FaB Test

Falmouth Bay Test Site
Marine Renewables Commissioning Site

Description of Site Characteristics and Eligible Test Installations

FHC / FT / 104

Falmouth Harbour Commissioners

UNIVERSITY OF EXETER

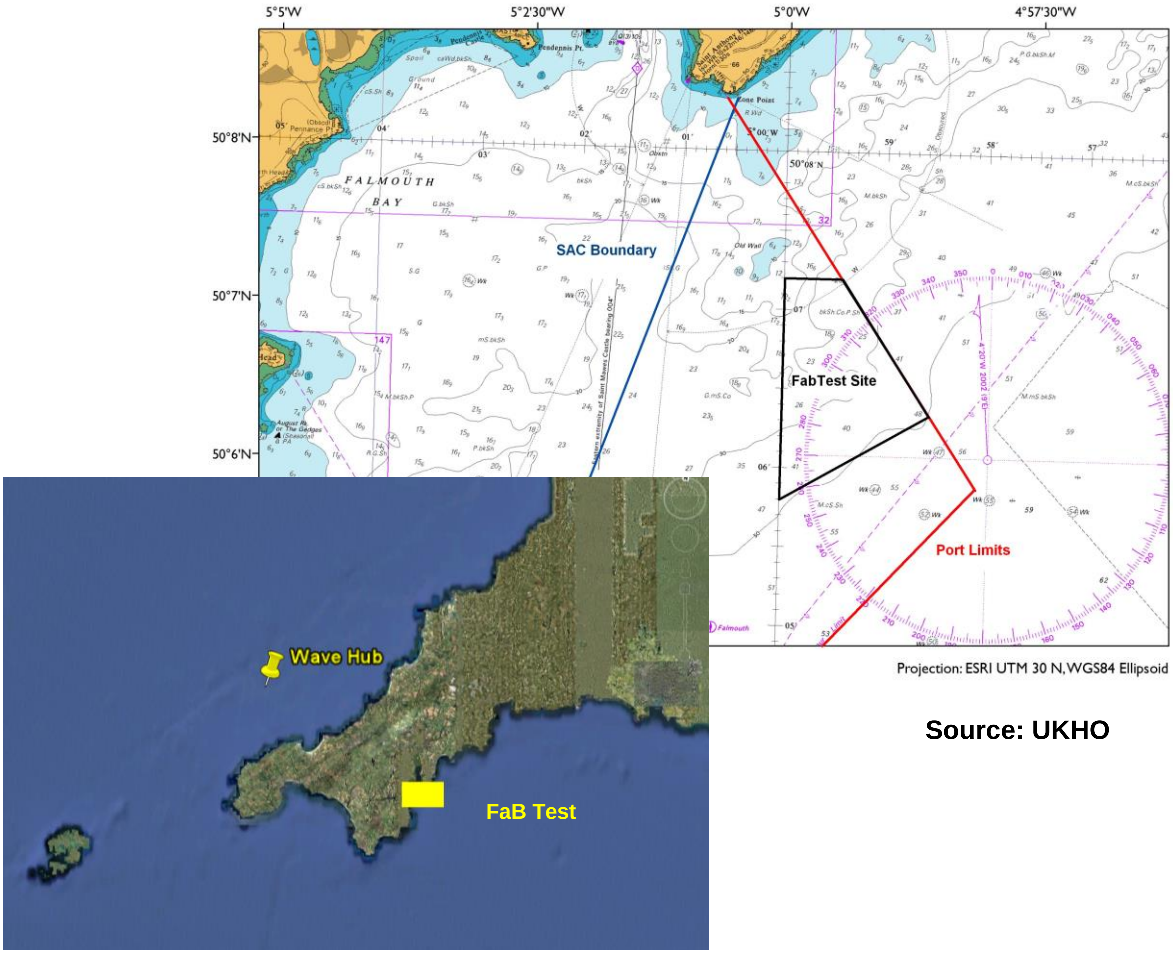
Document Control Register

Issue	Amendment	By	Date
1	Original release	DNP	30/11/2011
2	Figure 3 and accompanying text amended	DNP	07/02/2012
3	2016 update, with new figures and updated text.	JPH	5/2016

Contents

1. Location

The FaBTest site is located in Falmouth Bay some 4.5 km from Falmouth Harbour Entrance. Falmouth lies on the south coast of Cornwall in SW England and is reputed to be the world's 3rd largest deep water port.



Source: UKHO

Figure 1: FaB Test location **Source: Google Earth**

The test site location not only provides the advantages of very close port facilities but also benefits from being in the lea of the Lizard Peninsula during the prevailing south westerly conditions.

