

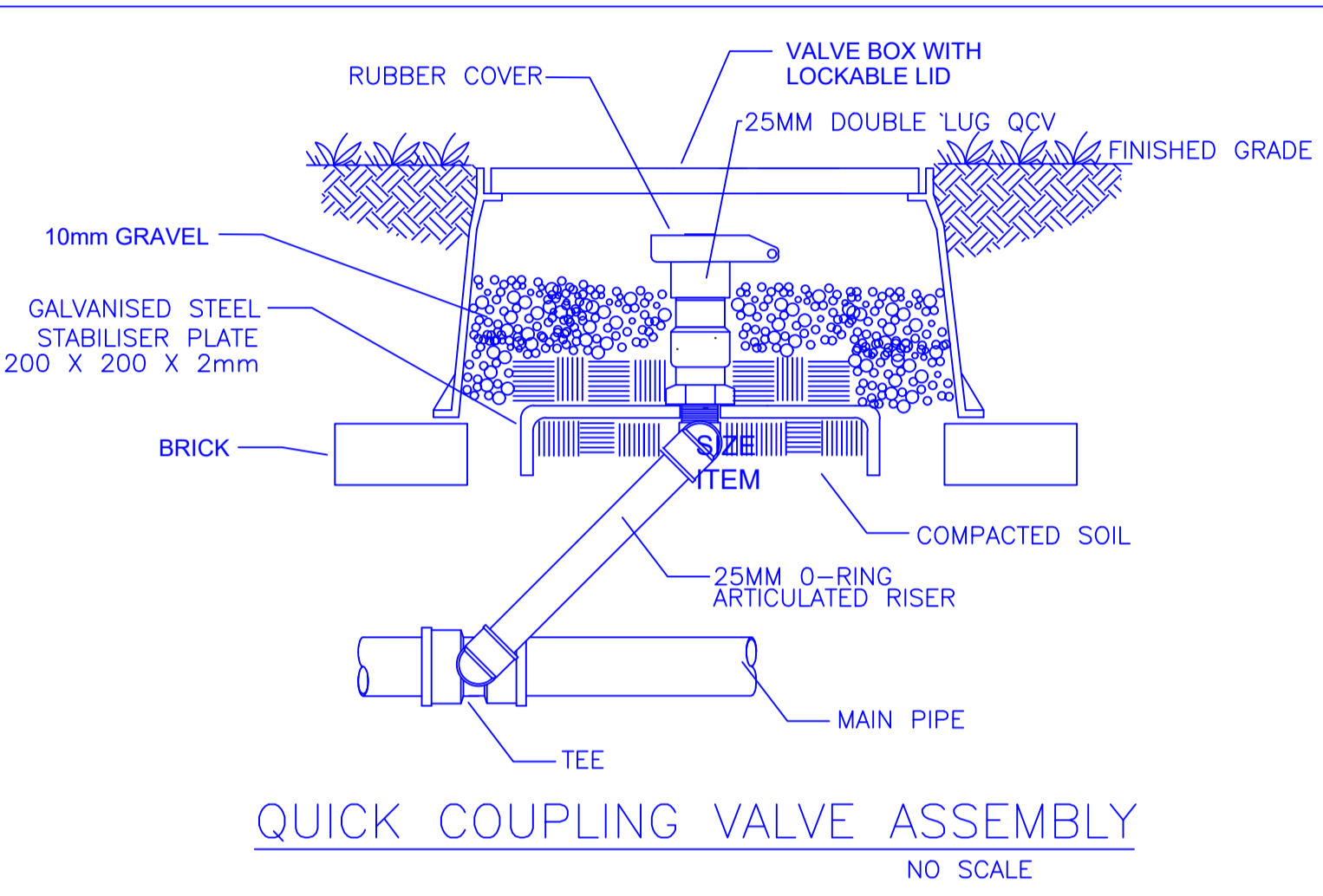
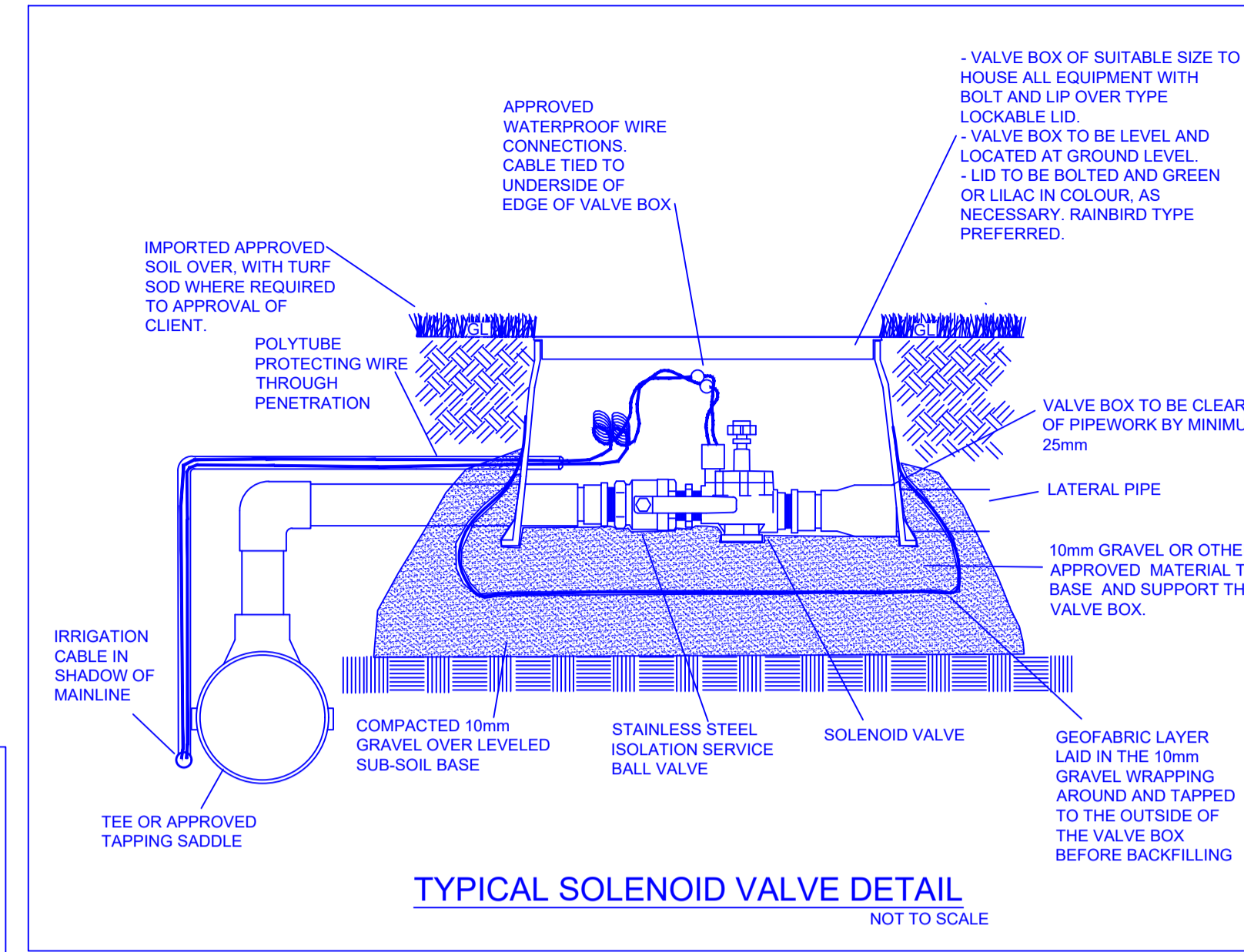
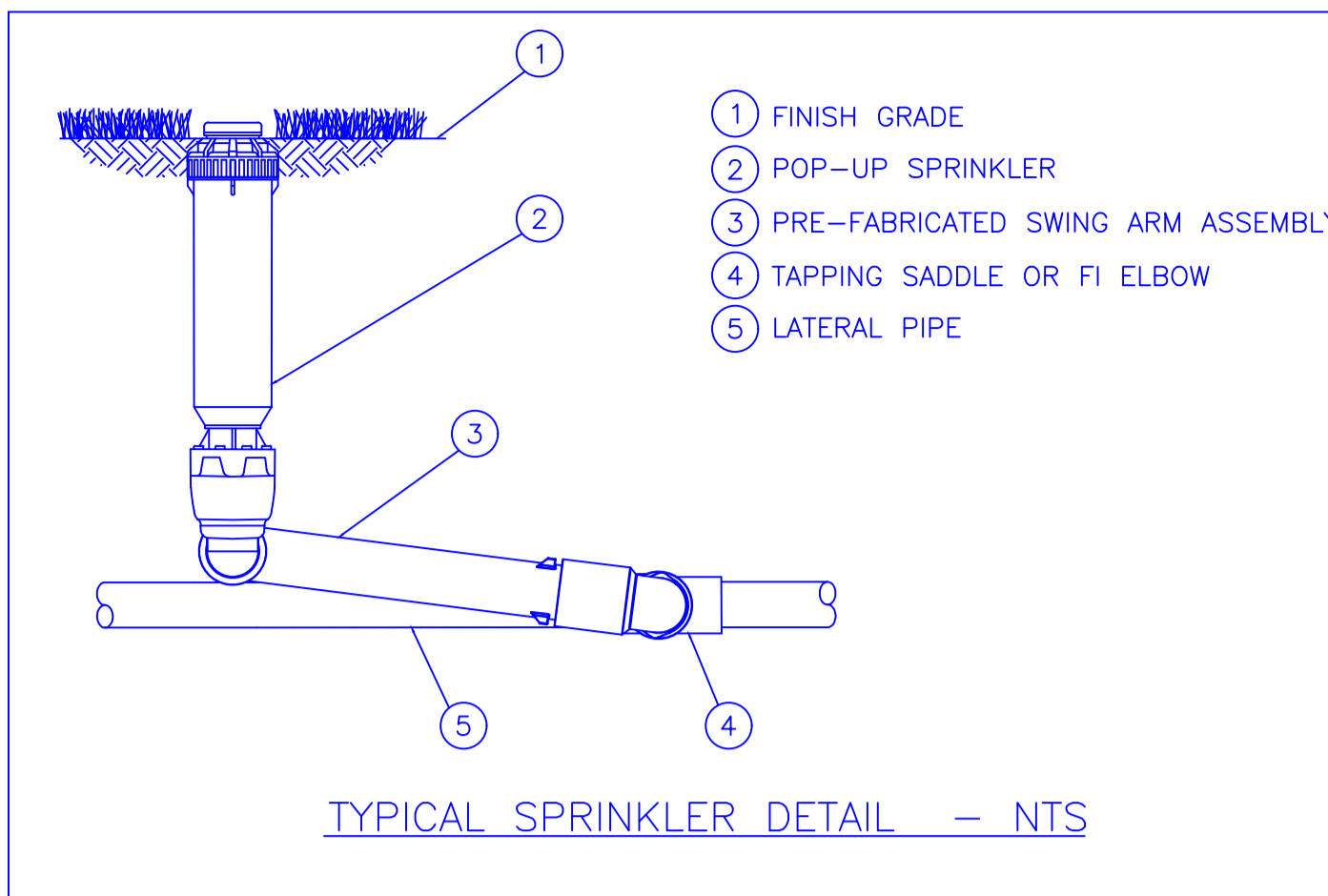
REV	DATE	DESCRIPTION	BY	CHK	APP
1	04/06/20	FSP	JBR	ACE	GA
2	13/07/20	FSP	JBR	ACE	GA
3	15/09/20	TCCS DESIGN REVIEW	JBR	ACE	GA
4	04/12/20	DR SUBMISSION	JBR	ACE	GA
5	10/02/21	FOR TENDER	JBR	ACE	GA
6	19/02/21	REVISED FOR TENDER	JBR	ACE	GA

