Bølgerapport
Aker Stord
Digernessundet

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TITTEL

EXTREME WAVES IN DIGERNESSUNDET

UTARBEIDET AV

SVEIN M. FIKKE

HELLE TØNNESSEN

OPPDRAGSGIVER

AKER STORD A/S

OPPDRAGSNR.

SAMMENDRAG

Significant wave heights are calculated for a 76x52 land/sea grid around Digernessundet and the harbour area at Aker Stord. Grid with = 250 m.
The highest significant waves with 10 years return period are 1.9 m and 2.4 m for the Gullfaks C - position and the harbour, respectively. Similar values for 100 years return periods are 2.3 m and 5.3 m.

UNDERSKRIFT

Svein M. Fikke
SAKSBEHANDLER

Bjørn Aune
FAGSJEF

EXTREME WAVES IN DIGERNESSUNDET

1 INTRODUCTION

Earlier analyses of wave conditions in Digernessundet is presented in (1). Recently a new and more detailed study of the wind conditions in the area is performed (2) and subsequently the corresponding wave conditions could be reconsidered. Due to the details of the local area and the narrow width of the sound, the grid size is reduced to 250 m in the FJORDSEA wave model in order to get a satisfactory resolution.

2 WIND

The development of extreme waves from a certain direction demands a steady wind for about 3-6 hours in this area. In (2) are given wind speeds representing 10 min. means, and the speeds with 10 and 100 years return period are listed in table 1.

Direction		Wind Speeds (m/s)	
		10 years	100 years
NNW	(320^0 - 355°)	13	15
NNE	(355^0 - 025°)	11	13
NE	(025^0 - 060°)	16	19
ENE	(060^0 - 085°)	22	25
E-S	(085^0 - 190°)	23	26
SW	(190^0 - 260°)	25	29
W-NW	(260^0 - 320°)	20	23

Table 1. 10 min. mean wind speeds for Digernessundet. Return period 10 and 100 years.

For wave calculations, directional variations should be taken into account for durations of 3-6 hours. In most cases the sea is fully developed after less than 6 hours (within the sound). The wind speeds are therefore reduced with respect to the longer averaging time by a factor of 0.85 - 0.9. The speeds thus obtained for the 8 main directions are listed in table 2.

3 THE GRID

The earlier wave calculations (1) for Digernessundet were made with a 500 m grid. Due to the narrow width of the sound and in order to get a better representation of the small islands, inlets and headlads of the shore lines, it was decided to reduce the grid size to 250 m. In order to cover the most interesting area of the fjords, a 19 x 13 km^2 grid was chosen as shown in figure 1. Thus, the model contains 76 x 52 = 3952 grid points.

As the FJORDSEA model assumes infinite fetch (perpendicular to the rim of the grid) for water along the boarder, the land/water distribution is somewhat adjusted in order to get a more realistic representation of the conditions outside the grid area, especially along the eastern boarder.

4 RESULTS

Some results of the model runs for the central area of the grid are shown in figures 2-25. The numbers represent the significant wave heights of each grid point. The figures represent mainly the 100 year return period case. The complete outprints for these and the 10 year return period cases are sent separately to Aker Stord.

The figures 2-25 show the grid values after 3, 6 and 9 hours for most of the directions. It is seen that the sea in most cases is fully developed after 3 hours. This is due to the relatively short fetch within the area.

Tabel 2 contains the complete list of significant wave heights for 10 and 100 years return periods for the eight main wind directions and for the three specified sites marked "Oseberg A", "Gullfaks C" and "Harbour", see figure 1. The values in table 2 represents the fully developed sea for each wind speed and direction.

Table 2.

Calculated wave heights (Hs) in metres for the mooring sites "Oseberg A" and "Gullfaks C" and the "Harbour". Wind speeds are given in knots.

Ref. per.	10 Years				100 Years			
Wind direction	Wind Speed	Oseb.A	Gfx.C	Harbour	Wind	Oseb.A	Gfx.C	Harbour
NE	30	0.5	0.5	0.5	35	0.6	0.6	0.6
E	45	1.7	1.9	2.1	50	2.1	2.3	2.6
SE	40	1.3	1.2	2.4	45	1.6	1.5	5.3
S	40	1.1	1.3	1.1	45	1.4	1.6	1.4
SW	45	1.0	1.5	0.9	50	1.2	1.9	1.3
W	45	1.2	1.2	0.8	50	1.4	1.5	1.0
NW	40	0.9	0.9	0.6	45	1.1	1.1	0.1
N	20	0.2	0.2	0.2	25	0.3	0.3	0.3

Note that the water depths are not included in the model so that the wave heights might be over-estimated in shallow waters, and especially along the shore lines. The values for the harbour site must be used with care both for this reason and because of the grid size of 250 m which is too high to represent the local details.

It should be stressed that the grid is most representative for the areas near the sound and the harbour. The wave heights for other grid points must be used with great care, mainly because of the problems with the energy flux into the grid through the rim of the grid. For instance, the calculated wave heights for the fjord areas with winds from SW (225^0) may be too high. However, these high waves in the Bømlafjord are not considered to have any significant effect within Digernessundet.

REFERENCES:

(1) J. Børresen, S.M. Fikke and K. Johansen:
Extreme Wind and Wave Conditions in Digernessundet. The Norwegian Meteorological Institute. (Undated report)

