OSPREY
CONSULTING SERVICES
a tpgroup company

# Radar Line of Sight Assessment Report

## Brockwell Energy - Breezy Hill Wind Farm

Date: 9th January 2025
Author: Linda-Jean Worley
Revision: Issue 1.0
Osprey Ref: 72049 001


Harston Mill, Royston Road Harston, Cambridge CB22 7GG
01172 422533 / enquiries@ospreycsl.co.uk
Registered in England and Wales under No: 06034579

# Document Details

| Reference | Description |
|---|---|
| **Document Title** | Radar Line of Sight Assessment Report |
| | Brockwell Energy - Breezy Hill Wind Farm |
| **Document Ref** | 72049 001 |
| **Issue** | Issue 1.0 |
| **Date** | 9th January 2025 |
| **Client Name** | Brockwell Energy Ltd |
| **Classification** | Commercial in Confidence |

| Issue | Amendment | Date |
|---|---|---|
| Draft A | Initial Draft | 8th January 2025 |
| Issue 1.0 | Initial Issue | 9th January 2025 |
| | | |

| Approval Level | Authority | Name |
|---|---|---|
| Author | Osprey CSL | Linda-Jean Worley |
| Reviewer | Osprey CSL | Foz Binning |

# Executive Summary

Brockwell Energy Limited are promoting the 80MW wind scheme, Breezy Hill Wind which is located approximately 13 kilometres (km) south-east of Ayr, 8.5 km south-west of Cumnock and 4.5 km north of Dalmellington. As part of the Environment Impact Assessment process, aviation impacts are being considered.

The Developer has commissioned Osprey Consulting Services Limited to conduct technical assessments to determine the likelihood of visibility Breezy Hill Wind Farm to the following three Air Traffic Control radars operated by various Air Navigation Service Providers:

- NATS - Great Dun Fell Radar
- NATS - Lowther Hill Radar
- Glasgow Prestwick Airport - Terma Radar

The Air Navigation Service Providers are responsible for the technical safeguarding of their Communications Navigation and Surveillance systems in accordance with Civil Aviation Authority requirements. To establish whether the Wind Turbine Generators of Breezy Hill Wind Farm are likely to be electronically visible to these radars and have a potential safeguarding issue, Radar Line of Site Assessments have been conducted, the results of which are reported in this document.

**Conclusions**

The Line of Site Assessments conducted conclude that all Wind Turbine Generators within the Breezy Hill Wind Farm development are expected to have a direct optical visibility to the Lowther Hill and Glasgow Prestwick Terma Radars and therefore without suitable mitigations might cause an impact upon the Air Traffic Services provided by the respective Air Navigation Service Provider.

The assessment indicates that none of the Wind Turbine Generators within the Breezy Hill Wind Farm development will be visible to the Great Dun Fell Radar.

**Recommendations**

Osprey recommends that NATS and Glasgow Prestwick Airport as the respective Air Navigation Service Providers operating the affected radars, review the results of this assessment against their operational coverage areas and identify suitable and appropriate mitigations that could reduce the operational impacts to a satisfactory level.

# Table of Contents



## Table of Figures

## Table of Tables

# 1 Introduction

## 1.1 Purpose

Brockwell Energy Limited (Ltd) ("the Developer") are promoting the 80MW wind scheme, Breezy Hill Wind Farm ("the Development") which is located approximately 13 kilometres (km) south-east of Ayr, 8.5 km south-west of Cumnock and 4.5 km north of Dalmellington. As part of the Environment Impact Assessment (EIA) process, aviation impacts are being considered.

The Developer has commissioned Osprey Consulting Services Limited (Osprey) to conduct technical assessments to determine the likelihood of visibility the Development to a number of Air Traffic Control (ATC) radars operated by two Air Navigation Service Providers (ANSPs).

ANSPs are responsible for the technical safeguarding of their Communications Navigation and Surveillance (CNS) systems in accordance with Civil Aviation Authority (CAA) requirements. To establish whether the Wind Turbine Generators (WTGs) of the Development are likely to be electronically visible to these radars and have a potential safeguarding issue, Radar Line of Site Assessments (LOS) have been conducted, the results of which are reported in this document.

## 1.2 Scope

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

- NATS - Great Dun Fell Radar
- NATS - Lowther Hill Radar
- Glasgow Prestwick Airport (GPA) - Terma Radar

Specific CNS parameters used in the assessments are detailed in Table 1, Table 2 and Table 3 below.

### 1.2.1 Great Dun Fell Radar Parameters

| Parameter | Value |
|---|---|
| Coordinates | 54°41'02.8"N, 2°27'03.1"W |
| Peak Power | 60 kilowatts (kW) |
| Frequency | 2800 megahertz (MHz) |
| Antenna Gain | 34 decibels (dB) relative to isotropic (dBi) |
| Antenna Electrical Centre Height | 16.1 meters (m) Above Ground Level (AGL) |

Table 1 - Great Dun Fell Radar Parameters

### 1.2.2 Lowther Hill Radar Parameters

| Parameter | Value |
|---|---|
| Coordinates | 55°22'40.0"N, 3°45'10.8"W |
| Peak Power | 40 kW |
| Frequency | 1300 MHz |
| Antenna Gain | 38 dBi |
| Antenna Electrical Centre Height | 15m AGL |

Table 2 - Lowther Hill Radar Parameters

### 1.2.3 GPA Terma Radar Parameters

| Parameter | Value |
|---|---|
| Coordinates | 55°30'08"N, 004°35'02"W |
| Peak Power | 6 kW |
| Frequency | 9100 MHz |
| Antenna Gain | 37 dBi |
| Antenna Electrical Centre Height | 22.3m AGL |

Table 3 - GPA Terma Radar Parameters

### 1.2.4 The Development

For the purposes of this report and the scope of work undertaken in the assessments contained within, the Development are defined as the Breezy Hill Wind Farm consisting of twenty (20) WTGs with a max blade tip height of 149.9m AGL. Specific WTG parameters and geolocations used in the assessments are detailed in Table 4 below.

| WTG | Easting | Northing | Max Tip Height (m) AGL |
|---|---|---|---|
| T01 | 247271 | 614508 | 149.9 |
| T02 | 247620 | 614116 | 149.9 |
| T03 | 247194 | 613858 | 149.9 |
| T04 | 247590 | 613695 | 149.9 |

| WTG | Easting | Northing | Max Tip Height (m) AGL |
|---|---|---|---|
| T05 | 248105 | 613774 | 149.9 |
| T06 | 248414 | 613503 | 149.9 |
| T07 | 248756 | 613253 | 149.9 |
| T08 | 248959 | 612926 | 149.9 |
| T09 | 247210 | 613183 | 149.9 |
| T10 | 247555 | 612926 | 149.9 |
| T11 | 248064 | 612898 | 149.9 |
| T12 | 248400 | 612655 | 149.9 |
| T13 | 246865 | 612263 | 149.9 |
| T14 | 247549 | 612303 | 149.9 |
| T15 | 247872 | 611984 | 149.9 |
| T16 | 246335 | 611844 | 149.9 |
| T17 | 246752 | 611639 | 149.9 |
| T18 | 247459 | 610783 | 149.9 |
| T19 | 247556 | 611130 | 149.9 |
| T20 | 247338 | 611513 | 149.9 |

Table 4 - Breezy Hill Wind Farm Parameters

### 1.2.5 Requirement

The Developer has commissioned a single specific type of technical assessment to be conducted. The assessment is detailed in the respective section of this document, as follows:

- **Section 2 - Radar LOS Assessment**
  LOS assessment of the Developments against the in-scope CNS using industry standard Radio Frequency (RF) Planning tools.

## 1.3 Abbreviations

The following abbreviations are used within this document:

| Abbreviation | Meaning |
|---|---|
| AGL | Above Ground Level |

| Abbreviation | Meaning |
|---|---|
| ANSP | Air Navigation Service Providers |
| ATC | Air Traffic Control |
| ATS | Air Traffic Services |
| CAA | Civil Aviation Authority |
| CNS | Communications Navigation and Surveillance |
| dBi | decibels |
| dBi | dB relative to isotropic |
| EIA | Environment Impact Assessment |
| GPA | Glasgow Prestwick Airport |
| HTZ Comms | ATDI HTZ Communications |
| km | kilometres |
| kW | kilowatts |
| Ltd | Limited |
| LOS | Line of Site Assessments |
| MHz | megahertz |
| MHz | meters |
| Osprey | Osprey Consulting Services Limited |
| RF | Radio Frequency |
| SME | Subject Matter Expert |
| the Developer | Brockwell Energy Ltd |
| the Development | Breezy Hill Wind Farm |
| WTG | Wind Turbine Generators |

Table 5 - Abbreviations

# 2 Radar Line of Sight Assessment

## 2.1 Introduction

This section presents the Radar LOS Assessment using composite optical line of site functions, coupled with RF propagation and Fresnel zone calculations in ATDI HTZ Communications (HTZ Comms) which is an industry standard RF network planning toolset with extensive RF Propagation analysis and modelling capabilities. Analysis has been conducted of point-to-point visibility between the In-Scope CNS and the individual WTGs of the proposed Development being considered.

## 2.2 Overview

LOS in its most simplistic form is a calculation to determine whether one object can see another in a direct path. A WTG presents 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 pulses of RF energy as a waveform. RF waveforms do not just propagate in straight 'optical' lines, but rather it spreads after it leaves the antenna. This spread is known as the Fresnel zones. Objects which appear in a Fresnel zone can cause in phase or out of phase reflections of the RF waveform.

Additionally, to better understand whether a reflecting object will be seen by a radar, consideration must also be made of interlaying terrain and the curvature of the Earth.

Osprey has extensive experience of modelling Radar LOS using HTZ Comms. Our assessment considers optical line of site, the upper Fresnel zone, the Earth's curvature and terrain.

## 2.3 Scope

The scope of the LOS assessment undertaken, is against the following In-Scope CNS systems:

- Great Dun Fell Radar
- Lowther Hill Radar
- GPA Terma Radar

## 2.4 Methodology

### 2.4.1 LOS Assessment

Each WTG is assessed for visibility against the In-Scope CNS. An example of a resultant profile path is depicted in Figure 1 below:

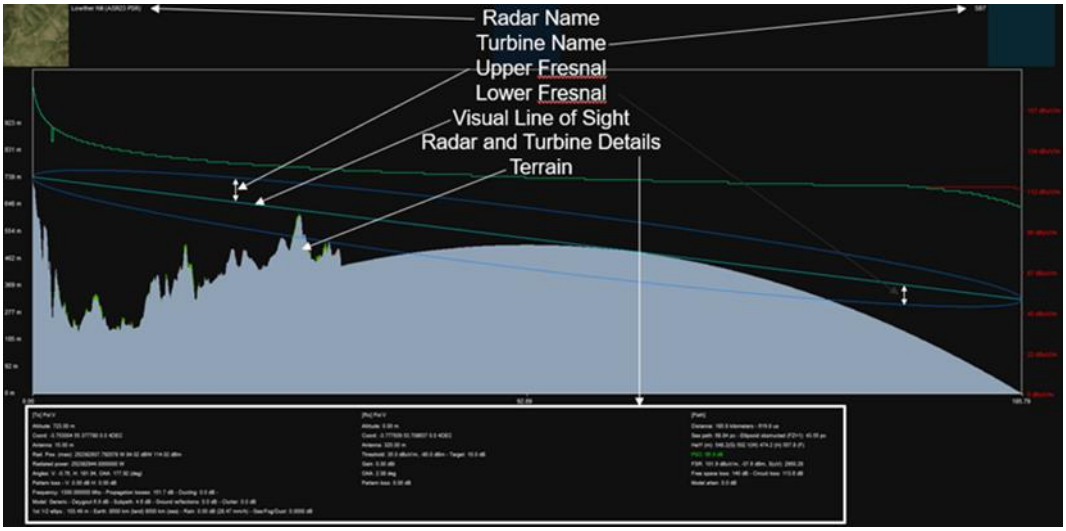



Figure 1 - Example LOS Profile Path

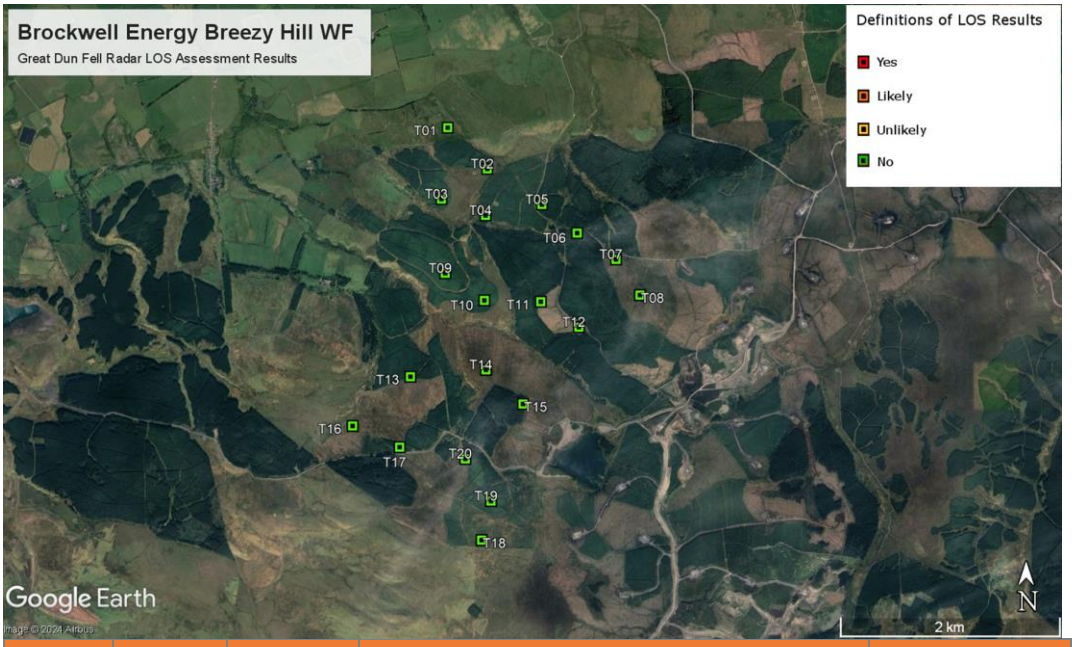
Profile paths were individually evaluated by a Subject Matter Expert (SME) who determined the results as presented in Section 2.5.

## 2.5 Results

Summary results of the LOS assessments conducted against the Development are presented in the following sections. Visibility results of each WTG are determined to be one of the following:

- **Yes** (Red) - Visible to the In-Scope CNS System (the WTG has direct optical LOS)
- **Likely** (Amber) - Likely to be visible to the In-Scope CNS System (the WTG does not have direct optical LOS, but the interlaying terrain intersects less than or equal to 60% of the upper Fresnel zone)
- **Unlikely** (Yellow) - Unlikely to be visible to the In-Scope CNS System (the wind turbine does not have direct optical LOS, but the interlaying terrain intersects more than 60% but less 100% of the upper Fresnel zone)
- **No** (Green) - Not visible to the In-Scope CNS System (the wind turbine generator does not have direct optical LOS as the interlaying terrain intersects more than 100% of the upper Fresnel zone).

### 2.5.1 Great Dun Fell Radar – LOS Results

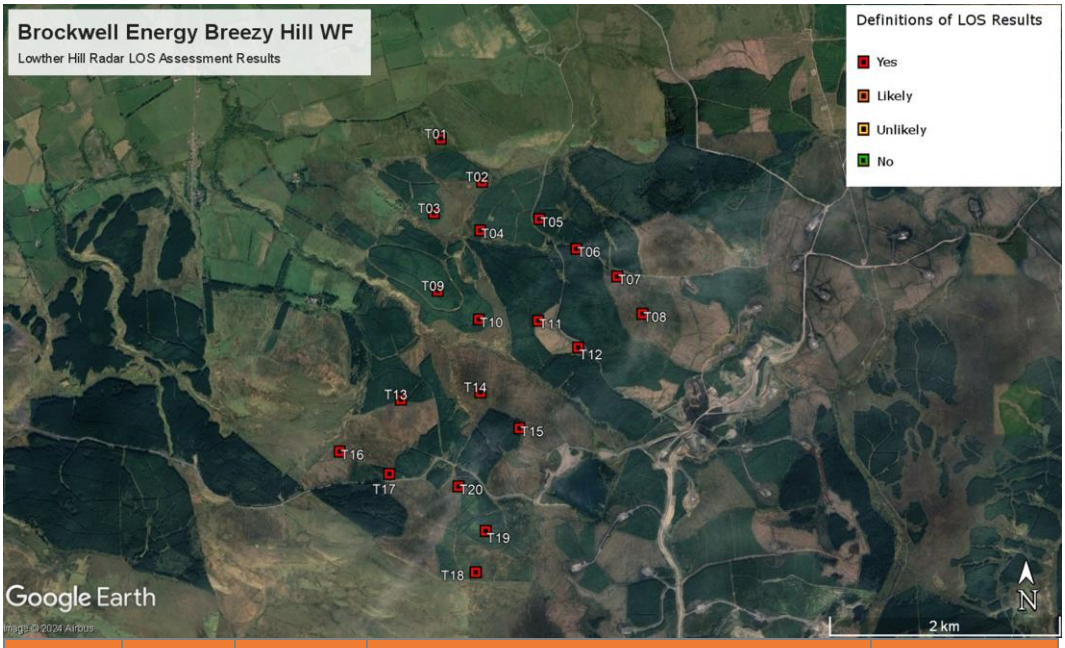



| WTG | Tip Height (m) | Visibility Result | Description | Annex A1 Reference |
|---|---|---|---|---|
| T01 | 149.9 | NO | Not visible to the In-Scope CNS System (the WTG does not have direct optical LOS) | Figure 2 |
| T02 | 149.9 | NO | Not visible to the In-Scope CNS System (the WTG does not have direct optical LOS) | Figure 3 |
| T03 | 149.9 | NO | Not visible to the In-Scope CNS System (the WTG does not have direct optical LOS) | Figure 4 |
| T04 | 149.9 | NO | Not visible to the In-Scope CNS System (the WTG does not have direct optical LOS) | Figure 5 |
| T05 | 149.9 | NO | Not visible to the In-Scope CNS System (the WTG does not have direct optical LOS) | Figure 6 |
| T06 | 149.9 | NO | Not visible to the In-Scope CNS System (the WTG does not have direct optical LOS) | Figure 7 |
| T07 | 149.9 | NO | Not visible to the In-Scope CNS System (the WTG does not have direct optical LOS) | Figure 8 |
| T08 | 149.9 | NO | Not visible to the In-Scope CNS System (the WTG does not have direct optical LOS) | Figure 9 |
| T09 | 149.9 | NO | Not visible to the In-Scope CNS System (the WTG does not have direct optical LOS) | Figure 10 |
| T10 | 149.9 | NO | Not visible to the In-Scope CNS System (the WTG does not have direct optical LOS) | Figure 11 |
| T11 | 149.9 | NO | Not visible to the In-Scope CNS System (the WTG does not have direct optical LOS) | Figure 12 |
| T12 | 149.9 | NO | Not visible to the In-Scope CNS System (the WTG does not have direct optical LOS) | Figure 13 |

| WTG | Tip Height (m) | Visibility Result | Description | Annex A1 Reference |
|---|---|---|---|---|
| T13 | 149.9 | NO | Not visible to the In-Scope CNS System (the WTG does not have direct optical LOS) | Figure 14 |
| T14 | 149.9 | NO | Not visible to the In-Scope CNS System (the WTG does not have direct optical LOS) | Figure 15 |
| T15 | 149.9 | NO | Not visible to the In-Scope CNS System (the WTG does not have direct optical LOS) | Figure 16 |
| T16 | 149.9 | NO | Not visible to the In-Scope CNS System (the WTG does not have direct optical LOS) | Figure 17 |
| T17 | 149.9 | NO | Not visible to the In-Scope CNS System (the WTG does not have direct optical LOS) | Figure 18 |
| T18 | 149.9 | NO | Not visible to the In-Scope CNS System (the WTG does not have direct optical LOS) | Figure 19 |
| T19 | 149.9 | NO | Not visible to the In-Scope CNS System (the WTG does not have direct optical LOS) | Figure 20 |
| T20 | 149.9 | NO | Not visible to the In-Scope CNS System (the WTG does not have direct optical LOS) | Figure 21 |