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ELECTRICAL CONSULTANT:  
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 F/P 02 6284 2215  
 E gordon@ahernce.com.au

PROJECT:  
**COOMBS EDGEWORTH PARADE PLAYGROUND**

DRAWING NAME: ELECTRICAL SERVICES - SITE PLAN		
DRAWING NO: 19008-E2	REVISION: 6	SHEET SIZE: A1
SCALE: 1:250	DRAWN: JBR	APPROVED: ACE



APPROVED UNDER THE REGULATION 7 OF THE CANBERRA SEWERAGE AND WATER SUPPLY REGULATIONS

(CERTIFIED BY) \_\_\_\_\_  
(CONSTRUCTION PRACTITIONERS REGISTRATION NUMBER) \_\_\_\_\_  
(SIGNATURE) \_\_\_\_\_ (DATE) \_\_\_\_\_

APPROVED PLAN No. \_\_\_\_\_


GENERAL NOTE:

- CONTRACTOR TO VERIFY ALL DIMENSIONS ON SITE PRIOR TO COMMENCING WORK.
- THE CONTRACTOR SHALL BE FULLY SATISFIED WITH THE NATURE AND INTENT OF ALL WORK TO BE PERFORMED AND SHALL GUARANTEE THE FINAL SYSTEM PERFORMANCE AND ALL WORKMANSHIP.
- THE CONTRACTOR SHALL NOTIFY THE CLIENT AND/OR THE DESIGNER IN WRITING IMMEDIATELY IF ANY DISCREPANCIES ARE FOUND AND PRIOR TO COMMENCING WORK.
- THIS PLAN IS TO BE READ IN CONJUNCTION WITH OTHER LANDSCAPE, SITE AND SERVICES PLANS AS MAY BE AVAILABLE BY THE CLIENT.
- THE CONTRACTOR IS TO ALLOW TO COORDINATE ALL WORK WITH ANY OTHER TRADES REQUIRED.
- THE CONTRACTOR IS TO RECEIVE WRITTEN APPROVAL FOR ANY VARIATIONS TO BE PERFORMED.
- ALL ITEMS OF EQUIPMENT ARE INDICATIVE OF LOCATION AND SHALL BE ADJUSTED AS NECESSARY ACCORDING TO FINAL SITE CONDITIONS.
- ANY DRIP LINE ROWS SHOWN ARE FOR DEMONSTRATION ONLY AND ARE INDICATIVE AS TO ROW DIRECTION AND SHALL BE ADJUSTED AS REQUIRED ON SITE.
- AS BUILT RECORDS ARE TO BE KEPT AND UPDATED DAILY. FINALS AS BUILT PLANS ARE TO BE SUPPLIED & APPROVED PRIOR TO FINAL COMPLETION.



**LOCALITY SKETCH: EDGEWORTH PARADE PLAYGROUND COOMBS ACT BLOCK 12 SECTION 52**

CERTIFIED IRRIGATION DESIGN:



MATTHEW WILSON

TECHNICAL DATA:  
SYSTEM DUTY AT POINT OF CONNECTION IS TO BE MIN 60l/min @ 340kPa.  
MAXIMUM TOTAL DRAW OFF: 1l/sec  
IRRIGATED AREA: ~5000m<sup>2</sup>  
DESIGNED SYSTEM PRESSURE: 340kPa.

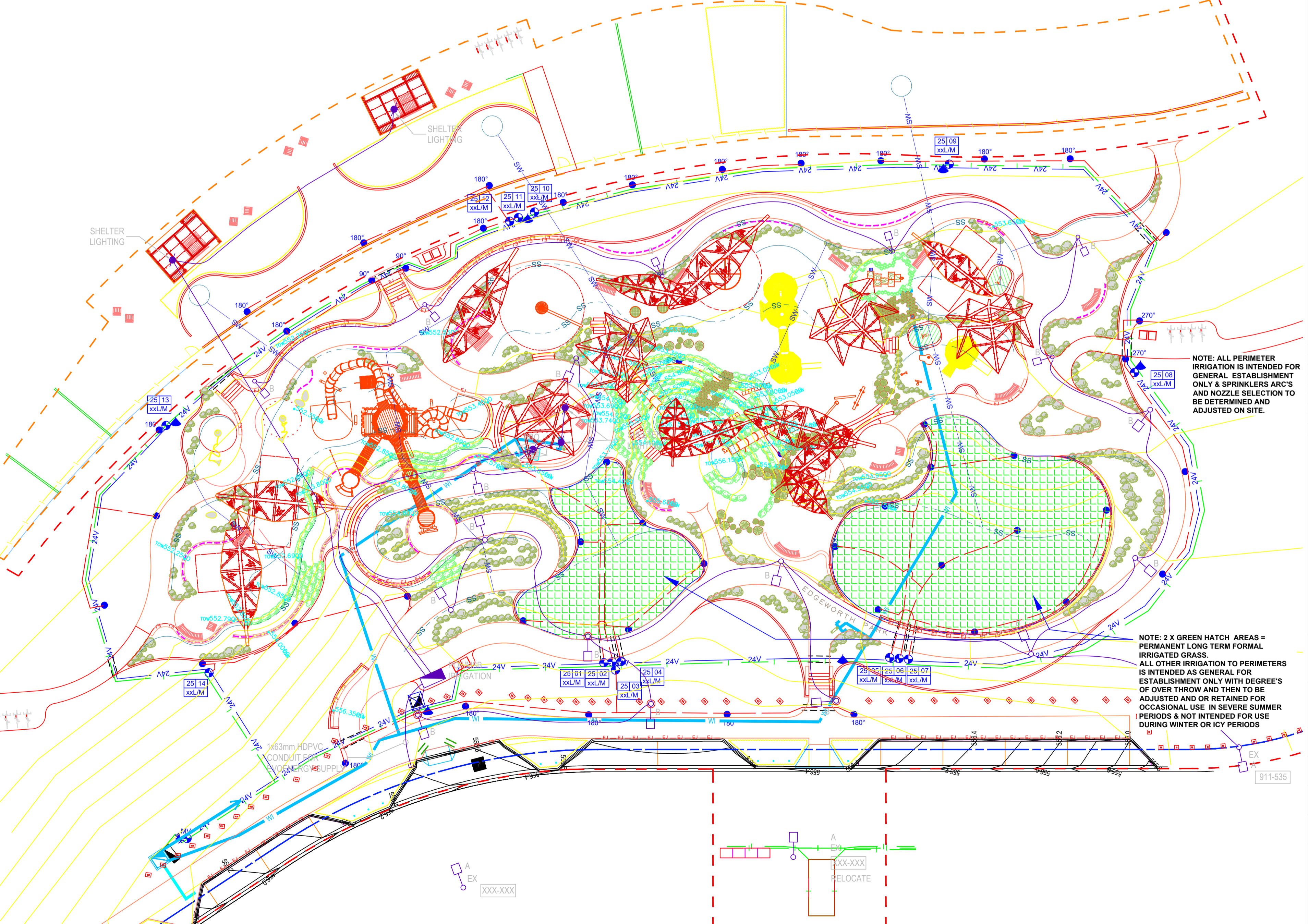
DESIGNED IRRIGATED TURF GRASS SPRINKLERS:  
HUNTER I20-SS 100mm POP UP NOZZLE AS SHOWN ON PLAN AT 275kPa  
FINAL SPRINKLER AT SPACING TO BE DETERMINED ON SITE BY CONTRACTOR GIVING CONSIDERATION TO FINAL SITE CONDITIONS AND OBSTRUCTIONS. NOMINAL AVERAGE SYSTEM APPLICATION RATE IS 15mm/Hr

DESIGNED SPRINKLERS IN GARDENS FOR TEMPORARY PLANTING ESTABLISHMENT AND PERIODIC SUMMER IRRIGATION AS NECESSARY  
NOTE: HUNTER HCV DRAIN CHECK DEVICE TO BE INSTALLED AT LOW POINTS AS/IF/WHERE NECESSARY  
FINAL SPRINKLER LOCATION PLACEMENT AND SPACING TO BE DETERMINED ON SITE BY CONTRACTOR GIVING CONSIDERATION TO FINAL SITE CONDITIONS AND OBSTRUCTIONS ESPECIALLY IN RESPECT OF ROCK PLACEMENTS WITHIN GARDENS.