(2) S.M. Fikke, L. Andersen, K. Harstveit and A. Sunde:
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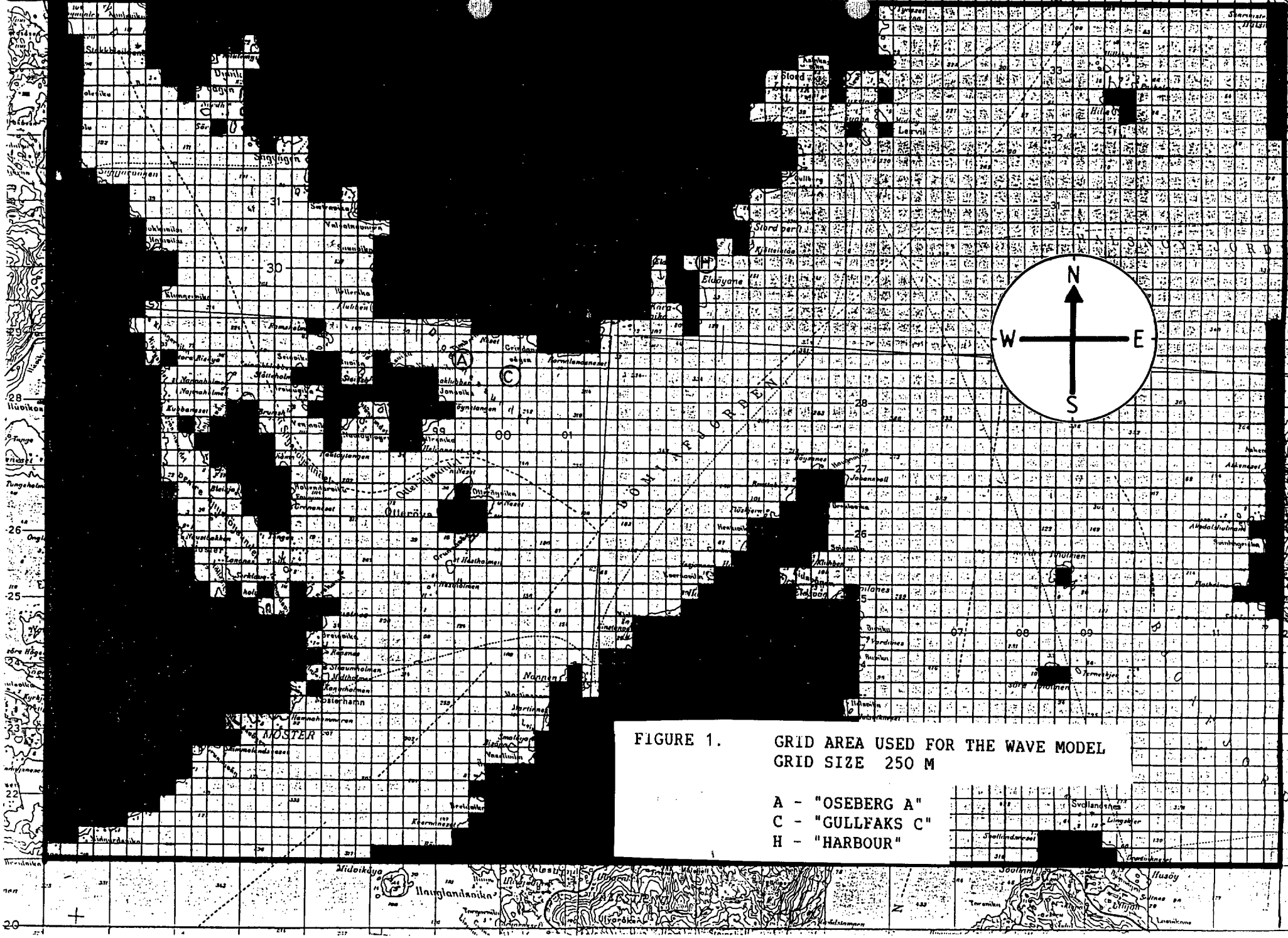

FIGURE 1. GRID AREA USED FOR THE WAVE MODEL
GRID SIZE 250 M

A - "OSEBERG A"
C - "GULLFAKS C"
H - "HARBOUR"