Table 6 - Great Dun Fell Radar - LOS Results

### 2.5.2 Lowther Hill Radar – LOS Results

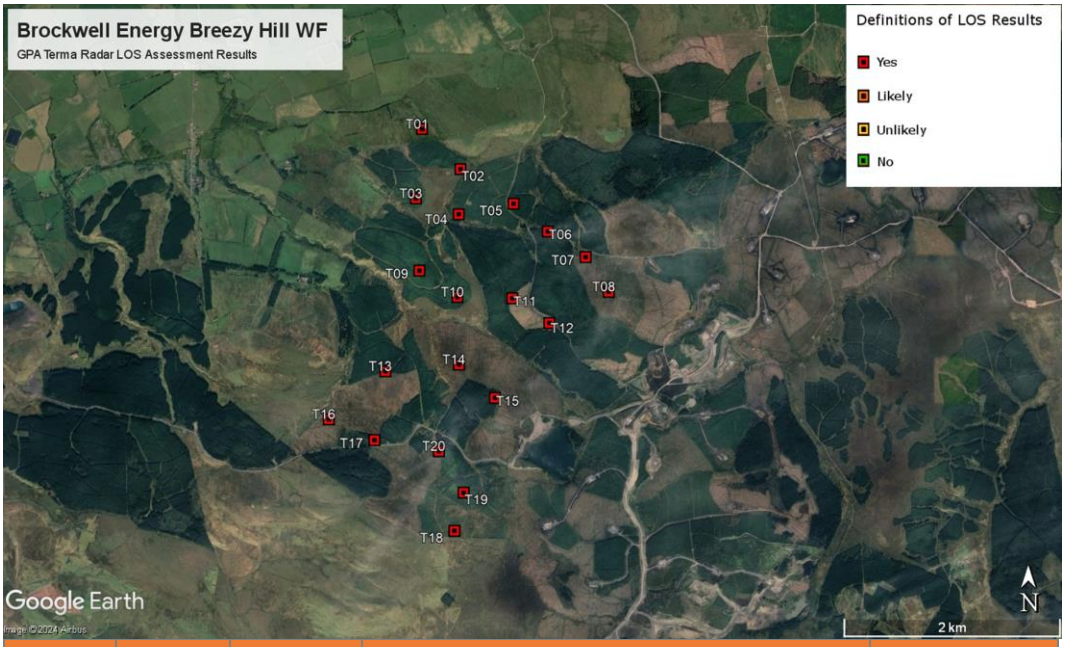



| WTG | Tip Height (m) | Visibility Result | Description | Annex A1 Reference |
|---|---|---|---|---|
| T01 | 149.9 | YES | Visible to the In-Scope CNS System (the WTG has direct optical LOS) | Figure 22 |

| WTG | Tip Height (m) | Visibility Result | Description | Annex A1 Reference |
|---|---|---|---|---|
| T02 | 149.9 | YES | Visible to the In-Scope CNS System (the WTG has direct optical LOS) | Figure 23 |
| T03 | 149.9 | YES | Visible to the In-Scope CNS System (the WTG has direct optical LOS) | Figure 24 |
| T04 | 149.9 | YES | Visible to the In-Scope CNS System (the WTG has direct optical LOS) | Figure 25 |
| T05 | 149.9 | YES | Visible to the In-Scope CNS System (the WTG has direct optical LOS) | Figure 26 |
| T06 | 149.9 | YES | Visible to the In-Scope CNS System (the WTG has direct optical LOS) | Figure 27 |
| T07 | 149.9 | YES | Visible to the In-Scope CNS System (the WTG has direct optical LOS) | Figure 28 |
| T08 | 149.9 | YES | Visible to the In-Scope CNS System (the WTG has direct optical LOS) | Figure 29 |
| T09 | 149.9 | YES | Visible to the In-Scope CNS System (the WTG has direct optical LOS) | Figure 30 |
| T10 | 149.9 | YES | Visible to the In-Scope CNS System (the WTG has direct optical LOS) | Figure 31 |
| T11 | 149.9 | YES | Visible to the In-Scope CNS System (the WTG has direct optical LOS) | Figure 32 |
| T12 | 149.9 | YES | Visible to the In-Scope CNS System (the WTG has direct optical LOS) | Figure 33 |
| T13 | 149.9 | YES | Visible to the In-Scope CNS System (the WTG has direct optical LOS) | Figure 34 |
| T14 | 149.9 | YES | Visible to the In-Scope CNS System (the WTG has direct optical LOS) | Figure 35 |
| T15 | 149.9 | YES | Visible to the In-Scope CNS System (the WTG has direct optical LOS) | Figure 36 |
| T16 | 149.9 | YES | Visible to the In-Scope CNS System (the WTG has direct optical LOS) | Figure 37 |
| T17 | 149.9 | YES | Visible to the In-Scope CNS System (the WTG has direct optical LOS) | Figure 38 |
| T18 | 149.9 | YES | Visible to the In-Scope CNS System (the WTG has direct optical LOS) | Figure 19 |
| T19 | 149.9 | YES | Visible to the In-Scope CNS System (the WTG has direct optical LOS) | Figure 40 |
| T20 | 149.9 | YES | Visible to the In-Scope CNS System (the WTG has direct optical LOS) | Figure 41 |

Table 7 - Lowther Hill Radar - LOS Results

### 2.5.3 GPA Terma Radar – LOS Results




| WTG | Tip Height (m) | Visibility Result | Description | Annex A1 Reference |
|---|---|---|---|---|
| T01 | 149.9 | YES | Visible to the In-Scope CNS System (the WTG has direct optical LOS) | Figure 42 |
| T02 | 149.9 | YES | Visible to the In-Scope CNS System (the WTG has direct optical LOS) | Figure 43 |
| T03 | 149.9 | YES | Visible to the In-Scope CNS System (the WTG has direct optical LOS) | Figure 44 |
| T04 | 149.9 | YES | Visible to the In-Scope CNS System (the WTG has direct optical LOS) | Figure 45 |
| T05 | 149.9 | YES | Visible to the In-Scope CNS System (the WTG has direct optical LOS) | Figure 46 |
| T06 | 149.9 | YES | Visible to the In-Scope CNS System (the WTG has direct optical LOS) | Figure 47 |
| T07 | 149.9 | YES | Visible to the In-Scope CNS System (the WTG has direct optical LOS) | Figure 48 |
| T08 | 149.9 | YES | Visible to the In-Scope CNS System (the WTG has direct optical LOS) | Figure 49 |
| T09 | 149.9 | YES | Visible to the In-Scope CNS System (the WTG has direct optical LOS) | Figure 50 |
| T10 | 149.9 | YES | Visible to the In-Scope CNS System (the WTG has direct optical LOS) | Figure 51 |
| T11 | 149.9 | YES | Visible to the In-Scope CNS System (the WTG has direct optical LOS) | Figure 52 |
| T12 | 149.9 | YES | Visible to the In-Scope CNS System (the WTG has direct optical LOS) | Figure 53 |

| WTG | Tip Height (m) | Visibility Result | Description | Annex A1 Reference |
|---|---|---|---|---|
| T13 | 149.9 | YES | Visible to the In-Scope CNS System (the WTG has direct optical LOS) | Figure 54 |
| T14 | 149.9 | YES | Visible to the In-Scope CNS System (the WTG has direct optical LOS) | Figure 55 |
| T15 | 149.9 | YES | Visible to the In-Scope CNS System (the WTG has direct optical LOS) | Figure 56 |
| T16 | 149.9 | YES | Visible to the In-Scope CNS System (the WTG has direct optical LOS) | Figure 57 |
| T17 | 149.9 | YES | Visible to the In-Scope CNS System (the WTG has direct optical LOS) | Figure 58 |
| T18 | 149.9 | YES | Visible to the In-Scope CNS System (the WTG has direct optical LOS) | Figure 59 |
| T19 | 149.9 | YES | Visible to the In-Scope CNS System (the WTG has direct optical LOS) | Figure 60 |
| T20 | 149.9 | YES | Visible to the In-Scope CNS System (the WTG has direct optical LOS) | Figure 61 |

Table 8 - GPA Terma Radar - LOS Results

## 2.6 Conclusions

The Radar LOS assessments conducted conclude that all WTGs within the Development are expected to have a direct optical visibility to the Lowther Hill and GPA Terma Radars and therefore without suitable mitigations might cause an impact upon the Air Traffic Services (ATS) provided by the respective ANSP.

None of the WTGs of the Development will be visible to the Great Dun Fell Radar.

## 2.7 Recommendations

Osprey recommends that NATS and GPA as the respective Air Navigation Service Providers operating the affected radars, review the results of this assessment against their operational coverage areas and identify suitable and appropriate mitigations that could reduce the operational impacts to a satisfactory level.

