Dear Marine Management Organization,

I write at the request of the Save Port Isaac Bay Group (SPIBG), who represent a number of concerned residents within the community of North Cornwall, in relation to a marine licence approved under MLA/2022/00180. The licence is for a 100 ha seaweed farm, west of Tregardock beach in Port Isaac Bay, in approximately 20 to 25 m of water. The developers are Penmayn Ltd., Falmouth, Cornwall.

I am writing to you as an experienced wave forecaster.

The SPIBG has asked me to evaluate the existing information provided in the application documents relating to wave data and sea state, and to further evaluate data from other sites, in order to provide an assessment of the likely conditions at the application site.

This includes estimating the frequency that wave heights would be expected to exceed your recommended maximum for the installation; estimating the maximum expected wave height during episodic storm events, and commenting on the implications of climate change on the sea state at the site.

The context of this analysis is your own guidance relating to the suitability of areas within coastal waters for suspended aquaculture schemes of this nature, namely document MMO1184, section 5.3. On page 65, it states:

"*In this study, peak wave height, for all seaweed species was considered optimal between 0-4 m, suboptimal between 4-6 m, and unsuitable >6 m.*" and

"*The possibility of a catastrophic loss of the farm during storm events must also be factored into the site placement, so a detailed study of the local wave climate should be considered (Capuzzo et al., 2014). In this context, the WaveNet network (https://www.cefas.co.uk/cefas-data-hub/wavenet/) provides continuous data of wave height (as well as water temperature) along the English coast.*"

The Capuzzo et al. (2014) study cited in the MMO1184 document states, on page 27:

"The probability of catastrophic loss of the farm during winter storm events must also be factored into the site placement, and for this reason it would be necessary to study the local wave climate in more details for extremely rare maximum wave height events e.g. using WaveNet continuous data."

That is to say, according to Capuzzo and co-workers, the most important parameter for assessing the likelihood of catastrophic failure of a seaweed farm is peak wave height[1].

In summary, according to your own guidance, to avoid catastrophic loss of the farm during storm events, peak wave heights at the site should not exceed 6 m.

Therefore, to avoid a possible catastrophic loss of the farm, it is necessary to assess whether peak wave heights at the site are likely to exceed 6 m anytime during the future deployment of the farm.

The developers have estimated future wave heights at the proposed site using historic data from the Port Isaac step gauge in Port Isaac Harbour. Details of these data can be found in Penmayn Ltd. Navigational Risk Assessment and Emergency Response Plan, Appendix 3, page 10.

[1] Maximum and peak wave height are synonymous

The geographical position from where these data were obtained is not representative of the proposed site. The wave gauge, at the western side of Port Isaac Harbour, is in a considerably more sheltered position and would experience wave heights much lower than those at the proposed site (Figure 1).

