



07 February, 2020

Tara Lockwood  
Project Manager  
Calibre Consulting (NSW) Pty Ltd  
Level 6, 121 Marcus Clarke Street  
Canberra City ACT 2601

Our ref: 12524019-93467  
Your ref:

Dear Tara,

## **Molonglo 132 kV Line EMF Review Peer Review**

This letter provides a summary of the peer review process undertaken by GHD of the following document:

[1] Molonglo 3 132kV Transmission Line Relocations Options Study Assessment of the Electro Magnetic Field (EMF) Profile Adjacent to the Proposed ActewAGL Distribution 132kV Underground Cable Installations (Revision 2.0A)

In accordance with our letter to Calibre Consulting on 8<sup>th</sup> January 2020, the following aspects of the report are noted:

- Text describing nature and effects of EMF and electromagnetic radiation (EMR) is accurate
- A review of applicable standards and legislation determined:
  - All aspects of [1] are correct, with exception to the statement that Australian industry follows the NHMRC (1989) interim guidelines for 50/60 Hz electric and magnetic fields, which uses a limit of 1000 mG for public exposure to fields.

Current practice by ARPANSA (the regulatory authority) is adoption of the ICNIRP (2010) guidelines for limits on electric and magnetic fields from 1 Hz to 100 kHz, which uses a limit of 2000 mG for public exposure to fields.

Therefore, the ultimate limit for compliance in [1] is more conservative than current practice.

- Typical EMR values for household appliances are in accordance with current literature (as specified in ENA EMF Handbook)
- A technical review of EMR calculations determined:

The simulated results specified in section 5 of [1] appear accurate, although [1] does not specify what elevation the calculation of EMR has been completed in.

GHD's simulation of the 132 kV underground cable arrangement using the same parameters described in [1] produced magnetic field values approximately the same as the values specified in [1] when completing the calculation at an elevation of 0.5 m above ground.

Typical practice is to complete calculation/measurement of EMR at 1 m above ground, where the magnitude of EMR reduces to approximately 66% of its peak value.

Consequently:

- The magnetic fields from the 132 kV cable arrangement do not exceed the 1000 mG or 2000 mG limits at any point above a height of 500 mm above ground level, when the 132 kV circuit is operating in emergency load conditions.
- Considering emergency load conditions are the most onerous emitting condition for EMR, the magnetic fields from the 132 kV cable arrangement do not exceed the 1000 mG or 2000 mG limits at any point above a height of 500 mm above ground level, when the 132 kV circuit is operating in peak or off peak normal load conditions.

Therefore, should the 132 kV underground circuit arrangement be installed as described in [1], the allowable magnetic field limits are not exceeded anywhere within or outside the 132 kV easement, during any of the operating conditions specified in [1].

Sincerely  
GHD

A handwritten signature in black ink, appearing to read 'MTC', with a long horizontal stroke extending to the right.

**Martyn Costello**

Technical Director - Electrical  
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**Report to:**

**Brown Consulting (ACT) Pty Ltd**

**Molonglo 3**

**132kV Transmission Line**

**Relocations Options Study**

**Assessment of the Electro**

**Magnetic Field (EMF) Profile**

**Adjacent to the Proposed**

**ActewAGL Distribution 132kV**

**Underground Cable Installations**



**LEVEL 3  
DESIGN**

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|      |            |         |          |                  |

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## **Appendix**

ActewAGL Distribution - Transmission Network Diagram.

## **1. Introduction**

The Land Development, Strategy and Finance Branch of the Economic Development Directorate (EDD) has initiated a feasibility study with the objective of investigating options for the relocation of existing 132kV overhead transmission lines through or around the Molonglo 3 development and to determine a preferred option.

In this regard, EDD has engaged Brown Consulting to perform this feasibility options study with the submission of a concept design report that includes the options considered.

The study comprises a range of options that includes:

- i. Leaving the existing 132kV steel towers transmission lines in their present location.
- ii. Relocation of the 132kV overhead lines to route locations that minimise the impact on the development of Molonglo 3.
- iii. Relocation of the 132kV overhead lines to an underground cable installation along route locations that minimise the impact on the development of Molonglo 3.
- iv. Relocation of the 132kV overhead lines to a combination of overhead line and underground cable installations.

