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DOCUMENT NUMBER	ISSUE	SYSTEM
WP 8412	1	Mercury Cluster Project

SUBJECT

RFI Assessment of the Proposed PV Plant Sites applicable to: (Northern PV Farms) Zaaiplaats Solar PV1 Kleinfontein Solar PV1 Vlakfontein Solar PV1

KEYWORDS

electrical equipment, electrical infrastructure, EMI, RFI

DISTRIBUTION

Landscape Dynamics

SUMMARY

The Mercury Cluster Project (Northern PV FARMS) is a newly proposed site for future PV plants. The purpose of this document is to report on the possible RFI from the PV plant to the surrounding area, to assess whether any mitigation will be required to the PV plant site equipment if the PV plant is to be constructed.

According to the DFFE screening report there are two medium sensitivity areas closer than approximately 8km from the perimeter of the Northern PV Farms. It is important to evaluate the possible RFI that the PV plant has on these two medium areas.

Literature study reveals that there will be no interference from the PV plant to the surrounding medium RFI sensitive areas assuming that the PV plant inverters comply to CISPR 11 class A specifications, as a technology partner has not yet been selected to provide actual EMC data.

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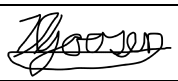
H Goosen	
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1. BACKGROUND

The Mercury Cluster Project is a set of 5 proposed PV plant sites for near future construction. The project area is located southeast from Viljoenskroon. The RFI that a new PV plant will have on existing electrical equipment must be evaluated. RFI from a PV plant is generally emitted from the inverters, as solar panels do not emit any RF. Thus, the effects of PV plant inverters will be the focus of this report. RFI and EMI can influence sensitive facilities such as airports, RF high sites, railway line control equipment, cell phone towers, EMI sensitive equipment in the area, etc. If a PV plant influences existing infrastructure, EMI mitigation will have to be implemented.

According to the DFFE screening report, there are two medium sensitivity areas located closer than 8 km from the proposed PV plant site. This means that there is a possibility that the proposed PV plant will interfere with existing electrical equipment or electrical infrastructure.

In Figure 1 below, two medium sensitive areas are identified by the DFFE screening report. In the north-western direction the area has been identified as Kopanang Gold Plant and to the north-eastern direction there is no visible infrastructure that can be sensitive to EMI (only farmland).

