

# Company Guideline: Major Network Connections Investment Scope Options and Costing Guideline

## CEOM7817

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## 1.0 PURPOSE

To provide high level connection options, general arrangements and non-contestable cost estimates for a HV embedded generator connection enquiry greater than 30kW into the Essential Energy (EE) network.

During the connection enquiry stage of a new HV embedded generator, potential connection applicant's require high level connection options for various sized generators. This includes but is not limited to different connection options at various voltages and typical non-contestable project costs.

Major Connections (both Chapter 5 and 5A connections under the National Electricity Rules) follow a detailed process from application, assessment, construction, commissioning and close out.

These works are subject to assessment during the early stages of the application process to determine which elements of the works are Contestable or Non-contestable.

All Contestable works are the ownership of the Connection Applicant. Works mentioned in this document refers to Non-contestable works delivered by Essential Energy.

### 1.1 Audience

This policy is intended for all Workers of the Company, including but not limited to executives, managers, staff, contractors, and third-party resources. It may also be used as reference for all Connection Applicants and related Parties.

## 2.0 ACTIONS

The following sections must be reviewed to ensure that all Parties achieve a thorough understanding of the typical Major Network Connection scope elements and the potential cost implications they present.

Additionally, it is expected that the Connection Applicant understands the Class of estimates provided in this document in relation to the level of maturity and accuracy range. The cost estimation approach, classifications and terminology applied in this document align with Essential Energy's Cost Estimation Principles & Methodology – External Reference (ND Doc 504).

### 2.1 Preliminary Costings

The supply and construction of any embedded generation substation or switching station, including all associated works, shall be fully funded by the Connection Applicant.

The project cost estimates provided in this document are for the HV connection of typical large-scale embedded generators and loads. Due to the scale and complexity of these projects, a range of unknown factors may influence the final cost, resulting in large variations from these indicative figures presented.

All cost ranges in this guideline are Class 5 (order-of-magnitude) estimates as defined by the Association for the Advancement of Cost Engineering (AACE), with expected accuracy ranges of approximately – 20% to – 50% on the low side and +30% to +100% on the high side.

The establishment of land tenure, land deeds and/or easements can be time-consuming and, in some cases, may not be feasible. Early investigation of land ownership, access and easement requirements is therefore strongly recommended as part of the initial connection enquiry.

Historically, high speed telecommunication and protection/SCADA requirements have significant cost implications which cannot be determined at the enquiry stage of the connection. These cost implications



will not be clear until further analysis and completion of detailed studies and preliminary design for each individual connection.

Consideration should be given to the existing generation or any facilities under development that may severely limit the available generation capacity in that region of the National Electricity Market (NEM).

This guideline is provided for information purposes only. A detailed and binding list of requirements, including the delineation of constable and non-contestable works, will be defined as part of the connection process, including a scope defined as contestable works. All costs associated with the engagement of an Accredited Service Provider (ASP) are the responsibility of the Connection Applicant.

## 2.2 Typical Voltage Level for Connections

Indicative generator capacity ranges for each network connection voltage are provided in Table 1 below. These values are intended as a general guide only to support early-stage connection enquiries.

Actual connection capacity will depend on the network conditions including system strength, fault level, and the outcome of detailed technical assessment undertaken through the formal connection process.

Connection Applicants should note that proposals exceeding typical capacity ranges may require significant network augmentation, resulting in increased cost and complexity.

This table applies to embedded generation connections only. Load connections are assessed separately in accordance with applicable planning and connection standards.

Table 1: Typical connection voltages aligned to indicative generation capacity

| Network Connection Voltage | Indicative Generator Capacity<br>(Typical) |
|----------------------------|--------------------------------------------|
| 11/22kV                    | 5MW                                        |
| 33kV                       | 20MW                                       |
| 66kV                       | 40MW                                       |
| 132kV                      | 100MW                                      |

The capacities presented are indicative only and do not represent firm or maximum network limits. Actual connection capacity is subject to network conditions, including system strength and fault level, and will be determined through detailed assessment in accordance with the formal connection process and applicable standards, including CEOP8003 - Subtransmission and Distribution Network Planning Criteria and Requirements.

## 2.3 Project Costs Considerations

### 2.3.1 Potential Cost Implications

The following factors can have connection cost implications that differ from the typical high-level figures provided in a typical connection arrangement. These considerations should be assessed as part of the connection enquiry and may require further investigation during subsequent stages of the connection process.



### 2.3.1.1 Land & Routes

Connection costs may be influenced by land and tenure and routing considerations, including:

- Requirements for land, easements, or assets to be gifted to Essential Energy
- The extent of civil works, bulk earthworks, and site preparation required
- Access road construction or upgrades
- Native Title claims, Crown Land, or other land-use constraints affecting conveyancing
- Existing easements and third-party land rights
- Whether existing infrastructure is located within road reserves or Council-controlled land
- Customer and community consultation requirements along new or modified routes
- Legislative protections applicable under the *Electricity Supply Act*.

### 2.3.1.2 Environmental

Environmental conditions and approval requirements may affect scope, timing, and cost, including:

- Requirements for a Review of Environmental Factors (REF) and/or Environmental Impact Assessment (EIA), including flora and fauna studies
- Availability and adequacy of site survey information
- Geotechnical conditions and reporting requirements
- Flood risk and hydrological assessment requirements
- Acoustic impact assessments
- Vegetation density along proposed routes or adjacent properties

### 2.3.1.3 Network Earthing

Connection costs may be affected by earthing requirements, including:

- Availability or need for a Network Earthing report
- Compliance with Essential Energy earthing standards and testing requirements
- Additional earthing works required to manage transferred or induced voltages

(Refer to *CERM2456 - External Network Connection: Earth System Design & Test Requirements* for further guidance.)

### 2.3.1.4 System Operations Planning

Operational considerations that may impact cost include:

- Existing network constraints
- Planned and unplanned outage requirements
- System security and operational risk management requirements

### 2.3.1.5 Telecommunication

Telecommunications requirements can represent a significant source of cost variability, including:

- New or augmented communications equipment (protocols, hardware type, locations, and installation requirements)
- High-speed protection or inter-site communications requirements
- Redundancy and diversity requirements
- Communications towers or antenna infrastructure
- Fibre Marshalling Cubicle (FMC) or Fibre Marshalling Kiosk (FMK) requirements at electrical stations
- Communications tier classification and secure room requirements

### 2.3.1.6 Load Control

Load control and frequency-related impacts may include:

- Impacts on existing Frequency Injection (FI) plants
- Requirements for reactors or other network support equipment
- Additional FI or load-control network studies
- Upgrades to protection or relay systems to manage altered operating conditions

### 2.3.1.7 Protection

Protection system requirements may influence both scope and cost, including:

- New or modified protection schemes
- Modifications to existing protection arrangements
- High-speed inter-tripping requirements
- Redundancy and duplication requirements
- Interfaces with third-party or external utility protection systems

### 2.3.1.8 SCADA

SCADA requirements may include:

- New or upgraded SCADA equipment and interfaces
- Adequacy of existing RTU capacity, I/O, and power supplies
- RTU replacement or upgrade requirements
- Redundancy requirements
- Integration of new assets into existing SCADA systems
- Requirements for Remedial Action Schemes (RAS) or generation run-back

### 2.3.1.9 Secondary Systems

Secondary system considerations may include:

- Capacity and location of new or modified secondary systems
- Battery capacity assessments
- Modifications to existing secondary systems
- Requirements for additional DC battery systems
- Additional AC/DC conversion or distribution equipment to support SCADA and telecommunications loads

### 2.3.1.10 Substation Design

Substation design considerations may affect cost and constructability, including:

- Availability of 2D and/or 3D survey data
- Geotechnical conditions
- Identification of ownership and delineation points at the connection interface
- Site access constraints
- Completeness and accuracy of existing drawings and documentation for brownfield sites
- Outcomes of preliminary Network Development assessments (e.g. transformer modelling, lightning studies, security assessments)

### 2.3.1.11 Overhead Mains Design

Overhead line design requirements may influence scope and cost, including:

- Long-term access and maintenance requirements
- Design temperatures and conductor ratings
- Load capability confirmation
- Availability of survey data and photographic records
- Span modelling requirements
- Wind loading criteria and regional design parameters
- Ground clearance assessment criteria
- Conductor operating temperature assumptions

## 2.3.2 Contestable (Connection Applicant) Scope

Under the Electricity Supply Act 1995 (NSW), customers may elect to engage an ASP to undertake contestable connections work in New South Wales. The NSW ASP Scheme Rules establishes the framework under which ASPs may deliver contestable network services and define their associated obligations.

