Appendix 14-3:
Communications Navigation and Surveillance (CNS) Technical Assessment Report (Radar Line of Site)

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Appendix 14-3: Communications Navigations and Surveillance (CNS) Technical Assessment Report (Radar Line of Sight)

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Coleman Aviation Limited - Oriel Wind Farm

CNS Technical Assessment Report (Radar Line of Site)

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Executive Summary

Coleman Aviation Ltd ("the Client") is providing aviation consultancy support to the Oriel Wind Farm ("the Development").

The Client has commissioned Osprey Consulting Services Limited (Osprey) to conduct a technical assessment ("the Assessment" to determine the likelihood of visibility of the Development to the Primary Surveillance Radar (PSR) at the Isle of Man Airport ("the Airport").

This report details the approach and presents the results of the Assessment commissioned and identifies the likelihood of visibility of the Development to the Airport's PSR.

Scope

Airport PSR

For the purposes of this report and the scope of work undertaken in the assessment contained within, the In-Scope PSR being considered is defined as:

- Isle of Man Airport
    - Selex ATCR-33S PSR

The Development

For the purposes of this report and the scope of work undertaken in the assessment contained within, the Development is defined as Oriel Wind Farm consisting of 25 Wind Turbine Generator's (WTG) with blade tip heights of 270m Above Sea Level (ASL).

Requirement

The Client has commissioned a technical safeguarding assessment to be conducted. The assessment is detailed in the respective section of this document, with summary conclusions and recommendations also being provided as follows:

- **Section 2 - Radar Line of Sight (LOS) Assessment**

  Radar LOS assessment of the Development to determine the likelihood of visibility of the Development by the Airport's PSR.

Conclusions

The Assessment concludes that none of the respective WTGs of the Development will be visible to the Airport's PSR due to intervening topography providing terrain shielding.

Recommendations

None.

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1 Introduction

1.1 Purpose

Coleman Aviation Ltd ("the Client") is providing aviation consultancy support to the Oriel Wind Farm ("the Development").

The Client has commissioned Osprey Consulting Services Limited (Osprey) to conduct a technical assessment ("the Assessment") to determine the likelihood of visibility of the Development to the Primary Surveillance Radar (PSR) at the Isle of Man Airport ("the Airport").

This report details the approach and presents the results of the Assessment commissioned and identifies the likelihood of visibility of the Development to the Airport's PSR.

1.2 Scope

1.2.1 Airport PSR

For the purposes of this report and the scope of work undertaken in the assessment contained within, the In-Scope PSR being considered is defined as:

- Isle of Man Airport
  - Selex ATCR-33S PSR

Specific PSR parameters used in the assessment are detailed in Table 1 below.

Parameter	Value
Power	9.5 kW
Frequency	2800 MHz
Antenna Gain	33.5 dBi
Tx/Rx Bandwidth	12.5 kHz
Antenna Height	13m Above Ground Level (AGL)

Table 1 - PSR Parameters

1.2.2 The Development

For the purposes of this report and the scope of work undertaken in the assessment contained within, the Development is defined as:

- Oriel Wind Farm consisting of 25 Wind Turbine Generators (WTG) with blade tip height of 270 meters (m) Above Sea Level (ASL).

Specific WTG parameters and geolocations used in the assessments are detailed in Table 2 below.

WTG	Coordinates (4NGR[1])		Tip Height (m)	ID
	East/ West	North/ South		
1	53.94788769	-6.091750746	270	T1
2	53.94730194	-6.066632531	270	T2
3	53.94678173	-6.041156639	270	T3
4	53.93884804	-6.077223928	270	T4
5	53.93884945	-6.055581783	270	T5
6	53.93479359	-6.100283378	270	T6
7	53.93038266	-6.077188612	270	T7
8	53.93044807	-6.048514259	270	T8
9	53.93376965	-6.034229709	270	T9
10	53.92244012	-6.108002138	270	T10
11	53.92245013	-6.091374914	270	T11
12	53.92236786	-6.062934582	270	T12
13	53.9205224	-6.027399216	270	T13
14	53.91390948	-6.077264146	270	T14
15	53.91393264	-6.048692722	270	T15
16	53.90994363	-6.101883262	270	T16
17	53.90568767	-6.08456894	270	T17
18	53.90557009	-6.055456822	270	T18
19	53.9097409	-6.033861871	270	T19
20	53.89933641	-6.096108	270	T20
21	53.89736278	-6.069608648	270	T21
22	53.89878609	-6.040805282	270	T22
23	53.88834409	-6.090270115	270	T23
24	53.88755813	-6.069543166	270	T24
25	53.8869835	-6.048070434	270	T25

Table 2 - Oriel WF Development Parameters

[1] National Grid Reference.

1.2.3 Requirement

The Client has commissioned a technical safeguarding assessment to be conducted, detailed in the respective section of this document, with summary conclusions and recommendations also being provided as follows:

- **Section 2 - Radar Line of Sight (LOS) Assessment**
  Radar LOS assessment of the Development to determine the likelihood of visibility of the Development by the Airport's PSR.

1.3 Abbreviations

The following abbreviations are used within this document:

Abbreviation	Meaning
AGL	Above Ground Level
ASL	Above Sea level
CNS	Communications Navigation and Surveillance
dB	decibels
dBi	dB relative to isotropic
ft	feet
kHz	kilohertz
kW	kilowatt
LOS	Line of Sight
m	meters
MHz	megahertz
NGR	National Grid Reference
Osprey	Osprey Consulting Services Limited
PSR	Primary Surveillance Radar
RF	Radio Frequency
RX	Receiver
the Development	Oriel Wind Farm
TX	Transmitter
WF	Wind Farm
WTG	Wind Turbine Generator

Table 3 - Abbreviations

2 Radar LOS Assessment

2.1 Introduction

This section presents the Radar LOS Assessment, using the industry standard ATDI HTZ Communications ("HTZ Comms") software toolset.

2.2 Overview

LOS in its most simplistic form is a calculation to determine whether one object can see another in a direct path. WTGs present reflecting surfaces on which a radar transmitting energy can be returned and processed from. If a radar can see a WTG, then it will most likely be processed and cause an impact to the radar's ability to determine valid targets.

Radars operate by transmitting Radio Frequency (RF) energy, RF does not just propagate in straight 'optical' lines, but rather it spreads after it leaves the antenna. This spread is known as the Fresnel zone, objects which appear in the Fresnel zones can cause in phase or out of phase reflections of the radio wave.

Additionally, to better understand whether a reflecting object will be seen by a radar, consideration must also be made of interlaying terrain, the curvature of the earth and other known clutter such as vegetation and buildings.

Osprey has extensive experience of modelling Radar LOS using HTZ Comms. Our assessments consider optical line of site, upper and lower Fresnel zones, the Earth's curvature and known clutter.

2.3 Methodology

Whilst not fully defined, Oriel Wind Farm is planned to be located in an offshore region which could be visible to radars. Specific LOS analysis has been conducted against the Airport's PSR.

To provide a relevant and representative model, the development region has been mapped and twenty-five 270m (tip height) WTGs were plotted and spaced throughout the volume of the red line boundary of the Development. Whilst this does not represent the final design, it provides an indication of the likelihood of visibility of the turbines across the Development site to the Airport's PSR.

The full methodology applied to conducting a Radar LOS Assessment is presented separate to this document in 20801 007 ATMS Safeguarding - Line of Site Analysis Methodology.

In summary:

- A parametric model of the Development was produced within HTZ Comms. The following parameters of the Development were required:
    - WTG Coordinates
    - WTG Max Tip height (ASL)
- A parametric model of the Airport's PSR was produced within HTZ Comms. The following parameters of the Airport's PSR were required:
    - Radar Coordinates
    - Radar Antenna Electrical Centre Height

- Radar TX Peak Power
- Radar TX Frequency
- Radar TX Antenna Gain

- Using the models of the Development and the Airport's PSR, visibility analysis of each WTG defined for the Development was conducted using industry standard propagation models and considering digital terrain profiles and known clutter.
- The visibility analysis provides a theoretical indication of the likelihood of a WTG being detected by the Airport's PSR, such that the technical and operational impact that the Development may have, can be assessed by the Airport.

2.4 Results

The results of the Radar LOS assessment, presented in Table 4, indicate whether each WTG is either:

- **Yes** (Red) - Visible to the Airport's PSR (the WTG has direct optical line of site)
- **Likely** (Amber) - Likely to be visible to the Airport's PSR (the WTG does not have direct line of site, but the interlaying terrain (or clutter) intersects less than or equal to 60% of the upper Fresnel zone)
- **Unlikely** (Yellow) - Unlikely to be visible to the Airport's PSR (the WTG does not have direct line of site, but the interlaying terrain (or clutter) intersects more than 60% but less 100% of the upper Fresnel zone)
- **No** (Green) - Not visible to the Airport's PSR (the WTG does not have direct optical line of site as the interlaying terrain (or clutter) intersects more than 100% of the upper Fresnel zone).