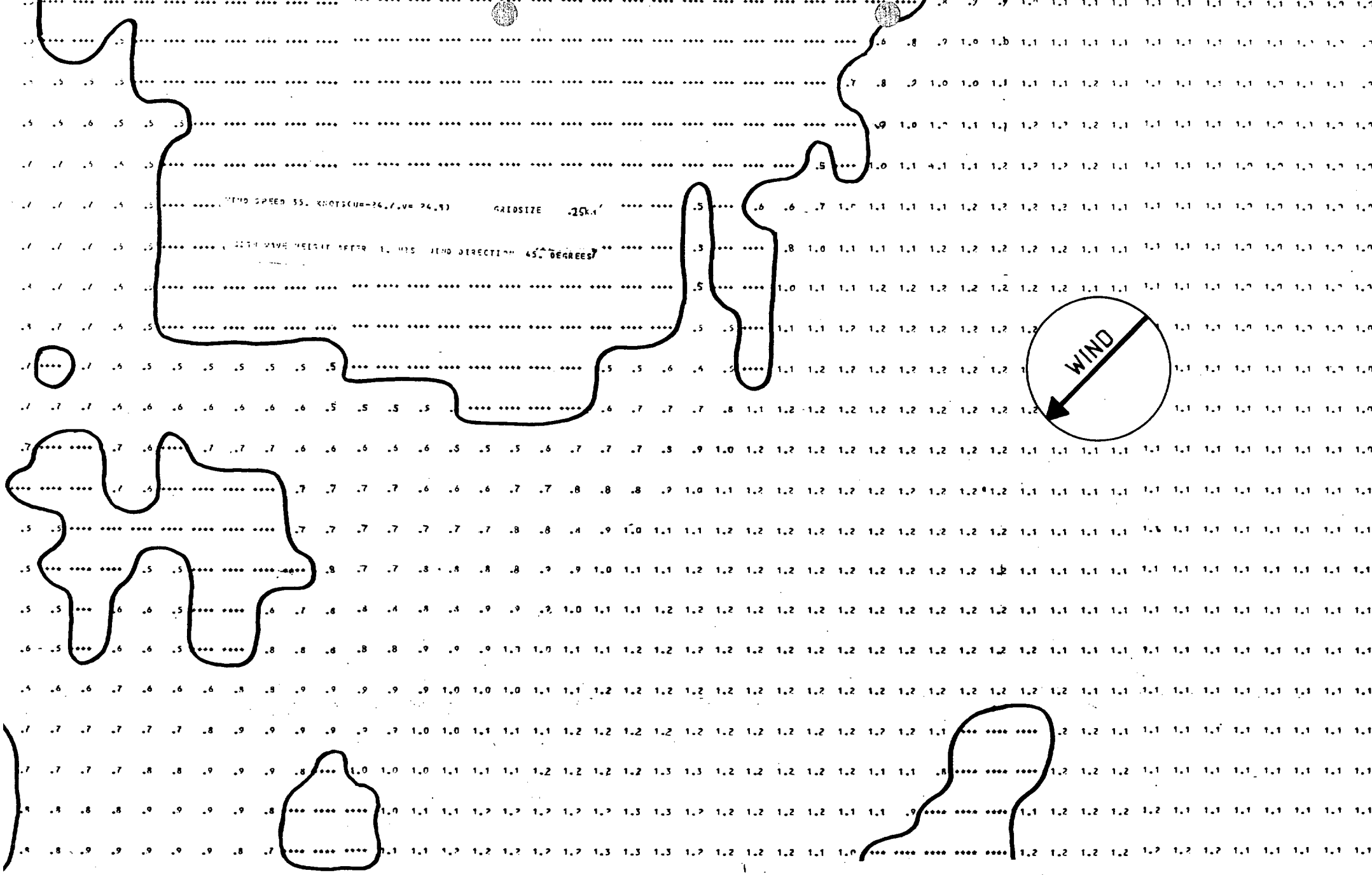

FIGURE 2. SIGNIFICANT WAVE HEIGHTS IN METER.
DIRECTION: 45°. WIND SPEED: 35 KNOTS.
DURATION: 1 HOUR.

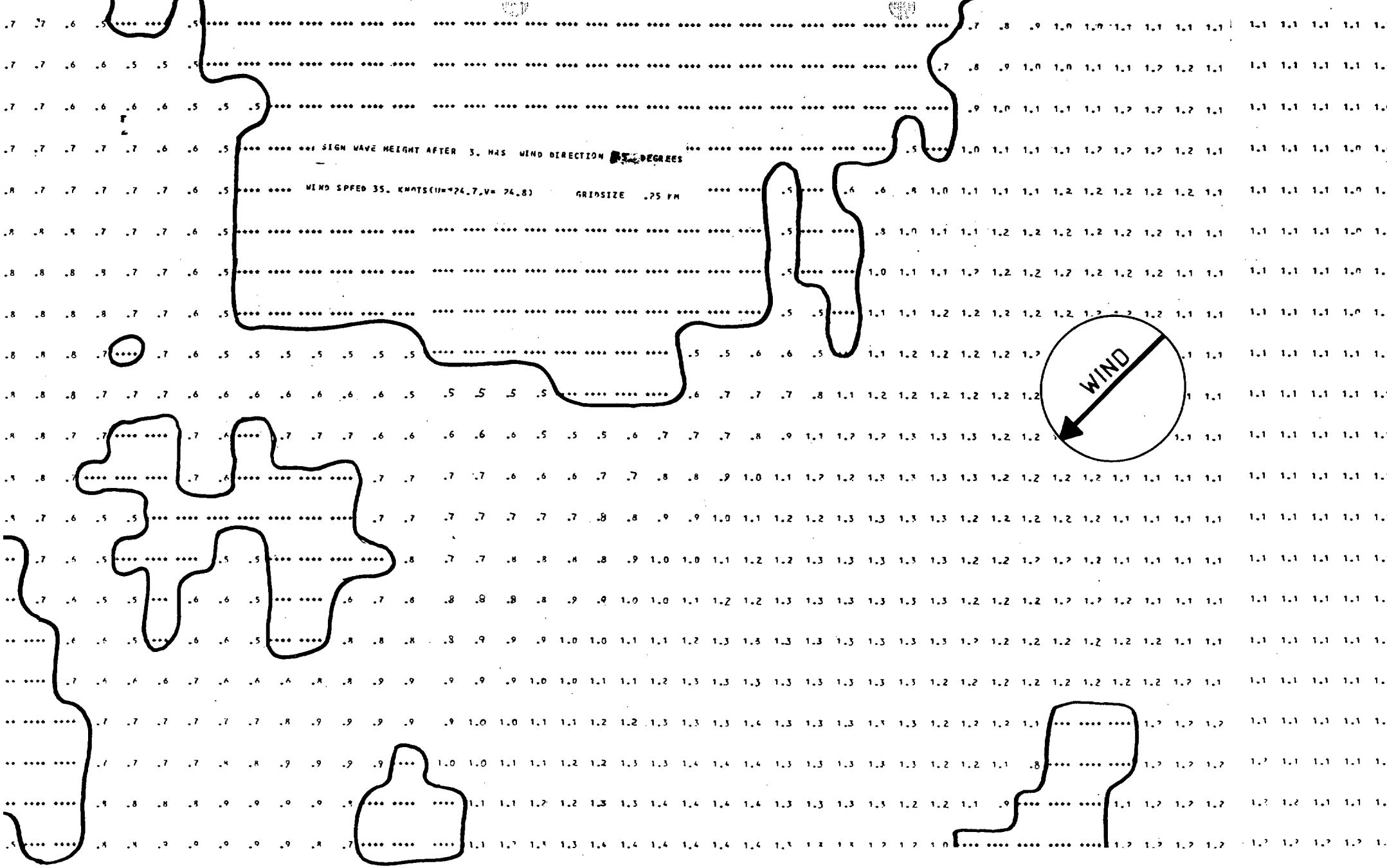

FIGURE 3. SIGNIFICANT WAVE HEIGHTS IN METER. DIRECTION: 45°. WIND SPEED: 35 KNOTS. DURATION: 3 HOURS.