Connection Applicants should familiarise themselves with CEOP2015 – Contestable Works Guidelines (Terms and Conditions for Contestable Works). This document sets out the requirements for the design,



construction and/or installation of assets delivered in a contestable environment, with ownership of gifted assets transferred to Essential Energy upon completion. CEOP2015 applies to Customers, Developers and ASPs undertaking contestable works on the Essential Energy subtransmission and distribution networks.

Essential Energy may determine that certain connection works, or elements of those works, are to be delivered as non-contestable works and undertaken directly by Essential Energy. Such determinations are based on risk management considerations, including but not limited to safety, network security, protection of critical network infrastructure, and reliability of supply to customers. Where works are deemed non-contestable, they will be delivered by Essential Energy and funded by the Connection Applicant.

Assessment of contestability is undertaken either through submission of a connection enquiry to Essential Energy or during the Detailed Impact Assessment (DIA) stage. Where a project is identified as higher risk, Essential Energy will notify the ASP or Connection Applicant that an assessment is required to determine whether any portion of the proposed works is to be treated as non-contestable.

The scope of works considered contestable, and therefore the responsibility of the Connection Applicant, may include but is not limited to the following.

#### *2.3.2.1 General*

The Connection Applicant is responsible for the design and construction of contestable works, which may include, but are not limited to:

- An embedded generation substation owned and operated by the Connection Applicant
- An embedded generation connection compound constructed to Essential Energy standards and gifted to Essential Energy
- Greenfield distribution and subtransmission mains constructed to Essential Energy standards and gifted to Essential Energy
- Provision of the primary auxiliary 400 V AC supply (No. 1) from the Essential Energy distribution network, gifted to Essential Energy

The Connection Applicant is also responsible for:

- Obtaining all necessary approvals from relevant authorities that may affect substation, switchyard, or line works
- Preparation and submission of Safety in Design (SiD) documentation

#### *2.3.2.2 Network Performance Analysis*

The Connection Applicant is responsible for undertaking and providing network performance studies, including:

- Voltage regulation assessments
- Fault level and protection sensitivity analysis
- Stability and harmonic assessments
- Protection coordination analysis
- Earthing analysis
- Assessment of operational parameters

- Frequency Injection (FI) impact studies

#### 2.3.2.3 *Subtransmission and Distribution Construction*

Contestable construction responsibilities include:

- Connection of the embedded generator as a high-voltage customer, generator, or developer
- Locating the point of connection, where practicable, adjacent to the Connection Applicant's embedded generation substation site
- Transfer of gifted assets and energisation of the embedded generator following successful commissioning and formal sign-off

#### 2.3.2.4 *Protection*

The Connection Applicant is responsible for:

- Installation and pre-commissioning of embedded generation protection relays, protection panels, and associated substation protection equipment
- Ensuring protection schemes and settings do not adversely impact existing network protection performance

Protection design and implementation shall comply with CEOP8012 – Generation Connection: Protection Guidelines.

#### 2.3.2.5 *SCADA*

The Connection Applicant is responsible for:

- Liaising with the Australian Energy Market Operator (AEMO) to determine data transfer requirements for the embedded generation site
- Ensuring SCADA integration complies with all applicable AEMO requirements, including the Power System Data Communication Standard and Remedial Action Scheme (RAS) Guidelines

#### 2.3.2.6 *Telecommunication*

Telecommunications responsibilities include:

- Telecommunications point-of-connection requirements as determined through the Detailed Enquiry Response (DER)
- Design, construction, and testing of all agreed contestable telecommunications works
- Provision of duplicated and diverse communications paths where required, excluding communications towers located at the sending and receiving ends of diverse paths

#### 2.3.2.7 *Metering*

The Connection Applicant is responsible for the procurement, installation, and commissioning of metering equipment in accordance with regulatory requirements, with metering located outside Essential Energy infrastructure.

### 2.3.2.8 Power Quality

The Connection Applicant is responsible for installation of an Essential Energy-approved Power Quality Meter (PQM) within the connection compound at the point of common coupling.

### 2.3.2.9 Earthing

Earthing responsibilities include:

- Preparation and submission of earthing designs for the embedded generation substation and connection compound
- Construction of a greenfield earthing system where proximity to existing in-service earthing systems presents a potential electrical hazard
- Submission of earthing system test reports to Essential Energy for approval prior to connection

### 2.3.2.10 Commissioning

The Connection Applicant is responsible for:

- Providing installation test documentation for Essential Energy review
- Providing pre-commissioning documentation for Essential Energy review
- Providing access to Essential Energy for commissioning of gifted assets and embedded generation substation data network equipment

### 2.3.2.11 Land and Routes

The Connection Applicant is responsible for the acquisition of land and easements required for the connection works, including:

- Provision of easements for altered or new lines in accordance with CEOP8046 – Easement Requirements
- Ensuring easement widths accommodate anchor and guying requirements
- Gifting of any required sites to Essential Energy as freehold title, including rights of access in favour of Essential Energy
- Ensuring finished site levels are at least 500 mm above the 1:100-year flood level
- Ongoing maintenance of access arrangements in accordance with the following memoranda:
  - CEOF9097A – Terms of Easement for Overhead Powerlines
  - CEOF9097B – Terms of Easement for Underground Powerlines
  - CEOF9097C – Terms of Easement for Multi-Purpose Electrical Installations

## 2.3.3 Remedial Action Scheme

To maintain a safe and reliable power supply for all Essential Energy customers and to protect the existing network assets from overload or unplanned outages, a Remedial Action Scheme (RAS) may need to be required as part of the new network connection. A RAS works in real time, utilising high-speed communications over multiple sites to monitor network conditions and automatically adjust generation to maintain operation within safe network limits.

A RAS is implemented as a system independent of any existing or proposed SCADA and protection schemes. Based on the requirements of the proposed connection and prevailing network conditions, the form of RAS required may vary and may include one or a combination of the following:

- A complex multi-site RAS
- A Transformer Overload Scheme (TOLS)
- A Line Overload Scheme (LOLS)

The requirement for a RAS may be triggered by a combination of factors, including but not limited to:

- Connection type, generator size, and operating protocol
- Feeder voltage level and conductor type or size
- Existing embedded generation connections within the wider network area
- Existing zone substation equipment capability and capacity
- TransGrid feeder and associated equipment capacity

Indicative costs associated with the implementation of a RAS (Essential Energy works only) are provided in Table 2, Table 3, and Table 4.

Table 2: Typical TOLS Costs

| CONNECTION VOLTAGE | NON-CONTESTABLE WORKS                                                                                                                                                                                             | POTENTIAL ADDITIONAL CONTESTABLE WORKS                                                                                                 | NON-CONTESTABLE CLASS 5 COST ESTIMATE* |
|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|
| All                | <ul style="list-style-type: none"> <li>• ZS design, materials, construction &amp; commissioning.</li> <li>• Supply materials, install &amp; commission EE specified TOLS equipment at Solar Farm site.</li> </ul> | <ul style="list-style-type: none"> <li>• Additional or upgraded communications bearers.</li> <li>• Solar Farm TOLS cabinet.</li> </ul> | \$200k - \$800k                        |

Table 3: Typical LOLS Costs

| CONNECTION VOLTAGE | NON-CONTESTABLE WORKS                                                                                                                                                                                             | POTENTIAL ADDITIONAL CONTESTABLE WORKS                                                                                                                         | NON-CONTESTABLE CLASS 5 COST ESTIMATE* |
|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|
| All                | <ul style="list-style-type: none"> <li>• ZS design, materials, construction &amp; commissioning.</li> <li>• Supply materials, install &amp; commission EE specified LOLS equipment at Solar Farm site.</li> </ul> | <ul style="list-style-type: none"> <li>• Independent high-speed communications bearers (OPGW, ADSS, microwave).</li> <li>• Solar Farm LOLS cabinet.</li> </ul> | \$250k - \$1 Million                   |



Table 4: Typical RAS Costs

| CONNECTION VOLTAGE | NON-CONTESTABLE WORKS                                                                                                                                                                                                                 | POTENTIAL ADDITIONAL CONTESTABLE WORKS                                                                                                                                               | NON-CONTESTABLE CLASS 5 COST ESTIMATE* |
|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|
| All                | <ul style="list-style-type: none"> <li>ZS design, materials, construction &amp; commissioning for all effected EE ZS's.</li> <li>Supply materials, install &amp; commission EE specified RAS equipment at Solar Farm site.</li> </ul> | <ul style="list-style-type: none"> <li>Independent high-speed communications bearers (OPGW, ADSS, microwave) between all affected sites.</li> <li>Solar Farm RAS cabinet.</li> </ul> | \$500k – \$2 Million                   |

\* Refer to clause 2.1 Preliminary Costings.