2. Wave Climate

The wave climate at the test site has been measured with a Oceanor Seawatch Mini II wave buoy deployed at the South West corner of the site from March 2012, this was joined by a Datawell Waverider Mk3 buoy in December 2014. In addition to the buoy, wave data has been modelled, the model is a hindcast running from March 2000 to November 2008 constructed using SWAN, a near shore wave modelling software with input data provided by the 2nd generation spectral wave model run by the UK Met Office.

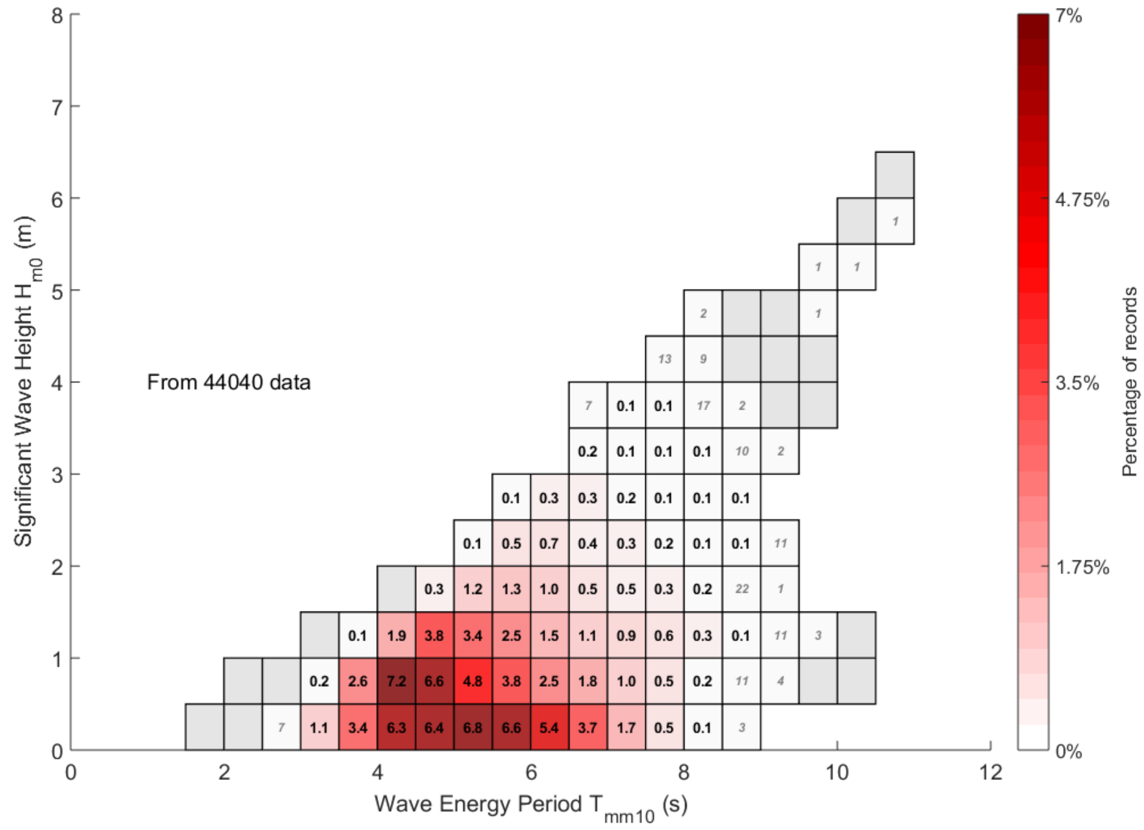


Figure 2: HT scatter diagram for in-situ data from the Seawatch Mini II wave buoy

Figure 2 presents the hindcast output data for a position within the site having a 45m depth (below chart datum). Table 1 gives statistically derived 'Return Period' significant wave heights for the same 45m position. The return period results are extrapolated from the data assuming a Gumbel distribution and using a least squares best fit straight line. Importantly though, a reasonable straight line fit is only achieved by disregarding data where H_{m0} < 1m (local wind waves). Extrapolation is performed on both the full data set and May - Sept incl.