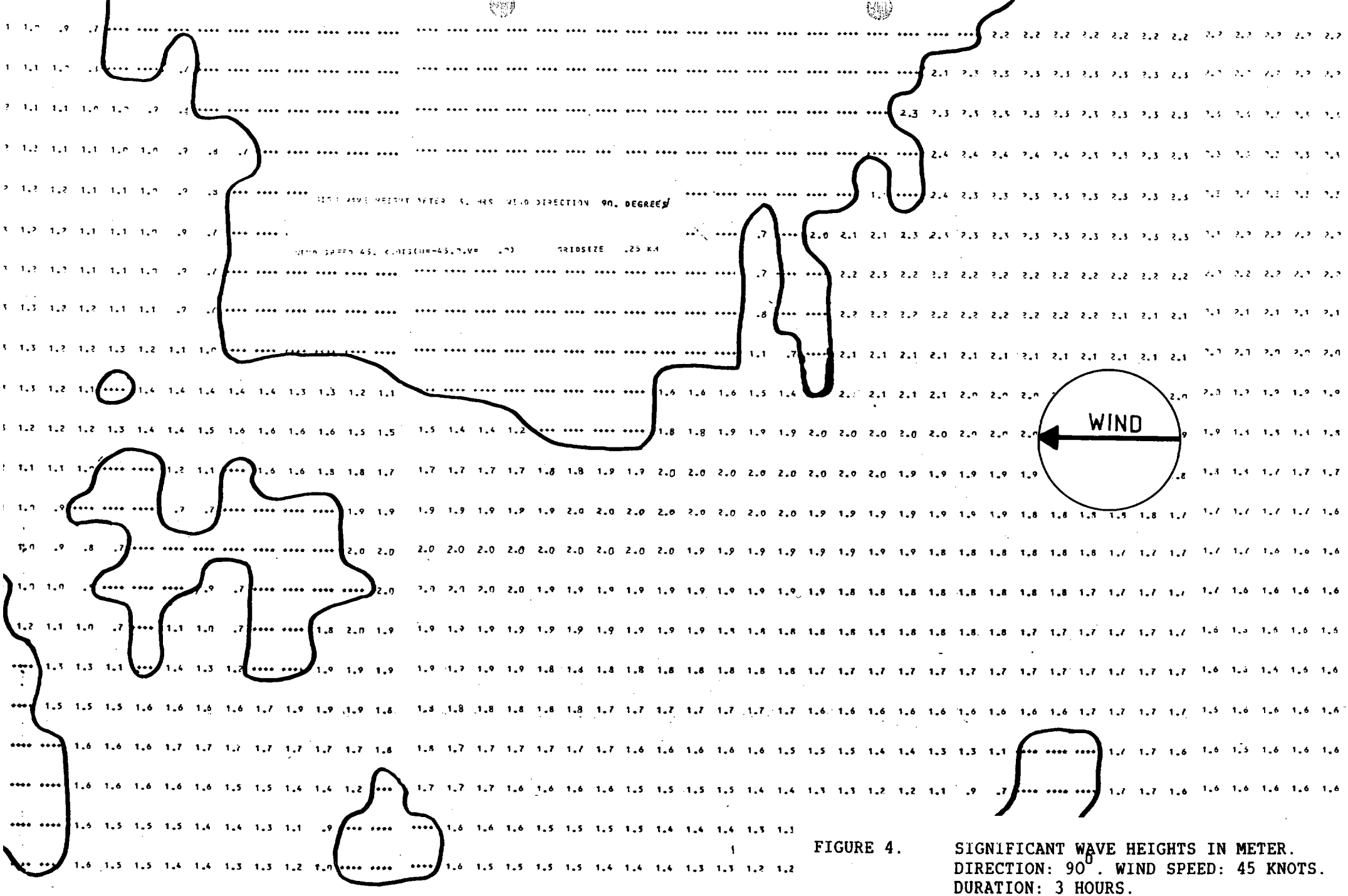

FIGURE 4. SIGNIFICANT WAVE HEIGHTS IN METER.
DIRECTION: 90°. WIND SPEED: 45 KNOTS.
DURATION: 3 HOURS.

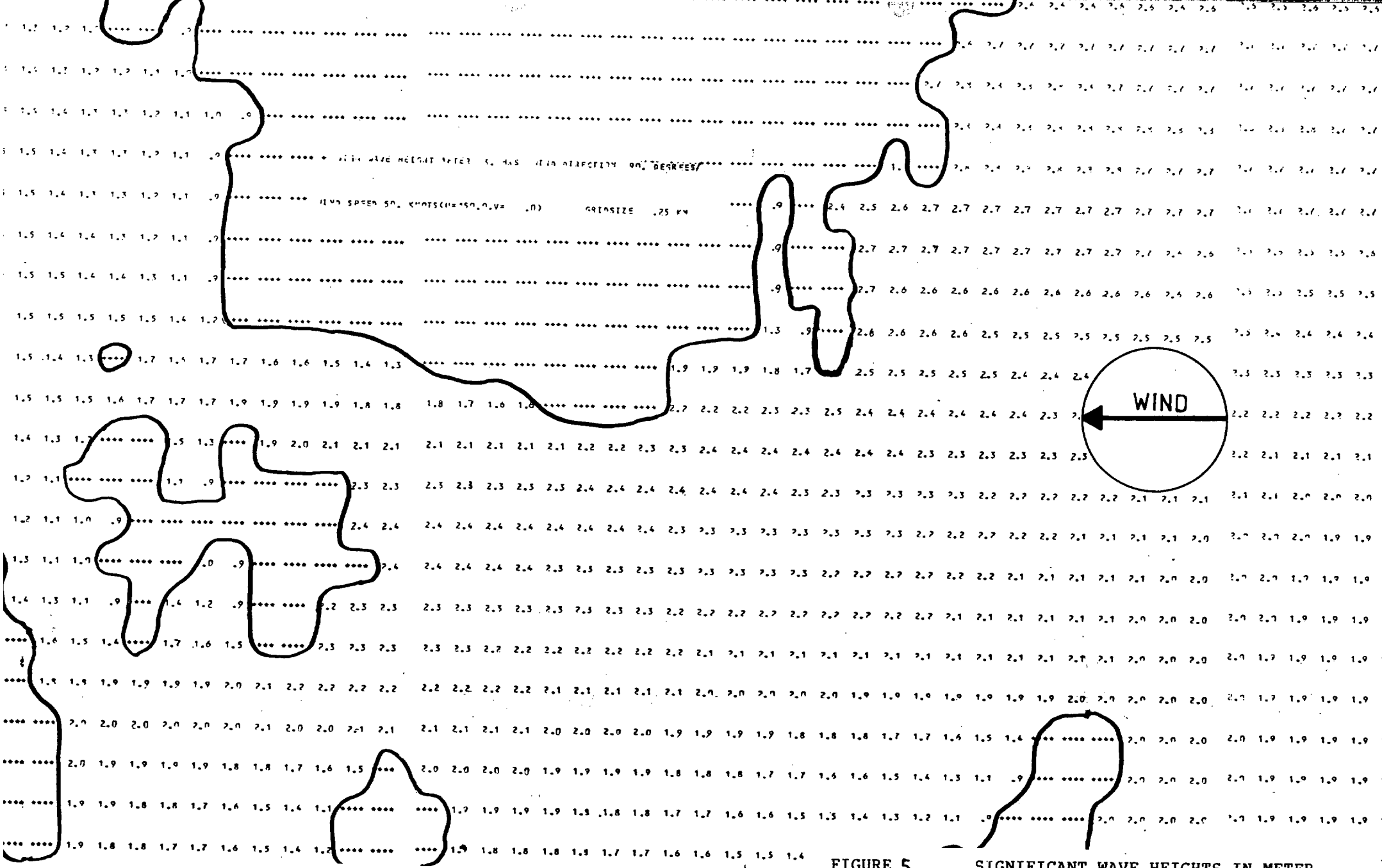

FIGURE 5. SIGNIFICANT WAVE HEIGHTS IN METER. DIRECTION: 90°. WIND SPEED: 50 KNOTS. DURATION: 3 HOURS.