#### Notes:

- The costs and typical requirements described in the tables above are indicative only. Detailed technical analysis undertaken during the connection process may result in scope and cost outcomes that differ materially from the ranges shown.
- The overall cost of a Remedial Action Scheme (RAS) is strongly influenced by factors such as the generation site location, installed capacity, and the extent of network impacts within the Essential Energy network and interconnected networks.
- Reducing the maximum export capability of the network connection may simplify the required RAS or, in some cases, remove the need for a scheme altogether.

### 2.3.4 Design References

Design references applicable to high-voltage (HV) assets to be owned by Essential Energy, and those to be owned and operated by others, are provided in CEOP2015 - General Terms and Conditions for Contestable Works.

Essential Energy HV connection documentation is available on the Essential Energy website.

#### 2.3.4.1 General

All electricity works shall be designed to operate safely under the electrical conditions likely to be experienced during service and within the physical environment in which they will operate.

Electrical distribution and transmission design are specialist engineering disciplines. The Connection Applicant is responsible for ensuring that the ASP1 and ASP3 service providers engaged to undertake works are suitably accredited, qualified and experienced.

All assets gifted to EE shall comply, at minimum, comply to all relevant Essential Energy procedures, guidelines, manuals and standards including the following requirements:

- All designs are to be carried out by an ASP3 accredited in transmission line and substation design.
- All designs to comply with relevant Essential Energy standards, templates and requirements.



- In absence of applicable EE standards, the minimum requirements will be as per the current version of the following:
  - AS/NZS 3000 – Australian and New Zealand Wiring Rules.
  - AS/NZS 7000 – Overhead Line Design.
  - AS 2067 – Substations and High Voltage Installations Exceeding 1 kV A.C.
  - AS 3007 – Electrical equipment in mines and quarries
  - National Electricity Rules.
  - Electricity Supply Act.
- All electricity works shall be designed to be safe for the electrical conditions likely to be experienced during service and the physical environment in which they will operate.

#### 2.3.4.2 Substation Design

All substation designs shall comply with the following standards:

- CEOP8032 – Transmission and Zone Substations: Design Guidelines
- CEOH7052a – Substation Design Workplace Instruction: Microstation Drawing Guidelines
- CEOM5113.01 – HV A.C. Transmission & Sub-Transmission Station: Earthing Techniques
- AS 2067 – Substations and High Voltage Installations Exceeding 1 kV A.C.

Essential Energy CAD workspace guidelines and drawing templates are available upon request.

The following concept design documentation shall be submitted for review:

- Single Line Diagram
- General Arrangement (plan view)
- Site plan
- Protection Single Line Diagram
- Phasing diagram (where available)
- Preliminary SCADA schedule
- Building floor plans
- Earthing design
- Safety in Design (SiD) report

Approval of the concept design package by Essential Energy is required prior to progression to detailed design.

All equipment and materials forming part of gifted assets shall be approved by Essential Energy prior to construction.

Dual auxiliary 400 V AC supplies may be provided using a combination of methods approved by Essential Energy. The primary auxiliary supply is typically provided from the embedded generation substation essential services board, with backup supplied from the Essential Energy distribution network. The use of a Power Voltage Transformer (PVT) may be considered for the primary auxiliary supply.

A separate application to Essential Energy is required for any connection to the distribution network.

#### **2.3.4.3 Mains Design**

Mains design shall comply with the criteria set out in this guideline and the following Essential Energy standards:

- CEOM7081 – Sub-transmission Line Design Manual.
- CEOM7082 – Sub-transmission Construction Manual.
- CEOP8042 – Network Asset Identification and Operational Labels.
- CEOM7097 – Overhead Design Manual.
- CEOM7098 – Distribution Underground Design and Construction Manual.
- CEOM7001 – Asset Management and Engineering: Network Mains Design - Construction Drawing Requirements.
- CEOM7199 – Underground Construction Manual.

Following route determination, and prior to final design approval, the ASP3 designer shall submit a conceptual design for Essential Energy review. Final design submission may proceed only after conceptual approval.

Design shall be undertaken using PLS-CADD or PowerLines Pro software. Where Essential Energy standards are not available, designs shall comply with AS/NZS 7000:2010.

The conceptual design is to include:

- Route plans.
- Line schedule.
- Line profile.
- PLS-Cad “bak” file or PowerLines Pro “power” file.
- Design criteria report.

#### **2.3.4.4 Protection, SCADA and Telecommunication**

All protection, control and communication designs shall comply with the following standards:

- CEOP8002.01 – Subtransmission Protection Guidelines.
- CEOP8002.02 – Distribution Protection Guidelines.
- CEOP8032 – Transmission and Zone Substation Design Guidelines
- CEOS7902 – Design Guidelines for SCADA and DSA.
- CEOP8012 – Generation Connection: Protection Guidelines.
- CEOM7621.01 – Technology Guideline (Telecommunications and Infrastructure).
- IEC 60255 Electrical Relays.
- IEC 61000 Electromagnetic Compatibility.
- AS/NZS 3000 Wiring Rules.

- Telecommunications Cabling Provider Rules.
- AS/CA S009 – Customer Cabling Installation Requirements.
- National Electricity Rules.

#### *2.3.4.5 Metering*

All metering designs shall comply with the following standards:

- CEOP8032 – Transmission and Zone Substation Design Guidelines
- IEC 60255 Electrical Relays.
- IEC 61000 Electromagnetic Compatibility.
- AS/NZS 3000 Wiring Rules.
- National Electricity Rules.
- AS/CA S009 – Customer Cabling Installation Requirements

Metering shall also comply with AEMO requirements, including NER Chapter 7 and the NEM Metrology Procedure.

Revenue metering shall be installed at the connection voltage and located as close as practicable to the point of connection. Power quality metering shall be installed at the connection voltage within the embedded generation substation control room.

#### *2.3.4.6 Network Earthing*

An earthing design and performance analysis shall be undertaken for the substation, connection compound or switching station and its connection to the Essential Energy network. A detailed earthing report shall be submitted to Essential Energy for review and approval.

The connection to any existing OPGW shall be non-conductive. Earthing systems shall be constructed and tested in accordance with Essential Energy standards, including:

- CEOM5113.01 – HV A.C. Transmission & Sub-Transmission Station: Earthing Techniques
- CERM2456 - External Network Connection: Earth System Design & Test Requirements.

#### *2.3.4.7 Contestability of Services*

Refer to CEOP2015 – General Terms and Conditions for Contestable Work

#### *2.3.4.8 Contestable Works Design Certification*

Refer to CEOP2015 – General Terms and Conditions for Contestable Work

#### **Note:**

- Compliant submissions to Contestable Works are subject to a 28-day turnaround period.
- Resubmissions due to non-compliance or omissions will trigger a new 28-day review period

## 2.4 Risks

All projects carry inherent risks. Potential risks should be identified and, where practical, mitigated early in the project lifecycle. For each identified risk, consideration should be given to:

- The nature of the risk.
- Proposed mitigation measures or contingencies.
- Justification for any residual risk.

### 2.4.1 Construction

- Site preparation, terrain grading, access roads requirements.
- Flood levels.
- Resource allocation and availability.
- Schedule changes impacting scope and cost.

### 2.4.2 Environment

- Aboriginal heritage constraints.
- Environmental investigations and approvals.
- Asbestos in existing buildings.
- Community consultation and opposition.

### 2.4.3 Equipment

- Lead time and cost of non-standard major plant.
- Global supply chain volatility.

### 2.4.4 Land Easements and Acquisitions

- Dependent on easement and land acquisition negotiations.
- Site suitability for operational and development requirements.

### 2.4.5 Network

- Network impacts including voltage support, harmonics and FI systems.
- Access to the network for planned outages.

