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WAVE CONDITIONS AT A HOLDING AREA NEAR BJØRNSUND LIGHT HOUSE

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SAMMENDRAG

The significant wave heights of a holding area southeast of Bjørnsund lighthouse are calculated. The waves are quickly damped off when passing Ørnhaugen, the eastern headland of the island Gossen. North of that area, waves of 3 - 6 m may be expected, the highest for long return periods at the outer part of the holding area, the lowest at shorter return periods during summer conditions. South of Ørnhaugen, waves from 0.5 - 2 m should be espected.

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1. INTRODUCTION

With reference to DNMI rep. no. 30/86 (1) Norwegian Contractors have made a request for wave conditions in the holding area near Bjørnsund lighthouse. We therefore have made an analysis of these conditions by the help of the wave model (FJORDSEA) (2).

2. SITE DISCRIPTION

The holding area is situated south to southeast of Bjørnsund lighthouse, from Harøyfjorden and through the sound east of the island Gossen (Fig. 1).

The area is exposed to waves from northwest through a deep water channel. To the west and westnorthwest, however, many islets, rocks, and shallows complicate the conditions. It is, however, very clear that these irregularities have a rather large sheltering effect on the waves coming through that region.

3. WIND CONDITIONS

Extreme 10 min wind speed with a 50 years return period at the free sea surface outside the coast may be taken to 35 ms^{-1} for the northwesterly sector and 40 ms^{-1} for southwesterly to westerly sector (3).

When using the method given in (1) for calculating extreme wind speeds with other return periods, we find the 2, 10, and 100 years wind speed to be 28, 32, and 36 ms^{-1} respectively.

The longer the wind blow, the larger the generated wave, until a balance situation has established. When blowing over free sea, where the fetch may be taken endless, there is more than 12 hours before such a balance situation is reached. However, the longer the average period, the weaker the average wind speed, and therefore the waves probably have no further growth after 12 hour. (It should be remembered that the wind direction has to be northwest through the whole averaging periods, or else the propagating waves into the holding area will be of less wave heights.)

From (1) we have given an estimate of 0.9 for the factor used in calculating 3 hourly extreme wind speeds from 10 min extremes, and 0.8 when calculating 6 hourly values. If we use 0.7 to calculate 12 hourly values, we get the wind speeds given in Table 1. The numbers in parenthesis are values reduced to 2/3 which should represent the extremes valid in the summer window season, may - august (1).

Table 1. Extreme wind speeds (ms^{-1}) from northwesterly direction outside the coast of Møre and Romsdal. Summer values in parenthesis.

RETURN PERIOD	AVERAGING TIME			
	10 min	3 hours	6 hours	12 hours
2 years	28 (19)	25 (17)	22 (15)	20 (13)
10 years	32 (21)	28 (19)	25 (17)	22 (15)
100 years	36 (24)	33 (22)	29 (19)	25 (17)

4. WAVE CONDITIONS

The waves are calculated by the model (FJORDSEA) (2). The input data used are averaged wind speeds of 30, 35, 40, 50, and 60 kts. The wind direction used is 310^0, which is the direction from the holding area and through the deep channel out into the open sea. The results are given for each 3 hours up to 12 hours. Some of those results are given as Fig. 2.

When using the results above combined with Table 1, it seems that the results from the 12 hours average period should be used because the largest waves are then created. The difference from the results found for the shorter average time and higher wind speed, however, is not large.

We then let 40 kts (1 kt = 0.514 ms^{-1}) represent the 12 hourly wind which creates the 2 years wave, and 50 kts the 100 years wave. The 10 years wave height may be interpolated.

For summer values we may correspondigly use 30 kts to create the 10 years wave, and 35 kts the 100 years wave, while the 2 years wave is extrapolated.

When lpoking at the map (Fig.1), and the reults from the wave model (Fig. 2), we find that the waves are damped when travelling into the holding area. The area of largest damping is the area near to Ørnhaugen, the eastern headland of the island Gossen. Straight to the south of that headland, the sea is sheltered.