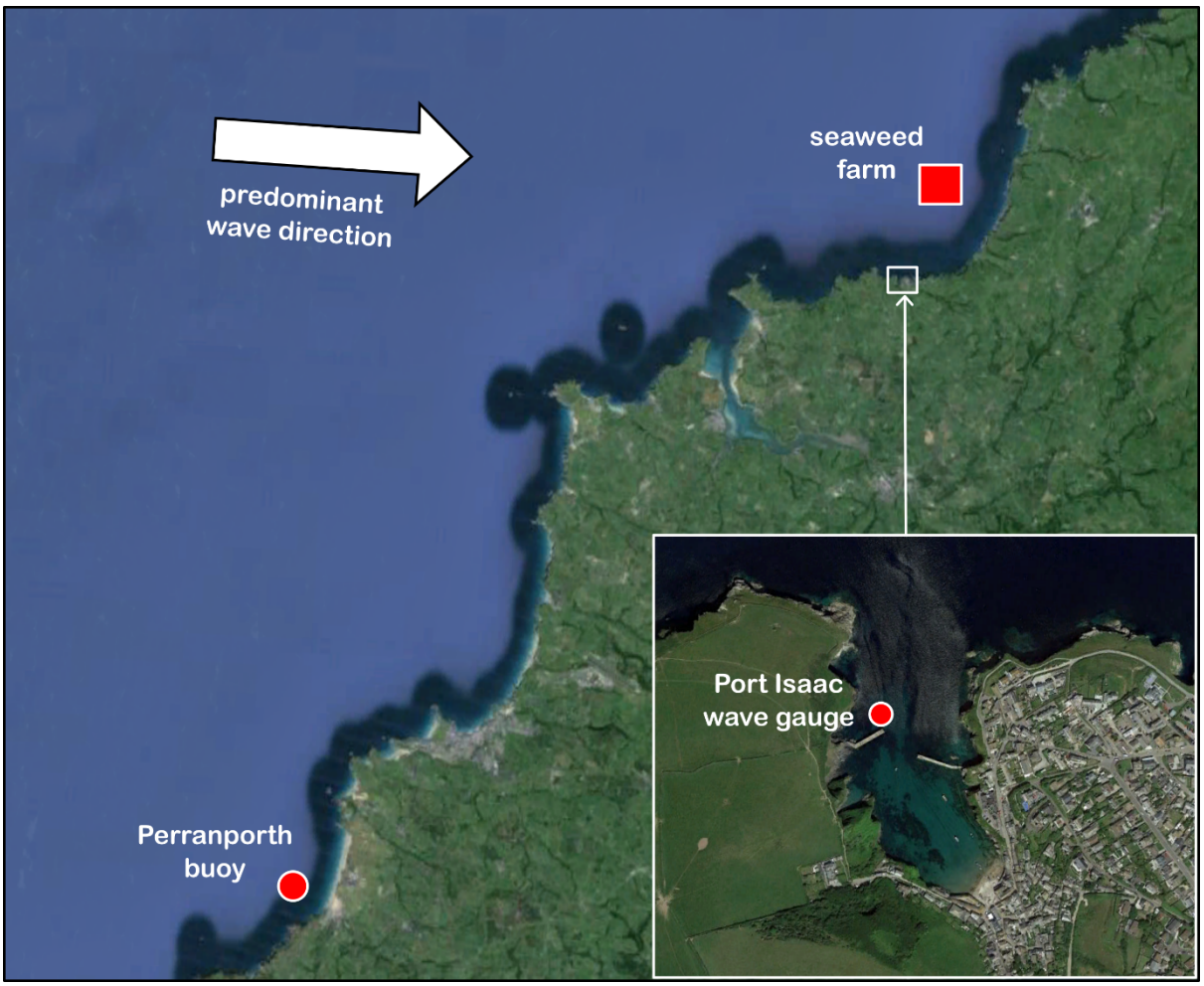

Figure 1: Locations of the Port Isaac wave gauge and the Perranporth buoy, relative to the proposed seaweed farm site.

The nearest available historic data with a similar exposure to the proposed site are from the buoy-mounted sensor at Perranporth. Statistical summaries of the wave data from this buoy are available from the National Network of Regional Coastal Monitoring Programmes (Table 1, source: coastalmonitoring.org).

Annual Statistics

Year	Annual H_s exceedance** (m)						Annual Maximum H_s	
	0.05%	0.5%	1%	2%	5%	10%	Date	A_{max} (m)
2007	7.75	5.43	5.03	4.58	3.84	3.15	09-Dec-2007 07:30	8.63
2008	8.02	4.80	4.30	3.91	3.30	2.87	10-Mar-2008 16:30	8.98
2009	5.46	4.74	4.44	4.07	3.56	3.00	22-Nov-2009 20:30	5.69
2010	5.91	3.98	3.51	3.04	2.57	2.16	11-Nov-2010 20:00	6.30
2011	6.02	4.45	4.15	3.87	3.37	2.91	15-Dec-2011 02:30	6.89
2012	5.59	4.61	4.23	3.76	3.17	2.71	18-Apr-2012 04:00	5.85
2013	6.30	4.87	4.56	4.17	3.56	2.97	02-Nov-2013 17:30	7.06
2014	7.00	5.57	5.16	4.41	3.46	2.89	01-Feb-2014 18:00	7.28+
2015	6.07	4.99	4.65	4.30	3.75	3.21	24-Feb-2015 04:30	6.75
2016	8.18	4.98	4.50	4.07	3.47	2.90	08-Feb-2016 13:30	8.68
2017	6.25	5.05	4.60	4.09	3.45	2.85	21-Oct-2017 18:30	6.69
2018	6.97	5.24	4.79	4.11	3.41	2.83	03-Jan-2018 06:30	7.77
2019	6.97	5.42	4.92	4.44	3.65	3.18	09-Dec-2019 00:00	7.54
2020	6.15	5.37	4.97	4.58	3.91	3.37	10-Feb-2020 17:30	6.97
2021	6.30	5.07	4.48	3.92	3.16	2.67	07-Dec-2021 16:00	7.42
2022	6.80	5.26	4.61	4.07	3.27	2.74	18-Feb-2022 11:00	8.03
2023	6.21	5.04	4.67	4.27	3.60	3.03	02-Nov-2023 07:30	6.68

Table 1: Annual wave statistics from the Perranporth buoy, from the National Network of Regional Coastal Monitoring Programmes. Significant wave heights have exceeded 6 m on at least one occasion during 15 of the past 17 years.

Therefore, in my opinion, based on historic data, the significant wave heights at the application site are likely to exceed your recommended maximum for peak wave height at least once during the estimated lifespan of the installation, which suggests that there is a risk that the installation may experience catastrophic failure. Significant wave height is defined as the mean height of the highest third of waves[2]. The peak wave height, by definition, is greater.

To estimate the expected wave height during episodic storm events in the future, wave height exceedance statistics for various return periods can be used. If the lifespan of the installation is 25 years, then the historic data from the Perranporth buoy suggests that the significant wave height will exceed 8.9 m on one occasion during this time (Table 2). Again, I note that significant wave heights are not peak wave heights and it is "rare maximum wave height events," i.e. peak wave height, that the Capuzzo et al. (2014) study discusses in the context of risk of catastrophic failure.

[2] https://coastalmonitoring.org/ccoresources/waveparameterhandbook/#_Wave_Parameter_Summary

Observation period	December 2006 to December 2023	
Return period (years)	**Significant wave height (m)**	**Comments**
0.25	5.40	No depth limitation
1	6.67	Depth-limited at MLWS
2	7.24	
5	7.94	Depth-limited at HAT
10	8.43	
20	8.90	
50	9.46	
100	9.85	

Table 2: Significant wave height exceedances at Perranporth for return periods of 0.25 to 100 years, from the National Network of Regional Coastal Monitoring Programmes. For example, significant wave heights are expected to exceed 8.9 m once every 20 years.

These estimates are based on historic data, and do not take into account the possible variations due to anthropogenic climate change. According to recent studies,[3] extreme storm events in the North Atlantic are expected to become more intense and frequent as the Earth's temperature increases. It is these storms that drive extreme wave heights; therefore it is likely that maximum wave heights at the proposed site during episodic storm events will be bigger than those estimated using historic data.

It is my recommendation that Cefas and the Environment Agency be consulted in relation to this licence and the data provided in the application, to ask whether they agree that the data upon which the licence was granted is representative of conditions at the proposed seaweed farm site.

[3] e.g. Manning et al. (2024) https://www.sciencedirect.com/science/article/pii/S2212094724000343