# A1 LOS Terrain Elevation Profiles

## A1.1 Great Dun Fell Radar LOS Assessment Profiles for the Development

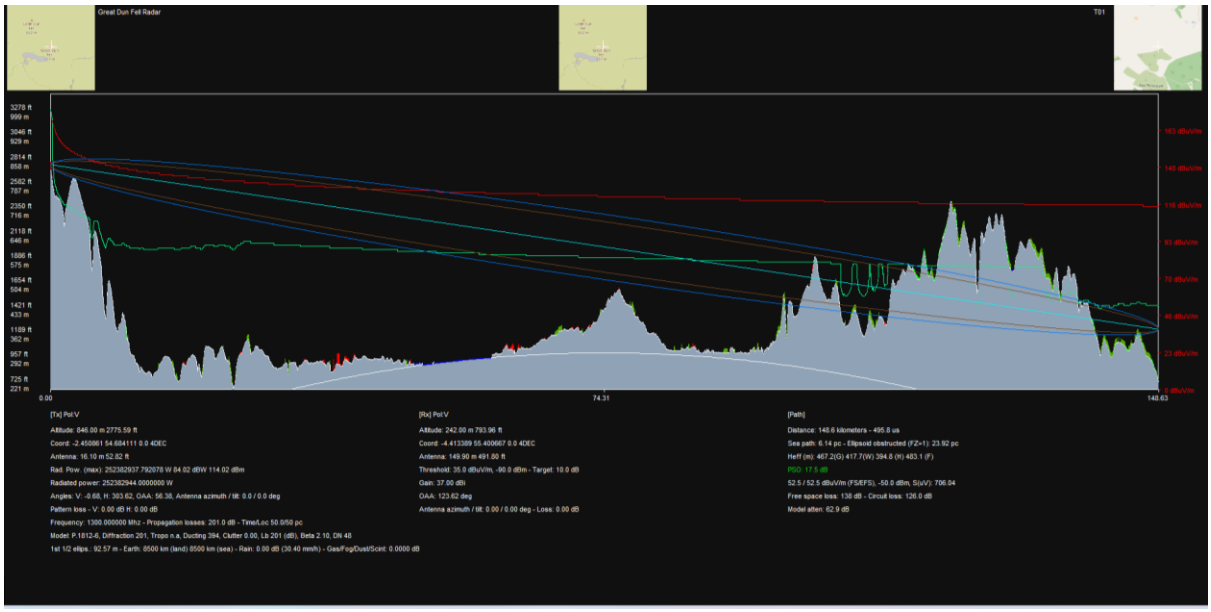



Figure 2 - Great Dun Fell Radar LOS Profile to T01

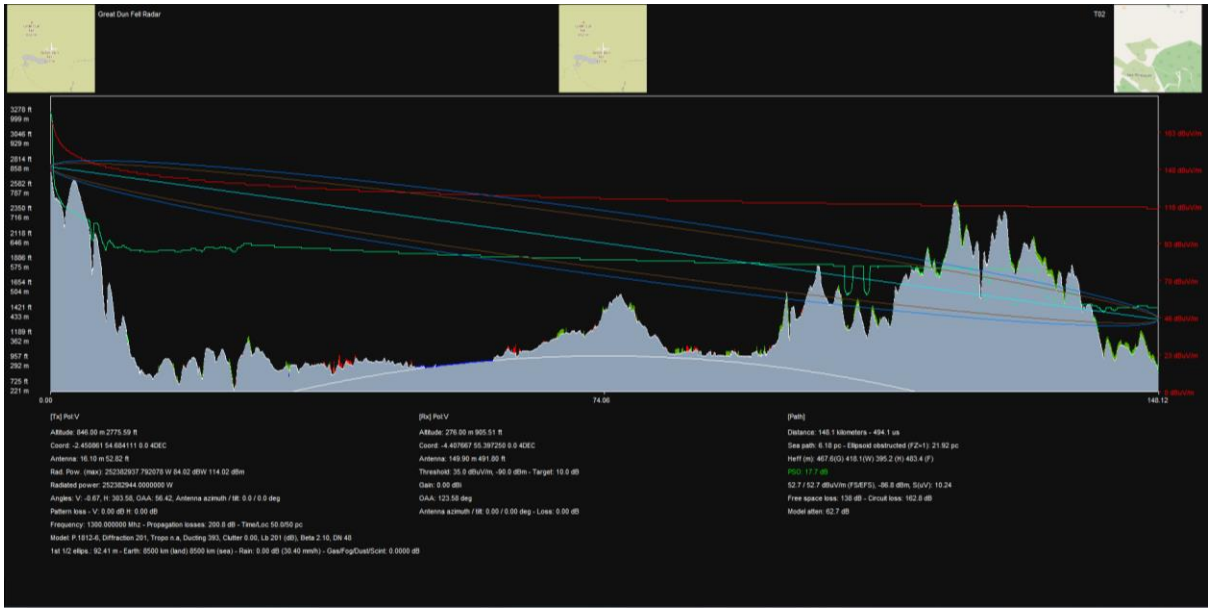



Figure 3 - Great Dun Fell Radar LOS Profile to T02

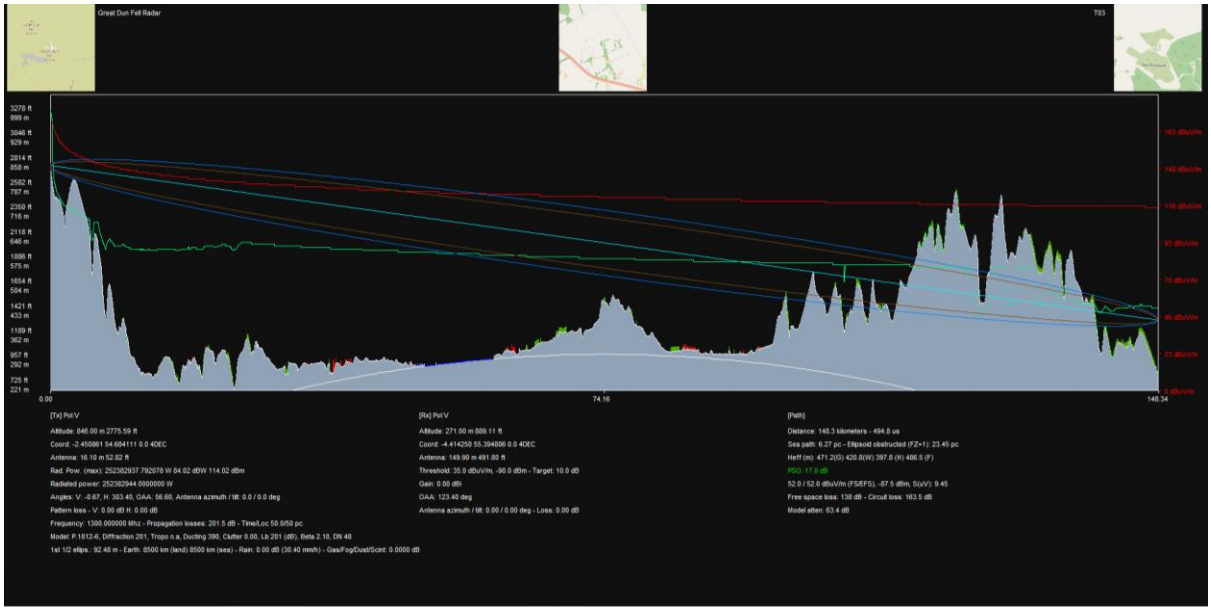



Figure 4 - Great Dun Fell Radar LOS Profile to T03

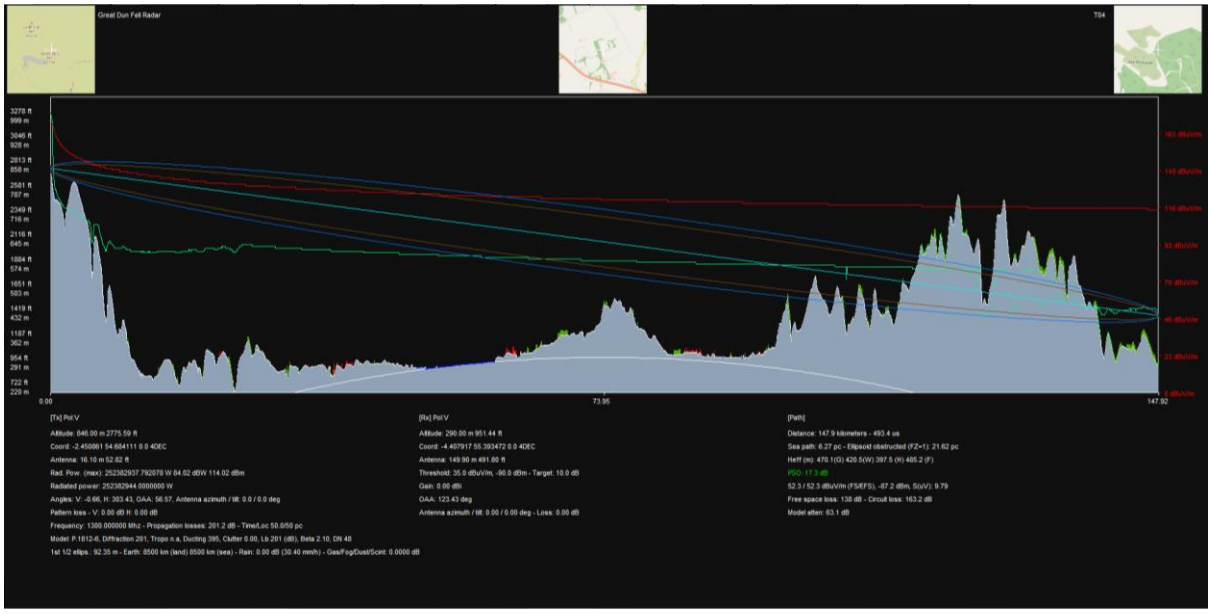



Figure 5 - Great Dun Fell Radar LOS Profile to T04

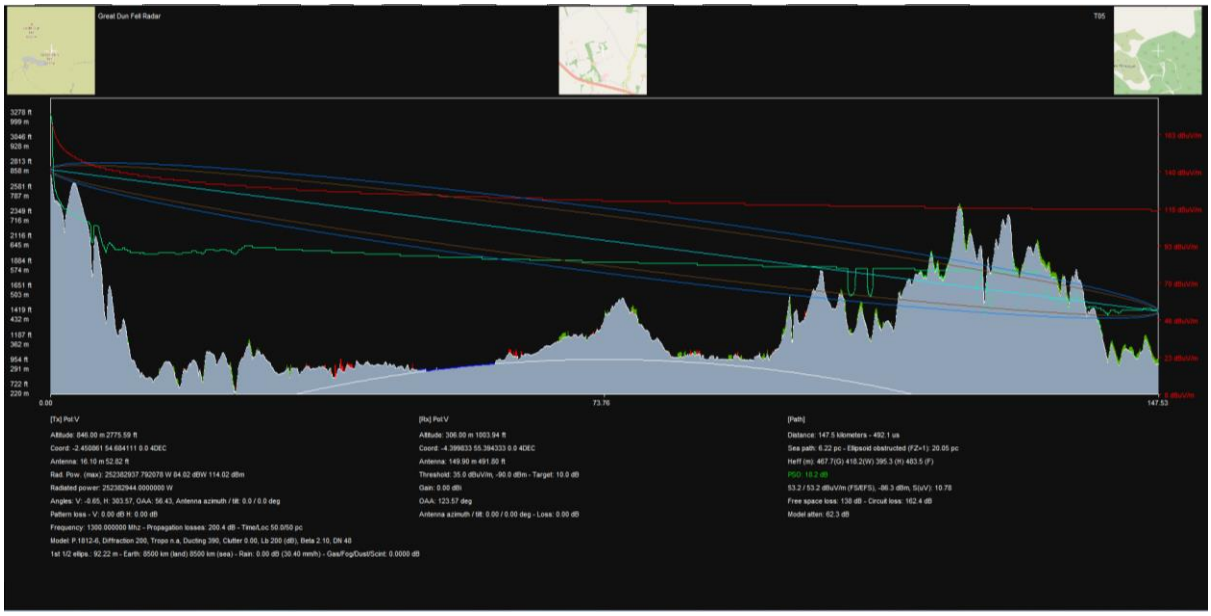



Figure 6 - Great Dun Fell Radar LOS Profile to T05

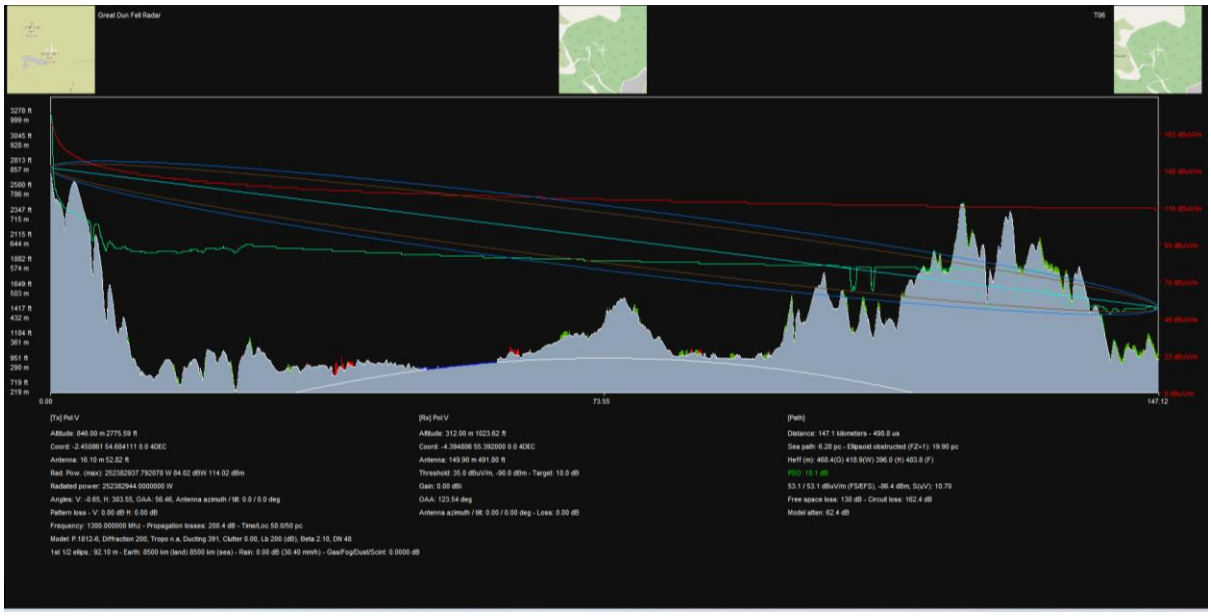



Figure 7 - Great Dun Fell Radar LOS Profile to T06

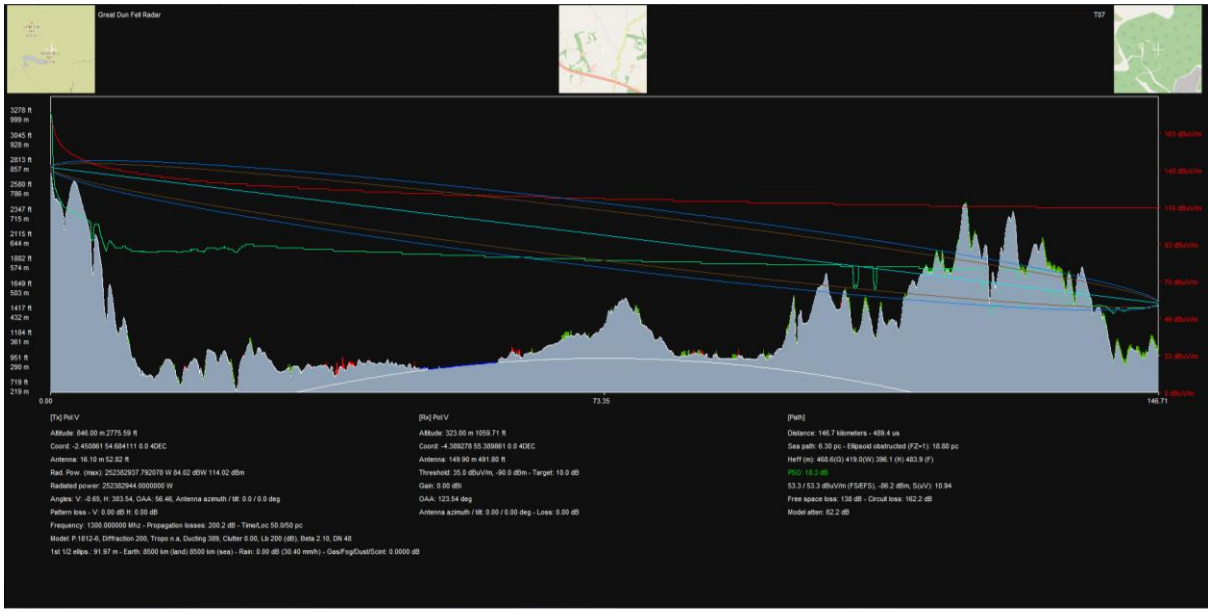



Figure 8 - Great Dun Fell Radar LOS Profile to T07

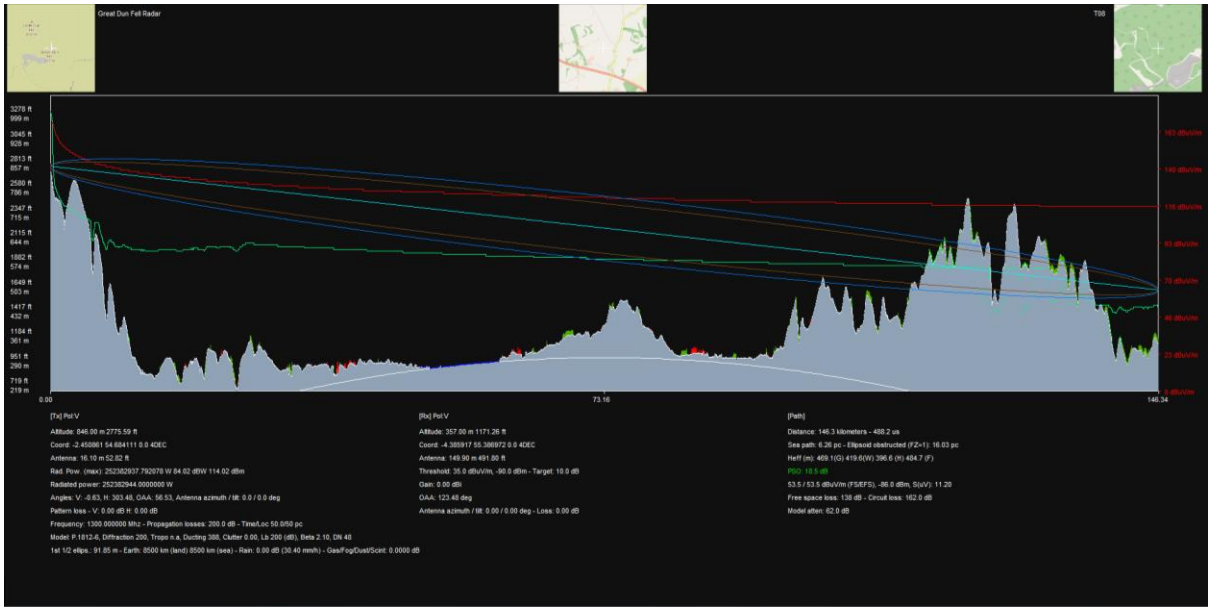



Figure 9 - Great Dun Fell Radar LOS Profile to T08

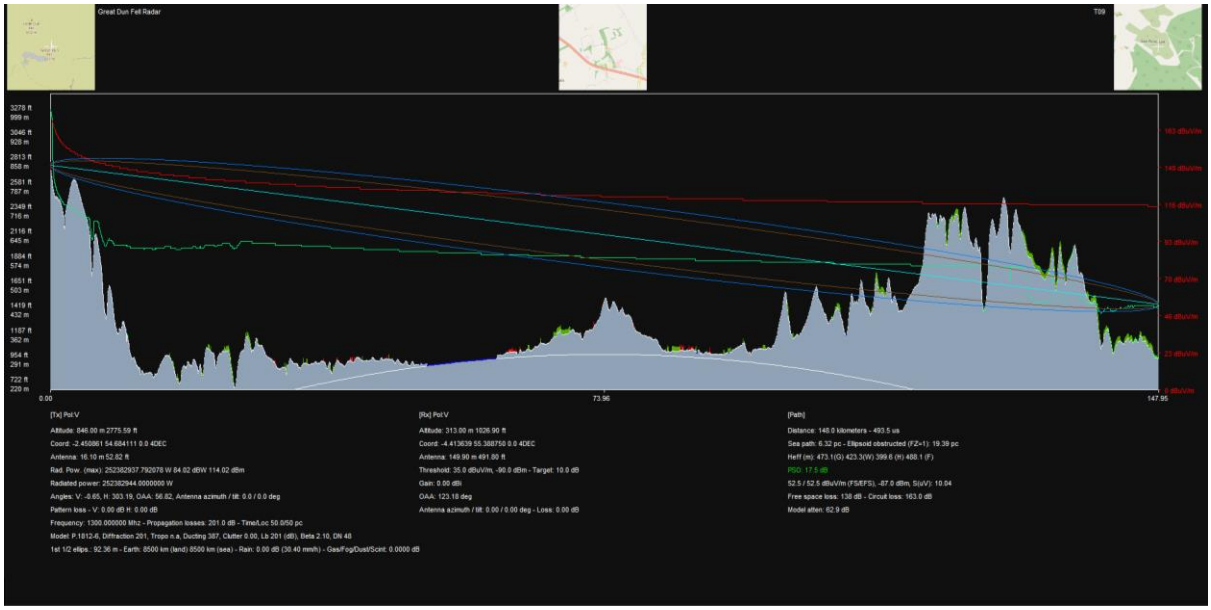



Figure 10 - Great Dun Fell Radar LOS Profile to T09

