earth return (SWER) transformer pole is equipped with an underground earthing system, typically installed around 7.0 m to 10 m away from the pole base. The exact distance is specified on the signage attached to the 19 kV SWER transformer pole.
Where excavations are planned to be deeper than 250 mm within the specified distance of the 19 kV SWER transformer pole, contact the relevant SA Power Networks' Project Manager.

5.3.7 Between SA Power Networks' Feeders on a Service Bridge

On a service bridge, the following are the minimum clearance requirements between SA Power Networks' HV and LV assets:

(1) When locating two or more (HV and LV) feeders from SA Power Networks along the same route, maintain the following clearances between feeders:

- Parallel separation: 1.0 m
- Crossing separation: Negligible
- For critical circuits, more detailed analyses are required

(2) For third-party telecommunications separation:

- Single-core cable: 450 mm
- Multicore cable: 300 mm
- Multiple cable: 150 mm (where there is an imposing barrier that is either durable insulating material or metal earthed)

For clearances of SA Power Networks' cables to other utilities on a service bridge, refer to vertical and horizontal separations given in Section 5.1.

5.3.8 Transformer (Indoor) Minimum Separation

For indoor equipment rooms, refer to TS108 for details on separation requirements between indoor equipment and to walls.

5.3.9 Transformer (Outdoor) Minimum Separation

The installation design of an outdoor padmount transformer shall ensure that no part of the padmount transformer enclosure is within 1200 mm from any part of a building or wall that has a fire rating less than three hours (i.e. FRL 180/180/180). Refer to TS100 for further information on outdoor distribution equipment enclosure requirements.

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6. Materials and Accessories

Customers and/or their agents may have the opportunity to purchase materials from SA Power Networks. For any assistance related to material purchases, contact Material Sales at materialsales@enerven.com.au.

Only approved materials, as specified on the design drawing, are to be used in the distribution network of SA Power Networks.

SA Power Networks holds the discretion to decline any alternative material specified on the design drawing, based on factors such as technical performance and logistical considerations.

6.1 Conduit and Coupling Sizes

6.1.1 PVC Conduit Sizes

Refer to Appendix L, for the sizes of the PVC conduits.

6.1.2 Polyethylene Flexible Coils and HDPE conduits

The polyethylene (PE) flexible coils and high-density polyethylene (HDPE) conduits used for trenchless boring and drilling shall comply with AS/NZS 4130. Refer to Appendix P, for the sizes of the PE flexible coils and HDPE conduits.

6.1.3 Conduit Couplings for Connecting PE conduits to PVC conduits

Refer to Appendix N, for the sizes of the conduit couplings used to connect a PE conduit to a PVC conduit.

6.2 Spare Conduit Provision

Appendix R specifies the minimum numbers of conduits and the requirements for spare conduits, which shall be installed in accordance with the design drawing.

6.2.1 Directly Buried Cables

Where cables are directly buried, the minimum number of spare conduits shall be in accordance with Appendix R.1.

6.2.2 Fully Conduited System

Where cables are fully conduited, the minimum number of spare conduits shall be in accordance with Appendix R.2.

6.3 Conduit Bends

Refer to Appendix M, for conduit bend sizes and approved stock items.

Note: All bends shall come pre-formed by the conduit manufacturer prior to arriving at the work site. Conduit bends shall not be made by bending straight conduit sections.

6.4 Conduit End Cap (Push on)

To prevent the ingress of water, dirt, and other foreign materials into conduits, conduit end caps shall be installed for all conduits that remain vacant or are left empty overnight. The exposed ends of all empty conduits shall be cleaned to ensure proper fitting of the conduit caps.

Refer to Appendix O for conduit end cap (push on) sizes.

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6.5 Conduit Spacers

Conduit spacers are not stocked or supplied by SA Power Networks. However, the use of conduit spacers or alternative spacing systems is highly recommended as they assist in maintaining separation between conduits, ensuring proper heat dissipation. The preferred solution is a prefabricated spacer system. Note that baffle spacers (i.e. cut-outs made from 15 mm PVC sheet) are not permitted.

Figure 1 shows an example of a commercially available conduit spacer system.



Figure 1: Example of conduit spacers (Non-Stock Item)

6.6 Padmount Transformers

Figure 2 shows a standard MK7 padmount transformer combined with a 'Wilson Ring Main Unit'. These are typically used in residential, industrial and commercial applications.

The padmount transformer's rating and dimensions shall be specified on the design drawing.

For further details on the selection and installation of padmount transformers, refer to TS100 and NICC802.



Figure 2: Typical Mk7 padmount transformer with 'Wilson Ring Main Unit'

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6.7 HV Switching Cubicle (HVSC)

Figure 3 shows a typical HV switching cubicle 630 A RM 6 type 2 downward arc venting.

The HV switching cubicle shall be specified on the design drawing.

Refer to TS100 for further details.



Figure 3: Typical HV switching cubicle 630 A RM 6 type 2 downward arc venting

6.8 LV Switching Cubicle (LVSC)

Figure 4 shows a typical LV switching cubicle (LVSC).

Where used, LV switching cubicles shall be specified on the design drawings.

Refer to TS100 for further details.



Figure 4: Typical LV switching cubicle (above ground level)

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6.9 Cable Marker Tape

Figure 5 shows the plastic cable marker tape (Stock Item KS 3765 complaint with AS/NZS 2648.1) is orange in colour, and comes as a 150 mm wide x 500 m long roll with 'DANGER ELECTRIC CABLES BELOW' text imprinted across its length. Refer to Table 5 for the minimum number of tape rolls required.

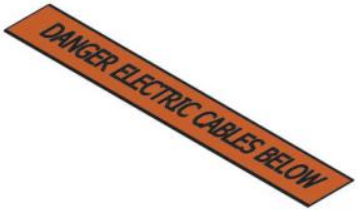


Figure 5: Typical cable marker tape

Table 5: Minimum number of cable marker tape requirements

Trench Width (mm)	Minimum Number of Cable Marker Tape Rolls Required
Up to 500	One (1)
501 up to 1000	Two (2)
1001 up to 2000	Three (3)

6.10 Polymeric Cable Protection Cover

Figure 6 shows the polymeric cable protection cover (Stock item RN 0202 compliant with AS 4702) is orange in colour and comes as a 5 mm thick x 300 mm wide (L1) x 15 m long (L2) roll with 'DANGER ELECTRIC CABLES BELOW' text imprinted across its length. Alternatively, a concrete cover may be used for mechanical protection in accordance with AS 3600.

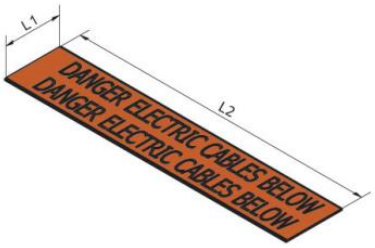


Figure 6: Typical polymeric cable protection cover

6.11 Polypropylene Draw Rope

The polypropylene draw rope compliant with AS 4142 (Stock item XX 7740) is constructed of monofilaments (blue/yellow strands) and comes in a minimum of 6.0 mm diameter x 400 m long, and a minimum breaking strain of 602 kgs (i.e. 5.9 kN).

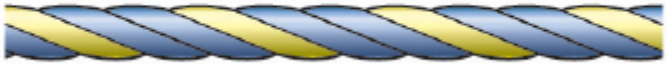


Figure 7: Polypropylene draw rope

6.12 Polypropylene Straps

At suitable intervals, the use of non-metallic/non-conductive polypropylene (PP) straps shall be used to hold conduits prior to inserting into boreholes. Acceptable PP straps are as follows:

- 12 mm wide x 0.6 mm thick x 1000 m long, breaking strain of 80 kgs; or
- 15 mm wide x 0.6 mm thick x 1000 m long, breaking strain of 130 kgs.

Polypropylene straps are not stocked or supplied by SA Power Networks.

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6.13 Cable Lubrication (Polywater® Lubricant J)

SA Power Networks has approved the use of Polywater® lubricant J (Stock item OC 8051, Figure 8) and Polywater® lubricant pump with conduit adaptors (Stock item OC 8052, Figure 9) for lubrication during cable pulling.

Similar or equivalent lubricants will also be considered. However, prior to their use, seek written approval from a relevant SA Power Networks Project Manager. Copies of the Material Safety Data Sheet (MSDS) shall be provided as part of the request and if used, copies of the MSDS shall be made available on-site during cable pulling.

Care shall be taken to ensure no spillage or contamination occurs as a result of using cable lubricants.



Figure 8: Polywater type J lubricant (OC 8051)



Figure 9: Polywater lubricant pump with conduit adaptors (OC 8052)

6.14 Cable Location Markers

Cable location markers include the following:

- Surface marker disc (Stock item KS 3722);
- Star dropper (Stock item JA 6440);
- Warning sign (Stock item KS 1149); and
- Cable identification post (Stock item KS 3720).

6.15 Danger Signage

Stock item KS 1167 (Figure 10) is an above ground HV danger sign used to identify the presence of HV infrastructure within close proximity to the vicinity. These shall be installed on a metal backing plate if the intention is to use them as a standalone sign for post mounting.



Figure 10: Above-ground danger sign (KS 1167)

Stock item KS 1149 (Figure 11) is an above-ground danger sign that is used to alert the presence of a high voltage and/or low voltage cable network located in the vicinity that is buried underground.

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Figure 11: Danger sign for underground buried cable network (KS 1149)

6.16 Reduced Cover Signage

Stock item KS 1140 (Figure 12) is an above-ground reduced cover sign used to advise that digging is not permitted in the area unless SA Power Networks has been consulted and provided approval to proceed.



Figure 12: Reduced cover signage (KS 1140)

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7. Civil Works

7.1 General

If the Before You Dig Australia (BYDA) plans show existing SA Power Networks assets nearby, then refer to NICC404: Working in the vicinity of SA Power Networks' Infrastructure, for SA Power Networks' requirements.

Before commencing any civil works, accurately locate any existing SA Power Networks and/or third-party assets. This can be achieved using the 'Electronic Ground Penetration Radar system (EGPR)' and/or via 'Potholing Works' as outlined in Section 7.2.

If the design indicates that a Network Access Permit (NAP) is necessary, the customer or the customer's agent is required to submit an online NAP request in line with the Network Access Permit Process as described in NICC404.

It is important to maintain a clean and tidy area around equipment vaults and footings. This will facilitate a safe environment for electrical works.

7.2 Potholing Works

Potholing work can be achieved by hydro-vacuum method or hand digging.

The following are the requirements for hydro-vacuum potholing works:

(1) The width of the trench or the diameter of a hole shall not exceed 1.0 m.
(2) The water pressure and the minimum distance between the nozzle tip and subsoil are to be no greater than those specified in Section 7.3.

7.3 Hydro-vacuum Excavation Works

Hydro-vacuum excavation is acknowledged as a safe, non-invasive method for operating around underground utilities, presenting a reduced risk of damage compared to mechanical excavation techniques.

High water pressures can potentially damage the conduits and cables. To prevent such damage during hydro-vacuum excavation work, the following requirements shall be adhered to:

(1) Maintain a minimum distance of 200 mm between the nozzle tip and the subsoil. The nozzle should not touch or be inserted into the soil.
(2) The operating water excavator pressure should not exceed 2000 psi (or 13,790 kPa).
(3) For critical cables (such as oil-filled, paper lead, paper insulated lead covered, fibre-optic), the working water excavator pressure shall not exceed 1200 psi (or 8,274 kPa).
(4) Where there is a risk of SA Power Networks' cables or conduits being exposed or unsupported, refer to Section 7.15, for SA Power Networks' requirements.
(5) The soil extracted from the hydro-vacuum excavation process may be contaminated, refer to Appendix K, for SA Power Networks' waste soil management requirements.

7.4 Conduit Installation in an Open Trench

The details of the conduit installation in an open trench shall be provided on the design drawings. Conduits, couplings and associated accessories shall be installed as per the manufacturer's instructions.

Precautions shall be taken to ensure that all conduit installation works, including conduit ends, joints and alignment etc., do not damage or cause excessive tension on the cables.

The requirements for conduit installation in an open trench are as follows:

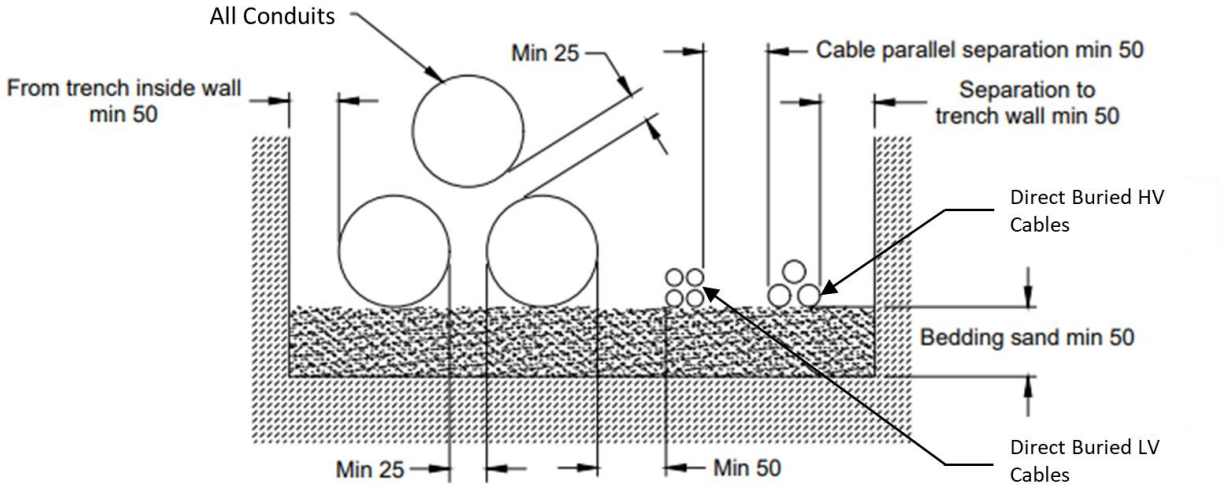
(1) Ensure trenching/conduit arrangements and minimum depth of cover is maintained as specified in Appendix C to J and the design drawings.
(2) The separation between two separate parallel trenches shall be maintained as specified in Appendix S and on the design drawings.
(3) Within an open trench, the following separations shall be maintained:

- A minimum separation of 25 mm in all directions between conduits (or as otherwise specified). Refer to Figure 13 for typical spacings within an open trench.

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- A minimum distance of 50 mm between direct buried cables, conduits and trench walls.
- A minimum distance of 50 mm between direct-buried HV and LV cables.
- A minimum distance of 50 mm between all conduits and direct-buried HV and LV cables.



Note: Drawing 'Not to Scale' and all dimensions are minimum and are in millimetres 'mm'.

Figure 13: Typical Spacings Within an Open Trench

(4) Install conduits and spare conduits as per design drawings, refer to Section 7.8.2 and Appendix R for more details regarding spare conduit requirements and stock items to use. Only straight lengths of conduits shall be installed and unless specified, the use of coiled flexible conduits shall be avoided. For trenchless boring, coiled flexible conduits are acceptable.

(5) Proper 'bell mouths' shall be provided at the ends of the conduits.

(6) Where specified, conduit spacers shall be installed. Refer to Section 7.4.4, for more details regarding conduit spacer requirements.

(7) Conduits shall be capped and buried 1.0 m beyond the stage boundary and have their origin and destination marked on the caps as well as the proposed future cable (if known).

(8) Conduits between new and existing subdivisions shall be joined together.

(9) Allow a minimum of one (1) hour between conduit gluing. The gluing of conduits should be carried out as per the manufacturer's recommendations. When all glued conduits have cured properly, all conduits (except empty, unused and spare conduits) shall be fitted with a polypropylene draw rope as per Section 7.14.

(10) All empty unused conduits/spare conduits shall be sealed against the ingress of water and any foreign material using an appropriately sized conduit end cap. Refer to Appendix O, for the conduit end cap sizes.

(11) Closed metallic loops shall not be introduced around cables/conduits, using items such as metallic ducts, metallic strapping, external steelwork or any ferromagnetic material or structures, to avoid current being induced in such materials.

(12) At pole locations, any over to underground conduit at the point of burial shall be installed as stated in Appendix B.

(13) Cable location markers shall be supplied and installed as per Section 7.18.

(14) For private conduits for consumer mains:

(a) 2 conduits or less, shall be installed with the alignment/orientation of junction/service pit maintained as stated in E-dwg 1921 series.

(b) 3 to 4 (maximum) conduits, the location of junction/service pit is adjusted to avoid interference to driveways, sewer connection points and water meter line. Consumers' services can be installed from any side of junction/service pits except from the bottom.

(15) All 'As Constructed' site installation information shall be forwarded to the designer and the relevant SA Power Networks' Project Manager to update design drawings. Refer to TS099, for more details.

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7.4.1 Conduit Storage

Degraded conduits are not accepted by SA Power Networks who reserves the right to inspect conduit storage facilities and conduit quality, prior to their installation.
Where deemed necessary, SA Power Networks may request for alternative storage arrangements, as to minimise damage to stored conduits, due to prolonged exposure to sunlight, heat entrapment, poor ventilation and/or inferior storage conditions (e.g. conduits covered under black sheeting, over stacking, contaminated area etc).

7.4.2 Conduit Preparation

Prior to installation, conduits shall:

(1) Be cleanly 'cut square and true' using a rotational pipe cutter. The use of hand saws is not permitted. Do not install under any circumstances, any conduit with a kink in its length. If damaged conduits are identified, then they shall be rectified by the installer.
(2) Have the edges chamfered in the direction of cable pull and deburred (i.e. sharp edges removed).
(3) Be internally 'de-beaded'.
(4) Be internally clean and free of debris.

7.4.3 Proving of Conduit

Prior to backfilling trenches, and before running cables through conduits, installed conduits shall be inspected and proved to confirm integrity and suitability for use.
The standard conduit proving procedure involves pulling a series of cylindrical brush, solid mandrel, and foam pig respectively in a single operation.
If the proving process cannot be completed in a single pull, an alternative three-stage method can be implemented as follows:

(1) Step 1: All conduits shall be thoroughly cleaned by inserting and pulling through a scraper or cylindrical brush.
(2) Step 2: An approved solid mandrel, 12 mm smaller in diameter than the conduit's internal diameter and 230 mm long, shall be pulled through each conduit.
(3) Step 3: A suitably sized foam pig, supplied by TDW or a similar approved provider, shall be pulled through each conduit. The foam pig serves the purpose of cleaning the conduit.

If the mandrel jams or the foam pig shows visible damage, the customer or their agent is responsible for investigating and covering the cost of any necessary rectification works.
SA Power Networks retains the right to request the installation of a waste length of cable through the conduits or the use of video cameras (CCTV) for conduit inspection, should reasonable concerns arise.

7.4.4 Conduit Spacers

The design drawings shall specify the required quantity of conduit spacers. To restrict movement, conduits and their spacers shall be securely anchored at the start and end of their run, and then at every 2.0 m to 3.0 m interval along their length. Note, manufacturers instructions may stipulate different installation requirements where if this is the case, they shall be followed.
Conduit spacers shall be installed 2.0 m before the development stage boundary where future connections or stages are expected.
Baffle spacers, created from 15 mm PVC sheet cut-outs, are not permitted.

7.5 Railway and Tramway Corridors

For the installation requirements of HV and LV conduits and cables within railway/tramway corridor, refer to TS117.

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7.6 Trenchless Works

The customer or customer's Agent is responsible for proposing a suitable trenchless method for conduit installation and approved by SA Power Networks. If there are any variations in cable alignments (vertical or horizontal), they shall be within deviations captured in the approved design specifications. However, any deviations in excess of the approved design specifications will not be accepted and the customer or their agent shall be responsible for covering the cost of any necessary rectification works.

Appendix H outlines SA Power Networks' requirements for typical underground boring arrangements such as separation distances between bores and minimum depth of cover. For further information on the DIT/Council's trenchless boring requirements, visit their website.

For trenchless works, the following requirements apply (but not limited to):

(1) Use a rotational cutter to trim the conduit ends squarely and neatly. Use of hand saws are not permitted for this type of work.
(2) Internal edges shall be chamfered and deburred with a router.
(3) Multiple conduits are permitted to be installed through a single bore.
(4) Mark conduits to indicate their orientation at the bore entrance and exit.
(5) Use non-metallic straps at suitable intervals to secure conduits in their intended configuration prior to insertion into the borehole (see Appendix H for more details). The use of metal strapping is not permitted.
(6) Flexible polyethylene (PE) conduits utilised for directional boring shall adhere to AS/NZS 4130. Appendix P provides list of conduits required for directional boring
(7) Use a reducer to transition from PE to PVC conduits. Refer to Appendix N, for coupling sizes.
(8) Ensure that the conduits are properly glued and cured before installing a polypropylene draw rope as per Section 7.14.
(9) Install the conduits, maintaining separation, and alignment as per Appendix H and the design drawings.
(10) When installing more than one conduit in the bored hole and/or the hole exceeds the outer diameter of the conduit by more than 25 mm, then fill the resulting voids with a suitable slurry and/or grouting, to prevent washout, subsidence and to maintain required cable ratings.
(11) A pilot conduit of at least 63 mm outer diameter to be attached to the conduit for pumping slurry. This pilot conduit shall extend to the deepest point of the bore.
(12) Slurry (such as bluey) shall be pumped in until it fills the bore and overflows out at both ends of the bore.
(13) Breakouts for pits shall be installed using PVC pipes and fittings.
(14) Submit bore logs daily for review and auditing. Accompany the bore log with the 'As Constructed' plan to confirm depth and alignment along each bore.
(15) The bore log shall be neat, legible, and presented in a tabular format. The information provided shall comply with TS099.

7.6.1 Directional Boring Design

At the preliminary stage, submit proposed directional boring design for approval from SA Power Networks' Project Manager.

The following are directional boring design requirements:

(1) Directional boring works are limited to depths between 1.5 m and 4.0 m.
(2) A bore depth exceeding 4.0m may necessitate the use of copper cables to meet the appropriate cable ratings.
(3) For multiple bores, maintain a minimum spacing of 10 times the diameter (D) of the largest conduit between bores. Additional details can be found in Figure 14.
(4) The designer shall assess whether backfilling is needed for the encasement to achieve the cable's desired continuous and/or cyclic rating.
(5) Breakouts for pits shall be designed for a minimum bend radius of 800 mm.
(6) The slurry used shall have a low thermal resistivity rating (TR) ≤ 0.9° K·m^2/W, to enhance the overall cable rating.

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(7) If encasing pipes are required, show their location and bore pit dimensions on the drawing.