**GENERAL NOTE:**

- \* CONTRACTOR TO SEEK WORKS APPROVAL AND MAKE APPLICATION FOR CERTIFICATION TO PROCEED WITH THE PROPOSED IRRIGATION SYSTEM IN ACCORDANCE WITH ICON WATER REQUIREMENTS FOR BACKFLOW PREVENTION AND AS3500. ALL SYSTEM COMPONENTS TO COMPLY WITH NEW TC05 IRRIGATION STANDARDS.
- \* IRRIGATION IS INTENDED AS GENERAL COVERAGE ONLY WITH SOME AREAS OF SPECIFIC WATERING OF LAWNS.
- \* THE CONTRACTOR WILL BE REQUIRED TO MAKE CHANGES TO SPRINKLER LOCATIONS "ON THE JOB" AS MAY BE REQUIRED DUE TO PLACEMENT OF ROCKS AND OTHER SITE OBSTACLES.
- \* THE CONTRACTOR IS TO ENSURE THAT CHANGES DO NOT EXCEED STATION FLOW CAPACITIES AND FINAL SPRINKLER PLACEMENT AND NOZZLE PROVIDES COVERAGE AS FAR AS POSSIBLE TO ENABLE PLANT ESTABLISHMENT.
- \* IT IS TO BE ACKNOWLEDGED BY THE LANDSCAPER THAT THERE WILL BE INITIAL HAND WATERING IN OF PLANTS AND SOME ADDITIONAL ONGOING HAND WATERING TO POCKETS OF PLANTING WHERE IRRIGATION DOES NOT REACH.
- \* THIS DESIGN IS PROVIDED AS A BASIS FOR QUOTATION AND TO DEPICT THE COMPLEXITY OF THIS PROJECT AND THE CONTRACTOR ACKNOWLEDGES IT IS NOT A SPECIFIC FINITE DESIGN.
- \* ALL ITEMS INCLUDING FINAL CONTROLLER LOCATION, PLACEMENT OF MAINS, VALVES AND SPRINKLERS, POINT OF CONNECTION ETC ARE SUBJECT TO FLEXIBILITY AND CHANGE ON SITE AND THE CONTRACTOR IS RESPONSIBLE FOR SUCH CHANGE AND IS TO PROVIDE A FINAL PLAN OF THE WORKS IN PDF AND DWG TO STROMLO SYSTEM UPON COMPLETION INDICATING AND SHOWING ACCURATELY (SUB METER), WITH TRIANGULAR MEASUREMENTS, STATION SOLENOID VALVE LOCATION, SPRINKLERS, LATERAL AND MAIN AND CABLE ROUTES ALSO TO BE SHOWN WITH LOCATION OF POINT OF CONNECTION WITH MASTER VALVE BACK FLOW PREVENTION ETC AND ALL PATH CROSSINGS.
- \* SPRINKLERS IN GRASS AND THEIR LATERAL PIPEWORK ARE TO BE ACCURATELY SHOWN. SPRINKLERS IN GARDENS MAYBE SHOWN AS MORE LIBERAL.

- LEGEND:**
- SPRINKLER TYPE 1 HUNTER I20-SS 100mm POP UP SPRINKLER NOZZLE AND APPROX. ARC AS SHOWN.
  - IRRIGATION MAINLINE, 40mm MDPE PN12.5.
  - LATERAL PIPE WORK 32mm MINIMUM MDPE PN 12.5
  - 24V — IRRIGATION CONTROL CABLE MINIMUM 1.0mm MULTI-CORE MULTI-STRAND DOUBLE INSULATED DIRECT BURIED ADJACENT TO MAIN LINE OR IN CONDUIT WHERE THE CABLE MAY DEVIATE AWAY FROM PIPE TO IRRIGATION CONTROL CABINET. MINIMUM 1 SPARE AT ENDS OF ALL CABLE RUNS.
  - ☒ IRRIGATION FREESTANDING PEDESTAL STYLE CONTROLLER CABINET. MINIMUM 1500mm HIGH X 450 X 300 SECURED TO CONCRETE PLINTH AND CONCRETE HARD STAND IN FRONT OF THE CONTROLLER CABINET. CABINET MAY FORM PART OF THE POWER SUPPLY CABINET OR BE LOCATED "BACK TO BACK".
  - ☑ IRRIGATION CONTROLLER TO BE RAINBIRD ESP WITH IQ. COMPLETE WITH RAIN SENSOR AND FLOW SENSOR TO ENABLE REMOTE ACCESS AND DATA LOGGING. SENSOR TO BE LOCATED AT THE BACK FLOW ALONG WITH A 40mm MASTER SOLENOID VALVE.
  - CONDUITS/ UNDER PATH SLEEVES - SIZE AS REQUIRED BY CONTRACTOR - TYPICAL 1000 STORM WATER.
  - ⊕ SOLENOID VALVE HUNTER 25mm ICV WITH PRECEDING 25mm ISOLATION STAINLESS STEEL SERVICE BALL VALVE COMPLETE IN COMMERCIAL 719 LIP OVER STYLE BOLT DOWN VALVE PIT FLUSH WITH GROUND LEVEL. PREFERENCE IS TO VALVE TO BE LOCATED IN GARDENS WHERE FEASIBLE.
  - ⊕ VALVE SIZE STATION NUMBER APPROXIMATE STATION FLOW
  - ⊕ 40mm MASTER SOLENOID VALVE AND RAINBIRD FLOW SENSOR.
  - ⊕ 25mm BRASS QUICK COUPLING VALVE FOR HAND WATERING OF TREES DURING ESTABLISHMENT
  - ⊕ WATER METER NB 32mm (NOT PART OF IRRIGATION WORKS TO BE ESTABLISHED BY PLUMBER ALONG WITH SITE DRINKING BUBBLERS AND POTABLE WATER TAPS.)
  - ⊕ BACKFLOW PREVENTION DEVICE BY IRRIGATION CONTRACTOR FOR IRRIGATION AT POINT OF CONNECTION. TO BE TO AS3500 TESTABLE DOUBLE CHECK 40mm OR 32mm COMPLETE IN EITHER ABOVE GROUND CABINET TO ICON WATER NEW STANDARDS AND APPROVAL OR BELOW GROUND IN VALVE PIT AS APPROVED BY ICON WATER.



REV	DATE	AMENDMENT	BY
E	24-03-2021	ISSUE 1 AND 1 SPRINKLER 6 RENEWED ISSUE 2 FOR PERMANENT	MW
F	22-03-2021	ISSUE 2 FOR PERMANENT AND 2021	MW
D	08-12-2020	ISSUE 2 FOR PERMANENT AND 2021	MW
D	07-12-2020	ISSUE 2 FOR PERMANENT AND 2021	MW
C	24-08-2020	FINAL ISSUE FOR APPROVAL AND TENDER - NOT FOR CONSTRUCTION	MW
B	18-08-2020	ISSUE 2 FOR PERMANENT AND 2021	MW
A	15-08-2020	ISSUE 2 FOR PERMANENT AND 2021	MW



PROJECT: **EDGEWORTH PARADE PLAYGROUND**

TITLE: **IRRIGATION LAYOUT**

CAD BY: M.A.	DESIGN BY: M.W.	CHECKED BY:
DATE: 29-03-21	DATE: 29-03-21	DATE:

BASE BY: Provided by Client

SHEET: 01 of 01 SCALE: 1:250 @A1

DRAWING No: 2067-I-01-01 REV: G

TOTAL IRRIGATION DESIGNERS  
P.O. BOX 577  
BATHURST, NSW, 2795  
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DR FOR APPROVAL AND TENDER - NOT FOR CONSTRUCTION



*Eagle Electromagnetic Design Services*

*Pty Ltd*

ABN 17 130 932 222

**TO: Mr. Gordon Ahern  
Principal Electrical Engineer,  
Ahern Consulting Engineers**

## **Substation Earth Mat Performance Study**

**Project:  
Coombs Edgeworth Parade Play Space**

**Report Number: 20-006**

**Issue A**

**Issue Date: 4/8/2020**

**Report Prepared by: - Gary Graham**

## A. Summary

**This Substation Report is for information only. To ensure safety precautions have been undertaken to the satisfaction of Evoenergy. The developer is to undertake his own assessments prior to lodging a “Request for Preliminary Electrical Network” with Evoenergy and prior to lodging a D.A. with EPSDD.”**

This report summarises the calculated the Earth Potential, Touch and Step potential effects resulting from an 11kV phase to earth fault at the Evoenergy padmount substation S9935, on the proposed Coombs Play Space to be located on the foreshore of the lake (Section 52) along Edgeworth Parade. The substation is located at the south western corner of Edgeworth Parade and Stan Davey Rise.

The author uses Advanced Grounding Concepts WinIGS finite element analysis software to model the Earth Potential Rise, Touch and Step potentials emanating from the substation across the whole play space. All 10 of the 11kV/415V distribution substations located around the Coombs precinct and the interconnected district LV earthing (layout provided by Evoenergy) have been included in the modelling. The assumed typical/standard earthing installation is to the requirements of AS3000 at the Coombs Play Space i.e. a 1.2 metre earth rod outside the Site Point of Entry/Main Switch Board at the south west of the Play Space. Two scenarios are investigated to determine compliance with the earthing risk analysis of AS 2067:2016: -

- i. For the probable (but not confirmed) existing substation separate HV and LV earthing arrangement of all 10 substations.
- ii. For a possible CMEN substation earthing connection of all 10 substations.