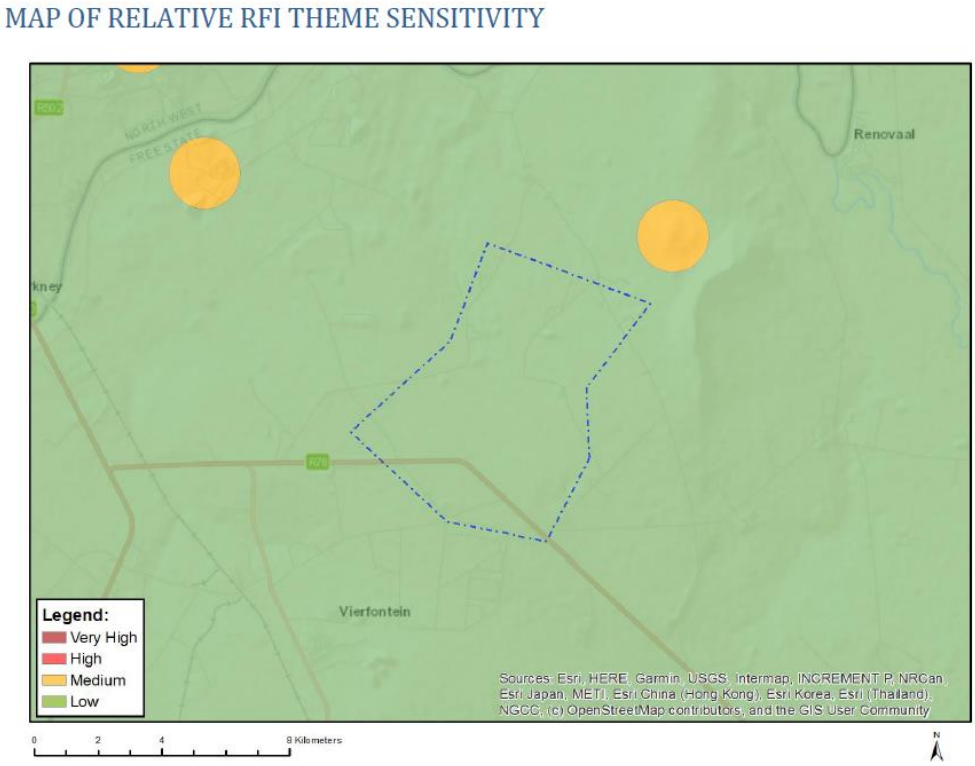

Figure 1 - DFFE Screening Report RFI Results

2. DEFINITIONS AND KEYWORDS

Electrical equipment	Any electrical machinery, electrical systems, appliances, or devices, including any wireless data communication used for the operation of these facilities, used for construction, distribution and transmission power systems, exploration, farming, household, manufacturing, maintenance, or mining purposes
Electrical infrastructure	Any infrastructure or facility, including any wireless data communication used for the operation of the electrical infrastructure, to be used in any way for electricity generation, electricity distribution, electricity transmission, or for a distribution or transmission power system, and electrical facilities and equipment used for these applications
EMI	Electromagnetic Interference
RFI	Radio Frequency Interference

Table 1: Definitions

3. REFERENCED AND APPLICABLE DOCUMENTS

[1] EMC ADCO 6th EMC Market Surveillance Campaign 2014

[2] CR-NAVFAC-EXWC-PW-1504
Renewable Energy, Photovoltaic Systems Near Airfields: EMI (April 2015)

[3] REPO Electro-Magnetic Interference from Solar Photovoltaic Arrays (April 2017)

[4] RF DISTURBANCES PRODUCED BY HIGH-POWER PHOTOVOLTAIC SOLAR PLANTS
Lappeenranta University of Technology

[5] RADIO MOBILE
RF Propagation simulation program by Roger Coude'

[6] SPLAT – RF Signal Propagation, Loss, And Terrain analysis tool

4. AIM

The aim of this document is to provide a statement with motivation regarding the RFI from the PV plants in the two medium sensitive areas identified by the DFFE screening report. The sphere of radio frequency influence from the PV plant will be noted and discussed.

As the project is still in early planning stage, no Technology partner has been selected yet. It is therefore assumed that the inverters to be used will comply to CISPR 11 Class A [1]. Receiver sensitivities, inside the indicated medium sensitivity areas, are assumed, and listed in Table 3.