Table 1: Return values for Significant Wave Height (H_{m0}) and Maximum Wave Height (H_{max}) at the FaBTest 45m location

Return Period	H_{m0} with data extrapolated from wave buoy measurements.	H_{m0} with data extrapolated from SWAN hindcast model.	H_{m0} with data extrapolated from wave buoy measurements taken in summer (May – Sept incl.).	H_{m0} with data extrapolated from SWAN hindcast model in summer (May – Sept incl.).	H_{max} with data extrapolated from wave buoy measurements..	H_{max} with data extrapolated from wave buoy measurements taken in summer (May – Sept incl.).
1 in 1yr	5.24	5.56	3.92	3.75	8.42	6.25
1 in 10yr	6.34	6.7	4.73	4.50	10.22	7.55
1 in 25yr	6.78	7.15	5.05	4.81	10.95	8.07
1 in 100yr	7.45	7.85	5.56	5.27	12.02	8.85

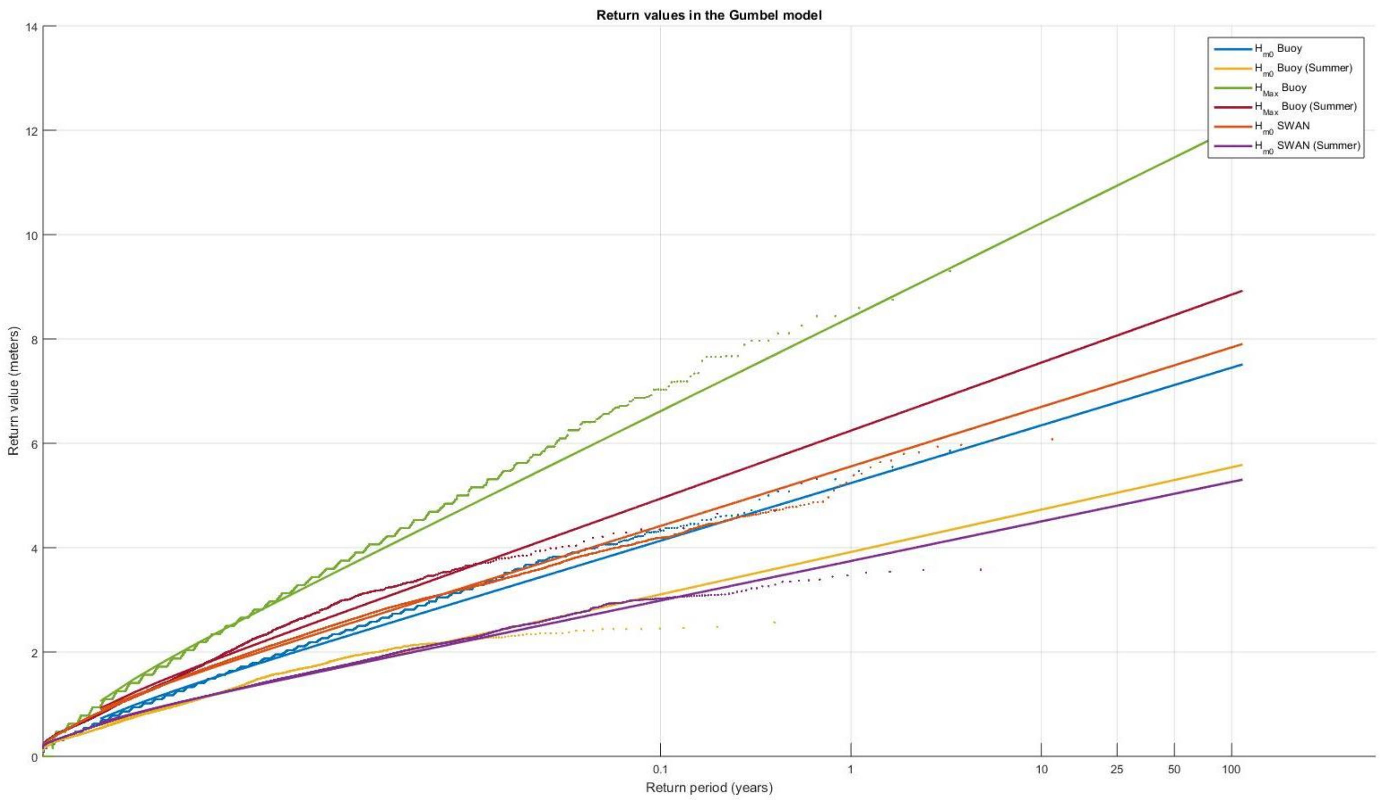


Figure 3 – Return values for extreme waves calculated using a Gumbel distribution.

The direction of extreme waves for the 45m position is shown in Figure 3. The significant wave height (Hs) and direction data from the hindcast are plotted as vectors with Hs given as the magnitude. It is clear that all major storm events at the site result in waves travelling towards a direction between compass bearings of 280°T and 010°T.