**The outcome of this study is:**

### **Separate HV & LV Earthing at all 10 Substations**

- iii. The Line-Earth fault current at the Substation 9935 HV Main Earth Bar is 627 amps.
- iv. The Earth Potential Rise due to the substation’s HV earth mat is only 398 volts at the substation HV Main Earth Bar. The earth potential falls to only 66 volts at the nearest point along the Play Space fence.
- v. The corresponding Earth Potential Rise due to the substation’s LV earth electrode is only 19 volts at the substation LV Main Earth Bar. This voltage rise is transferred to the Play Space Main Earth Bar, providing the reference voltage at any play or electrical equipment bonded to the Play Space electrical system. The touch potential anywhere across the Play Space must be less than 56 volts

**The computed touch potential plot shows the maximum is only 45 volts.**

- vi. **Therefore, an 11kV line to earth fault at S9935 produces no hazardous touch potentials across any portion of the Coombs Play Space, thereby complying with the earthing requirements of AS 2067:2016.**

### **Combined (CMEN) Earthing at all 10 substations**

- vii. The Line-Earth fault current at the Substation 9935 HV Main Earth Bar is 638 amps.
- viii. The Earth Potential Rise due to the substation’s HV and connected LV earth mats is only 104 volts at the substation’s HV and LV Main Earth Bars. The earth surface potential falls to only 32 volts at the nearest point along the Play Space fence.
- ix. The substation LV Main Earth Bar EPR is transferred to the Play Space Main Earth Bar, providing the reference voltage at any play or electrical equipment bonded to the Play Space electrical system. A touch potential profile shows the maximum touch potential is 97 volts at the north west boundary of the Play Space.

**This is less than the maximum allowable limit (120 volts), thereby also complying\* with the earthing requirements of AS 2067:2016.**

*\*The satisfactory performance of the earth system for the CMEN connection is subject to the 11kV fault clearance time at substation 9935. The author has assumed a calculated time of 0.8 second based on the parameters of Section B.(ii). If a CMEN earthing system already exists across the Coombs precinct, or the decision is made to convert to CMEN, the actual clearance time needs to be confirmed and if necessary, set to no more than 1.0 seconds to maintain compliance with AS 2067:2016.*

## B. Modelling

In determining the fault model using WinIGS, the author uses the following information gained specifically for this project:

- i. Soil Resistivity measurements carried out by Colterlec – on 17/7/2019 at the Play Space site; and on 6/7/2015 within the Coombs precinct.
- ii. Feeder circuit/network maps provided by Evoenergy. The relevant information is:
  - Woden Zone Substation supplies the Coombs precinct. All cable and overhead line conductor sizes and lengths have been gained from a layout map.
  - The Coombs 11kV feeder route from Woden Zone substation contains overhead line sections which are 3 wire only (e.g. over Tuggeranong Parkway). This means that the only return path for the fault current to the Woden Zone Substation transformer neutrals is via the soil.
  - With reference to the ActewAGL Electrical Data Manual (Doc. No. EN 4.04 P10 – pages 5, 8), Woden's Transformer capacity = 3 x 50 MVA ONAN (per transformer), 132/11kV, YNd1 configuration, with the 132kV neutral of each transformer connected directly to earth.
  - With reference to Clause 5.8 of the newly released draft document "Distribution Earthing Design Manual Appendix A – Evoenergy Distribution System",
    - The near (to Woden substation) line-earth fault current is limited to 3kA for each main transformer. To model this in WinIGS, the author has used a 2.13 MVA zigzag transformer as the neutral current limiting device connected to the 11kV delta secondary winding of each main transformer.
    - The 11kV fault clearance characteristic at the Woden substation is IEC Type A Standard curve inverse time – based on 0.5s for 2.5kA and 1 sec for 300A. This curve is used to calculate the fault clearance time in the Argon Software analysis of allowable Touch Potentials (refer Section D).
    - The standard operation of the Woden main transformers is separation of the 11kV secondaries. Parallel operation occurs for very short periods (a few minutes) almost every day. However, Evoenergy considers the probability of coincidence with an earth fault at the distribution substation to be small (negligible?). The author has therefore modelled the effect of an 11kV earth fault at the relevant distribution substations on the Coombs Play Space based on a single 50MVA feeder supply from Woden Zone substation.
  - Conductor sizes along the feeder are shown on the WinIGS Single Line Diagram (Appendix C)
  - Standard screen sizing is 22.7 mm<sup>2</sup> per core according to the Olex 11kV cable catalogue.
  - Substation 9935 capacity = 500 kVA. All other substation capacities are shown on the SLD overview (Appendix C).
  - The local earthing layout of the 10 padmount substations and their respective HV and LV connections are according to the following Evoenergy drawings:
    - 392-8-01 (Padmount Substation HV, LV & Grading Ring Earthing Arrangement).
    - D303-0009 (Standard Construction, Distribution, Underground, Stations, Sub-Assembly, SA, Earthing, Separate Earthing HV and LV Padmount Substation).
    - The additional deep electrodes shown on the drawing are 20 metres long.
    - Substation canopy dimensions are approximately 3000 (L) x 1300 (W) x 1700 (H) for the 315kVA and 500kVA substations. The 1500kVA substation is estimated from Google Earth to be 4000 (L) x 2400 (W) x 2000 (H). The transformer earth ring extends 1000 mm from the canopy.

*Computed HV electrode earth resistance of the 315 and 500kV substations is ~ 4.2 Ω. For the 1500kVA substation the computed earth resistance is ~ 3.9 Ω.*
  - The HV earth systems of all 10 padmount substations are assumed to be connected via the 11kV cable screen conductors.

The WinIGS modelling is according to the following flow process:

- i. Developing a 3-layer soil resistivity model from the test measurements (Refer Section C).
- ii. Preparing an electrical layout of all relevant substations. This is shown in the SLD (Refer Appendix D1 for the Node Earth Potential Rise under a fault condition). These diagrams include lengths and sizing of overhead lines and cables.
- iii. Preparing an earth system layout of the total Coombs precinct for the separate HV and LV earth systems of all 10 substations and the district LV earth systems connected to each of the substations. The district earthing layout is according to information provided by Evoenergy. This earth system layout may be seen in Appendix B2.
- iv. Determining the safety performance criteria of the proposed Coombs Play Space earthing system according to Section 8 'Earthing Systems' and Appendix B – Substation Earthing Systems of AS 2067:2016, by using Argon software supplied with the standard. This is discussed in detail in Section D of this report. Though the Argon software nominally determines a safe step potential limit, the values are unbelievably large. The author has therefore chosen to use a value determined from IEEE 80 criteria.
- v. Computing the maximum earth bar potential rise and contour plots of equal touch, earth and step potentials for the standard AS3000 LV earthing of the proposed Coombs Play Space located outside the Main Switch Board at the south western end of the Play Space. Underlying these plots is an image of the Play Space site to show where hazardous areas may occur under an earth fault condition.
- vi. Section E examines the performance of the standard AS3000 earthing arrangement for the Coombs Play Space against the requirements determined in Section D.