5. TYPICAL PV PLANT ARCHITECTURE

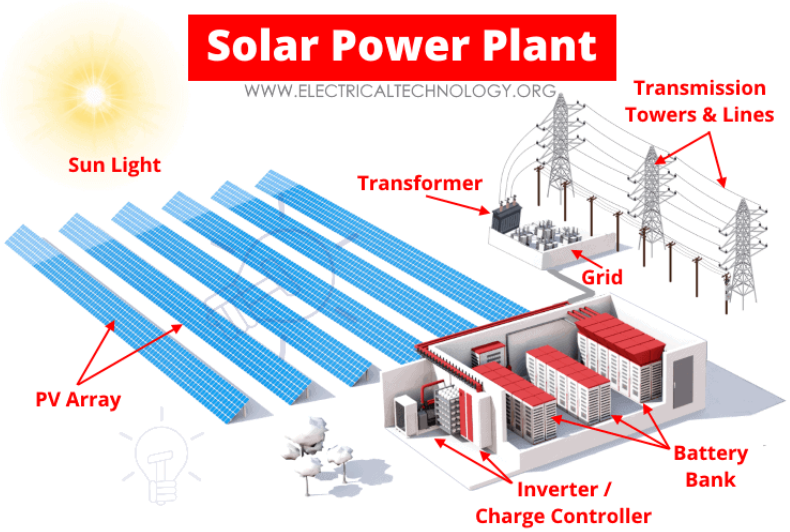

Figure 2 - Typical PV facility architecture

5.1 PV PLANT COMPONENTS AND LAYOUT

A typical PV plant consists of PV panels, sun tracking systems, batteries, Inverters, and cabling. In this case the inverters and the possibility of a sun tracking system will be the highest generators of unwanted RF signals. The inverter is used to convert the DC power produced by the PV modules to AC power.

Cabling on the DC side can act as an unintentional antenna radiating between 30MHz – 300kHz, assuming the typical length will be between 10 to 100 meters [4].

5.2 PV TRACKING SYSTEM

A tracker system intends to face the PV panels towards the sun throughout the day by tracking the sun position in an East-West direction. The motors used in the tracking system can be a source of unwanted RF signals. A tracker system usually consists of the following components:

- Drive unit for solar tracking (motor and motor controller);
- Internal communication system;
- Site wide communications.

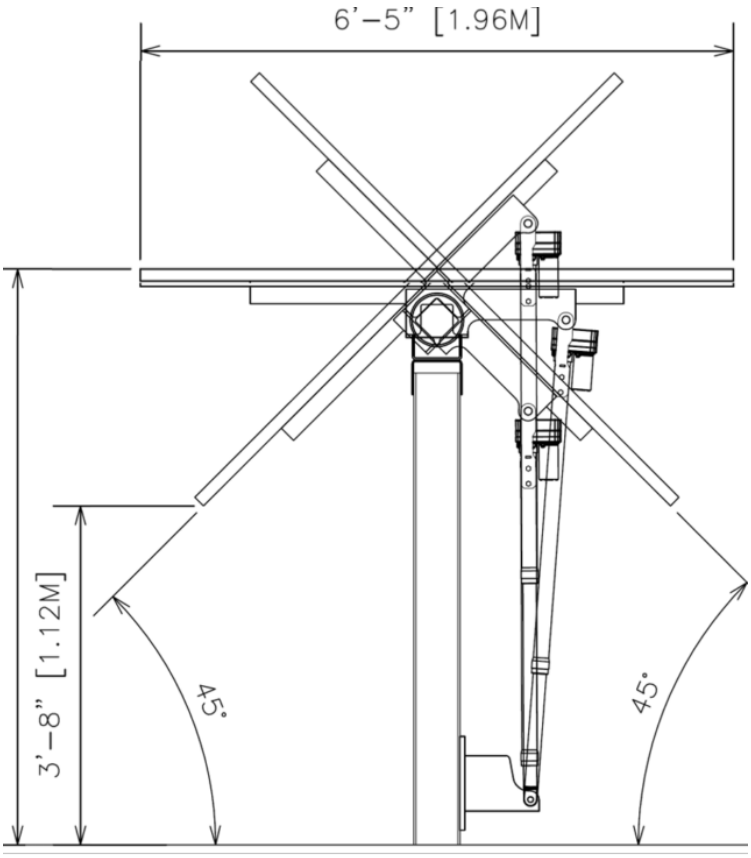

Figure 3 – Typical PV Tracker system

6. GOOD PRACTISE RFI MITIGATION METHODS

There are some steps that can be considered when designing a new PV plant to minimise the amount of RFI or EMI that can be emitted:

- Properly ground the PV modules to reduce common mode impedance.
- Shield the DC cabling to ensure a good connection to ground.
- Only use inverters with an approved CE mark.
- Ensure that there is proper electrical bonding on the PV modules as well as the mounting structure of the modules.