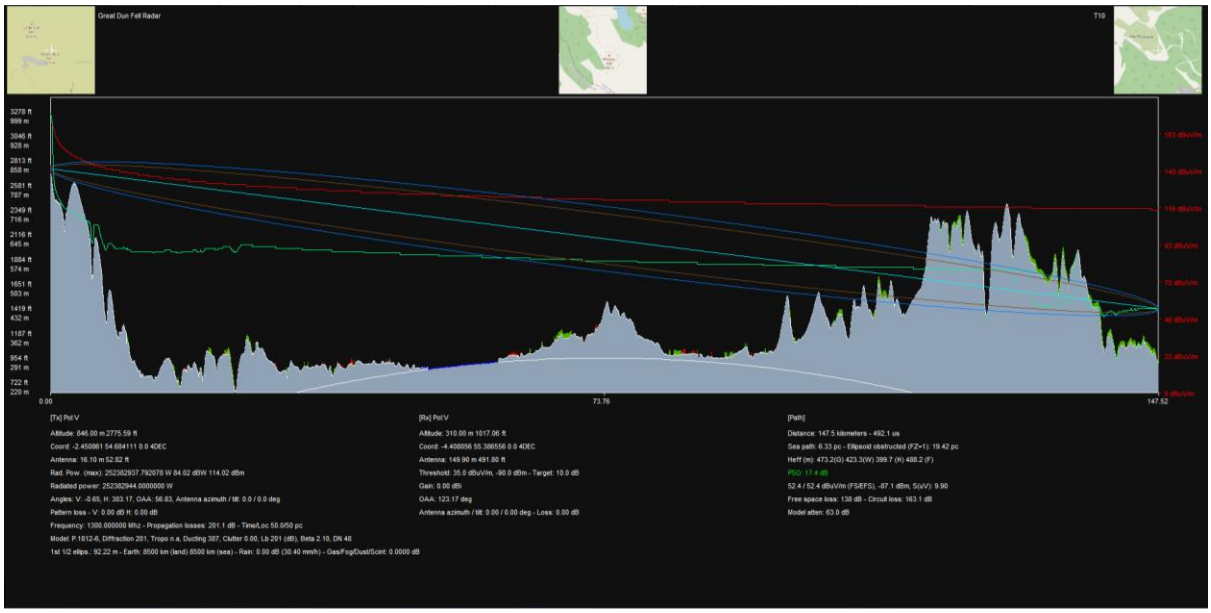



Figure 11 - Great Dun Fell Radar LOS Profile to T10

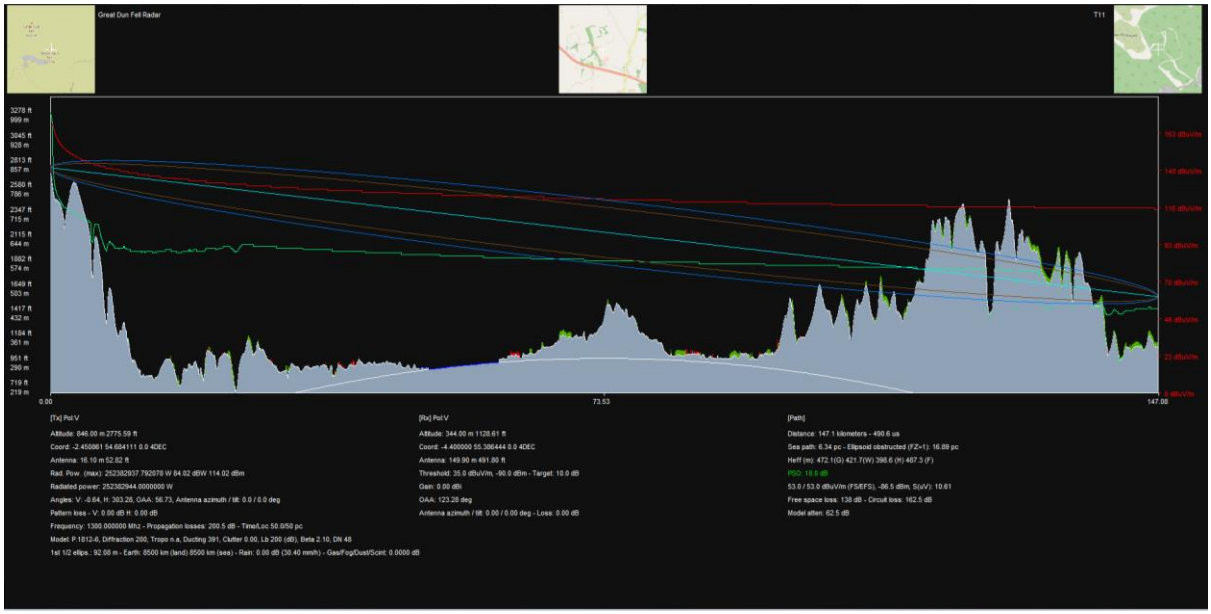



Figure 12 - Great Dun Fell Radar LOS Profile to T11

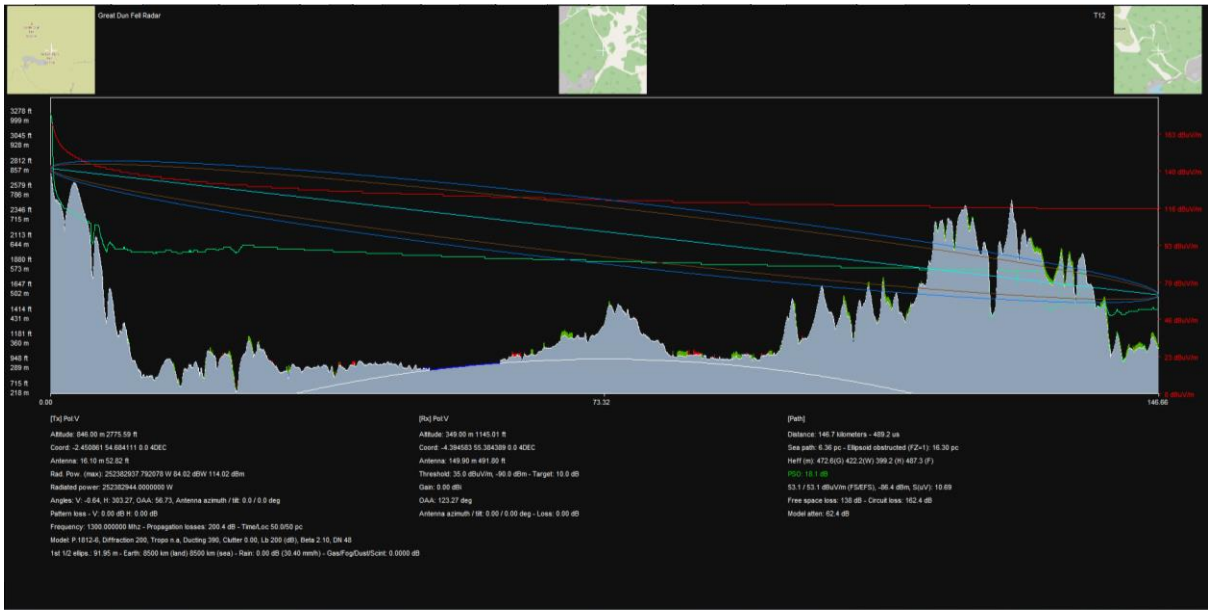



Figure 13 - Great Dun Fell Radar LOS Profile to T12

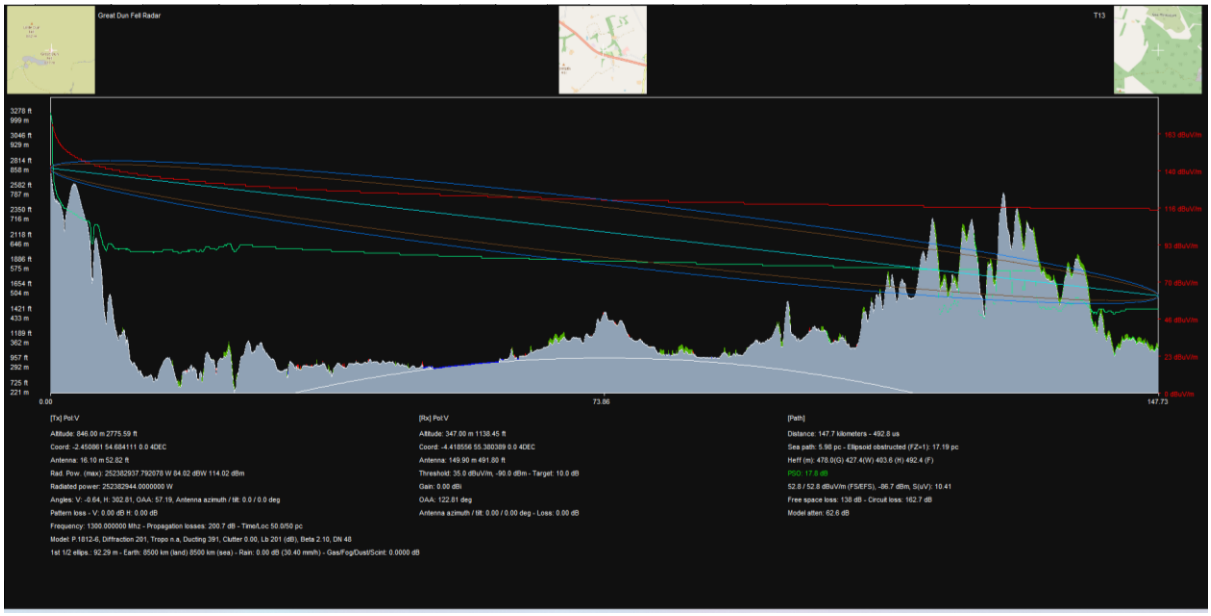



Figure 14 - Great Dun Fell Radar LOS Profile to T13

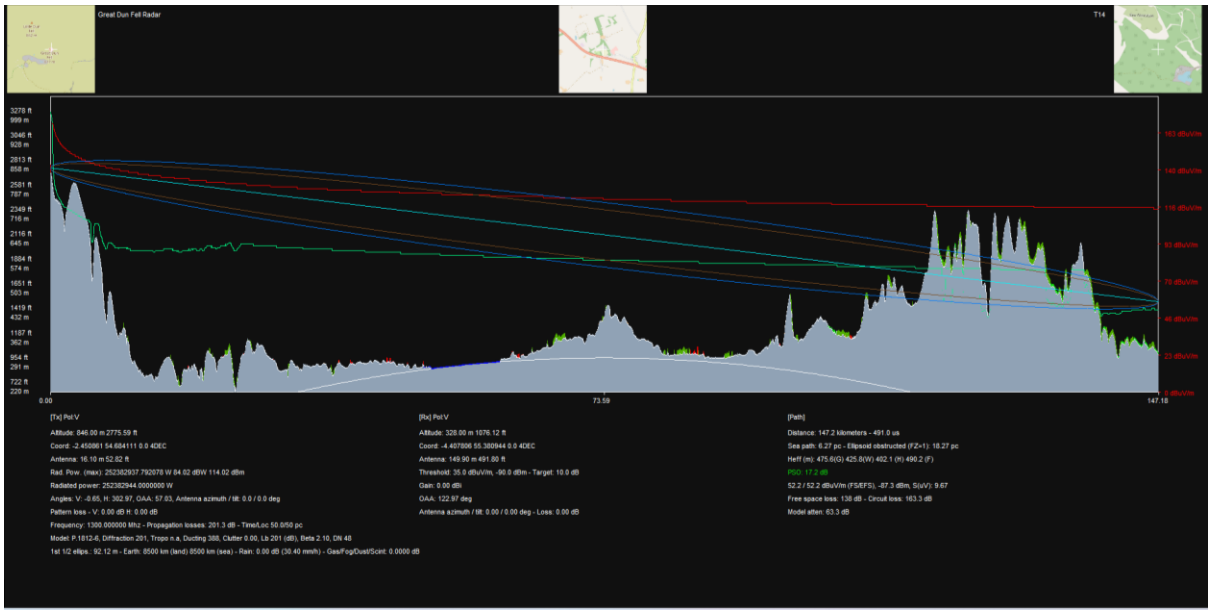



Figure 15 - Great Dun Fell Radar LOS Profile to T14

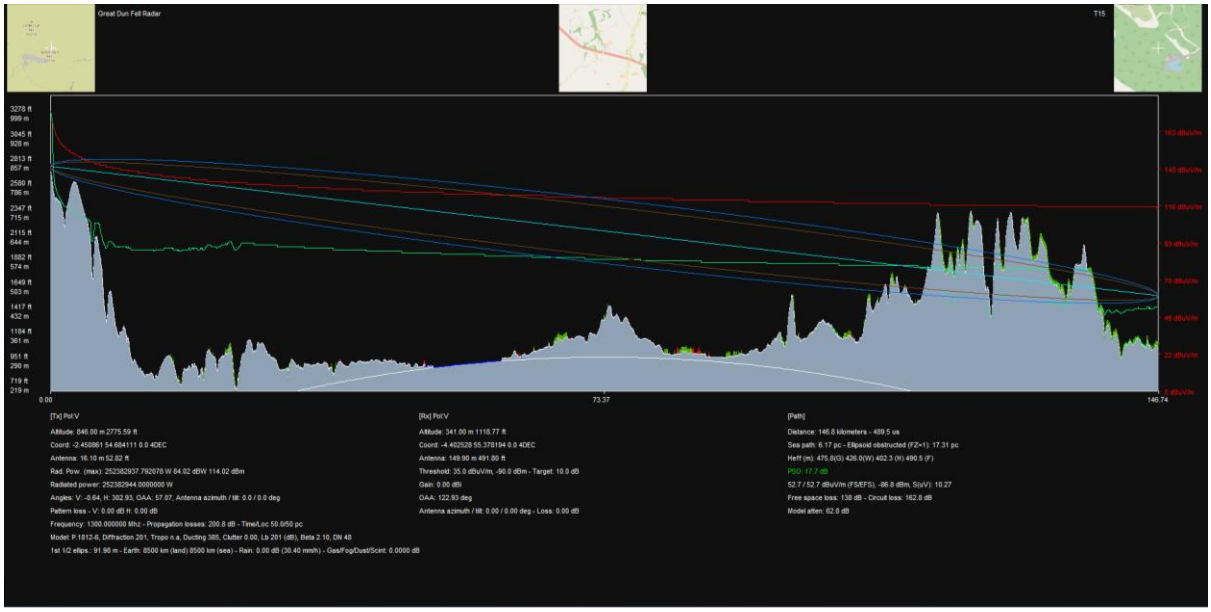



Figure 16 - Great Dun Fell Radar LOS Profile to T15

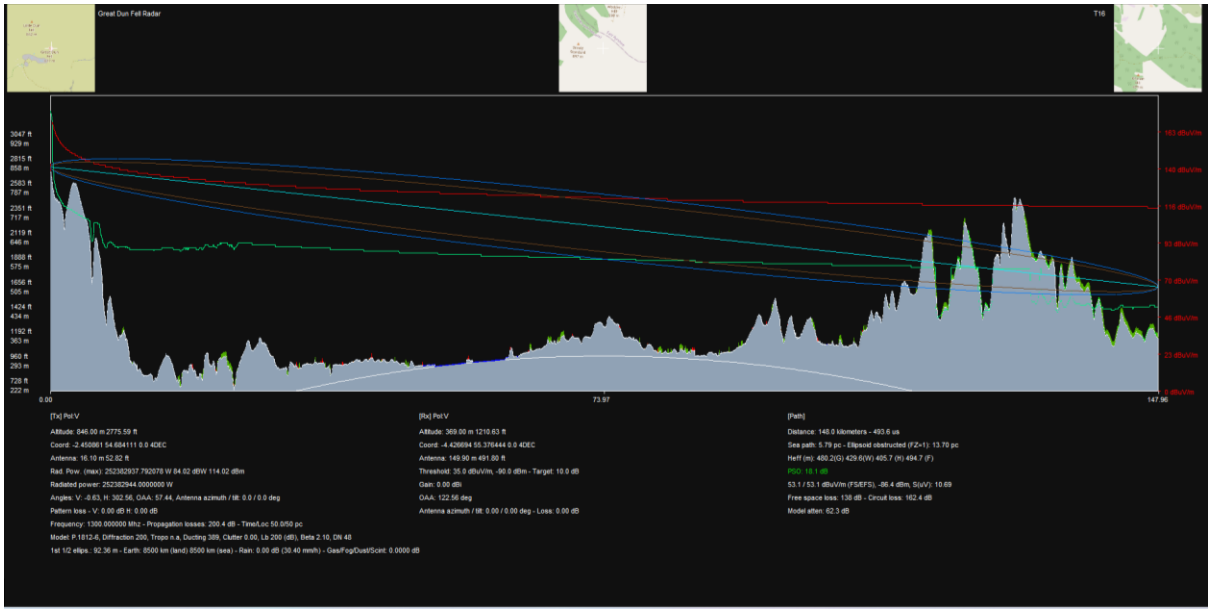



Figure 17 - Great Dun Fell Radar LOS Profile to T16

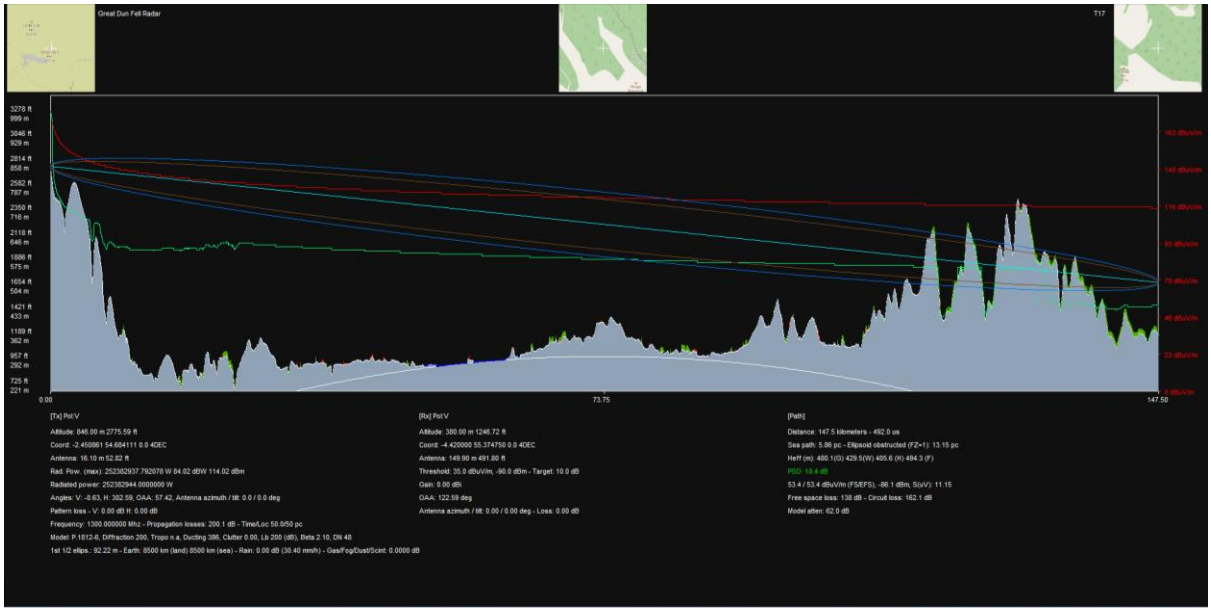



Figure 18 - Great Dun Fell Radar LOS Profile to T17

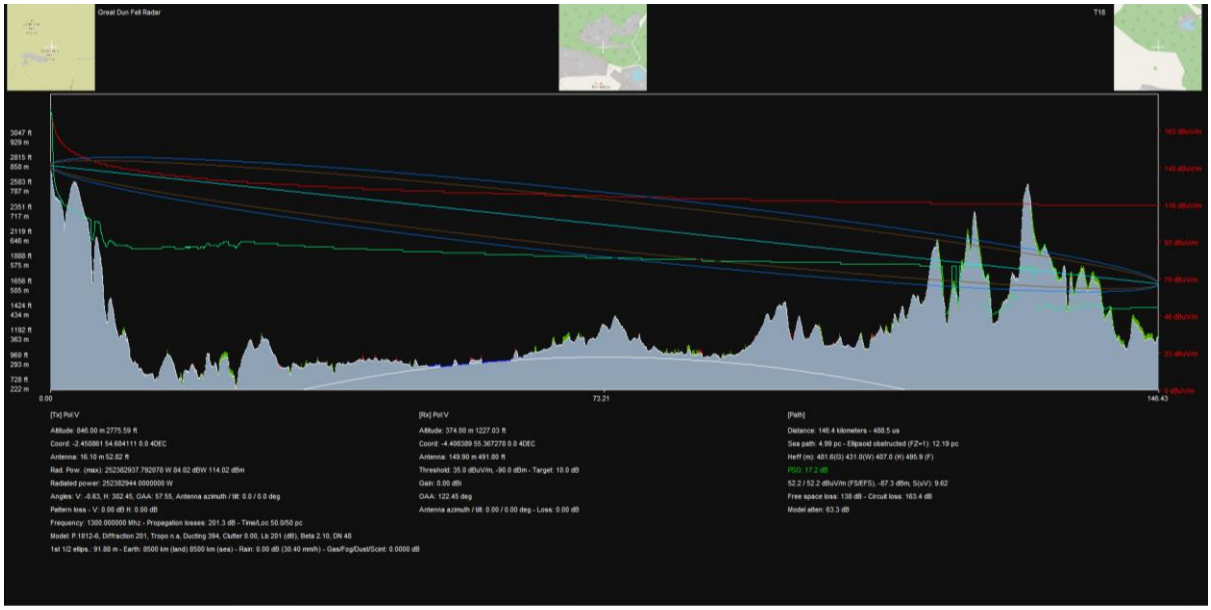



Figure 19 - Great Dun Fell Radar LOS Profile to T18

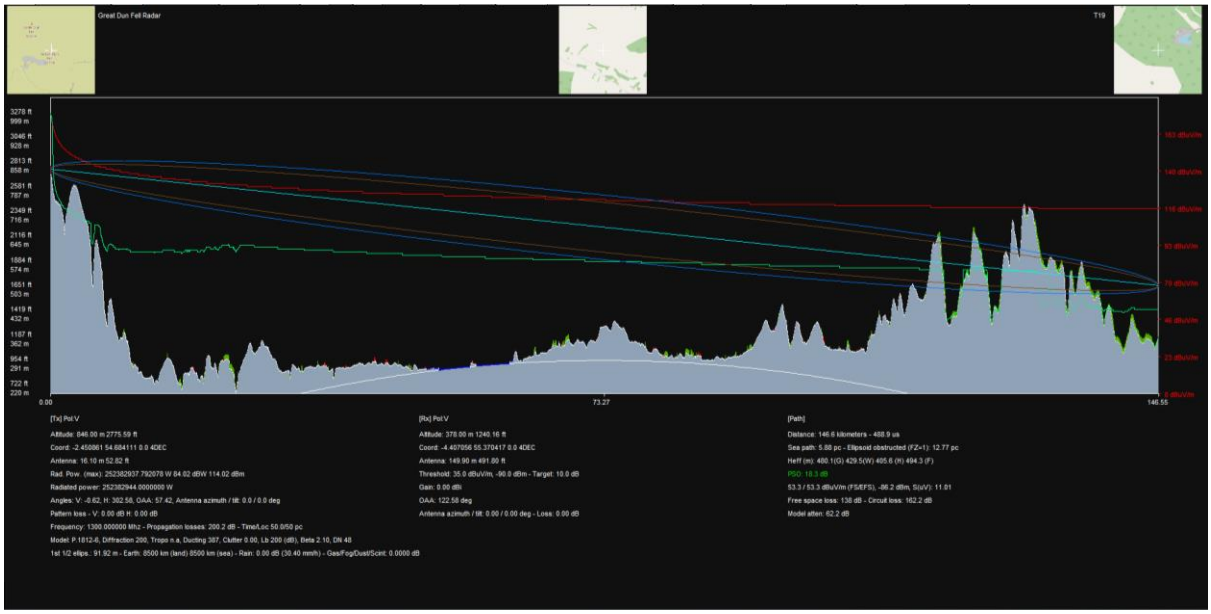



Figure 20 - Great Dun Fell Radar LOS Profile to T19

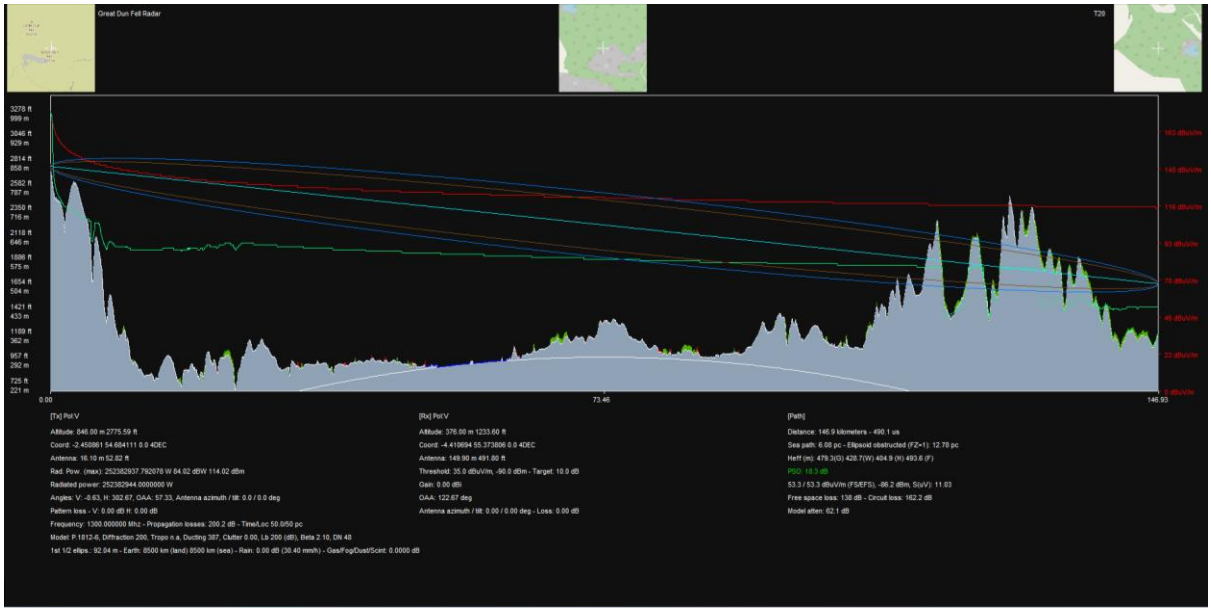