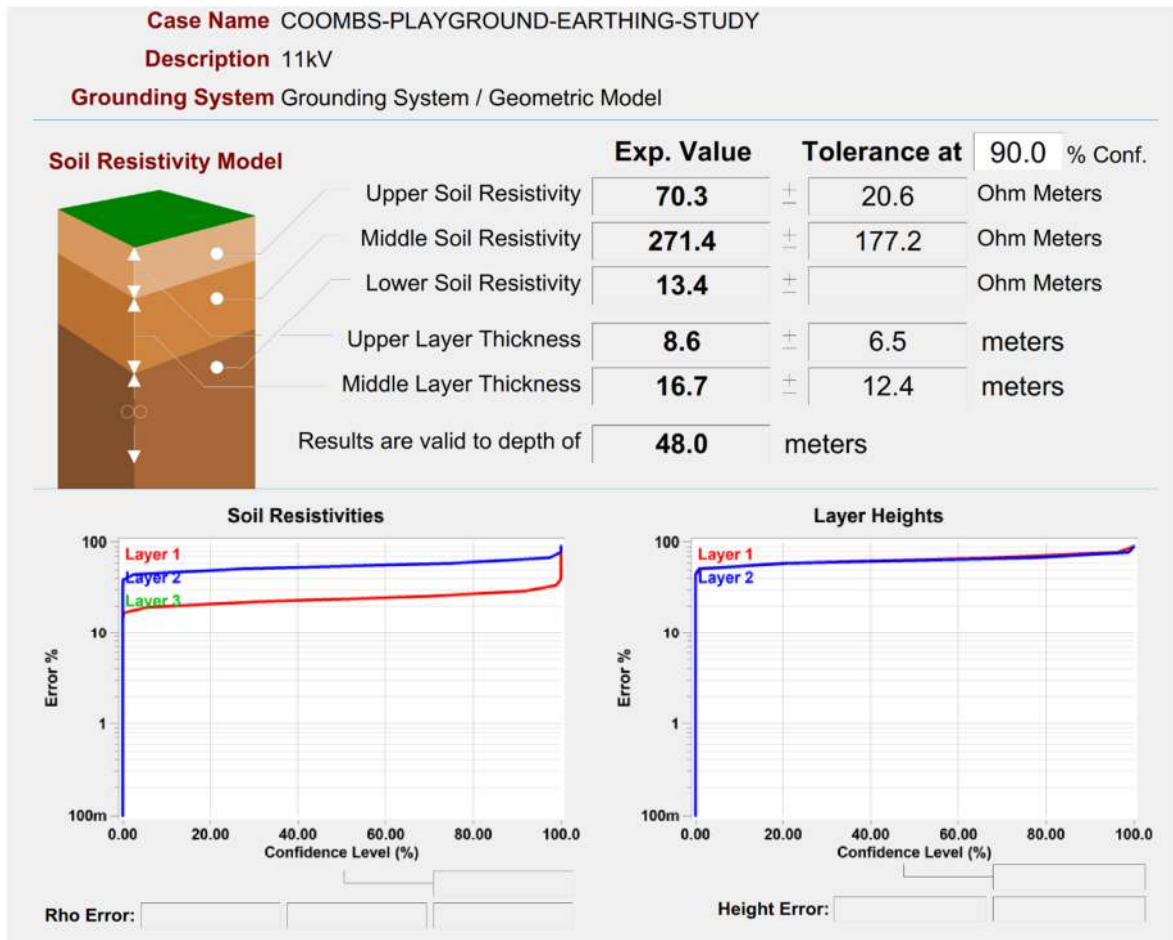
## C. Soil Resistivity

- i. At the instruction of the author and using the Wenner method, Colterlec took soil resistivity measurements along 2 mutually perpendicular traverses at the site of the Coombs Play Space. Measurements along a 150 metre east west traverse allowed for 50 metres probe spacing. However, along the north south traverse the maximum probe spacing was only 16 metres due to the lake. The author has therefore also referred to measurements taken in 2015 (by Colterlec). These measurements were along 2 x 96 metre traverses with centre points 480 and 670 metres south of the recent measurements. The Google Earth image shows the locations of both sets of measurements and the table shows the soil resistivity measurements for each electrode spacing.



Sample Number	Probe Spacing (meters)	Probe Length (meters)	Apparent Resistance (Ohms)	Resistivity Ohm-Meters	
July 17 <sup>th</sup> 2020	1	0.50	0.05	22.47000	70.59200
	2	1.00	0.05	7.05000	44.29600
	3	2.00	0.10	2.13000	26.76600
	4	4.00	0.10	1.59000	39.96100
	5	8.00	0.15	1.44000	72.38200
	6	16.00	0.15	1.05000	105.56000
	7	24.00	0.15	1.20000	180.96000
	8	32.00	0.15	0.61000	122.65000
	9	50.00	0.15	0.29000	91.10600
	10	0.50	0.05	30.10000	94.56200
	11	1.00	0.05	11.27000	70.81100
	12	2.00	0.10	6.14000	77.15800
	13	4.00	0.10	3.23000	81.17900
	14	8.00	0.15	1.80000	90.47800
	15	16.00	0.15	1.55000	155.82000
July 6 <sup>th</sup> 2015	16	1.00	0.05	18.07000	113.54000
	17	2.00	0.10	7.96000	100.03000
	18	4.00	0.10	4.58000	115.11000
	19	8.00	0.15	2.14000	107.57000
	20	16.00	0.15	1.02000	102.54000
	21	24.00	0.15	0.94000	141.75000
	22	32.00	0.15	0.62000	124.66000
	23	1.00	0.05	9.44000	59.31300
	24	2.00	0.10	11.71000	147.15000
	25	4.00	0.10	1.63000	40.96600
	26	8.00	0.15	2.14000	107.57000
	27	16.00	0.15	0.62000	62.32900
	28	24.00	0.15	0.56000	84.44600
	29	32.00	0.15	0.54000	108.57000

- ii. WinIGS has determined the following 3-layer soil resistivity model for the average of measurements at each probe spacing along the 4 traverses.
- iii. This model shows using earth rods deeper than 6.5 metres will provide minimal improvement in the performance of an earth system.



## **D. Determination of Touch Voltage Limit & Probabilistic Design Details**

### **i. Argon Software**

The author has used the Argon – Safety Assessment software made available with AS2067:2016 to determine the allowable touch voltage limit and the probability of a fatality associated with this limit. Input data applied to this software is determined as below. This software applies the deterministic principles of ENA EGO for common scenarios:

### **ii. Fault Frequency at Substation 7756**

From EGO, Table E2, the author has assumed an average of 1 line to earth fault every 10 years (i.e. 0.1 faults/year).

### **iii. Contact Scenarios**

The author has selected an MEN scenario for the Coombs Play Space due to its connection to the overall Coombs MEN network and therefore greater possibility of earth faults at other substations having influence at the site. The probability of coincidence is chosen as Societal with a population of up to 100. Based on this, the average contacts/year/person = 1500 and the average contact duration = 4 seconds.

### **iv. 11kV Fault Duration = 0.6 seconds.**

Based on the Evoenergy setting guidelines (Refer Section B) – i.e. clearance time = 0.5s for 2.5kA and 1s for 300ms for tripping an 11kV fault at substation 9935 via the Woden zone backup circuit breaker,

The necessary relay pickup current = 50A,  
The TMS setting = 0.23,  
The Circuit Breaker actuating time = 0.107s.

Applying the computed fault current 627A, the calculated fault clearance time = 0.8 seconds. This is the backup fault clearance time the author has specified in Argon. It is the worst condition since the expected fault clearance time of the primary protection at substation 9935 will be less.

### **v. Upper Layer Soil Resistivity = 100 $\Omega$ .m**

### **vi. Surface cover**

The worse condition of bare soil is chosen due to the large playing area although the author acknowledges the likelihood of rubberised safety ground cover which will increase the resistance to hazardous body current.

### **vii. Footwear.**

Standard footwear is chosen.

### **viii. Argon Output**

(a) For a maximum allowable touch potential for negligible risk = 120 volts

(b) The probability of heart fibrillation at this voltage  $P_{\text{fibrillation}} = 1.33\%$

## **Conclusion**

For the location of the Coombs Play Space relative to substation 5390, a value of 109 volts is chosen as the maximum permissible touch potential limit that provides a negligible risk of fatality.

**The Argon – Safety Assessment Reports are attached in Appendix B.**

## **Step Potentials IEEE 80**

*The Argon software computes the allowable step voltage for the above criteria = 3268 volts. The author does not accept this as a realistic value and instead reverts to the use of the IEEE 80/ENA EG1 calculation method.*

The allowable step potential according to IEEE 80 over bare soil = 183 volts.

## E. Performance of Standard Coombs Play Space Earthing (1.2m earth rod)

Using the above information and assumptions, the WinIGs model calculates the following for an 11kV Line to Earth fault at substation 9935:

- Computed Results at Substation 9935:

11kV L-E Fault at SS 9935		
With Earthing of all 10 Substations within Coombs Precinct	Separated HV/LV	CMEN
Fault Current	627.0A	638.2A
Earth Current	639.6A	651.0A
Main Earth Bar Potential	HV = 397.5V	HV = 103.5V
	LV = 19.4V	LV = 103.5V
Computed Earth Resistance as seen at Main Earth Bar	HV = 0.621Ω	HV = 0.159Ω
	LV = N/A*	HV = 0.159Ω

\* All LV earth current is recirculating between different voltage contours. None returns to Woden Zone substation.

- Computed Earth resistances of Substation 9935 and Coombs Play Space in isolation:

SS 9935 HV Earth Grid	4.19Ω
SS 9935 LV Earth Rod	5.67Ω
Play Space Earth Rod	53.2Ω

- Earth Bar Potentials

Appendices D1 & E1 shows the Earth Bar potentials at all substations within in the Coombs precinct feeder network for a fault at S9935 for Separated HV/LV Earthing and CMEN respectively.

- Earth Surface Potential

*For a Fault at S9935*

The maximum earth surface potential across the Coombs Play Space is:

Separated HV/LV earthing	66V	Boundary Fence – intersection of Edgeworth Parade/Stan Davey Rise
CMEN earthing	32V	Boundary Fence – intersection of Edgeworth Parade/Stan Davey Rise

Refer Appendix D2 & E2 for the respective Earth Surface Potential plot.

- Touch Potentials

*For a Fault at S9935*

- The maximum touch potential across the Coombs Play Space is:

Separated HV/LV earthing	45V	Boundary Fence – intersection of Edgeworth Parade/Stan Davey Rise
CMEN earthing	97.5V	NW boundary adjacent to lake at shelters

- Refer Appendix D2 & E2 for the respective Earth Surface Potential plot.

- Step Potentials

All Earth surface potentials are << the maximum allowable step potential limit (183V). This means that Step potentials across the Coombs Play Space are quite safe.

## F. Coombs Play Space AS 3000 Standard Earthing Conclusions

**In the event of an 11kV line to earth fault at the substation S9935, the assumed AS 3000 standard 1.2m earth rod provides a safe environment across the whole of proposed Coombs Play Space.** This applies for both the condition of (a) Separated HV/LV earthing or (b) CMEN earthing of all 10 substations along the network feeder system within the Coombs precinct.