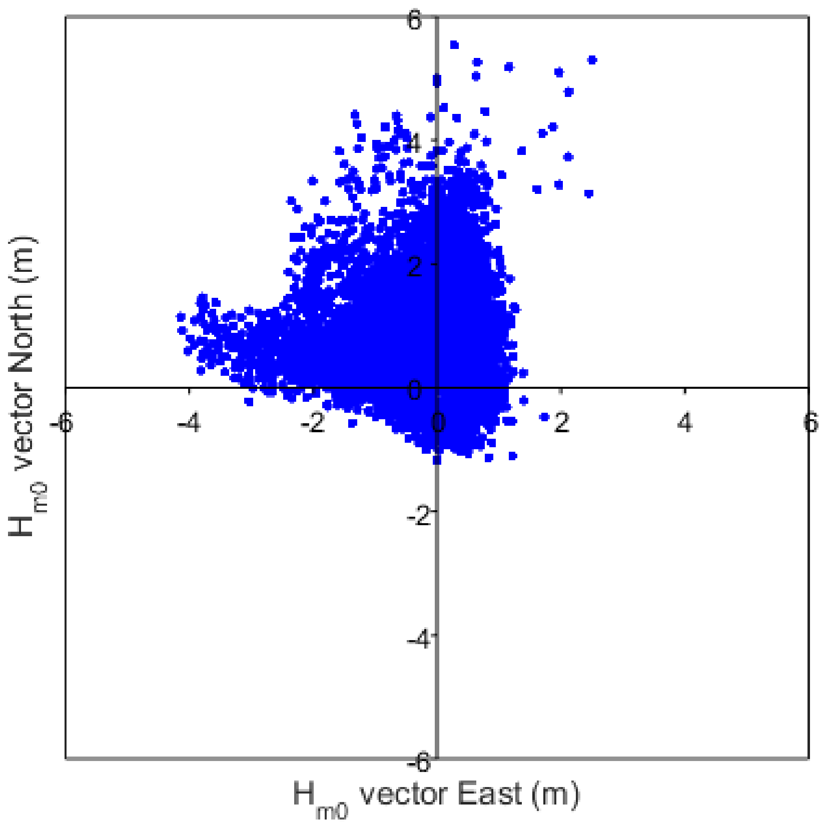


Figure 3: Wave directions and magnitudes from the Seawatch Mini II wave buoy.

3. Tidal Conditions

ADCP (Acoustic Doppler Current Profilers) have been deployed on the site to measure the current velocity throughout the water column, the data presented here is from a 100 day long deployment form January 17th – April 24th 2016. The maximum current at the surface was measured as 1.39ms^{-1} during the deployment.

The magnitude of the depth averaged current velocity along with the surface current velocity are shown as a time series in Figure 4 and the depth averaged current is shown in vector form in Figure 5.

The tide height for the same period is shown as a time series in Figure 6.

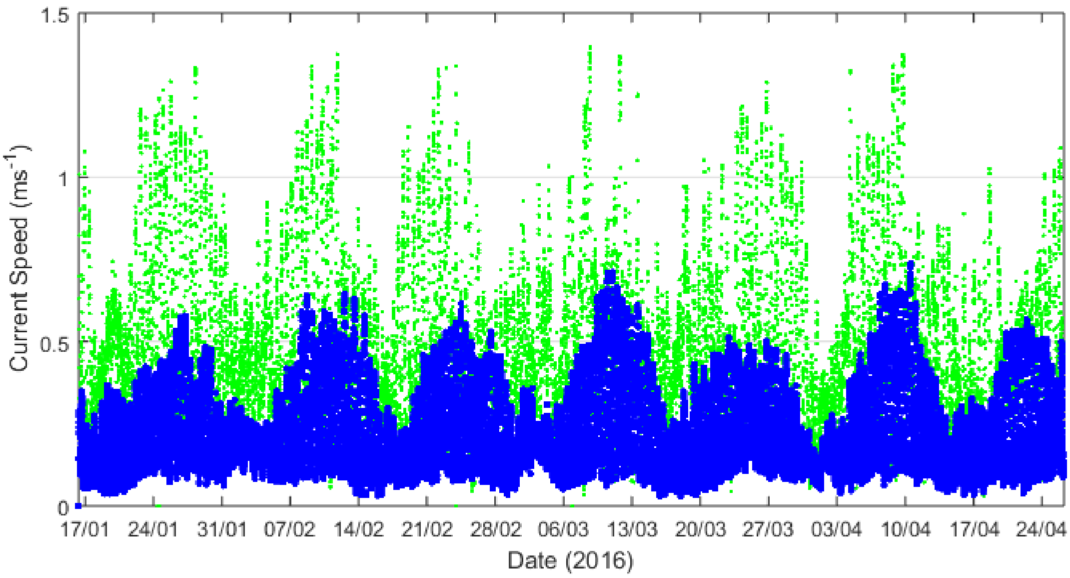


Figure 4: Depth averaged (blue) and surface (green) tidal currents at 35m depth on the Eastern side of the site recorded with an ADCP.