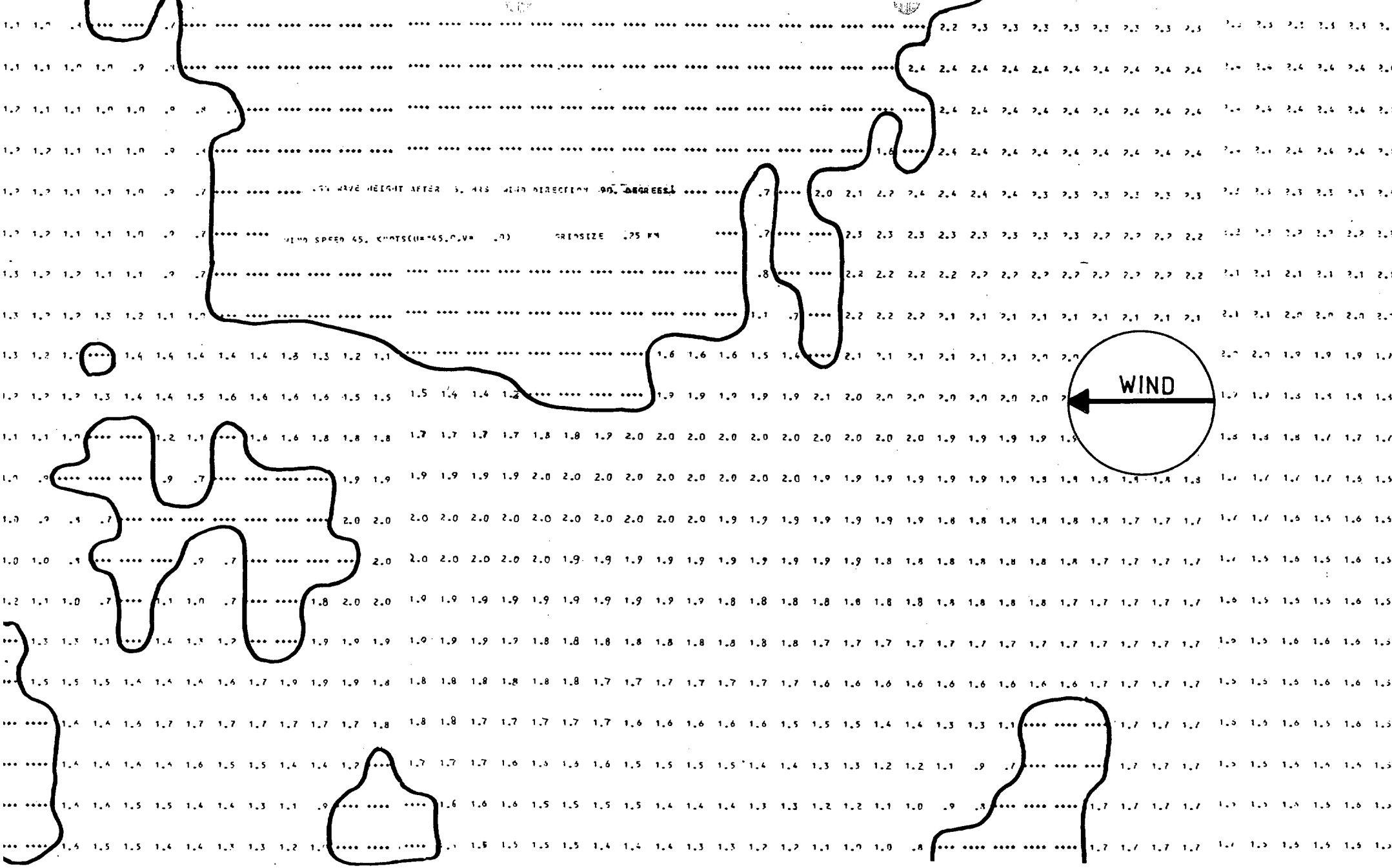

FIGURE 6. SIGNIFICANT WAVE HEIGHTS IN METER. DIRECTION: 90°. WIND SPEED: 45 KNOTS. DURATION: 6 HOURS.