### 2.4.6 Safety

- Any safety risk that cannot be effectively mitigated may require modification or reassessment of the development

### 2.4.7 Third Party Interfacing

- Interfacing with third-party electrical and telecommunications networks.
- Interfacing with other utilities or infrastructure owners



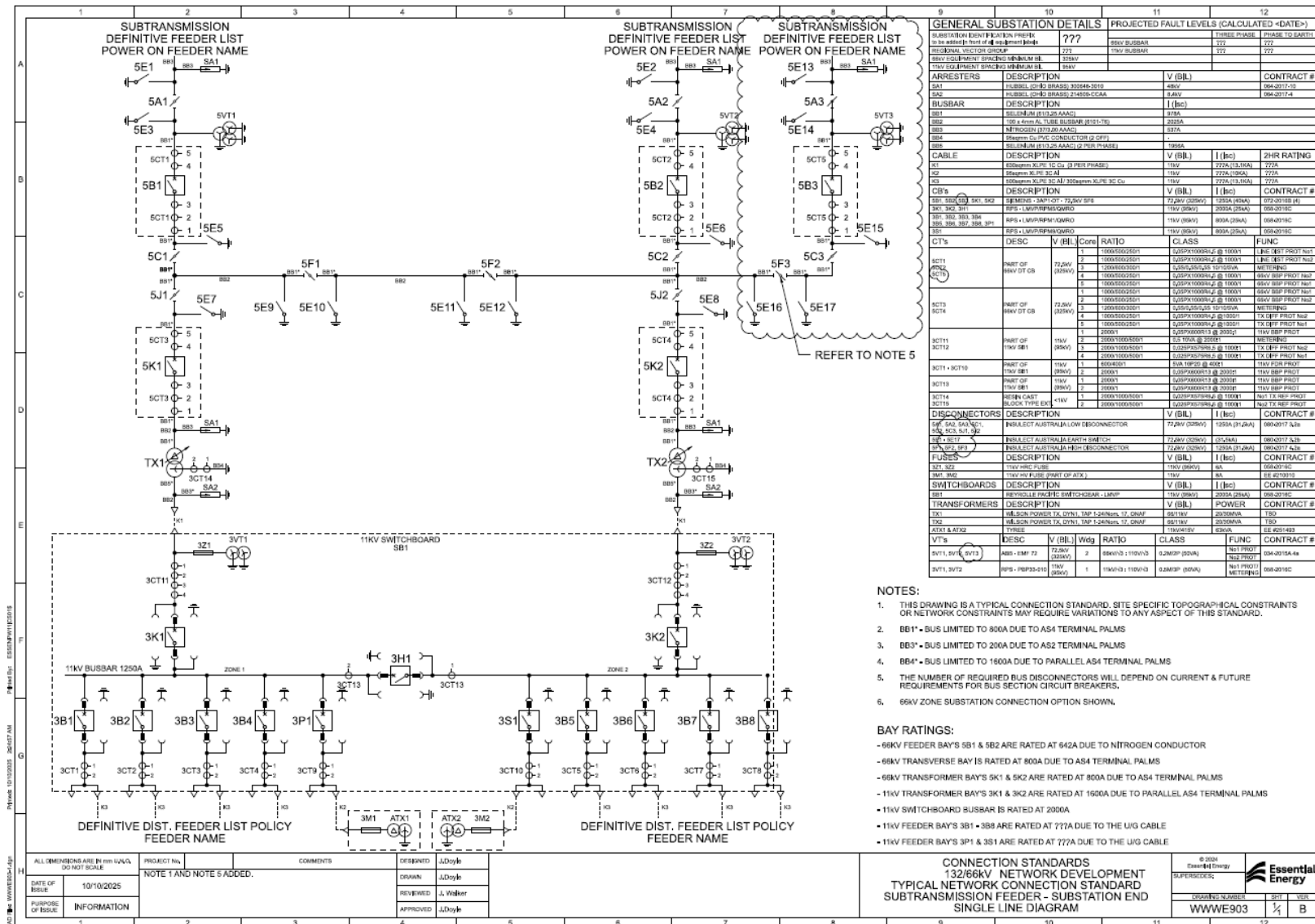
2.5 Typical Connection Arrangements

Typical connection arrangements, including high level scope and costs are provided in the following section

2.5.1 Option 1: Additional Feeder Bay in Zone Substation

| APPLCIABLE VOLTAGES | TELECOMMS REQUIREMENTS | CLASS 5 COST ESTIMATION | NON-CONTESTABLE SCOPE INCLUSIONS                                                                                                         | NON-CONTESTABLE SCOPE EXCLUSIONS                                                                                                                                      |
|---------------------|------------------------|-------------------------|------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 66/132kV            | Duplicate Paths        | \$3M – \$4M             | Design and construction inside ZS Fence, Feeder bay primary electrical equipment, Prot/Cont panels, Integration into existing SCADA RTU. | Building modifications, SCADA RTU upgrade, bench extensions & land acquisition, access road upgrade, Power TX upgrade, Metering/PQM, Communications, network studies. |

### Figure 1: Additional Feeder Bay Single Line Diagram



2.5.2 Option 2: Subtransmission Feeder Ended Connection

| APPLCIABLE VOLTAGES | TELECOMMS REQUIREMENTS | CLASS 5 COST ESTIMATION | NON-CONTESTABLE SCOPE INCLUSIONS                                                                                | NON-CONTESTABLE SCOPE EXCLUSIONS                                                                                  |
|---------------------|------------------------|-------------------------|-----------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|
| 66/132kV            | Duplicate              | \$200k – \$400k         | Design and construction of switching station (connection compound), including landing span, disconnector & FMC. | Design & construction of any assets beyond the PoC, access road, land acquisition, Metering/PQM, network studies. |