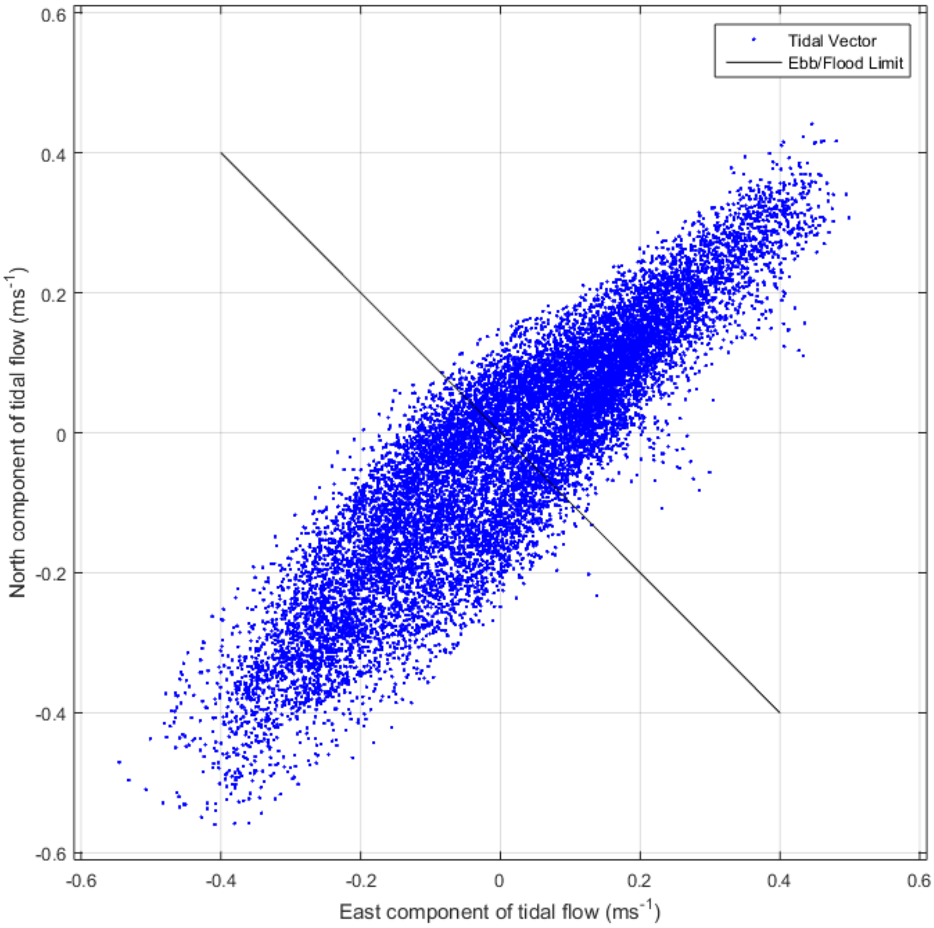


Figure 5: Depth averaged tidal current vectors at 35m depth on the Eastern side of the site recorded with an ADCP.

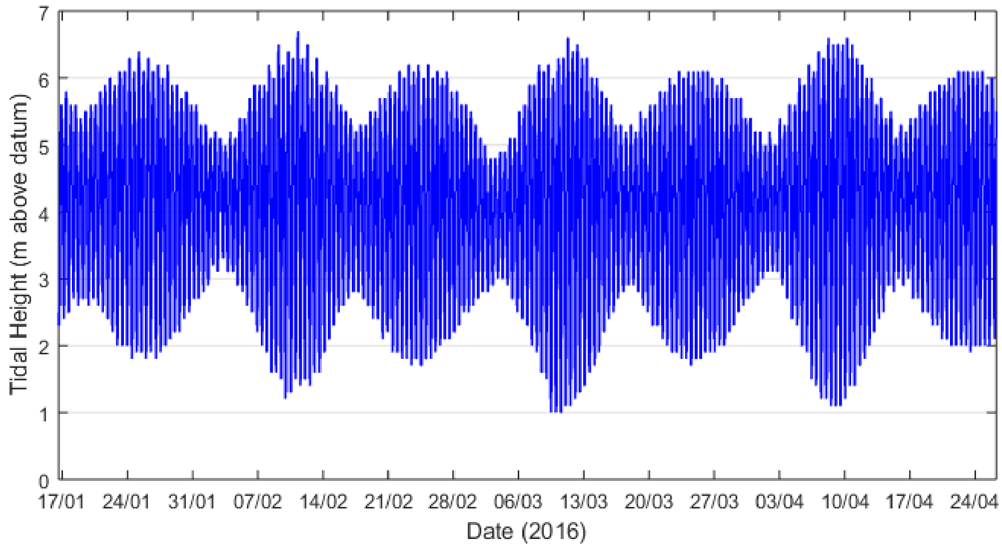


Figure 6: Tide range at 35m depth on the Eastern side of the site recorded with an ADCP.