Figure 21 - Great Dun Fell Radar LOS Profile to T20

## A1.2 Lowther Hill Radar LOS Assessment Profiles for the Development

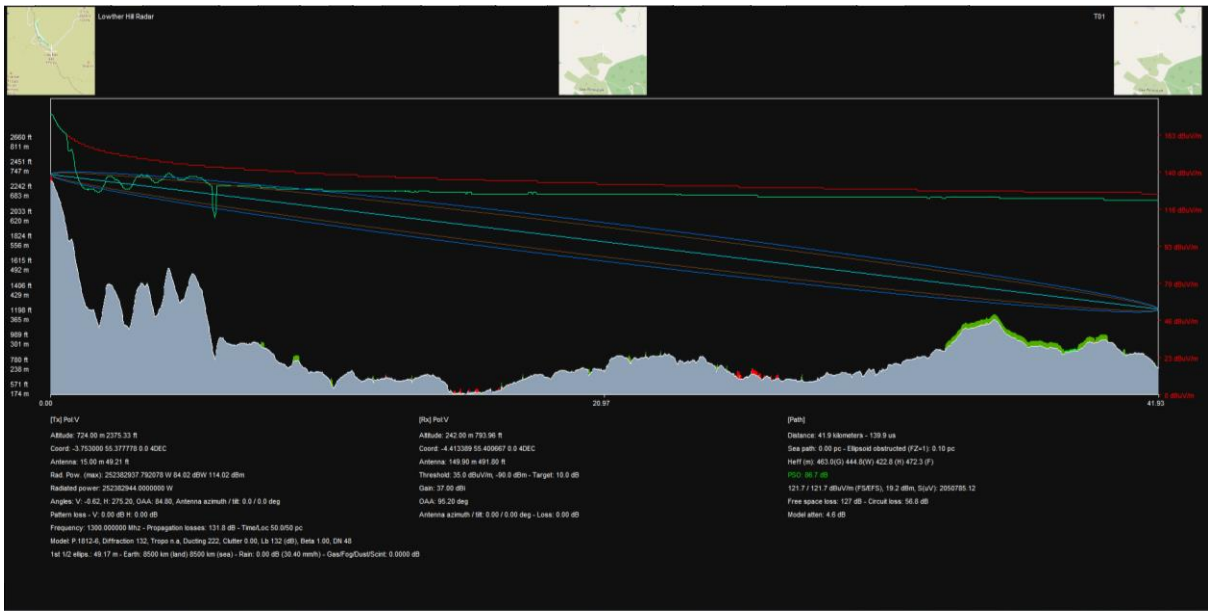



Figure 22 – Lowther Hill Radar LOS Profile to T01

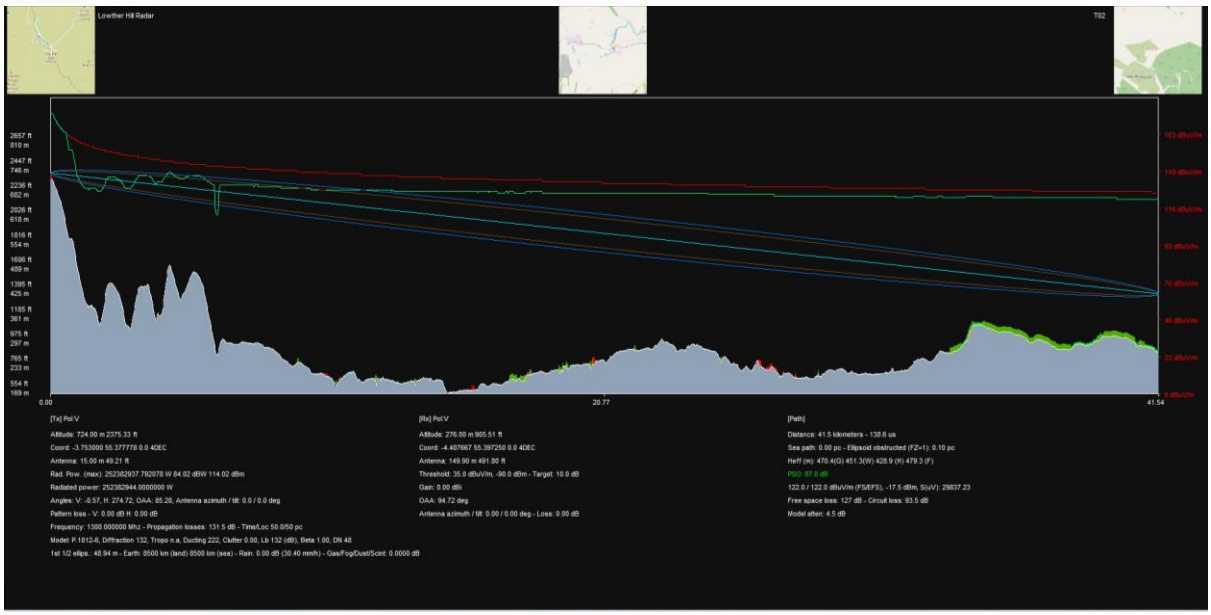



Figure 23 - Lowther Hill Radar LOS Profile to T02

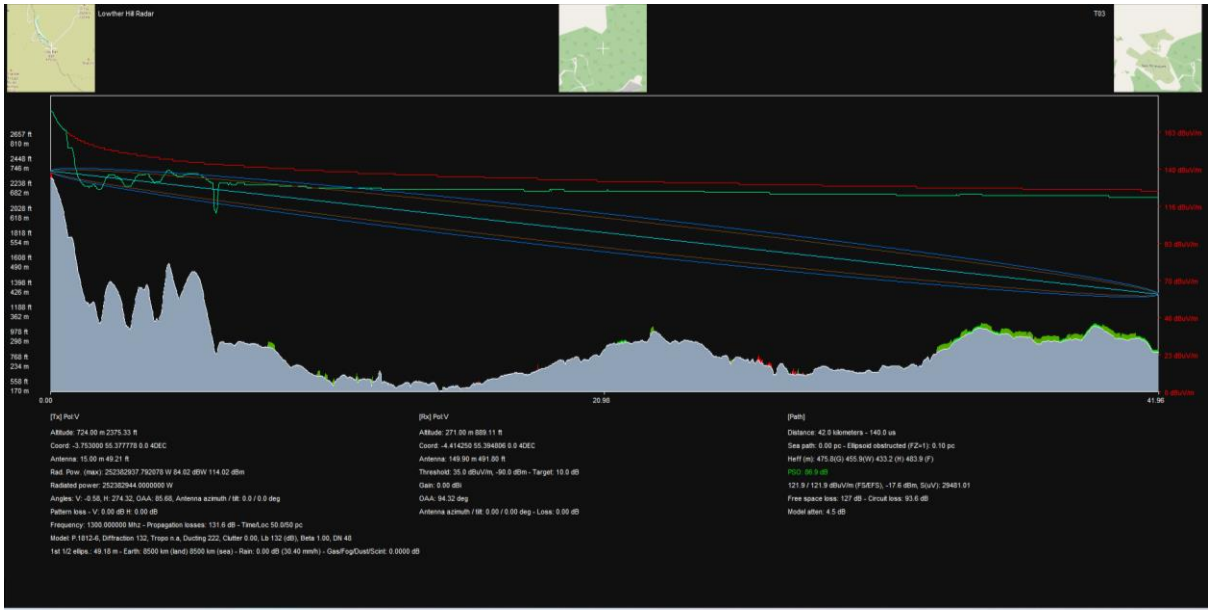



Figure 24 - Lowther Hill Radar LOS Profile to T03

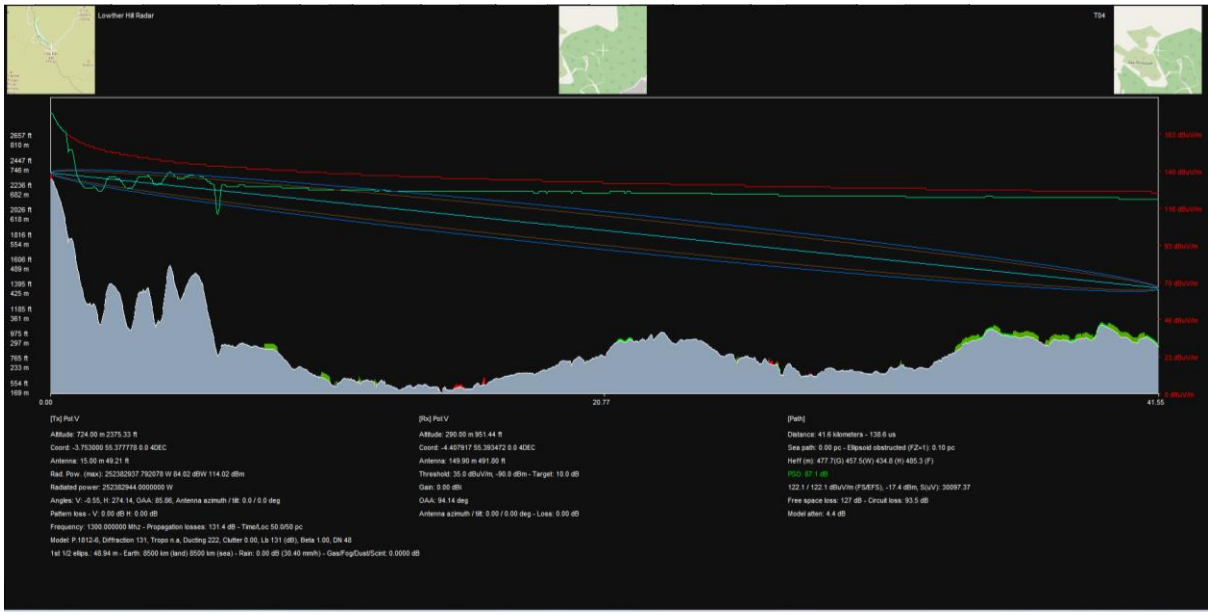



Figure 25 - Lowther Hill Radar LOS Profile to T04

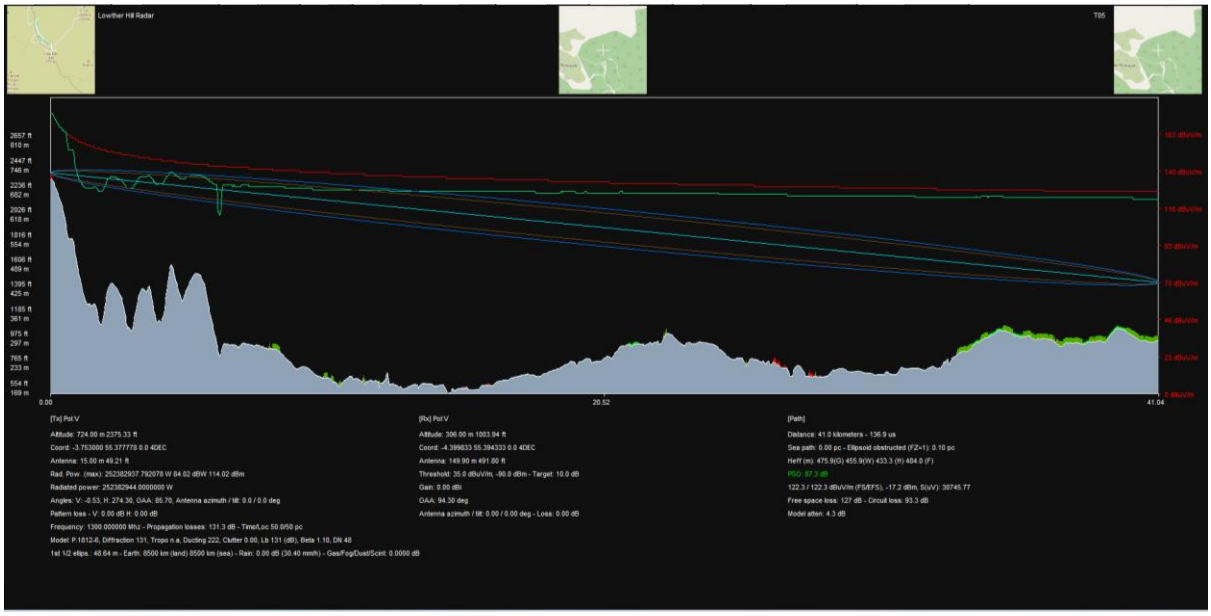



Figure 26 - Lowther Hill Radar LOS Profile to T05

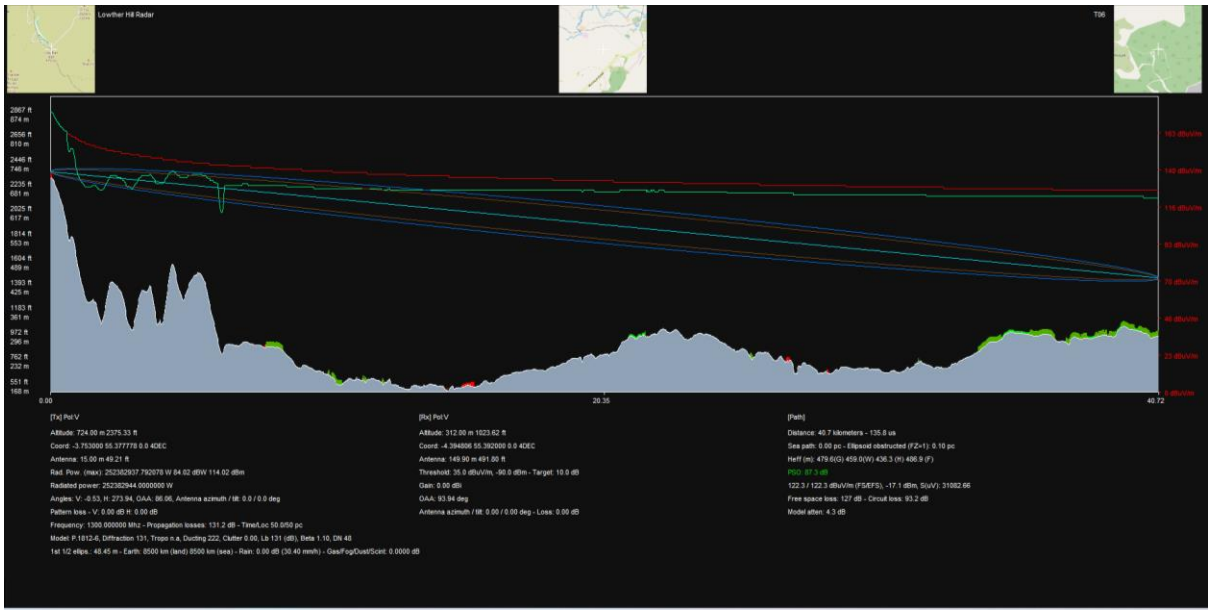



Figure 27 - Lowther Hill Radar LOS Profile to T06

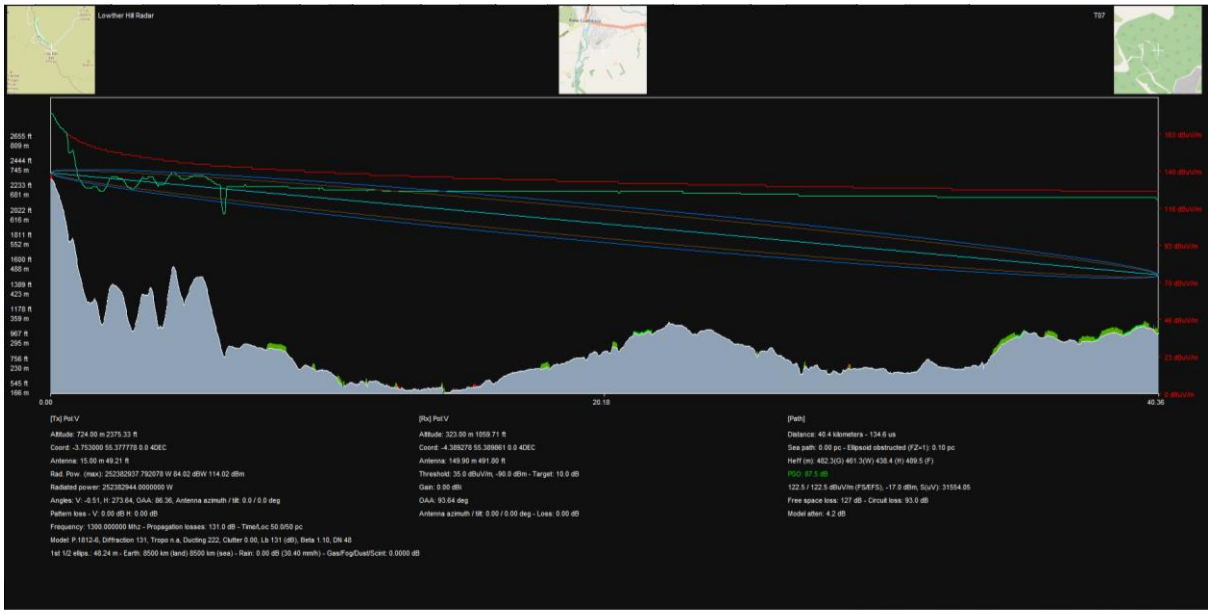



Figure 28 - Lowther Hill Radar LOS Profile to T07

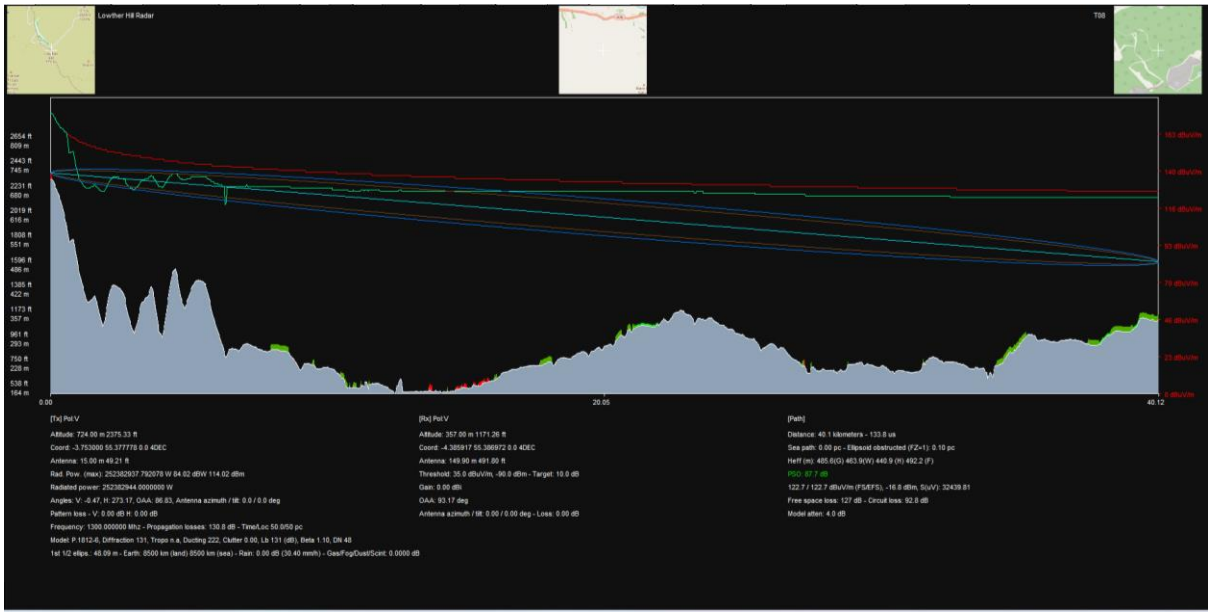



Figure 29 - Lowther Hill Radar LOS Profile to T08

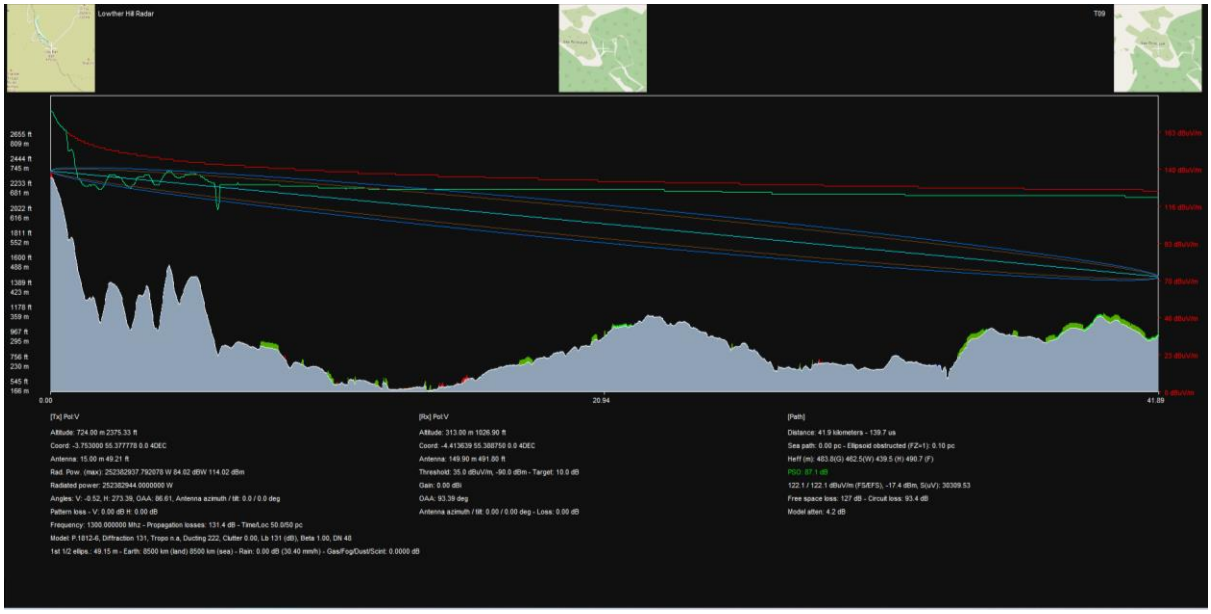



Figure 30 - Lowther Hill Radar LOS Profile to T09