Figure 2: Subtransmission Connection Compound Single Line Diagram

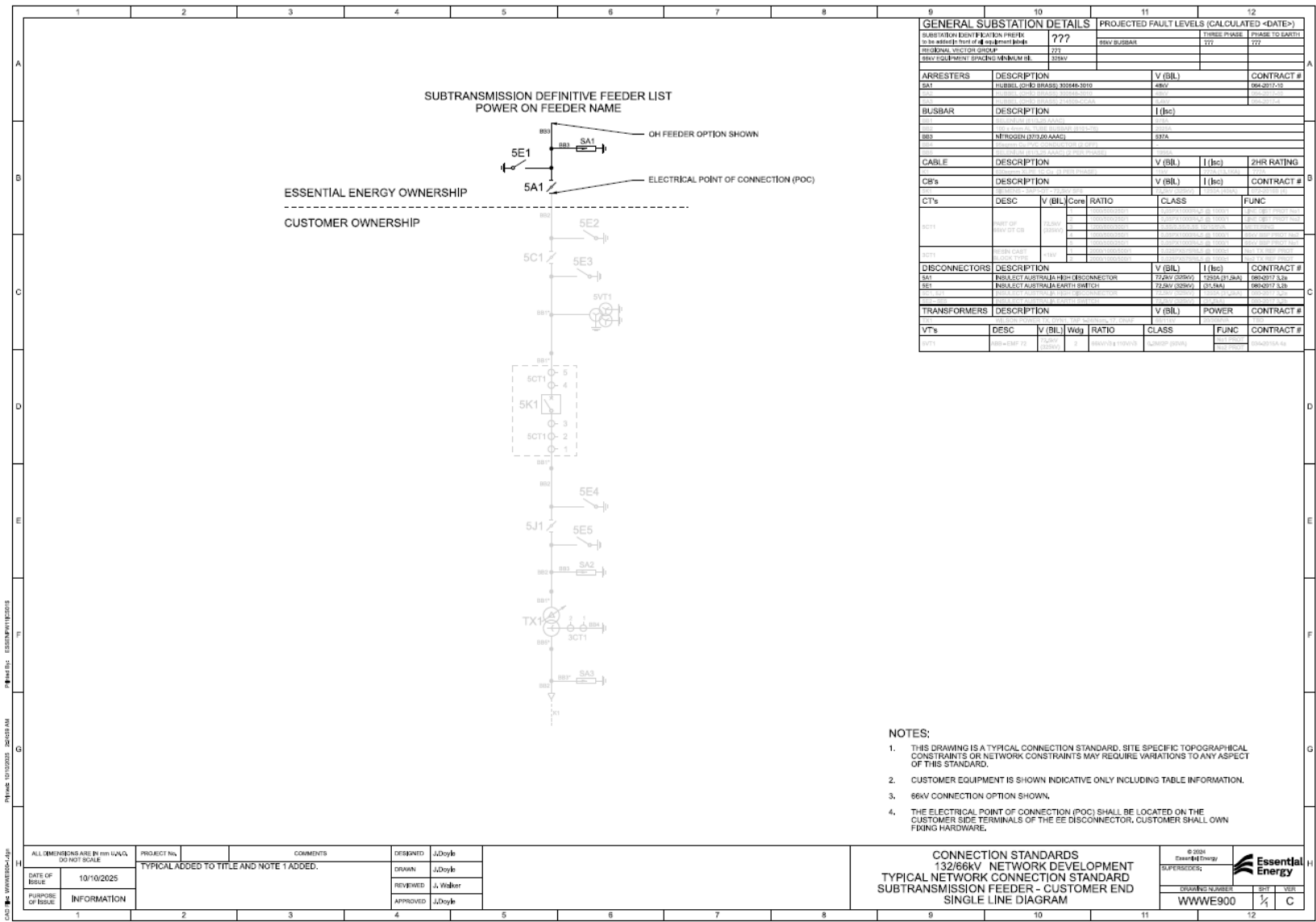
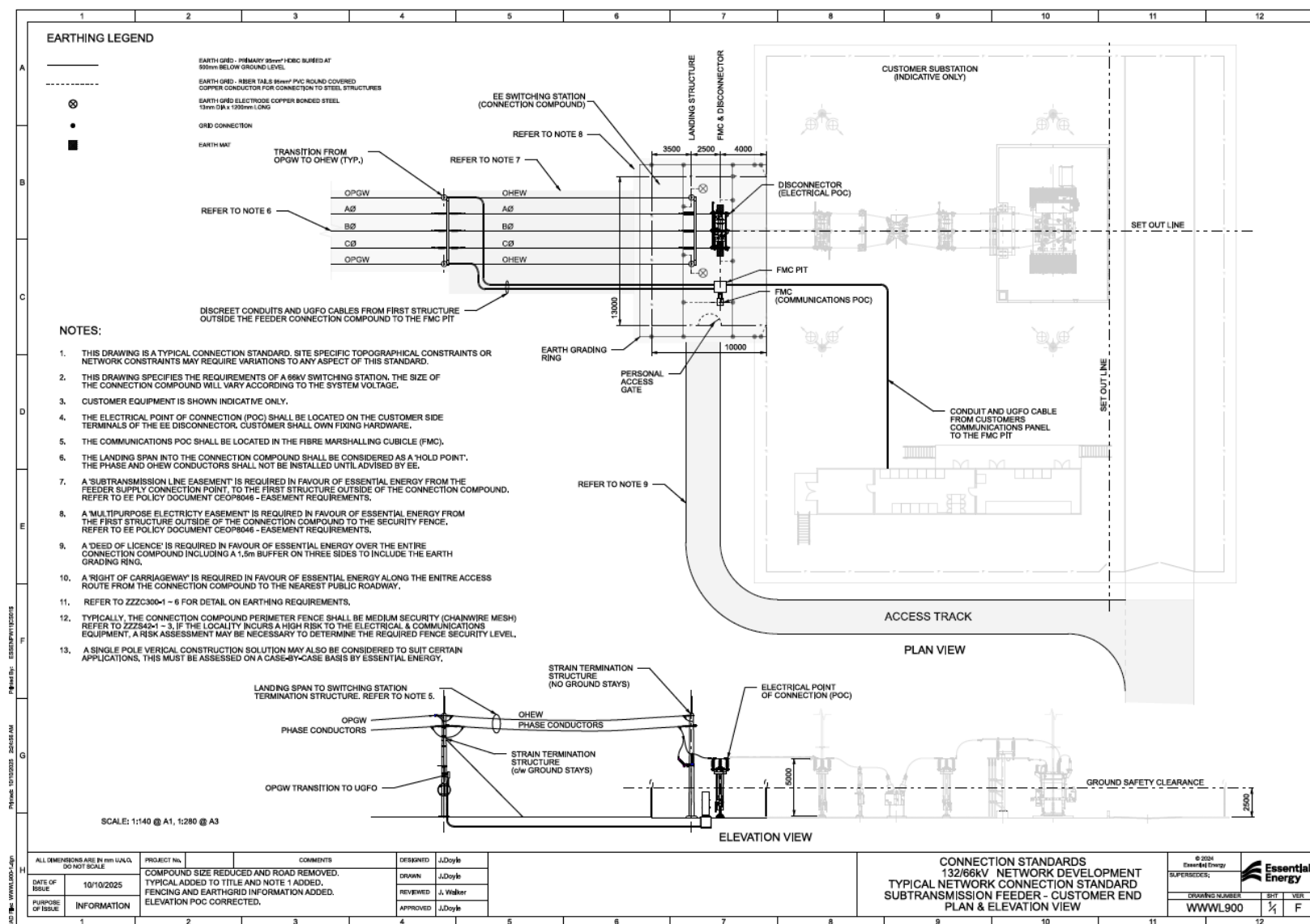


Figure 3: Subtransmission Connection Compound Plan &amp; Elevation View



2.5.3 Option 3: New 3 Way Switching to Existing Sub-transmission line

| APPLCIABLE VOLTAGES | TELECOMMS REQUIREMENTS | CLASS 5 COST ESTIMATION | NON-CONTESTABLE SCOPE INCLUSIONS                                                                                                                                                                | NON-CONTESTABLE SCOPE EXCLUSIONS                                                                                                |
|---------------------|------------------------|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|
| 66/132kV            | Duplicate              | \$13M – \$14M           | Design and construction of 3-way switching station, bench & internal access road, Prot/Cont panels, SCADA & Telecommunications hardware, commissioning, switching, integration into EE Network. | Design & construction of any assets beyond the PoC, access road, land acquisition, customer metering compound, network studies. |



Figure 4: 3-Way SS Connection SLD

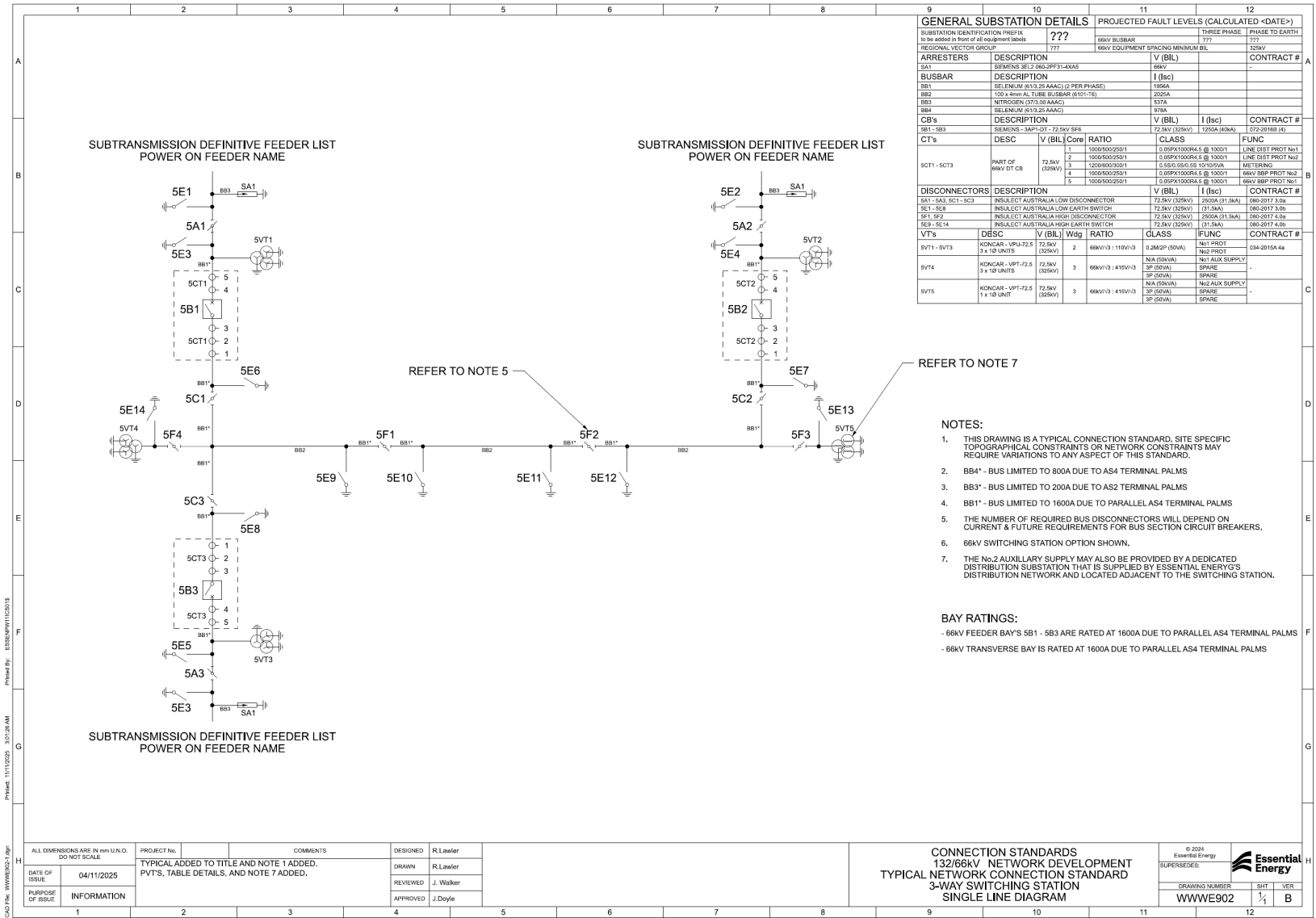
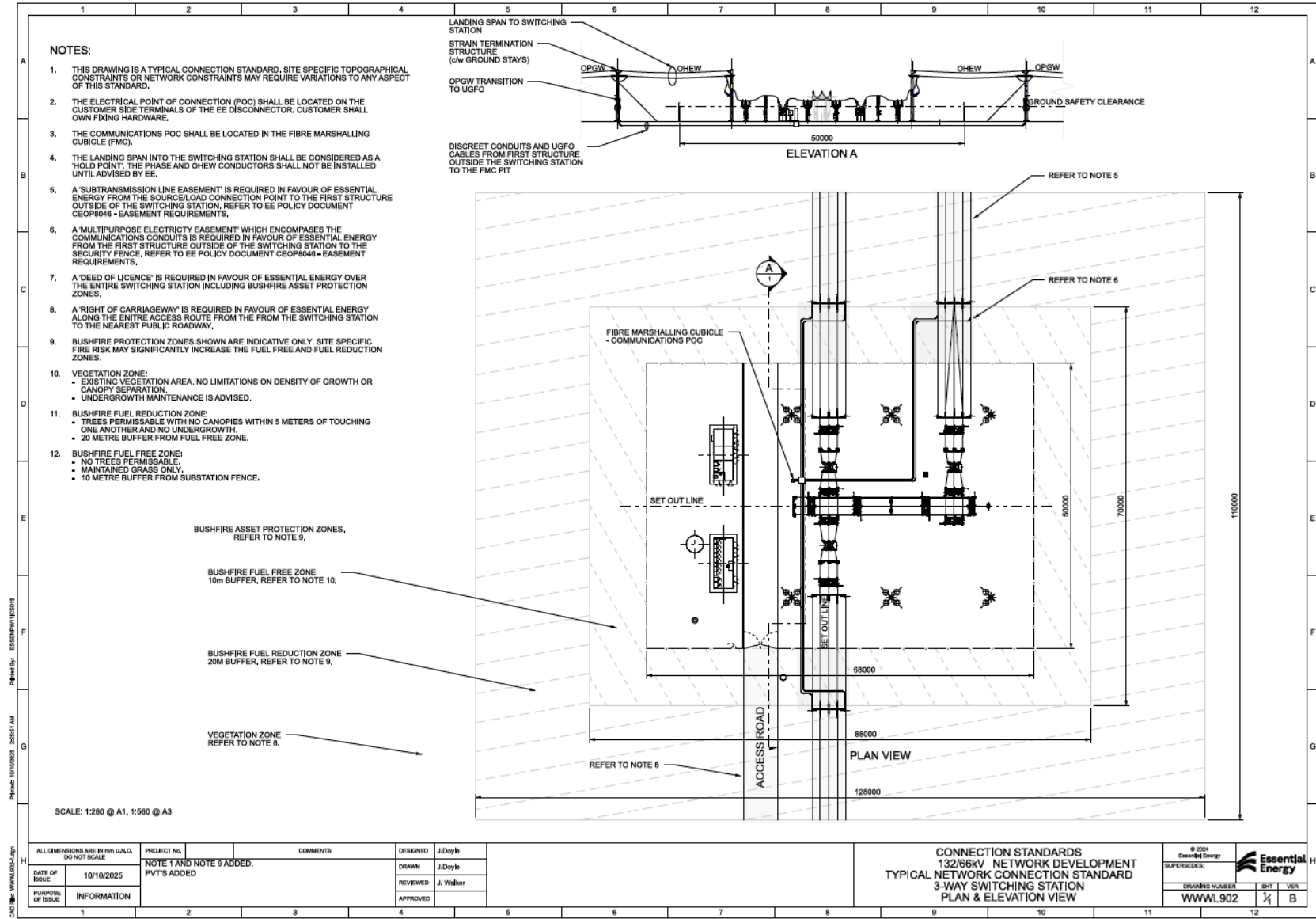