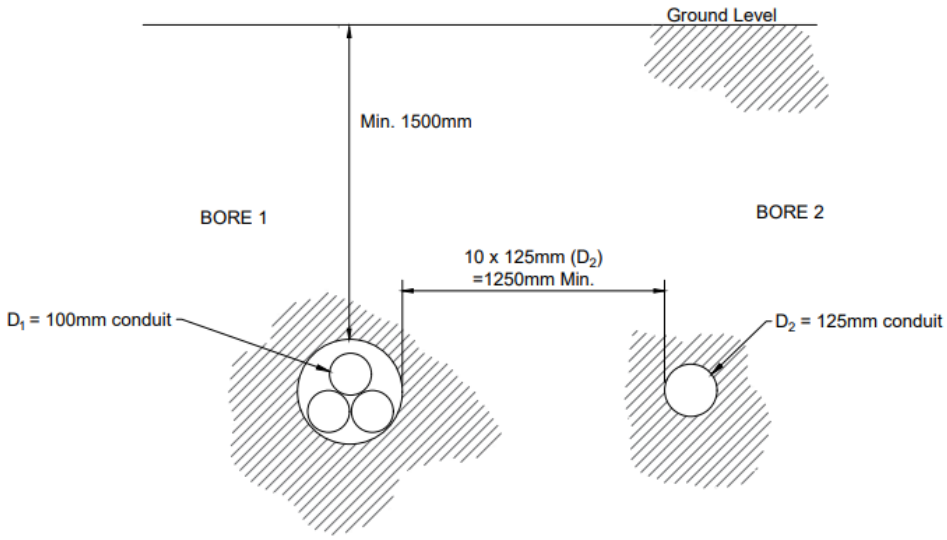


Figure 14: Specific DIT/Council requirements for directional boring

7.6.2 Requirements for Welding HDPE conduits

The electrofusion jointing of HDPE conduits and fittings shall comply with ISO 21307.

Before butt welding, the internal butt weld beads shall be minimised by chamfering the internal tube diameter. A sample of welds shall be available to SA Power Networks on request.

Conduit clamps shall be used to secure the conduit(s) to prevent movement and fitting shall be adequately supported to avoid sagging during the fusion process.

7.6.3 Conduits for Directional Boring

The PE material used for conduits in directional boring has a 'memory' and will attempt to coil up, which has potential to introduce stress on the conduit at the start, transition and end locations of boring installations. Therefore, the conduits shall be anchored appropriately at the conduit entry/exit points to maintain its horizontal configuration. Refer to Figure 15 for an example of securing conduits during directional boring with the coiled state of the conduit represented by the dashed lines.

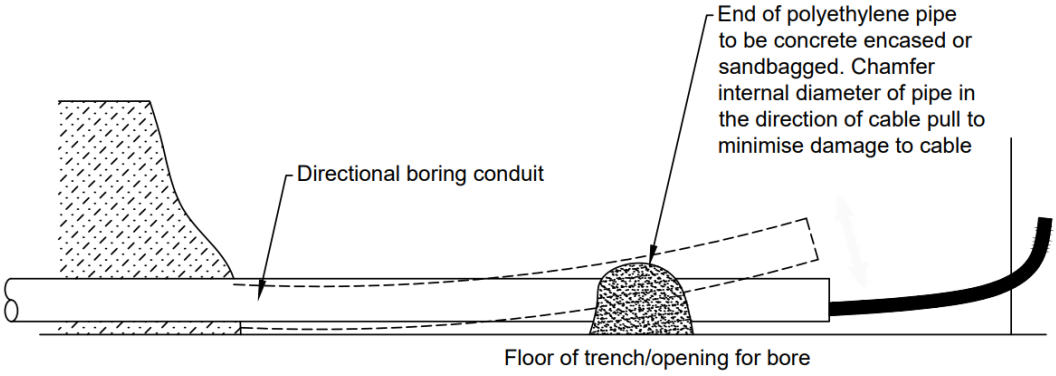


Figure 15: Securing the end of the directional boring conduit

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7.7 Changes in Ground Level and Directional Changes

Where there is a rate of change of ground levels (gradient rise and/or fall, 100 mm per 1.0 m), then it is important to establish appropriate ground levels at the time of the installation, to ensure that there are no requirements to alter ground levels after installation.

Figure 16 indicates incorrect and preferred installation of conduit, where the conduit route needs directional changes. Note the inappropriate conduit coupling position, where excessive tension is applied to both the coupling and the straight length of conduit.

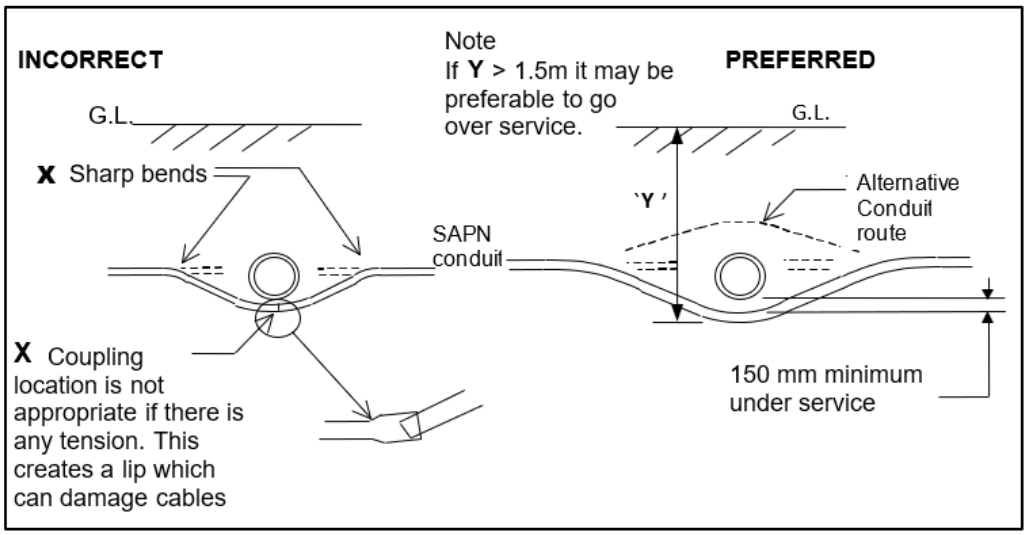


Figure 16: Preferred option where the conduit route needs directional changes

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7.8 Standard Footing – Cable and Conduit Entry

Padmount transformers or switching cubicles shall be installed on a concrete pad footing, which incorporates a cable vault under the HV and LV compartments, as shown in Figure 17. Refer to TS100 for footing design requirements for padmount transformers or switching cubicles.

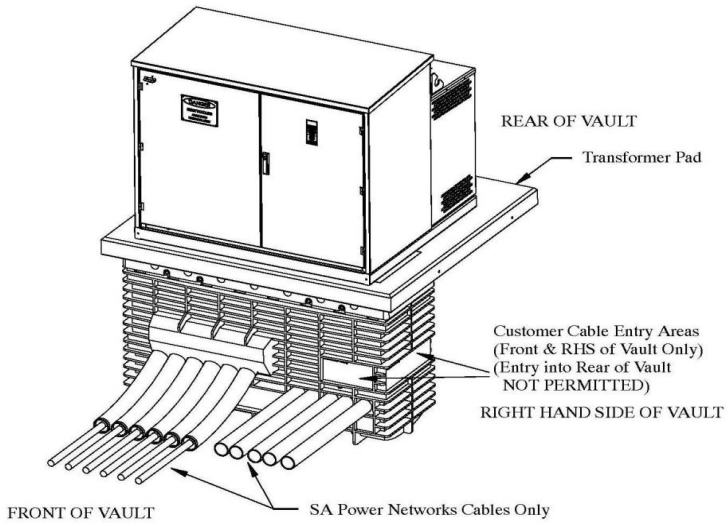


Figure 17: Mk7 Padmount Transformer Typical Footing Arrangement

Notes:

(1) All SA Power Networks distribution cables shall enter the front of the cable vault via their designated areas (i.e. LV and HV in separate compartments). Refer to Figure 17 as an example. The entry of LV cables into the HV compartment is not permitted, and vice versa.

(2) Where cables are installed in conduits, the conduit entry shall be adequately sealed. (i.e. around conduits and inside conduits end around cables) to prevent the ingress of dirt, stones, white ants, and transfer of moisture into the vault via conduits. Refer to Section 8.4 and 8.5 for details on conduit sealing requirements.

(3) Cable entry into the vault shall be via drilled entry holes. The customer or customer's agent shall produce neat, drilled entry holes using a hole saw or similar to suit the conduit size being used.

(4) Consumer mains shall:

- (a) Enter the vault through the front or right-hand side of the vault via the designated areas only.
- (b) Not enter via the rear (i.e. behind) of the vault.
- (c) Only enter the LV compartment of an energised transformer with a 'Network Access Permit'. SA Power Networks shall connect consumer mains to transformer LV side at the time of energising.

(5) Conduit entries into buildings (i.e. equipment rooms) have additional requirements around fire protection. Refer to TS108 for further details.

7.8.1 Vault Arrangement - Extended Vault Cover

The design drawings shall indicate the positioning of an extended vault cover where required. Refer to TS100 for more information on extended vault cover arrangements.

7.8.2 Vault Arrangement – Spare Conduits

Unless stated otherwise, all spare conduits shall be capped between 1.5m and 2.0m in front of the padmount transformer and switching cubicle cable vaults (i.e. spare conduits are not required to enter through the vault and shall be project specific to do otherwise).

Refer to E-dwgs E 1982 series and Figure 18 for more details.

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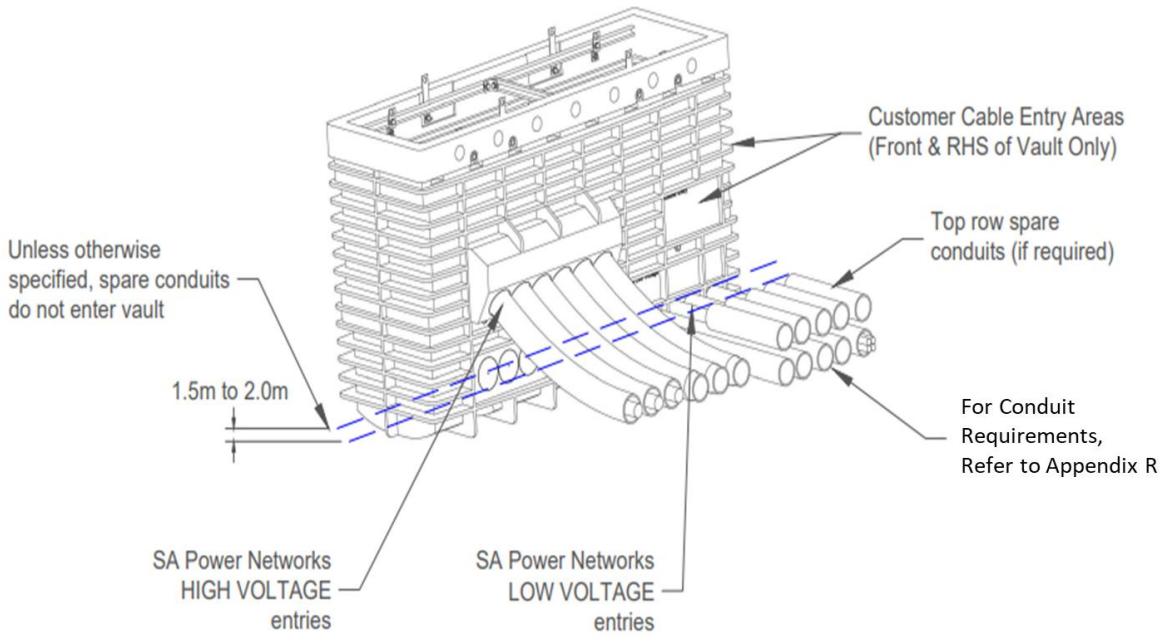


Figure 18: Spare Conduits and Vault Arrangement

7.8.3 HV Equipment Within CBD Locations – Telecommunications Conduit

Smart transformers and RMU/switching cubicles in CBD locations may come with smart controllers (i.e. remote SCADA enabled functionality) operated wirelessly via 4G modems. However, installations within the CBD may experience disrupted 4G coverage due to numerous environmental factors and obstructions.

In instances where a smart padmount transformer or RMU/switching cubicle (i.e. remote SCADA enabled functionality) is to be installed in a CBD location, it is mandatory to install a white MD telecommunications conduit to the transformer or RMU/switching cubicle vault. This is applicable to ground-level installations, building transformer rooms and basements. This telecommunication conduit will enable the connection of hardwired communications cabling where required.

7.9 Lubrication Injection Points (LIPs) and Pulling Pits

Install LIPs and pulling pits, as indicated on the design drawings and consider any other project specifications. Notionally, LIPs and/or pulling pits are required before bends and over long lengths, where heavy cable hauling is expected.

LIPs are essential for long pulls with multiple bends where heavy cable hauling is expected. However, in certain cases where lube LIPs are not feasible, the 'Front End Lubrication' method is an acceptable alternative.

Refer to Section 6.13 for further details on the SA Power Networks' approved cable lubrication product to be used.

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7.10 LV Standard Service/Junction Pits

7.10.1 LV Pit Arrangements

LV standard service/junction pits in a trench shall be installed as specified on design drawings.

Service and junction arrangements are to meet the following requirements:

- Where, the LV circuits are for 'Loop In/Loop Out', then the conduits and spare conduits shall be installed within the footpath and close to the front property boundary side, for entering directly into the ends of pits. Refer to E-dwgs E 1923 series for more details.
- Where the LV circuits bypass the pits, then conduits and associated spare conduits for those circuits shall also bypass the pits. Third parties' assets (e.g. Telstra, Optus etc.) including their associated spares, shall also bypass SA Power Networks' pits as shown in Appendix I.
- Unfused LV pits shall only be installed immediately adjacent to a property boundary on a road reserve/public land. For further details, refer to Manual 32: Service and Installation Rules.
- Service/junction pit positions within the trench may be adjusted for neat installation of conduits and spare conduits within the footpath.
- For design and installation requirements for LV pits in residential driveways, refer to TS100 and E-dwg series E1921.

7.10.2 LV Pit Access Cover/Lid and Lid Plugs

LV footpath service/junction pit shall have appropriate access cover or lid that is flushed with the ground level. The access cover or lid shall have lettered engraved 'SA Power Networks', Electrical', 'Class B', 'AS 3996', Pit Type and weight in kilograms. Refer to Table 6 for standard SA Power Networks LV pit lid selection.

The access cover or lid shall have lifting slots (for lifting handle KL 3602) and be blocked with plugs (RA 5447). To overcome any loose fittings around plugs, butyl rubber (EK 7665) shall also be used. Refer to E-dwgs E1921 series for installation details.

Table 6: LV Pit Lid Selection

Footpath Pit Type	Lid Details					
	Width (mm)	Length (mm)	Thick (mm)	Gross Weight (Kgs)	Lettering Engraved?	Stock Item No.
P7	560	498	50	10	Y	RA 5446 (Steel)
						RA 5555 (composite)
P8/P9	650	500	50	12	Y	RA 5556 (composite)

7.11 LV Service Pillars

Conduit arrangements into service pillars differ between radial and loop feed installations. Details of conduit entry arrangements into service pillars can be found in E-Dwgs E 1923 series.

Refer to TS100 for LV service pillar selection and design requirements.

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7.12 Typical Over To Under Conduit Entry Into Ground

Refer to Appendix B, for typical over to under conduit entry into ground arrangements.

In cases where cables have been installed at the poles for connection and left exposed, the contractor shall refer to the project specification for requirements on ensuring the security of the cable. The contractor shall discuss with the relevant SA Power Networks Project Manager for clarification if required.

Note: Where corrugated black PE piping (Stock item NC 4970) is used, it shall be restricted to short distances where the pipe is provided with mechanical protection from a polymetric slab. Corrugated piping is only intended for short distances where the installation of rigid orange PVC conduit is not feasible. Corrugated piping does not provide sufficient impact/protective strength for cabling and shall not be used to connect entire distances between equipment.

7.13 Reduced Cover Installation

7.13.1 Within Footpath

On a footpath, where a 750 mm minimum cover requirement is not feasible due to rocky areas, heritage landmarks, hard digging, unknown obstacles, conflicts with third-party assets, etc., the conduits can be installed at reduced cover, as indicated in Appendix J.

SA Power Networks' reduced depth of the cover trench may or may not have enough space to accommodate all other services; therefore, other services may need to be installed in a separate trench to achieve sufficient clearance.

The following are the requirements for reduced cover installation within a footpath:

(1) From the finished ground level to the standard depth of cover (i.e. 750 mm) to reduced depth of cover (i.e. 450mm), shall occur at a minimum of a transition length of 3 m.
(2) Utilise 100 mm diameter conduits in orange HD PVC class 12.
(3) 100mm thick poured concrete (reinforcement not required) must be installed 50mm above spare conduits to envelop the gradual transition area. The strength of the poured concrete shall be a minimum of 20MPa at 28 days.
(4) Marker tape (stock item KS3765) installed above the concrete slab shall cover the gradual transition area.
(5) Install surface marker discs (stock item KS3722) centrally on the conduits at the start and end of each trench at a spacing of 20 m to 30 m (where practical) for the full length of the reduced depth of the cover trench.
(6) Refer to Appendix J for the reduced depth of cover trenching in the footpath.
(7) Display standard reduced cover signs (stock item KS1140) on the site as specified in Section 6.16. Such information shall be incorporated on the 'As Constructed' drawing.

7.13.2 Within A Road Carriageway

A minimum of 1.0 m of road carriageway cover is required. SA Power Networks will evaluate reduced cover installation within road carriageways on a case-by-case basis.

The reduced cover installation methodology may vary for different road categories (e.g. highways, high loads corridor, main roads, interior roads); therefore, past approvals, which may have been provided by SA Power Networks, shall not take precedence.

7.14 Provision of Polypropylene Draw Rope

A polypropylene draw rope shall be installed as specified in Section 6.11, through each conduit where cables will be installed. Note that draw ropes are not required for spare or vacant conduits.

Polypropylene draw ropes shall not be jointed without approval from a SA Power Networks' Project Manager and under no circumstances be loaded beyond their 'Safe Working Load' (SWL).

The minimum breaking load (breaking strain) shall not be considered as the SWL. The required 'Factor of Safety' to be applied is specified in AS 4142.

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7.15 Polypropylene Straps

Before inserting conduits into the borehole, they must be secured with non-metallic/non-conductive straps at suitable intervals. For more details, refer to Appendix H and Section 6.12 for the polypropylene strap specifications.

When a third party needs to install their asset in an open trench, resulting in more than 1.0 m width of SA Power Networks' conduits being exposed, a central non-ratcheted, flat strapping polypropylene strap shall be installed under the Network Access Permit (NAP). This strap shall be suspended from a support beam, such as a slimlite soldiers formwork system and placed across the open trench to prevent sagging of the exposed conduits.

When dealing with multiple conduit banks that require additional support, a non-ratcheted polypropylene strap shall be installed at every 1.0 m interval.

7.16 Marker Tapes with Trace Wires

For SA Power Networks' telecommunications conduits that exclusively contain optical fibre cables, a centrally placed marker tape with a tracer wire shall be installed above the conduit. This requirement is applicable only when the optical fibre cables lack tracing wires or the capability to execute tracing functionality.

7.17 Mandatory Requirements for Looped HV Networks

Refer to TS100 for looped HV network design requirements.

Where looped HV cable networks deviate from the alignment of 'Common Service Trenches (CST)', they shall be identified by cable marker tape and protected by polymeric cable protection covers.

7.17.1 Cable Marker Tape

Cable marker tape as per Section 6.9 are mandatory for all projects.

It shall be installed lengthwise in all trenches at a depth half the distance from the finished ground level to the top of buried conduits.

It shall be installed for the full length of the deviated loop and extend at least 1.0m along the main 'Common Service Trench' (CST).

Where a polymeric cable protection cover is installed, the cable marker tape shall be placed halfway between finished ground level and the top of the polymeric cable protection cover.

7.17.2 Polymeric Cable Protection Cover

Polymeric cable protection cover shall be provided and installed by the customer/customer's agent in accordance with the design drawings and Section 6.10.

When the looped HV cable networks deviate from the CST alignment, a polymeric cable protection cover shall be installed for the entire deviated loop and extend at least 1.0m along the main CST.

It shall be installed at least 75mm above the looped HV cable networks and overhang sideways by a minimum of 50mm. If more than one polymeric cable protection cover is needed, they shall overlap each other by at least 50mm.



Figure 19: Typical Polymeric Cable Protection Cover Laid over HV Cables

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7.18 Cable Location Markers

Cable location markers shall be installed as shown in Appendix A, for clear and visible identification of SA Power Networks' underground assets.

Cable location markers shall be provided and installed by the customer/customer's agent in accordance with Section 6.14 and the design drawing.

The cable location markers are required in the following instances:

- when URD/UID development is likely to be unoccupied for an extended period
- in rural regions
- on private properties; and/or
- where the natural vegetation will prevent the obvious identification of the SA Power Networks' equipment.

For reduced depth of cover conduit installation, surface marker discs are required (installed centrally on the conduits) at the start and finish at spacing of 20 m to 30 m (where practical) for the full length of the reduced depth of cover.

7.19 Cable Clamps and Joint Support

Cable clamps to be supplied by the customer. Cable clamps and joints shall be installed such that localised heating of cables do not occur due to eddy currents, therefore cable clamps and joint support shall be made from non-ferrous materials. The two halves of the cable clamps and joint support shall be kept separate and secured using non-ferrous bolts, nuts, and washers.

A suitable elastic softener, which allows for normal heat-expansion movement of the cable, shall be used between the cable clamps and over the cable's sheath.

The cables and joints within the joint bays shall be adequately supported and restrained to prevent movement during installation, restoration, future excavation or operational events (for example, during faults). The supports and associated clamps shall be constructed using galvanised mild steel.

7.20 Star Dropper with Warning Signage

Star dropper with a warning sign (KS1149) shall be installed as stated in Appendix A.2. For signage requirements related to underground cables/conduits within railway/tramway corridors, refer to AS 4799.

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7.21 Bedding Sand Specifications

The purpose of bedding sand is to protect and identify the underground asset. The sand delivered onsite will be regularly checked and SA Power Networks shall not compromise on bedding sand specifications. If the installer is unsure, they shall verify with the sand supplier, prior to using sand.

SA Power Networks reserves rights to ask for bedding sand test compliance certificate, to ensure that the following requirements for standard bedding sand are met:

(1) It shall be free of silt, rocks, clay lumps, tree roots, building rubble, metal, glass, sharp objects, organic solvents, slag, harmful substances and/or any other contaminated material which has potential to damage cables. Also note that the recycled crushed glass products are not approved as bedding sand.
(2) It shall comply with the specification stated in Table 7.
(3) It shall be layered below and above the cable and conduits to the depths, as indicated on the design drawing.
(4) For more information on various installation arrangements, refer to Appendices C to J, E-dwgs E1920 - E1930, and E1978 - 1985 series.