Relocations will be subject to ActewAGL Distribution (AAD) transmission line standards and approvals. As the transmission lines form part of the transmission network supplying the NSW south coast approvals will also be required from TransGrid and the Australian Energy Management Operator (AEMO).

## **2. ActewAGL Distribution (AAD) 132kV Transmission Network**

AAD's 132kV transmission network is supplied from the TransGrid 330/132kV Canberra and Williamsdale Substations.

*Refer 132kV Network Diagram – Appendix 1*

The AAD 132kV transmission lines impacting of the Molonglo 3 development are the following circuits:

- i. TransGrid Canberra Transmission Substation – Woden Zone Substation
- ii. Civic Zone Substation - Woden Zone Substation
- iii. In addition, AAD plan to develop the Molonglo 132/11kV Zone substation in the near future, which will be connected into the Civic Zone Substation - Woden Zone Substation transmission line.

From the conduct of previous studies, AAD advised that the rated capacity of the 132kV transmission lines is defined in the following Table:

| <b>132kV Subtransmission Line Current Rating (Amps)</b> |           |            |           |
|---------------------------------------------------------|-----------|------------|-----------|
| Summer Day                                              |           | Winter Day |           |
| Continuous                                              | Emergency | Continuous | Emergency |
| 1950A                                                   | 2960A     | 2540A      | 3320A     |

### **3. Electro Magnetic Fields (EMF) and Radiation (EMR)**

A common concern with the operation of transmission assets is the effect of the electromagnetic fields produced by transmission lines and underground cable systems. Any device that produces a voltage and carries electric current will produce electric and magnetic fields. As well as electricity supply network assets, EMF and EMR are also produced by industrial, commercial equipment and household appliances.

Electromagnetic fields are made up of two components – electric fields and magnetic fields.

An electric field (kV/m) is produced by the network operating voltage and is not a concern in an underground cable installation because the field is completely contained within the underground cable.

A magnetic field is produced by the flow of electric current and is measured in gauss (G) or teslas (T).

The EMR produced by underground cable installation will be greatest directly above the cable circuit, and will diminish as the distance increases away from the circuit. EMR levels will also vary depending on the load currents carried by the underground cable circuit.

The peak body for Energy networks is the Energy Networks Association Ltd and relevant documentation "emf update" that includes the following advice:

*"The Australian electricity industry follows the "Interim guidelines on limits of exposure to 50/60 Hz electric and magnetic fields" as developed by the National Health and Medical Research Council (NHMRC) in 1989. The NHMRC Guidelines suggest a magnetic field public exposure limit of 1,000mG. These Guidelines are currently recommended by ARPANSA pending finalisation of their new Guideline.*

*The two internationally recognised exposure limit guidelines originate from the*

- » *Institute of Electrical and Electronics Engineers (IEEE) of the USA, and;*

*Molonglo 3 - 132kV Transmission Line Relocations Options Study  
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ActewAGL Distribution 132kV Underground Cable Installations*

- »International Commission on Non-Ionizing Radiation Protection (ICNIRP), an expert advisory body to the WHO.

Under the IEEE Standard of 2002 the recommended magnetic field public exposure limit is **9,040 milligauss (mG)**.

Under the ICNIRP guidelines of 2010 the recommended magnetic field public exposure limit is **2,000 milligauss (mG)**."

Energy Networks Association publication Electricity Industry EMF Measurement Protocol for High Field Areas states that "High field areas are considered to be those that may be comparable to or exceed the NHMRC or ICNIRP recommended limits of exposure at power frequencies in Tables 1 and 2".

**Table 1. NHMRC (1989) recommended EMF limits of exposure**

|                   | Electric Field Strength (kV/m) | Magnetic Flux Density (mG) |
|-------------------|--------------------------------|----------------------------|
| Occupational      |                                |                            |
| Whole working day | 10                             | 5,000                      |
| Short term        | 30                             | 50,000                     |
| For limbs         | -                              | 250,000                    |
| General Public    |                                |                            |
| Up to 24h/day     | 5                              | 1,000                      |
| Few hours/day     | 10                             | 10,000                     |

**Table 2. ICNIRP (1998) recommended EMF limits of exposure**

|                   | Electric Field Strength (kV/m) | Magnetic Flux Density (mG) |
|-------------------|--------------------------------|----------------------------|
| Occupational      |                                |                            |
| Whole working day | 10                             | 5,000                      |
| General Public    |                                |                            |
| Up to 24h/day     | 5                              | 1,000                      |

Table 3 shows the corresponding limits of exposure for the IEEE standard for comparison.