We now split the holding area into three parts. First, we have the area straight south of Ørnhaugen, (1), which strictly spoken is south of the area suggested by Norwegian Contractors. Further on, the area at the northern side of Ørnhaugen, and southeast to east of the islet Sessholmen is chosen as the area (2), while the area north of

Sessholmen and southeast to east of Svanshomen makes the area (3). The area (3) is most exposed, and the area (1) is mosed sheltered. We then give the 2, 10, and 100 years wave heights for the three areas, for all-year and summer conditions (Table 2).

Table 2. Significant wave heights with given return periods through the holding area near Bjørnsund lighthouse.

	RETURN PERIOD	SOUTH OF ØRNHAUGEN (1)	ØRNHAUGEN - SESSHOLMEN (2)	SESSHOLMEN - SVANSHOLMEN (3)
ALL YEAR	2 years	~ 1 m	~ 4 m	~ 5 m
	10 years	~ 1 - 2 m	~ 5 m	~ 6 m
	100 years	~ 2 m	~ 5 - 6 m	~ 6 - 7 m
SUMMER	2 years	~ 0.5 m	~ 3 m	~ 3 - 4 m
	10 years	~ 0.5 - 1 m	~ 3 - 4 m	~ 4 m
	100 years	~ 1 m	~ 4 m	~ 4 - 5 m

The differences between the northern and southern parts of the holding area is in fact more striking than the differences between seasons or different return periods. Moreover, it is believed that the wave model at this point give results that corresponds rather well with reality. However, it should be remembered both that the grid point representation of the land/sea distribution is not 100% perfect on this scale, and that the water depth is not included in the model. The variations in the calculated wave heights within area must not be taken too literally, although they probably representent some valuable information.

It is of interest to look at how the islet Sessholmen influences the area southeast of the island. The influence is probably enlarged in the model, since the island has a less area than the gridpoint area of 500 m x 500 m. We therefore also tested the wave response when no island was put in the model. We found that the waves then were of the order 0.5 m higher in the area southeast of the disturbance (area (2)), and the effect was even smaller in the area (1). Possible errors introduced by wrong modelling of Sessholmen therefore are small (0.1 - 0.3 m).

It is also of interest to examine how exposed the two northern parts

of the holding area are to westerly winds. We therefore put 40 kts wind speed and 270° into the model (Fig. 2e). We found that the wave heights in region (2) now was reduced to the level of region (1), while for region (3) the wave heights were reduced to half of what is expected in northwesterly wind. For region (1) only minor reductions were found.

The reason for the high sheltering in westerly wind also for the northern parts (area (2) and (3)) of the holding area is the effect of the irregularities (islets, rocks and shallows) west of that area.

It should, however, be noticed that this area to the west is difficult to model, and that the results therefore should not be used in detail.