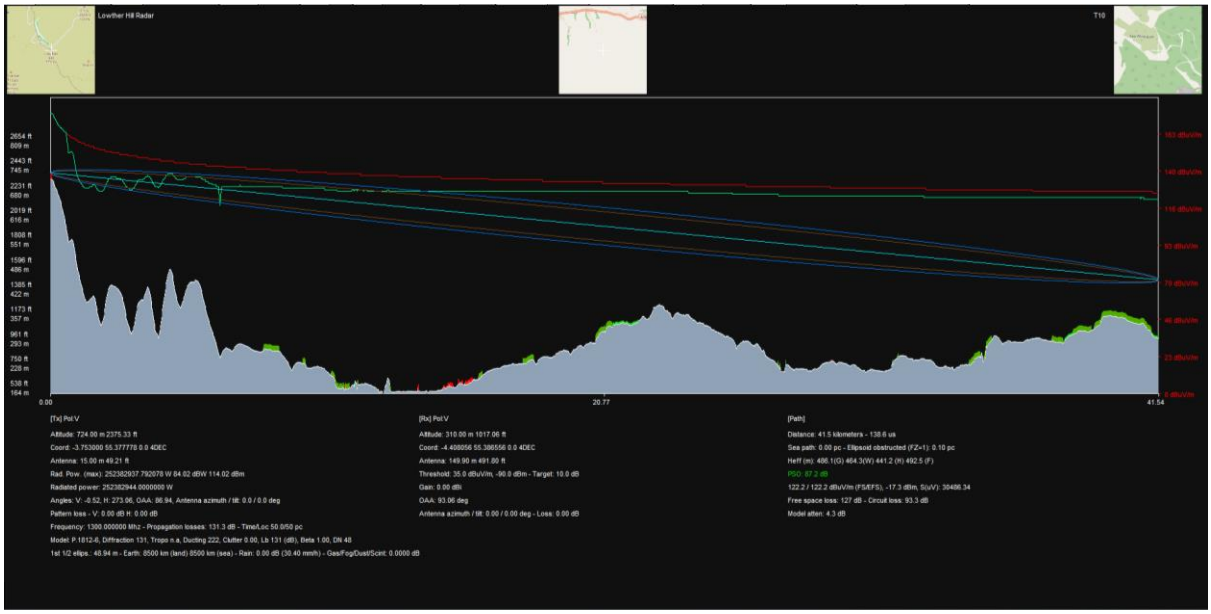



Figure 31 - Lowther Hill Radar LOS Profile to T10

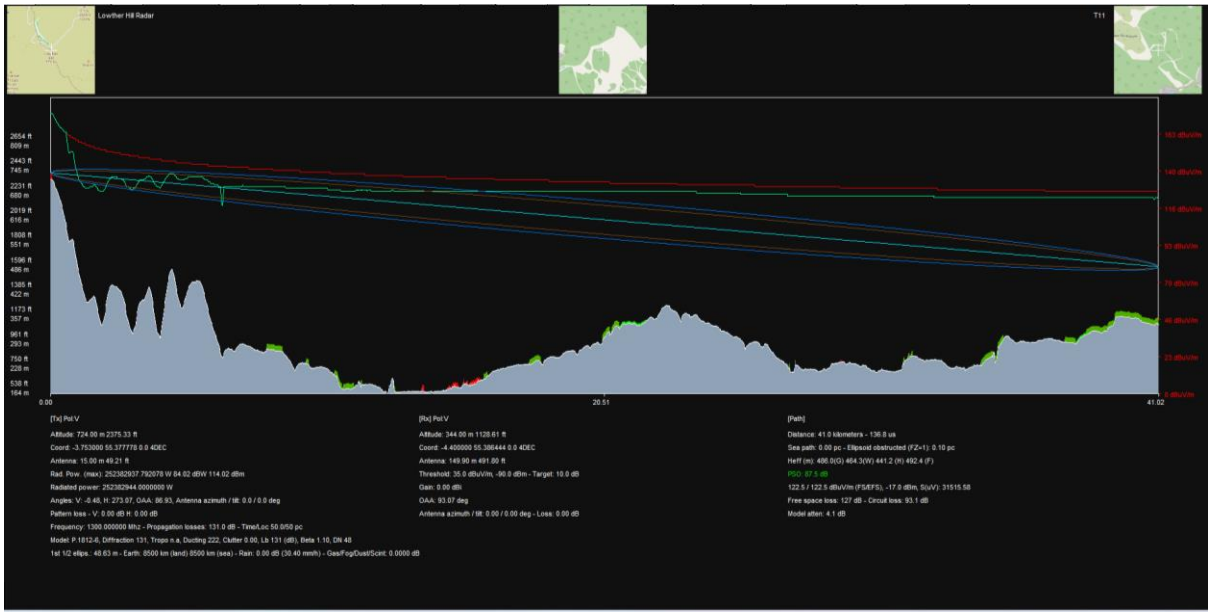



Figure 32 - Lowther Hill Radar LOS Profile to T11

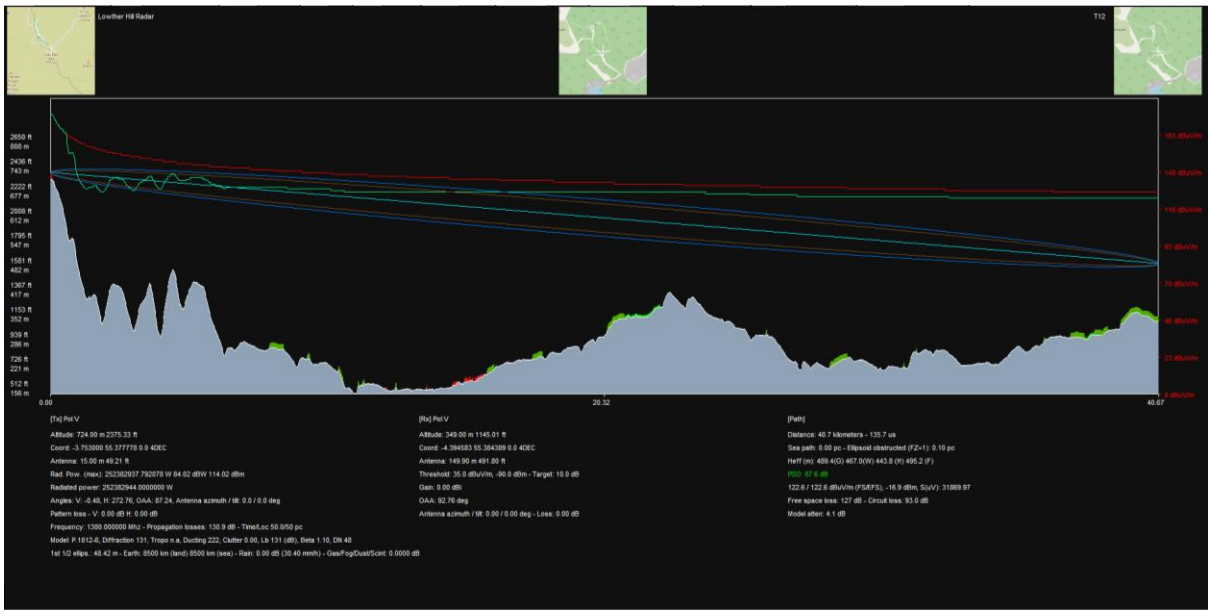



Figure 33 - Lowther Hill Radar LOS Profile to T12

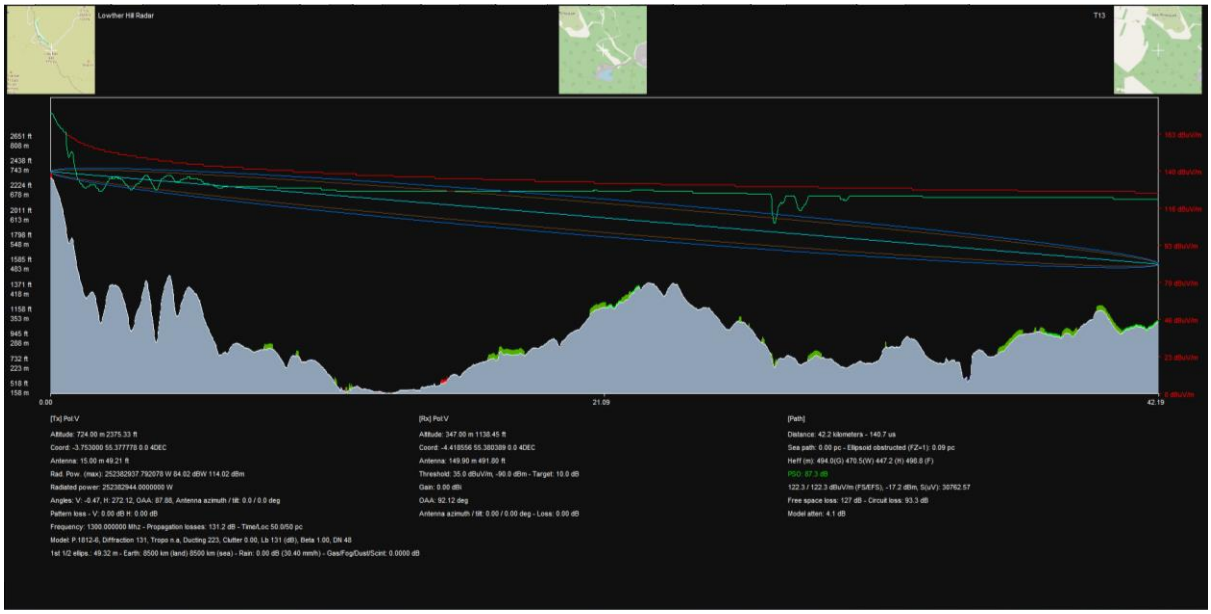



Figure 34 - Lowther Hill Radar LOS Profile to T13

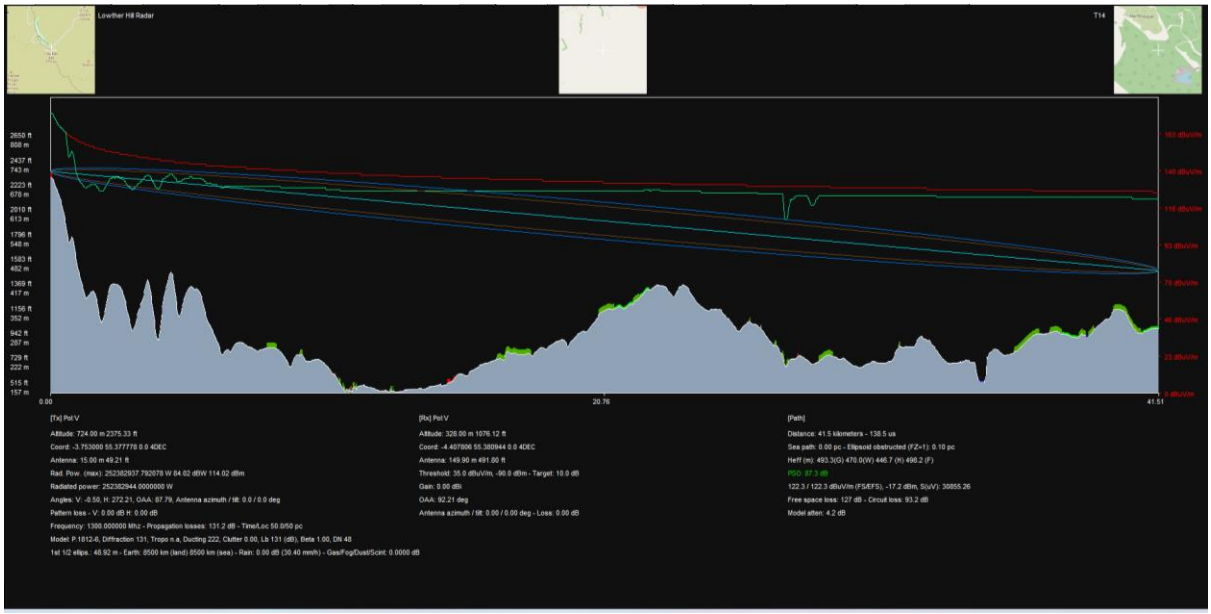



Figure 35 - Lowther Hill Radar LOS Profile to T14

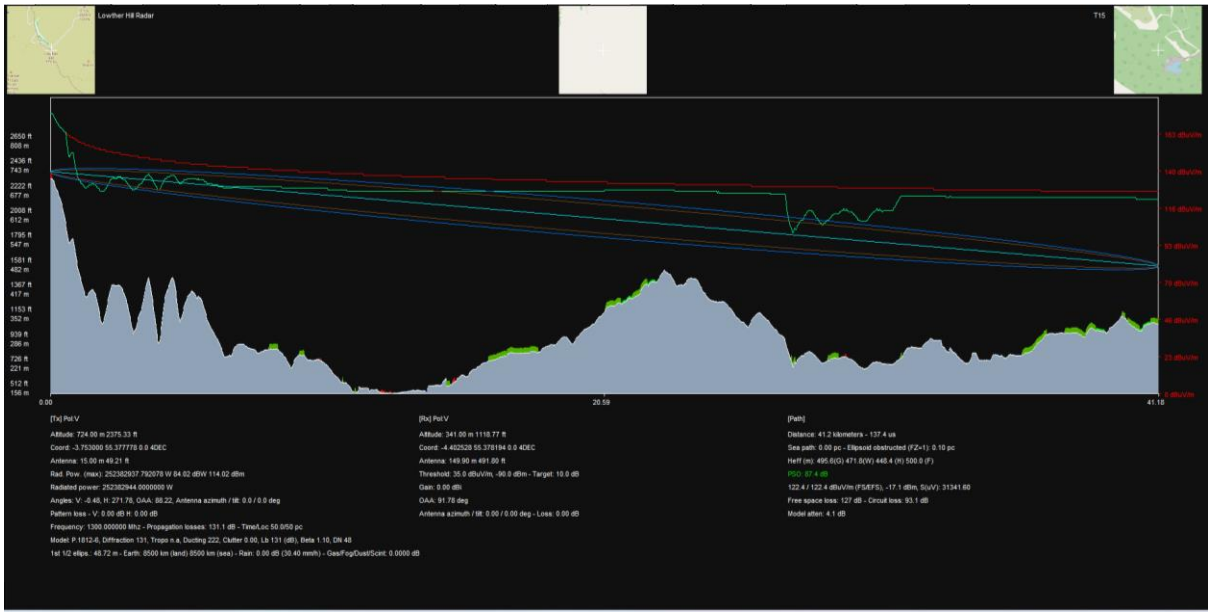



Figure 36 - Lowther Hill Radar LOS Profile to T15

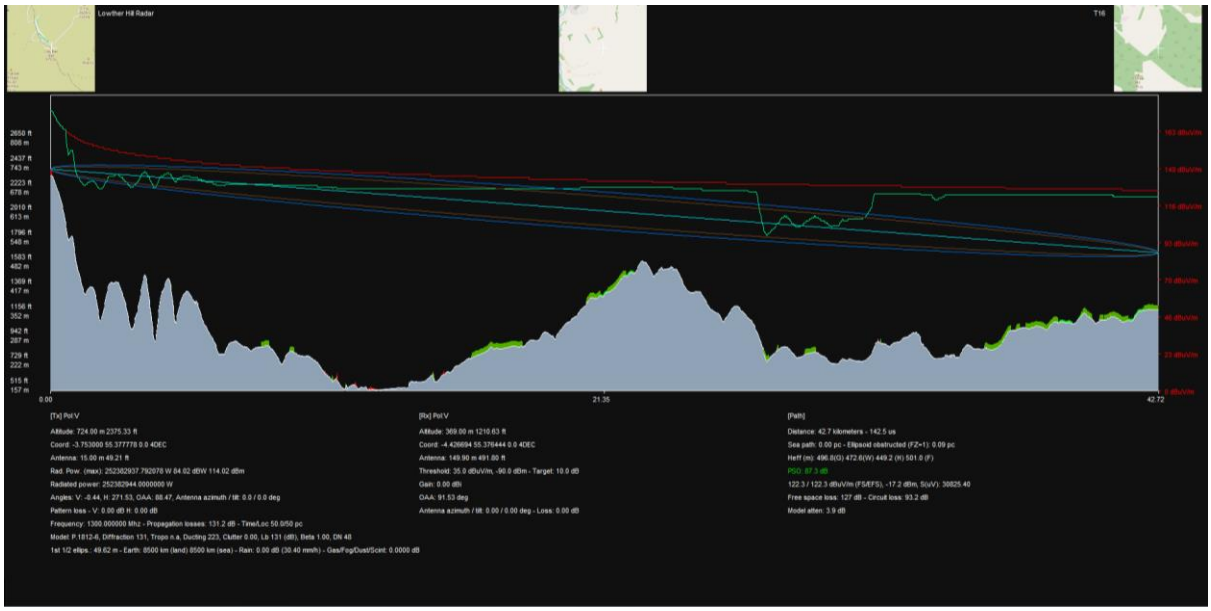



Figure 37 - Lowther Hill Radar LOS Profile to T16

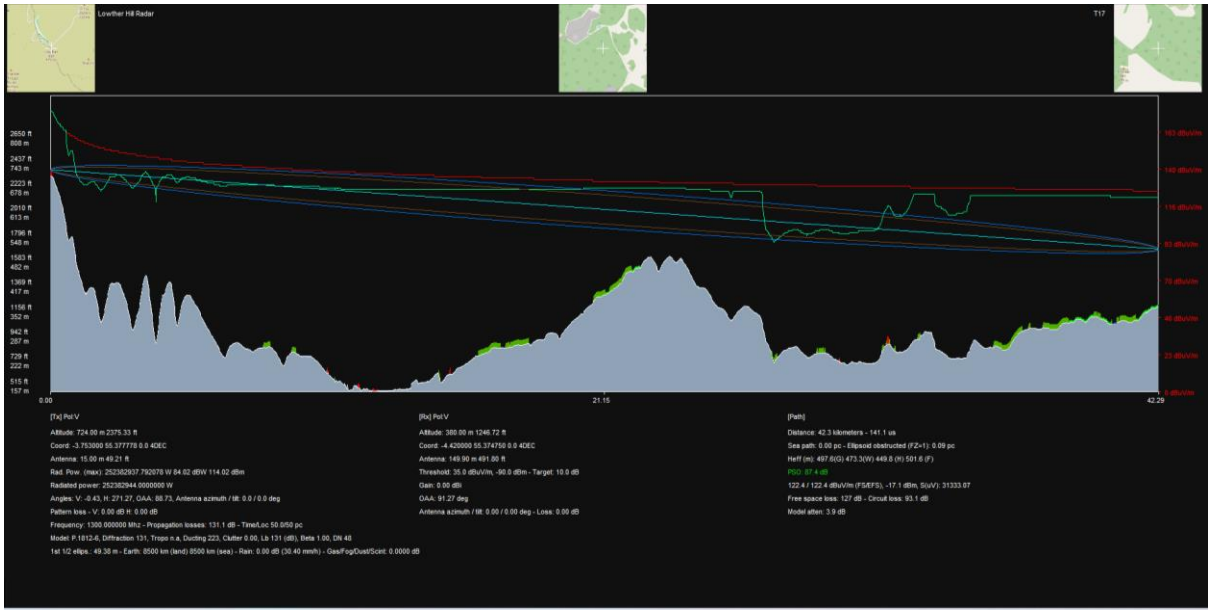



Figure 38 - Lowther Hill Radar LOS Profile to T17

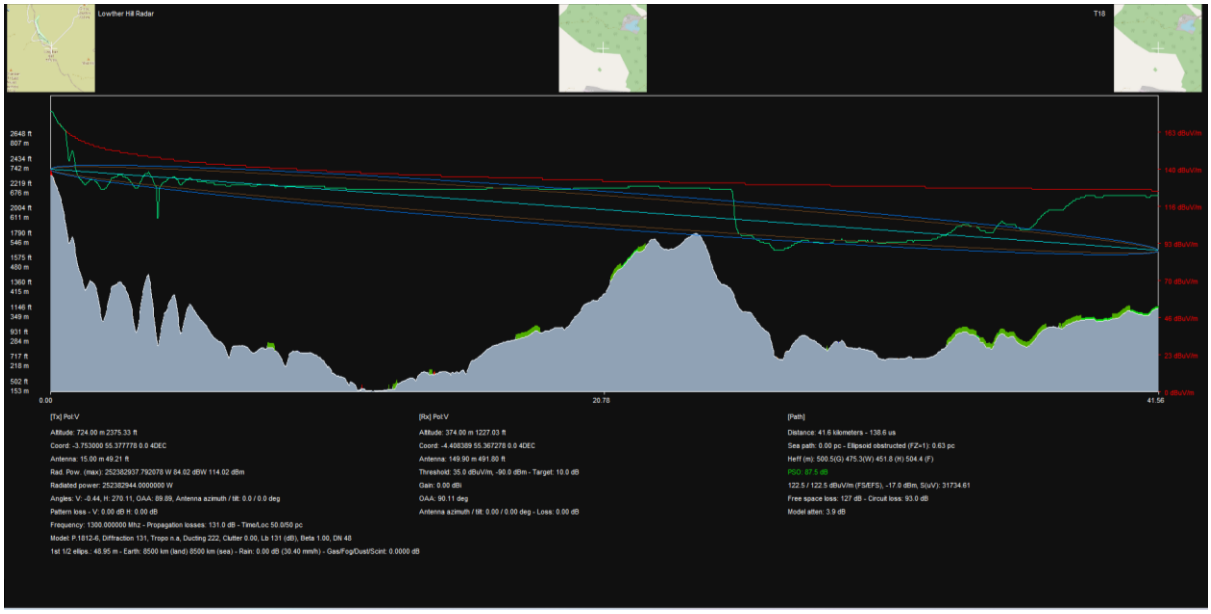



Figure 39 - Lowther Hill Radar LOS Profile to T18

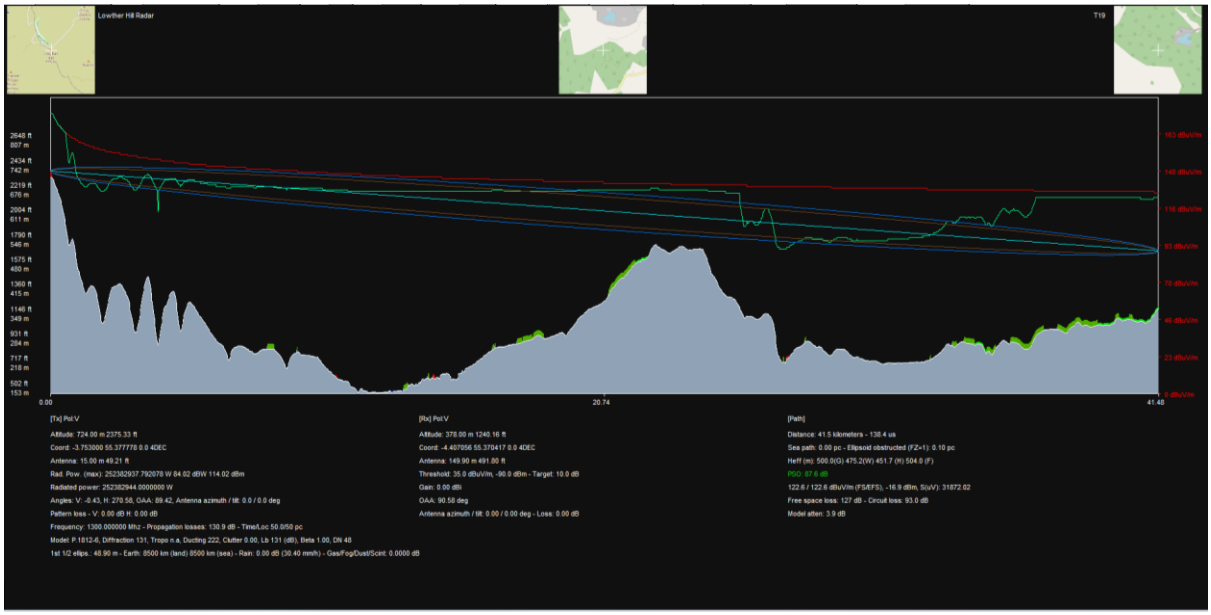



Figure 40 - Lowther Hill Radar LOS Profile to T19

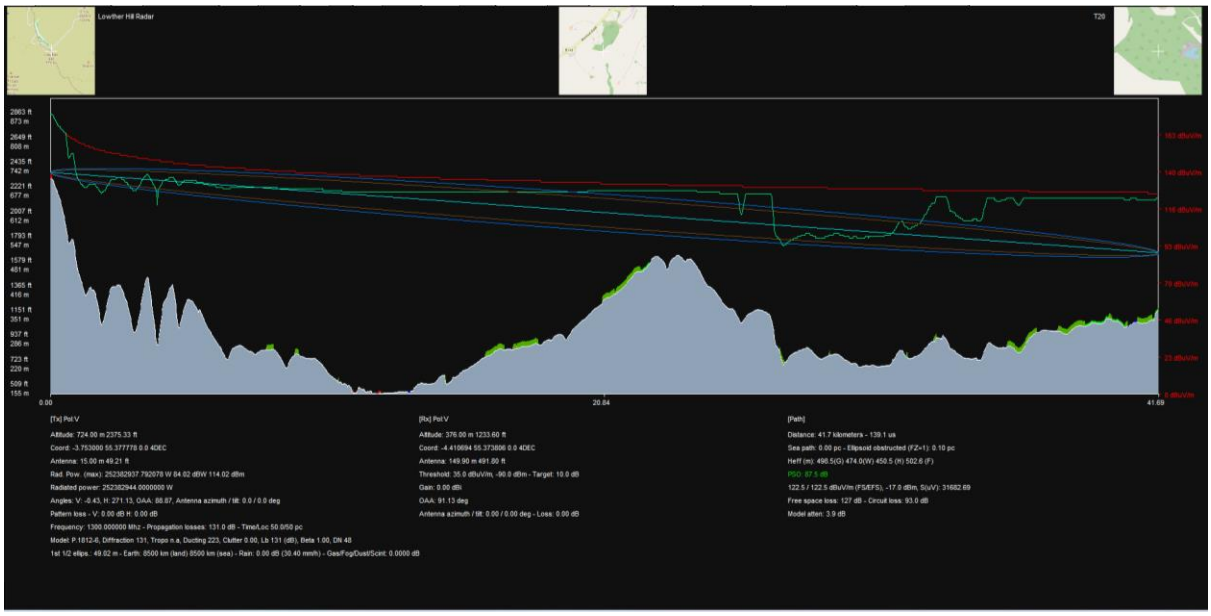