**Table 3. IEEE (2002) recommended EMF limits of exposure**

|                   | Electric Field Strength (kV/m) | Magnetic Flux Density (mG) |
|-------------------|--------------------------------|----------------------------|
| Occupational      |                                |                            |
| Whole working day | 20                             | 27,100                     |
| For limbs         | -                              | 758,000                    |
| General Public    |                                |                            |
| Up to 24h/day     | 5*                             | 9,040                      |
| Extremities       | -                              | 758,000                    |



### 3.1. Regulation

*"In Australia, the Commonwealth body with responsibility for developing safety standards for electric and magnetic fields (EMFs) is the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA), an agency of the Commonwealth Department of Health and Ageing." (Reference ENA Update 2011).*

ARPANSA has a range of publications and statements on its web site [www.arpansa.gov.au](http://www.arpansa.gov.au) related to electricity and health, including information on the draft EMF Standard. In particular Fact Sheet 19 "Electricity and Health" of May 2011 in summary states:

*"The scientific evidence does not firmly establish that exposure to 50Hz electric and magnetic fields found around the home, the office or near power lines is a hazard to human health."*

### 3.2. Typical EMR Values for Household Appliances

For comparison with the EMR values emitted by a power frequency underground cable installation the following table provides a listing of typical EMR values from household appliances as published by the Energy Networks Association.

| Appliance         | Range of measurements (mG) |
|-------------------|----------------------------|
| Electric stove    | 2 – 30                     |
| Refrigerator      | 2 – 5                      |
| Electric kettle   | 2 – 10                     |
| Toaster           | 2 – 10                     |
| Television        | 0.2 – 2                    |
| Personal computer | 2 – 20                     |
| Electric blanket  | 5 – 30                     |
| Hair dryer        | 10 – 70                    |
| Pedestal fan      | 0.2 – 2                    |

**It is worthwhile to note that the range for magnetic fields at the edge of an overhead transmission line easement is 2mG to 50mG with a typical value of 10mG.**

## 4. 132kV Underground Cable Arrangement

The existing 132kV overhead lines that traverse the Molonglo 3 development have been constructed with Twin 'Moose (54/6/0.139" + 1/0.146" ACSR/GZ) phase conductors on single circuit steel transmission towers. A 132kV underground cable

installation to replace the existing transmission line will be designed and installed to have an equal current rating to the 132kV transmission lines.

The proposed 132kV underground cable groups have been selected from manufacturer's data to provide a load carrying capacity equivalent to the 132kV transmission lines.

From discussion with AAD, the load carrying capacity of the preferred underground cable equivalent to the 132kV transmission line is two (2) parallel underground cable groups, with each group comprising 3 x 72.5/132kV, single core (1c), 1,600mm<sup>2</sup> copper conductor, XLPE insulated / lead alloy sheath / copper wire screened / PVC / HPDE over-sheath cable.

It is noted that cable designs are available with other types of metallic sheaths such as corrugated aluminium alloy and corrugated stainless steel sheaths that provide a moisture / water barrier for the cable and will have similar current ratings to the cable specified above.

- i. The combined rated capacity of the above twin cable groups, direct buried and in a flat configuration is as follows:
  - Summer rating with a Load Factor of 1.0 and an operating temperature of 90°C is 2,394A and;
  - Winter rating with a Load Factor of 1.0 and an operating temperature of 90°C is 2540A.