Table 7: Bedding sand specifications and permitted test values for the sand

Test Method	Test	Permitted Test Values
AS 1141.11.1	Grading Sieve Sizes (mm) of AS 1152	% Passing
	4.75	100
	2.36	98 - 100
	1.18	94 - 100
	0.60	85 - 100
	0.425	55 - 100
	0.30	25 - 100
	0.15	5 - 40
	0.075	0 - 10
AS 1289.3.3.1	Plasticity Index	(Non - Plastic)

7.22 Backfilling

The following are the requirements for backfilling:

(1) Open trenches shall be backfilled, as soon as practicable, after cable and/or conduit laying and/or jointing works is completed. If any excavation works cannot be backfilled at the end of the working day, then security provisions shall be required, to protect from vandals and for public safety.
(2) Before backfilling any excavation, surplus-jointing materials, any waste materials, all rubbish including timber, foreign material, free water and slurry shall be removed from the trench.
(3) Backfill material shall not be placed in any excavation containing free water or slurry and is not permitted to be used (or mixed) as bedding sand, around SA Power Networks' assets.
(4) The excavation shall be clean and completely free from all fibrous and vegetable matter and other material, which may attract termites.
(5) For a public road that is not under the control of DIT the authorisation to excavate, backfill and any other specific requirements will be sourced from the relevant council.
(6) As a part of compliance requirements, SA Power Networks will require a copy of the approval from the relevant council and/or DIT including details of works.
(7) For DIT and local council roads, the backfilling and compaction shall comply to their specific requirements, however, if no compaction specification is found, then as a minimum, soil compaction shall comply with the SA Power Networks' requirements as stated in Section 7.22.1.
(8) SA Power Networks reserves the right to request for backfilling and compaction test compliance certificate.
(9) It is the responsibility of the customer or the customer's agent to reinstate any disturb backfill around any exposed third-party utilities to the requirements of the utility owner.

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7.22.1 Backfilling Compaction

The following are the requirements for backfilling compaction:

(1) Backfilling shall be uniformly compacted in horizontal layers not exceeding 200mm (loose) thickness.
(2) Backfilling compaction (over the bedding sand layer) shall not be less than 95% Maximum Dry Density (M.D.D) standard (avoiding any damage to SA Power Networks' asset) to provide a cohesive uniform layer.
(3) Compaction shall be tested at random depths every 50m or less and a minimum of three compaction tests per trench.
(4) If available, then the local council and/or DIT's backfilling compaction specifications are also acceptable.

7.23 Excavated Open Site Safety and Security Management

Any excavation sites that need to be left open or unattended (i.e. unsupervised overnight) shall be effectively covered for public safety, to prevent potential hazards, theft, and/or accidental damage to SA Power Networks' assets.

Trenches with exposed cabling/conduit can be managed using trafficable metal road plates, solid roadside barriers and/or temporary fencing. Bunting is not considered as an adequate form of safety or security barrier.

In cases where open trench sites are publicly accessible and cable drums or other equipment need to be left unsecured overnight, security measures such as a security guard or other precautions shall be implemented at the expense of the installer.

All exposed cables (i.e. in jointing bays, in open trenches) shall be treated as 'Live' until they are confirmed as 'Dead'.

7.24 Reinstatement of Trenches

The reinstatement of trenches in public roadways, footpaths and easement areas shall be in accordance with the requirements of the appropriate controlling authority or to the condition in which it existed, prior to the commencement of works.

7.25 Civil Works Forms

The TS105A (Forms) series assists in verifying all project works are completed to the standards.

As stated in TS105 Part B 'Index of Forms', the relevant forms shall be completed and submitted to SA Power Networks' representative.

If any portion of the work is sealed within an enclosure, concealed, or buried prior to examination, the Compliance Coordinator from SA Power Networks may ask for the work to be exposed to facilitate inspection and testing. This stipulation is detailed in the work agreement.

7.25.1 Provision of Photographic Evidence

If the completed works are contestable, the customer/customer's Agent shall provide photographic evidence to prove that all works have been completed correctly and in line with SA Power Network's technical standards.

Photos shall be provided of:

- Typical parts of the project, including common service trench, conduits crossing other services, and electrical tape.
- Any parts that are different from the usual, like reduced cover.
- Where equipment enters the ground, like pits, pillars and vaults.
- Include the date and location (latitude & longitude)

  These photos shall be provided to the relevant Compliance Coordinator from SA Power Networks.

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7.25.2 Notification Form

The civil works notification form TS105 C-1 'SA Power Networks' Civil Infrastructure Works Notification Form' is the component of SA Power Networks' asset inspection and vesting process. The civil contractor shall complete and submit form TS105 C-1 to SA Power Networks' representative at least 10 business days prior to commencement of any civil works.

Civil works shall not proceed until the responsible civil contractor have received acknowledgement of receipt and approval of this form from SA Power Networks' representative.

7.25.3 Compliance Form

Upon completion of civil works, the customer/customer's agent shall complete and submit the form TS105 C-2 'Civil Infrastructure Works Compliance Form' to SA Power Networks' representative.

If the customer/customer's agent delays or fails to submit the completed forms, this may result in delays to the customer's electrical supply and/or energisation works.

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8. Electrical Works

8.1 General

The following are the general requirements (but not limited to) for electrical works:

(1) Notify the relevant SA Power Networks' Project Manager four (4) weeks prior to starting cable installation works.
(2) Where design drawings indicate a requirement for a 'Network Access Permit (NAP)', prior arrangements shall be made in advance in accordance with the Network Access Permit Process in NICC404.
(3) Cable drums shall be transported vertically, with cable ends effectively sealed and clearly visible. For further details, refer to E-dwgs E1900 to E1910 series.
(4) Inspect the civil works and verify the cleanliness and integrity of the cables prior to initiating the cable installation. This will facilitate safe cable pulling operations.
(5) Always treat SA Power Networks' infrastructure as live unless proven otherwise (i.e. not energised).
(6) When working near energised cables, prioritise safety to prevent personnel exposure to potential dangers from induced cable sheath voltages due to abnormal system operation.
(7) Upon request, provide all necessary documentation, including instrumentation calibration certificates used for cable installation or testing, to SA Power Networks' Project Manager.
(8) Do not connect or energise installed cables or equipment to SA Power Networks' live infrastructure.
(9) SA Power Networks will do connection works.

8.2 Cable Installation

Cable installation works shall be as per SA Power Networks' requirements and the manufacturer's instructions.

(1) HV cables shall not be installed in the same conduit as LV cables.
(2) The cable pulling process should be slow and steady, applying tensions as indicated in the design drawing's 'Cable Pulling Tension Chart'. Ensure cables are not damaged, do not exceed pull limits, and are not subjected to over-tension. Utilise tension-limiting devices to avoid over-tensioning.
(3) For smooth cable pulling operations, use Polywater® Lubricant 'J' (OC 8051) and Polywater® Lubricant Pump with conduit adaptors (OC 8052) or equivalent. Cable pulling without sufficient lubrication (i.e. dry run) is unacceptable. Care shall be taken to ensure that no spillage or site contamination occurs, because of its use.
(4) Duplicate copies of Safety Data Sheets (SDS) for any proposed substitute lubricant should be provided to SA Power Networks' Project Manager before its use. The SDS should be readily available on-site during cable pulling.
(5) Prevent stones or other harmful particles from being drawn into the conduits by the cables, either by sticking to the cable surface or by the cable's movement to the conduit entrance.
(6) Ensure all cable phases have suitable visible cable destination labels with their phase identification.
(7) Within six (6) weeks of completing the cable installation, submit accurate onsite cable installation information to both the designer and SA Power Networks' Project Manager.

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8.3 Cable Cutting and Sealing

Only qualified cable installers shall carry out cable cutting and sealing procedures, following the manufacturer's guidelines. SA Power Networks may request proof of the installer's qualifications or training.

Ensure all cable ends, whether in the trench or on the cable drum, are appropriately sealed promptly after cutting. Refer to Table 8, for the cable sealing cap sizes and their respective stock numbers.

Cables shall not be cut using saws or similar hand tools, as they may contaminate the cable's insulation layers with metal filings. Only approved cable cutting methods shall be utilised.

Table 8: Cable Sealing Cap Sizes

Stock item number	Cable range-outside diameter (mm)
ER 5450	8-16
ER 5455	18-32
ER 5460	28-48
ER 5465	42-68

8.4 HV Cable, Conduit, and Vault Sealing

When third-party gas lines are found near SA Power Networks ‘Open Bushing’ type HVSC, the use of a duct sealing system (stock item JA 7005) is mandatory. Refer to Figure 20, for details on installation.

The properties of the 'Duct Sealing System’ used for sealing are as follows:

- non-corrosive, fire-resistant, gas-tight
- resistant to damage from vermin
- comes as a complete kit
- quick and easy to install.

Use standard 'Silicon' (stock item XX 1650) as a sealant around (outside) the conduit entry point into the vault wall to ensure a tight conduit fit.

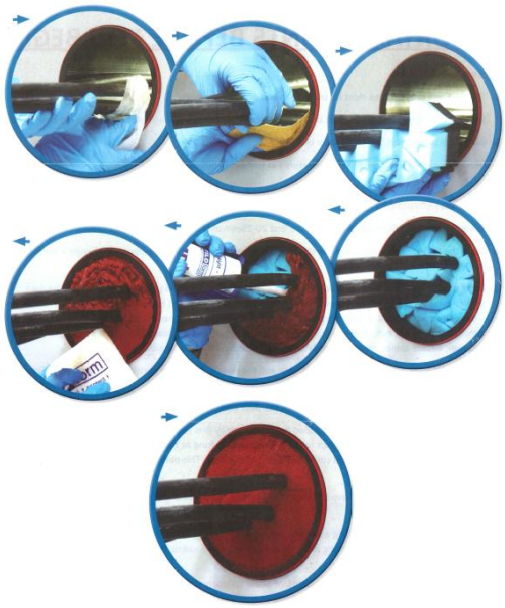


Figure 20: Duct Sealing System (JA 7005)

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8.5 LV Cable, Conduit, and Wall Gap Sealing

Conduits for LV cabling shall protrude approximately 25 mm to 50 mm into pits, with all sharp edges chamfered. The bottom of the conduits shall be positioned between 0 mm to 40 mm (maximum) above the bottom of the pit.

Where cables enter the pit through the conduit, fill approximately 75 mm around the cables inside the conduit with ‘Expanding Foam’ (stock item JA 7000).

The properties of the 'Expanding Foam' used for sealing are as follows:

- non-corrosive; certified as fire-resistant
- completely non-flammable propellants
- provides a tight seal against gas and water
- resistant to termites and rats
- fluorescent in colour
- can be applied at any angle for difficult areas.

Use standard 'Silicon' (stock item XX 1650) as a sealant around (outside) the conduit entry point into the service/junction pit wall to ensure a tight conduit fit.

Ensure that a 900 mm radius bend (stock item NC 5741) is installed from the road crossing to enter the pit within the footpath. Refer to Appendix I for more details. Note that road crossing trench alignment shall be at 90 degrees to the kerb.

Install a 1.8 m radius bend for any directional change where there is space, (i.e. at corners).

The details of conduit entries into service/junction pits are outlined below in Figure 21 and Figure 22. Also refer to E-dwgs E 1921 and E 1923 series for more information.

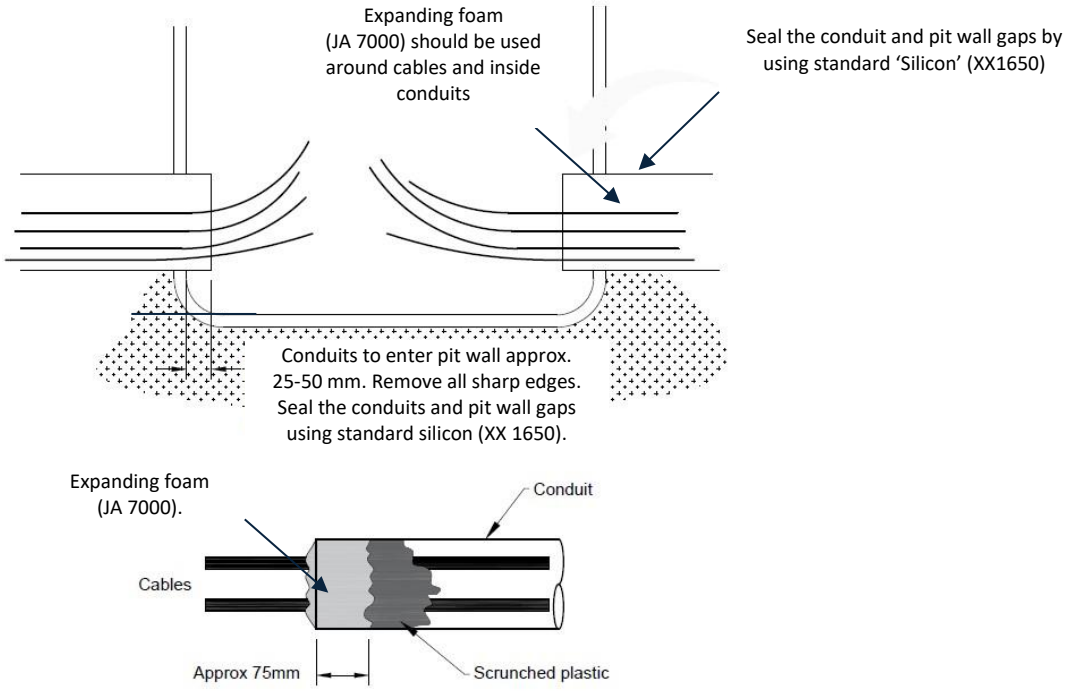


Figure 21: Typical LV cable, conduit, and wall gap sealing

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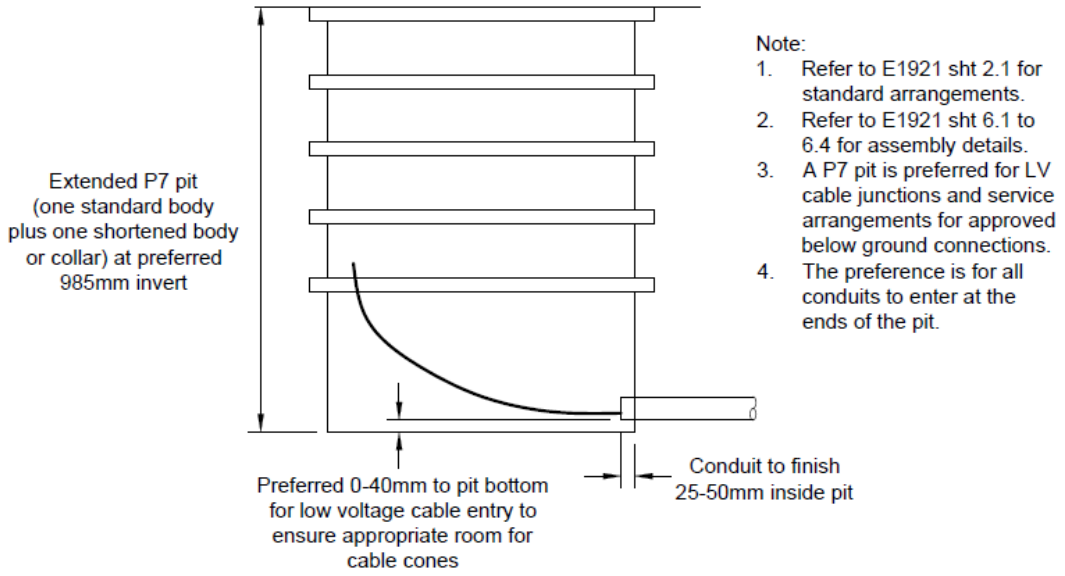


Figure 22: Typical cable and conduit entry into a service/junction pit

8.6 Locking Facilities

Padmount transformers and switching cubicles are equipped with locking mechanisms. Doors shall be locked when equipment is not being used.

8.7 Labelling and Identification

8.7.1 Cable Phase and Destination Labels

Self-laminating write-on markers shall be used for cable phase identification and destination labels (Stock item ER 4240). These labels shall be affixed to the ends of both HV and LV cables to denote the circuit names and destinations (i.e. from/to padmount transformers or switching cubicles). These labels shall be clearly identifiable, durable, permanent, and weatherproof.

At both ends, each cable shall be uniquely labelled to avoid confusion between two separate connections verses a parallel connection. Parallel cables shall be clearly taped to identify the cable grouping as per E-drawing E 1921 series using a self-adhesive, yellow PVC tape with text “PARALLEL CABLES” (Stock item number KS 2591).

The cables may be inspected by a SA Power Networks representative to verify their correct placement and the accurate designation of all cable ends.

Underground HV and LV cables shall be marked with coloured PVC tape for phase identification, as detailed in Table 9.

Table 9: Cable Phase Identification and Colour Code

Voltages	Cable phase identification (colour coding) i.e. Phase (colour of PVC tape)			
230 V/400 V	R (Red)	W (White)	B (Blue)	N (Neutral) (Do not disconnect tape)
7.6 kV	A (Red)	B (White)	C (Blue)	--
11 kV	G (Red)	H (White)	J (Blue)	See Note
33 kV	1 (Red)	2 (White)	3 (Blue)	--

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Note: HV 95 mm^2 3 x 1c (bundled) cables are marked with numbers for phase identification, such as 1 = Red, 2 = White, and 3 = Blue.

8.7.2 Padmount Transformer and Switching Cubicle Identification Labels

A unique identification number shall be requested from the relevant SA Power Networks representative who will assign a prefix for ground mounted transformers and switching cubicles as follows:

- **TG** – Ground mounted transformers (padmounts, open bushing types and dustbin styles)
- **TC** – Transformer Cubicles
- **C** – Switching Cubicles

The prefixes are followed by a six-digit number. For example, TG123456.

The identification label material shall be made from UV-stabilised PVC white /black sheet, 'TAKIRON' or approved equivalent. The label shall measure 3.0 mm thick, 35 mm wide, and 150 mm long, with a letter size of 25 mm.

A structural adhesive (Stock item XX 3708) or equivalent shall be used to affix the label. For additional details, refer to E-dwg E 1945/5.1.

8.7.3 Pit Identification

Where pits are used, cable phase and destination shall be clearly marked on the insulating barrier top cover of the pits (Refer to E-Dwg 1921/2.1). These markings shall be clearly legible to assist with identification of the service.

8.8 Access Permissions and Connection to Existing Equipment

When cables need to be terminated on existing equipment of SA Power Networks, such as a padmount transformer, switching cubicle, or Stobie pole, SA Power Networks shall do the connection. This includes de-energising and isolating all relevant points of the feed.

Where it states on design drawings that a Network Access Permit is required, prior arrangements shall be made to obtain all access permits for the project as per NICC404.

8.9 Cable Testing

Cable testing shall be conducted in accordance with TS105 requirements.

8.10 Cable Traceability

All the information concerning the HV and LV cables shall be recorded on form TS105 F-44 before SA Power Networks accepts the Certificate of Practical Completion.

8.11 Public Street Lighting

Public streetlight installation works shall comply with TS101 and NICC402 requirements. Refer to the E-dwgs E 1720 series for the public lighting conduit arrangement.

8.12 Earthing

The earthing system shall comply with TS109 and AS 2067 requirements.

8.13 Fibre Optic Cable Termination

When dealing with fibre optics within the cable, termination shall occur in an appropriate junction box as designated by SA Power Networks. Unless directed otherwise, the junction box shall be situated below the over/under termination frame.

The fibre optic cable shall not be bent beyond its minimum bending radius (consult the cable manufacturer for details regarding the specific cable).

Set up a 'Distributed Temperature Sensing (DTS)' system to terminate the fibres of all three-phase cables, ensuring it is configured for future use.

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8.14 Cable Jointing and Future Connections

All works related to cable jointing and termination shall adhere to the relevant Job Safe Work Procedures (JSWP), TS100, and the requirements set out in E-dwgs E 1911 to E 1919 series.

Cables shall be inspected for any indications of moisture on the conductors or any discolouring of the copper screen wires. Should moisture contamination be found, the compromised cable shall be removed and replaced with a new cable. A report detailing the issue shall be provided to SA Power Networks' Project Manager before proceeding with the cable jointing.

The Network Access Permit (NAP) shall align with the requirements stated in NICC404. The NAP shall be secured prior to the de-energisation of the cable to establish an open point at the last live pillar.

It is important to ensure that the pillar is removed when making connections to future cables and that the joints are executed within a shared trench.

8.15 Typical Securing LV cables

The customer's mains terminated in the padmount transformer shall be secured. All cable vaults are pre-assembled with a center cross member. The support rails shall be supplied by SA Power Networks.

The customer shall provide cable clamps (Unistrut P2024 series or equivalent) and ensure that the clamps do not allow a continuous magnetic loop around the cable using a brass screw, nut, and spacer washer. Refer to Figure 23 for additional details.

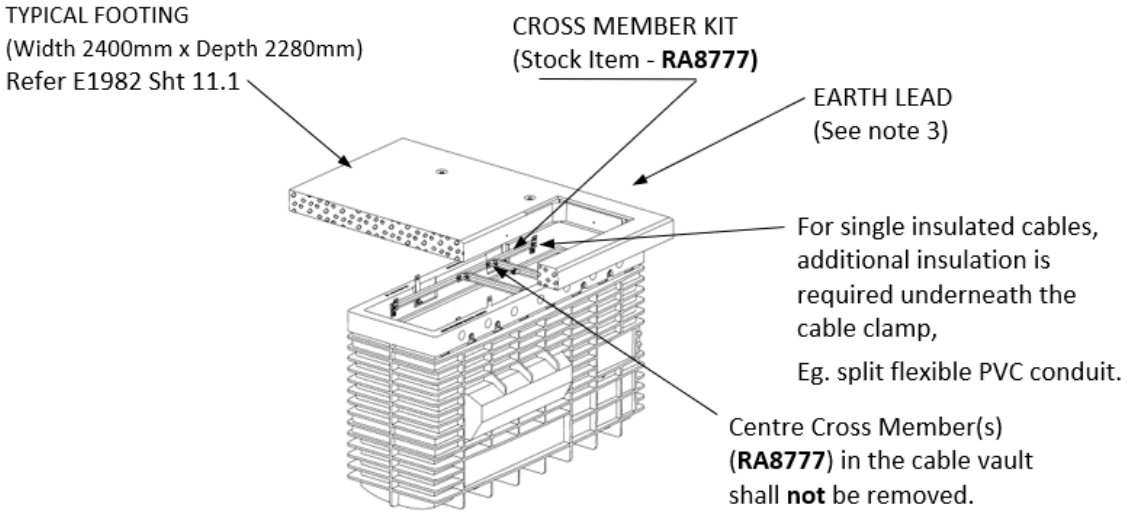


Figure 23: Typical securing LV cables

Notes:

(1) Where more than one cross-member kit is used for securing cables, one steel angle bracket and one copper angle bracket (as supplied in the kit) shall be used to avoid magnetic loops around single-core cables.
(2) The channels, brackets, spring nuts, and setscrews are Unistrut components or equivalent.
(3) In CMEN areas bond framework to transformer LV earth bar using earth lead and in MEN areas bond framework to transformer case using an earth lead.