Figure 41 - Lowther Hill Radar LOS Profile to T20

## A1.3 GPA Terma Radar LOS Assessment Profiles for the Development

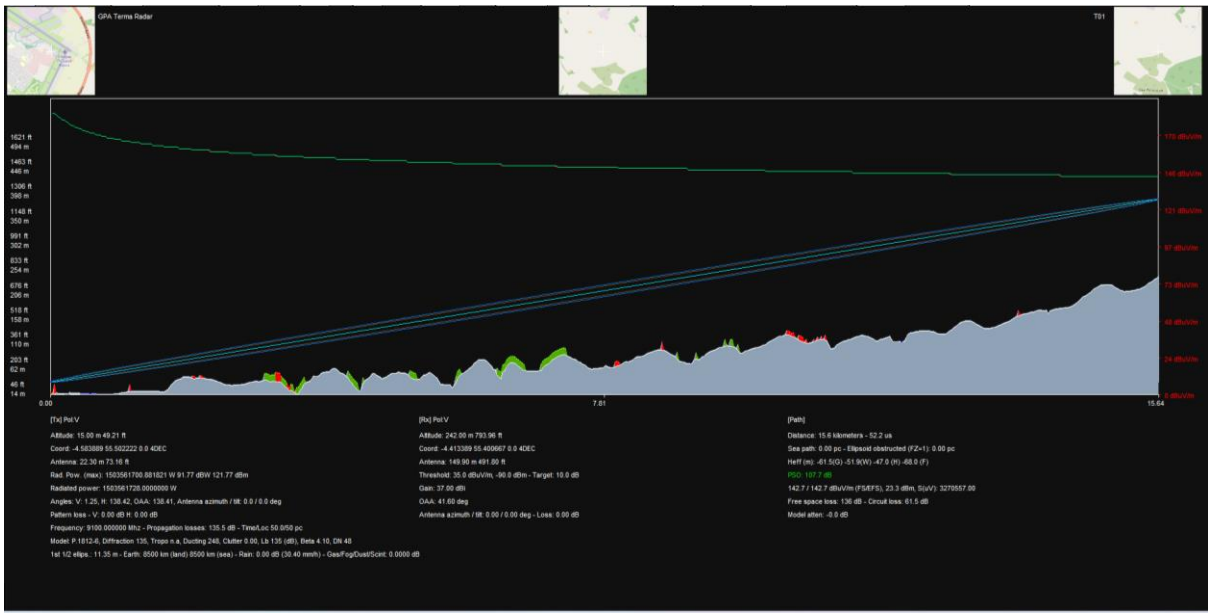



Figure 42 – GPA Terma Radar LOS Profile to T01

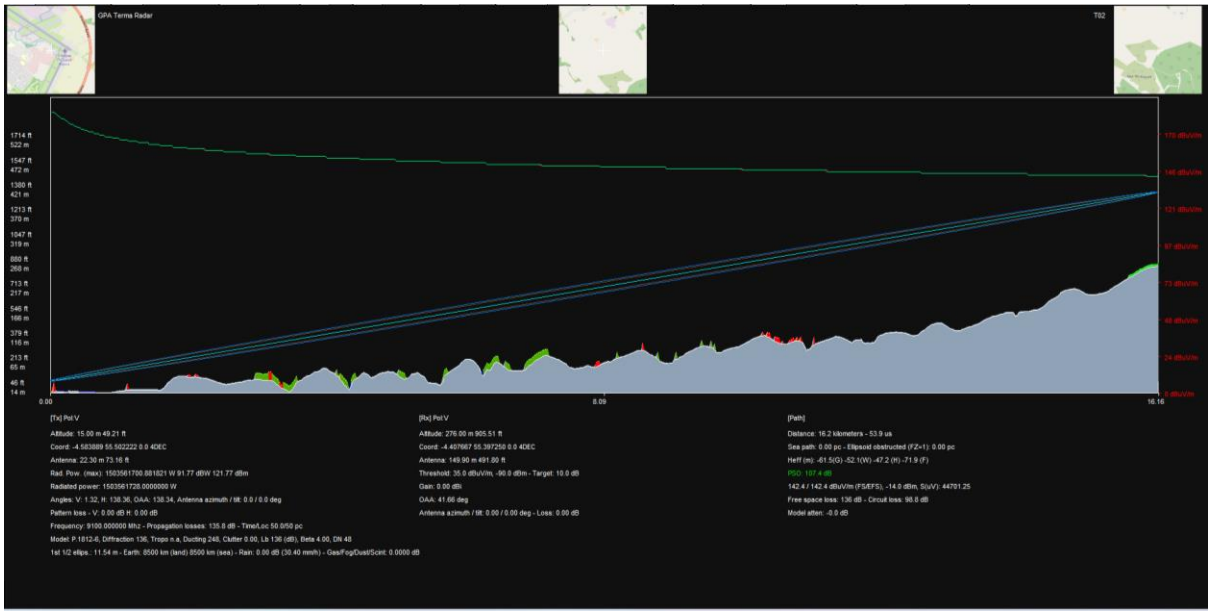



Figure 43 - GPA Terma Radar LOS Profile to T02

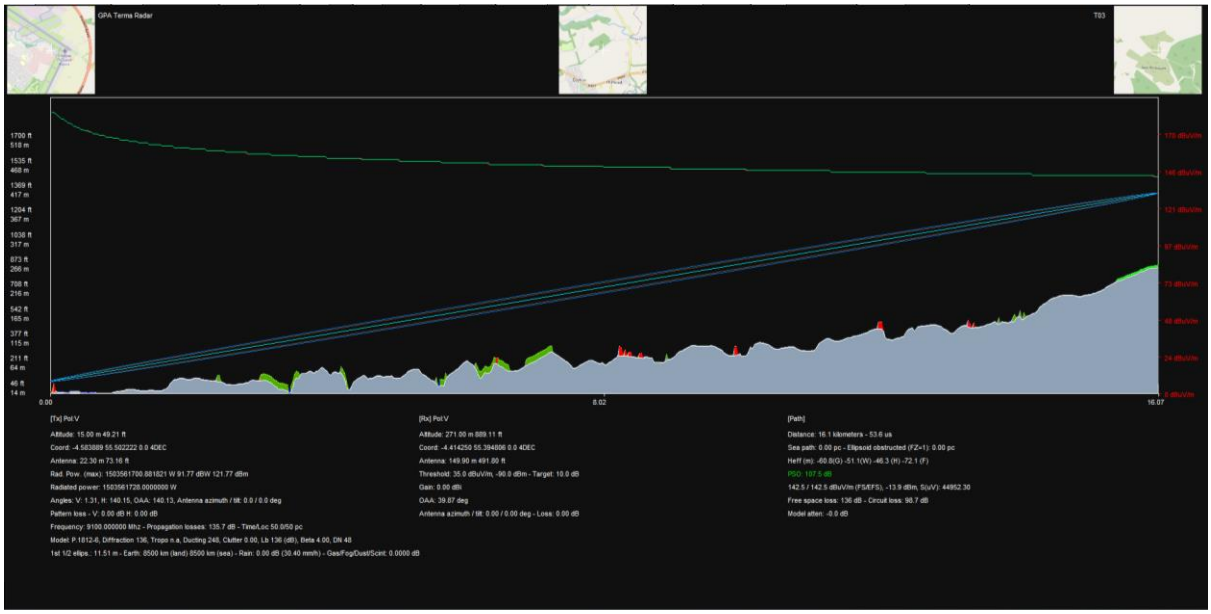



Figure 44 - GPA Terma Radar LOS Profile to T03

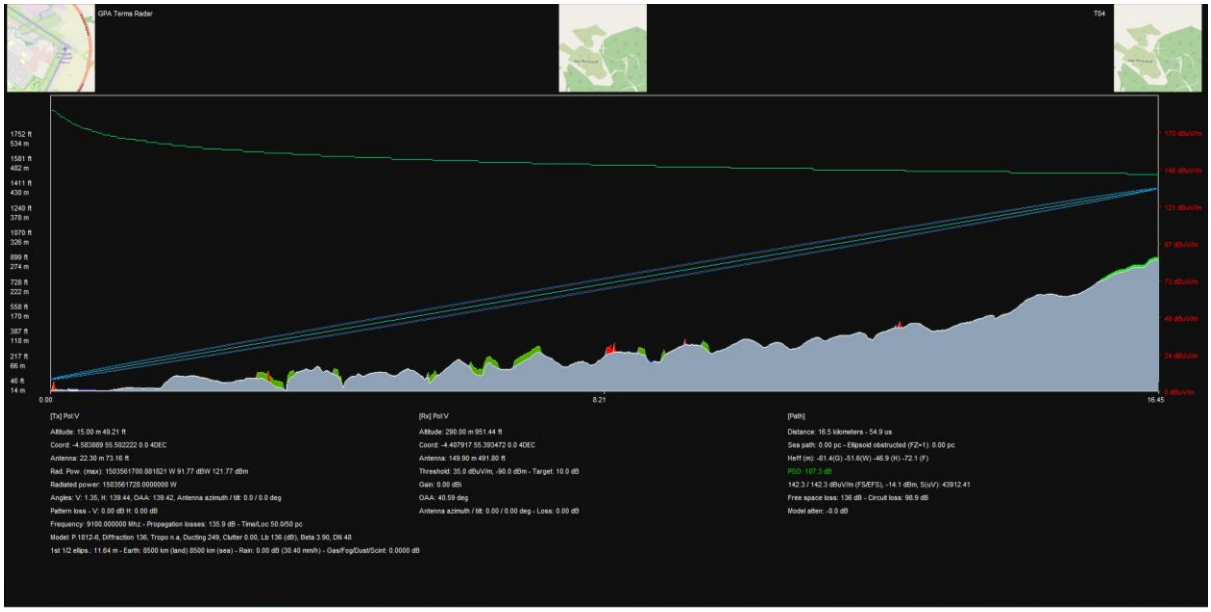



Figure 45 - GPA Terma Radar LOS Profile to T04

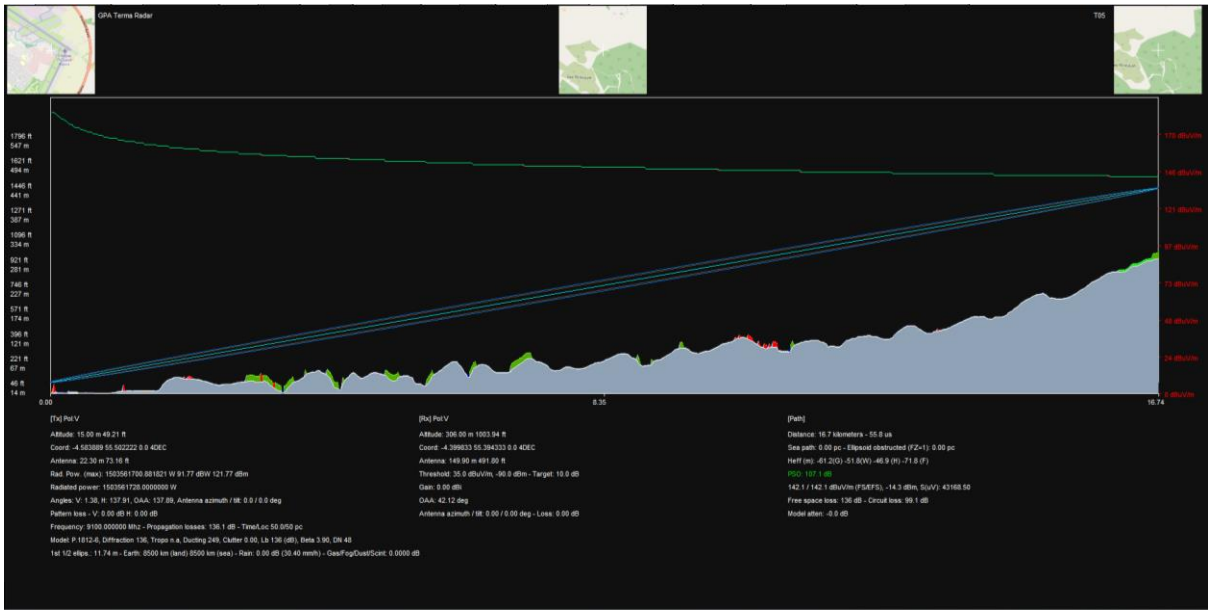



Figure 46 - GPA Terma Radar LOS Profile to T05

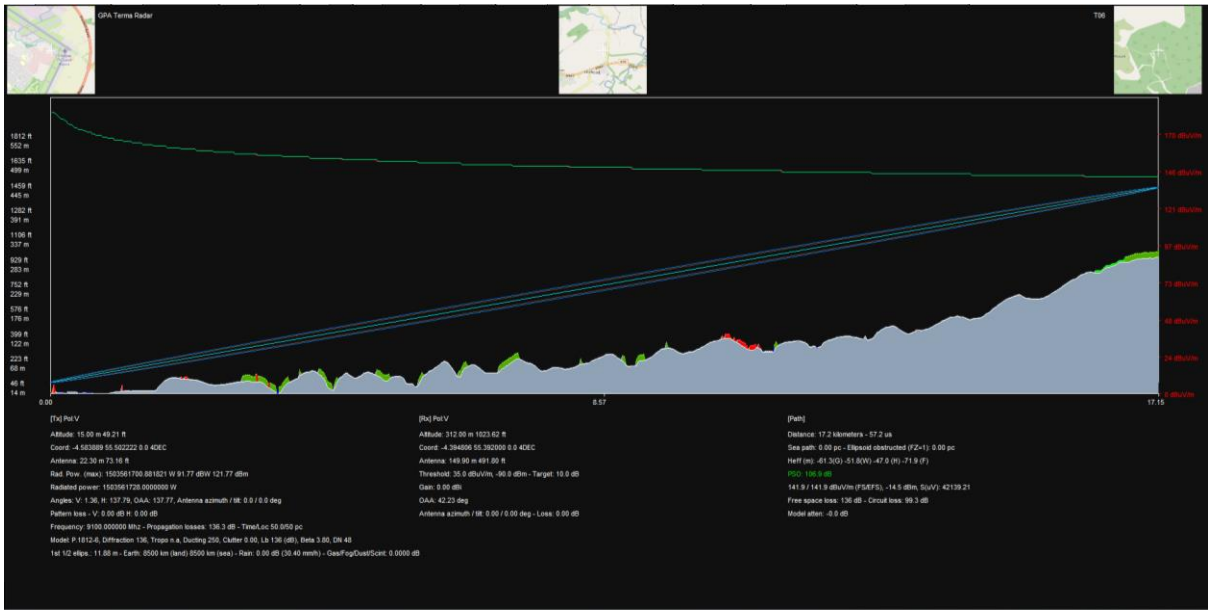



Figure 47 - GPA Terma Radar LOS Profile to T06

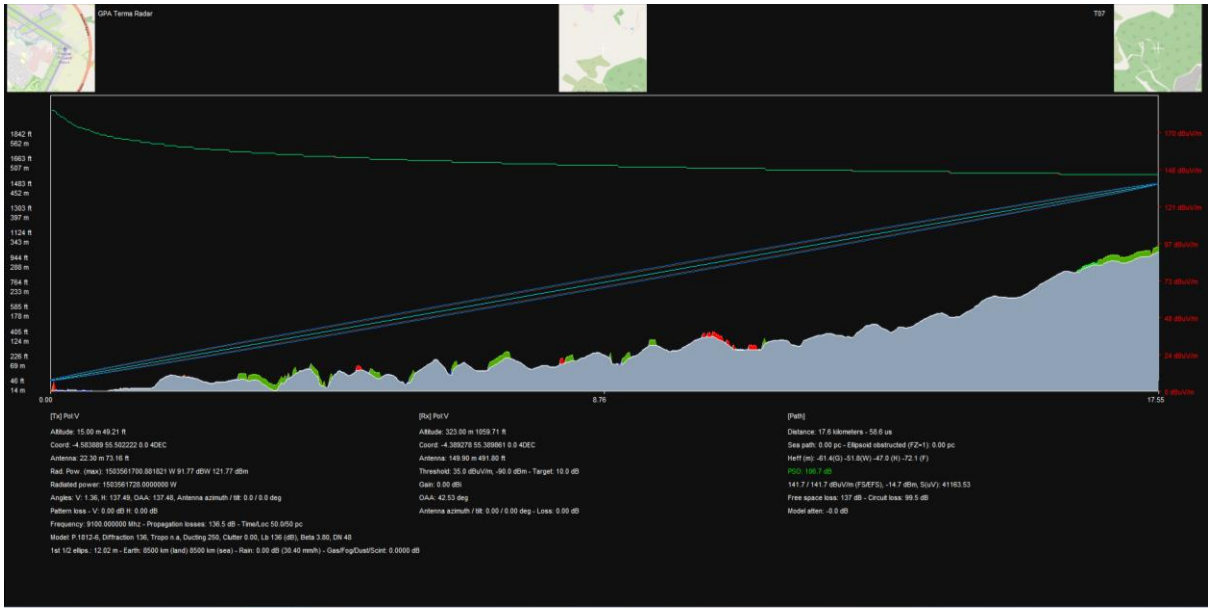



Figure 48 - GPA Terma Radar LOS Profile to T07

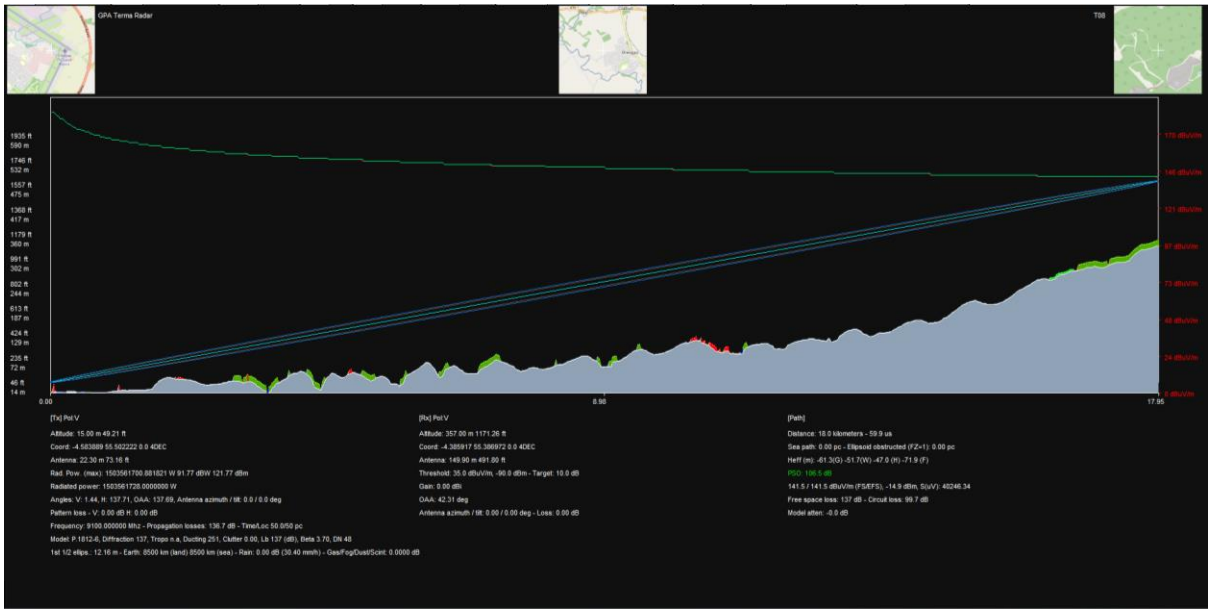



Figure 49 - GPA Terma Radar LOS Profile to T08

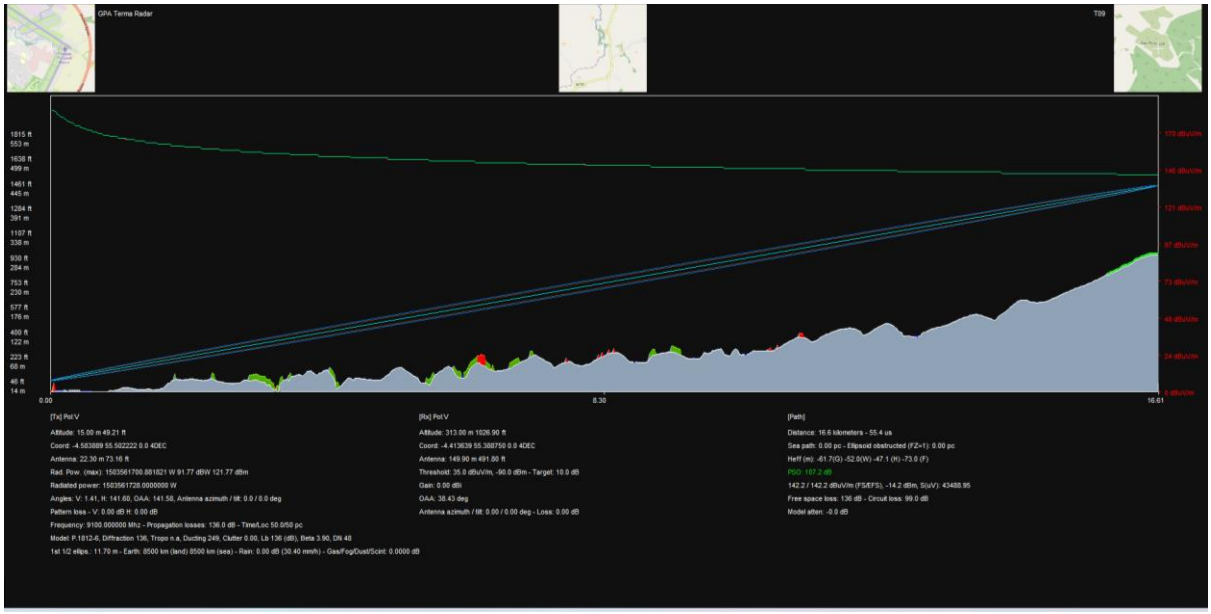



Figure 50 - GPA Terma Radar LOS Profile to T09

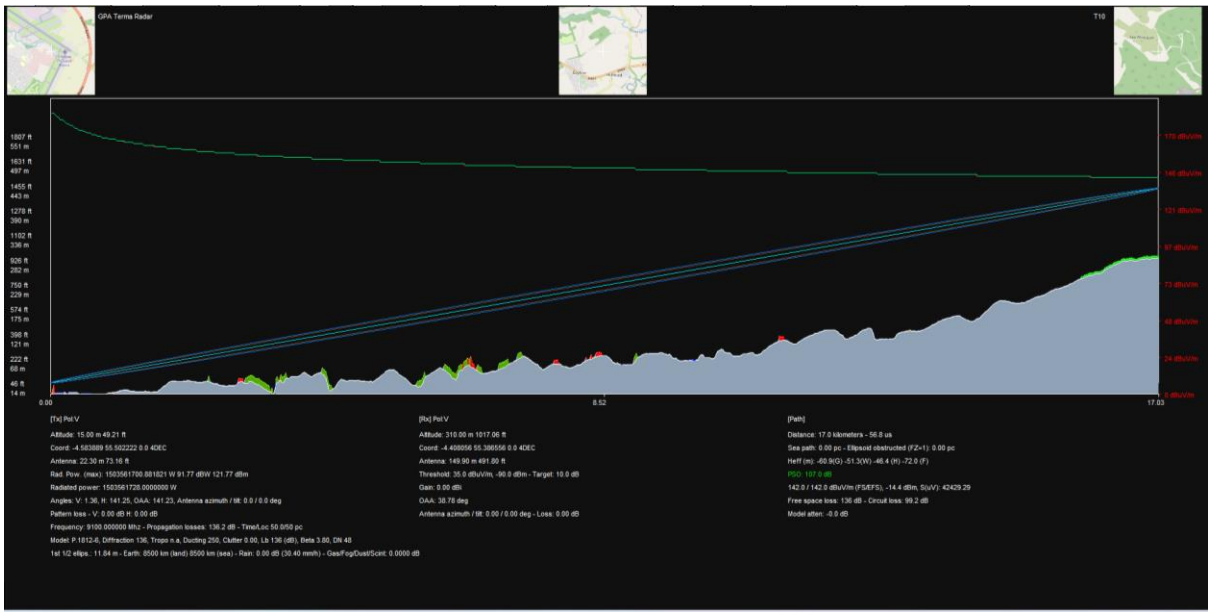