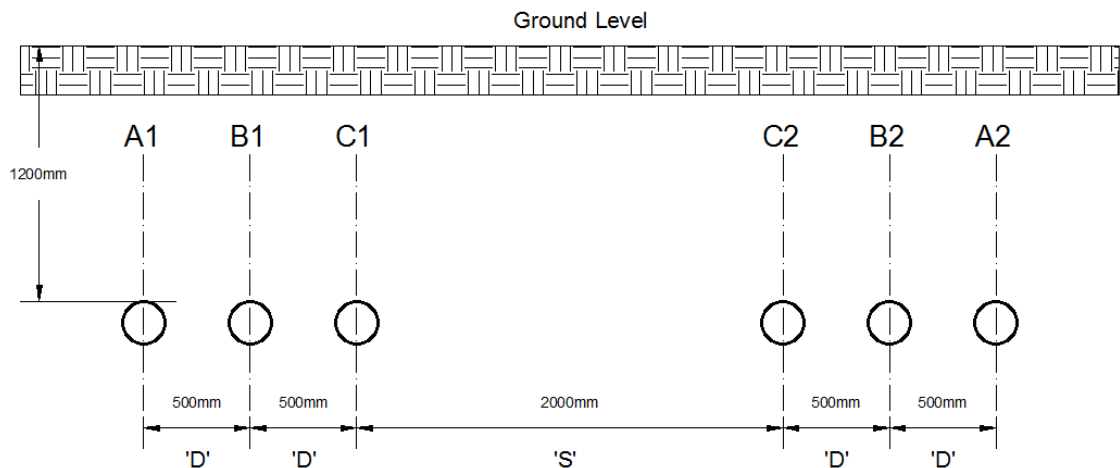
The ultimate cable rating will be determined by the type of cable selected, geothermal data of the local soil conditions along the easement and installation configuration relating to a preferred flat cable arrangement.

Underground cables can also be installed in a trefoil arrangement but configuration is NOT preferred by AAD for operational and maintenance reasons and is therefore not considered in this report.

- ii. Laying depth: 1200mm; Soil Resistivity: 1 <sup>0</sup>Cm/W; Load Factor 1.0; Conductor Temperature: 90°C; Soil Temperature: 30°C; Ambient Temperature: 40°C; and Earthing Method of Single Point Bonding.
- iii. A 15m nominal easement width, as initially proposed by AAD for a 132 kV underground cable installation.
- iv. Direct buried cable installation with a backfill of 14:1 sand and cement mixture and a concrete cover to protect the installation.

The sketch below shows a cross-section of a 132kV underground cable installation comprising two groups of single core cables.

*Molonglo 3 - 132kV Transmission Line Relocations Options Study*  
*Assessment of the Electro Magnetic Field (EMF) Profile Adjacent to the Proposed*  
*ActewAGL Distribution 132kV Underground Cable Installations*



NOT TO SCALE

ActewAGL Easement Width 15m

Proposed ActewAGL 132kV Underground Cable Installation  
Flat Configuration

| Two (2) Cable Group Configuration | S (mm) | D (mm) |
|-----------------------------------|--------|--------|
| Flat Cable Arrangement            | 2,000  | 500    |

## 5. 132kV Underground Cable Electro Magnetic Radiation Analysis

To determine the 24hour electromagnetic radiation exposure located adjacent to the 132kV underground cable easement, consideration has been given to the cyclic nature of the load transmitted through the underground cable groups during peak and off peak periods. Daily load profiles for the cables will vary over the year, with different maximum demands expected during winter and summer. It should be noted that the maximum or emergency loading would only occur very infrequently, when the network has been reconfigured for operational purposes. EMR studies have been conducted on a flat cable configuration under estimated continuous maximum load, estimated daily peak loads (occurring for up to five hours per day) and off-peak loads.

The following table records the results of EMR calculations conducted for the 132kV underground cable installations comprising two groups of single core cables. The single core cables of the two cable groups are arranged with the following phasing relationship **A1-B1-C1 and C2-B2-A2**.