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8.16 Electrical Work Forms

The TS105A (Forms) series assists in verifying all project works are executed in accordance with the required standards.

As outlined in TS105 Part B 'Index of Forms', the necessary forms related to electrical work construction will be supplied by the SA Power Networks' Compliance representative.

Should any portion of the work be enclosed, concealed, or interfered with prior to inspection, the Compliance Coordinator from SA Power Networks has the authority to demand that such work be exposed to facilitate examination and testing, as stipulated in the work agreement (should photographic evidence not be sufficient per section 7.25.1).

8.16.1 Notification Form

The Electrical Contractor shall complete and submit form TS105 F-1 'Authority to Proceed Request (ATP)' and TS105 F-2 'Documentation - Check List' to SA Power Networks' representative at least 10 business days prior to commencement of any electrical works.

Electrical works shall not proceed until the responsible Electrical Contractor has received acknowledgement of receipt and approval of these forms from SA Power Networks' representative.

8.16.2 Compliance Form

For all projects with the electrical installation component, the form TS105 F-3 'SA Power Networks' Electrical Infrastructure Works Compliance Form', or TS105 F-4 'SA Power Networks' Partial Electrical Infrastructure Works Compliance Form' will be completed by the SA Power Networks Compliance representative and signed by the contractor.

In line with the requirements of the Electricity (General) Act and Regulations, an Electrical Certificate of Compliance (eCoC) shall be obtained for any work carried out on a customer's electrical installation.

9. As Constructed Drawings

'As Constructed' drawings shall be provided within 30 days of practical completion.

The customer or the customer's agent shall provide accurate 'As Constructed' drawings to ensure clear identification of asset details and locations for future reference.

This will assist SA Power Networks in maintaining up-to-date Geographical Information System (GIS) data and asset drawing records, which will be used to provide reliable information for 'Before You Dig Australia'.

Any submitted drawings found to be non-compliant with technical standard TS099 shall be amended and resubmitted by the Customer or their agent at their own expense.

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10. Who should you talk to?

(1) SA Power Networks' Customer Solutions Managers:

- Website: https://www.sapowernetworks.com.au/public/download.jsp?id=315697

(2) General Enquiries:

Contact SA Power Networks' Customer Service Team:

- Website: https://www.sapowernetworks.com.au/contact-us
- Email: customerservice@sapowernetworks.com.au;
- Call: 13 12 61

(3) Faults and Emergencies:

Contact SA Power Networks' 24/7 phone line:

- Call: 13 13 66

(4) Network Access Permit Requests:

Contact SA Power Networks' Customer Solutions-Connection Central Team during business hours 8:00 am to 3:00 pm, Monday to Friday:

- Email: connectioncentral@sapowernetworks.com.au;
- Call: (08) 8404 5409

(5) Before You Dig Australia (BYDA) Enquiries:

- Website: https://www.byda.com.au/

(6) Service and Installation Rules Enquires:

Contact SA Power Networks' Network Connections Manager:

- Email: ConnectionsManager@sapowernetworks.com.au;

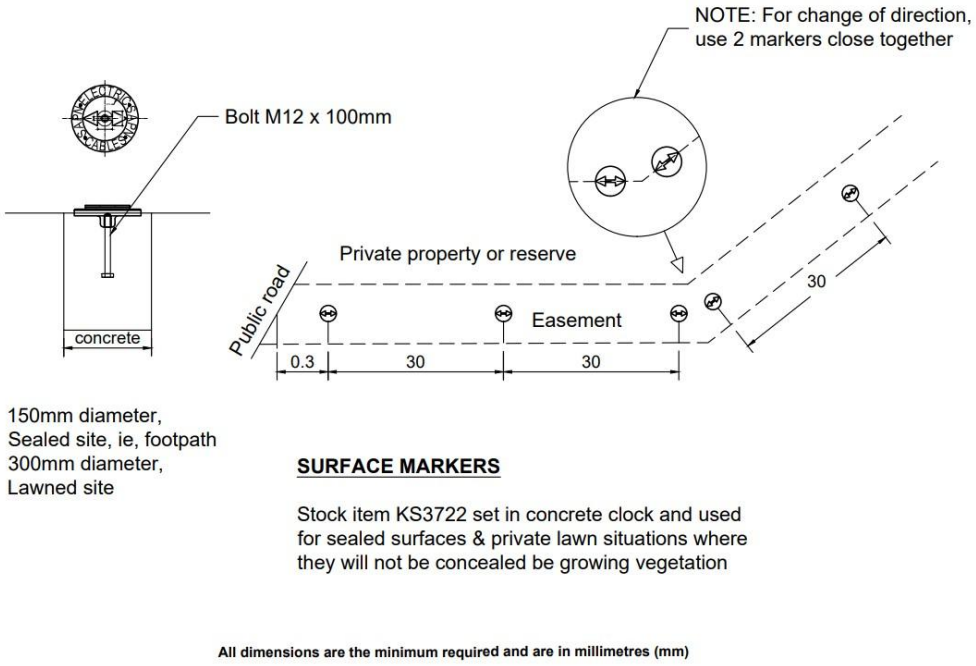
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Appendices

A. Cable Location Marking Drawings

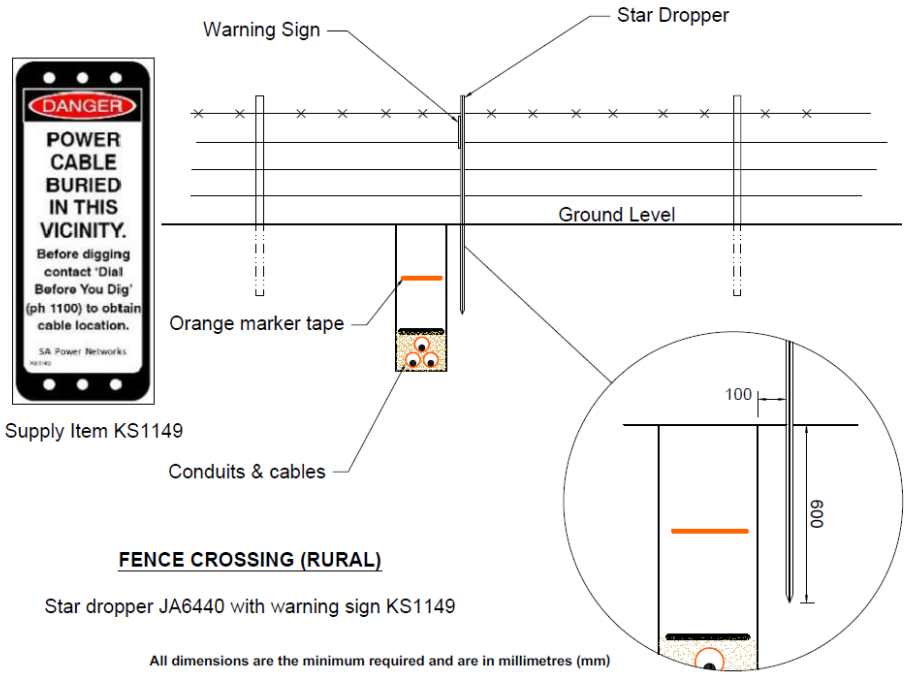
A.1 Surface Markers



Drawing 'Not to Scale'
All dimensions are minimum and are in millimeters 'mm'

Figure 24: Surface markers

A.2 Star dropper with a warning signage



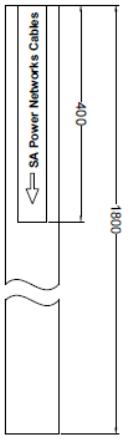
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All dimensions are minimum and are in millimeters 'mm'

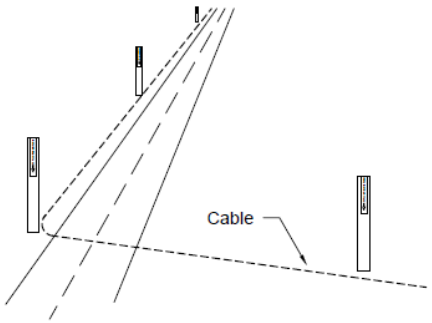
Figure 25: Star dropper with a warning signage

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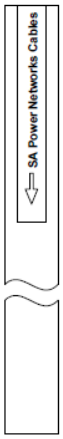
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A.3 Cable identification posts





Identification post, KS3720, at each change in direction and at suitable distances apart on a straight cable run.



Install an identification post next to a service pillar where it is envisaged that the property will not be developed for some time and during this period the pillar may be obscured from view by vegetation or other matter.

Drawing 'Not to Scale'
All dimensions are minimum and are in millimeters 'mm'

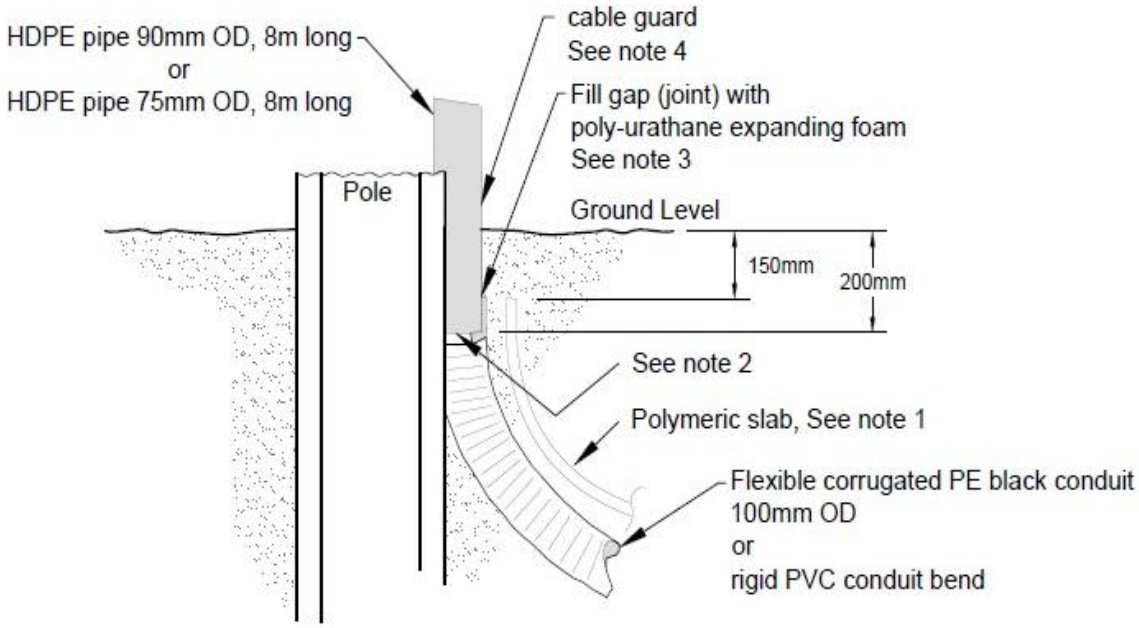
Figure 26: Cable identification posts

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B. Typical Over to Under Conduit: Entry Detail

B.1 Over to under: HDPE conduit entering ground - Arrangement 1



DETAIL OF OVER TO UNDER HDPE PIPE ENTERING GROUND

Also applicable when the over/under is installed on the concrete face of the pole. Cable guard not shown.

NOTES

1. If the cable is not mechanically protected by the concrete footing to a depth of 1m, use Polymeric slabs.
2. Internal sharp edges at the bottom of the pipe must be removed to prevent cutting of cable insulation.
3. After installing HDPE pipe into conduit, scrunch plastic sheet into the gap before sealing the joint with expanding foam.
4. Cable guards are required only in bushfire risk areas. Cable guard to be bonded to the pole in accordance with E1009.

Ref: E 1996 sheet 1.2/D

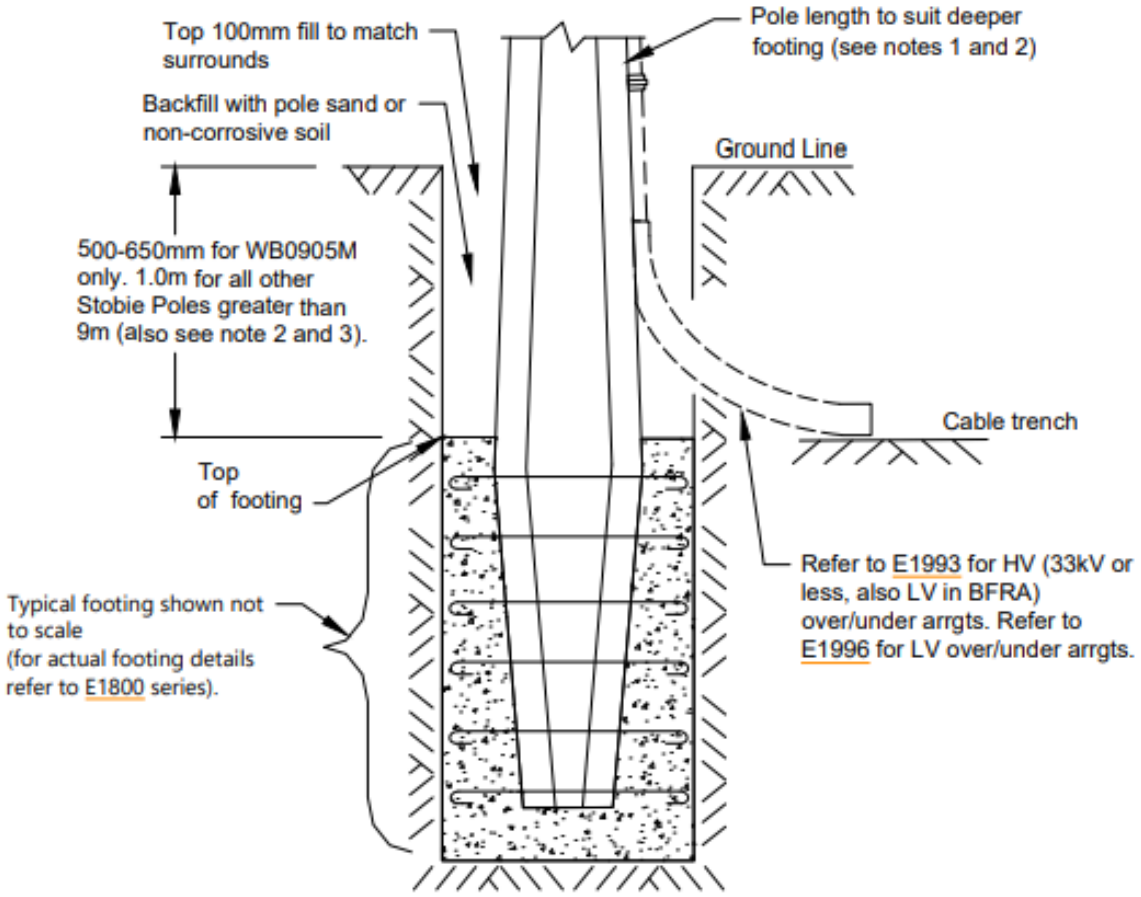
Drawing 'Not to Scale'

Figure 27: Over to Under: HDPE conduit entering ground - Arrgt 1

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B.2 Over to under transition: Above lowered footing - Arrangement 2



FOOTING DETAIL ARRGT 1

OVER/UNDER TRANSITION ABOVE LOWERED FOOTING

APPLICATION

1. The lowered footing allows over/ unders to be readily installed without the need to alter the footing. Arrangement 1 is the preferred arrangement for:
   - all new LV over/ unders with cable size greater than 35mm^2 (for smaller cables see E1996); and
   - all new HV over/ under cables.

   Arrangement 1 is able to be used on all footing types, however, can be subject to cable bend radius and other arrangement or site specific constraints.

2. If existing construction is being replaced, the change in footing height should be taken into consideration to ensure conductor's ground clearance / existing tensions on the conductors remains the same. Therefore, if footing is lowered, pole length should be increased to suit. WB0905 Stobie Poles can be readily replaced with WB0905M and footing lowered between 500mm-650mm below GL to ensure conductor attachment height remains the same. Other 9m poles should use arrangement 2 or arrangement 3.

3. New LV cables 4x35mm^2 (or less), earth cables 70mm^2 (or less), are generally able to be run above the footing without the need to lower the footing as above, however, consideration should be given for existing (or known future) third party services.

Ref: E 1994/1/D

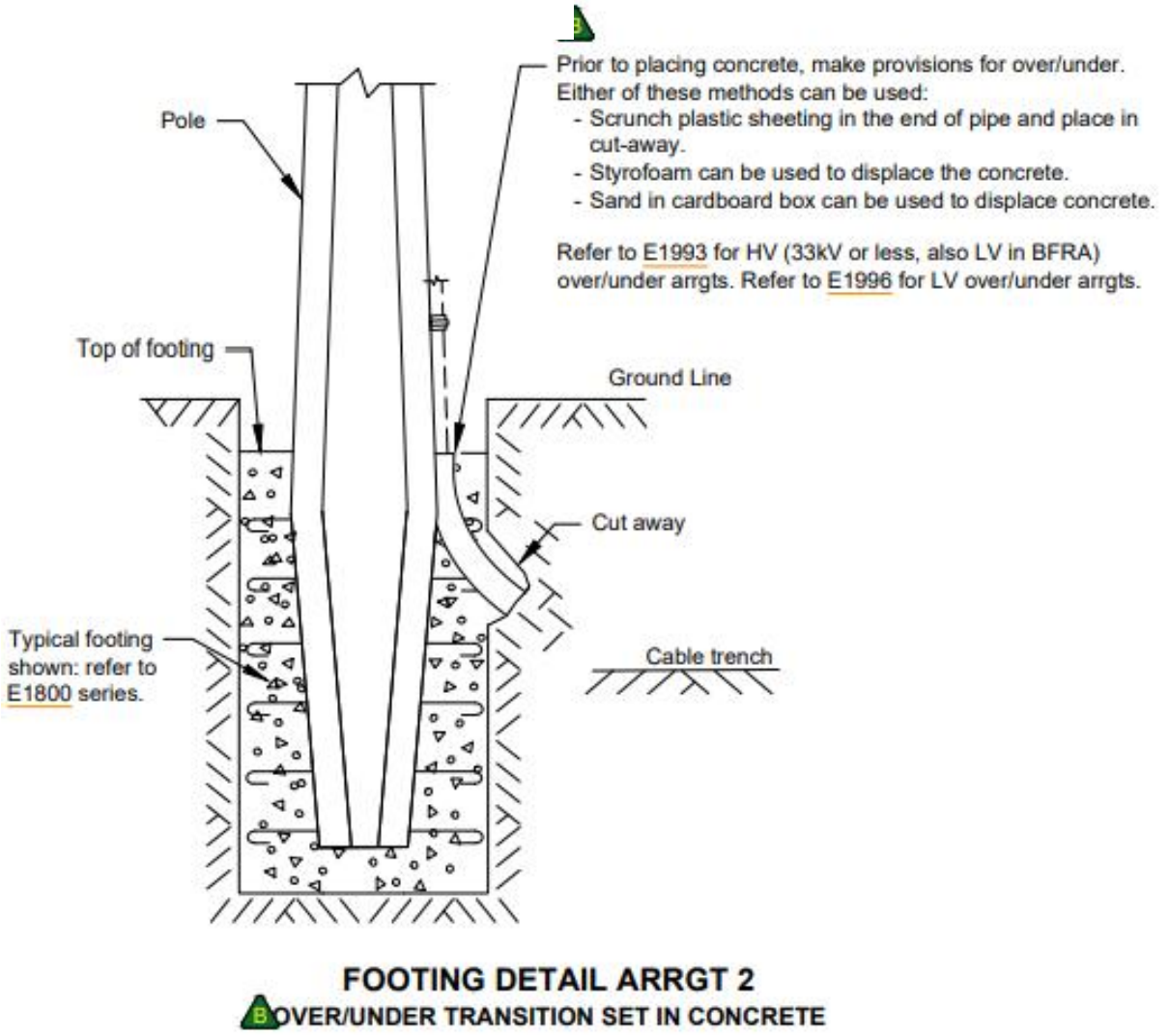
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Figure 28: Over to Under transition: above lowered footing - Arrgt 2

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B.3 Over to under transition: Set in concrete - Arrangement 3



Ref: E 1994/2/B

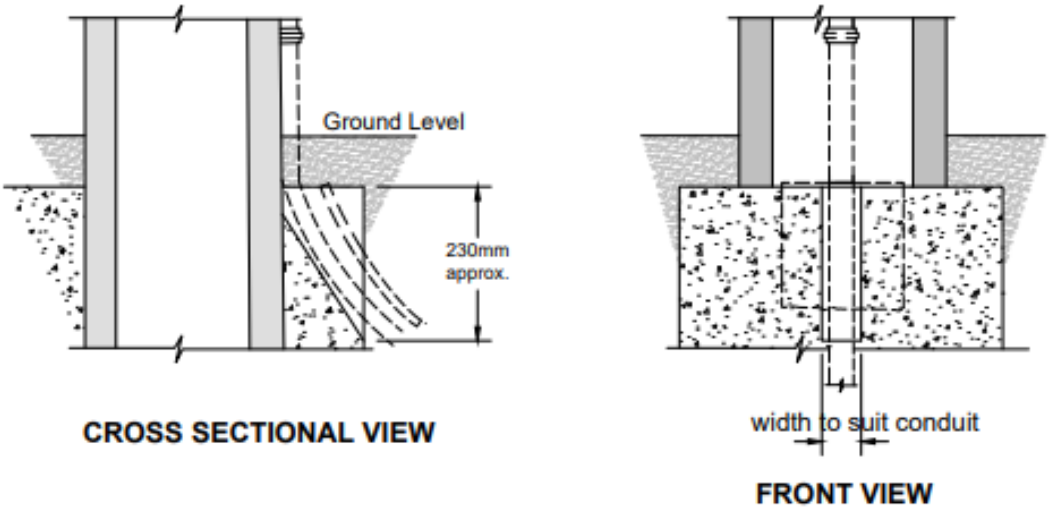
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Figure 29: Over to Under transition: set in concrete - Arrgt 3

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B.4 Over to under transition: Footing cut away limitation - Arrangement 4



FOOTING DETAIL ARRGT 3

FOOTING CUT AWAY FOR OVER/UNDER TRANSITION

WARNING
Do not cut reinforcement (cage)

WARNING
This arrangement does not apply to any reduced strength drawings, such as Toe & Collar (E1801-E1802) or In-Situ (E1803-E1804). Instead refer to E1994 Arrangement 1 or Arrangement 2.

NOTES

1. If Toe & Collar (E1801-E1802) is required to be broken to fit over/under then the top collar is required to be replaced. If In-Situ (E1803-E1804) is required to be broken to fit over/under, footing must be replaced.
2. This arrangement applies to both concrete and steel face.
3. Installation of Over/Under on Existing footings to meet the criteria of non traffic sides of the pole, and on same side of pole as the line for line or brace pole and opposite side of the line tension for dead-end pole.
4. New LV cables 4x35mm^2 (or less) earth cables 70mm^2 (or less) are generally able to be run above the footing without cut-away.

