

moray offshore renewables ltd

Environmental Statement

Technical Appendix 5.3 C - Radar Propagation Modelling

Telford, Stevenson, MacColl Wind Farms
and associated Transmission Infrastructure
Environmental Statement



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MORL Three Development Sites: Radar Line of Sight Assessment

Methodology

This letter describes the methodology and results of the radar line of sight assessment carried out by Osprey.

Osprey used the ATDI ICS Basic Version 10 tool to model the terrain elevation profile between the given radar and each wind turbine point. Otherwise known as a point-to-point line of sight analysis the result is a graphical representation of the intervening terrain and the direct signal line of sight (taking into account earth curvature and radar signal properties).

*Caveat: This is a limited and theoretical desk based study; in reality there are unpredictable levels of signal diffraction and attenuation within a given radar environment that can influence the probability of a turbine being detected. Our analysis is designed to give an indication of the likelihood of the turbine being detected such that the **operational** significance of the wind farm relative to nearby aviation assets can be assessed.*

The qualitative definitions used in our assessment are defined in Table 1 below.

Result	Definition
Yes	the turbine is highly likely to be detected by the radar: direct line of sight exists between the radar and the turbine
Likely	the turbine is likely to be detected by the radar at least intermittently
Unlikely	the turbine is unlikely to be detected by the radar but cannot rule out occasional detection
No	the turbine is unlikely to be detected by the radar as significant intervening terrain exists

Table 1 Qualitative Definitions of line of sight results

The figures in this assessment show the line of sight terrain elevation profile between the PSR (left of the diagram) and the blade tips of a 204m turbine at the given coordinates. The grey area represents the intervening terrain. The direct line of sight is represented by the red straight line and the orange ellipse around the signal is known as the 1st Fresnel zone. The Fresnel zone is an area around the direct line of sight where the signal remains strong; Osprey looks at the degree to which the direct line of sight and the Fresnel ellipse are blocked by the terrain in order to make a qualitative assessment of the likelihood that turbines will be detected.

Figure 1 below gives the locations of the points assessed for theoretical radar detectability with regard to the identified aviation stakeholder radar systems. The complete sets of Line of Sight profiles are contained in Annex A at the end of this report.

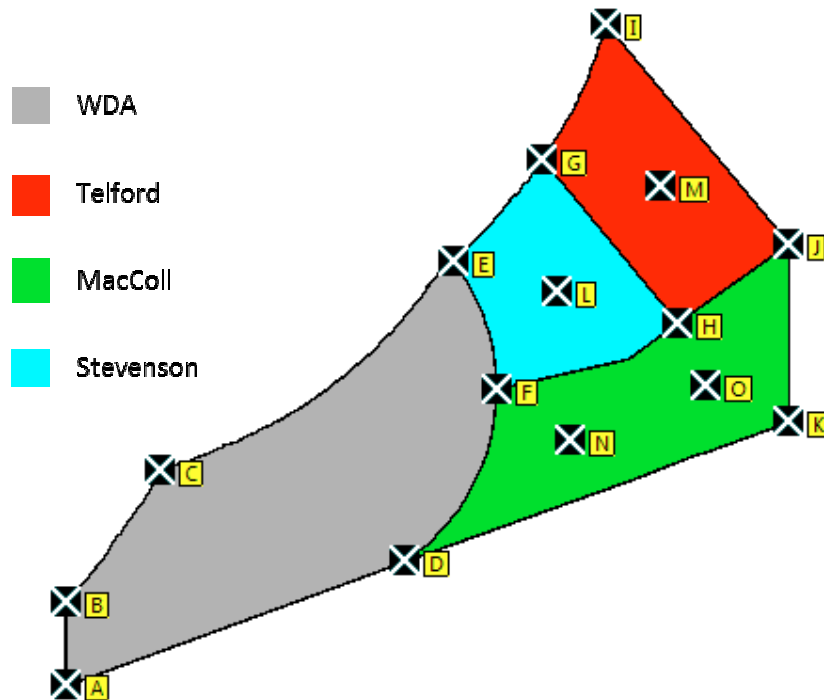


Figure 1 Turbine Theoretical Detectability - Assessed Points

For reference, points A-C are not considered as constituent points of the three proposed wind farm sites as they lie within the Western Development Area, and are not included in further analysis.

Table 2 below indicates whether the radars will theoretically detect the individual turbines at a maximum blade tip height of 204m. The results for Buchan ADR are presented illustratively overlaid in Figure 2.

Turbine Location	NERL Allanshill PSR	ASACS Buchan ADR	RAF Lossiemouth PSR
D	Yes	No	Yes
E	Yes	No	Yes
F	Yes	No	Yes
G	Yes	Unlikely	Yes
H	Yes	Likely	Yes
I	Yes	Unlikely	Likely
J	Yes	Likely	Yes
K	Yes	Likely	Yes
L	Yes	No	Yes
M	Yes	Likely	Yes
N	Yes	No	Yes
O	Yes	Likely	Yes

Table 2 Theoretically Detectability - maximum blade tip height of 204m

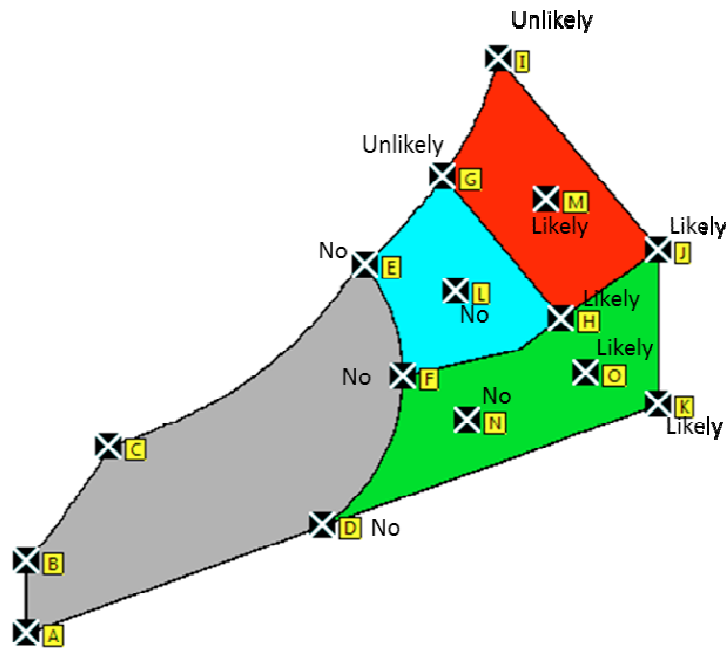


Figure 2 Buchan ADR Turbine Theoretical Detectability - Assessed Points with Results

Breakdown by Aviation Stakeholder

NERL Allanshill PSR

An assessment was completed to ascertain the likelihood of the MORL development having the potential to be detected by the NERL Allanshill PSR.

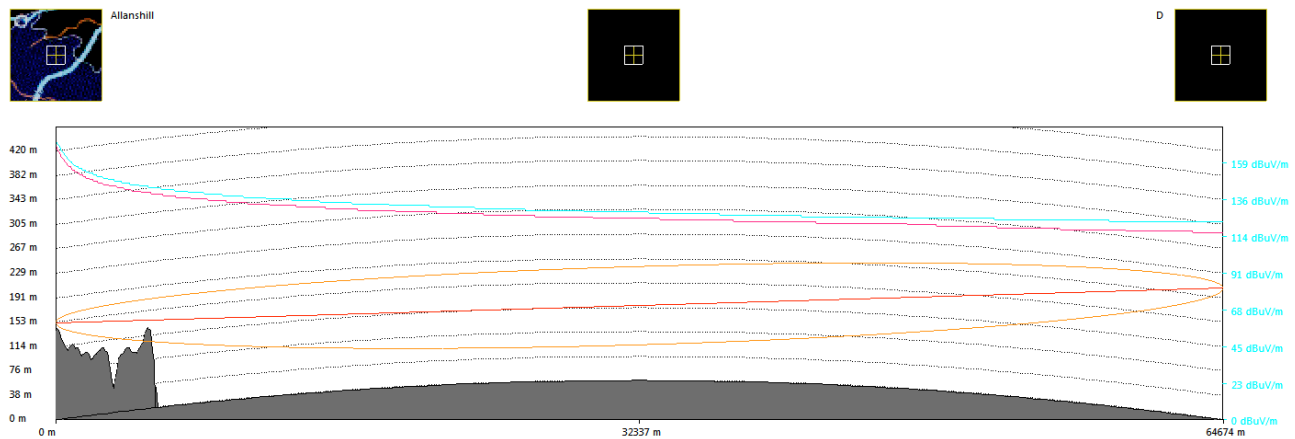


Figure 3 Terrain elevation profile Allanshill PSR to MORL Point D

Figure 3 shows that the direct line of sight, the red line, is unobstructed. The turbine will, in theory, be detected by the Allanshill PSR. The result is indicative of the results of line of sight assessments for Points D-O.