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| EMR Calculation Values (mG) |                                                                                                    |                                            |                   |                     |
|-----------------------------|----------------------------------------------------------------------------------------------------|--------------------------------------------|-------------------|---------------------|
| Cable Spacing               | 2 132kV Cable Groups                                                                               | Phasing Arrangement<br>A1-B1-C1 - C2-B2-A2 | 2m Between Groups | 0.5m Between Cables |
| Distance m                  | 132kV UG Cable Rating<br>Equivalent to Winter<br>Transmission Line<br>Continuous Thermal<br>Rating | AAD Anticipated<br>Maximum Load            | AAD Peak Load     | AAD Off Peak Load   |
| Load                        | 2540A                                                                                              | 1175A                                      | 750A              | 375A                |
| -25.00                      | 14.12                                                                                              | 6.53                                       | 4.17              | 2.09                |
| -24.50                      | 14.71                                                                                              | 6.80                                       | 4.34              | 2.17                |
| -24.00                      | 15.33                                                                                              | 7.09                                       | 4.53              | 2.26                |
| -23.50                      | 15.99                                                                                              | 7.40                                       | 4.72              | 2.36                |
| -23.00                      | 16.70                                                                                              | 7.72                                       | 4.93              | 2.47                |
| -22.50                      | 17.45                                                                                              | 8.07                                       | 5.15              | 2.58                |
| -22.00                      | 18.26                                                                                              | 8.45                                       | 5.39              | 2.70                |
| -21.50                      | 19.12                                                                                              | 8.84                                       | 5.65              | 2.82                |
| -21.00                      | 20.04                                                                                              | 9.27                                       | 5.92              | 2.96                |
| -20.50                      | 21.04                                                                                              | 9.73                                       | 6.21              | 3.11                |
| -20.00                      | 22.11                                                                                              | 10.23                                      | 6.53              | 3.26                |
| -19.50                      | 23.26                                                                                              | 10.76                                      | 6.87              | 3.43                |
| -19.00                      | 24.51                                                                                              | 11.34                                      | 7.24              | 3.62                |
| -18.50                      | 25.86                                                                                              | 11.96                                      | 7.63              | 3.82                |
| -18.00                      | 27.32                                                                                              | 12.64                                      | 8.07              | 4.03                |
| -17.50                      | 28.91                                                                                              | 13.37                                      | 8.54              | 4.27                |
| -17.00                      | 30.65                                                                                              | 14.18                                      | 9.05              | 4.52                |
| -16.50                      | 32.54                                                                                              | 15.06                                      | 9.61              | 4.80                |
| -16.00                      | 34.62                                                                                              | 16.02                                      | 10.22             | 5.11                |
| -15.50                      | 36.91                                                                                              | 17.07                                      | 10.90             | 5.45                |
| -15.00                      | 39.43                                                                                              | 18.24                                      | 11.64             | 5.82                |
| -14.50                      | 42.21                                                                                              | 19.53                                      | 12.46             | 6.23                |
| -14.00                      | 45.30                                                                                              | 20.96                                      | 13.38             | 6.69                |
| -13.50                      | 48.74                                                                                              | 22.55                                      | 14.39             | 7.20                |
| -13.00                      | 52.59                                                                                              | 24.33                                      | 15.53             | 7.77                |
| -12.50                      | 56.92                                                                                              | 26.33                                      | 16.81             | 8.40                |
| -12.00                      | 61.80                                                                                              | 28.59                                      | 18.25             | 9.12                |
| -11.50                      | 67.33                                                                                              | 31.15                                      | 19.88             | 9.94                |