WTG ID	Visibility	Reference
T1	**No**	Figure 2
T2	**No**	Figure 3
T3	**No**	Figure 4
T4	**No**	Figure 5
T5	**No**	Figure 6
T6	**No**	Figure 7
T7	**No**	Figure 8
T8	**No**	Figure 9
T9	**No**	Figure 10
T10	**No**	Figure 11
T11	**No**	Figure 12

T12	**No**	Figure 13
T13	**No**	Figure 14
T14	**No**	Figure 15
T15	**No**	Figure 16
T16	**No**	Figure 17
T17	**No**	Figure 18
T18	**No**	Figure 19
T19	**No**	Figure 20
T20	**No**	Figure 21
T21	**No**	Figure 22
T22	**No**	Figure 23
T23	**No**	Figure 24
T24	**No**	Figure 25
T25	**No**	Figure 26

Table 4 - Oriel WF LOS Visibility Results

2.5 Conclusions

The Assessment concludes that none of the respective WTGs of the Development will be visible to the Airport's PSR due to intervening topography providing terrain shielding. Figure 1 below depicts the results:

Figure 1 - Oriel WF LOS Results

Appendix 1 LOS Terrain Elevation Profiles

A1.1 LOS Assessment Profiles for the Proposed Oriel WF WTG

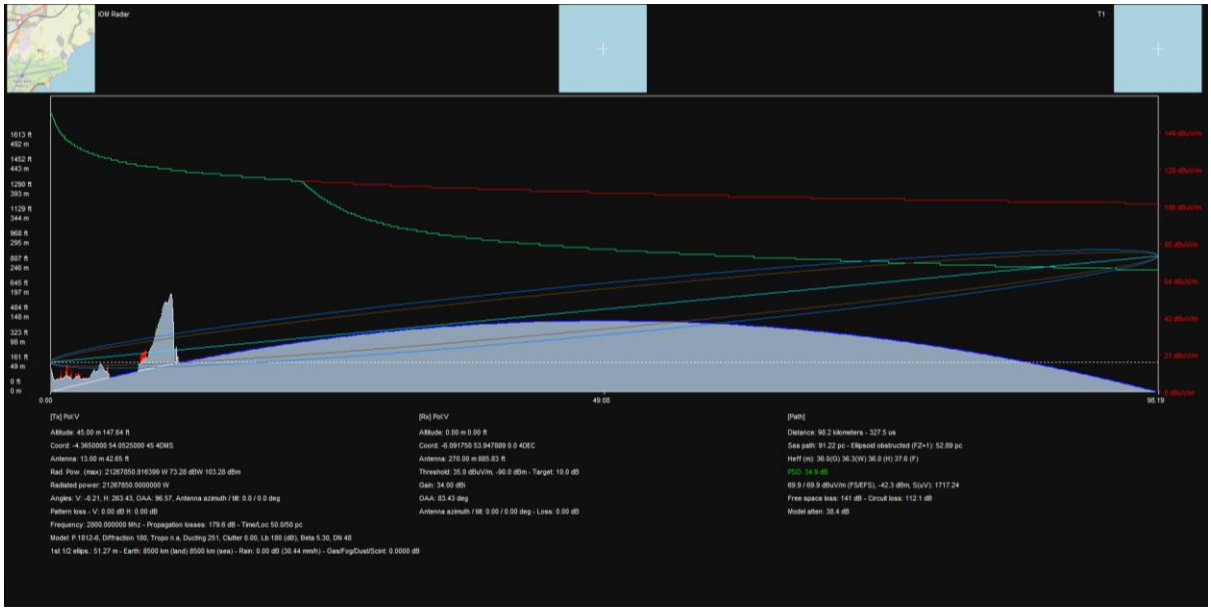

Figure 2 – IOM LOS Profile to T1

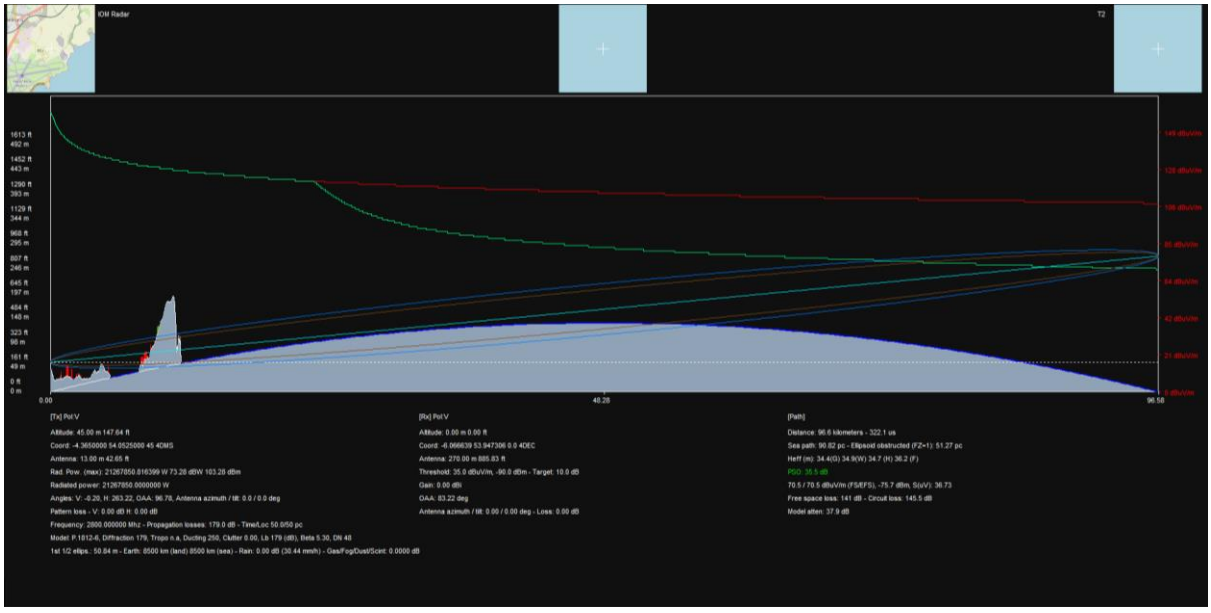

Figure 3 – IOM LOS Profile to T2

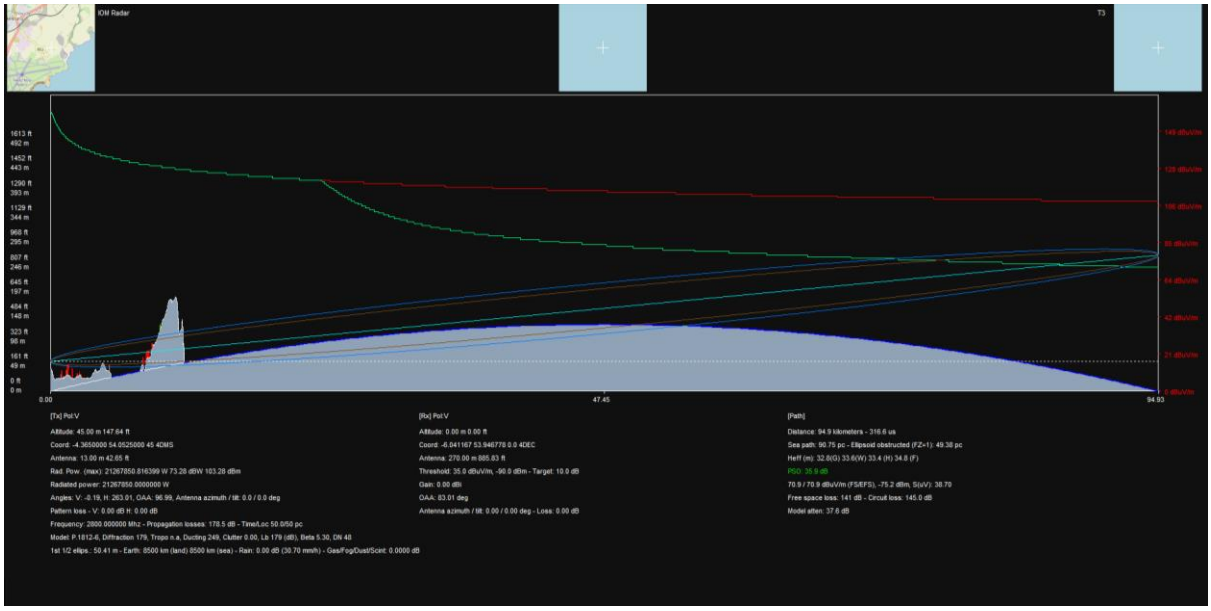

Figure 4 – IOM LOS Profile to T3

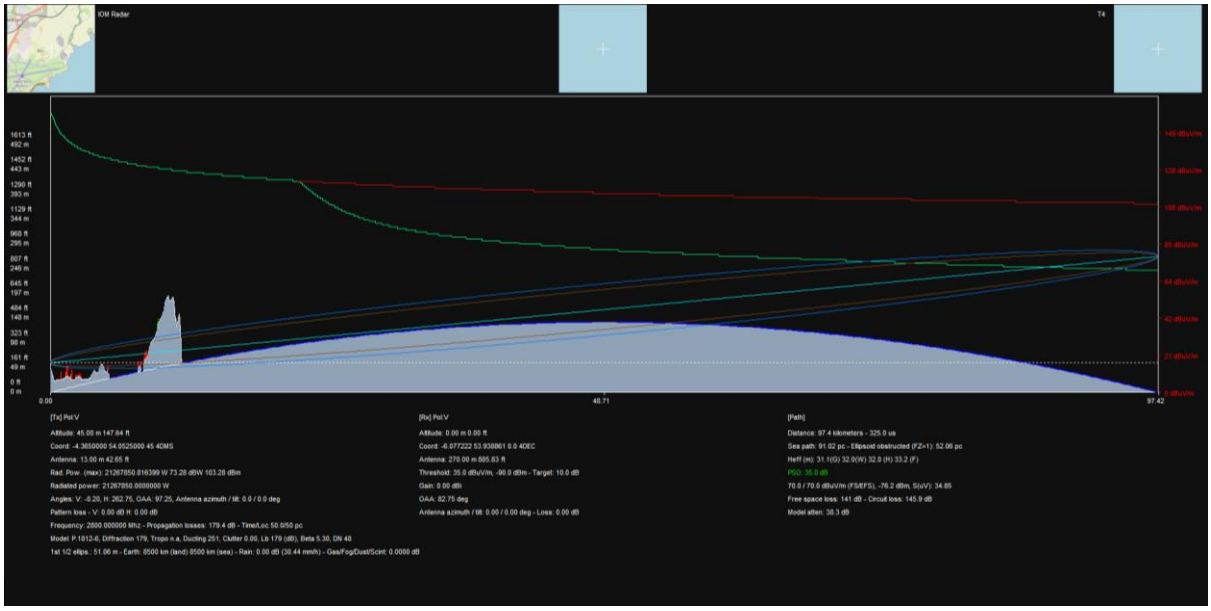

Figure 5 – IOM LOS Profile to T4