**Attachments:**

**Appendix A – District Layout of Feeder and Modelled Substations**

**Appendix B1 – SLD of WinIGS Model**

**Appendix B2 – Earthing Layout of the Coombs Precinct**

**Appendix C – Argon Safety Assessment Report (6 pages)**

**Appendix D1 – Node EPRs, Fault at S9935, Separated HV/LV earthing at all feeder substations**

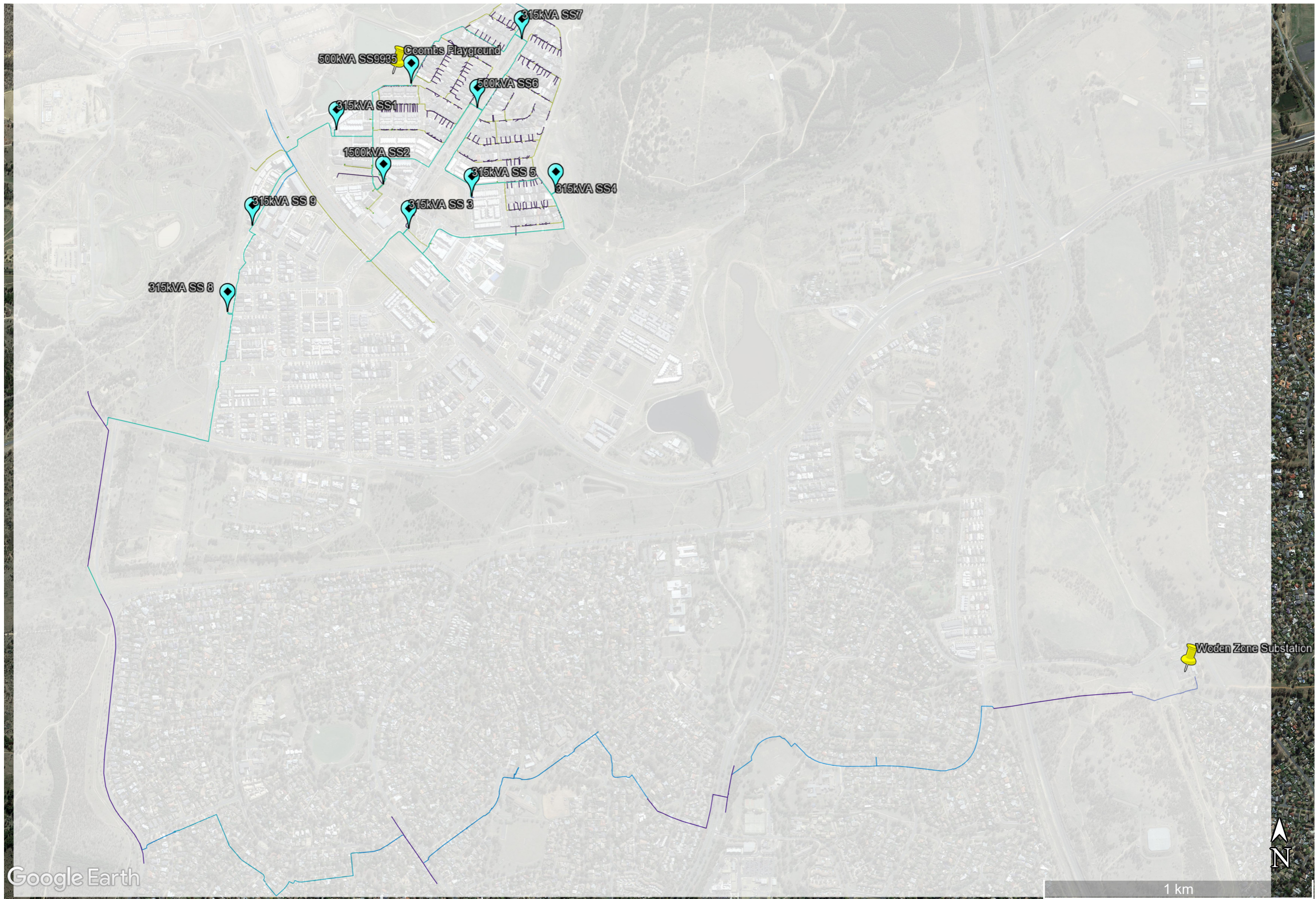
**Appendix D2 – Earth Potential Plot, Fault at S9935, Separated HV/LV earthing at all feeder substations**

**Appendix D3 – Touch Potential Plot, Fault at S9935, Separated HV/LV earthing at all feeder substations**

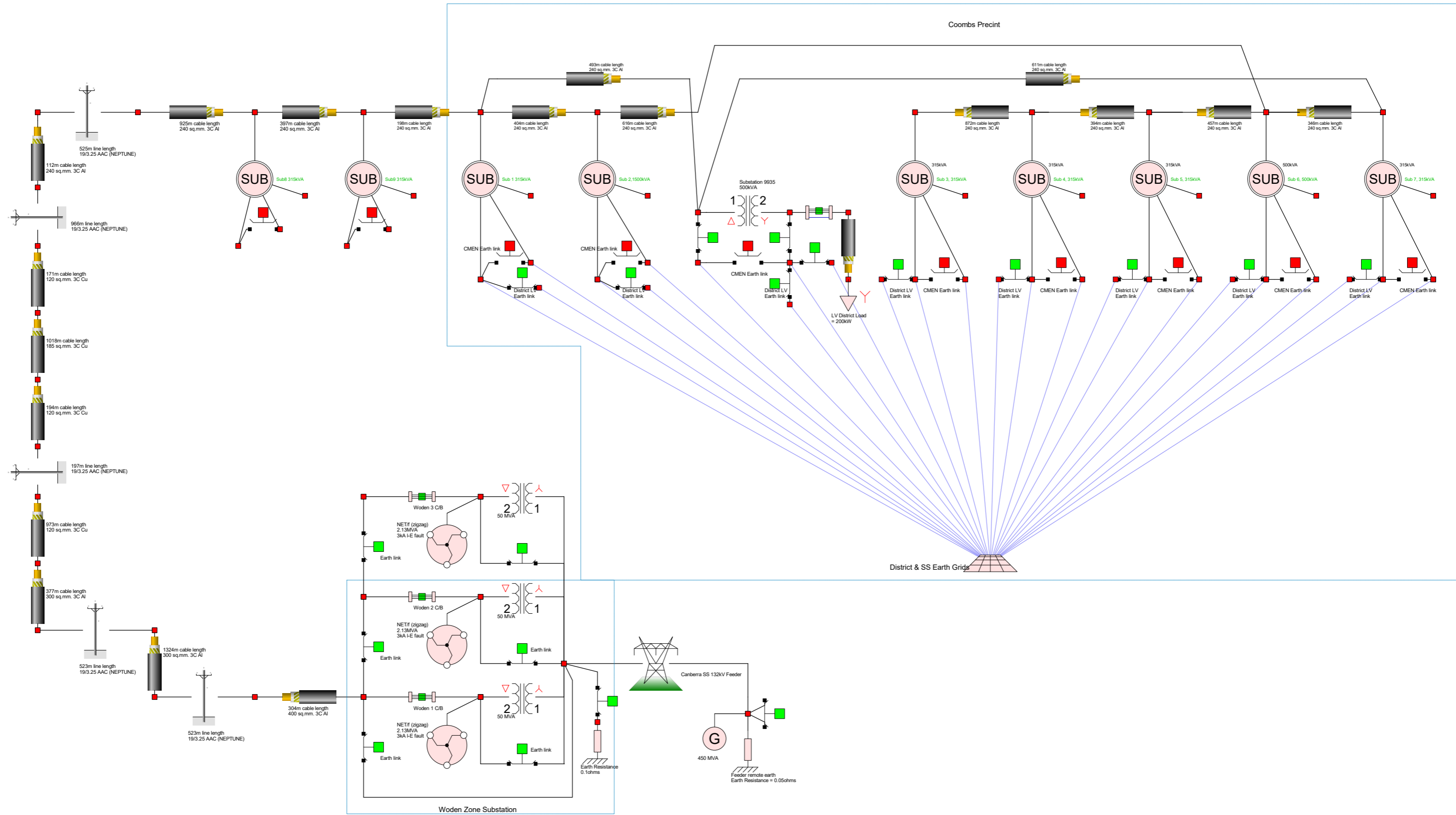
**Appendix E1 – Node EPRs, Fault at S9935, CMEN earthing at all feeder substations**

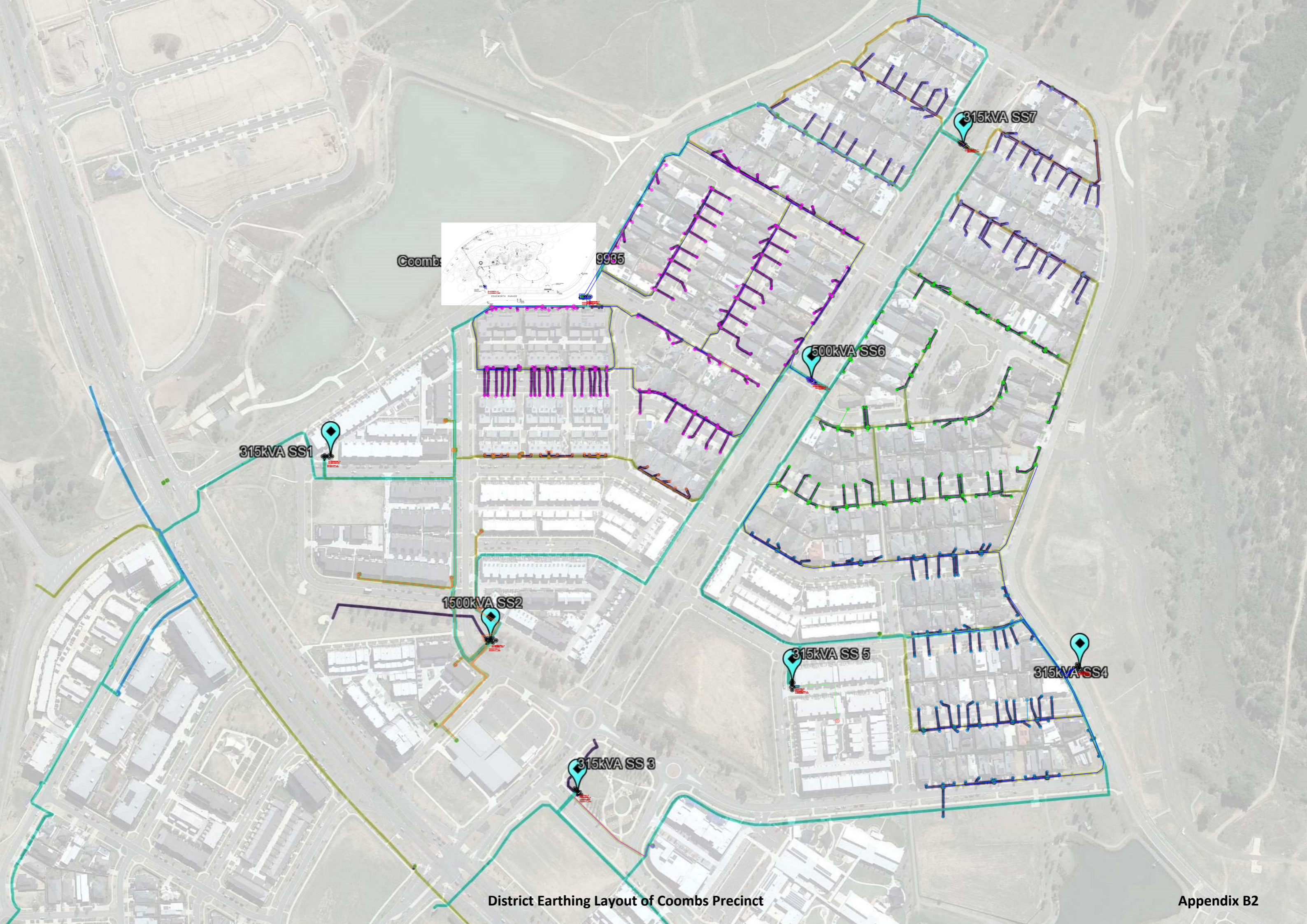
**Appendix E2 – Earth Potential Plot, Fault at S9935, CMEN earthing at all feeder substations**