Figure 5: 3-Way Switching Station Plan & Elevation View

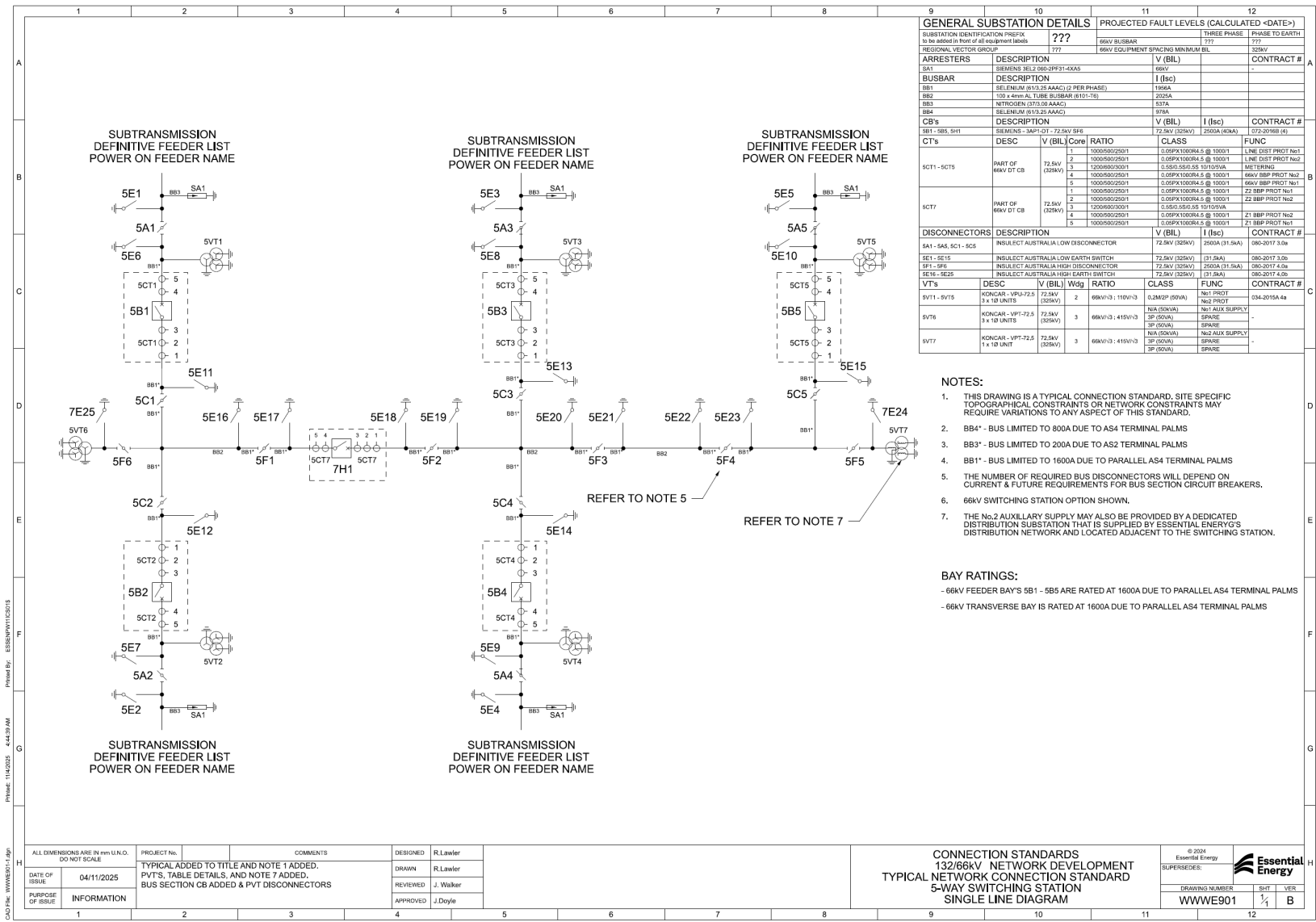


2.5.4 Option 4: New 5 Way Switching to Existing Sub-transmission line

| APPLCIABLE VOLTAGES | TELECOMMS REQUIREMENTS | CLASS 5 COST ESTIMATION | NON-CONTESTABLE SCOPE INCLUSIONS                                                                                                                                                                | NON-CONTESTABLE SCOPE EXCLUSIONS                                                                                                |
|---------------------|------------------------|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|
| 66/132kV            | Duplicate              | \$18M – \$20M           | Design and construction of 5-way switching station, bench & internal access road, Prot/Cont panels, SCADA & Telecommunications hardware, commissioning, switching, integration into EE Network. | Design & construction of any assets beyond the PoC, access road, land acquisition, customer metering compound, network studies. |