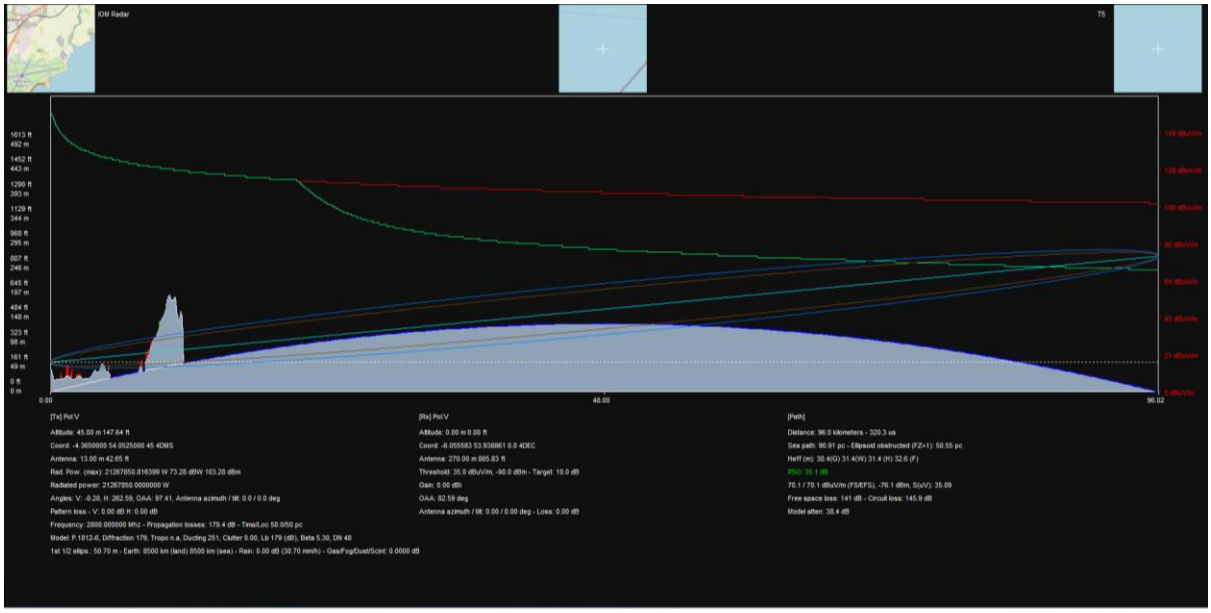

Figure 6 – IOM LOS Profile to T5

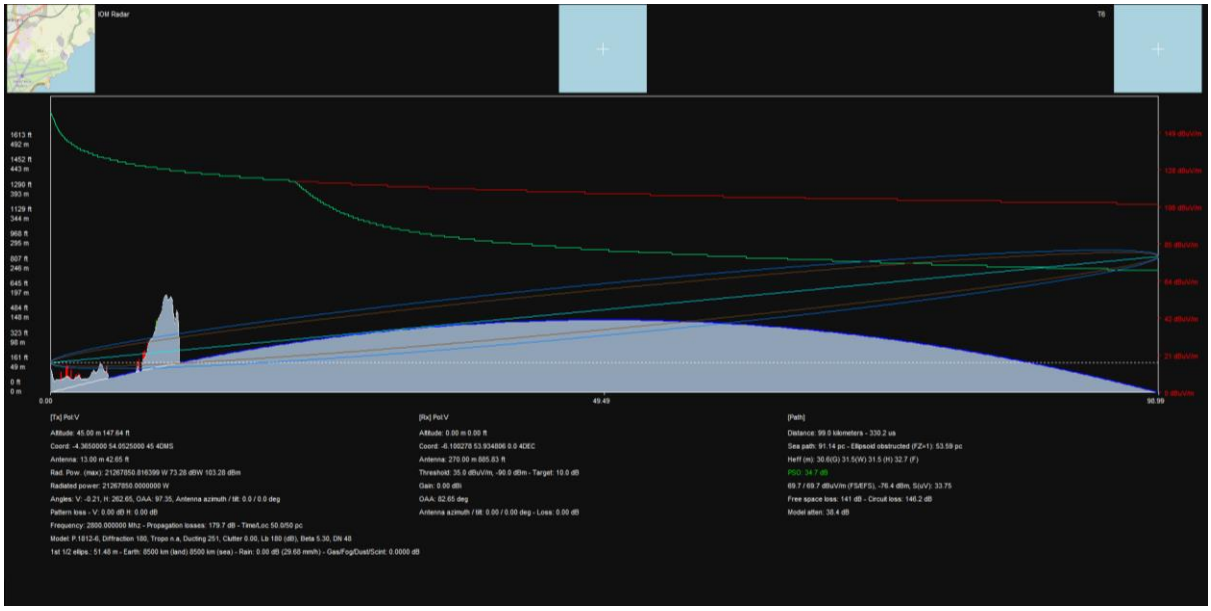

Figure 7 – IOM LOS Profile to T6

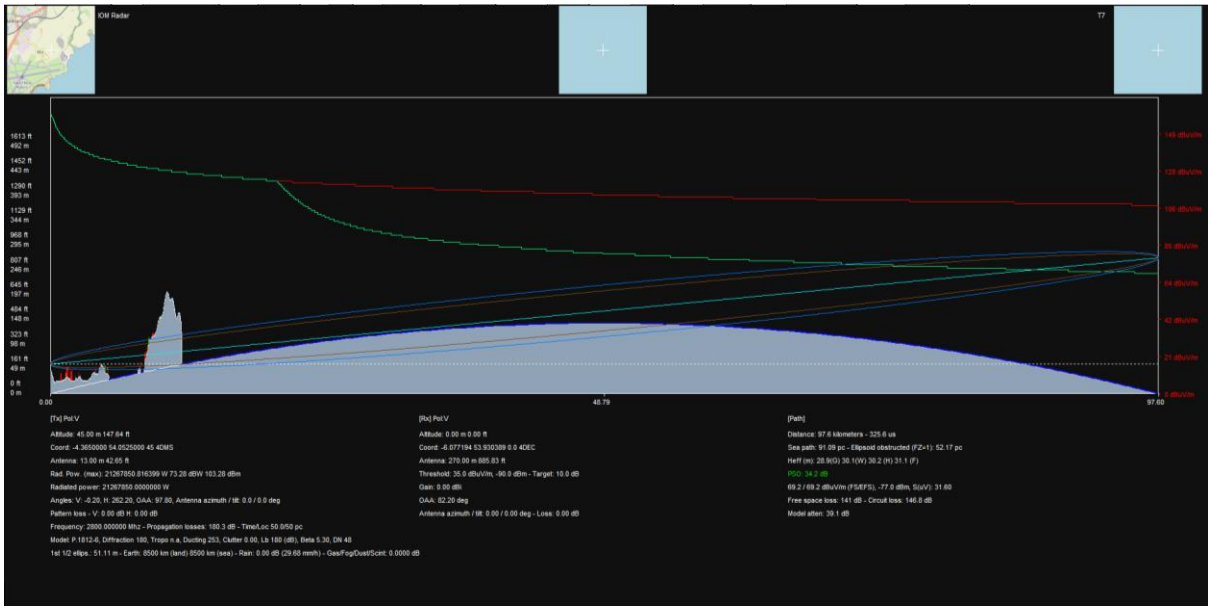

Figure 8 – IOM LOS Profile to T7

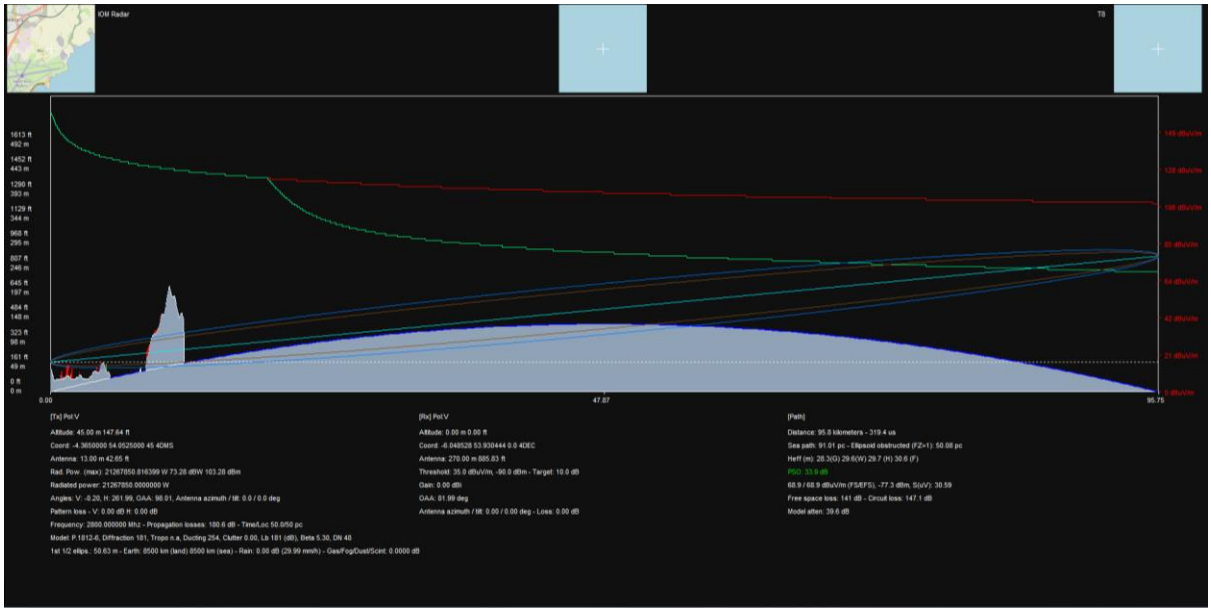

Figure 9 – IOM LOS Profile to T8

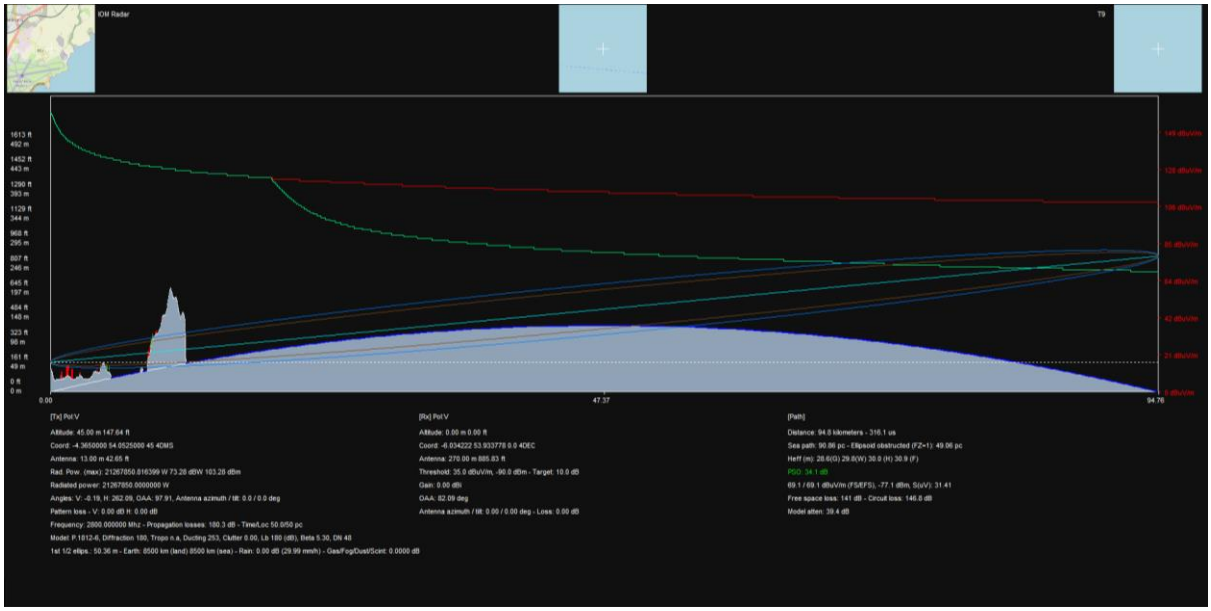

Figure 10 – IOM LOS Profile to T9