**Appendix E3 – Touch Potential Plot, Fault at S9935, CMEN earthing at all feeder substations**



District Layout of Feeder and Modelled Substations





Coombs



9985

315kVA SS1

1500kVA SS2

315kVA SS3

315kVA SS5

315kVA SS4

500kVA SS6

315kVA SS7

District Earthing Layout of Coombs Precinct

# ARGON - SAFETY ASSESSMENT REPORT

Report Generated On : 4 August 2020

Report Generated By : Gary Graham

from : Eagle Electromagnetic Design Services

Design Location : Coombs Play Space

## INTRODUCTION

### Individual Probability of Fatality

This report outlines the results of a risk-based safety criteria assessment study for the above location. The analysis is based on the fact that a fatality due to contact with an external voltage can only occur if both a person is present when a fault occurs and the touch (or step) voltage generated is sufficient to allow a large enough current to pass through the body for sufficient time to cause fibrillation of the heart muscle. The probability that an individual will be present and in contact with an item at the same time that the item is affected by a fault is defined as the Probability of Coincidence ( $P_{coinc}$ ). The probability that the heart will enter ventricular fibrillation due to contact with an external voltage is the Probability of Fibrillation ( $P_{fibrillation}$ ). This situation can be described by the following simple equation:

$$P_{fatality} = P_{coinc} * P_{fibrillation}$$

The probability of coincidence has been calculated using contact and fault data as detailed in this report. The probability of fibrillation has been calculated using the impedance and applied voltage / clearing time information as detailed in this report.

The calculation of the probability of fatality allows the design to be classified according to risk targets ( $1e-6$  to  $1e-4$ ) as either negligible risk, intermediate risk or intolerable risk.

### Societal Probability of Fatality

For situations where more than one person may feasibly be present at any time, the individual process outlined above is modified slightly to allow for an altered societal probability of coincidence and hence probability of fatality to be calculated in accordance with accepted F-N curves. For societal probability of fatality, the targets are altered from the individual targets based on the frequency of occurrence of N or more deaths. This allows sliding scales to be defined which classifies the negligible, intermediate and intolerable risk zones for a given population size. A design curve can be defined over a range of clearing times which corresponds to the highest applied voltage in the negligible region for each clearing time.

### Design Compliance

Designs with a negligible risk determination are accepted and the attached design curve(s) may be used at locations with similar contact, fault and series impedance characteristics. Designs which are determined as high risk are not acceptable and there is no valid design curve available until mitigation results in a compliant design. Designs placed in the intermediate risk range may be considered compliant provided the ALARP (As Low As Reasonably Practicable) principle is applied. For designs of this type, documentation is supplied at the end of this report outlining the justification.

The following information outlines the design assumptions and classifies the compliance of the design.

## COINCIDENCE PROBABILITY

### Access / Fault Assumptions

**Scenario Name** MEN

**Description** Multiple contacts with items associated with the MEN on a daily basis

			<i>Individual</i>		<i>Societal (popn = 100)</i>	
<b>Fault Frequency</b>	.1	<i>per year</i>	<b>Contact Frequency</b>	2000 <i>per Year</i>	1500	<i>ave / Year / Person</i>
<b>Fault Duration</b>	0.8	<i>seconds</i>	<b>Contact Duration</b>	4 <i>seconds</i>	4	<i>seconds</i>

### Coincidence Reduction

**Coincidence Reduction Method** None

**Coincidence Reduction Factor** 1

**Individual Coincidence Probability =** 3.04e-5

## FIBRILLATION PROBABILITY

### Assumptions

<b>Current Path</b>	Touch Voltage	
<b>Footwear</b>	Standard Footwear	
<b>Wet / Dry ?</b>	Dry	
<b>Soil Resistivity</b>	100	$\Omega$ -m
<b>Applied Voltage</b>	120	<i>volts</i>
<b>Fault Duration</b>	0.8	<i>seconds</i>

### Surface Layer

<b>Type</b>	None	
<b>Resistivity</b>	0	$\Omega$ -m
<b>Depth</b>	0	<i>metres</i>
<b>Flashover Voltage</b>	Not Specified	<i>volts</i>

**Fibrillation Probability =** 0.0133

# RISK DETERMINATION

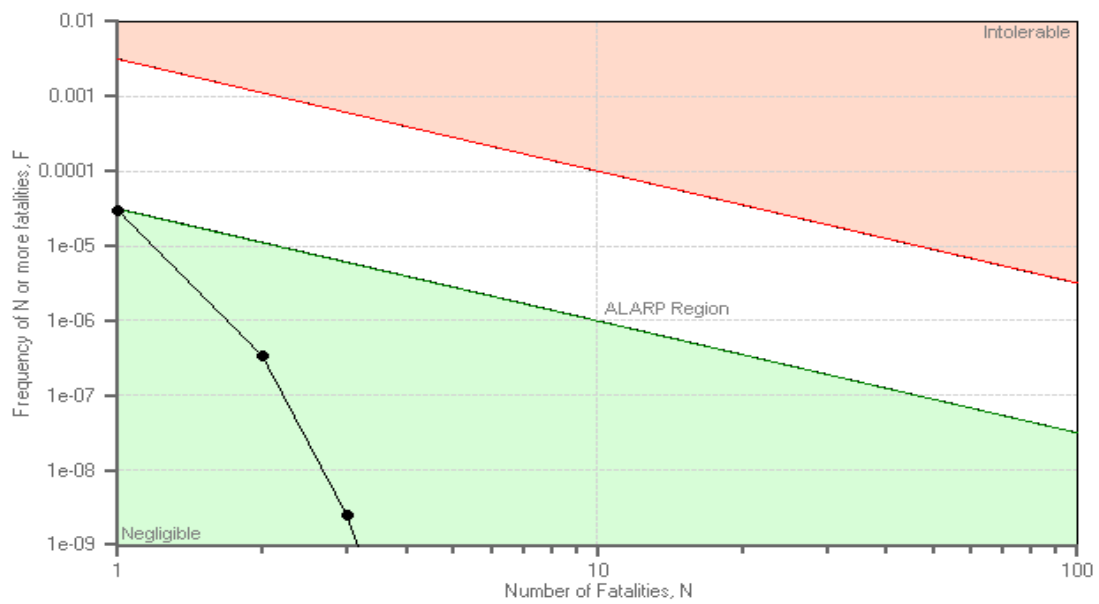
## Individual

<b>Risk Zone :</b>	Negligible
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Probability of Fatality =  $4.034e-7$