Ref: E 1994/3

Drawing 'Not to Scale'
All dimensions are minimum and are in millimeters 'mm'

Figure 30: Over to under transition: footing cut away limitation - Arrgt 4

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C. Typical Trenching for PLEC Projects

C.1 Cables in Conduits: PLEC Projects

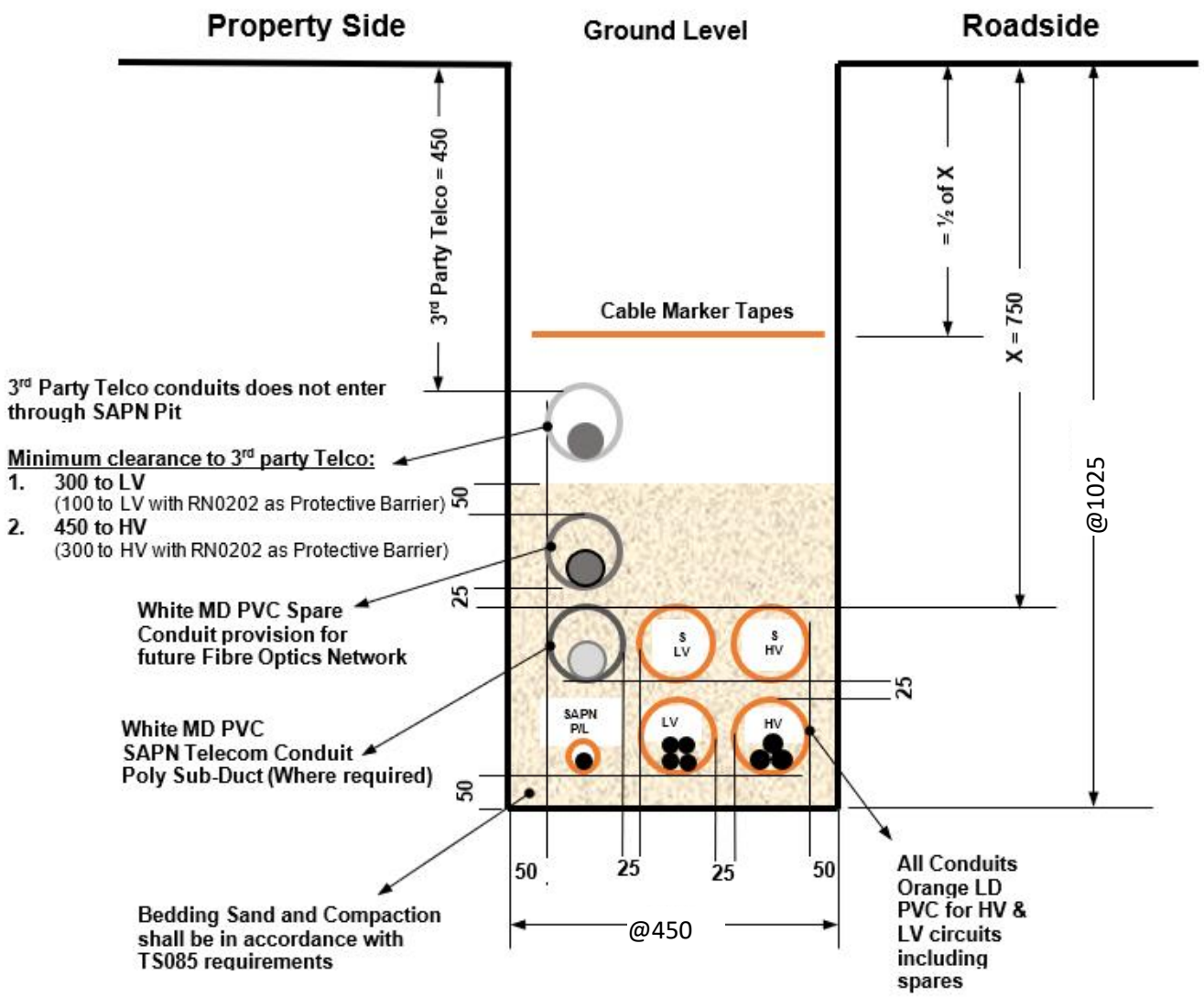


Figure 31: Cables in conduits: PLEC project

Notes:

(1) Drawing 'Not to Scale'
(2) All dimensions are minimum and are in millimetres 'mm'
(3) @ = Approximate dimension.

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D. Typical Shared Trench Arrangement

D.1 Separation From and Between Direct Buried HV/LV Electrical Cables

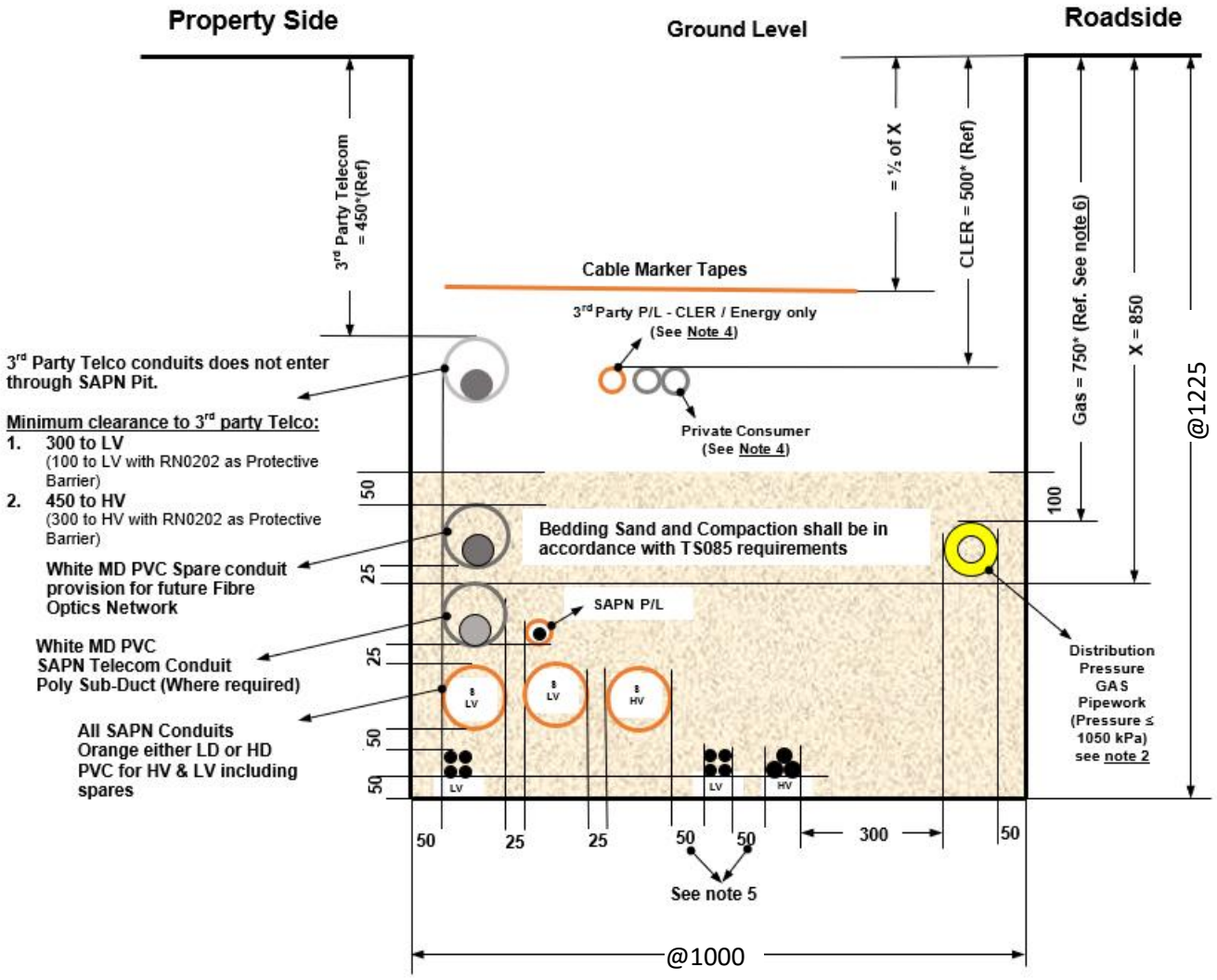


Figure 32: Separation from and between the HV/LV electrical cables buried directly

Notes:

1. Protected means mechanical protection (e.g.by the concrete slabs, polymeric cable protection cover (RN 0202), continuous pour, bricks, designed for protecting etc) for the electrical supply cables, so that during any work the likelihood of damage to the conduits or cables and injury to agency or contractor personnel is reduced.
2. APA standards do not allow vertical separation. For SA Power Network cables running parallel to the APA, the horizontal separation stipulated in Section 5.1.2 shall be maintained.
3. All clearances mentioned in this sketch are in 'mm' and SA Power Networks' minimum requirements; other utilities may have greater separation requirements; therefore, before starting any work, the associated utilities should consult for mutual agreement.
4. Consumer mains and third-party public lighting (e.g. CLER, Energy only) installations shall comply with AS/NZS 3000 and Manual 32: Service and Installation Rules requirements.
5. Maintain a minimum separation of 50 mm between directly buried HV or LV cables, trench walls, and conduits. Refer to Section 7.4 for the typical spacing requirements.
6. The 3rd party asset depth of the installation mentioned in this document is for 'Reference only'.
7. Drawing 'Not to Scale'.
8. All dimensions are minimum and are in millimetres 'mm'.
9. @ = Approximate dimension.

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D.2 Cables in conduits (in footpath): Shared trench

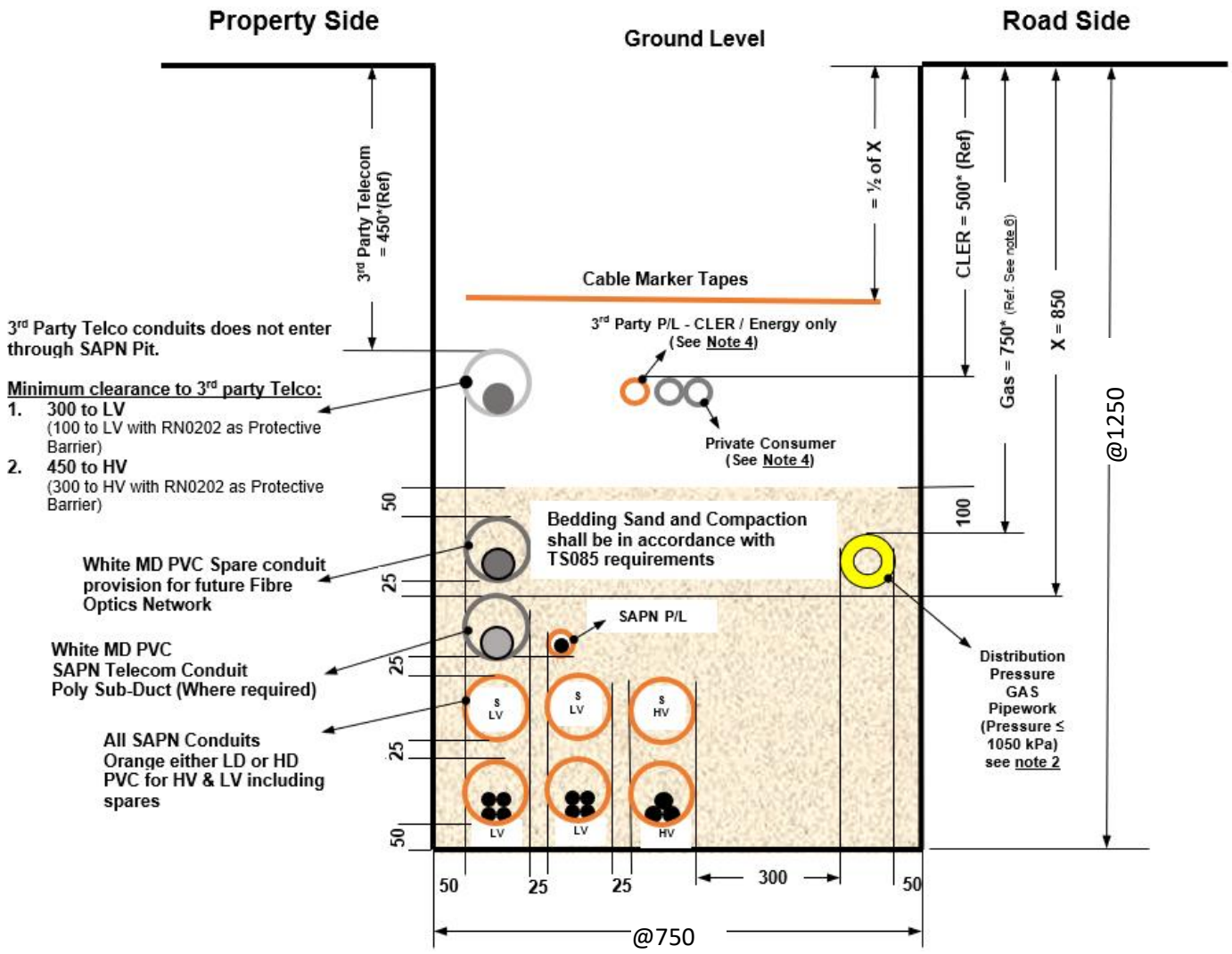


Figure 33: Cables in conduits (in footpath): Shared trench

Notes:

1. Protected means mechanical protection (e.g. by the concrete slabs, polymeric cable protection cover (RN 0202), continuous pour, bricks, designed for protecting etc) for the electrical supply cables, so that during any work the likelihood of damage to the conduits or cables and injury to agency or contractor personnel is reduced.
2. APA standards do not allow vertical separation. For SA Power Network cables running parallel to the APA, the horizontal separation stipulated in Section 5.1.2 shall be maintained.
3. All clearances mentioned in this sketch are in 'mm' and SA Power Networks' minimum requirements; other utilities may have greater separation requirements; therefore, before starting any work, the associated utilities should consult for mutual agreement.
4. Consumer mains and third-party public lighting (e.g. CLER, Energy only) installations shall comply with AS/NZS 3000 and Manual 32: Service and Installation Rules requirements.
5. Maintain a minimum separation of 50 mm between directly buried HV or LV cables, trench walls, and conduits. Refer to Section 7.4 for the typical spacing requirements.
6. The 3rd party asset depth of the installation mentioned in this document is for 'Reference only'.
7. Drawing 'Not to Scale'.
8. All dimensions are minimum and are in millimetres 'mm'.
9. @ = Approximate dimension.

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E. Typical SA Power Networks Non-shared Trench

E.1 Cables buried directly (in footpath): Non-shared trench

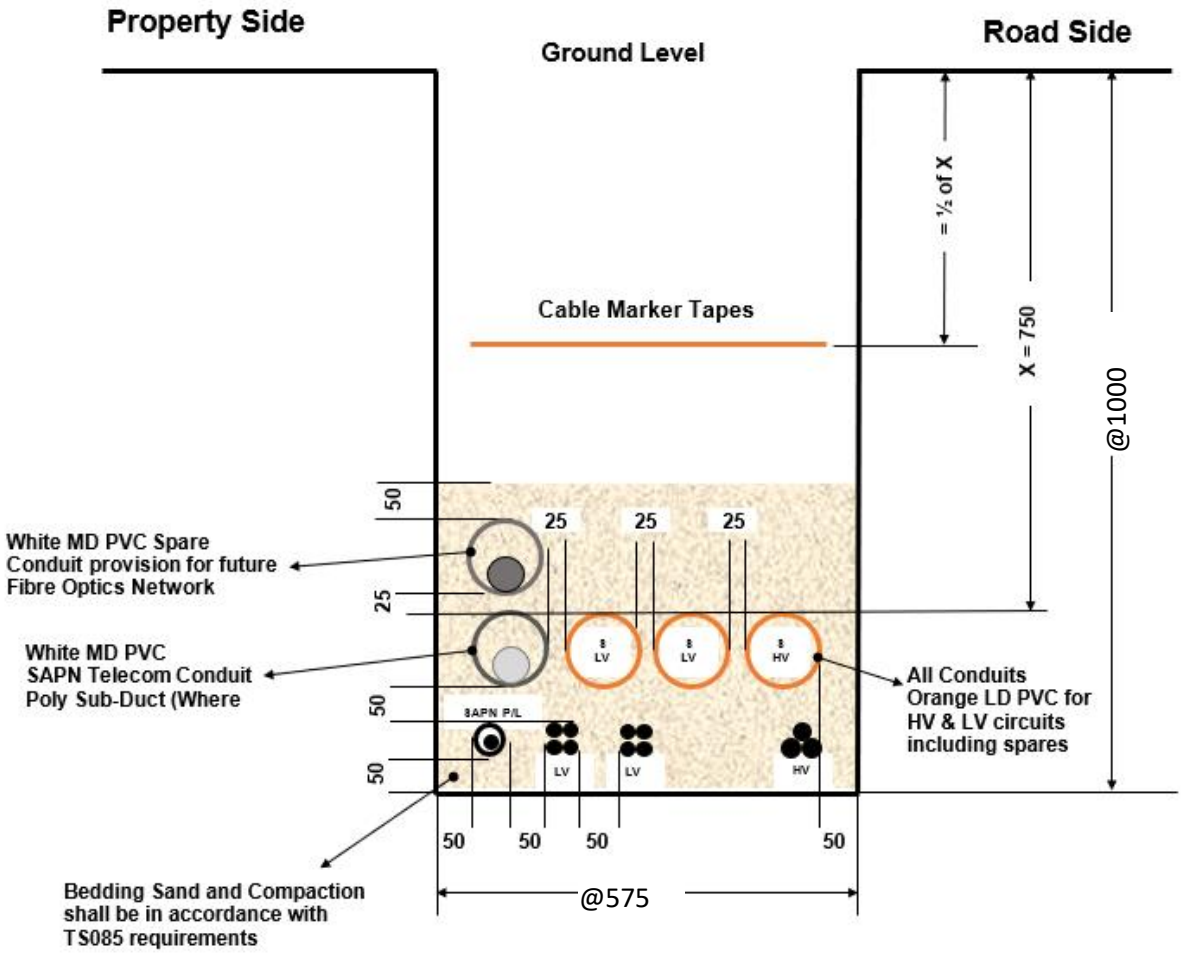


Figure 34: Cables buried directly (in footpath): Non-shared trench

Notes:

(1) Drawing 'Not to Scale'
(2) All dimensions are minimum and are in millimetres 'mm'.
(3) @ = Approximate dimension.

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E.2 Cables in conduits (in footpath): Non-shared trench - Arrgt 1

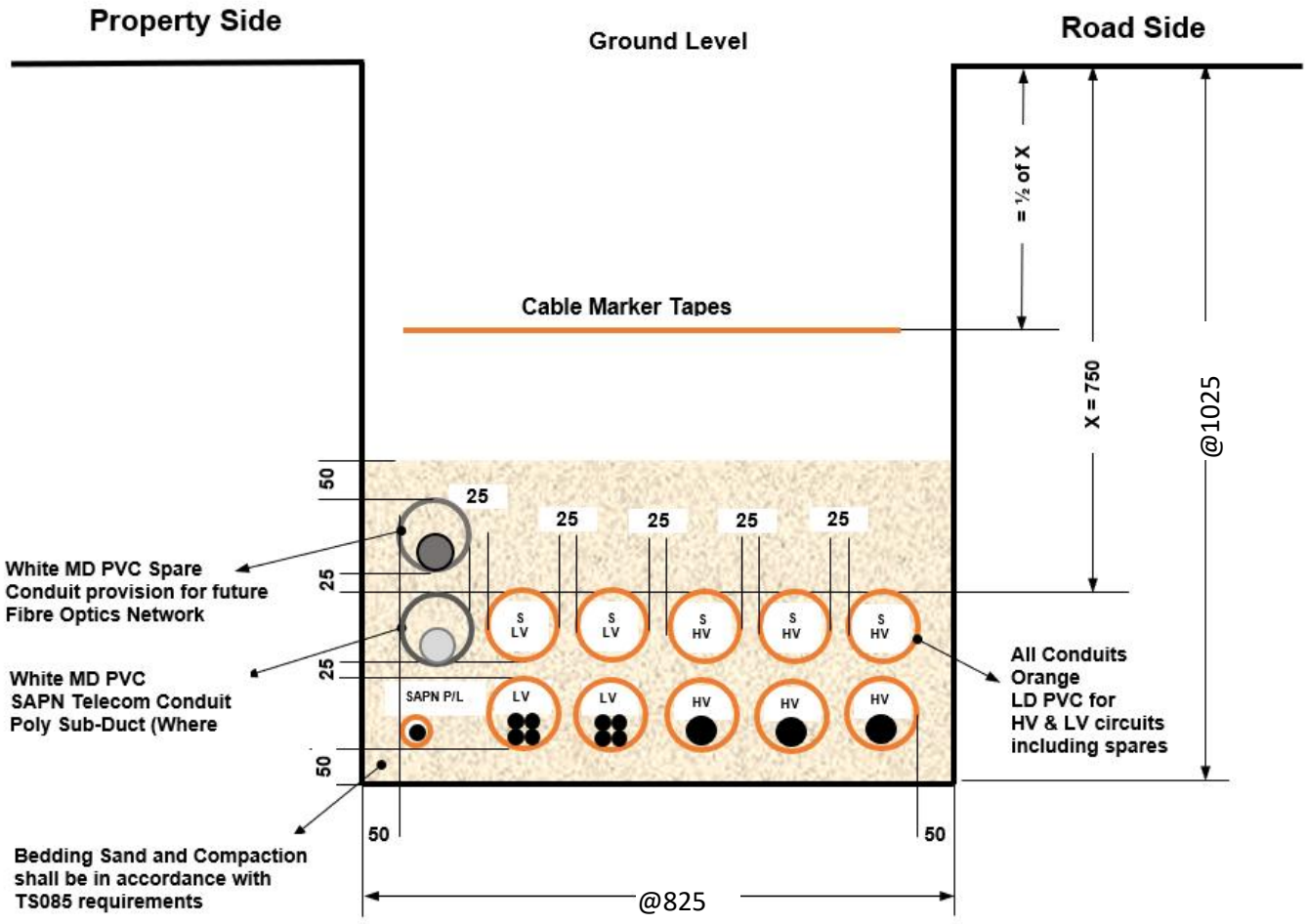


Figure 35: Cables in conduits (in footpath): Non-shared trench - Arrangement 1

Notes:

(1) Drawing 'Not to Scale'
(2) All dimensions are minimum and are in millimetres 'mm'.
(3) @ = Approximate dimension.