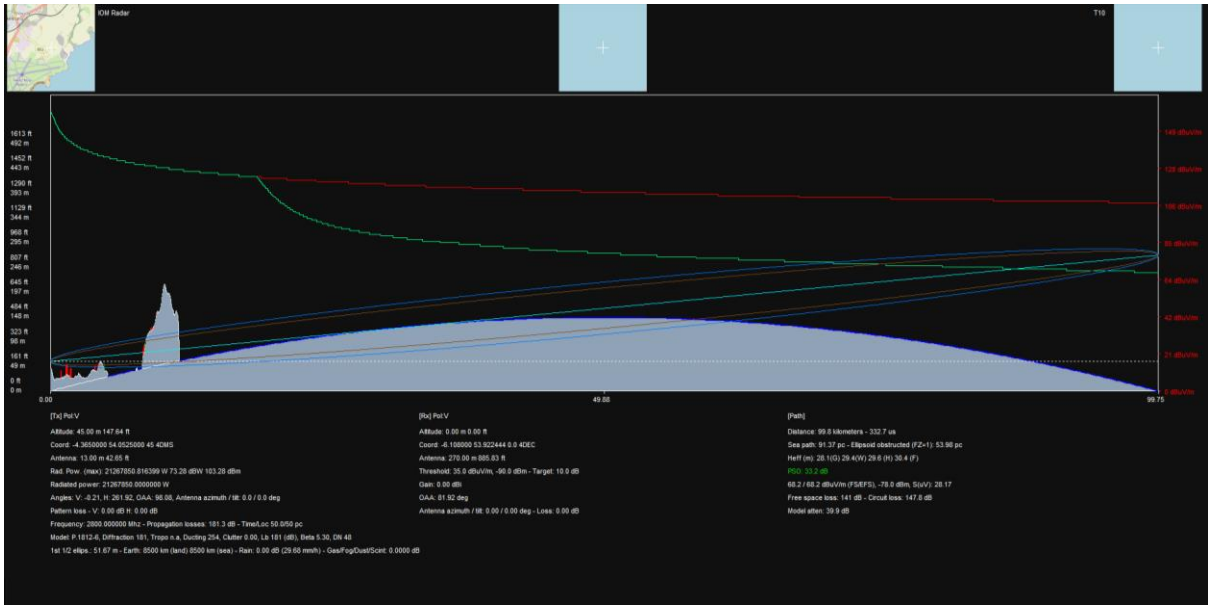

Figure 11 – IOM LOS Profile to T10

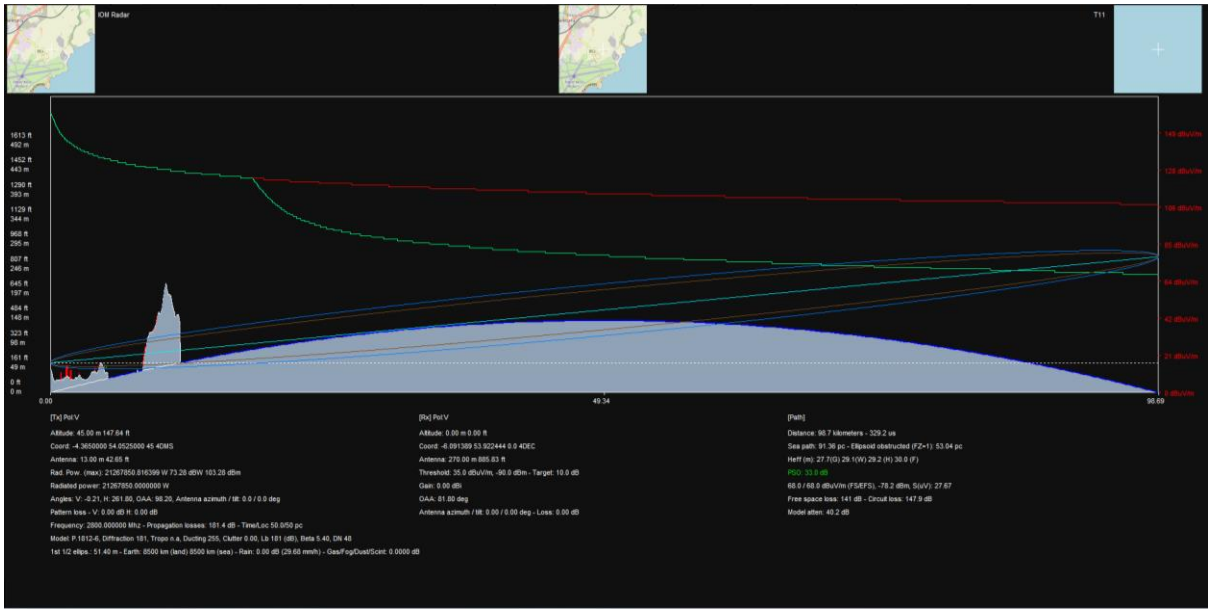

Figure 12 - IOM LOS Profile to T11

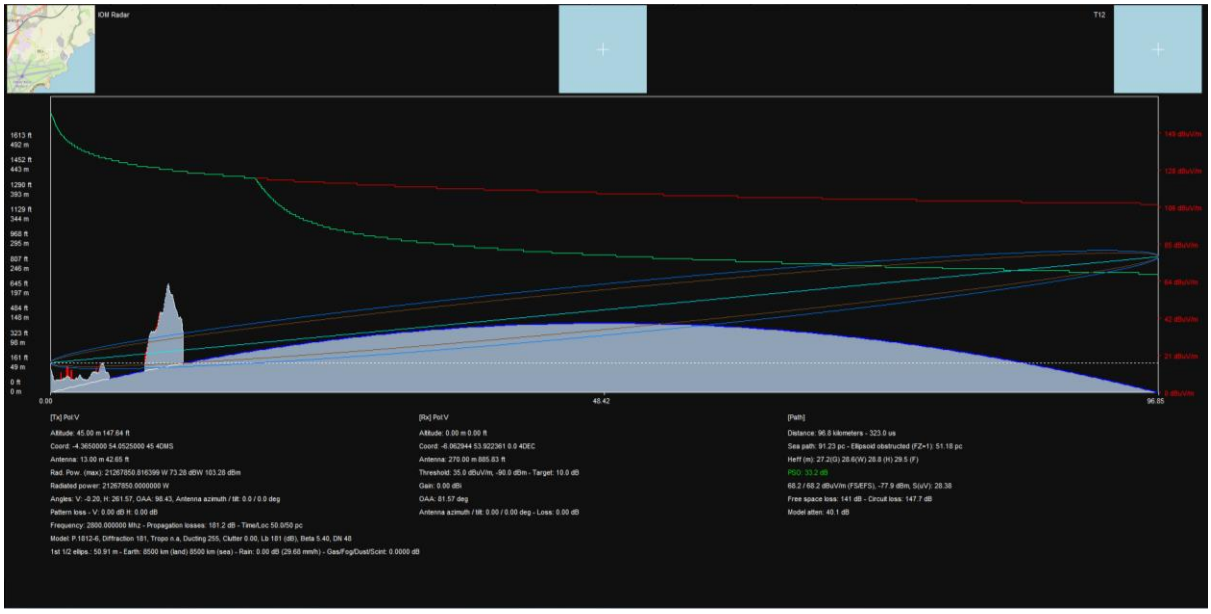

Figure 13 - IOM LOS Profile to T12

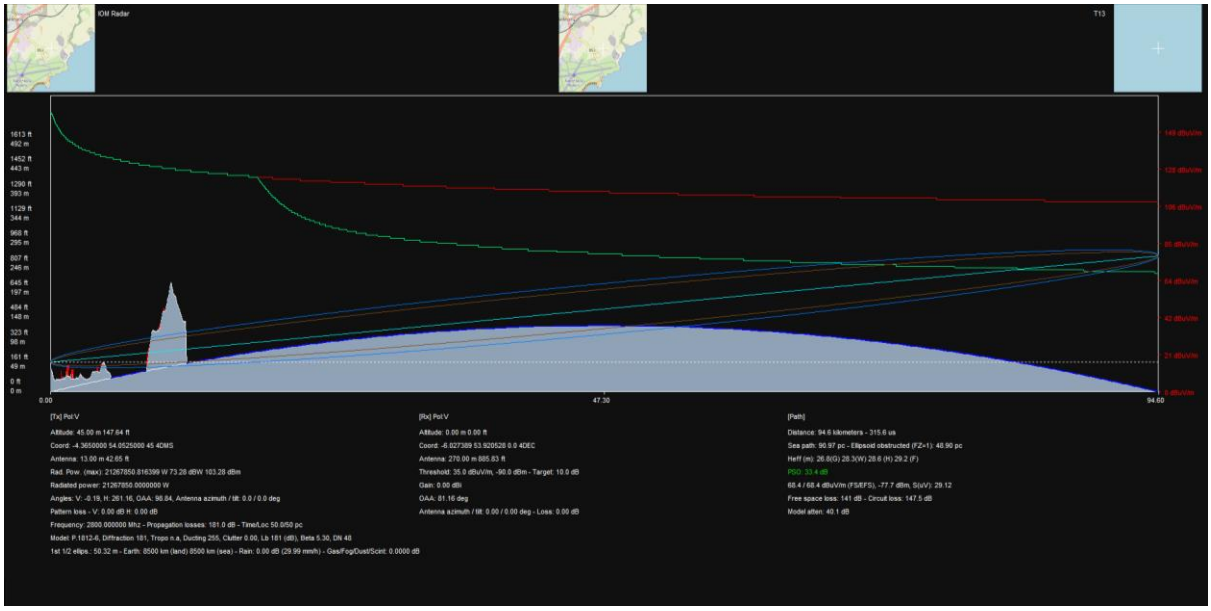

Figure 14 - IOM LOS Profile to T13

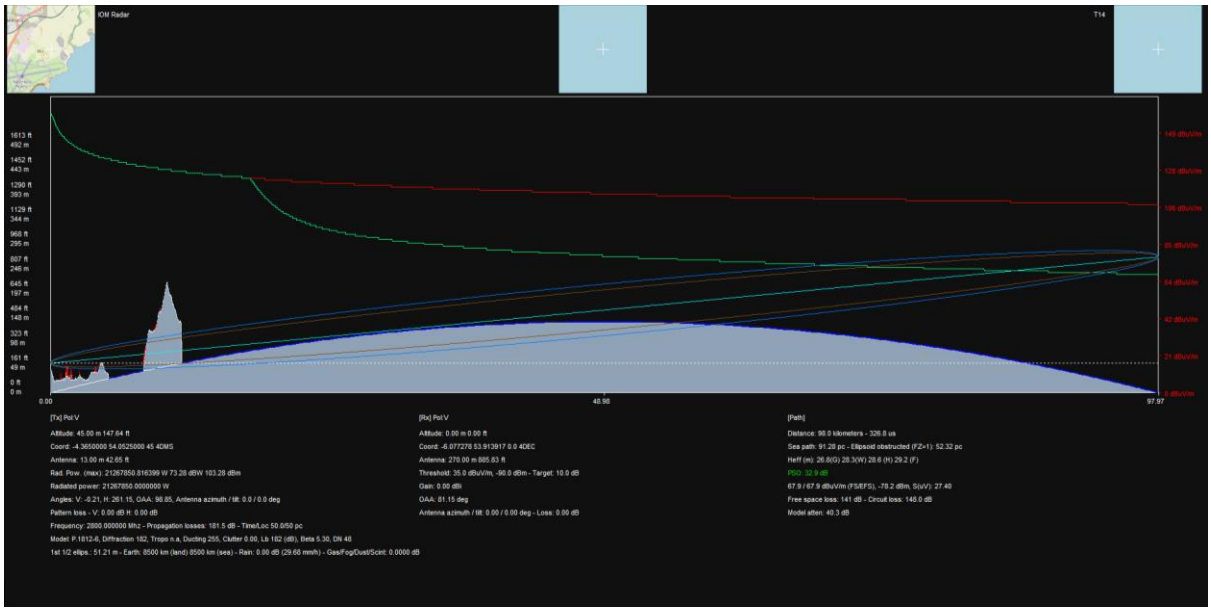

Figure 15 - IOM LOS Profile to T14

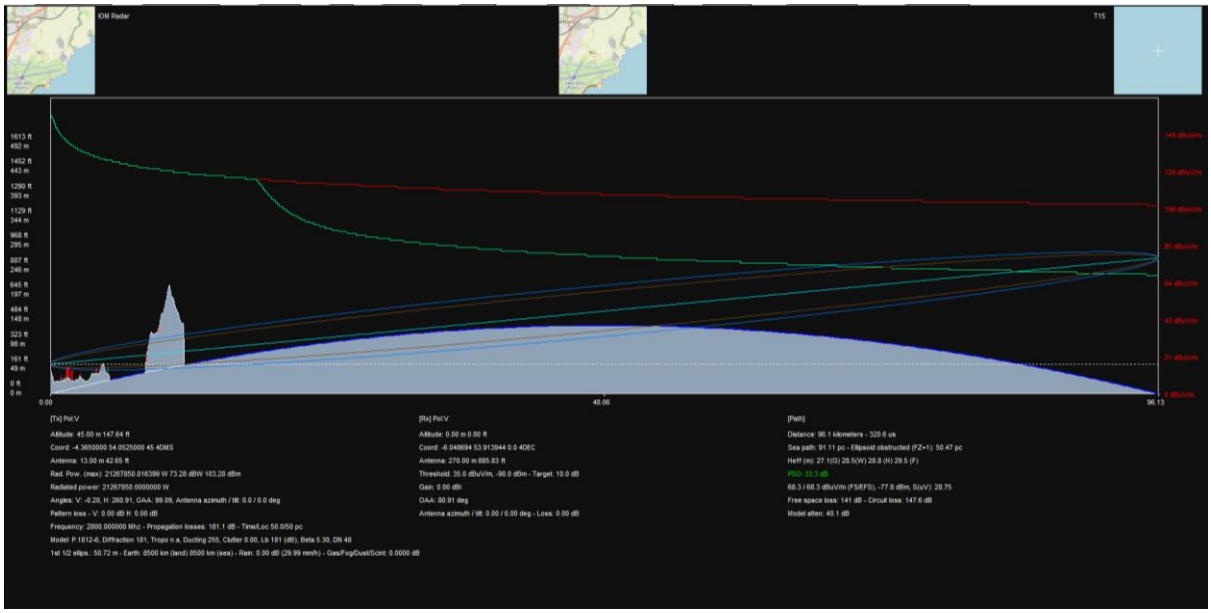