ASACS Buchan ADR

An assessment was also completed to ascertain the likelihood of the MORL development having the potential to be detected by the ASACS Buchan ADR.

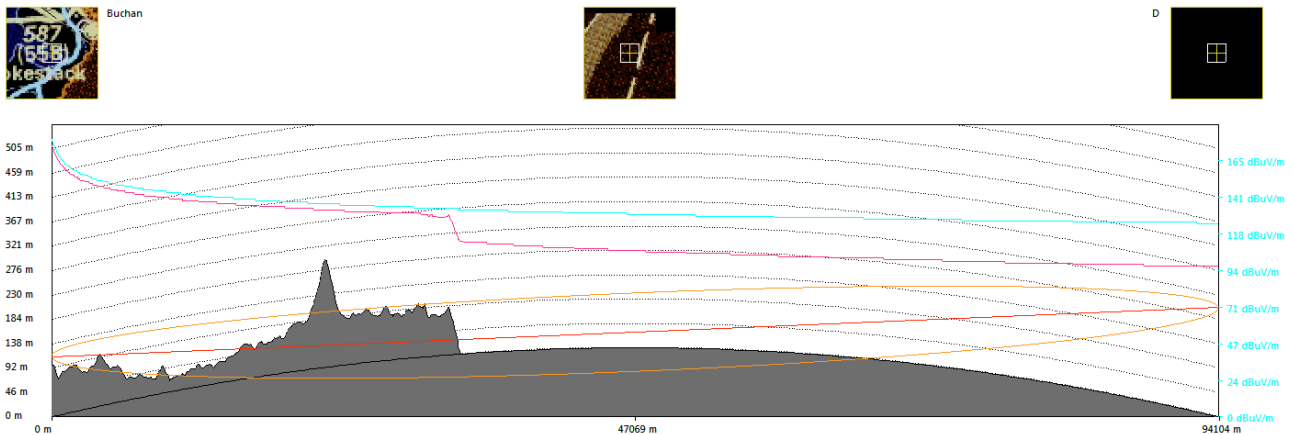


Figure 4 Terrain elevation profile Buchan ADR to MORL Point D

Figure 4 shows that the direct line of sight, the red line, is obstructed. The turbine will, therefore, not be detected by the Buchan ADR. The result is indicative of the results of line of sight assessments for Points D-F and Points L and N. Points H, J, K, M and O are theoretically likely to be detected by the radar at least intermittently. Points G and I are unlikely to be theoretically detected by the radar, but cannot rule out occasional detection.

RAF Lossiemouth

A similar assessment was completed with regard to the potential for the development to be detected by the Lossiemouth PSR.

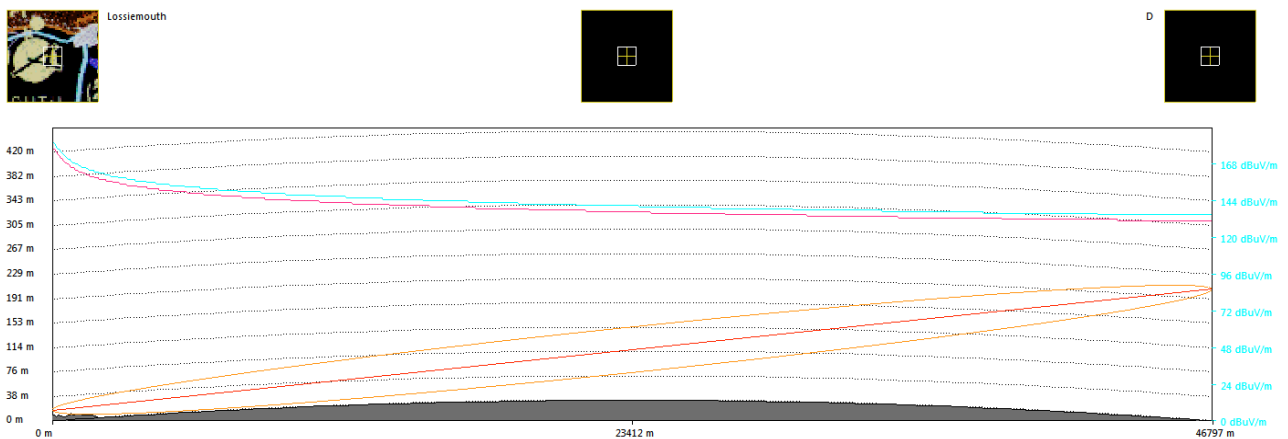


Figure 5 Terrain elevation profile Lossiemouth PSR to MORL Point D

Figure 5 shows that the direct line of sight, the red line, is unobstructed. The turbine will therefore be theoretically detected by the Lossiemouth PSR. The result is indicative of the results of line of sight assessments for Points D-H and Points J-O. Point I is theoretically likely to be detected by the radar at least intermittently.



Annex A – Turbine Location Point - Theoretical Detectability to Radar

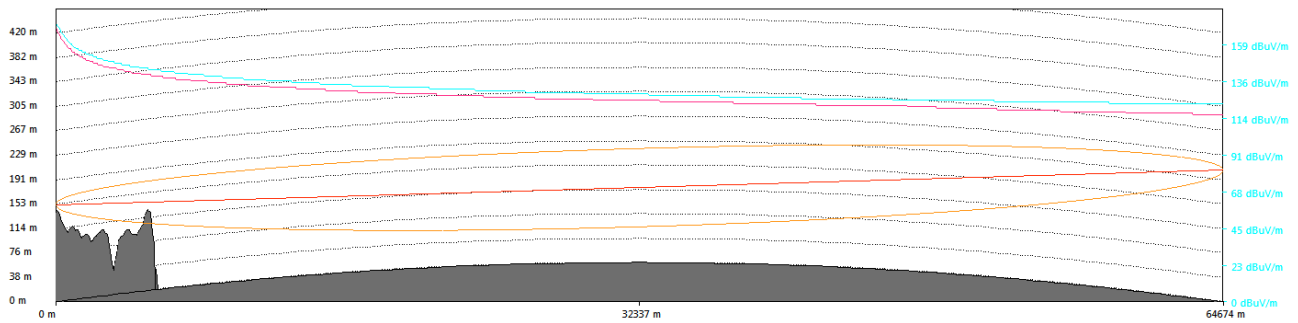
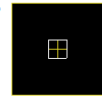
NERL Allanshill PSR



Allanshill



D



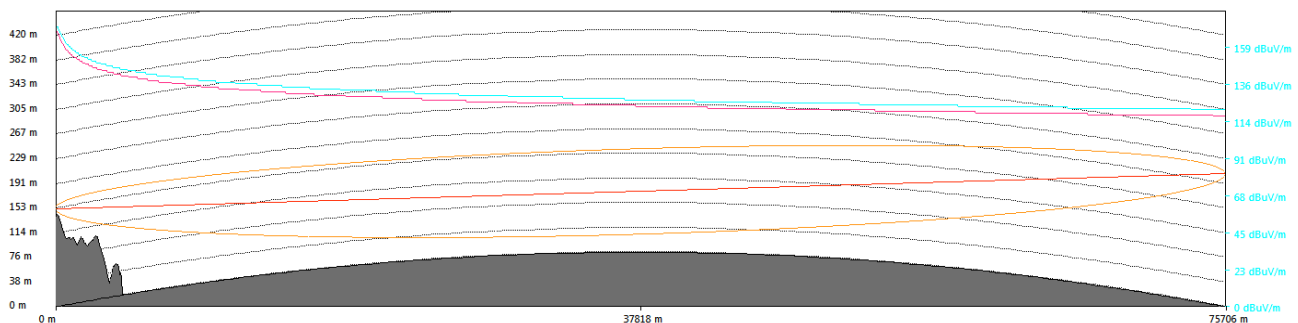
Terrain elevation profile Allanshill PSR to MORL Point D



Allanshill



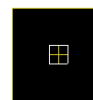
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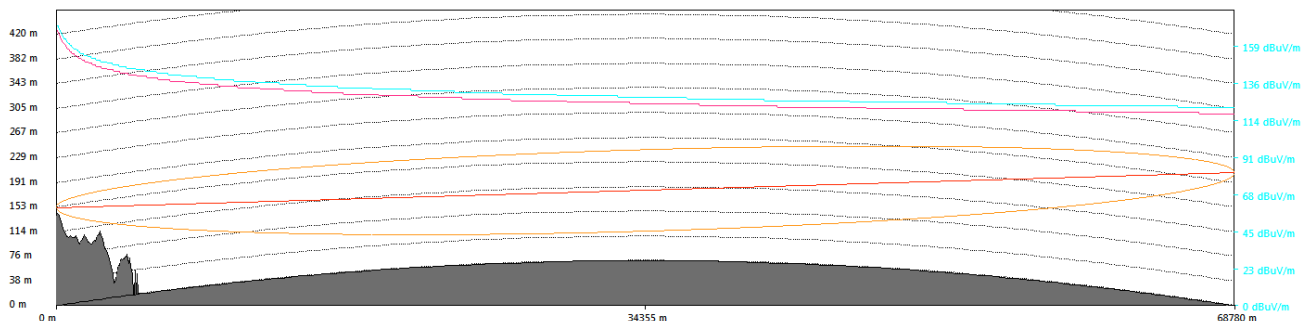
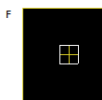
Terrain elevation profile Allanshill PSR to MORL Point E