The purpose of electrical bonding is to provide structural homogeneity with respect to the flow of electrical currents, including high frequency currents for proper operation of filters and fault current paths. Bonding prevents or safely discharges static charges. Sufficient bonding ensures a good ground connection. A good ground connection of equipment will prevent unintentional transmissions to occur.

7. LOCATION

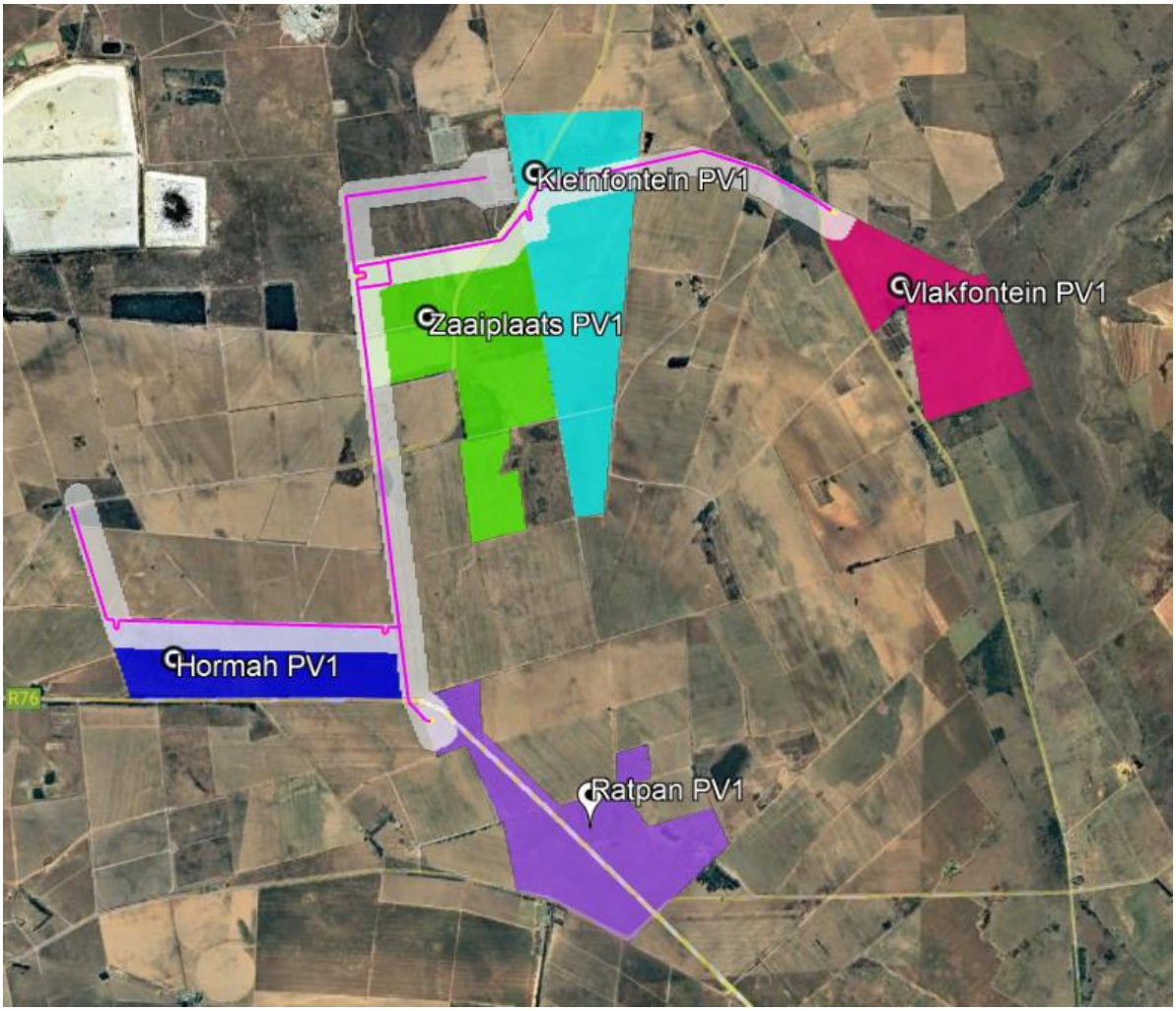

Figure 4 - Entire Proposed PV site location

Figure 5 - Distance between the closest PV site in the Northern PV farms to Kopanang Gold Plant