Figure 16 - IOM LOS Profile to T15

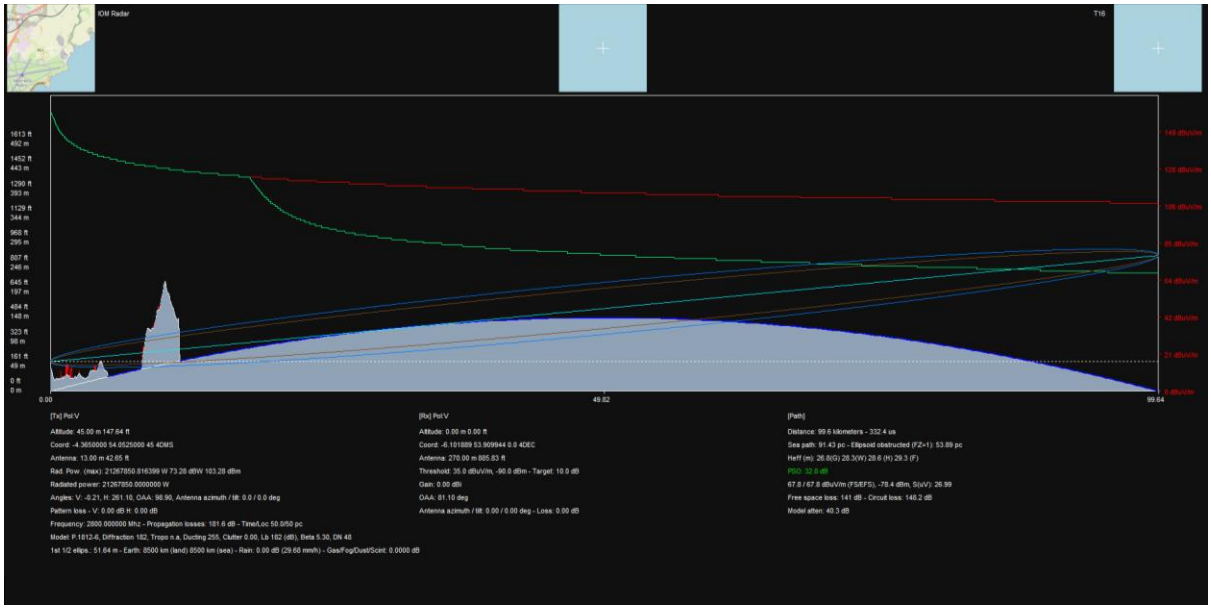

Figure 17 - IOM LOS Profile to T16

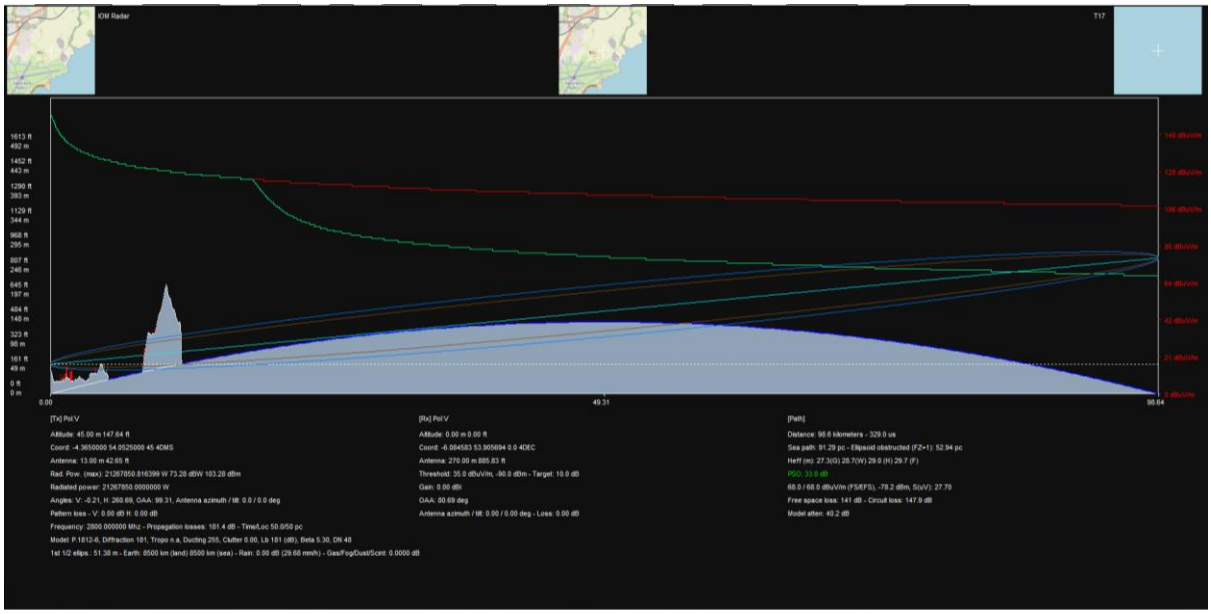

Figure 18 - IOM LOS Profile to T17

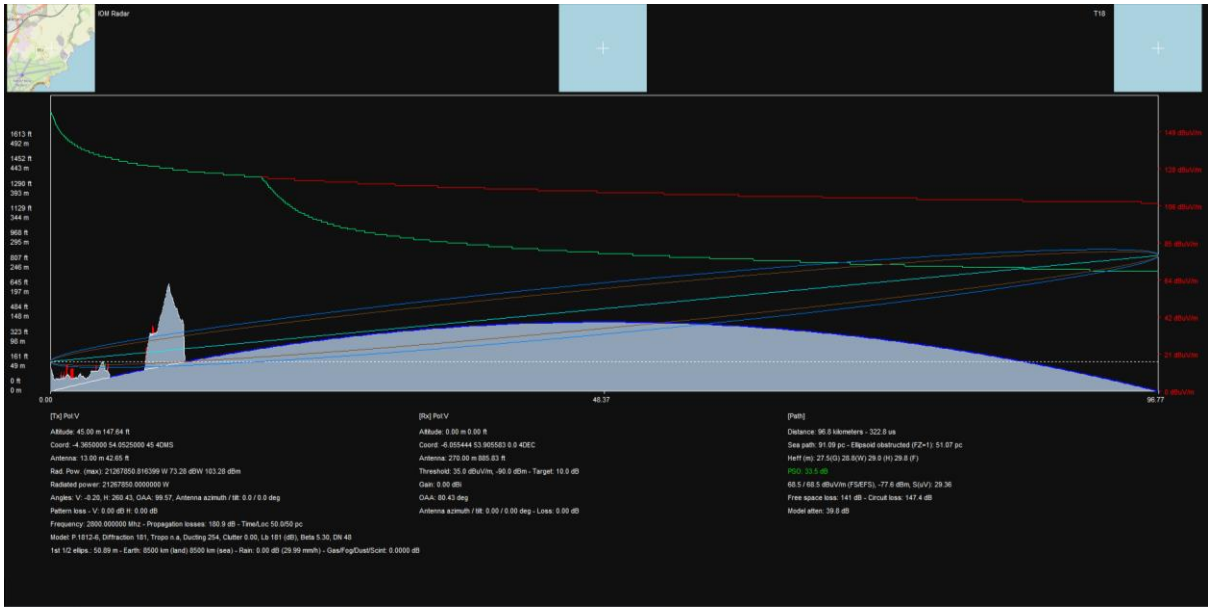

Figure 19 - IOM LOS Profile to T18

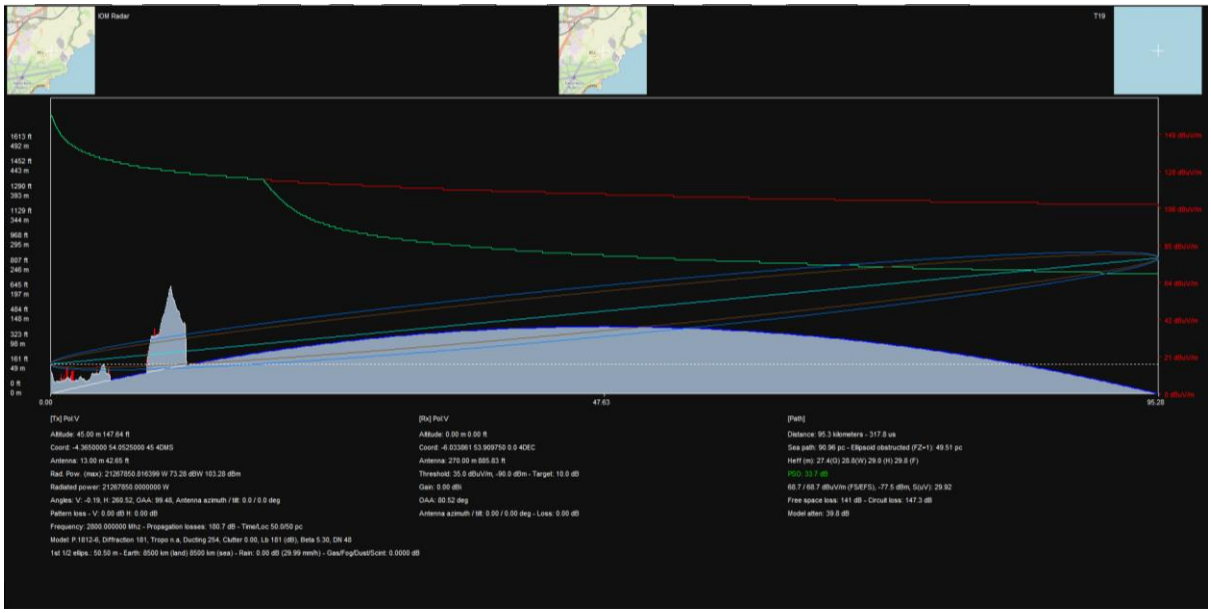

Figure 20 - IOM LOS Profile to T19

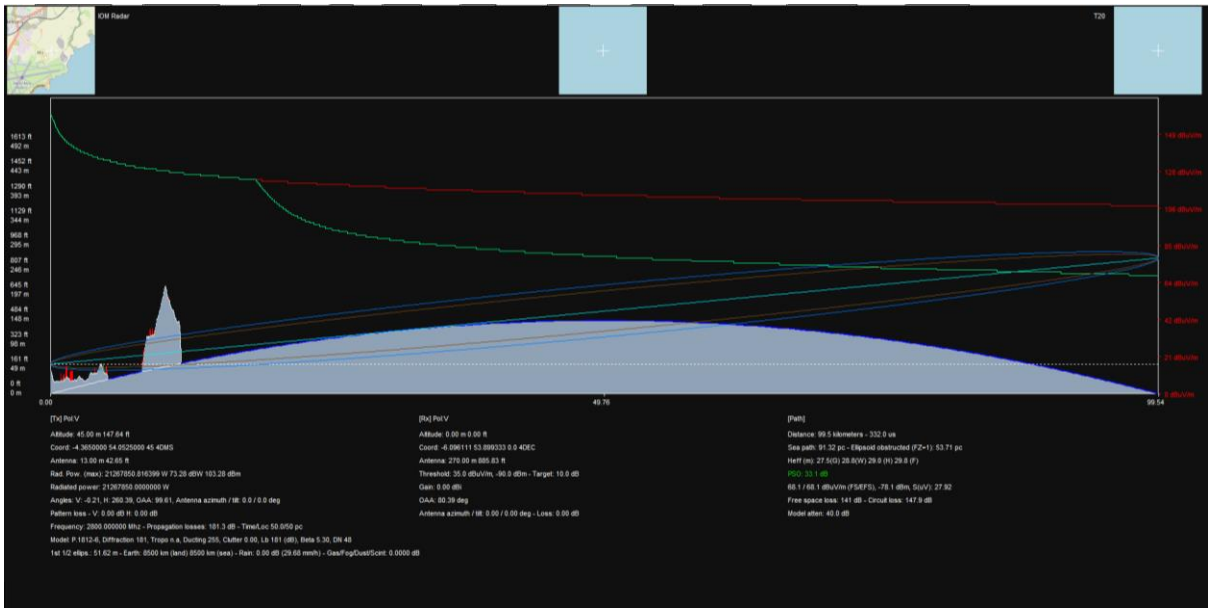