5. LIST OF REFERENCES

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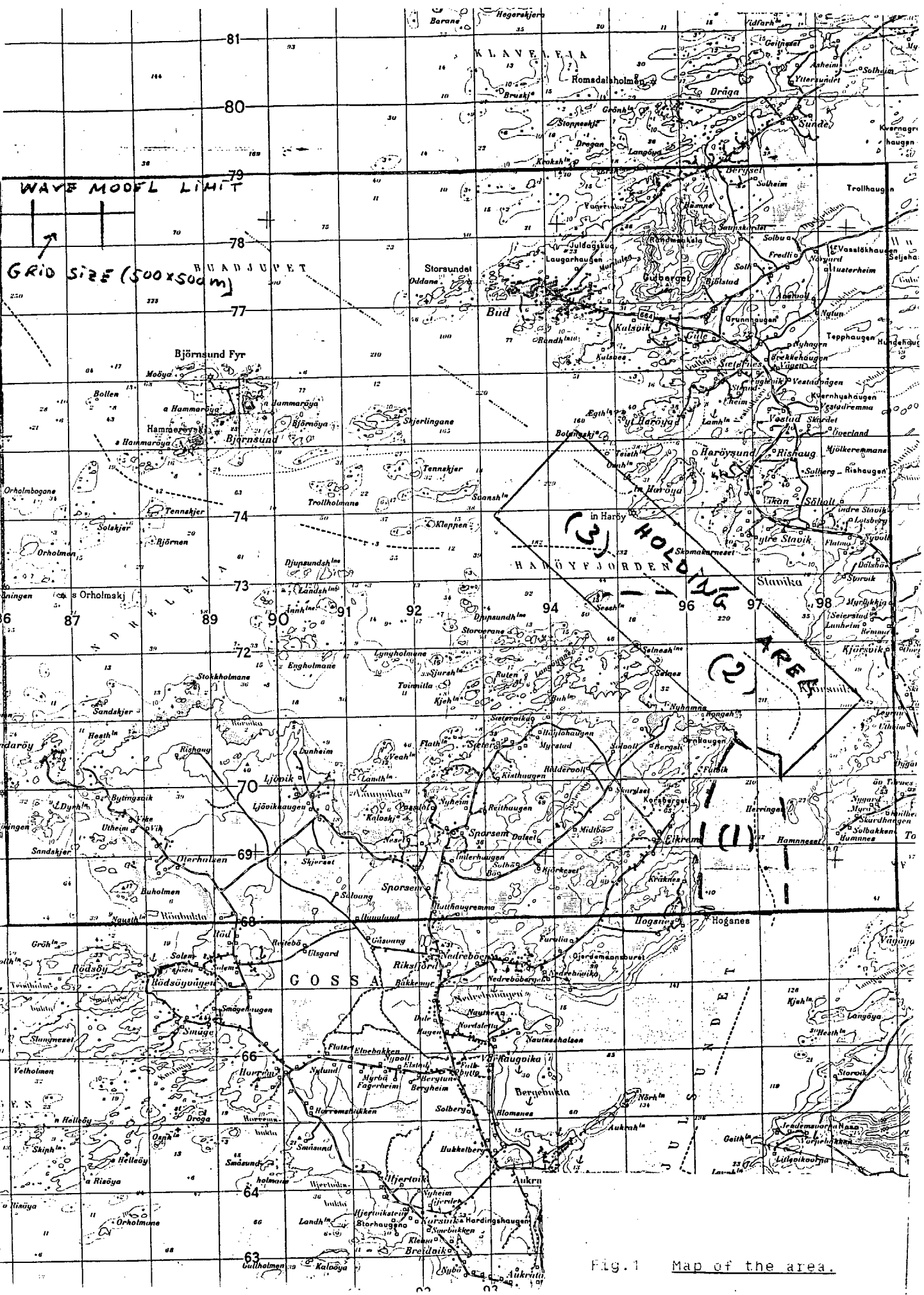

Fig.1 Map of the area.

AVEHEIGHT AFTER 12. HRS. WIND DIRECTION 310. DEGREES WIND SPEED 30. KT. GRID SIZE 0.50 KM.