Allanshill



F



Terrain elevation profile Allanshill PSR to MORL Point F

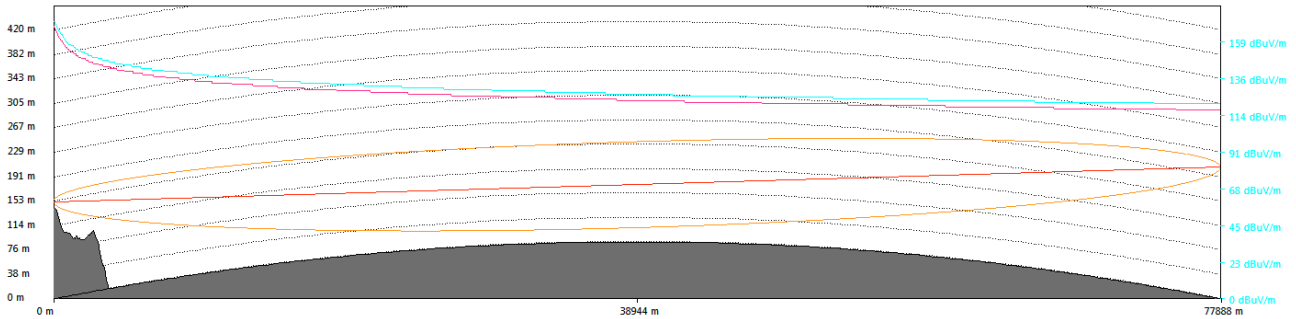
APPENDIX 5.3 C



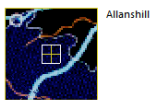
Allanshill



G



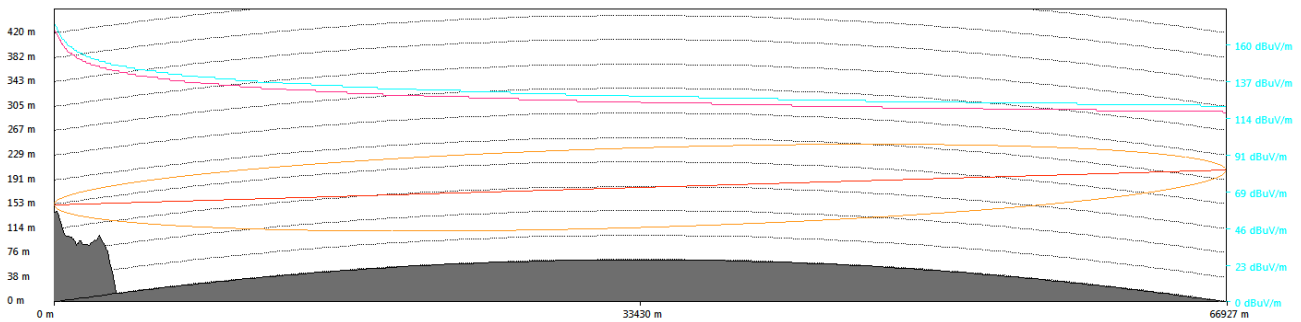
Terrain elevation profile Allanshill PSR to MORL Point G



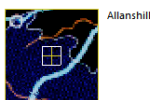
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H



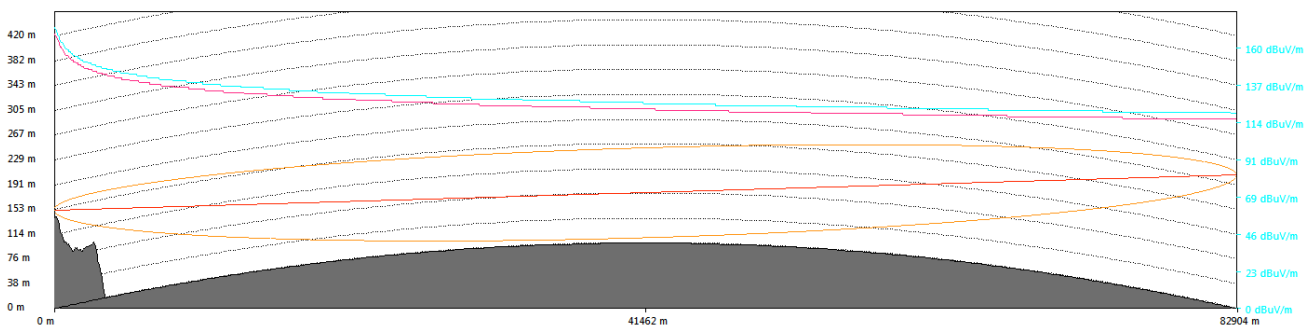
Terrain elevation profile Allanshill PSR to MORL Point H



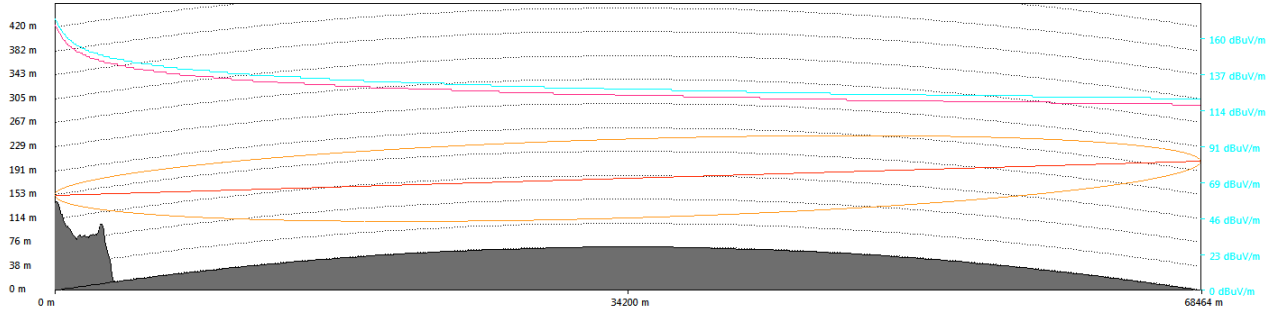
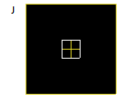
Allanshill



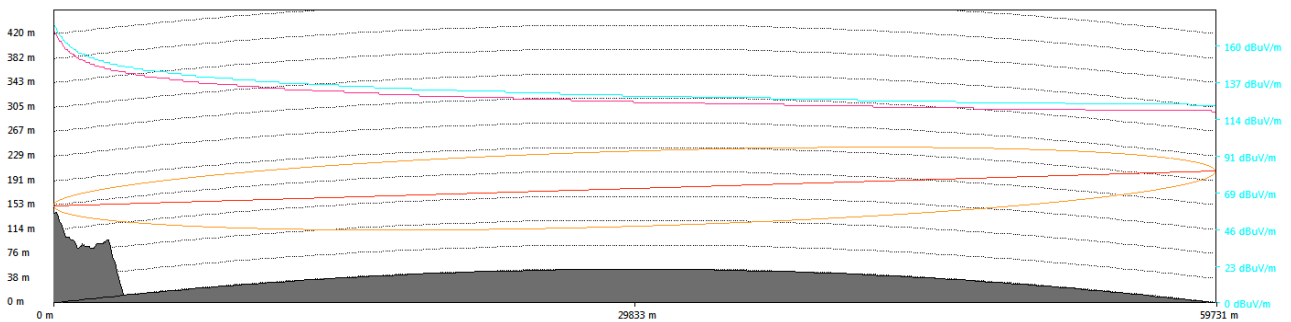
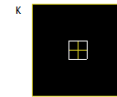
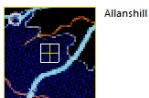
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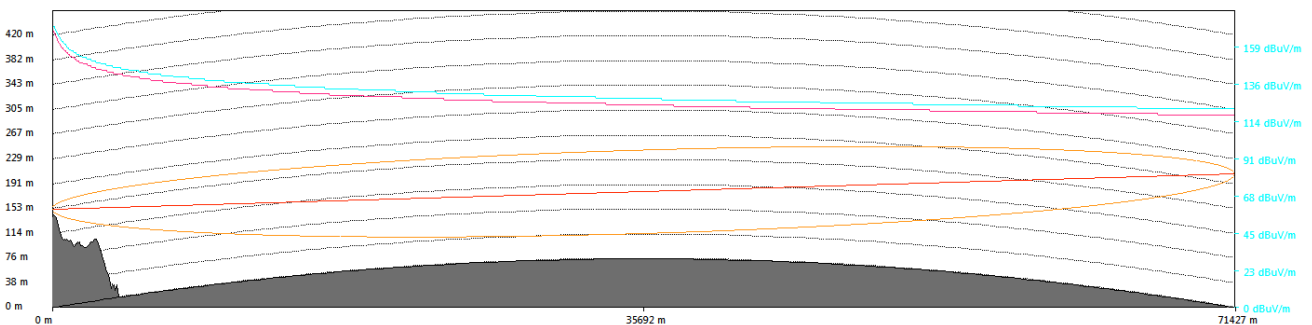
Terrain elevation profile Allanshill PSR to MORL Point I