Figure 21 - IOM LOS Profile to T20

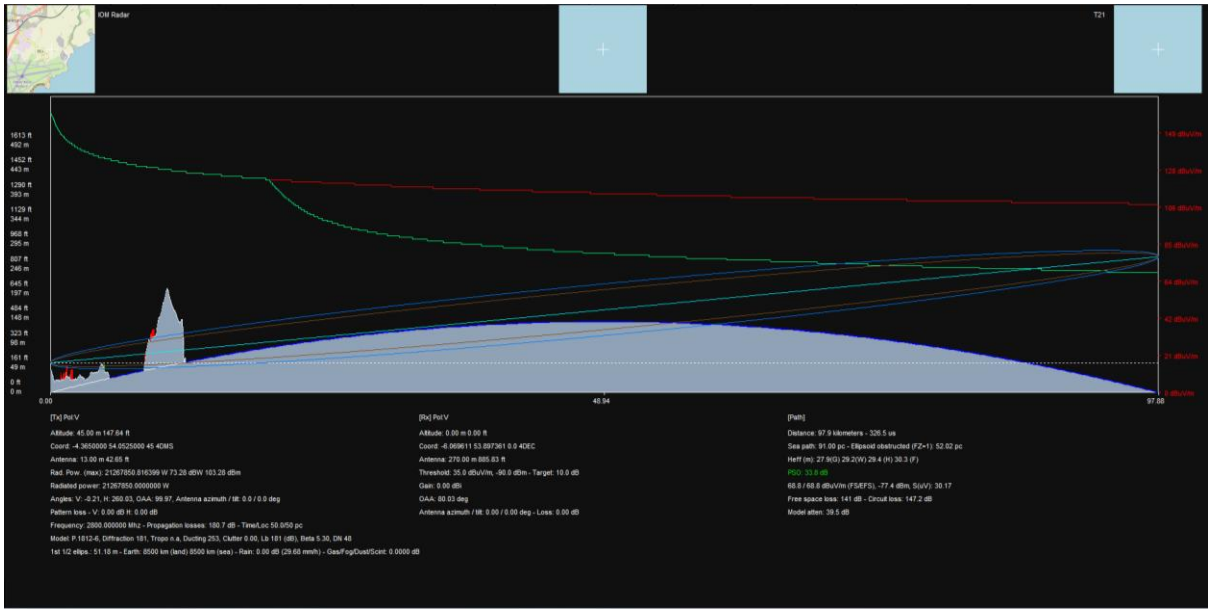

Figure 22 - IOM LOS Profile to T21

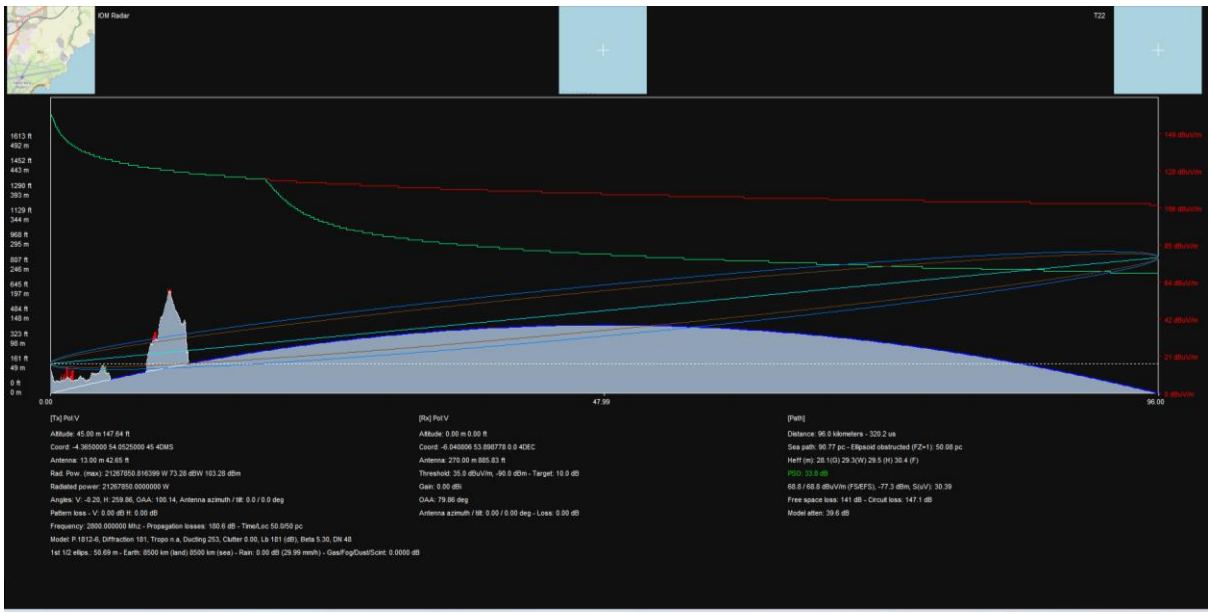

Figure 23 - IOM LOS Profile to T22

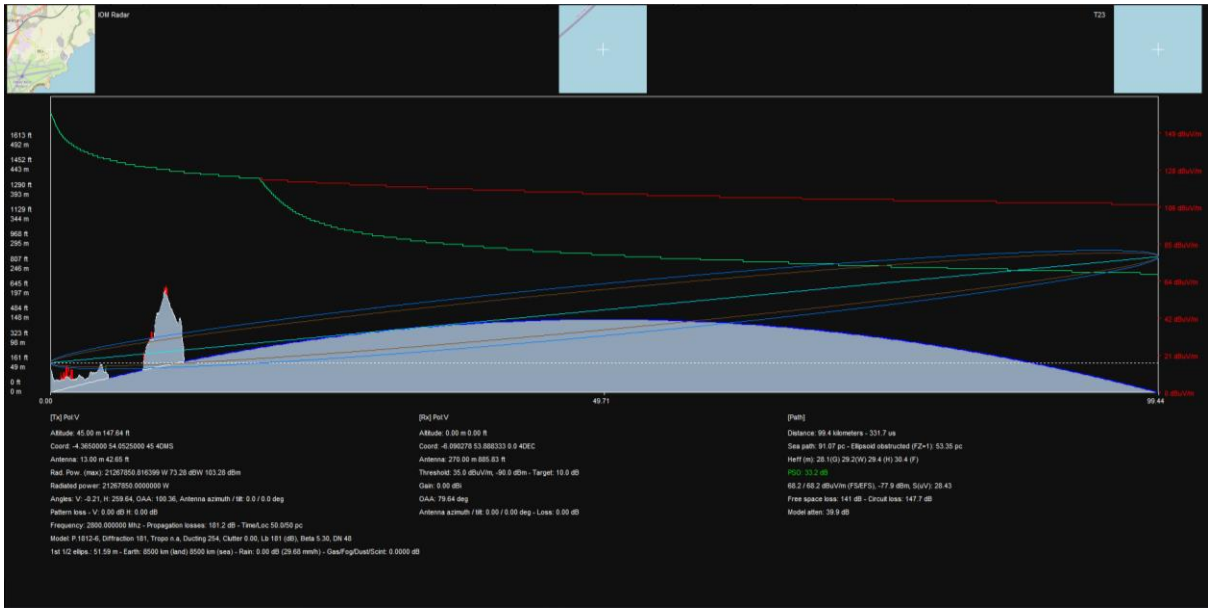

Figure 24 - IOM LOS Profile to T23

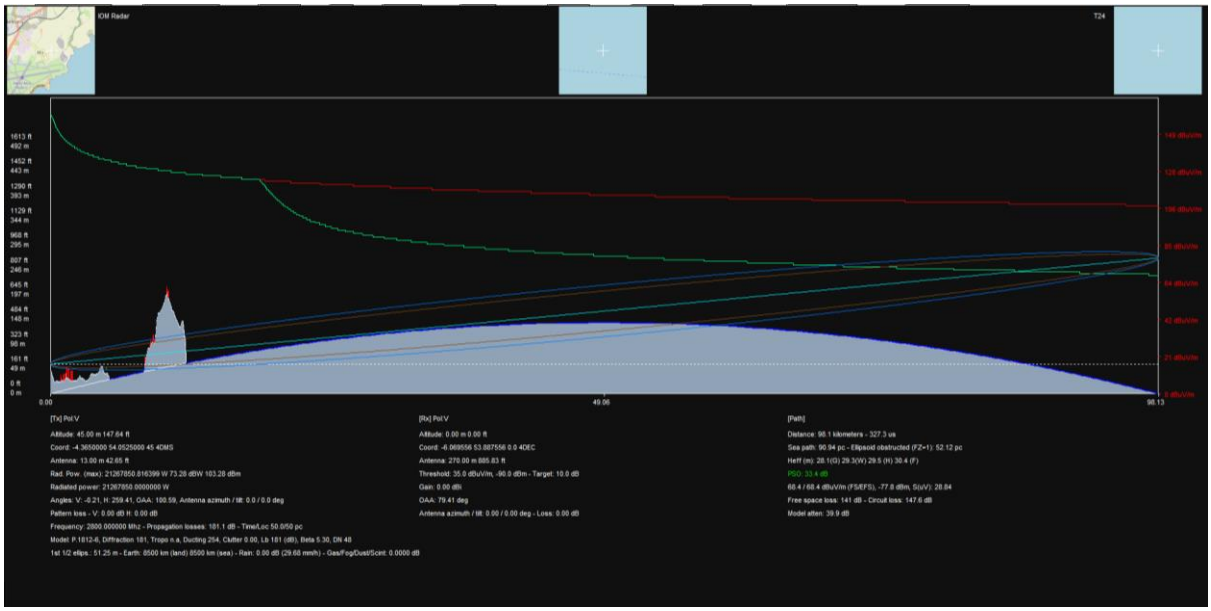

Figure 25 - IOM LOS Profile to T24

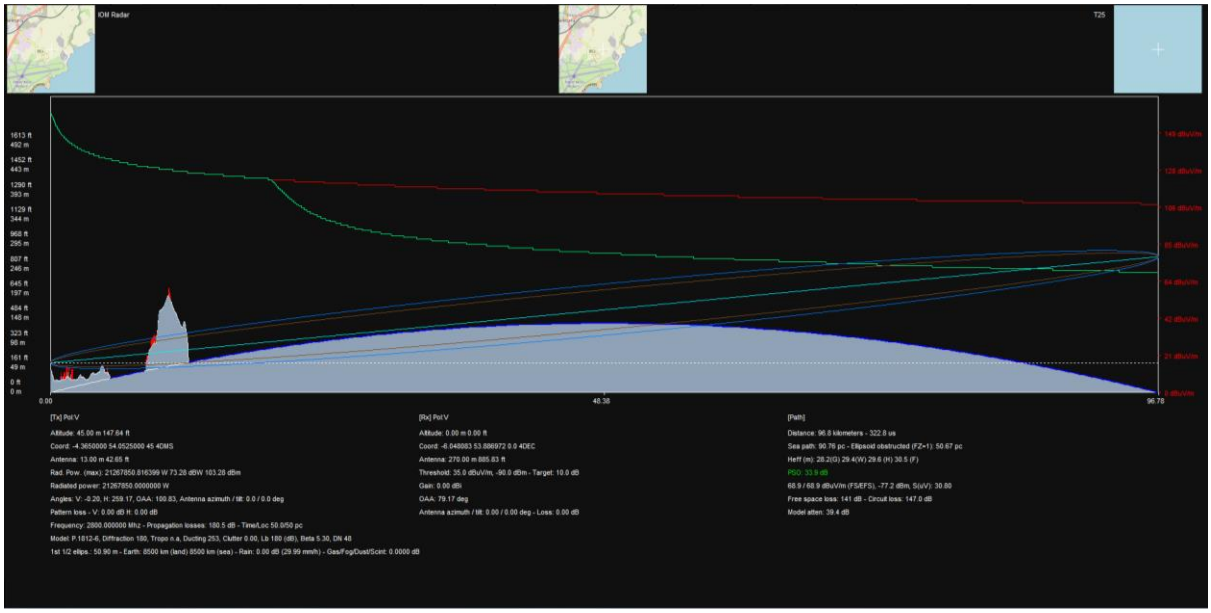

Figure 26 - IOM LOS Profile to T25