4. Bathymetry / Bottom Type

The test site encompasses water depths (above chart datum) of between 15m and 50m. The MCZ Project describes four distinct bottom types which are as follows:

1. Rock
2. Maerl gravel
3. Subtidal sand gravels
4. Subtidal sand / mud

Source: Defra, Natural England & JNCC via website http://www.mczmapping.org/#

A condition of the Marine Licence issued by the Marine Management Organisation discourages the deposit of mooring equipment within the maerl gravel bed (zone 2).

The four bottom type zones are shown in Figure 7 together with isobaths from 15m to 55m in 5m increments.

It should be noted that whilst observations of the seabed within the site generally validate the information given by the MCZ Project, there are instances where inconsistencies occur. Therefore it may be wise that a detailed seabed / sub-bottom survey of the elected position be undertaken, providing for example, information on sediment depth, small rocky outcrops, fine resolution bathymetry etc.

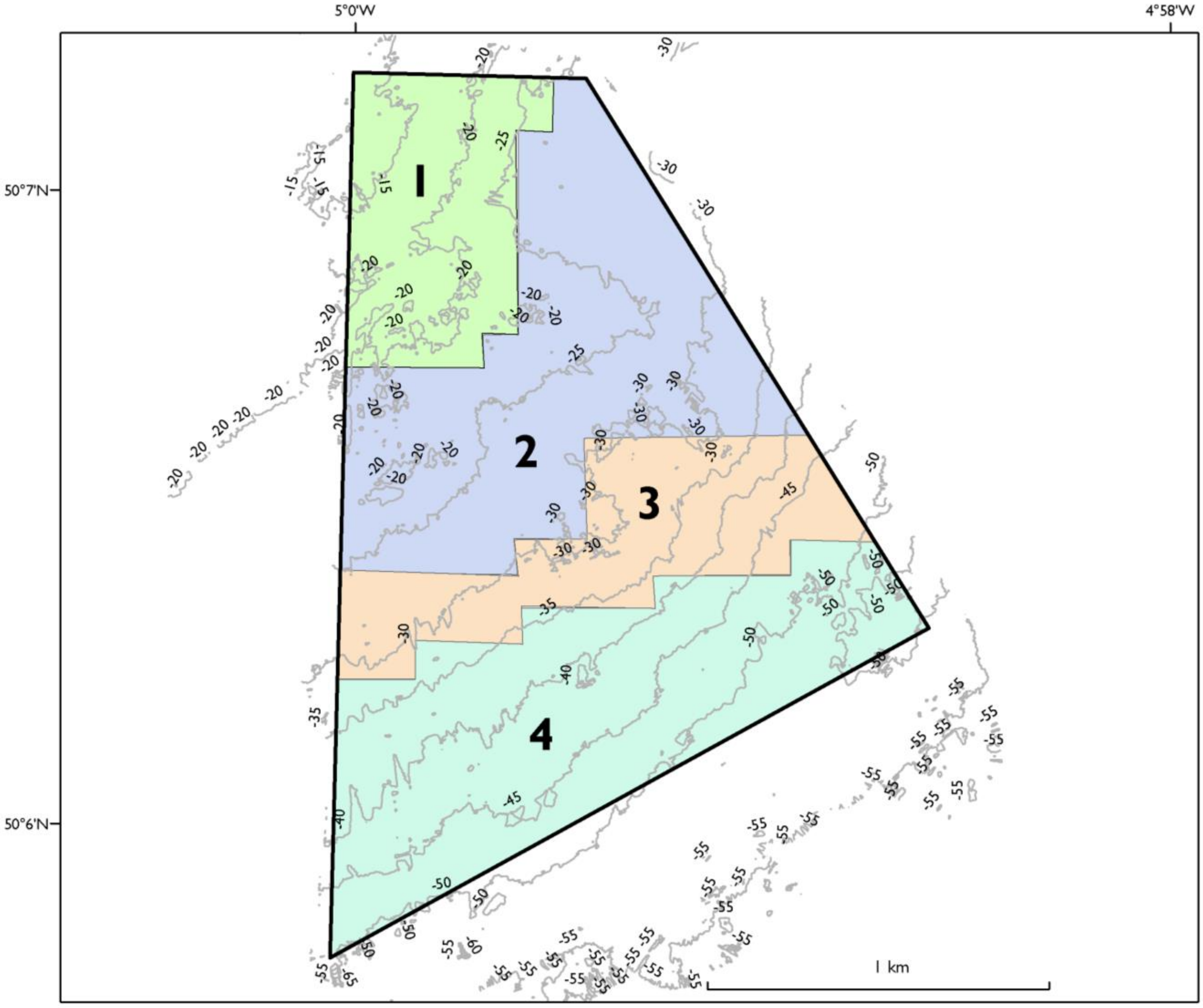


Figure 7: The test site showing bottom type zones and isobaths

5. Eligible Devices

The Marine Licence issued to FHC by the MMO together with the terms of the seabed lease between FHC and The Crown Estate defines the installations that are eligible for deployment at the test site. These are described as buoyant or semi-buoyant experimental marine energy convertors (MECs) including those utilising energy from waves and those utilising energy from marine currents. No single device is permitted to have a potential generating output in excess of 3MW. Buoyant devices designed to extract energy from the wind, are currently not eligible for deployment at the site. Sub-systems of eligible devices are also eligible for deployment without the necessity to deploy the full device e.g. a device's mooring system or umbilical may be deployed from a standard vessel / barge, substituting for the full device. No device is permitted to introduce an unguarded (in respect of marine mammals) open water turbine.