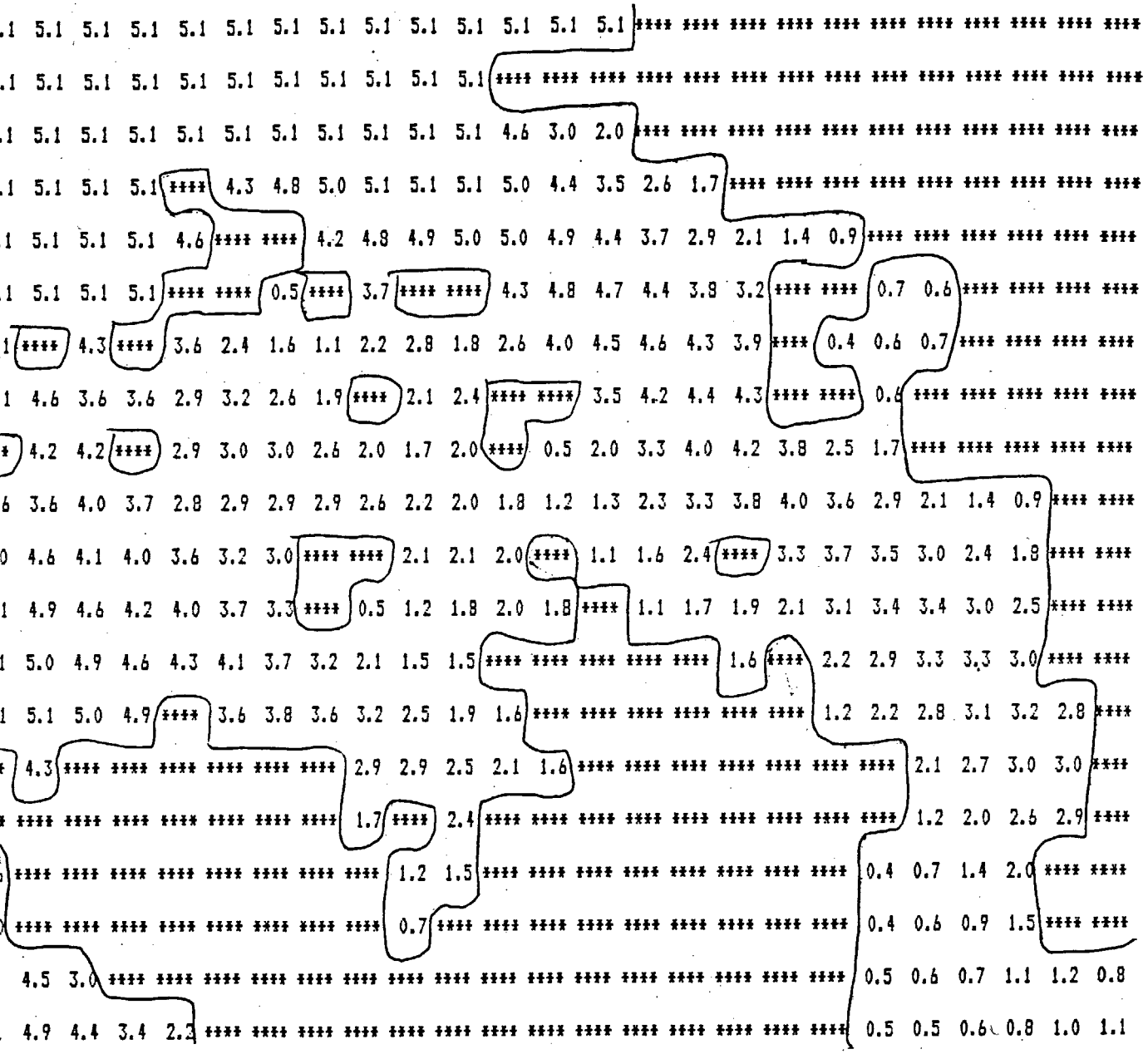

Fig.2a Significant wave heights at the holding area near Bjørnsund lighthouse after 12 hours. Wind direc.: 310^0
Wind speed : 30 kts
Represent summer conditions, r.p.:10 y