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E.3 Cables in conduits (in footpath): Non-shared trench - Arrangement 2

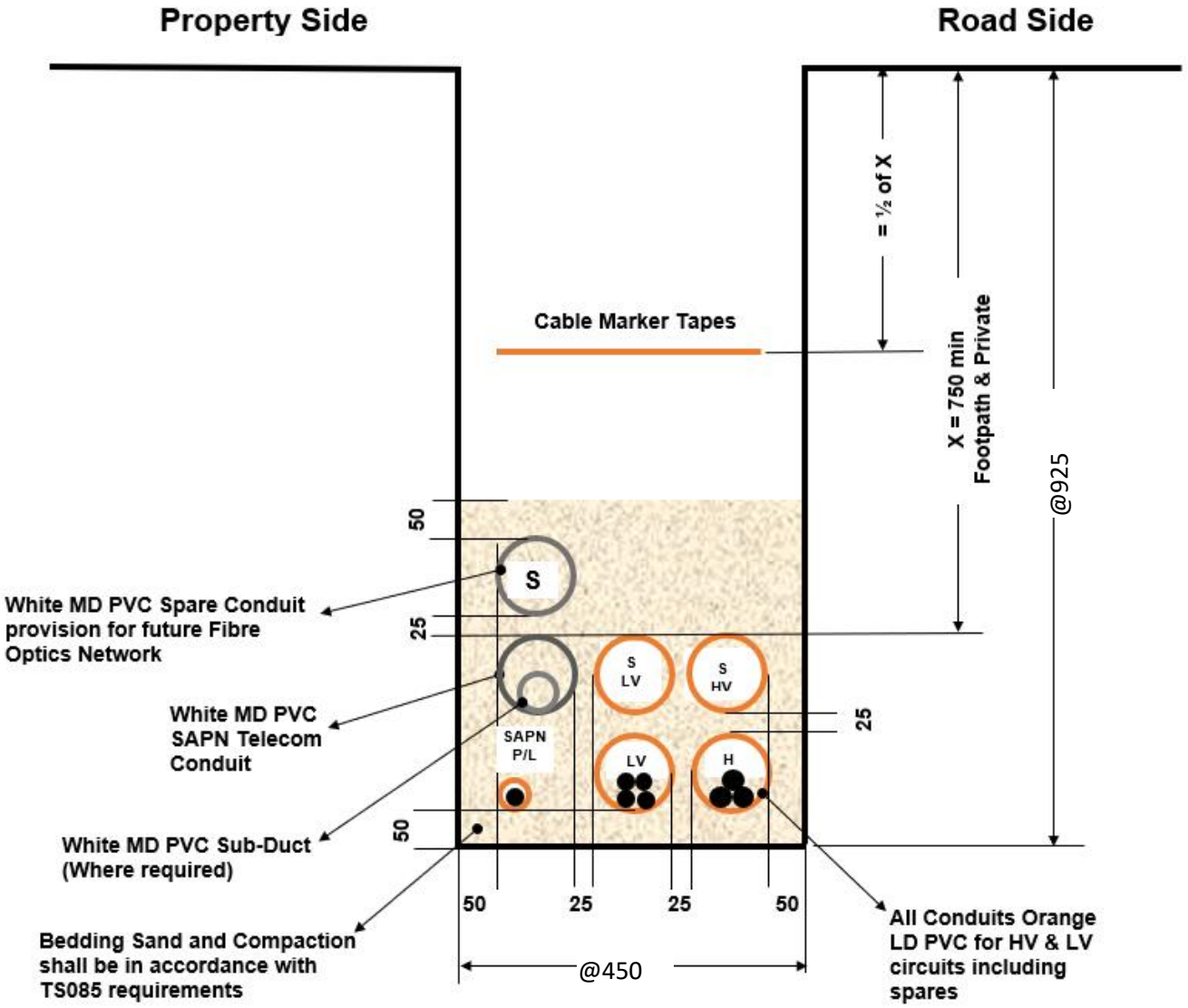


Figure 36: Cables in conduits (in footpath): Non-shared trench - Arrangement 2

Notes:

(1) Drawing 'Not to Scale'
(2) All dimensions are minimum and are in millimetres 'mm'.
(3) @ = Approximate dimension.

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E.4 Typical Telecommunications Trench - Non-shared trench

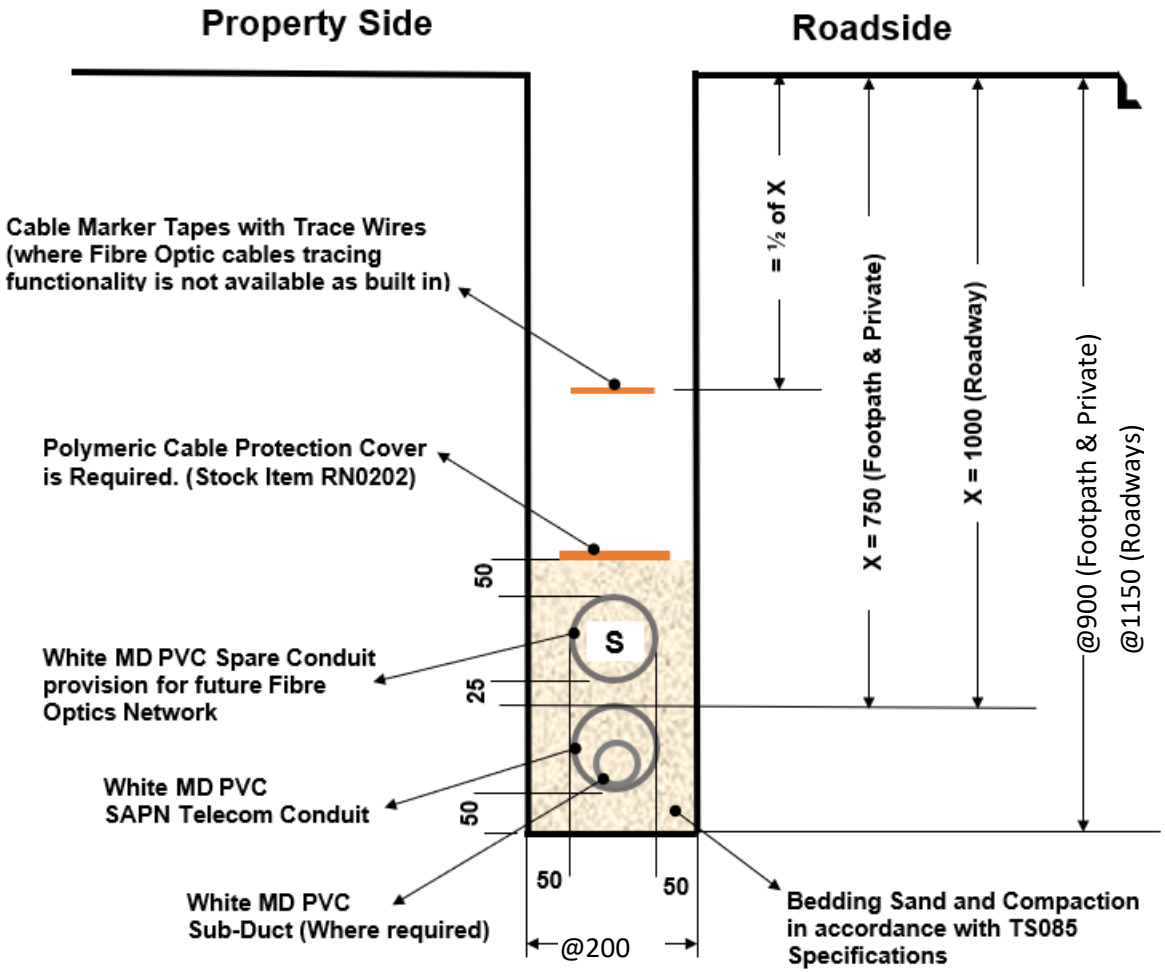


Figure 37: Typical telecommunication trench - Non-shared trench

Notes:

(1) Drawing 'Not to Scale'
(2) All dimensions are minimum and are in millimetres 'mm'.
(3) @ = Approximate dimension.

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E.5 Typical public lighting trench - Non-shared trench

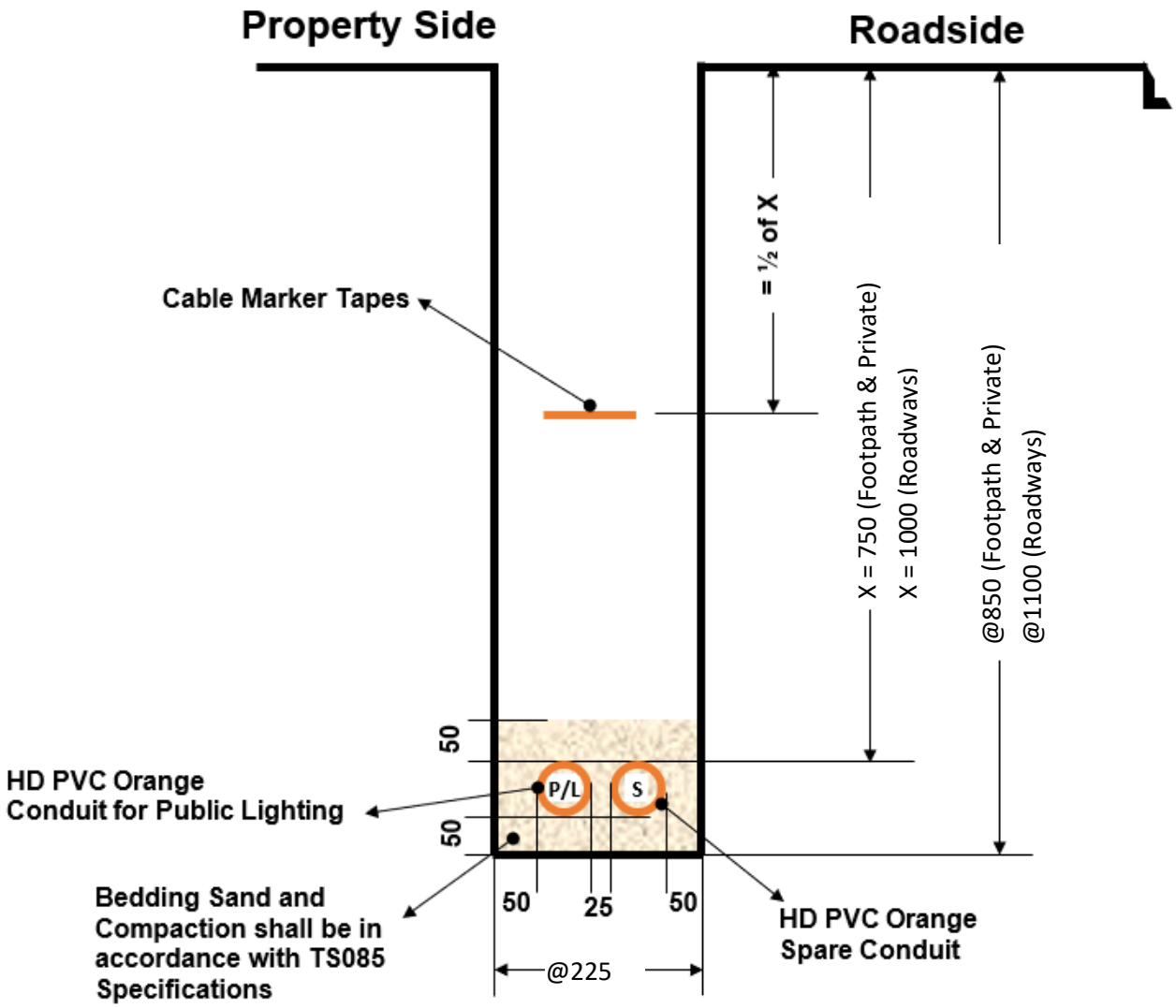


Figure 38: Typical public lighting trench - Non-shared trench

Notes:

(1) Drawing 'Not to Scale'
(2) All dimensions are minimum and are in millimetres 'mm'.
(3) @ = Approximate dimension.

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F. Typical Trenching in Private Property

F.1 Cables in conduits: (in private property) - Arrangement 1

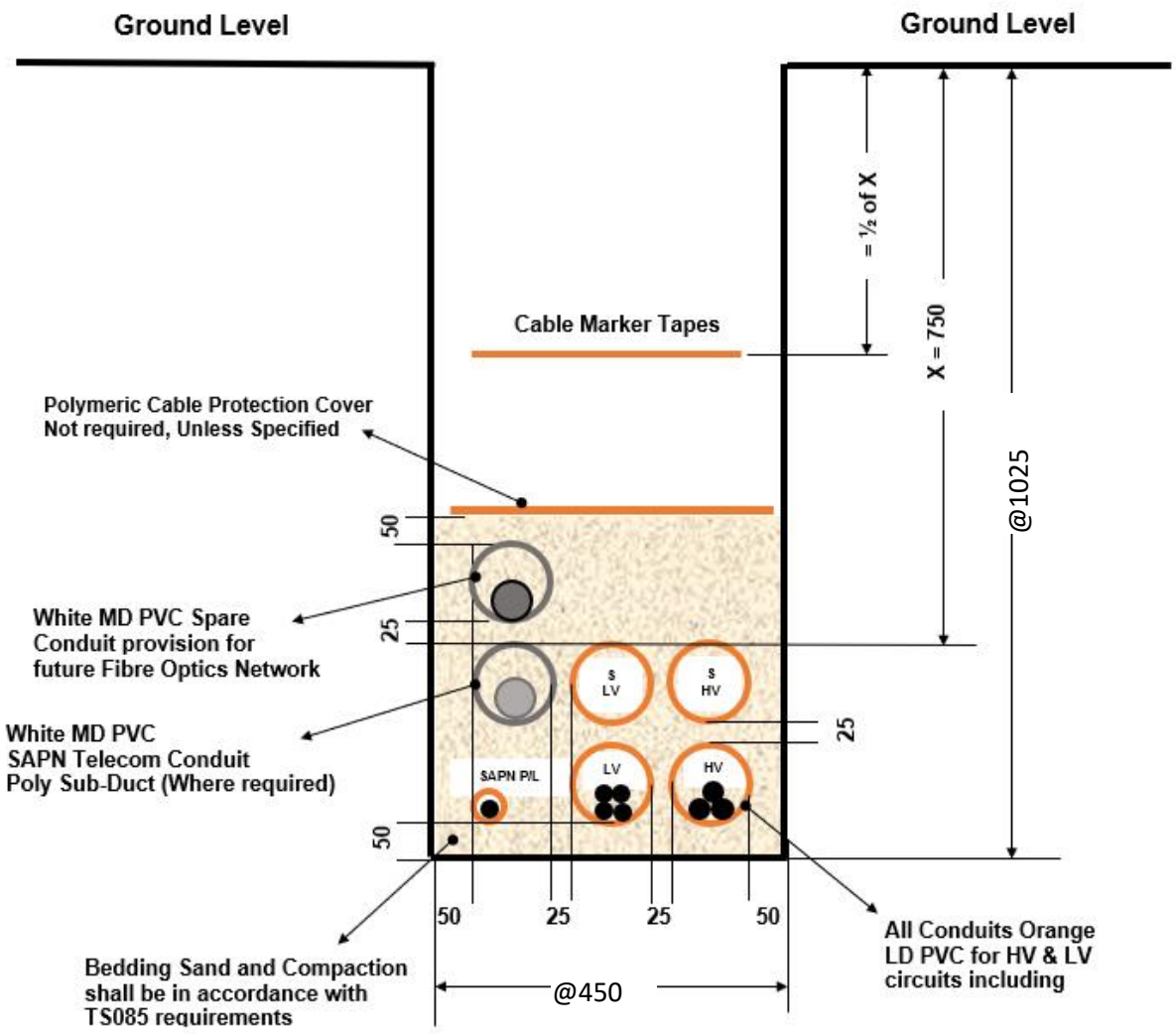


Figure 39: Cables in conduits: (in private property) - Arrangement 1

Notes:

(1) Drawing 'Not to Scale'
(2) All dimensions are minimum and are in millimetres 'mm'.
(3) @ = Approximate dimension.

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F.2 Cables in conduits: (in private property) - Arrangement 2

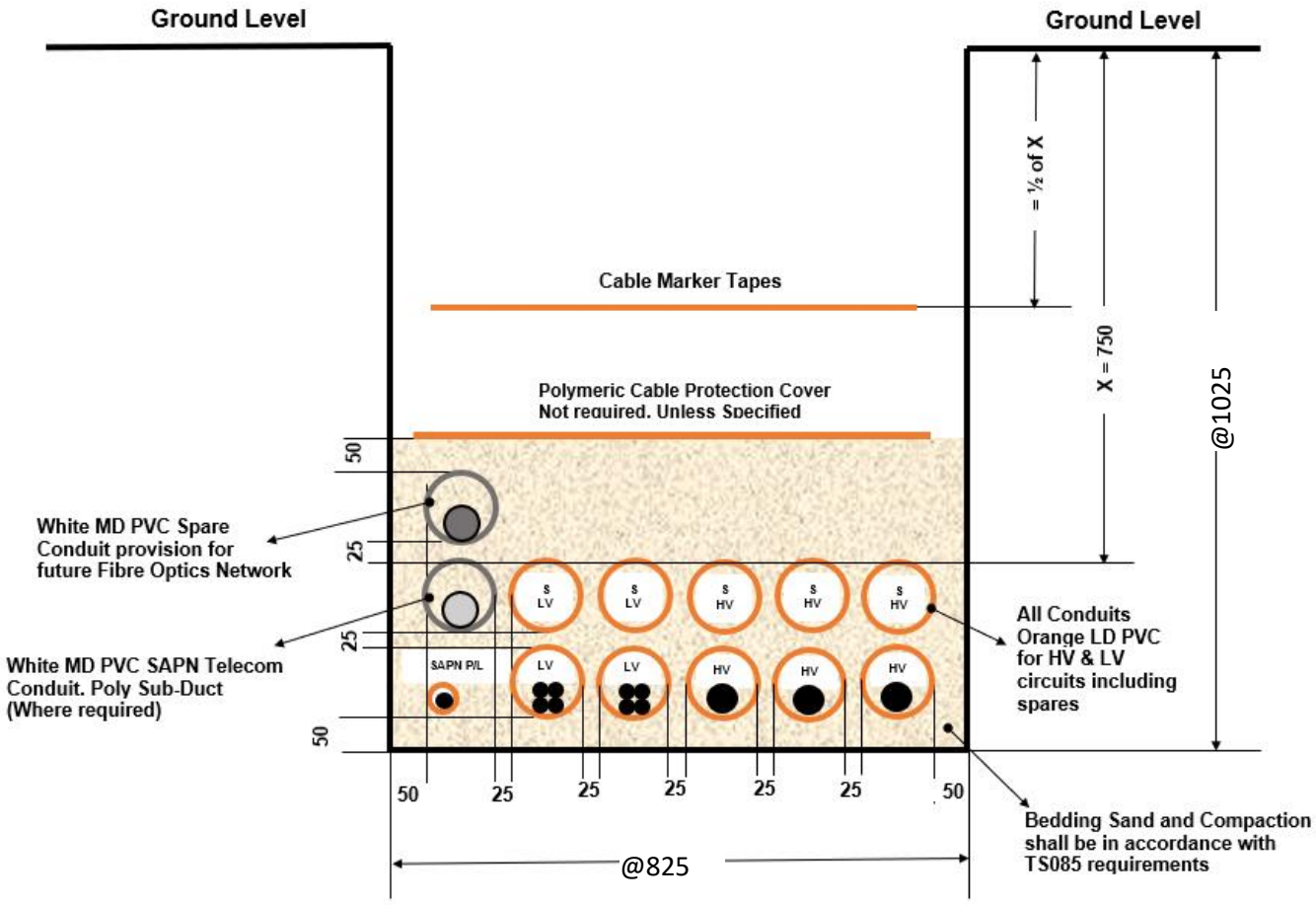


Figure 40: Cables in conduits: (in private property) - Arrangement 2

Notes:

(1) Drawing 'Not to Scale'
(2) All dimensions are minimum and are in millimetres 'mm'.
(3) @ = Approximate dimension.

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G. Typical DIT/Council Roads: Cables in Conduits

G.1 Cables in conduits: (in DIT/council roads) - Arrangement 1

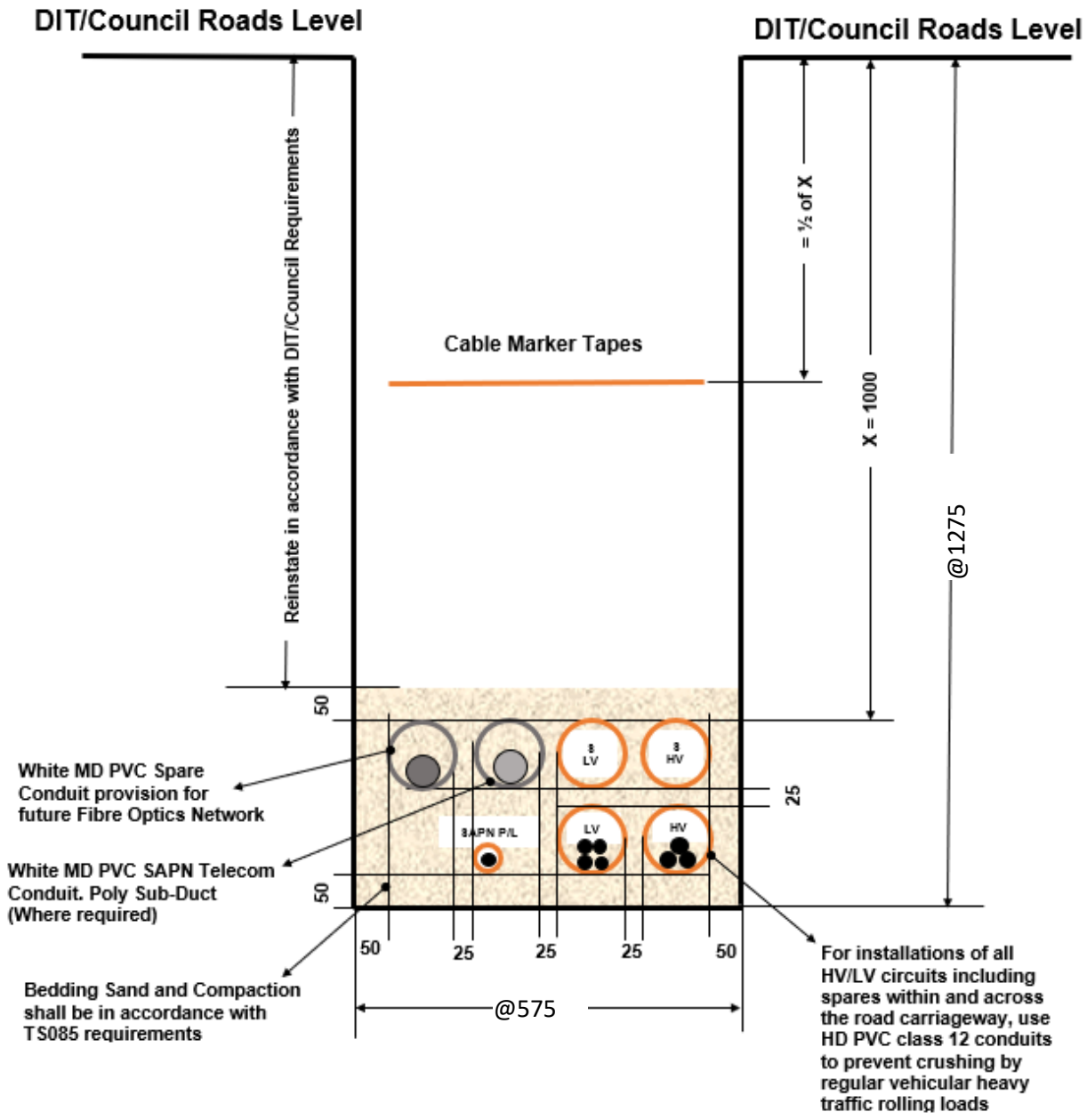


Figure 41: Cables in conduits: (in DIT/council roads) - Arrangement 1

Notes:

(1) Drawing 'Not to Scale'
(2) All dimensions are minimum and are in millimetres 'mm'.
(3) @ = Approximate dimension.