Eligible devices are further described by shape and size as follows:

- A substantially buoy shape device
- A substantially box shape device
- A platform type device
- A substantially tubular shaped device

The allowable size of an eligible device is variable but indicative maximum sizes are given as:

- 30 m diameter for a buoy form
- 30 m x 30 m (or equivalent area in plan) for a box form
- 35 m x 35 m (or equivalent area in plan) for a platform
- 180 m long for a tubular form.

6. Eligible Seabed Anchors / Mooring Systems

Seabed anchors will be drag embedment or gravity anchors. Gravity anchors will be of steel, iron or concrete construction. Any loose ballast included within a gravity anchor (e.g. sand gravel etc) will be sealed so that no exchange with seawater is possible. Piled, rock bolted and suction anchors are not permitted at the test site. The indicative maximum number of mooring limbs for a box shaped device is twelve.

7. Communications

Whilst data and command communications are possible via dedicated telemetry links to Falmouth and via satellite, it is notable that good UMTS (3G) and LTE (4G) services with HSDPA / HSUPA are available at the test site. A survey of the site using a spectrum analyser showed that all four service providers EE, Three, O2 and Vodafone had good 3G signal strength, EE also had 4G coverage available on the site. Figure 8 shows a typical scan trace showing received signal strengths (isotropic antenna) of useable 3G frequencies. Figure 9 shows a wider scan of the spectrum identifying the 4G signal from EE. Table 2 summarises the scan results.

Table 2: Summary of 3G and 4G scan receive signal strengths

Downlink Frequency (MHz)	Service Provider	Signal strength (dBm)
2110 - 2125	Three 3G	- 50.4 / - 52.3 / -52.5
2125 - 2135	O2 3G	-54.7 / -57.2
2135 - 2150	Vodafone 3G	-58.8
2150 - 2170	EE 3G	-50.7 / -53.8 / -54.1
2160 - 2170	EE 4G	-47.6