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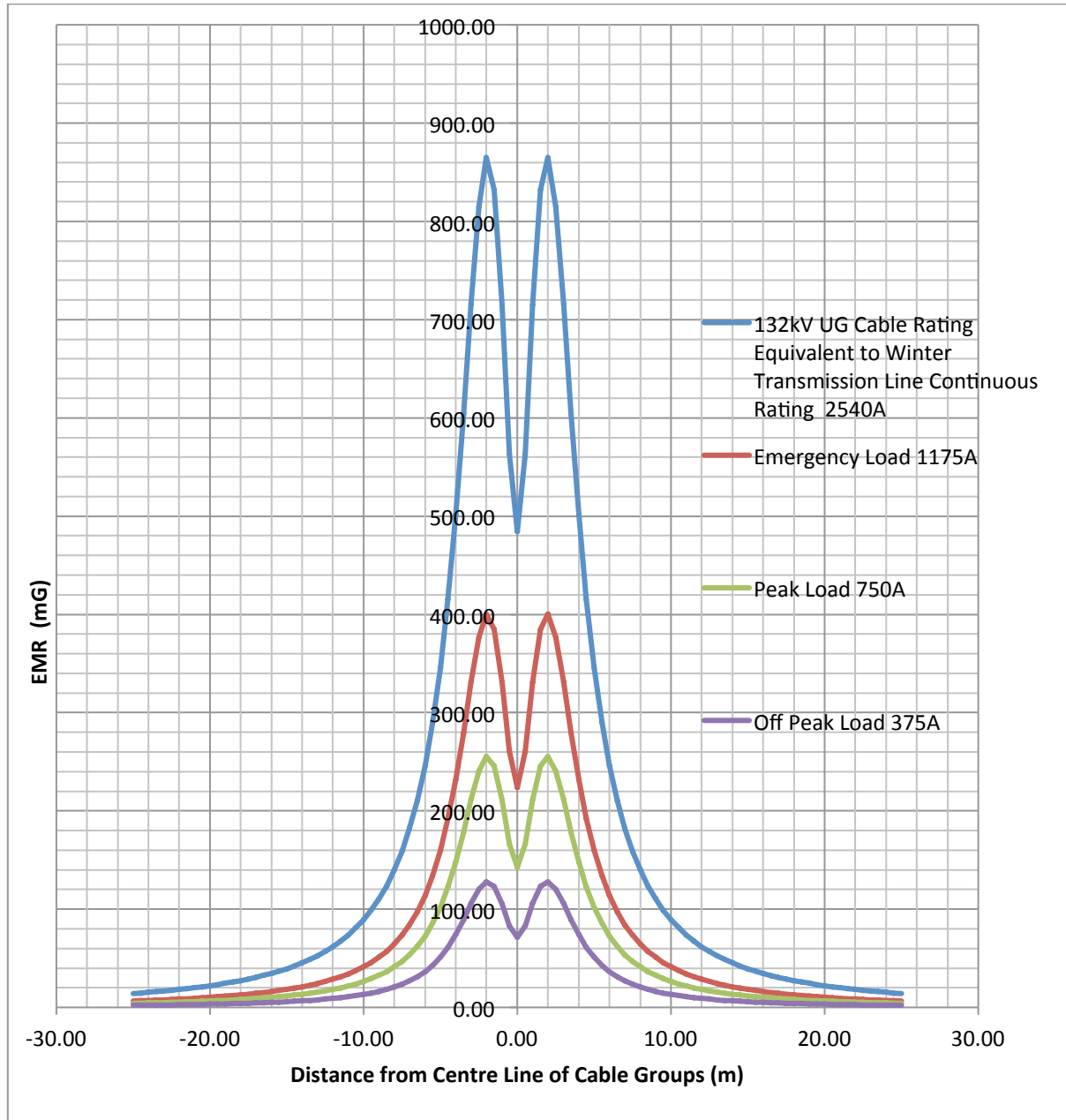
|               |        |        |        |        |
|---------------|--------|--------|--------|--------|
| <b>-11.00</b> | 73.64  | 34.07  | 21.75  | 10.87  |
| <b>-10.50</b> | 80.88  | 37.41  | 23.88  | 11.94  |
| <b>-10.00</b> | 89.23  | 41.28  | 26.35  | 13.17  |
| <b>-9.50</b>  | 98.93  | 45.76  | 29.21  | 14.61  |
| <b>-9.00</b>  | 110.28 | 51.02  | 32.56  | 16.28  |
| <b>-8.50</b>  | 123.69 | 57.22  | 36.52  | 18.26  |
| <b>-8.00</b>  | 139.65 | 64.60  | 41.23  | 20.62  |
| <b>-7.50</b>  | 158.82 | 73.47  | 46.90  | 23.45  |
| <b>-7.00</b>  | 182.08 | 84.23  | 53.77  | 26.88  |
| <b>-6.50</b>  | 210.60 | 97.42  | 62.19  | 31.09  |
| <b>-6.00</b>  | 245.91 | 113.76 | 72.61  | 36.31  |
| <b>-5.50</b>  | 290.02 | 134.16 | 85.64  | 42.82  |
| <b>-5.00</b>  | 345.47 | 159.82 | 102.01 | 51.01  |
| <b>-4.50</b>  | 415.16 | 192.05 | 122.59 | 61.29  |
| <b>-4.00</b>  | 501.55 | 232.01 | 148.09 | 74.05  |
| <b>-3.50</b>  | 604.44 | 279.61 | 178.47 | 89.24  |
| <b>-3.00</b>  | 716.13 | 331.28 | 211.46 | 105.73 |
| <b>-2.50</b>  | 814.86 | 376.95 | 240.61 | 120.30 |
| <b>-2.00</b>  | 864.98 | 400.14 | 255.41 | 127.70 |
| <b>-1.50</b>  | 832.32 | 385.03 | 245.76 | 122.88 |
| <b>-1.00</b>  | 715.08 | 330.79 | 211.14 | 105.57 |
| <b>-0.50</b>  | 562.96 | 260.43 | 166.23 | 83.11  |
| <b>0.00</b>   | 484.01 | 223.90 | 142.92 | 71.46  |
| <b>0.50</b>   | 562.83 | 260.36 | 166.19 | 83.10  |
| <b>1.00</b>   | 715.15 | 330.83 | 211.17 | 105.58 |
| <b>1.50</b>   | 832.27 | 385.01 | 245.75 | 122.87 |
| <b>2.00</b>   | 864.86 | 400.08 | 255.37 | 127.69 |
| <b>2.50</b>   | 814.94 | 376.99 | 240.63 | 120.32 |
| <b>3.00</b>   | 716.14 | 331.29 | 211.46 | 105.73 |
| <b>3.50</b>   | 604.42 | 279.60 | 178.47 | 89.24  |
| <b>4.00</b>   | 501.53 | 232.01 | 148.09 | 74.04  |
| <b>4.50</b>   | 415.15 | 192.05 | 122.58 | 61.29  |
| <b>5.00</b>   | 345.47 | 159.81 | 102.01 | 51.00  |
| <b>5.50</b>   | 290.02 | 134.16 | 85.64  | 42.82  |
| <b>6.00</b>   | 245.91 | 113.76 | 72.61  | 36.31  |