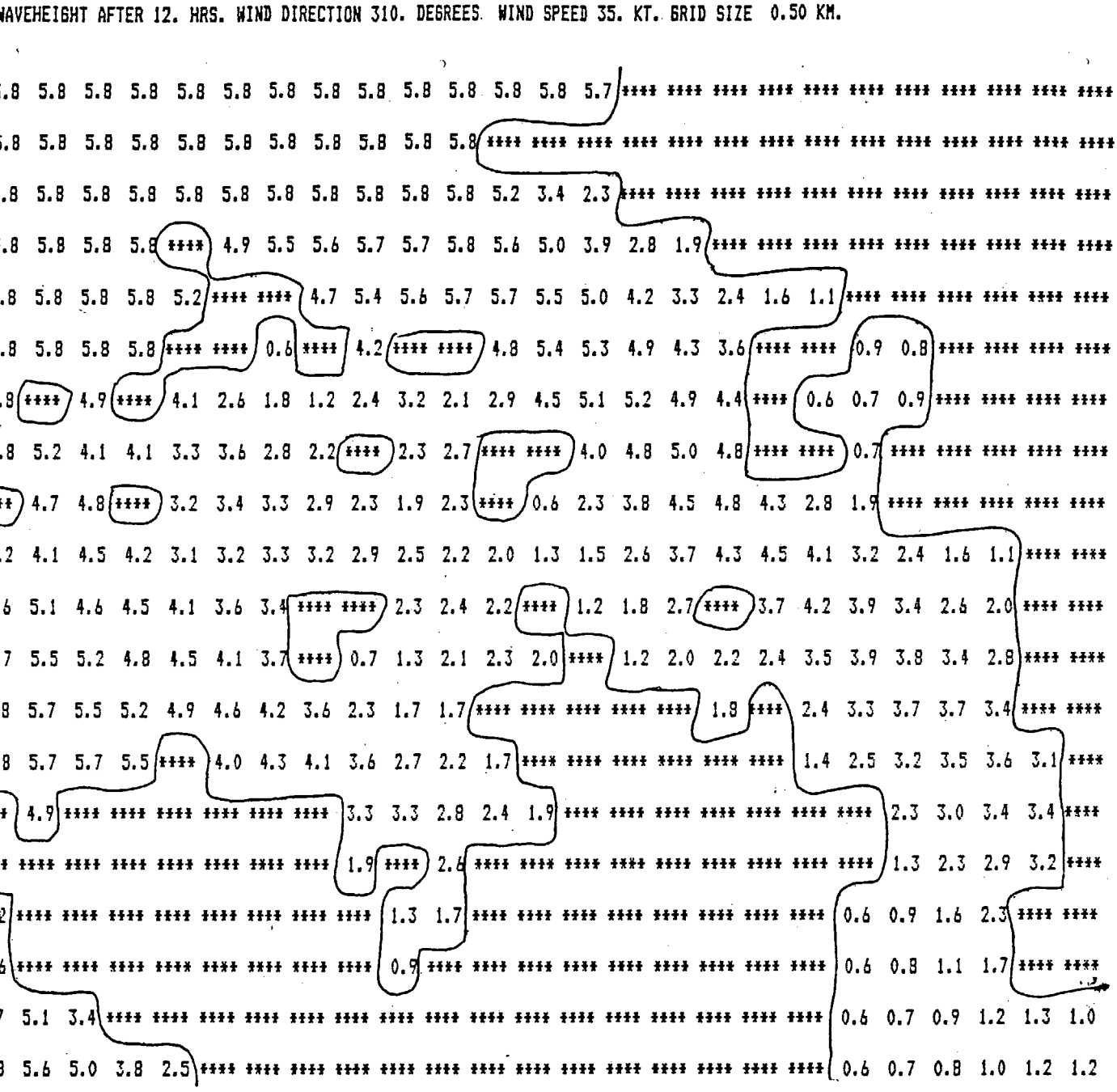

Fig.2b Significant wave heights at the holding area near Bjørnsund lighthouse after 12 hours. Wind speed: 35 kts
Wind direc.: 310°
Represent summer conditions, r.p.: 100 y