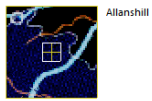
Terrain elevation profile Allanshill PSR to MORL Point J



Terrain elevation profile Allanshill PSR to MORL Point K



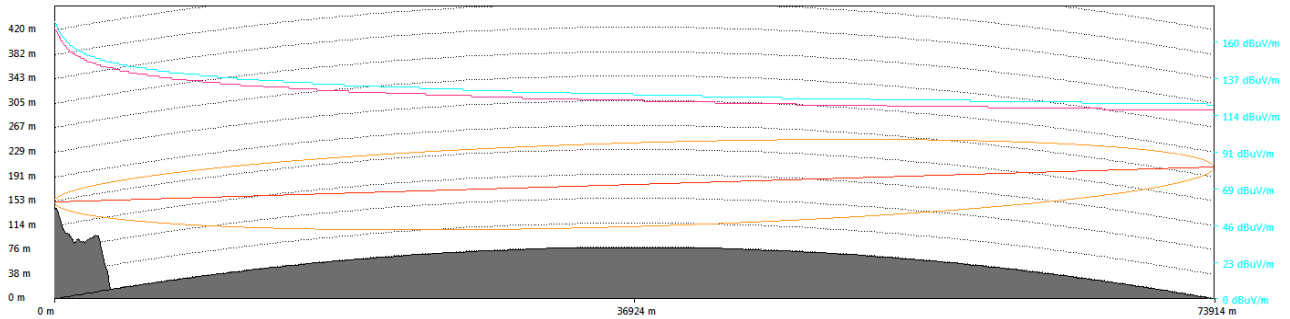
Terrain elevation profile Allanshill PSR to MORL Point L



Allanshill



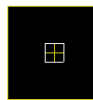
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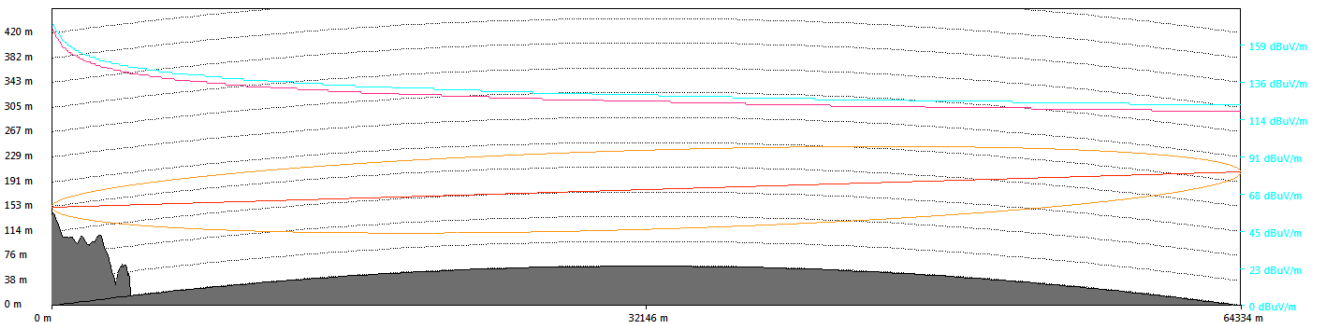
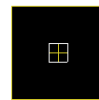
Terrain elevation profile Allanshill PSR to MORL Point M



Allanshill



N



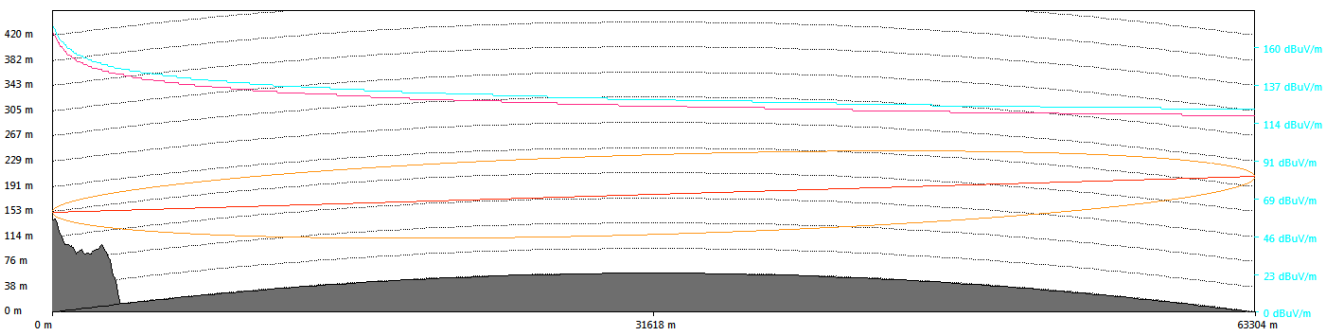
Terrain elevation profile Allanshill PSR to MORL Point N



Allanshill



O



Terrain elevation profile Allanshill PSR to MORL Point O



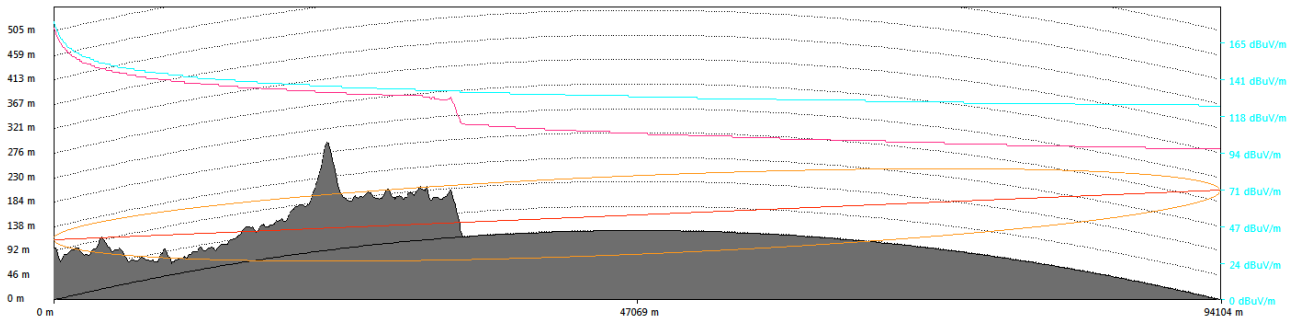
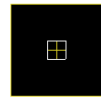
ASACS Buchan ADR



Buchan



D



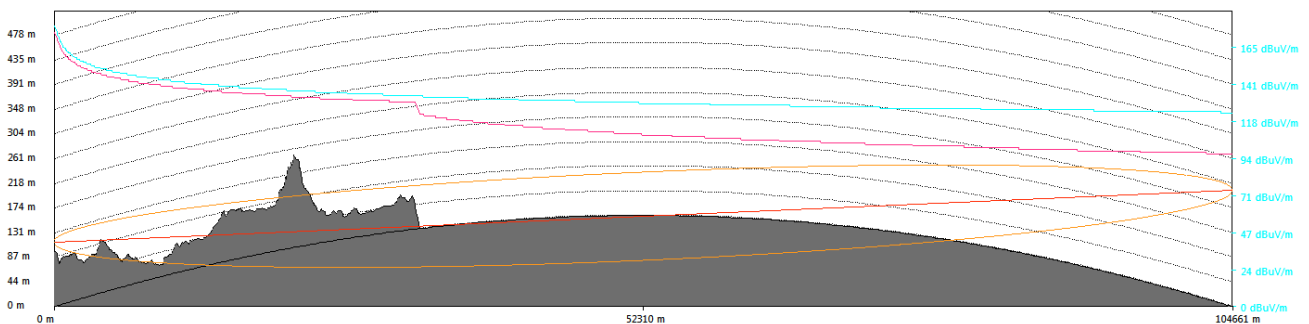
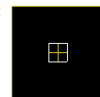
Terrain elevation profile Buchan ADR to MORL Point D