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|              |        |       |       |       |
|--------------|--------|-------|-------|-------|
| <b>6.50</b>  | 210.61 | 97.43 | 62.19 | 31.09 |
| <b>7.00</b>  | 182.09 | 84.24 | 53.77 | 26.88 |
| <b>7.50</b>  | 158.83 | 73.48 | 46.90 | 23.45 |
| <b>8.00</b>  | 139.66 | 64.61 | 41.24 | 20.62 |
| <b>8.50</b>  | 123.70 | 57.22 | 36.53 | 18.26 |
| <b>9.00</b>  | 110.29 | 51.02 | 32.57 | 16.28 |
| <b>9.50</b>  | 98.93  | 45.77 | 29.21 | 14.61 |
| <b>10.00</b> | 89.23  | 41.28 | 26.35 | 13.17 |
| <b>10.50</b> | 80.87  | 37.41 | 23.88 | 11.94 |
| <b>11.00</b> | 73.64  | 34.06 | 21.74 | 10.87 |
| <b>11.50</b> | 67.32  | 31.14 | 19.88 | 9.94  |
| <b>12.00</b> | 61.79  | 28.58 | 18.24 | 9.12  |
| <b>12.50</b> | 56.91  | 26.33 | 16.80 | 8.40  |
| <b>13.00</b> | 52.58  | 24.32 | 15.53 | 7.76  |
| <b>13.50</b> | 48.73  | 22.54 | 14.39 | 7.19  |
| <b>14.00</b> | 45.29  | 20.95 | 13.37 | 6.69  |
| <b>14.50</b> | 42.20  | 19.52 | 12.46 | 6.23  |
| <b>15.00</b> | 39.41  | 18.23 | 11.64 | 5.82  |
| <b>15.50</b> | 36.89  | 17.07 | 10.89 | 5.45  |
| <b>16.00</b> | 34.61  | 16.01 | 10.22 | 5.11  |
| <b>16.50</b> | 32.53  | 15.05 | 9.61  | 4.80  |
| <b>17.00</b> | 30.64  | 14.17 | 9.05  | 4.52  |
| <b>17.50</b> | 28.90  | 13.37 | 8.53  | 4.27  |
| <b>18.00</b> | 27.31  | 12.63 | 8.06  | 4.03  |
| <b>18.50</b> | 25.85  | 11.96 | 7.63  | 3.82  |
| <b>19.00</b> | 24.50  | 11.33 | 7.23  | 3.62  |
| <b>19.50</b> | 23.25  | 10.76 | 6.87  | 3.43  |
| <b>20.00</b> | 22.10  | 10.22 | 6.53  | 3.26  |
| <b>20.50</b> | 21.03  | 9.73  | 6.21  | 3.10  |
| <b>21.00</b> | 20.04  | 9.27  | 5.92  | 2.96  |
| <b>21.50</b> | 19.11  | 8.84  | 5.64  | 2.82  |
| <b>22.00</b> | 18.25  | 8.44  | 5.39  | 2.69  |
| <b>22.50</b> | 17.45  | 8.07  | 5.15  | 2.58  |
| <b>23.00</b> | 16.69  | 7.72  | 4.93  | 2.46  |
| <b>23.50</b> | 15.99  | 7.40  | 4.72  | 2.36  |