Figure 6: 5-Way SS Connection SLD



**NOTES:**

- THIS DRAWING IS A TYPICAL CONNECTION STANDARD, SITE SPECIFIC TOPOGRAPHICAL CONSTRAINTS OR NETWORK CONSTRAINTS MAY REQUIRE VARIATIONS TO ANY ASPECT OF THIS STANDARD.
- THE ELECTRICAL POINT OF CONNECTION (POC) SHALL BE LOCATED ON THE CUSTOMER SIDE TERMINALS OF THE EE DISCONNECTOR, CUSTOMER SHALL OWN FIXING HARDWARE.
- THE COMMUNICATIONS POC SHALL BE LOCATED IN THE FIBRE MARSHALLING CUBICLE (FMC).
- THE LANDING SPAN INTO THE SWITCHING STATION SHALL BE CONSIDERED AS A HOLD POINT. THE PHASE AND OHEW CONDUCTORS SHALL NOT BE INSTALLED UNTIL ADVISED BY EE.
- A 'SUBTRANSMISSION LINE EASEMENT' IS REQUIRED IN FAVOUR OF ESSENTIAL ENERGY FROM THE SOURCE/OAD CONNECTION POINT TO THE FIRST STRUCTURE OUTSIDE OF THE SWITCHING STATION. REFER TO EE POLICY DOCUMENT CEOP8046 - EASEMENT REQUIREMENTS.
- A 'MULTIPURPOSE ELECTRICITY EASEMENT' WHICH ENCOMPASSES THE COMMUNICATIONS CONDUITS IS REQUIRED IN FAVOUR OF ESSENTIAL ENERGY FROM THE FIRST STRUCTURE OUTSIDE OF THE SWITCHING STATION TO THE SECURITY FENCE. REFER TO EE POLICY DOCUMENT CEOP8046 - EASEMENT REQUIREMENTS.
- A 'DEED OF LICENCE' IS REQUIRED IN FAVOUR OF ESSENTIAL ENERGY OVER THE ENTIRE SWITCHING STATION INCLUDING BUSHFIRE ASSET PROTECTION ZONES.
- A 'RIGHT OF CARRIAGEWAY' IS REQUIRED IN FAVOUR OF ESSENTIAL ENERGY ALONG THE ENTIRE ACCESS ROUTE FROM THE FROM THE SWITCHING STATION TO THE NEAREST PUBLIC ROADWAY.
- BUSHFIRE PROTECTION ZONES SHOWN ARE INDICATIVE ONLY. SITE SPECIFIC FIRE RISK MAY SIGNIFICANTLY INCREASE THE FUEL FREE AND FUEL REDUCTION ZONES.
- VEGETATION ZONE:  
- EXISTING VEGETATION AREA, NO LIMITATIONS ON DENSITY OF GROWTH OR CANOPY SEPARATION.  
- UNDERGROWTH MAINTENANCE IS ADVISED.
- BUSHFIRE FUEL REDUCTION ZONE:  
- TREES PERMISSIBLE WITH NO CANOPIES WITHIN 5 METERS OF TOUCHING ONE ANOTHER AND NO UNDERGROWTH.  
- 20 METRE BUFFER FROM FUEL FREE ZONE.
- BUSHFIRE FUEL FREE ZONE:  
- NO TREES PERMISSIBLE.  
- MAINTAINED GRASS ONLY.  
- 10 METRE BUFFER FROM SUBSTATION FENCE.

BUSHFIRE ASSET PROTECTION ZONES. REFER TO NOTE 9.

BUSHFIRE FUEL FREE ZONE  
10m BUFFER, REFER TO NOTE 12.

BUSHFIRE FUEL REDUCTION ZONE  
20M BUFFER, REFER TO NOTE 11.

VEGETATION ZONE  
REFER TO NOTE 10.

SCALE: 1:280 @ A1; 1:560 @ A3

ELEVATION A

PLAN VIEW

| ALL DIMENSIONS ARE BY REF UNLESS DO NOT SCALE |             | PROJECT N° | COMMENTS                                 | DESIGNED | DRAWN   | REVIEWED | APPROVED |
|-----------------------------------------------|-------------|------------|------------------------------------------|----------|---------|----------|----------|
| DATE OF ISSUE                                 | 10/10/2025  |            | NOTE 1 AND NOTE 8 ADDED.<br>PVT'S ADDED. | J Doyle  | J Doyle | J Walker | J Doyle  |
| PURPOSE OF ISSUE                              | INFORMATION |            |                                          |          |         |          |          |

CONNECTION STANDARDS  
132/66KV NETWORK DEVELOPMENT  
TYPICAL NETWORK CONNECTION STANDARD  
5-WAY SWITCHING STATION  
PLAN & ELEVATION VIEW

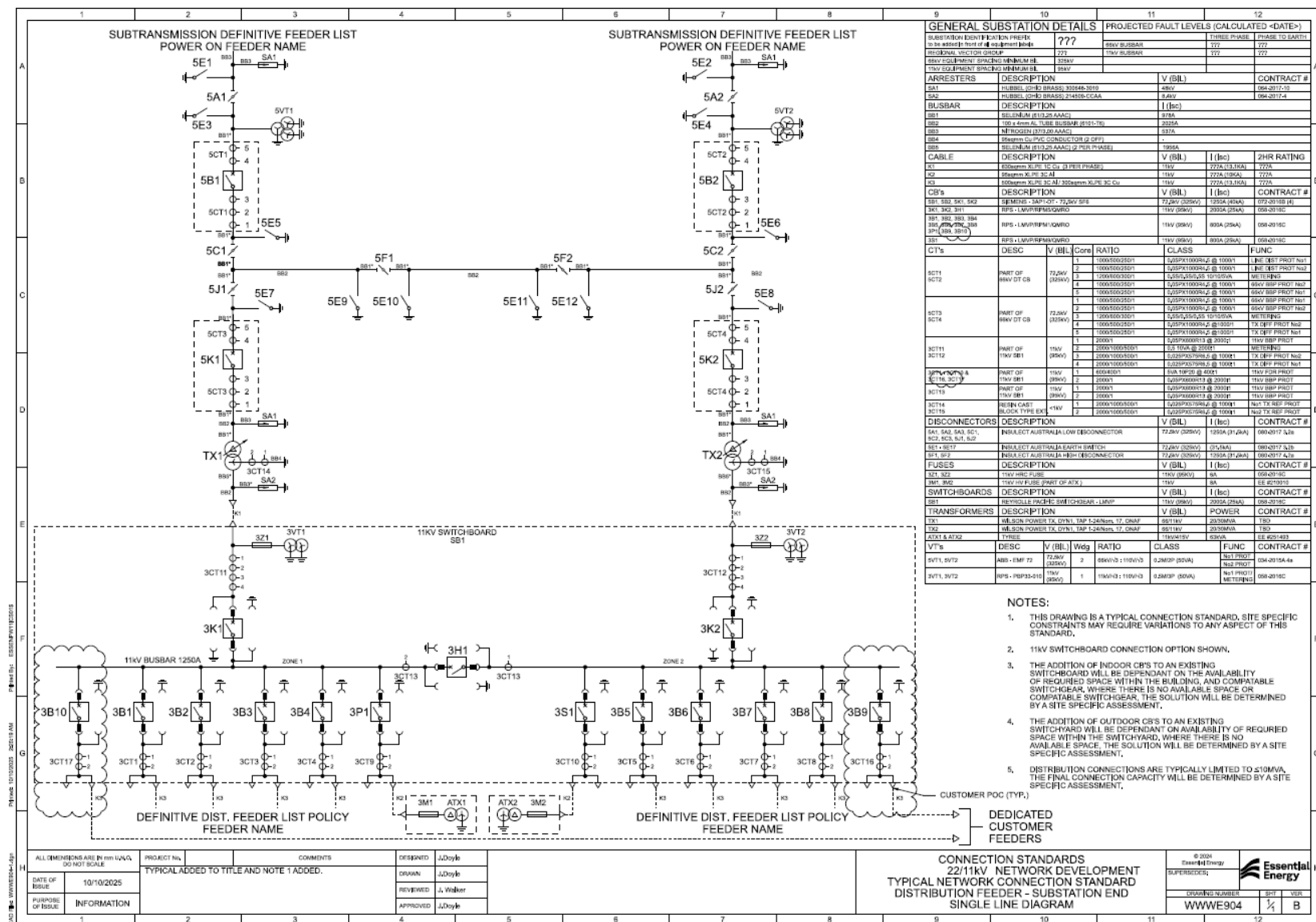
© 2024 Essential Energy  
SUPERSEDES:  
DRAWING NUMBER: WWWL901  
REV: 1/1