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G.2 Cables in conduits: (in DIT/council roads) - Arrangement 2

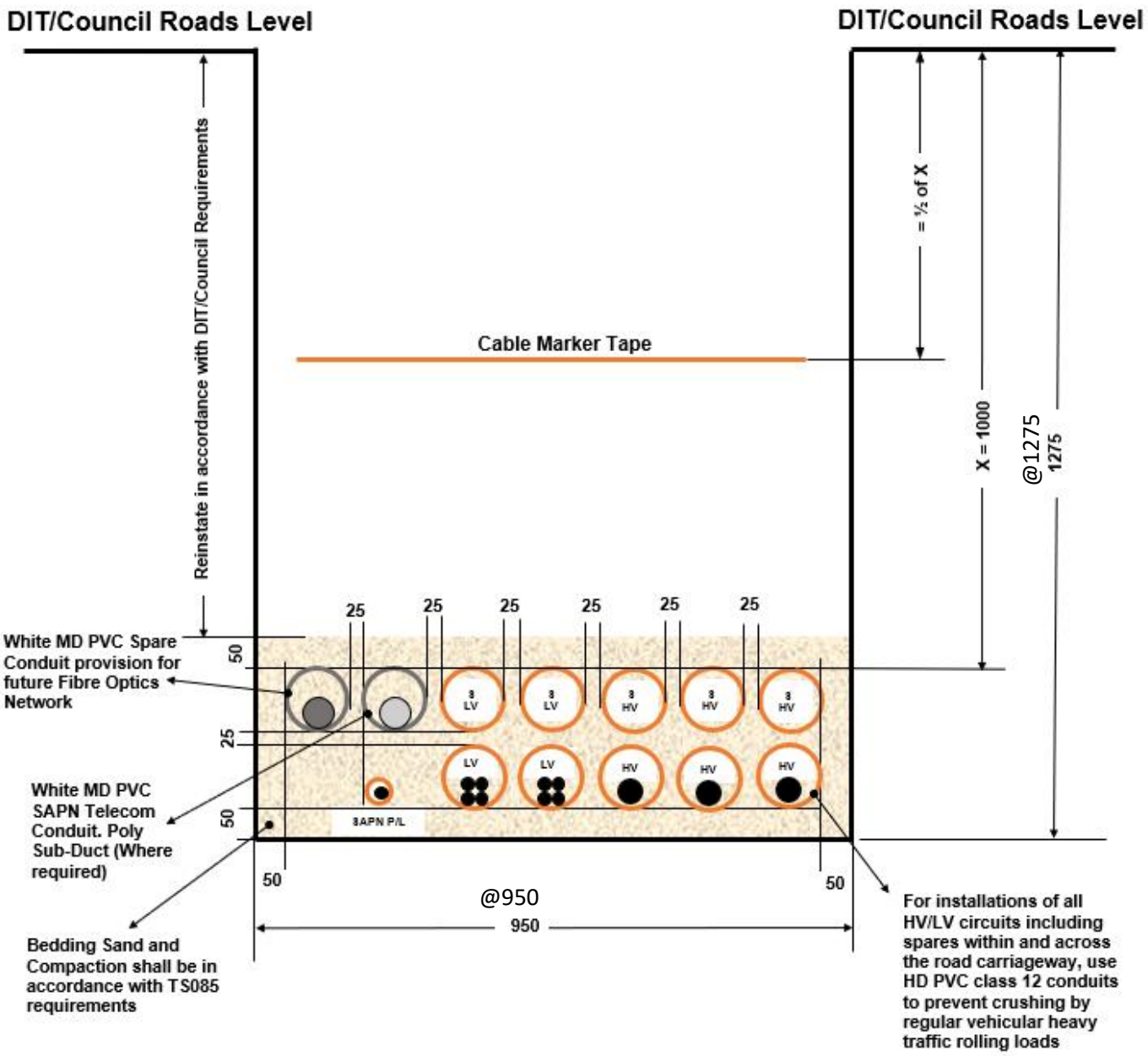


Figure 42: Cables in conduits: (in DIT/council roads) - Arrangement 2

Notes:

(1) Drawing 'Not to Scale'
(2) All dimensions are minimum and are in millimetres 'mm'.
(3) @ = Approximate dimension.

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H. Typical Underground Boring/Drilling Arrangement

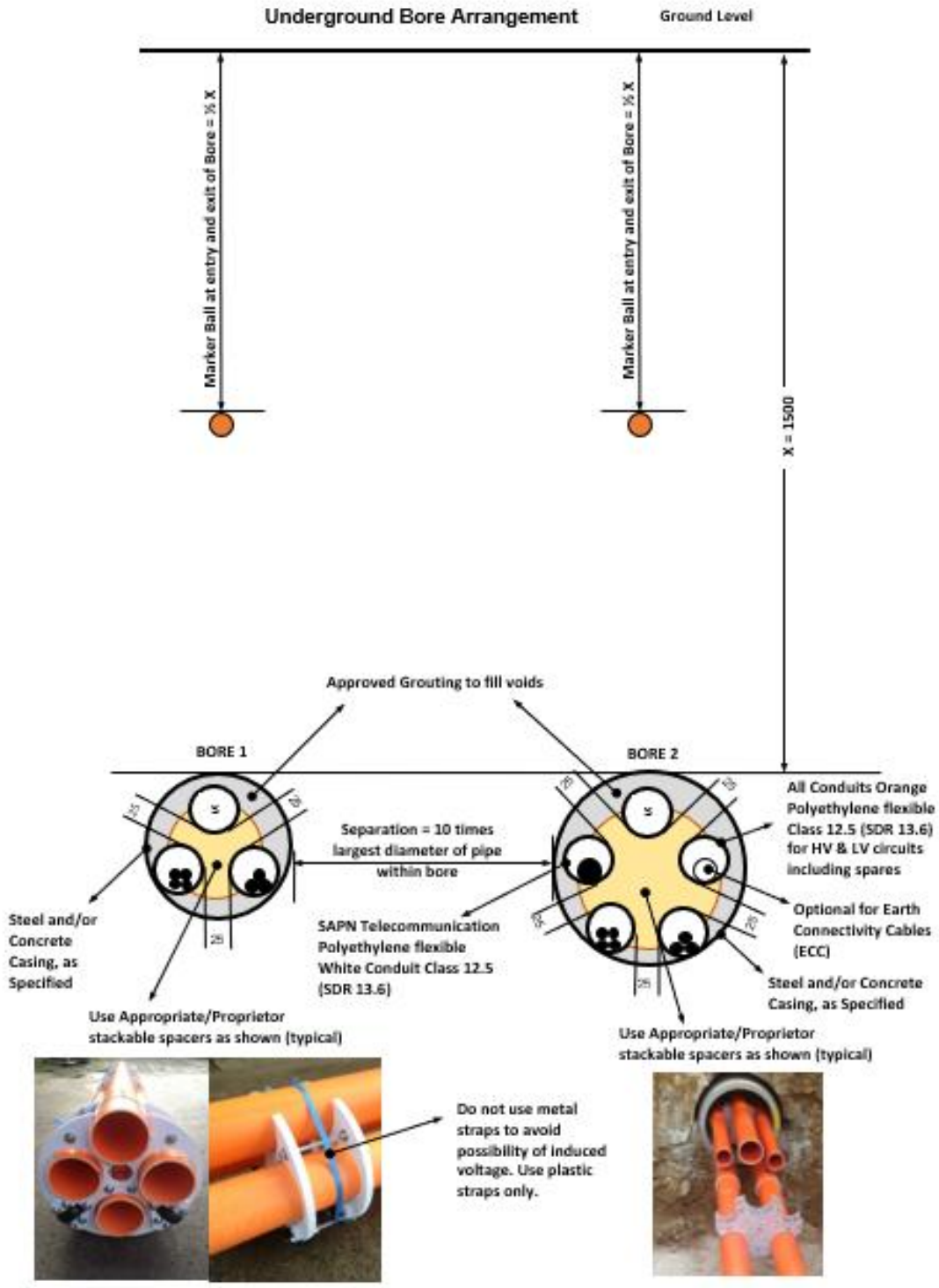


Figure 43: Typical underground boring/drilling arrangement

Notes:

(1) Drawing 'Not to Scale'.
(2) All dimensions are minimum and are in millimetres 'mm'.

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I. Typical road crossing conduits arrangement

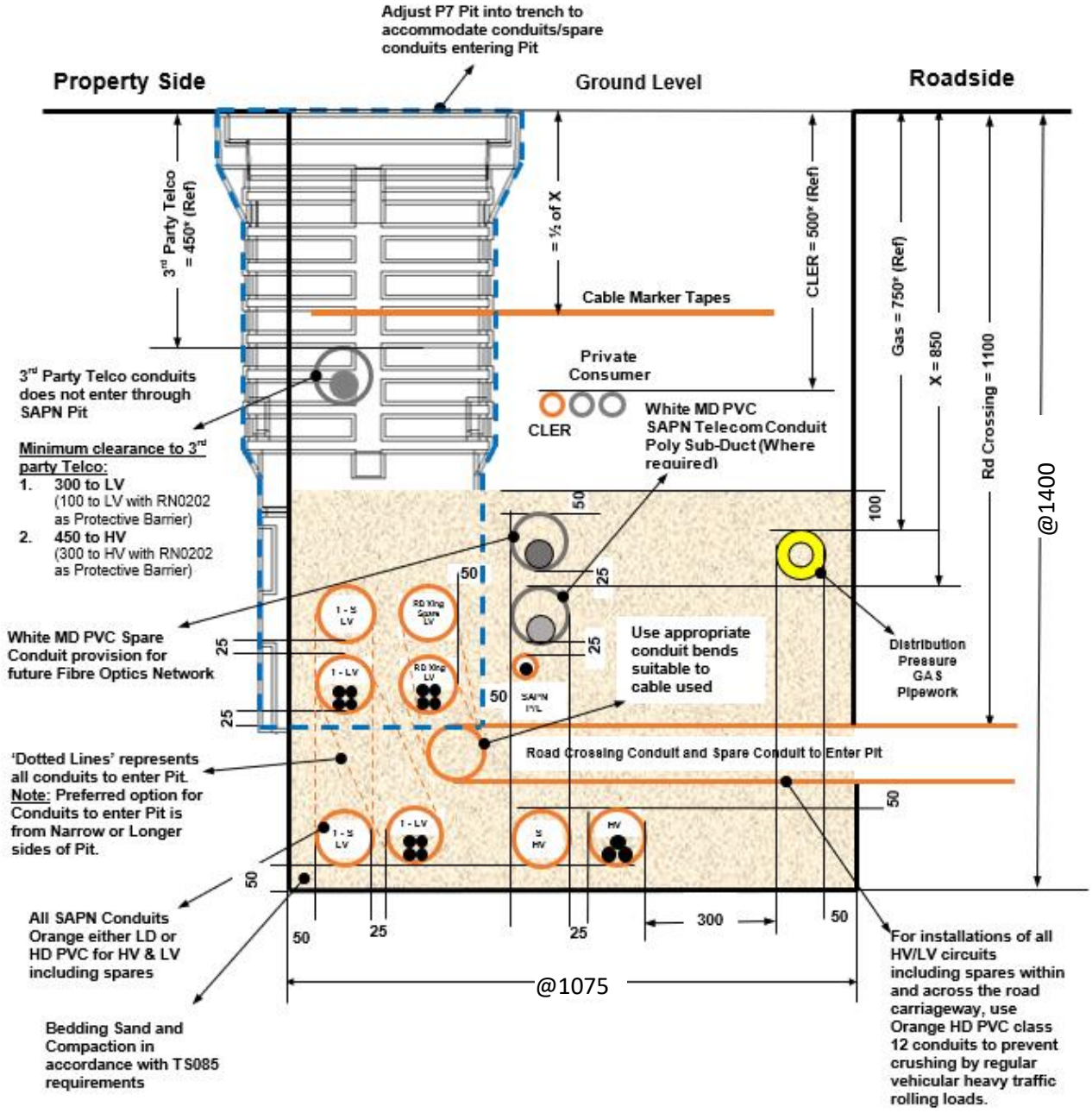


Figure 44: Typical road crossing conduits arrangement

Notes:

(1) Drawing 'Not to Scale'.
(2) All dimensions are minimum and are in millimetres 'mm'.
(3) @ = Approximate dimension.
(4) Ensure a 900 mm radius bend (stock item NC 5741) is installed from the road crossing to enter the pit within the footpath.
(5) Road crossing trench alignments shall be at 90 degrees to the kerb.

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J. Reduced cover trenching depth in the footpath

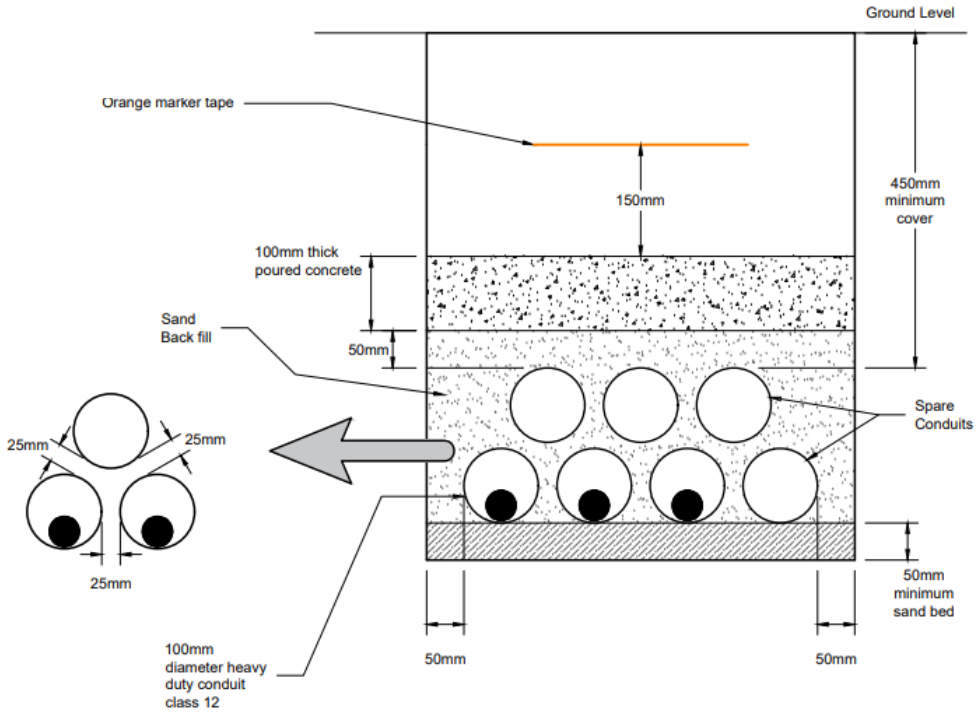


Figure 45: Reduced cover trenching depth in the footpath

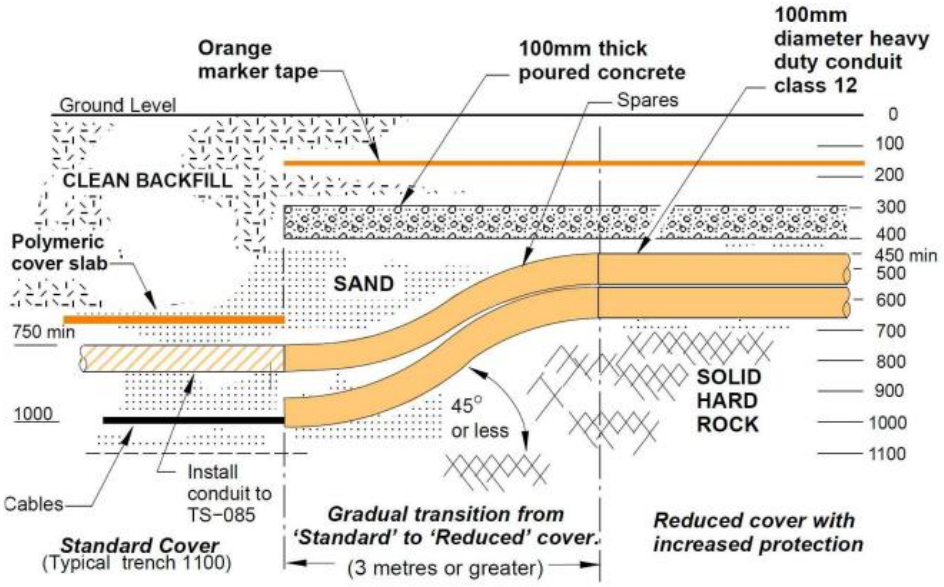


Figure 46: Gradual transition from 'Standard' to 'Reduced Cover'

Notes:

(1) Drawing 'Not to Scale'.
(2) All dimensions are minimum and are in millimetres 'mm'.
(3) Display standard warning sign (stock item KS 1140) on the site stating, Contact SA Power Networks before trenching in this reduced depth of cover area. Such information shall also be highlighted on the 'As Constructed' dwgs.
(4) The arrangement shown in this appendix is not suitable for installation in road carriage ways because it is not designed to withstand trafficable rolling loads.

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K. Waste soil management procedure: Summary

This Appendix is an extract from the SA Power Networks internal environmental document 'Waste Soil Management Procedure' (i.e. EMS Procedure 5.3), which is derived from the SA EPA standard for the production and use of waste-derived fill. Please contact the SA Power Networks Environment Branch on 08 8404 5888 to obtain a copy of these documents and/or for further assistance.

SA Power Networks undertakes a large range of activities that may generate soil that needs to be removed from an excavated location. The following key questions may provide a starting point for judging contaminated soil.

(1) Is the soil coming from a site associated with potentially polluting activities (PCA), for example, around transformers or substations?

(d) YES: If the material comes from a PCA site, it shall be tested for disposal suitability. If testing (refer to Notes) confirms that the material is either Waste Fill or Intermediate Waste Soil, it shall be transported in EPA-licensed vehicles, and each load shall require a transport certificate and be disposed at an EPA-approved facility for recycling or disposal.

(e) NO-refer to question 2.

(2) Is the volume of soil from a project site OVER 100 tons?

(f) YES - If the volume is greater than 100 tons, the material shall be tested and assessed (refer to Notes) by an EPA-approved consultant (e.g. Enviropacific Services, BlueSphere Environmental, McMahon Services or URS) prior to transportation to an EPA-approved recycling or disposal facility.

(g) NO-If the volume of soil is less than 100 tons and passes an olfactory and visual inspection, the material can be reused onsite or transported to any EPA-approved recycling or disposal facility. Refer to 'Standard for the production and use of Waste Derived Fill (WDF)' and 'Site Contamination' for EPA's compliance requirements.

Notes:

(3) If after testing, the material is classified as a low-level contaminated soil, it shall be disposed off at either TPI Inkerman, IWS in Dublin, or Southern Waste in Maslin Beach.

(4) The reuse at another site of any soil from a PCA site (even if the soil is assessed as Waste Fill) is not recommended until it is assessed by a suitably qualified auditor/consultant prior to transport for reuse. Soil that passes an olfactory and visual inspection may be reused at the site where the activity takes place without additional testing.

(5) The test results shall accompany any material transported.

(6) All soil removed from SA Power Networks or third-party sites shall meet the EPA's compliance standards.

(7) Organisational and individual penalties may apply for non-compliance under the EPA Act.

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L. Conduit Sizes: Straight lengths (PVC)

Table 10: Conduit sizes: Straight lengths (PVC)

Conduit nominal Size (mm) (See Note 3)	Conduit type (See Notes 4 & 5)	Cond req.	For use with the following cable size only	Conduit technical data			SAPN conduit stock item
				Inside diam. (mm)	Avg. wall thick (mm)	Stra. length (m)	
40 (Public Lighting and Customers) Service)	HD PVC (Orange)	1	Public Lighting and Customers' Mains to Service Pillars	33.6	3.2	4	EA 8046 (See Notes 1 & 2)
50 (Public Lighting and Customers) Service)	HD PVC (Orange)	1	LV Customers' Mains to Service Pillars	42.6	3.4	4	EA 8048
100 (Electrical)	LD PVC (Orange)	1	CK 5310, CK 5350, CK 6006, and CK 3185 (Bundled/Triplex & 3-Core Cables)	107.8	3.0	6	NC 2505
		1	CK 6005, CK 8090 (Shared conduit-3 cables installed in a single conduit)				
		3	CK 6005, CK 6025, CK 6019, CK 6060, CK 8070, CK 8240, CK 8090, CK 8092, CK 8095, and CK 8120 (Individual conduit-1 cable in single conduit)				
100 (Electrical)	HD CL12 HD PVC (Orange) Installation of HV/LV circuits, including spares within and across road carriageways and tree root areas	1	CK 5310, CK 5350, CK 6006, and CK 3185 (Bundled/Triplex & 3-Core Cables)	101.7	5.9	4	NC 4535
		1	CK 6005, CK 8090 (Shared conduit-3 cables installed in a single conduit)				
		3	CK 6005, CK 6025, CK 6019, CK 6060, CK 8070, CK 8240, CK 8090, CK 8092, CK 8095, CK 8120, (Individual conduit- one cable per single conduit)				
125 (Electrical)	LD PVC (Orange)	1	CK 3240 (Bundled/Triplex & 3-Core Cables)	132.2	3.7	6	NC 2509
		1	CK 6025, CK 8070, CK 8092, and CK 8120 (Shared conduit-3 cables installed in a single conduit)				
125 (Electrical)	HD PVC (Orange)	1	CK 3240 (Bundled/Triplex & 3-Core Cables)	124.9	7.2	4	EA 8051
		1	CK 6025, CK 8070, CK 8092, and CK 8120 (Shared conduit-3 cables installed in a single conduit)				
150 (Electrical)	LD PVC (Orange)	1	CK 6019, CK 6060, CK 8240, and CK 8095 (Shared conduit-3 cables installed in a single conduit)	151.3	4.2	6	NC 2518
100 (Telecom)	MD PVC (White)	1	Telecommunications Cables (Note 6)	104.6	4.9	6	NC 4527

Notes:

(1) 32 (OD) HD PVC (EA 8045), an orange conduit is required by AS/NZS 3000 as minimum for public lighting circuits and is required for connection to the service fuse box at the over/under pole.