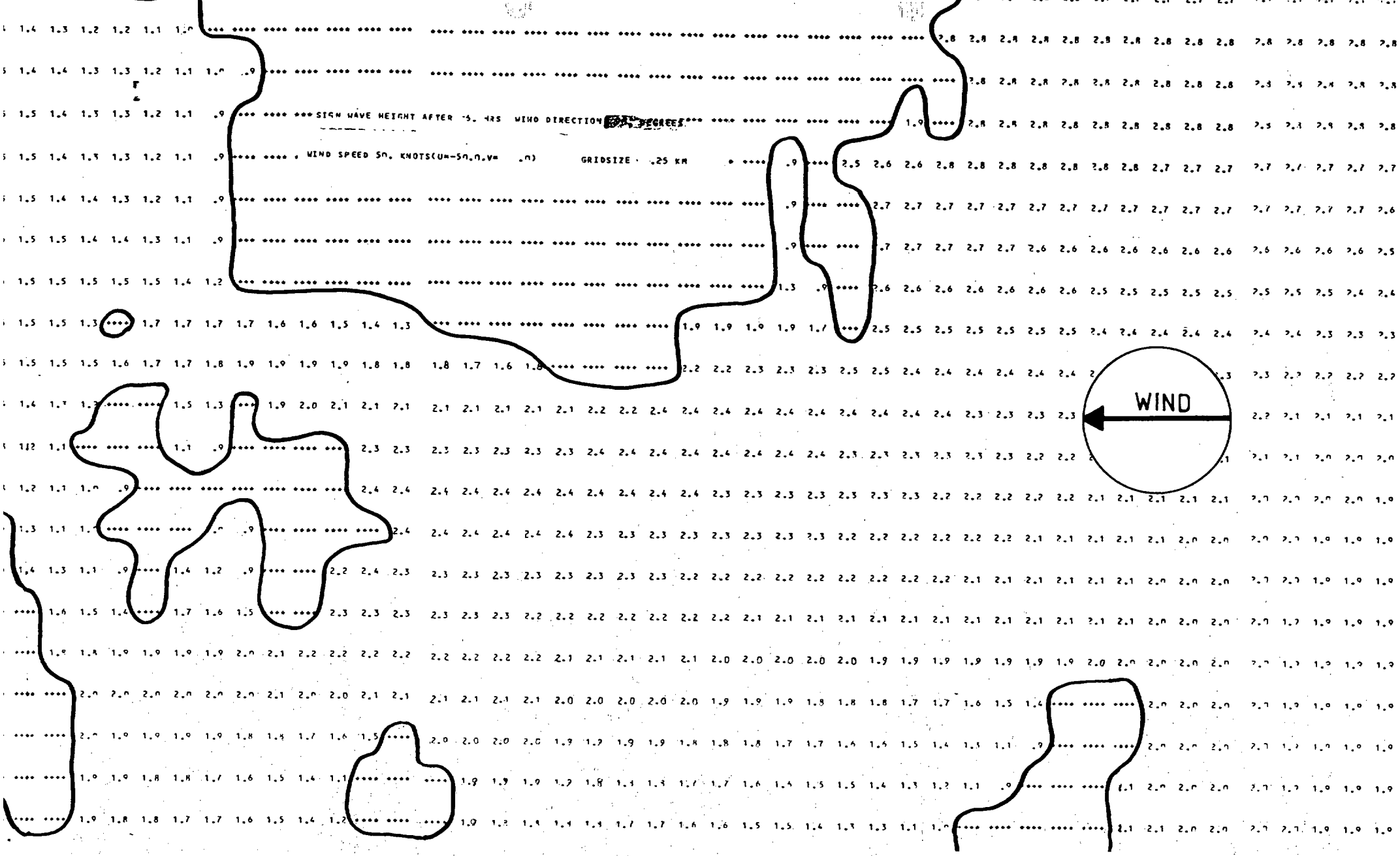

FIGURE 7. SIGNIFICANT WAVE HEIGHTS IN METER.
DIRECTION: 90°. WIND SPEED: 50 KNOTS.
DURATION: 6 HOURS.

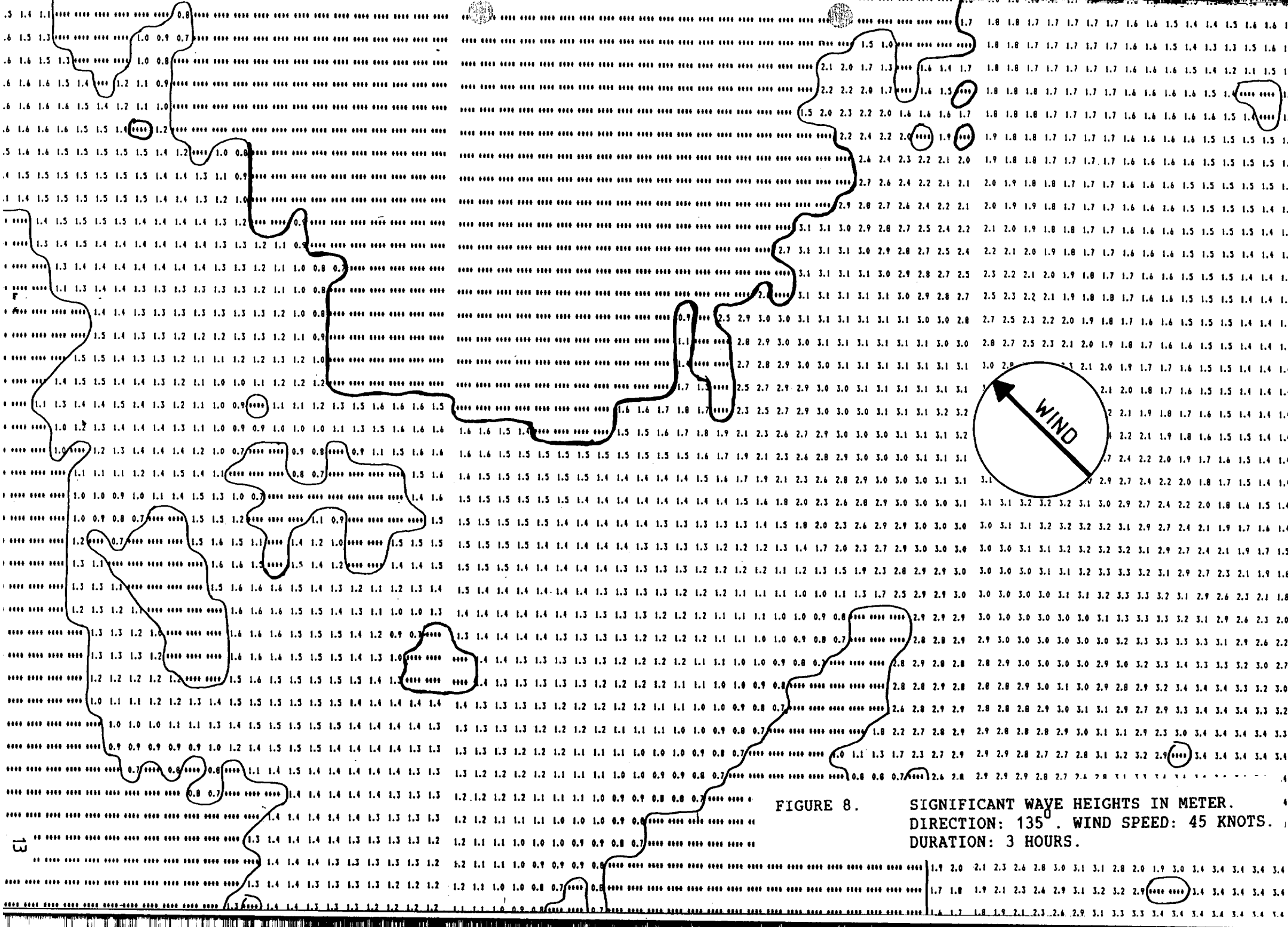

FIGURE 8. SIGNIFICANT WAVE HEIGHTS IN METER.
DIRECTION: 135°. WIND SPEED: 45 KNOTS.
DURATION: 3 HOURS.