Buchan



E



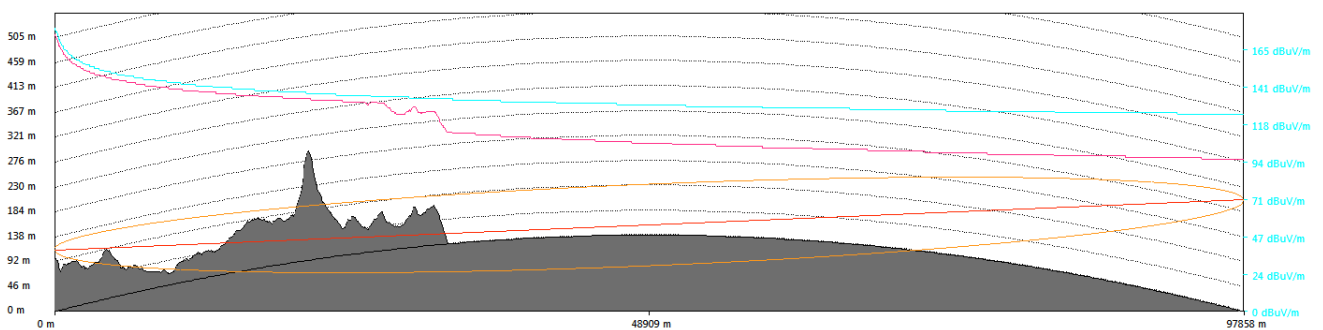
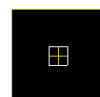
Terrain elevation profile Buchan ADR to MORL Point E



Buchan



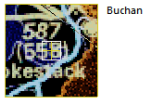
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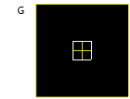
Terrain elevation profile Buchan ADR to MORL Point F

5.3 C

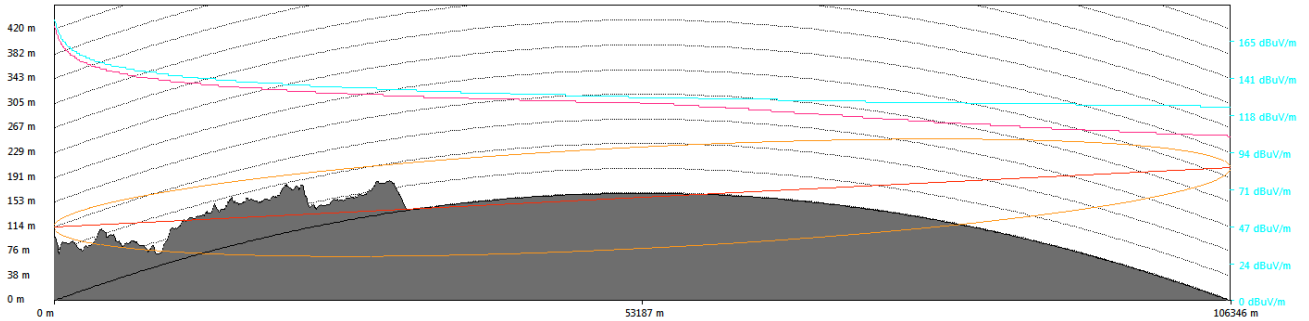
APPENDIX



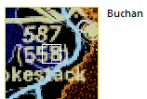
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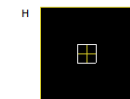
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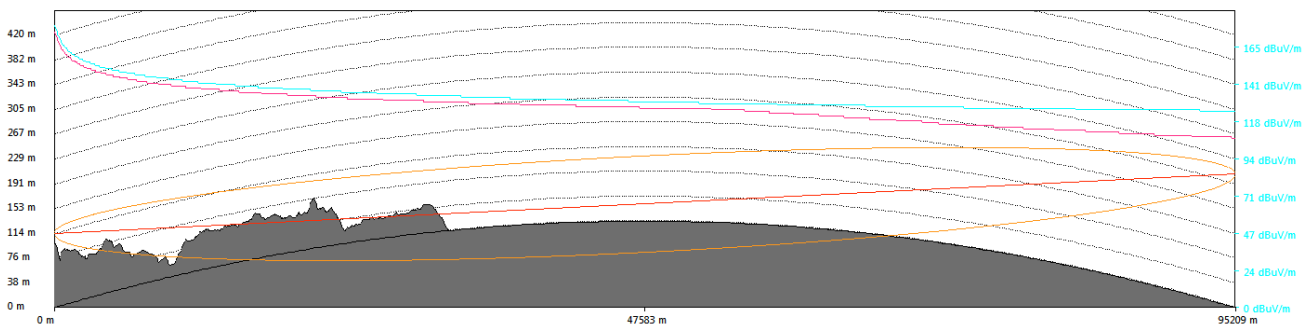
Terrain elevation profile Buchan ADR to MORL Point G



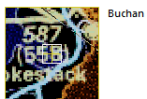
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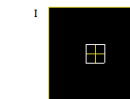
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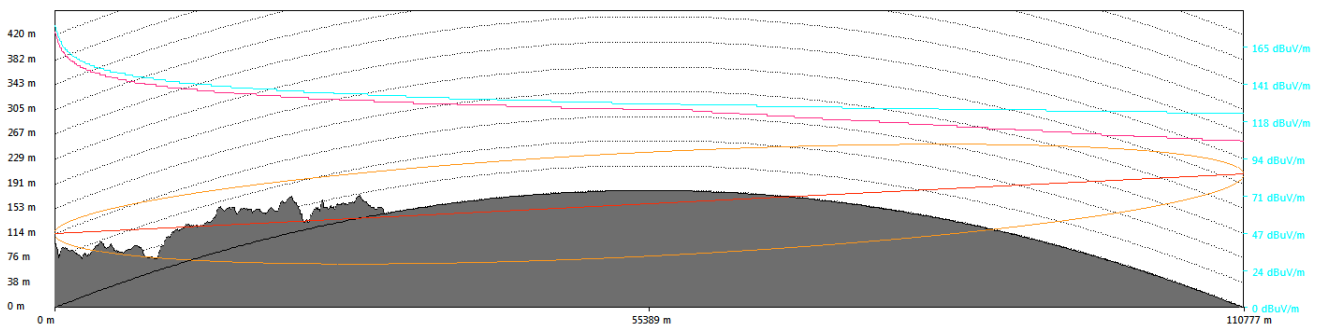
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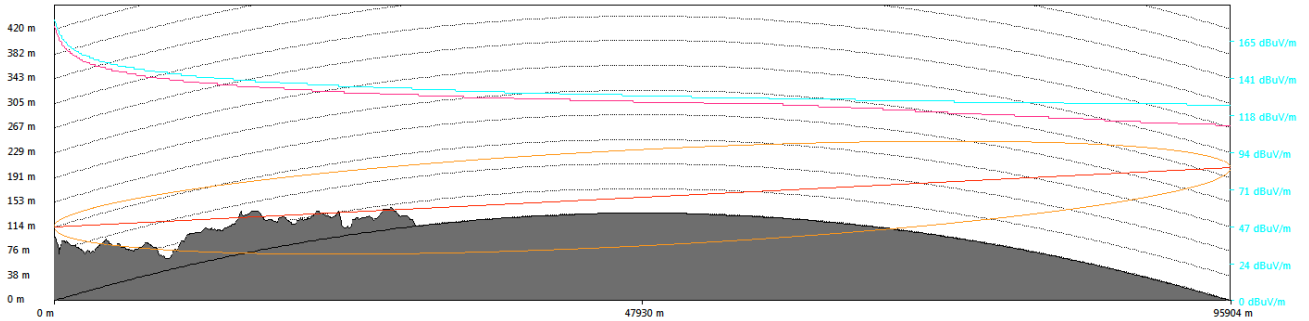
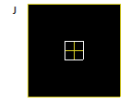
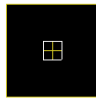
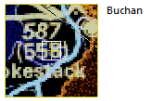
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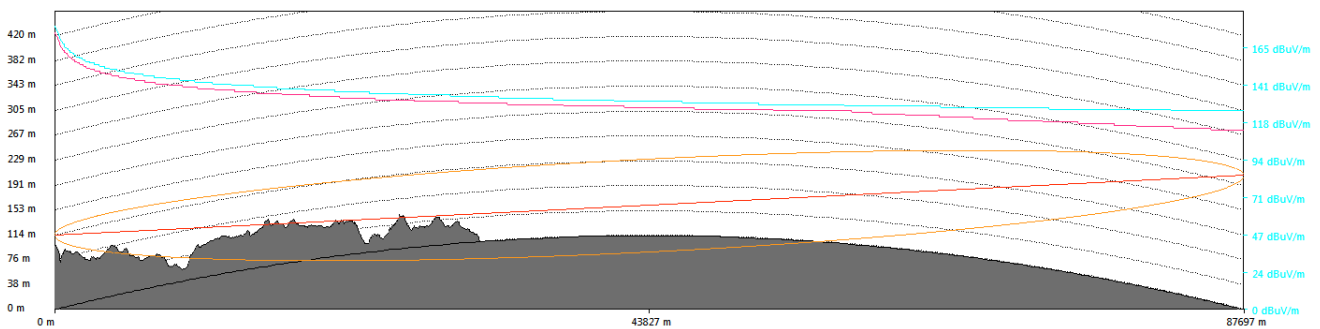
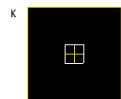
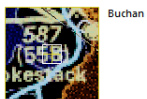
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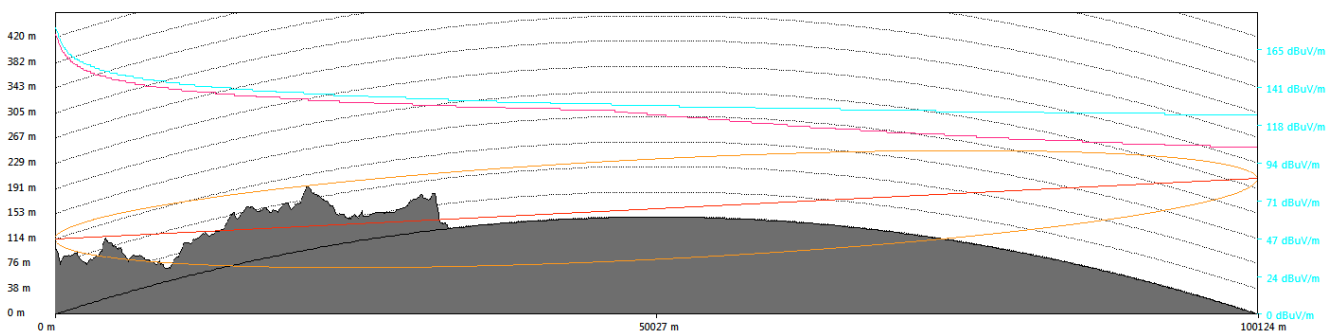
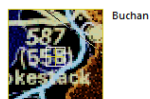
Terrain elevation profile Buchan ADR to MORL Point I