*Molonglo 3 - 132kV Transmission Line Relocations Options Study*  
*Assessment of the Electro Magnetic Field (EMF) Profile Adjacent to the Proposed*  
*ActewAGL Distribution 132kV Underground Cable Installations*

|              |       |      |      |      |
|--------------|-------|------|------|------|
| <b>24.00</b> | 15.33 | 7.09 | 4.53 | 2.26 |
| <b>24.50</b> | 14.71 | 6.80 | 4.34 | 2.17 |
| <b>25.00</b> | 14.12 | 6.53 | 4.17 | 2.08 |



## 6. Conclusions and Discussion

The recommended Electromagnetic Radiation Levels (EMR) that the public are exposed to are summarised as follows:

| Organisation                                                            | Recommended EMR Value | Comment                                         |
|-------------------------------------------------------------------------|-----------------------|-------------------------------------------------|
| Energy Networks Association Ltd (ENA)                                   | 1,000mG               | Reference - ARPANSA and NHMRC Guidelines        |
| Institute of Electrical and Electronics Engineers (IEEE) of the USA     | 9,040mG               | IEEE Standard of 2002                           |
| International Commission on Non-Ionizing Radiation Protection (ICNIRP), | 2,000mG               | Advisors to the World Health Organisation (WHO) |

| Loading Condition | Load   | EMR Level at Edge Distance of 7.5m from the Centre Line of the Cable Group and Easement | EMR Level at Distance 25m from the Centre Line of the Cable Group and Easement |
|-------------------|--------|-----------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|
| Continuous Load   | 2,540A | 158.83mG                                                                                | 14.12mG                                                                        |
| Emergency Load    | 1175A  | 73.47mG                                                                                 | 6.53mG                                                                         |
| Peak Load         | 750A   | 46.90mG                                                                                 | 4.17mG                                                                         |
| Off Peak Load     | 375A   | 23.45mG                                                                                 | 2.08mG                                                                         |

As determined from the EMR levels calculated, residents living adjacent to the underground cable easement would not be exposed to high levels of EMR radiation that exceed the 24 hour exposure level of 1,000mG advised by the Energy Networks Association Ltd (ENA) based on *ARPANSA and NHMRC Guidelines*.

Under normal network operations the EMR exposure levels will vary daily with peak and off peak loads over the working week and during weekends.



## **7. References**

|      |                                                                                                                                                                                                                           |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| i.   | <a href="http://www.ena.asn.au/policy/consumer-and-community/electric-and-magnetic-fields/">http://www.ena.asn.au/policy/consumer-and-community/electric-and-magnetic-fields/</a>                                         |
| ii.  | <a href="http://www.ena.asn.au/wp-content/uploads/2013/04/EMF_Update_May-11.pdf">http://www.ena.asn.au/wp-content/uploads/2013/04/EMF_Update_May-11.pdf</a>                                                               |
| iii. | Energy Networks Association - Electricity Industry EMF Measurement Protocol for High Field Area.                                                                                                                          |
| iv.  | Australian Government –Australian Radiation Protection and Nuclear safety Agency – Technical Report – Pilot Study of Residential Power Frequency Magnetic Fields in Melbourne (2005) - Ken Karipidis and Lindsay J Martin |



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