Figure 51 - GPA Terma Radar LOS Profile to T10

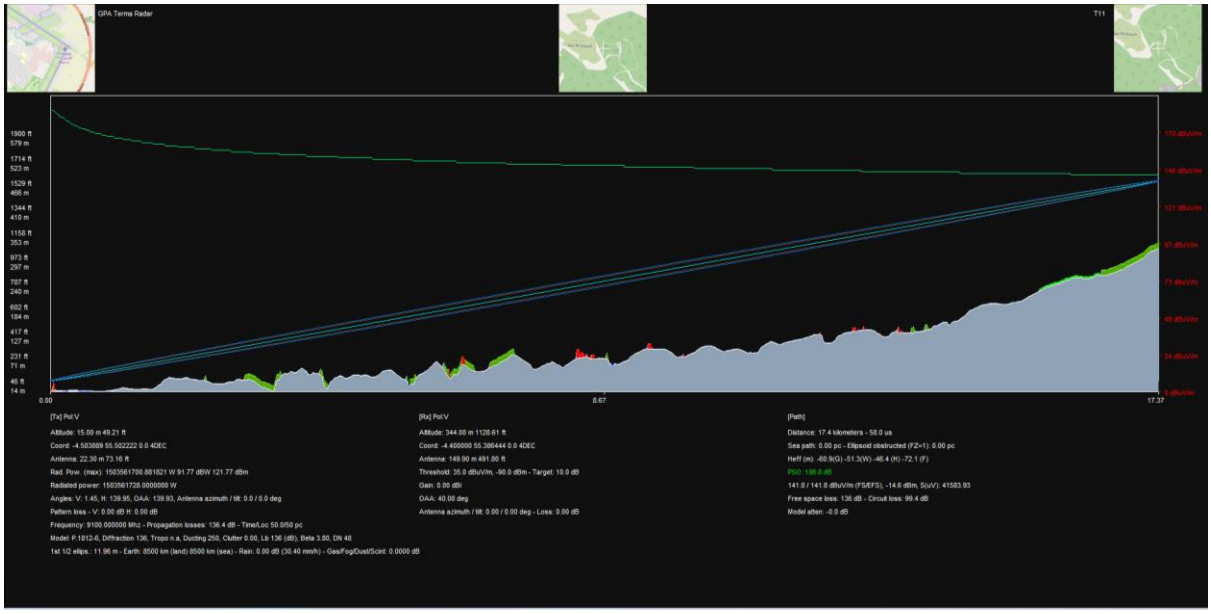



Figure 52 - GPA Terma Radar LOS Profile to T11

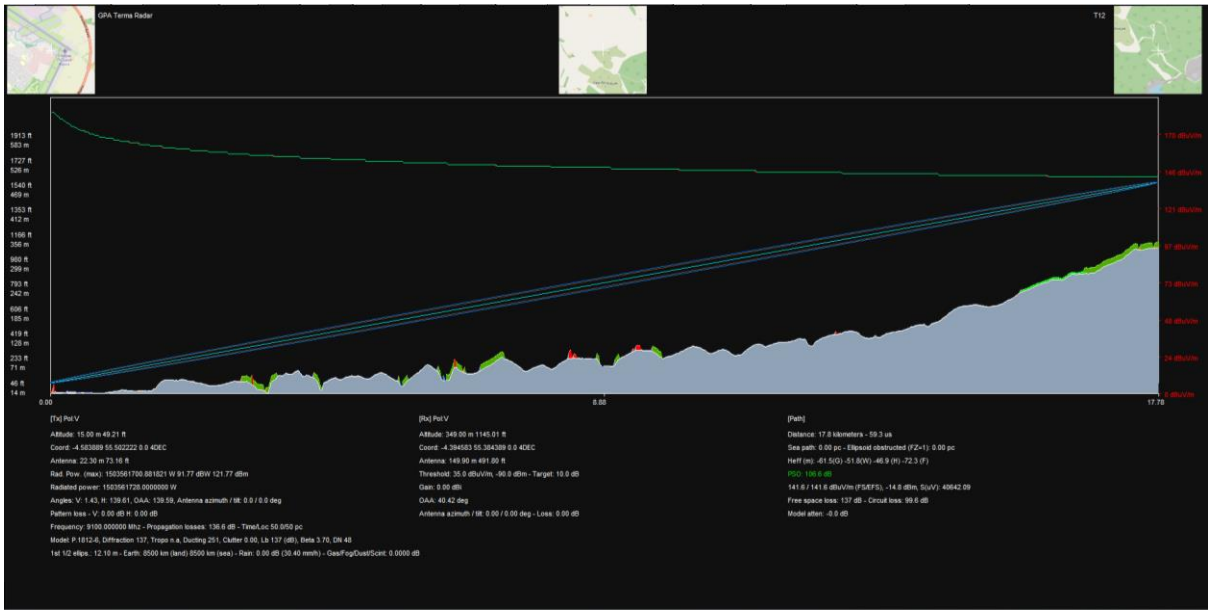



Figure 53 - GPA Terma Radar LOS Profile to T12

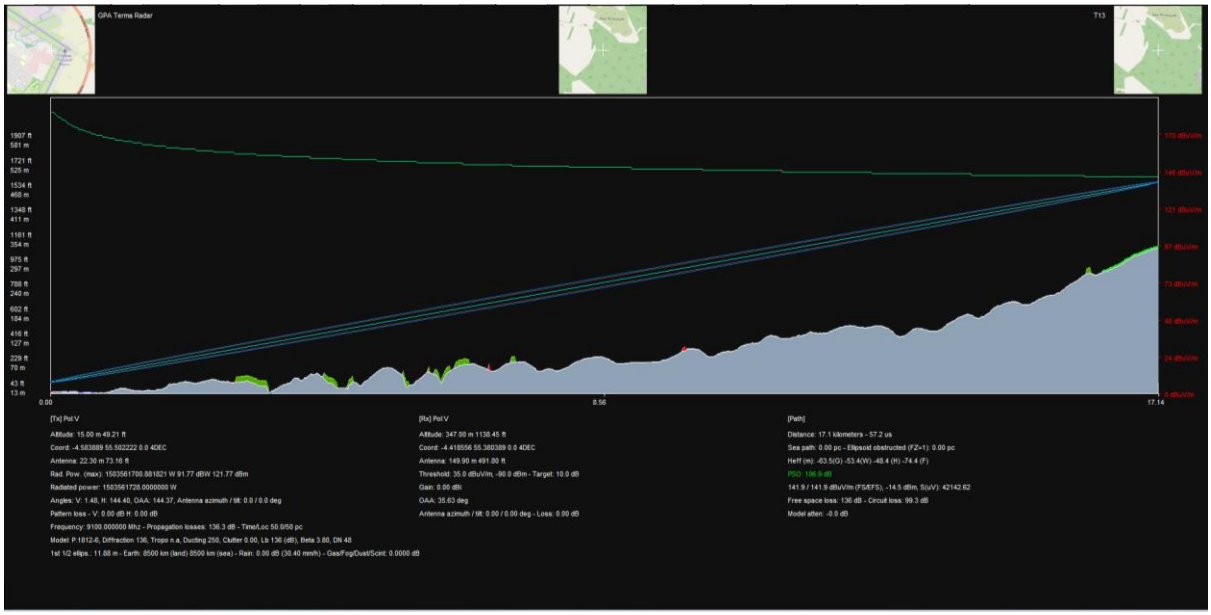



Figure 54 - GPA Terma Radar LOS Profile to T13

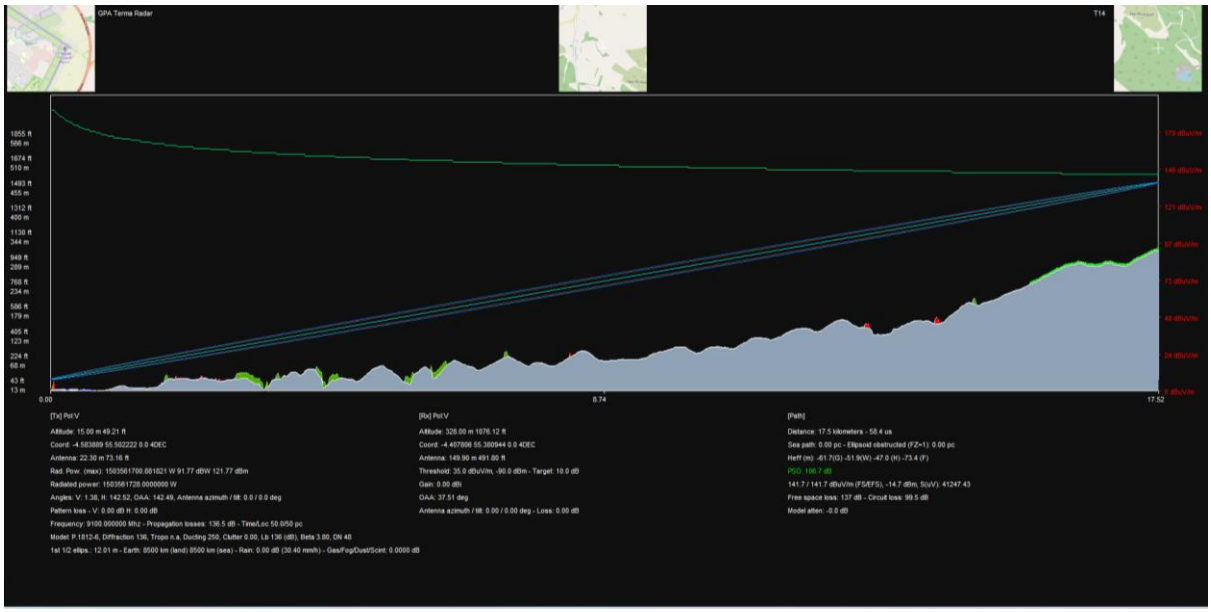



Figure 55 - GPA Terma Radar LOS Profile to T14

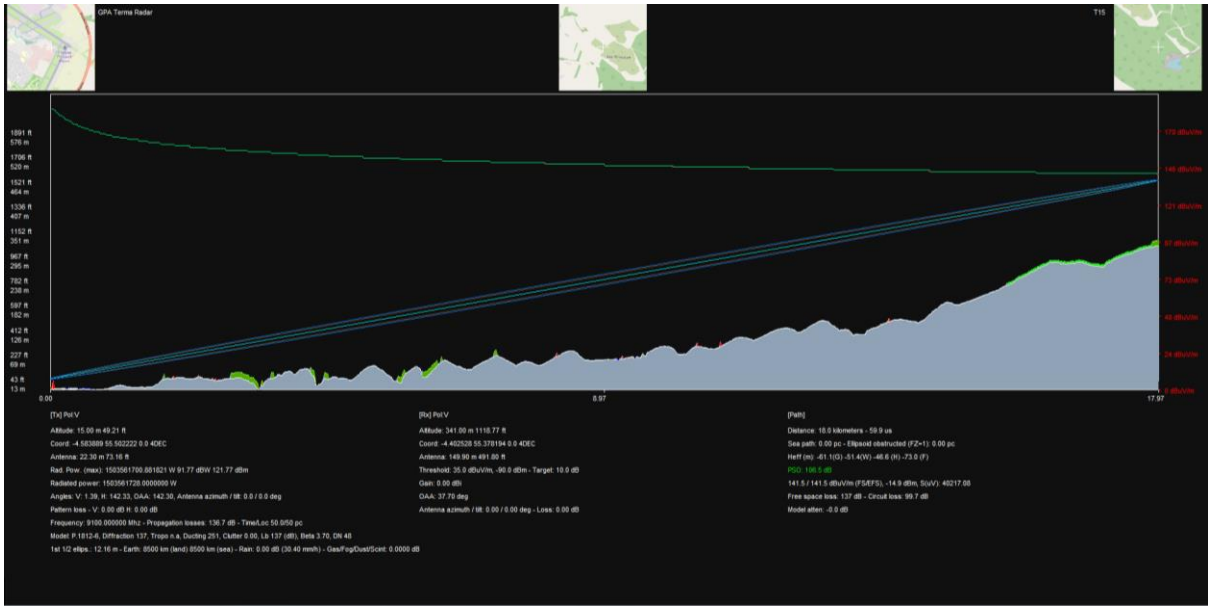



Figure 56 - GPA Terma Radar LOS Profile to T15

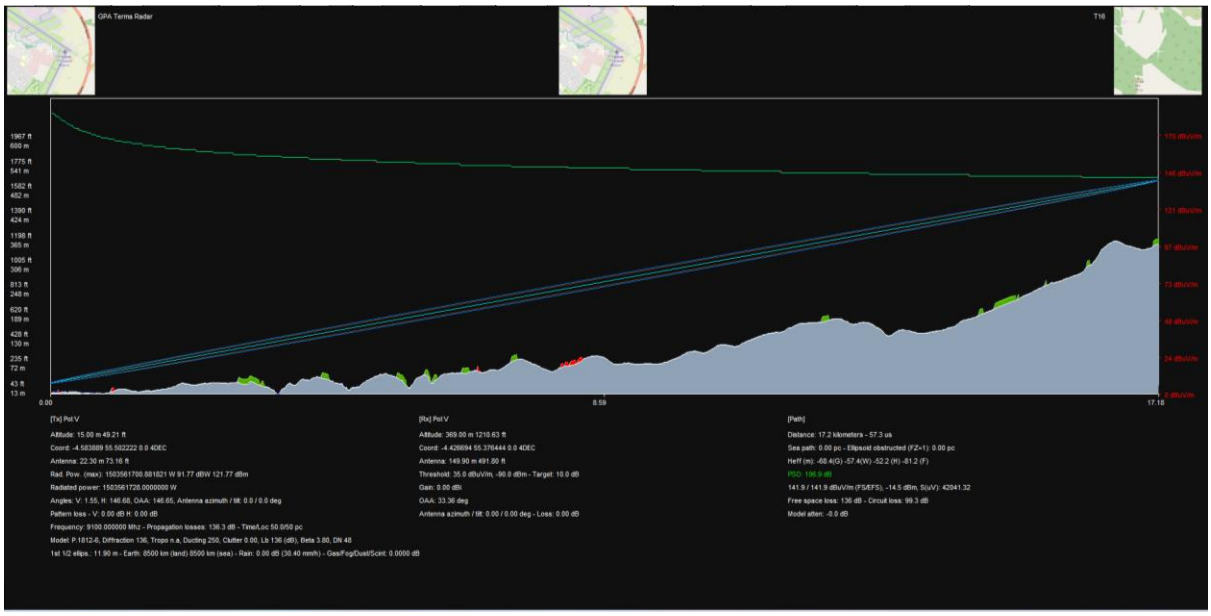



Figure 57 - GPA Terma Radar LOS Profile to T16

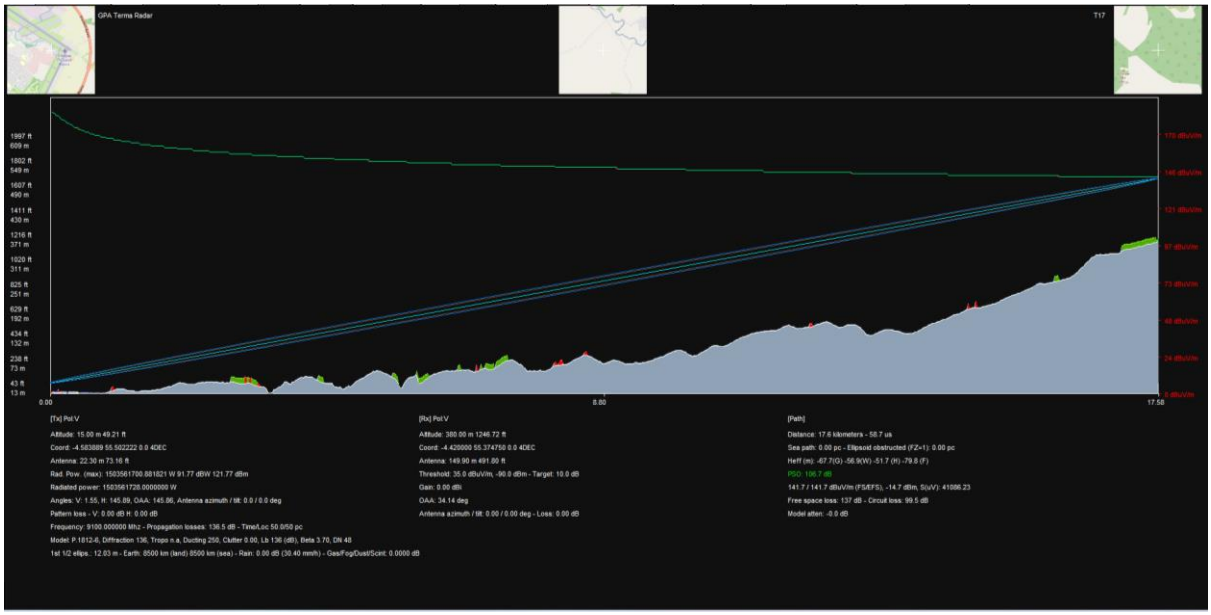



Figure 58 - GPA Terma Radar LOS Profile to T17

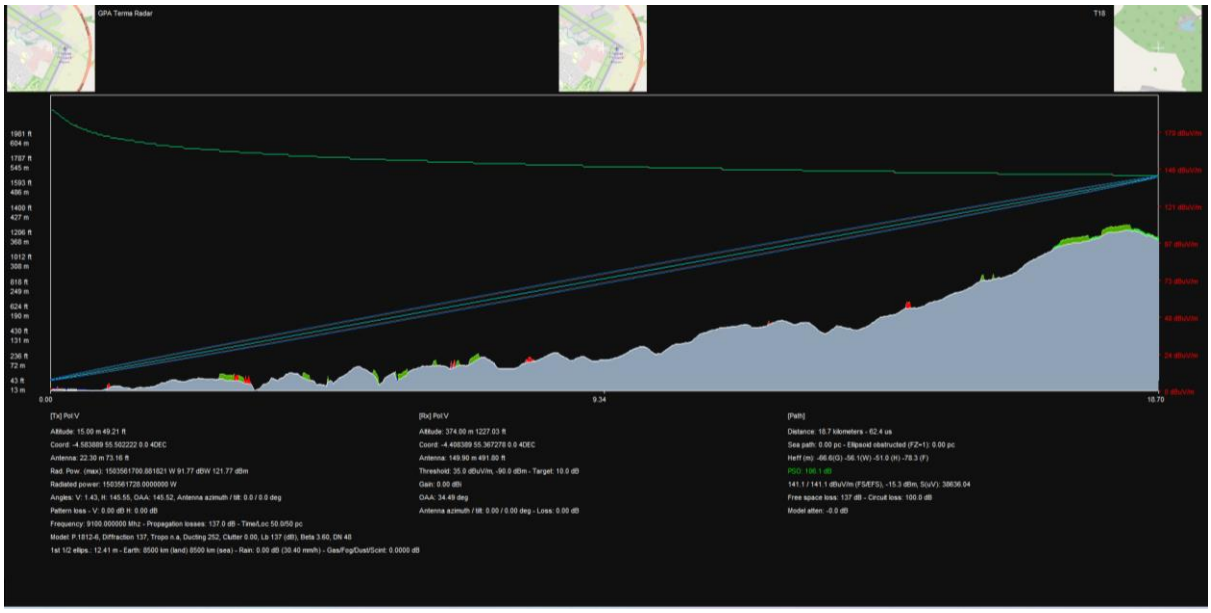



Figure 59 - GPA Terma Radar LOS Profile to T18

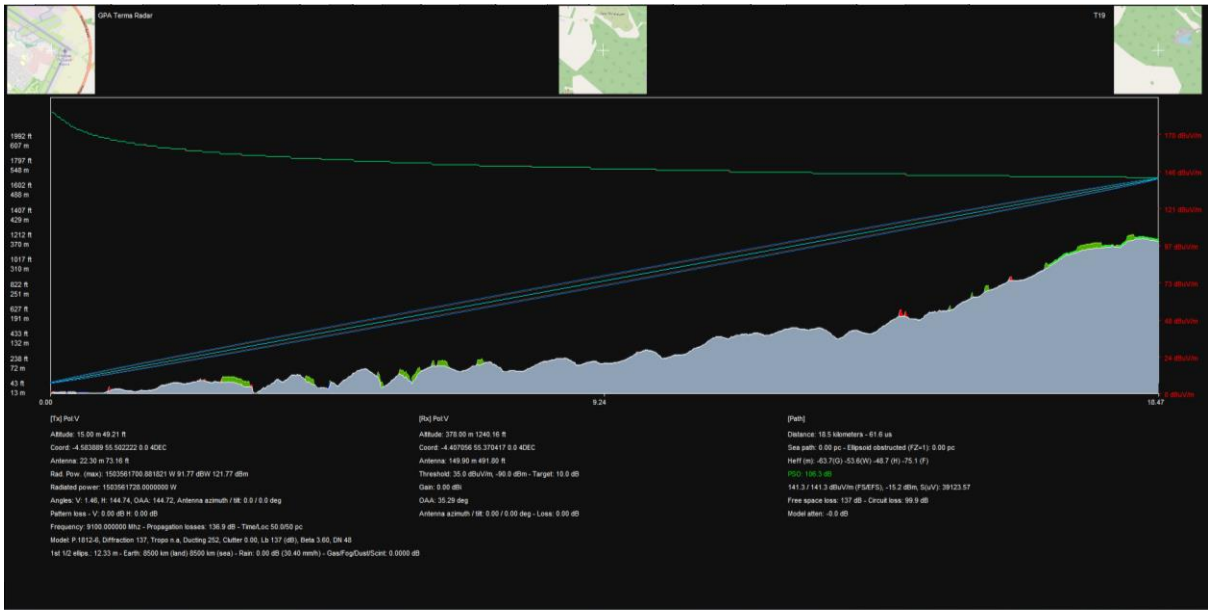



Figure 60 - GPA Terma Radar LOS Profile to T19

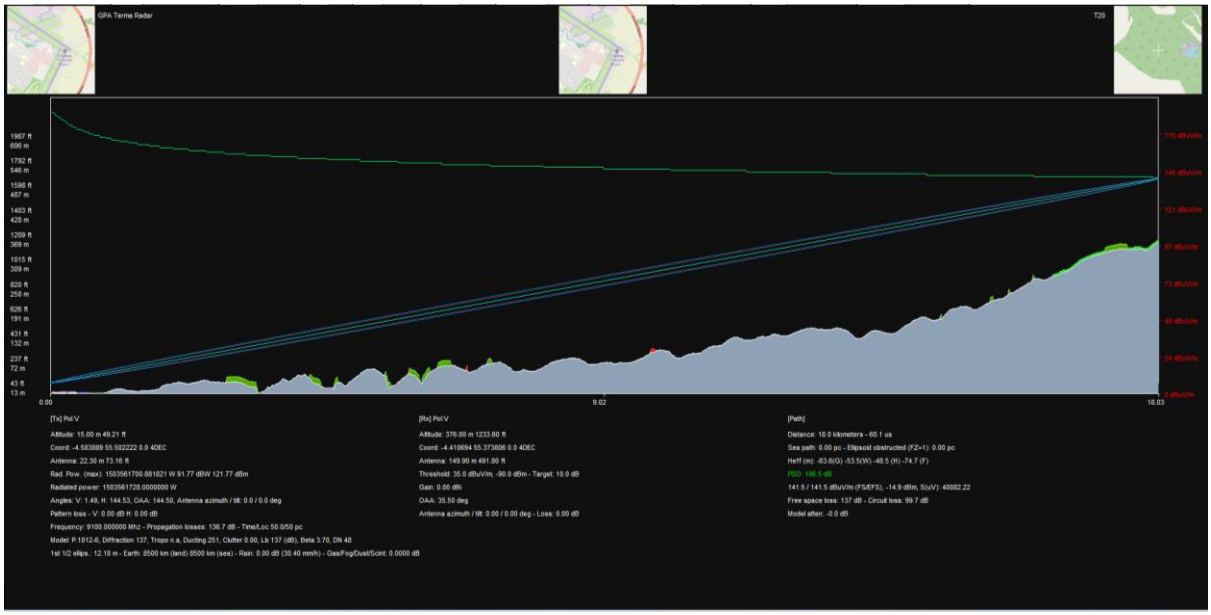



Figure 61 - GPA Terma Radar LOS Profile to T20