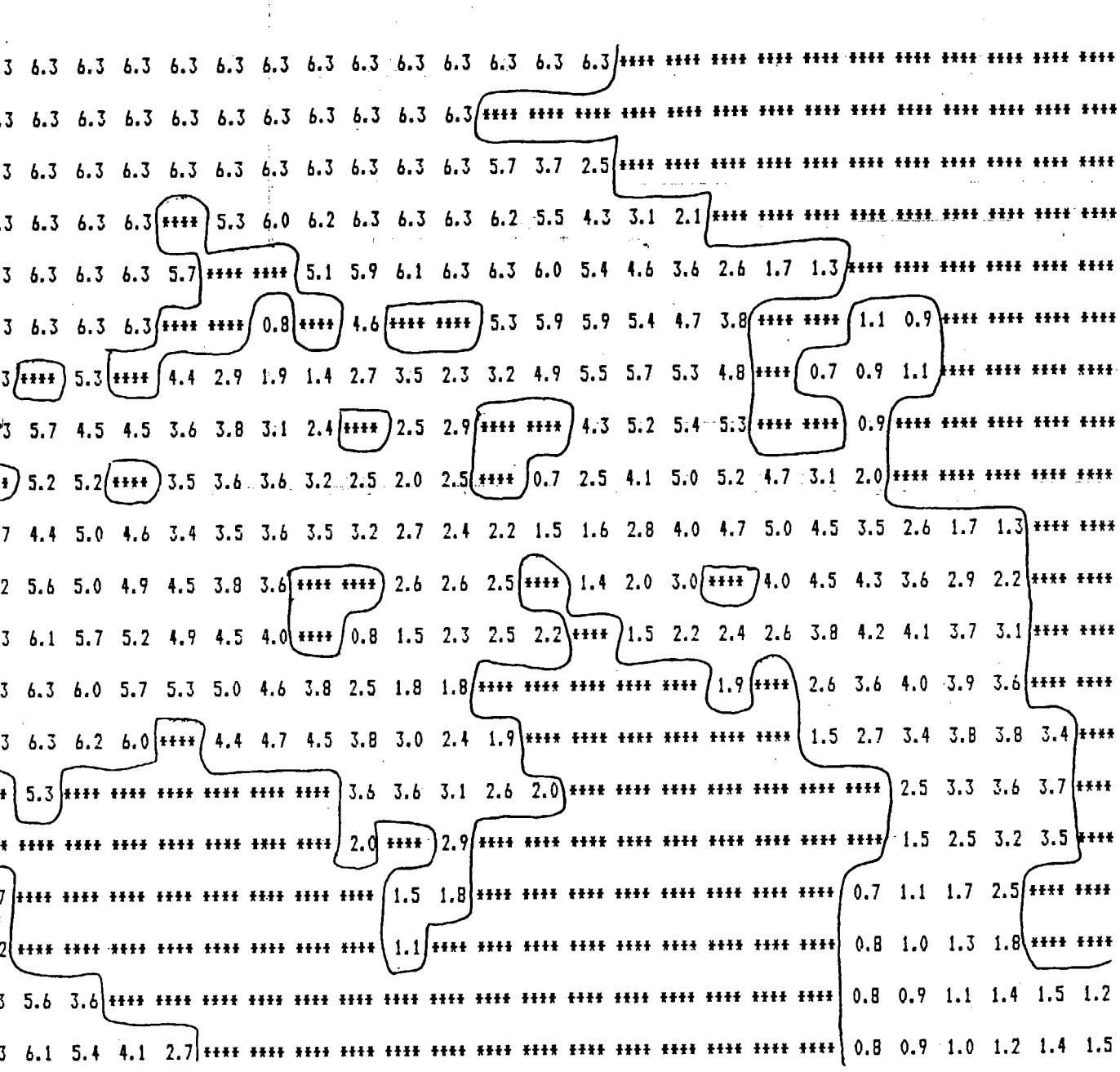

Fig.2c Significant wave heights at the holding area near Bjørnsund lighthouse after 12 hours. Wind speed: 40 kts
Wind direc.: 310°
Represent all-year conditions, r.p.: 2 y