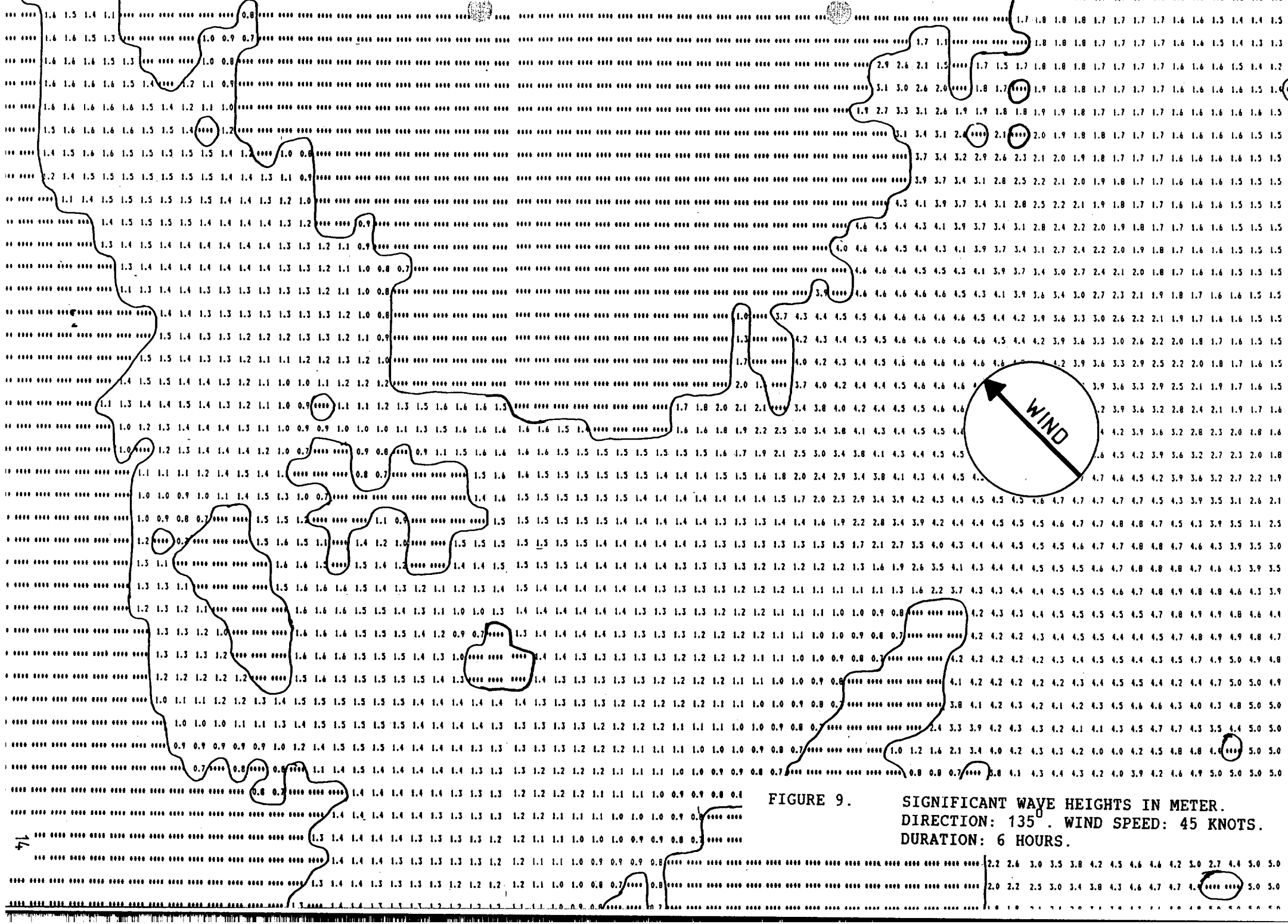

FIGURE 9. SIGNIFICANT WAVE HEIGHTS IN METER.
DIRECTION: 135°. WIND SPEED: 45 KNOTS.
DURATION: 6 HOURS.