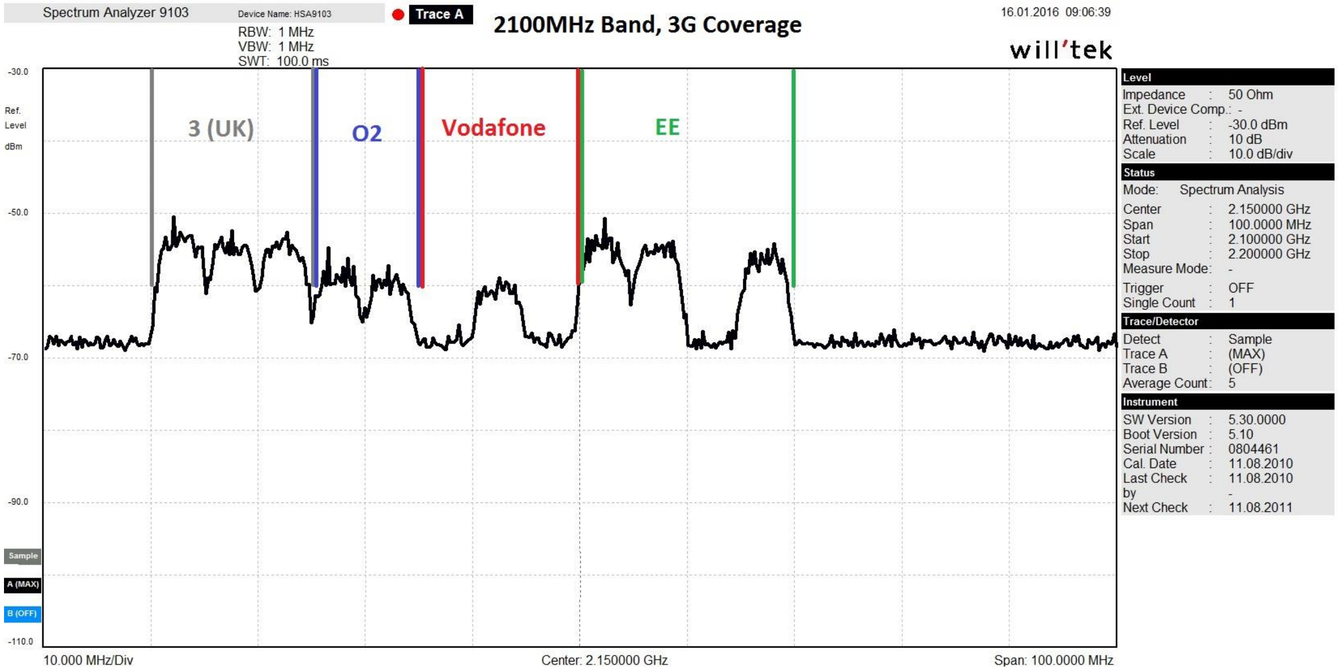


Figure 8: 3G signal scan trace (16/01/2016)

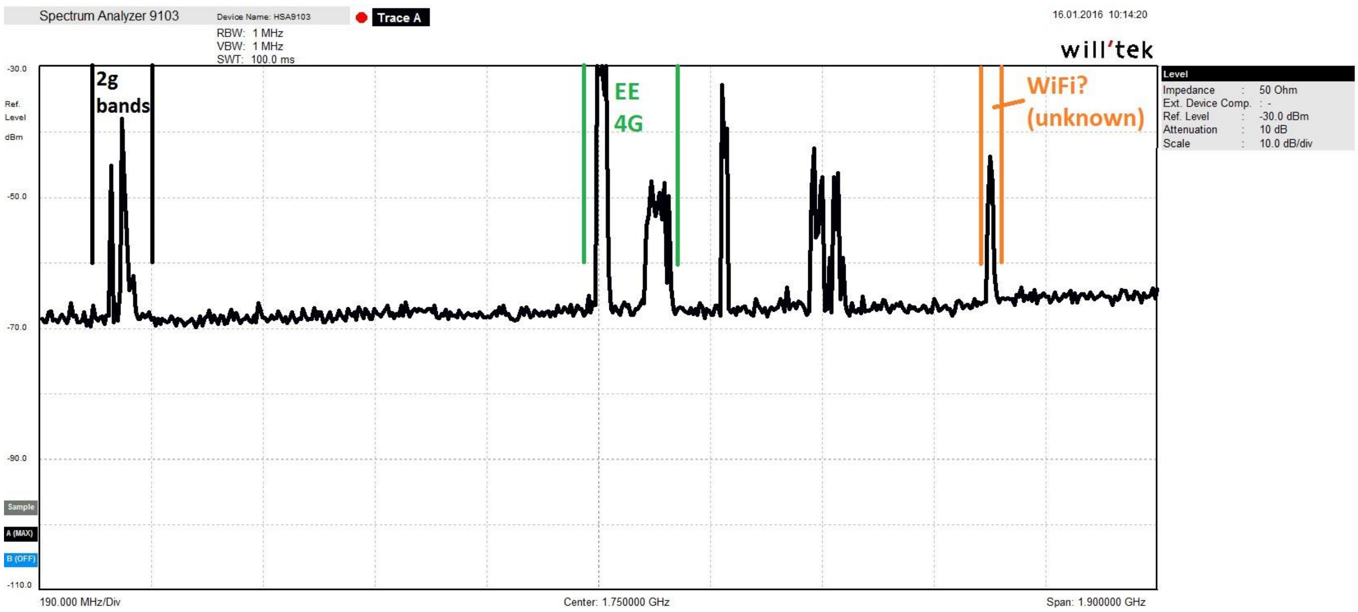


Figure 9: Trace of wider spectrum (16/01/2016)