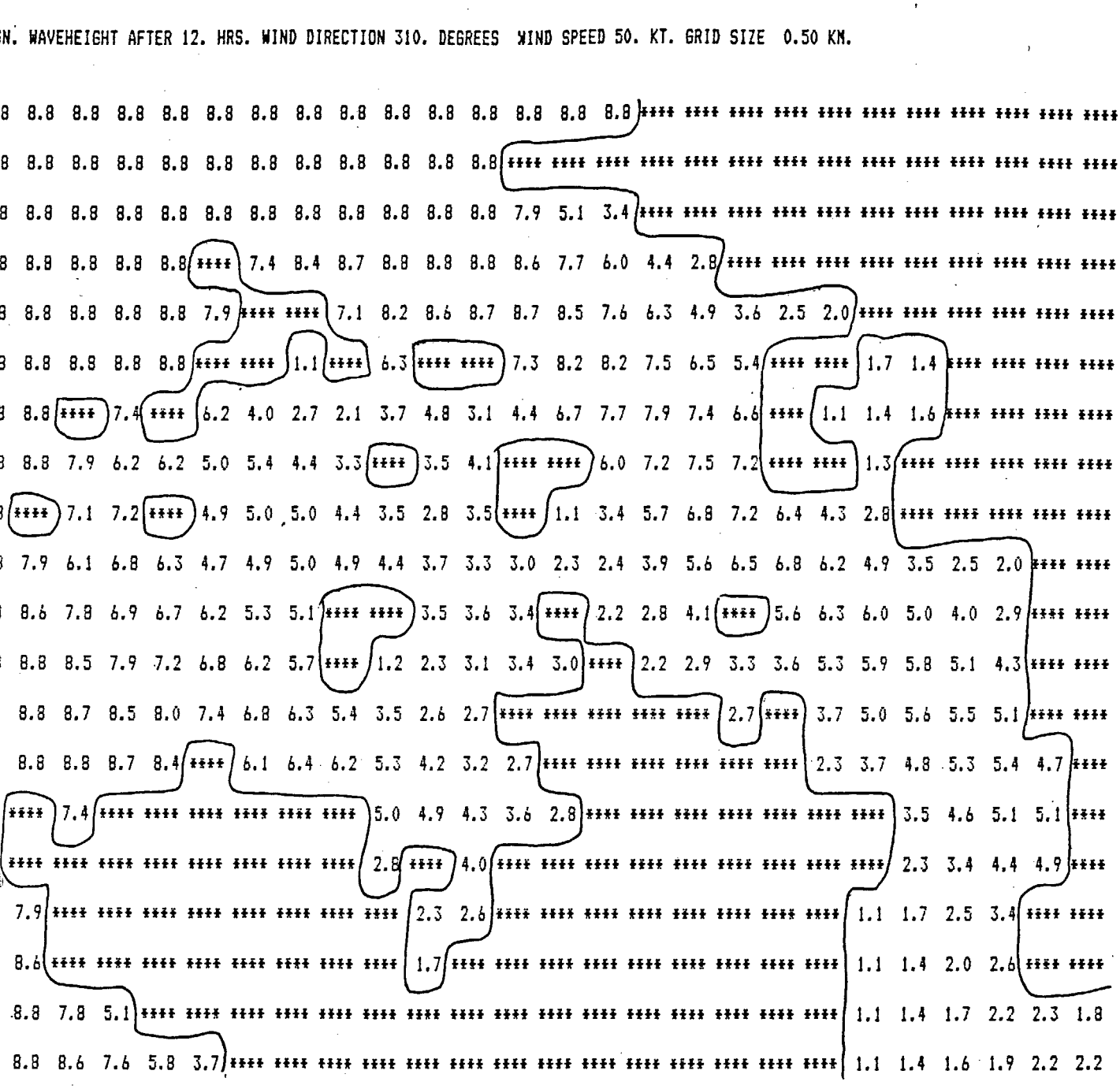

Fig.2d Significant wave heights at the holding area near Bjørnsund lighthouse after 12 hours. Wind speed: 50 kts
Wind direc.: 310°
Represent all-year conditions, r.p.: 100