2.5.5 Option 5: Distribution Connection to Zone Substation

| APPLCIABLE VOLTAGES | TELECOMMS REQUIREMENTS | CLASS 5 COST ESTIMATION | NON-CONTESTABLE SCOPE INCLUSIONS                                                                                                                                                                           | NON-CONTESTABLE SCOPE EXCLUSIONS                                                                      |
|---------------------|------------------------|-------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|
| 11/22kV             | Duplicate              | \$2M – \$5M             | Design and construction of all primary electrical equipment inside ZS, including a single CB. Prot/Cont panel, SCADA & Telecommunications hardware, commissioning, switching, integration into EE Network. | Building modifications, SCADA RTU upgrade, bench extensions & land acquisition, HV cable, TX upgrade. |



### Figure 8: Distribution Connection to Zone Substation SLD



**2.5.6 Option 6 Install RAS**

| APPLCIABLE VOLTAGES | TELECOMMS REQUIREMENTS | CLASS 5 COST ESTIMATION | NON-CONTESTABLE SCOPE INCLUSIONS                                                                                                                                                                                                                                                                                                                                       | NON-CONTESTABLE SCOPE EXCLUSIONS                                                   |
|---------------------|------------------------|-------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| 66/132kV            | Duplicate              | \$200k – \$2M           | SCADA Development & modifications/upgrades, Design and construction of all primary electrical equipment inside ZS, including a single CB. Prot/Cont panel, SCADA & Telecommunications hardware, commissioning, switching, integration into EE Network. Design and construction of switching station (connection compound), including landing span, disconnector & FMC. | Design & construction of any assets beyond the PoC, access road, land acquisition. |

**2.5.7 Option 7: Distribution Network Connection**

| APPLCIABLE VOLTAGES | TELECOMMS REQUIREMENTS | CLASS 5 COST ESTIMATION | NON-CONTESTABLE SCOPE INCLUSIONS                                                                                | NON-CONTESTABLE SCOPE EXCLUSIONS                                                   |
|---------------------|------------------------|-------------------------|-----------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| 11/33kV             | Duplicate              | \$200k – \$500k         | Design and construction of switching station (connection compound), including landing span, disconnector & FMC. | Design & construction of any assets beyond the PoC, access road, land acquisition. |



### 3.0 AUTHORITIES AND RESPONSIBILITIES

| POSITION / TITLE                                                          | RESPONSIBILITY                    |
|---------------------------------------------------------------------------|-----------------------------------|
| Manager Network Development                                               | Review and approve this document  |
| Team Leader - Network Development                                         | Review and endorse this document  |
| All Major Stakeholders consulted in the Major Network Connection process. | Familiarise and adhere to Policy. |

### 4.0 DEFINITIONS

- **AEMO** - Australian Energy Market Operator.
- **ASP Accredited Service Provider** - A person accredited under a scheme approved by the NSW Department of Trade and Investment.
- **Connection Applicant** - For the purposes of this document shall mean the customer / generator / developer requesting the works to be conducted.
- **Contestable Works** - Works for which a Connection Applicant may choose the provider of services.
- **EE** - Essential Energy.
- **EG** - Embedded Generator.
- **EIA** - Environmental Impact Assessment.
- **FI** - Frequency Injection.
- **FMC** - Fibre Marshalling Cubicle.
- **NER** - National Electricity Rules.
- **NEM** - National Energy Market.
- **Non-Contestable works** - Works which Essential Energy deem to be impractical or too great a risk, to allow external parties to undertake.
- **OPGW** - Optical Ground Wire or optical fibre composite overhead ground wire.
- **POC** - Point of Connection, the physical connection between Essential Energy's network and a private network.
- **PQM** - Power Quality Meter.
- **PVT** - Power Voltage transformer
- **RAS** - Remedial Action Scheme.
- **REF** - Review of Environmental Factors.
- **RTU** - Remote Terminal Unit.
- **SCADA** - Supervisory Control and Data Acquisition.
- **SiD** - Safety in Design.



- **SLD** - Single Line Diagram.
- **SS** - Switching Station.
- **ZS** - Zone Substation.

## 5.0 REFERENCES

| INTERNAL                                                                                                                 |
|--------------------------------------------------------------------------------------------------------------------------|
| <a href="#">Branch Procedure: Connection Process Guideline – CEOP8079</a>                                                |
| <a href="#">Branch Procedure: Transmission and Zone Substation Design Guidelines - CEOP8032</a>                          |
| <a href="#">Division Procedure: Contestable Works Guidelines (Terms and Conditions for Contestable Works) - CEOP2015</a> |
| <a href="#">Branch Procedure: Generation Connection: Protection Guidelines - CEOP8012</a>                                |
| <a href="#">Easement Requirements - CEOP8046</a>                                                                         |
| <a href="#">Branch Procedure: Subtransmission and Distribution Network Planning Criteria and Requirements – CEOP8003</a> |
| <a href="#">Company Procedure: Network Asset Identification and Labels - CEOP8042</a>                                    |
| <a href="#">Branch Procedure: Subtransmission Protection Guidelines - CEOP8002.01</a>                                    |
| <a href="#">Branch Procedure: Distribution Protection Guidelines – CEOP8002.02</a>                                       |
| <a href="#">Branch Manual: Technology Guideline – Places in the Network - CEOM7621.01</a>                                |
| <a href="#">Division Manual: Subtransmission Line Design Manual – CEOM7081</a>                                           |
| <a href="#">Branch Manual: Subtransmission Construction Manual – CEOM7082</a>                                            |
| <a href="#">Overhead Construction Manual: Index - CEOM7099</a>                                                           |
| <a href="#">Division Manual: Construction Plan Requirements - CEOM7001</a>                                               |
| <a href="#">Division Manual: HV A.C. Transmission &amp; Sub-Transmission Station: Earthing Techniques - CEOM5113.01</a>  |
| <a href="#">Division Manual: Overhead Design Manual - CEOM7097</a>                                                       |
| <a href="#">Division Manual: Distribution Underground Design and Construction - CEOM7098</a>                             |
| <a href="#">Underground Construction Manual: Index - CEOM7199</a>                                                        |
| <a href="#">External Network Connection: Earth System Design &amp; Test Requirements - CERM2456</a>                      |
| <a href="#">Operational Standard - SCADA and DSA Systems - CEOS7902</a>                                                  |
| <a href="#">Terms of Easement for Overhead Powerlines - CEOF9097A</a>                                                    |
| <a href="#">Terms of Easement for Underground Powerlines - CEOF9097B</a>                                                 |
| <a href="#">Terms of Easement for Multi-Purpose Electrical Installations - CEOF9097C</a>                                 |



**INTERNAL**

[Substation Design Workplace Instruction: Microstation Drawing Guideline – CEOH7052a](#)

[Cost Estimation Principles & Methodology – External Reference \(ND Doc 504\)](#)

Essential Energy's HV connection documentation is available [HERE](#)

**EXTERNAL**

IEC 60255 Electrical Relays.

IEC 61000 Electromagnetic Compatibility.

AS/NZS 3000 Wiring Rules.

AS/CA S009 – Customer Cabling Installation Requirements

AS 2067 – Substations and High Voltage Installations Exceeding 1 kV A.C.

AS 3007 – Electrical equipment in mines and quarries.

AS/NZS 7000 – Overhead Line Design.

Electricity Supply Act.

National Electricity Rules.

Telecommunications Cabling Provider Rules.

**6.0 REVISIONS**

| ISSUE NO. | SECTION                                     | DETAILS OF CHANGES IN THIS REVISION                                                                                                                                                                                                                                    | CHANGE RISK IMPACT? |
|-----------|---------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| 2         | 2.3.3<br>2.4.6<br>2.8.2<br>Various<br>2.8.5 | Addition of SPS requirements.<br>Addition of CERM2456.<br>Updated EE Non contestable scope for construction of 3-way SS.<br>Update references to CEOS7902 – Design Guidelines for SCADA and DSA.<br>Updated reference to Standard O/H and U/G Connection Arrangements. | Low                 |



| ISSUE NO. | SECTION | DETAILS OF CHANGES IN THIS REVISION                                                                                                                                                                                             | CHANGE RISK IMPACT? |
|-----------|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| 3         | Various | Updated reference to connection compounds.<br>SPS references updated to RAS.<br>Telecommunications requirements updated.<br>Addition of PVT for SS auxiliary supply.<br>Removed reference to NDD. Now Network Development (ND). | Moderate            |
|           | 2.7     | Risk section updated.                                                                                                                                                                                                           |                     |
|           | 2.8     | Connection Compound and 5-way SS options added. Costs updated for all Options. Updated typical Single Line Diagrams and General Arrangements added.                                                                             |                     |
|           | 6.0     | References removed from within doc and added to table.                                                                                                                                                                          |                     |
|           | All     | Update to current brand style guide and template                                                                                                                                                                                | Low                 |