7.1 LINE OF SIGHT AND PATHLOSS BETWEEN THE NORTHEN PV LOCATIONS AND KOPANANG GOLD PLANT

GP - Gold Plant
ZPV - Zaaiplaats PV
KPV - Kleinfontein PV
VPV - Vlakfontein PV

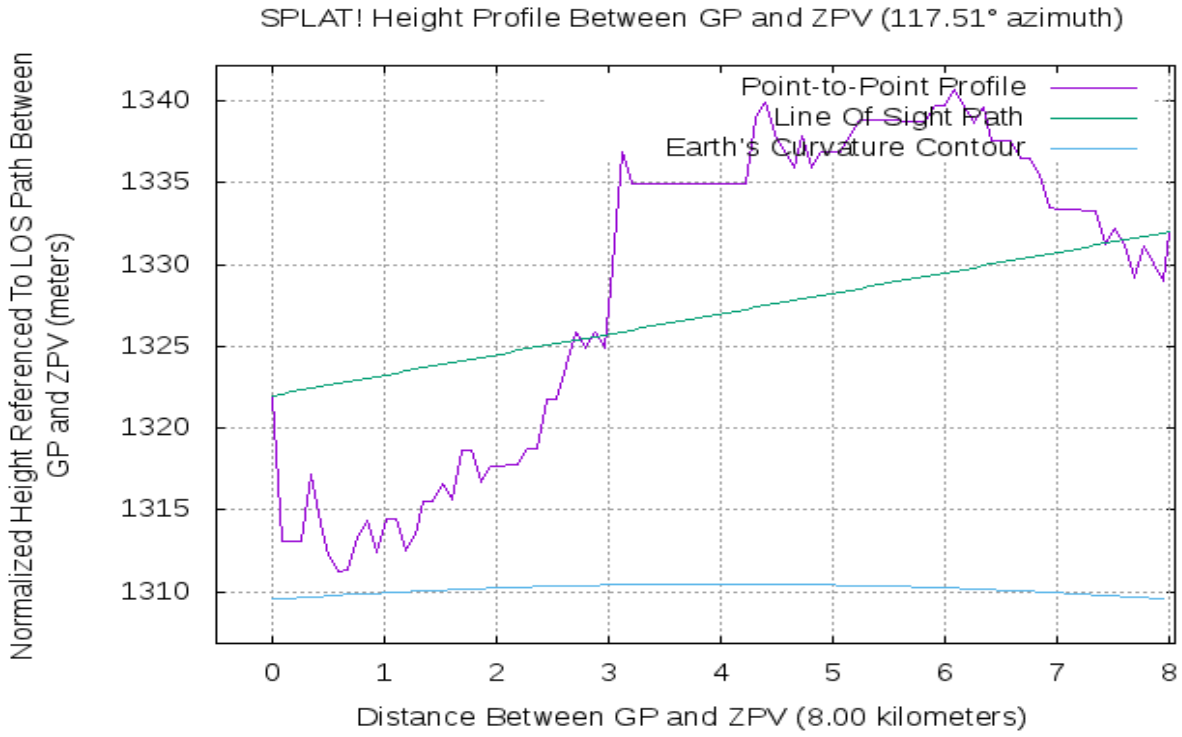

Figure 6 - Line of Sight between Zaaiplaats PV and Kopanang Gold Plant

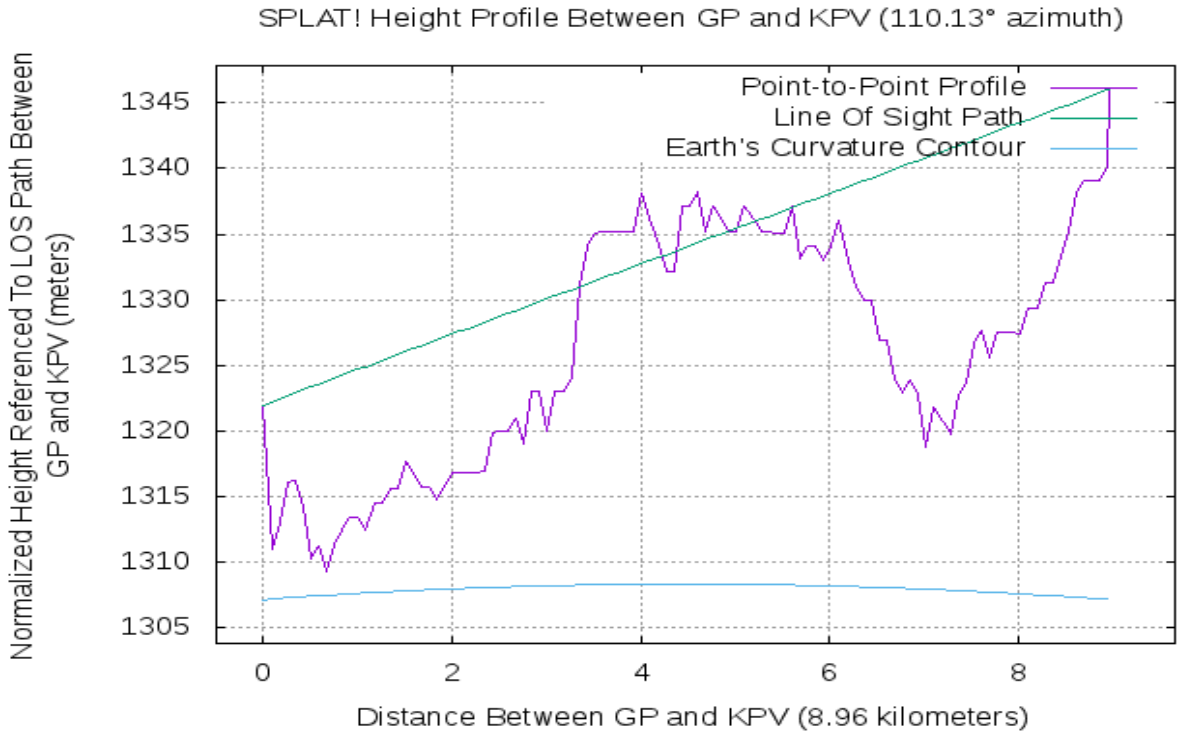

Figure 7 - Line of Sight between Kleinfontein PV and Kopanang Gold Plant

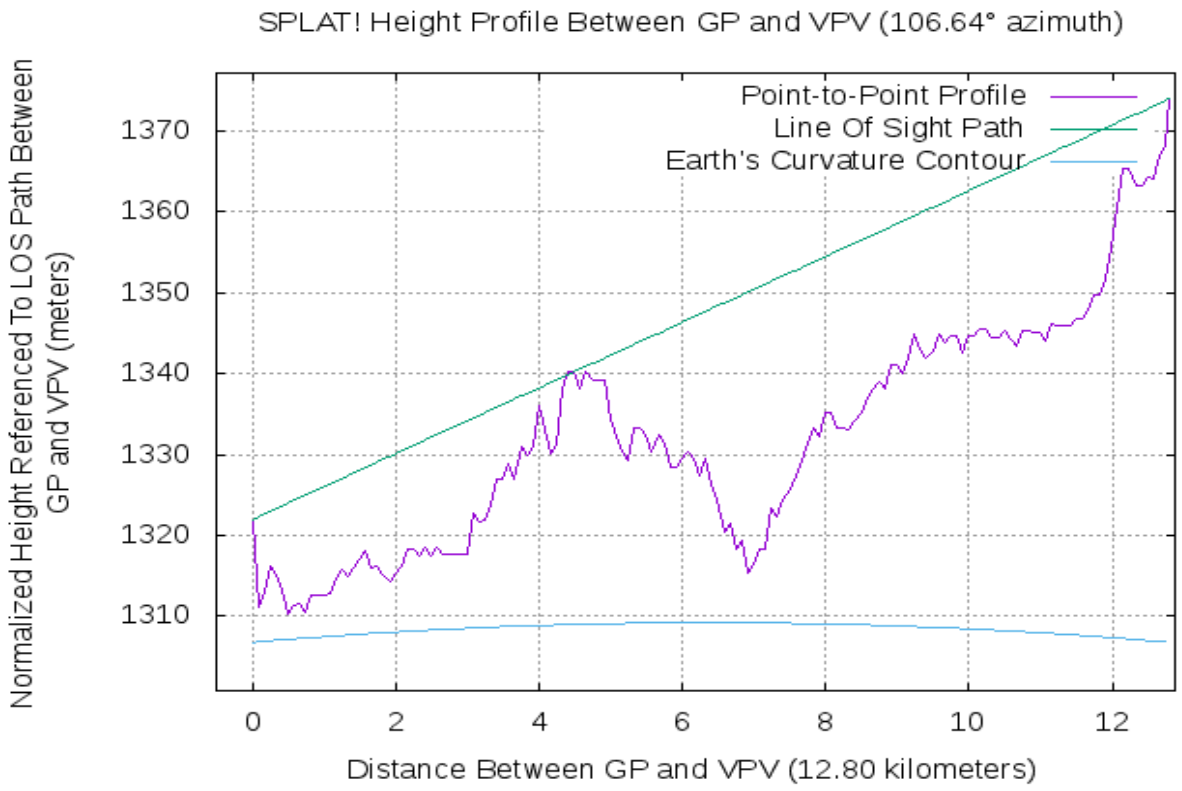

Figure 8 - Line of Sight between Vlakfontein PV and Kopanang Gold Plant

8. CLEARANCE ZONE

The clearance zone around a PV farm is the separation distance needed, between the edge of the PV plant (source) to a specific EMI sensitive location or infrastructure (victim), for the PV plant to have no RFI on existing electrical infrastructure. It is assumed that the inverters that will be used complies to CISPR11 Class A specification. (57 dBµV/m @ 3m). The recommended clearance zones are listed in Table 2.

Table 2 - Clearance Zone Distances [2, 3]

EMI sensitive location	Distance Between the Edge of a PV plant and an EMI sensitive location in meter
Existing Radar equipment	152.4 m
Navigational and communication equipment	45.72 m
Equipment sensitive to EMI	45.72 m
Airfield/Airport Radar system	76.20 m

8.1 COVERAGE MAP AND TYPICAL SENSITIVITIES

A coverage map generated using Radio Mobile RF software [5] is shown below in figure 9. This map shows the worst-case signal strength transmitted from Zaaiplaats PV1 (Tx) and received at Kopanang Gold Plant (Rx). The signal strength at Kopanang is -165.5 dBm. For the Northern PV plant, only the coverage map from Zaaiplaats PV is considered, as it has been identified as the worst case. This means that transmitted power from the other PV plants will be equal to or less than -165.5 dBm.