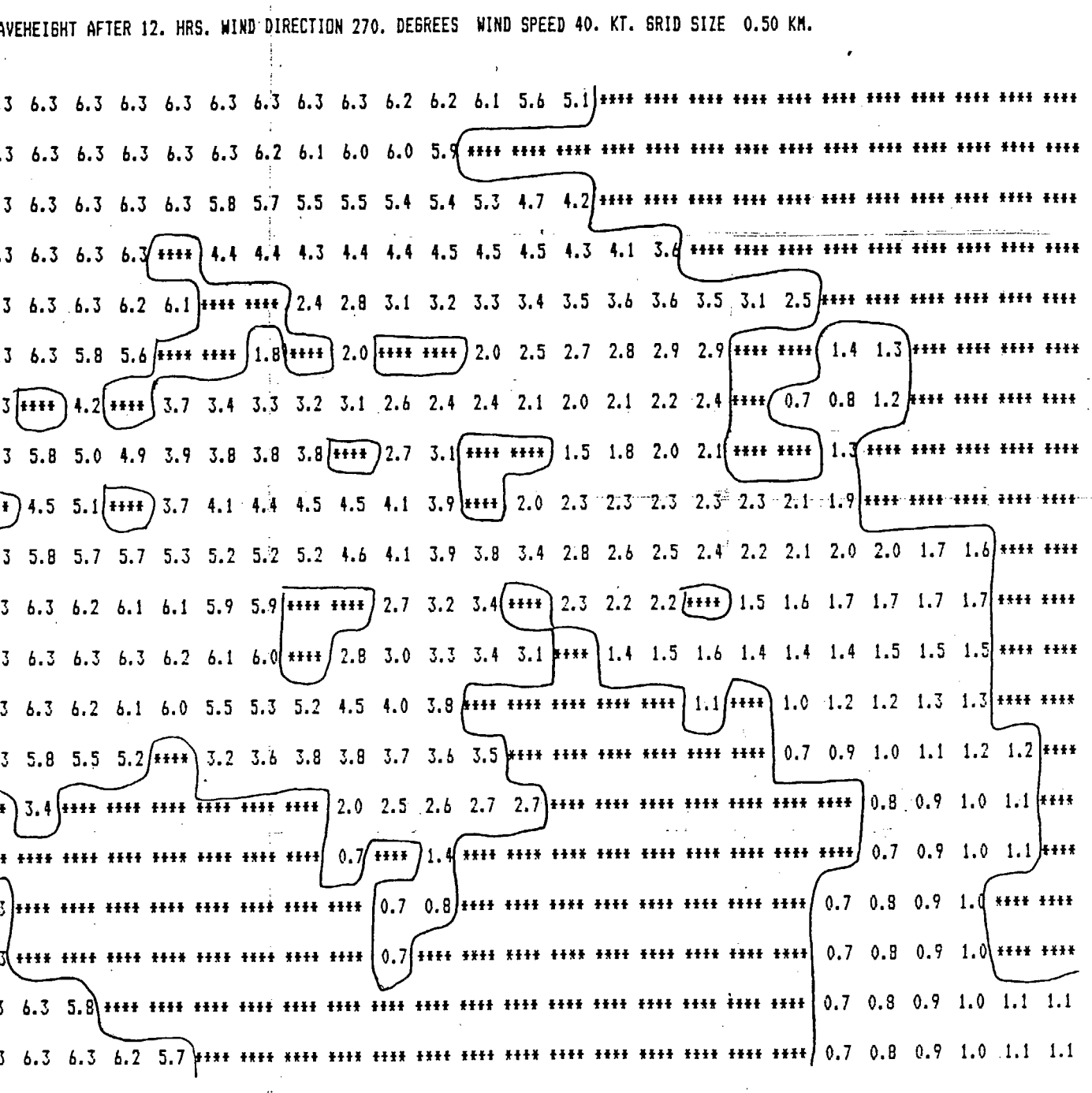

Fig.2e Significant wave heights at the holding area near Bjørnsund lighthouse after 12 hours. Wind speed: 40 kts Wind direc.: 270°