(2) Where 40 (OD) (EA 8046) is used as the underground conduit, a plain reducer (e.g. Clipsal 264/4SM or similar) is used to connect 32 (OD) conduits. Refer to the E-dwg E1710 series for public lighting cabling arrangements.

(3) The table provides minimum conduit sizes for each cable; larger conduit sizes can be used.

(4) LD = Light Duty; MD = Medium Duty; and HD = heavy duty.

(5) Before using any non-listed items, they shall be specified with the project scope and shall require approval from a relevant SA Power Networks Project Manager.

(6) The construction of telecommunications underground conduits prohibits flexible corrugated conduits because it is difficult to install cables within these systems. Do not install corrugated (flexible) bends in rigid straight conduit systems.

(7) Following a risk assessment, if there is a possibility of tree roots interfering with the buried HV or LV cable system, all conduits in the affected path/area shall use HD PVC conduit (including spares)

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M. Conduit Bend Sizes

The following table provides conduit bends and their respective stock numbers.

Table 11: Conduit bend sizes (HD)

Conduit size (mm)	Conduit bend 'bending radius' (mm) (See Note 1)	Conduit bend 'bend angle' (degrees) (See Note 4)	Conduit bend bell end type (See Note 2)	SA Power Networks' stock items number conduit bend	Use with only the following cable (See Note 3)
40 HD PVC (Orange)	300	90	F-F	EA 8061	Public Lighting and LV Consumers' Main Cables
	600	90	F-F	EA 8101	
	300	90	F-F	EA 8111	
50 HD PVC (Orange)	300	90	F-F	Non-Stock	LV Customers' Mains to Service Pillars
	600	90	F-F	Non-Stock	
	1200	90	F-F	Non-Stock	
100 HD PVC (Orange)	600	22.5	M-F	NC 5713	CK 5310 only
		30	M-F	NC 5721	
		45	F-F	NC 5729	
		90	F-F	NC 5742	
	900	90	F-F	NC 5741	CK 5310, CK 5350, and CK 6005
	1200	22.5	M-F	NC 5770	CK 5310, CK 5350, CK 6005, CK 6006, CK 6025, CK 8070, CK 8090, CK 8092
		30	M-F	NC 5771	
		45	F-F	NC 5772	
		90	F-F	NC 5773	
	1830	15	M-F	NC 5774	CK 5310, CK 5350, CK 6005, CK 6006, CK 6025, CK 6019, CK 6060, CK 3185, CK 8070, CK 8240, CK 8090, CK 8092, CK 8095, CK 8120
		30	M-F	NC 5775	
		45	F-F	NC 5776	
		90	F-F	NC 5743	
100 HD PVC (White)	800	45	M-F	NC 5930	Telecommunication Cables See Note 5
		90	M-F	NC 5929	
125 HD PVC (Orange)	1830	15	M-F	NC 5777	CK 5310, CK 5350, CK 6005, CK 6006, CK 6025, CK 6019, CK 6060, CK 3185, CK 3240, CK 8070, CK 8240, CK 8090, CK 8092, CK 8095, CK 8120
		30	M-F	NC 5778	
		45	F-F	NC 5779	
		90	F-F	NC 5780	
150 HD PVC (Orange)	1830	30	F-F	NC 5783	CK 5310, CK 5350, CK 6005, CK 6006, CK 6025, CK 6019, CK 6060, CK 3185, CK 3240, CK 8070, CK 8240, CK 8090, CK 8092, CK 8095, CK 8120
		45	F-F	NC 5781	
		90	F-F	NC 5782	
		30	F-F	NC 5786	
		45	F-F	NC 5787	

Notes:

(1) The conduit-bending radius shall be greater than the minimum bending radius of the cable for cable installation. For the cable's minimum bending radius, refer to the manufacturer's cable data and/or the E 1900 and E 1910 E-dwgs series.

(2) 'M-F' = Male to Female and 'F-F' = Female to Female.

(3) The conduit diameter is for individual installation (i.e. bundled, triplex, 3-core cable, or single core per conduit). For the shared conduit (i.e. 3.0 cables per conduit).

(4) The conduit bending radius does not change when 2.0 or more bends are added together.

(5) The construction of telecommunications underground conduits prohibits flexible corrugated conduits because it is difficult to install cables within these systems. Do not install corrugated (flexible) bends in rigid straight conduit systems.

(6) All conduit bends shall be of "solid wall" design. "Foam core" design conduits shall not be used as they are prone to damage during cable hauling.

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N. PE Conduit to PVC Conduit: Couplings

Table 12: PE conduit to PVC conduit: couplings

PE conduit type	PVC conduit type	Couplings length (mm)	SA Power Networks' stock item number for couplings
PE 110, Orange	HD PVC 100, Orange	250	NC 8160
PE 125, Orange	HD PVC 100, Orange	300	NC 8161
PE 180, Orange	HD PVC 150, Orange	370	NC 8162
PE 110, White	HD PVC 100, White	250	NC 8164

Note: Before use of any non-listed items, they shall be specified with the project scope and require approval from the SA Power Networks Project Manager.

O. Conduit End Caps (Push On)

Table 13: Conduit end caps (push on)

Cap types	Minimum Cap length (mm)	SA Power Networks' stock item number
40 PVC, Orange	--	Non-Stock
50 PVC, Orange	--	NC 6462
100 PVC, White	91	NC 6501
125 PVC, White	--	NC 6502
100 PVC, Orange	35	NC 6503
150 PVC, Orange	35	NC 6504
150 PVC, Gray	38	NC 6505

Note: When required, non-stock items shall be specified with the project scope and will require approval from the relevant SA Power Networks' Project Manager.

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P. PE Coils and HDPE Conduits for Trenchless Boring/Drilling

Table 14: PE coils and HDPE conduits for trenchless boring/drilling

Conduit nominal size (mm) (See Note 4)	Cond. Type (See Notes 1 & 4)	Cond. reqd.	For use with the following cable sizes only	Maxi. Pull force (kN)	Conduit technical data (Comply with AS/NZS 4130) (See Notes 2, 3, 4)						SAPN stock item nos.
					Wall thickness (mm)		Inside diam. (mm)		Mean outer diam. (mm)	Coil length (m)	
					Min	Max	Min	Max			
Polyethylene conduits HDPE - Coils											
110	PE 110 Coils SDR 13.6 PN 12.5 Orange	1	CK 9250 (ECC, 240 mm^2) CK 9251 (Bonding cable, 240 mm^2)	22.0	6.6	7.4	95.2	97.8	110.5	100	NC 5800
		1	CK 5310, CK 5350, CK 6006, and CK 3185 (Bundled/Triplex & 3-Core Cables)								
		1	CK 6005, CK 8090 (Shared conduit) 3 cables installed in a single conduit)								
		3	CK 6005, CK 6025, CK 6019, CK 6060, CK 8070, CK 8240, CK 8090, CK 8092, CK 8095, and CK 8120 (Independent conduit) 1 cable in a single conduit								
125	PE 125 Coils SDR 13.6 PN 12.5 Orange	1	CK 9250 (ECC, 240 mm^2) CK 9251 (Bonding cable, 240 mm^2)	28.2	7.4	8.3	108.4	111.4	125.6	100	NC 5801
		1	CK 3240 (Bundled/Triplex & 3-Core Cables)								
		1	CK 6025, CK 8070, CK 8092, and CK 8120 (Shared conduit) 3 cables installed in a single conduit)								
110 (Telecom)	PE 110 Coils SDR = 13.0 PN 12.5 White	1	Optical Fibre Telco Cables	22.0	6.6	7.4	95.2	97.8	110.5	100	NC 5802
Polyethylene conduits HDPE - Straight lengths											
180	HDPE SDR 17 Orange	3	CK 9280 (300 mm^2) (Individual conduit-1 cable in single conduit)	58.5	10.7	11.9	156.2	160.3	180.9	12	NC 5810

Notes:

(1) SDR = standard-dimensional ratio, PE = Polyethylene, HDPE = high-density polyethylene

(2) Install a polypropylene draw rope compliant with AS 4142.1 through each conduit for cable pulling (except for spare conduits). Under no circumstances shall a draw rope be loaded more than its 'Safe Working Load' (SWL). The minimum breaking load cannot always be considered the SWL. The draw rope may be capable of pulling a hauling rope for a specified cable size through the specified cable length.

(3) All conduits installed shall be clean and free from debris or internal rough edges which may cause damage to the cable's outer sheath during cable installation. Similarly, all PE conduit joints shall be internally 'de-beaded' to prevent damage to the outer serving of the cable.

(4) Before use of any non-listed item, it shall be specified with the project scope and shall require approval from the SA Power Networks Project Manager.

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Q. Conduit Bends for Trenchless Boring/Drilling

Table 15: Conduit bends for trenchless boring/drilling - Guide only

Conduit Nominal size (mm)	Conduit bending radius	SA Power Networks' conduit bends (stock item)
PE 110 Coils SDR 13.6, PN 12.5, Orange (NC 5800)	Minimum Conduit Bending Radius shall be greater than the minimum Bending Radius of the Cable (See Note 1)	Non-Stock Item (See Notes 2 & 3)
PE 125 Coils SDR 13.6, PN 12.5, Orange (NC 5801)		
PE 110 Coils SDR = 13.6, PN = 12.5, White (NC 5802)		

Notes:

(1) The conduit-bending radius shall be greater than the minimum bending radius of the cable and shall match the conduit size for cable installation. For the cable's minimum bending radius, refer to the manufacturer's cable data and/or the E 1900 and E 1910 E-dwgs series.

(2) SA Power Networks do not stock conduit bends of larger sizes.

(3) When required, non-stock items shall be specified with the project scope and shall require approval from the SA Power Networks Project Manager.

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R. Spare Conduits

R.1 Direct Buried Cables

Where cables are direct buried, the minimum number of spare conduits shall be as per Table 16.

Table 16: Spare conduits for directly buried cables

Types of direct buried cables	Spare Conduits				
	HV	LV	Spare SCADA/Comms/Third Party Communications		
			LV supply to the SCADA Comms (Orange)	SCADA/ Comms (White)	Third-Party Comms Fibre/Optics (White) (Note 4)
Small individual cable circuits					
1 LV cable e.g. 4 x 240 mm² LV AL XLPE/HDPE UBC or 4 x 150 mm² LV AL XLPE/HDPE UBCs	-	1 (Note 5)	-	-	1
2 LV cables e.g. 2 Ckts of 4 x 240 mm2 LV AL XLPE/HDPE UBC or 2 Ckts of 4 x 150 mm² LV AL XLPE/HDPE UBC	-	2 (Note 3)	--	-	1
1 LV Parallel cables e.g. 1 Ckt of 2 x (4 x 240 mm² LV AL XLPE/HDPE UBC) Or 1 Ckt of 2 x (4 x 150 mm² LV AL XLPE/HDPE UBC)	-	2 (Note 3)	-	-	1
1 HV cable e.g. 95 mm² 3x1c (bundled) or 185 mm2 3c or 240 mm² 3c + SCADA/Comms	1 (Note 1)	-	1 (Note 2)	1	1
Larger individual cable circuits					
1 HV (Large) cable e.g. 1 Ckt of 300 mm2 3 x 1c or 1 Ckt of 630 mm² 3x1c + SCADA/Comms	3 (Note 1)	-	1 (Note 2)	1	1
2 HV (Large) cable e.g. 2 Ckts of 300 mm² 3 x 1c or 2 Ckts of 630 mm² 3 x 1c + SCADA/Comms	6 (Note 1)	-	1 (Note 2)	1	1
3 HV (Large) cable e.g. 3 Ckts of 300 mm² 3 x 1c or 3 Ckts of 630 mm² 3x1c + SCADA/Comms	6 (Note 1)	-	1 (Note 2)	1	1
More than 3 HV (Large) cable e.g. 4 Ckts of 300 mm² 3 x 1c or 4 Ckts of 630 mm² 3x1c + SCADA/Comms	6 (Note 1)	-	1 (Note 2)	1	1
Mixed cable circuits: Examples					
4 Mixed HV Circuits e.g. 1 Ckt of 95 mm² 3x1c (bundled) + 3 Ckts of 300 mm² 3 x 1c + SCADA/Comms	6 (Note 1)	-	1 (Note 2)	1	1
4 Mixed HV and 2 LV Mixed Circuits e.g. 1 Ckt of 95 mm² 3 x 1c (bundled) + 3 Ckts of 300 mm² 3 x 1c + 1 LV parallel Ckt 1, Ckt 2 x (4 x 240 mm² LV AL XLPE/HDPE UBC) or 1 Ckt 2 x (4 x 150 mm² LV AL XLPE/HDPE UBC) + 1 LV Ckt (4 x 240 mm² LV AL XLPE/HDPE UBC or 4 x 150 mm² LV AL XLPE/HDPE UBC) + SCADA/Comms	6 (Note 1)	3 (Note 3)	1 (Notes 2)	1	1

Notes:

(1) Install minimum 1-off spare conduit per HV circuit and follow that HV cable circuit route. When 3 or more HV large cable circuits (e.g. 300 mm² 3 x 1c or 630 mm² 3 x 1c) exist, the total number of spares required is reduced to a maximum of 6, however, the designer, in consultation with the SA Power Networks Project Manager, may specify the need for 'additional conduits' if there is a logical need (e.g. high road traffic or congested utilities within the ground location) where future earthworks may be avoided.

(2) An orange conduit for providing LV supply to the SCADA system and a white conduit to accommodate the SCADA/Telecommunication cable are required, unless specified otherwise.

(3) Where 1 LV parallel cable is installed as buried direct, then provide 2 spare conduits follow that LV parallel cable route. However, for each individual LV circuit, provide 1 spare conduit shall be provided, and the circuit shall follow their individual cable route.

(4) 1-off white MD PVC conduit is required for accommodating future Fibre Optics network.

(5) For 1 directly buried public lighting circuit, 1 available LV spare conduit is permitted for use. Where 1 LV spare conduit is not available, then 1 spare conduit for 1 directly buried public lighting circuit is required.

(6) As per Section 7.8.3, padmount transformers or RMU/switching cubicles in CBD areas shall be provided with a 1-off white MD PVC conduit for accommodating hardwired SCADA functionality when required.

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R.2 Fully Conduited System

Where cables are fully conduited, the minimum number of spare conduits shall be as per Table 17.

Table 17: Spare conduits for fully conduitted system

Types of cables installed in conduits	Conduits required		Spare Conduits				
					Spare SCADA/Comms/Third Party Communications		
	HV	LV	HV	LV	LV supply to the SCADA/ Comms (Orange)	SCADA/ Comms (White)	Third-Party Comms Fibre/Optics (White) (Note 4)
Small individual cable circuits							
1 LV cable e.g. 4 x 240 mm² LV AL XLPE/HDPE UBC or 4 x 150 mm² LV AL XLPE/HDPE UBCs	-	1	-	1 (Note 5)	-	-	1
2 LV cables e.g. 2 Ckts 4 x 240 mm² LV AL XLPE/HDPE UBC or 2 Ckts 4 x 150 mm² LV AL XLPE/HDPE UBCs	-	2	-	2	-	-	1
1 LV parallel cables e.g. 1 Ckt 2 x (4 x 240 mm² LV AL XLPE/HDPE UBC) Or 1 Ckt 2 x (4 x 150 mm² LV AL XLPE/HDPE UBC)	-	2	-	2 (Note 3)	-	-	1
1 HV cable e.g. 95 mm² 3 x 1c (bundled) or 185 mm² 3c or 240 mm² 3c + SCADA/Comms	1	-	1 (Note 1)	-	1 (Note 2)	1	1
Larger individual cable circuits							
1 HV (Large) cable e.g. 1 Ckt of 300 mm² 3 x 1c or 1 Ckt of 630 mm² 3x1c + SCADA/Comms	3	-	3 (Note 1)	-	1 (Note 2)	1	1
2 HV (Large) cable e.g. 2 Ckts of 300 mm² 3 x 1c or 2 Ckts of 630 mm² 3 x 1c + SCADA/Comms	6	-	6 (Note 1)	-	1 (Note 2)	1	1
3 HV (Large) cable e.g. 3 Ckts of 300 mm² 3 x 1c or 3 Ckts of 630 mm² 3x1c + SCADA/Comms	9	-	6 (Note 1)	-	1 (Note 2)	1	1
More than 3 HV (Large) cable e.g. 4 Ckts of 300 mm² 3 x 1c or 4 Ckts of 630 mm² 3 x 1c + SCADA/Comms	12	-	6 (Note 1)	-	1 (Note 2)	1	1
Mixed cable circuits: Examples							
4 Mixed HV Circuits e.g. 1 Ckt of 95 mm² 3 x 1c (bundled) + 3 Ckts of 3 x 300 mm² 3x1c + SCADA/Comms	10	-	6 (Note 1)	-	1 (Note 2)	1	1
4 Mixed HV & LV Mixed Circuits e.g 1 Ckt of 95 mm² 3 x 1c (bundled) + 3 Ckts of 300 mm² 3 x 1c + 1 LV parallel Ckt 1 Ckt 2 x (4 x 240 mm² LV AL XLPE/HDPE UBC) or 1 Ckt 2 x (4 x 150 mm² LV AL XLPE/HDPE UBC) + 1 LV Ckt (4 x 240 mm² LV AL XLPE/HDPE UBC or 4 x 150 mm² LV AL XLPE/HDPE UBC) + SCADA/Telecommunication	10	3	6 (Note 1)	3 (Note 3)	1 (Note 2)	1	1

Notes:

(1) Install minimum 1-off spare conduit per HV circuit and follow that HV cable circuit route. When 3 or more HV large cable circuits (e.g 300 mm² 3x1c or 630 mm² 3x1c) exist, the total number of spares required is reduced to a maximum of 6, however, the designer, in consultation with the SA Power Networks Project Manager, may specify the need for 'additional conduits' if there is a logical need (i.e. high road traffic or congested utilities within the ground location) where future earthworks may be avoided.

(2) An orange conduit for providing LV supply to the SCADA system and a white conduit to accommodate the SCADA/ Telecommunication cable are required, unless specified otherwise.

(3) Where 1-off LV parallel cable is installed in 2 separate conduits, provide 2 spare conduits follow the LV parallel cable route. However, for each individual LV circuit, provide 1 spare conduit shall be provided, and the circuit shall follow their individual cable route.

(4) 1-off white MD PVC conduit is required for accommodating future Fibre Optics network.

(5) For 1 public lighting circuit installed in a conduit, 1 available LV spare conduit is permitted to be used. Where 1 LV spare conduit is not available, then 1 spare conduit for 1 public lighting circuit is required.

(6) As per Section 7.8.3, padmount transformers or RMU/switching cubicles in CBD areas shall be provided with a 1-off white MD PVC conduit for accommodating hardwired SCADA functionality when required.

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S. Parallel Trench Separation

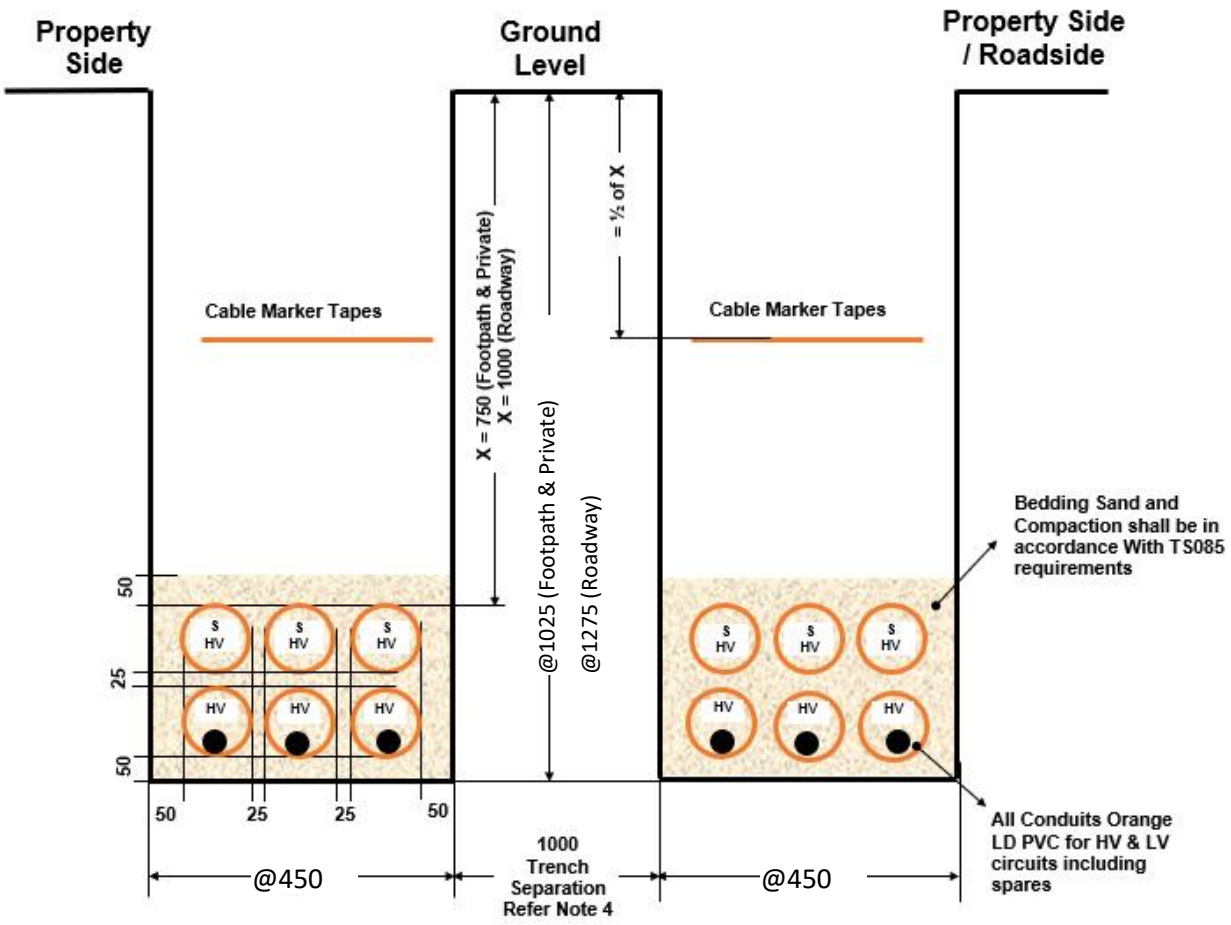


Figure 47: Parallel trench separation

Notes:

(1) Drawing 'Not to Scale'.
(2) All dimensions are minimum and are in millimetres 'mm'.
(3) @ = Approximate dimension.
(4) The minimum trench separation between parallel trench shall be largest diameter of conduit in either trench x 10 times) i.e. 100 mm largest conduit diameter x 10 times = 1000 mm.

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