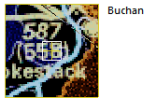
Terrain elevation profile Buchanan ADR to MORL Point J



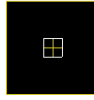
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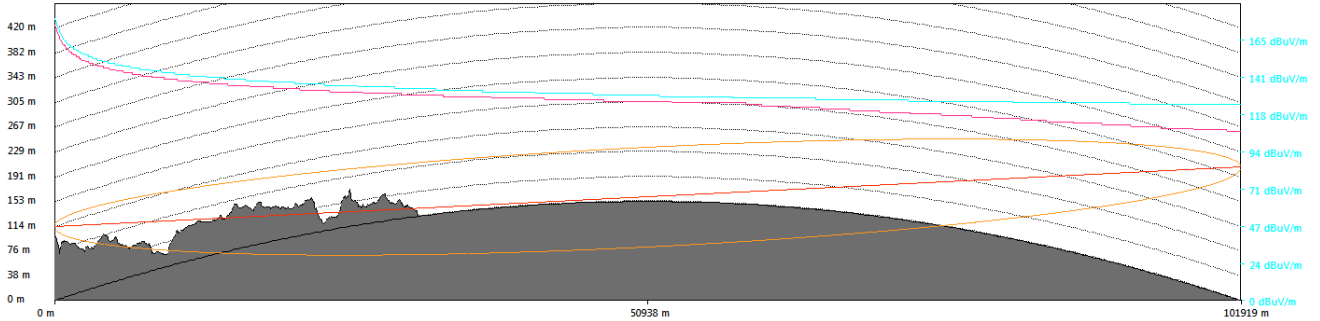
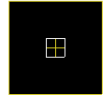
Terrain elevation profile Buchanan ADR to MORL Point L



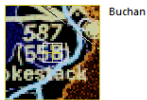
Buchan



M



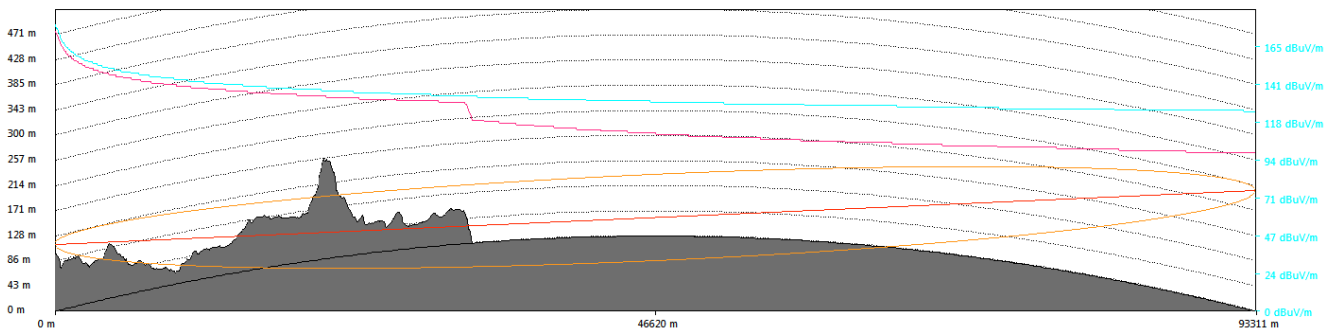
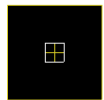
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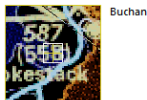
Buchan



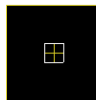
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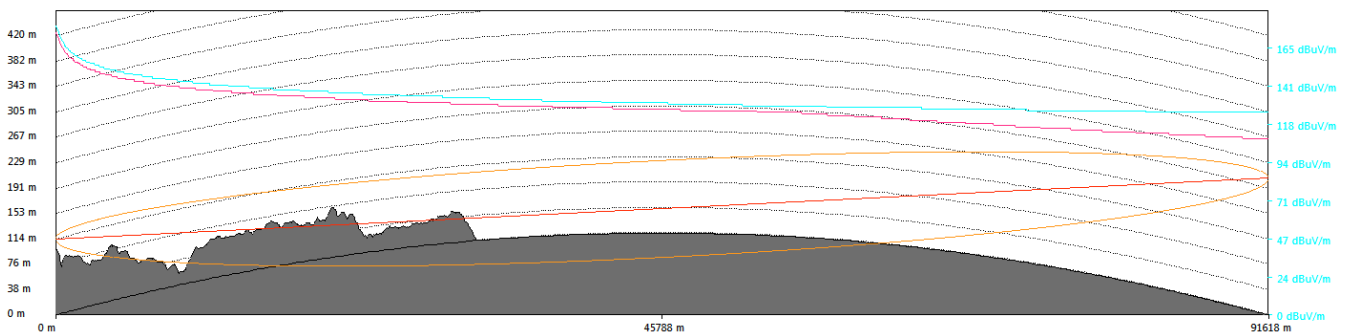
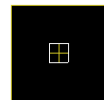
Terrain elevation profile Buchan ADR to MORL Point N



Buchan



O



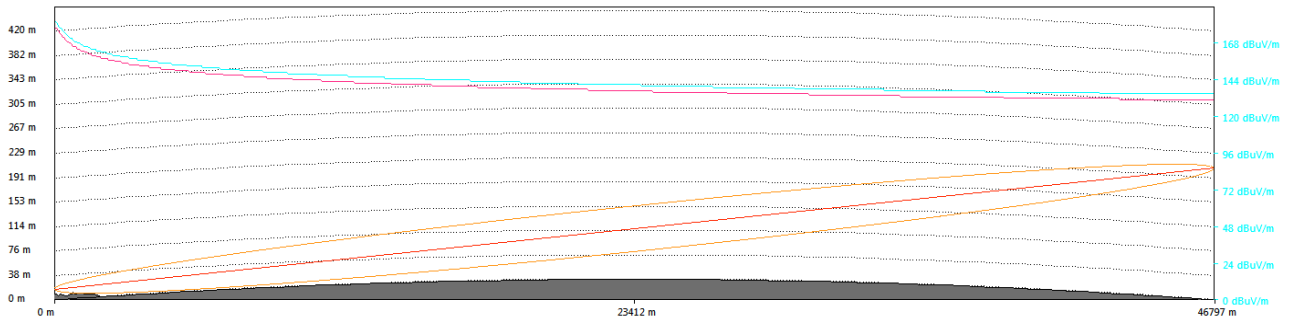
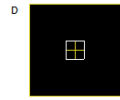
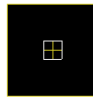
Terrain elevation profile Buchan ADR to MORL Point O