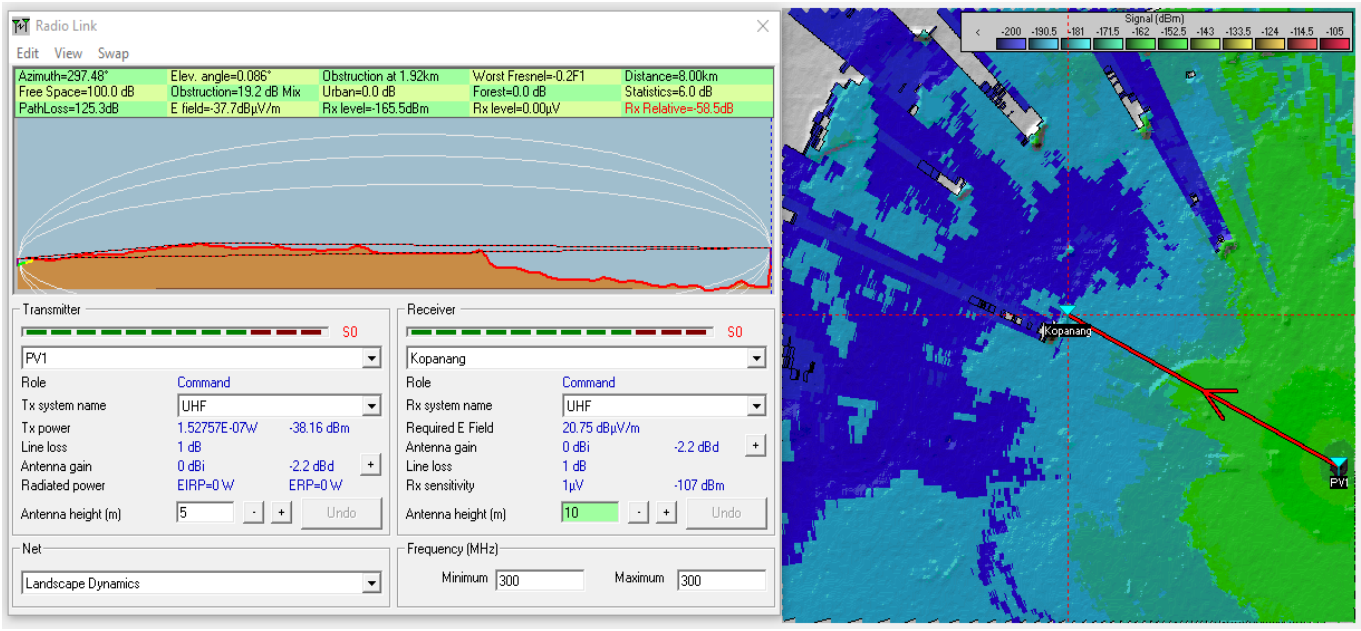

Figure 9 - Signal strength coverage map between Zaaiplaats PV1 and Kopanang Gold Plant

Table 3 - List of typical sensitivities from EMI sensitive equipment

Receiver	Sensitivity
LoRa	-130 dBm
Wifi (common 802.11g)	-85 dBm
GSM/LTE/GPRS	-102 dBm
UHF	-100 dBm
Bluetooth	-82 dBm

9. CONCLUSION

Both areas identified by the DFFE screening tool were identified to be more than 7km away from the nearest proposed PV site. Kopanang Gold Plant is 8 km away from Zaaiplaats PV1. The second EMI sensitive area cannot be identified using Google Earth, the location is situated on open farmland.

Figures 6 to 8 showcase the line of sight between the gold plant and each of the three Northern PV sites. Only Vlakfontein has a direct line of sight to the gold plant, but at a distance of 12.8 km. The other two sites are more than 8 km with no direct line of sight. The Northern PV farm is further away than the clearance zone indicated in Table 2. Pathloss over this distance is high enough for the other PV farms to have no significant RFI or EMI impact on the electrical infrastructure at Kopanang Gold Plant.

Table 3 showcases possible EMI sensitive receivers with their respective sensitivities that can be used on site at Kopanang. According to the coverage data generated in Radio Mobile seen in figure 9, the receivers at the gold plant will not be desensitised by the Northern PV farms.

No other EMI sensitive receivers inside the clearance zone could be identified using Google Maps.

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