## Societal

Societal Fatality Risk, Population Size = 100



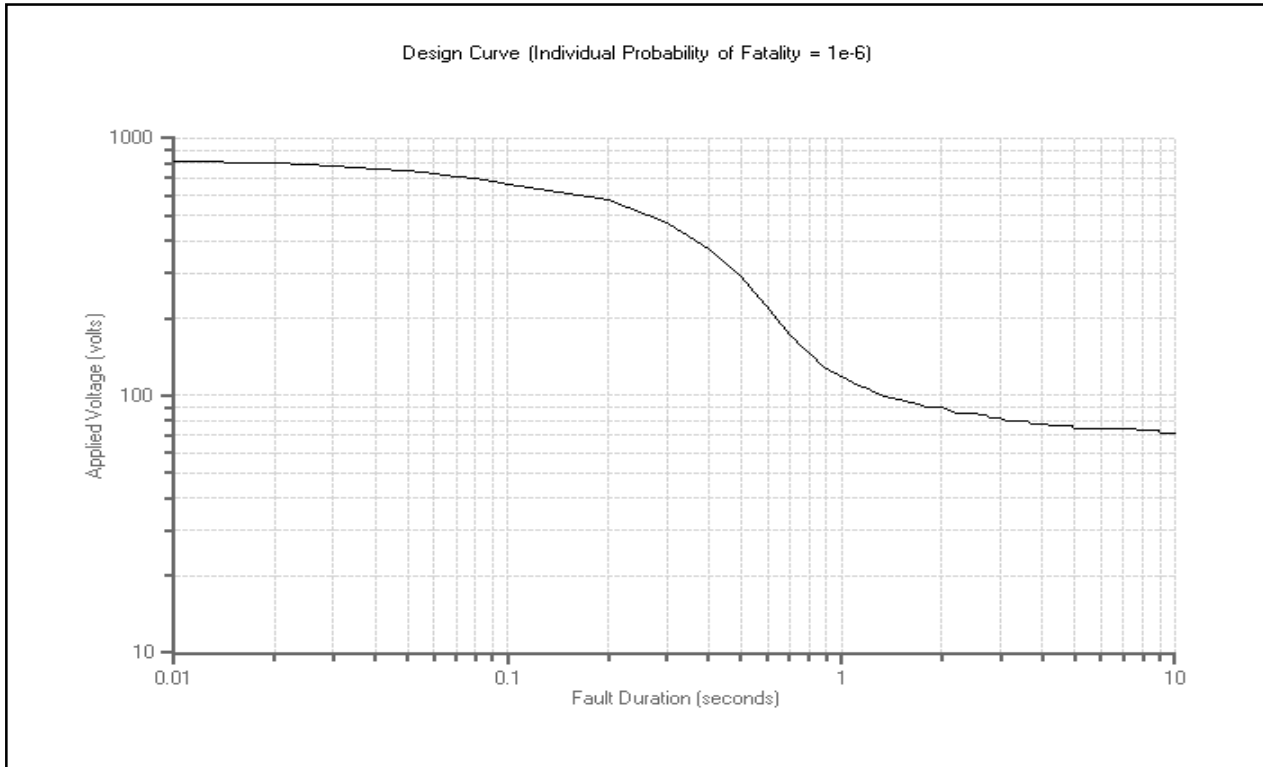
## Worst Case Risk Zone

<b>Risk Zone :</b>	Negligible
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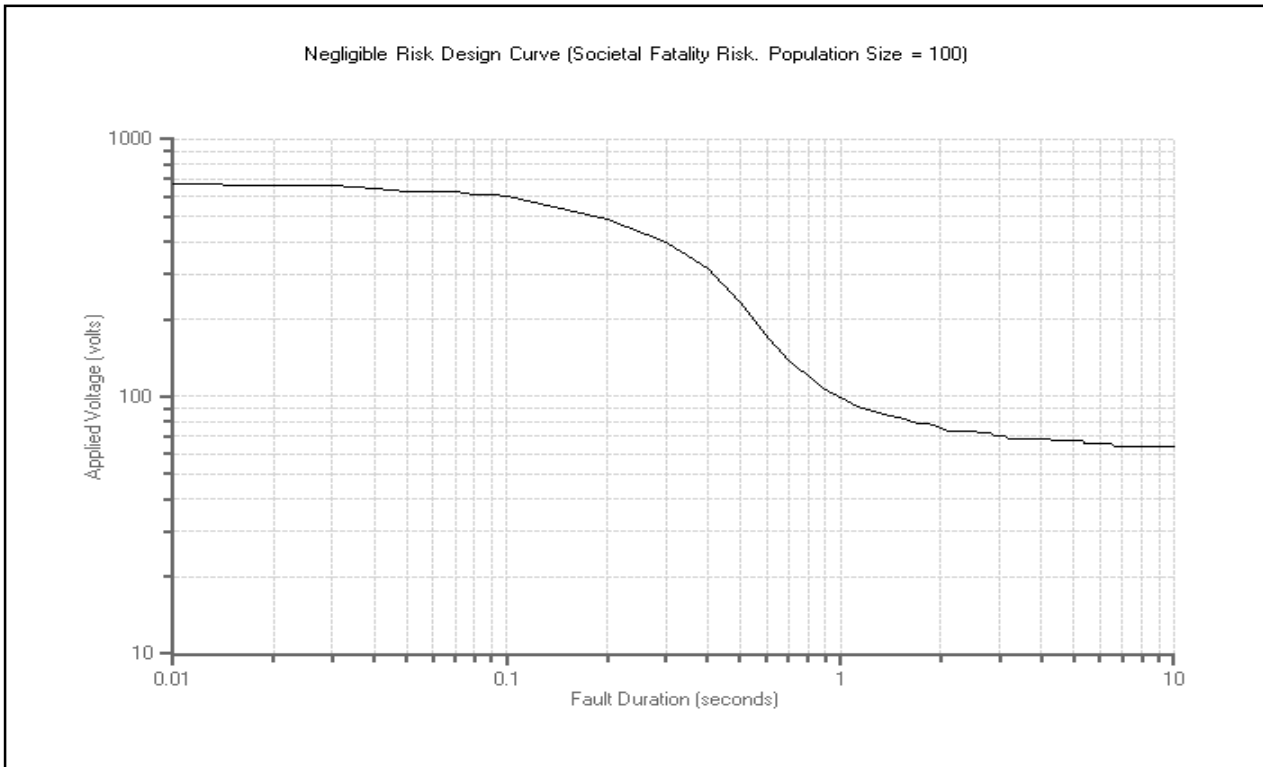
## DESIGN CURVE

These curves are valid for designs which have contact, fault, and series resistance characteristics similar to those outlined in this report. Fault duration need not remain the same. Designs must be compliant with the most stringent requirements from the curves.

### Individual



### Societal



## RISK MITIGATION COMMENTS

No additional mitigation comments provided.

## SUMMARY

Based on the information supplied in this report, the design is considered to be **COMPLIANT**

## APPLICATION NOTES

### Surface Soil Resistivity

Surface soil resistivity has a significant effect on the current that can pass through a body. The effect of soil resistivity is linear with the effect on the body and results can be interpolated linearly between two resistivities to provide the effect at the required resistivity when undertaking Argon based analysis.

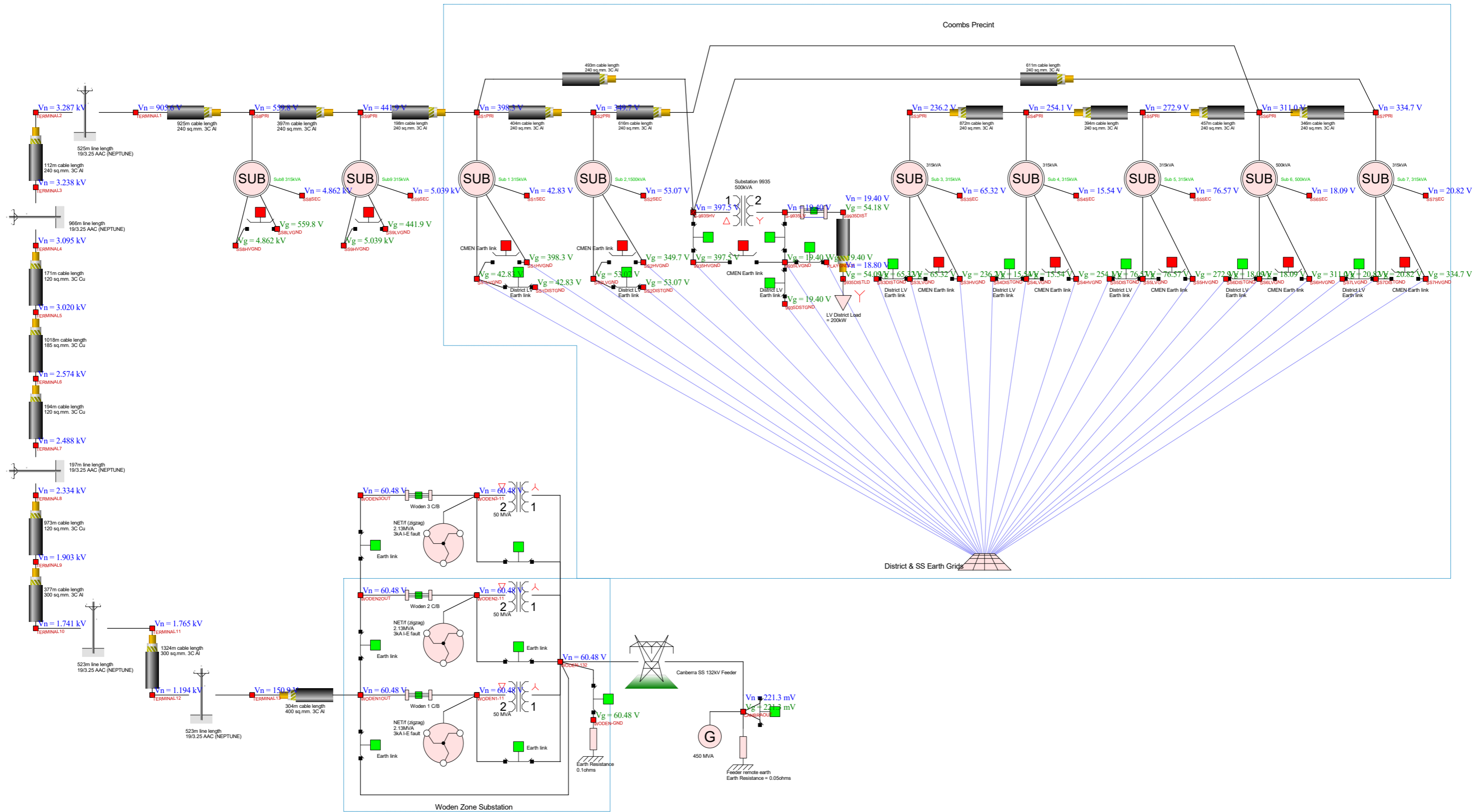
### Footwear

Appropriate footwear can significantly reduce the current that can pass through a body. Under dry conditions any enclosed leather or non-conductive rubber or plastic footwear in good condition is as effective as electrical safety boots in reducing the risk. Without such footwear the risk is equivalent to bare feet.

Appropriate gum boots are those which pass the following test to ensure that material from which they are made is adequately insulating:

Fill the boot to approximately 90% of it's height with salt water and place it in a container of salt water that reaches the same water level. The resistance between electrodes inserted in the water inside the boot and outside of the boot should be determined with a high voltage resistance tester. The resistance should not be less than 1 mega ohm.

Gum boots should be maintained in good condition and replaced if any splits or cracks appear.



Node EPRs, Fault at S9935, Separate HV/LV Earthing at all Feeder Substations