RAF Lossiemouth PSR



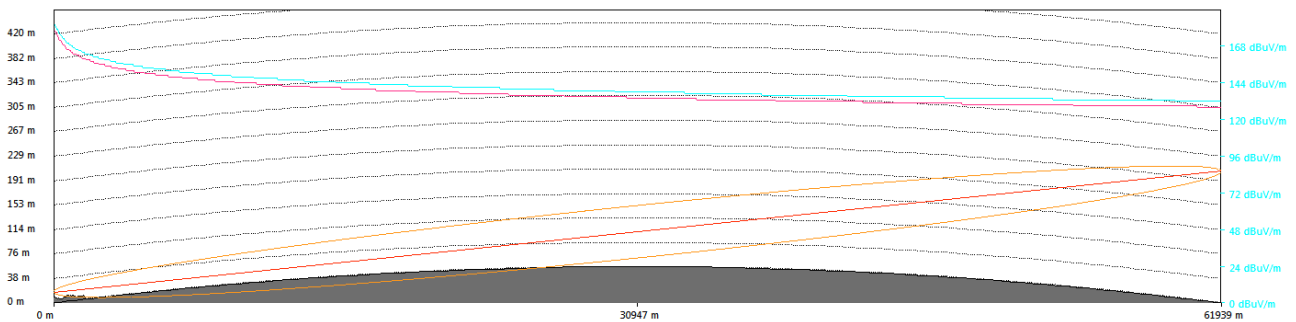
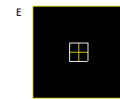
Lossiemouth



Terrain elevation profile Lossiemouth PSR to MORL Point D



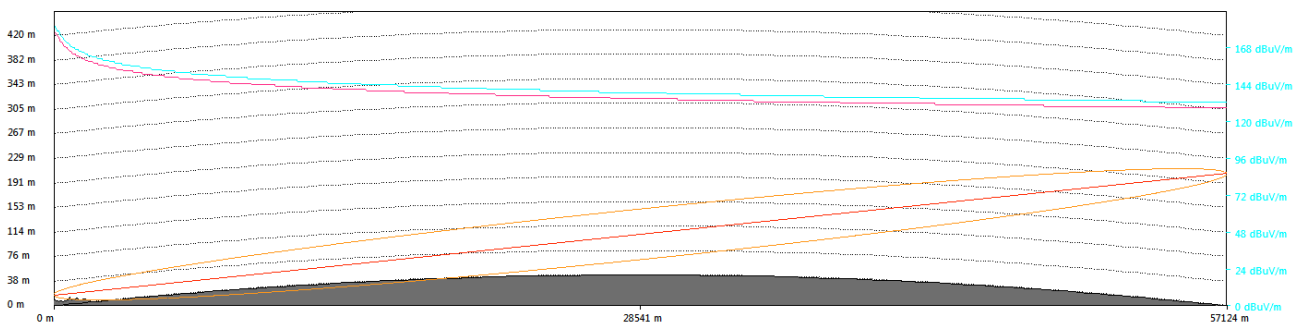
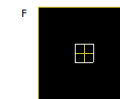
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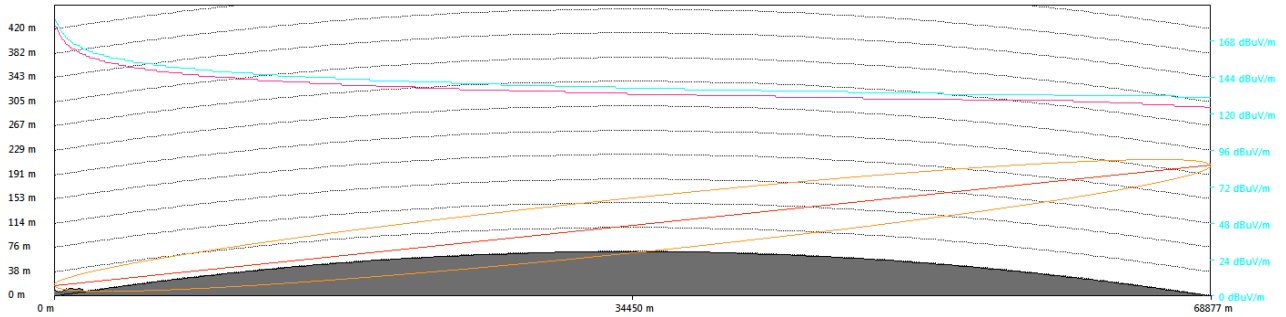
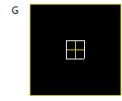
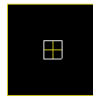
Terrain elevation profile Lossiemouth PSR to MORL Point E



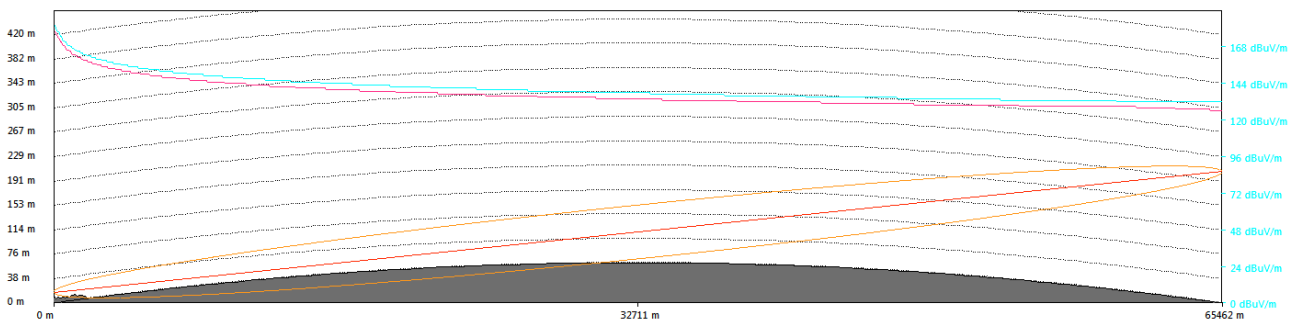
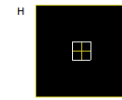
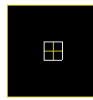
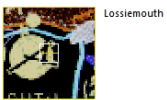
Lossiemouth



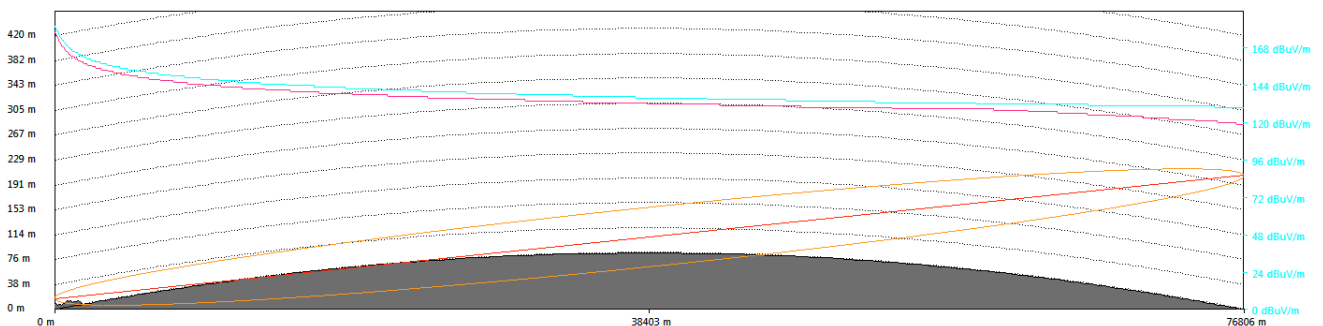
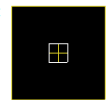
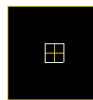
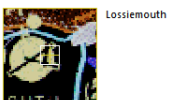
Terrain elevation profile Lossiemouth PSR to MORL Point F



Terrain elevation profile Lossiemouth PSR to MORL Point G



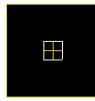
Terrain elevation profile Lossiemouth PSR to MORL Point H



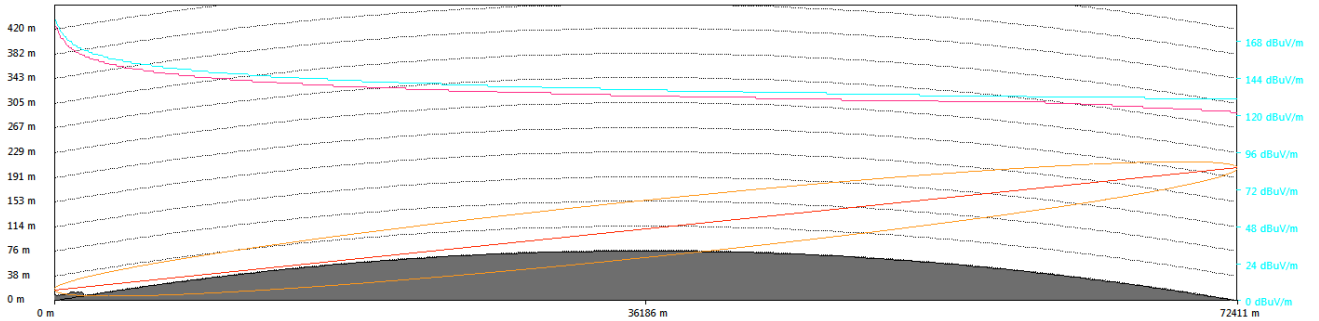
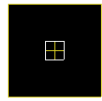
Terrain elevation profile Lossiemouth PSR to MORL Point I



Lossiemouth



J



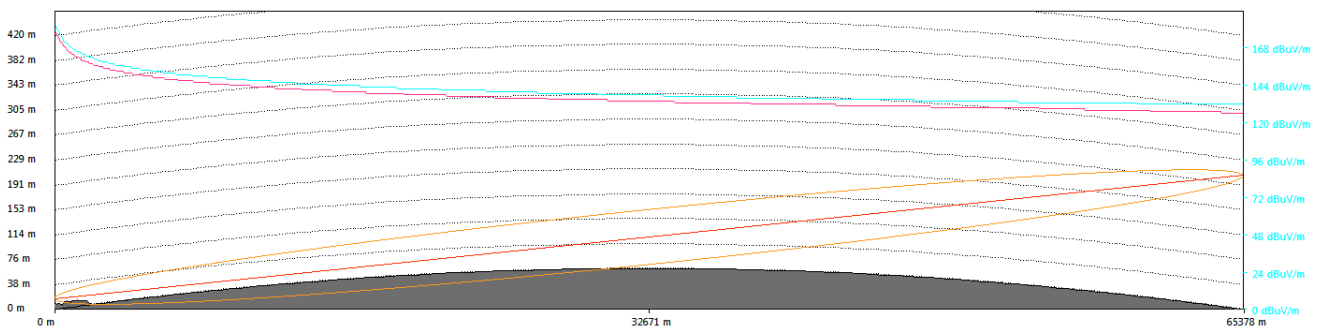
Terrain elevation profile Lossiemouth PSR to MORL Point J



Lossiemouth



K



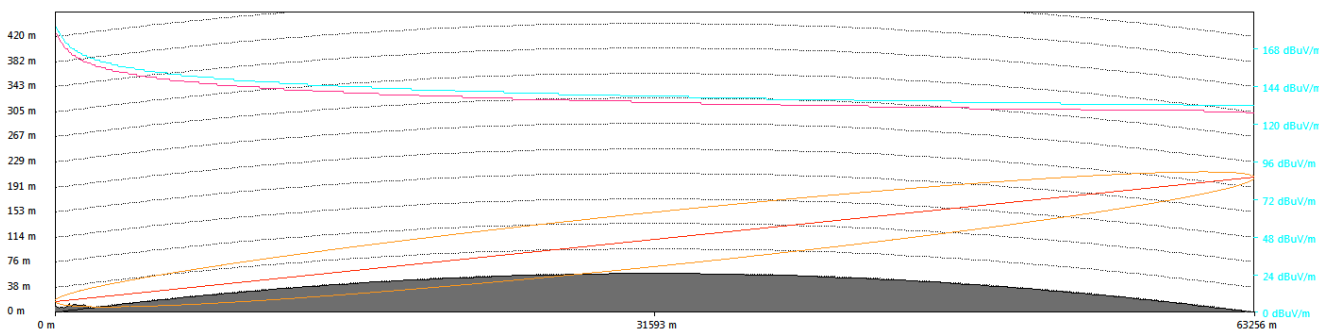
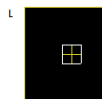
Terrain elevation profile Lossiemouth PSR to MORL Point K



Lossiemouth



L

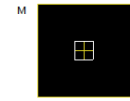
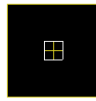


Terrain elevation profile Lossiemouth PSR to MORL Point L

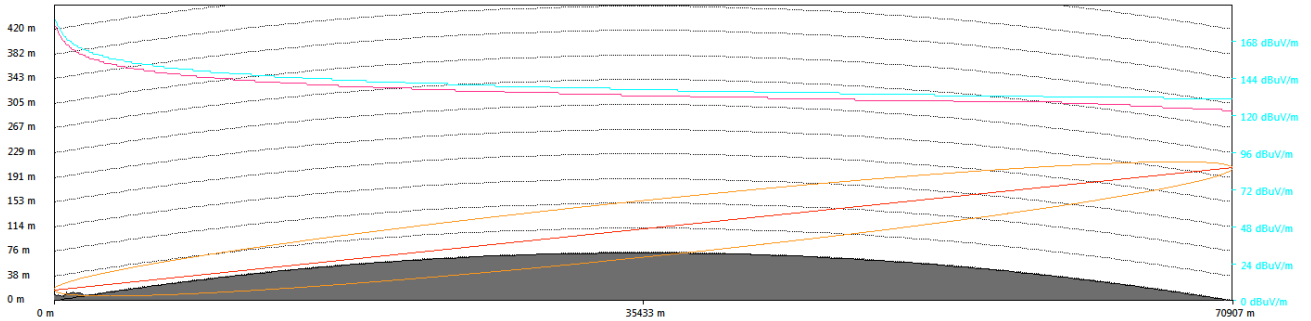
APPENDIX 5.3 C



Lossiemouth



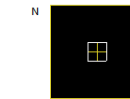
M



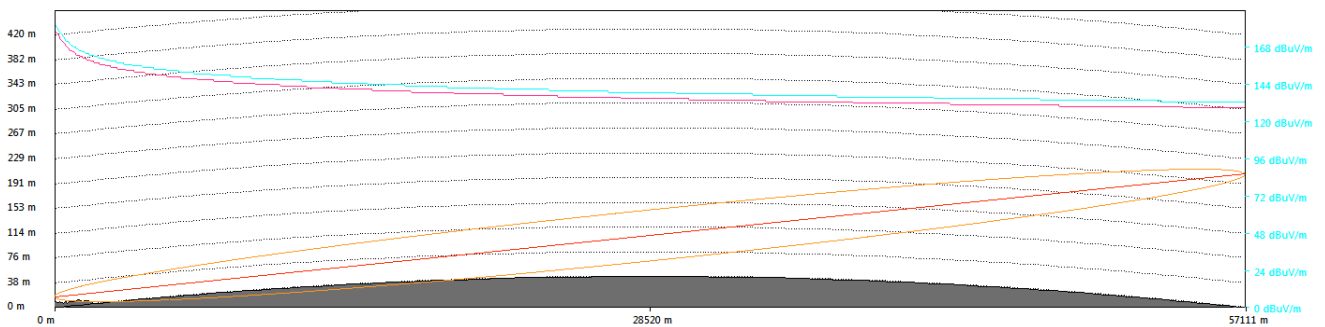
Terrain elevation profile Lossiemouth PSR to MORL Point M



Lossiemouth



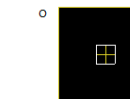
N



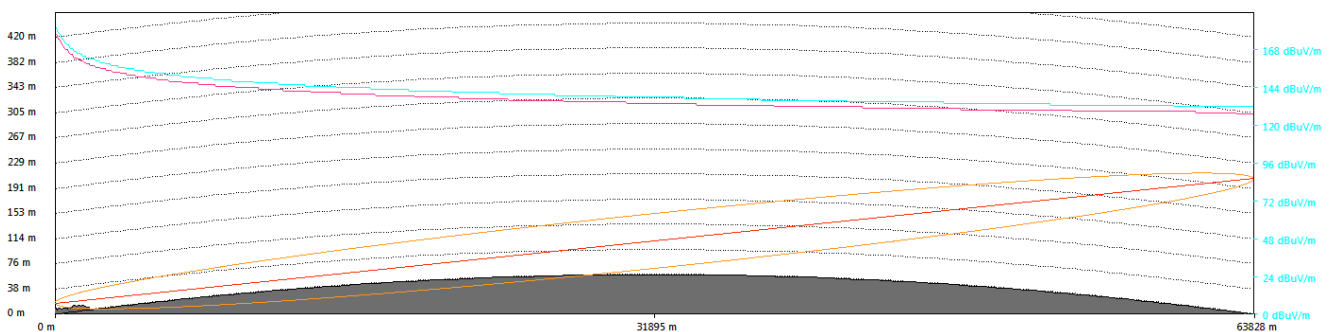
Terrain elevation profile Lossiemouth PSR to MORL Point N



Lossiemouth



O



Terrain elevation profile Lossiemouth PSR to MORL Point O