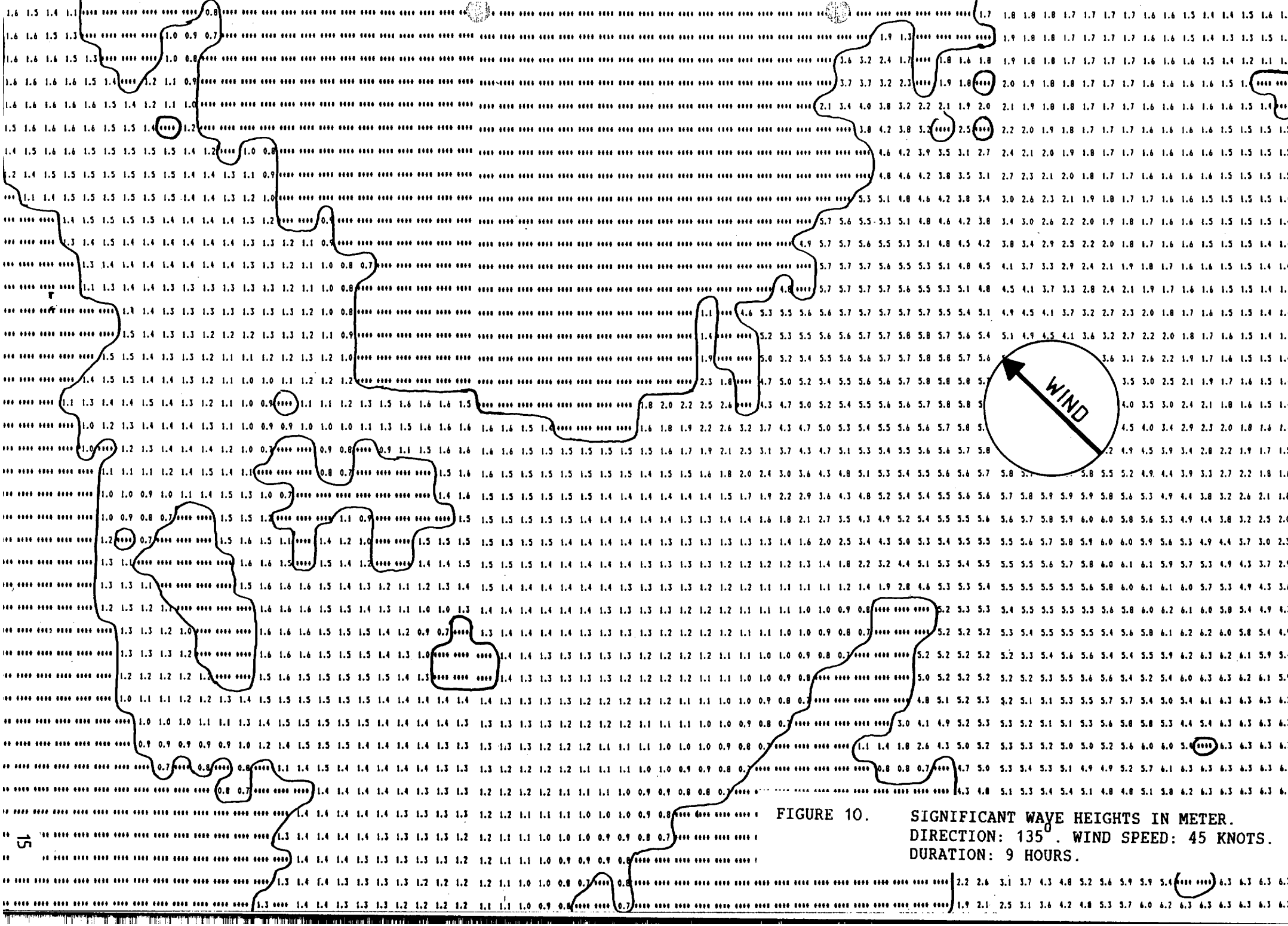

FIGURE 10. SIGNIFICANT WAVE HEIGHTS IN METER. DIRECTION: 135°. WIND SPEED: 45 KNOTS. DURATION: 9 HOURS.

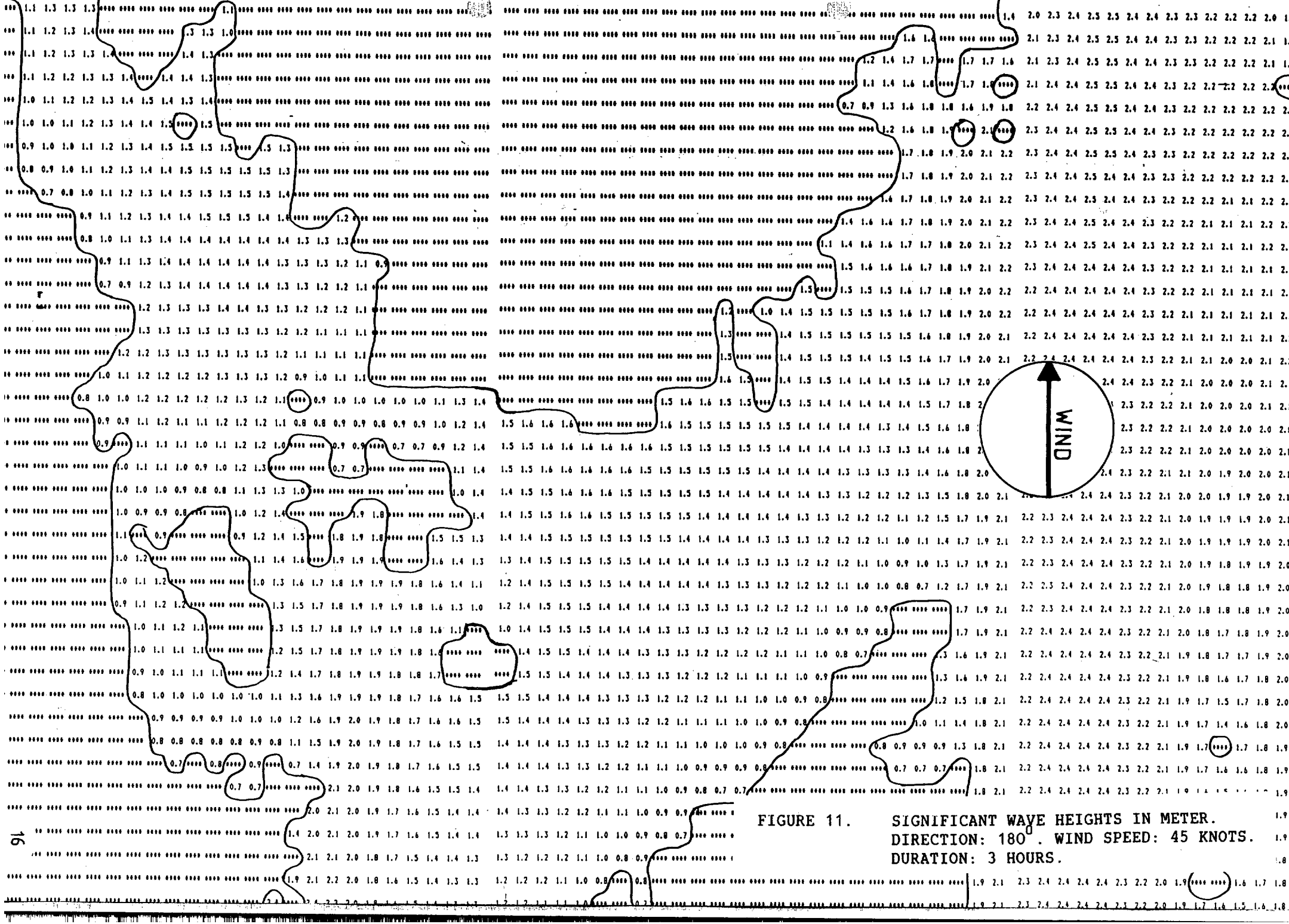

FIGURE 11. SIGNIFICANT WAVE HEIGHTS IN METER.
DIRECTION: 180°. WIND SPEED: 45 KNOTS.
DURATION: 3 HOURS.

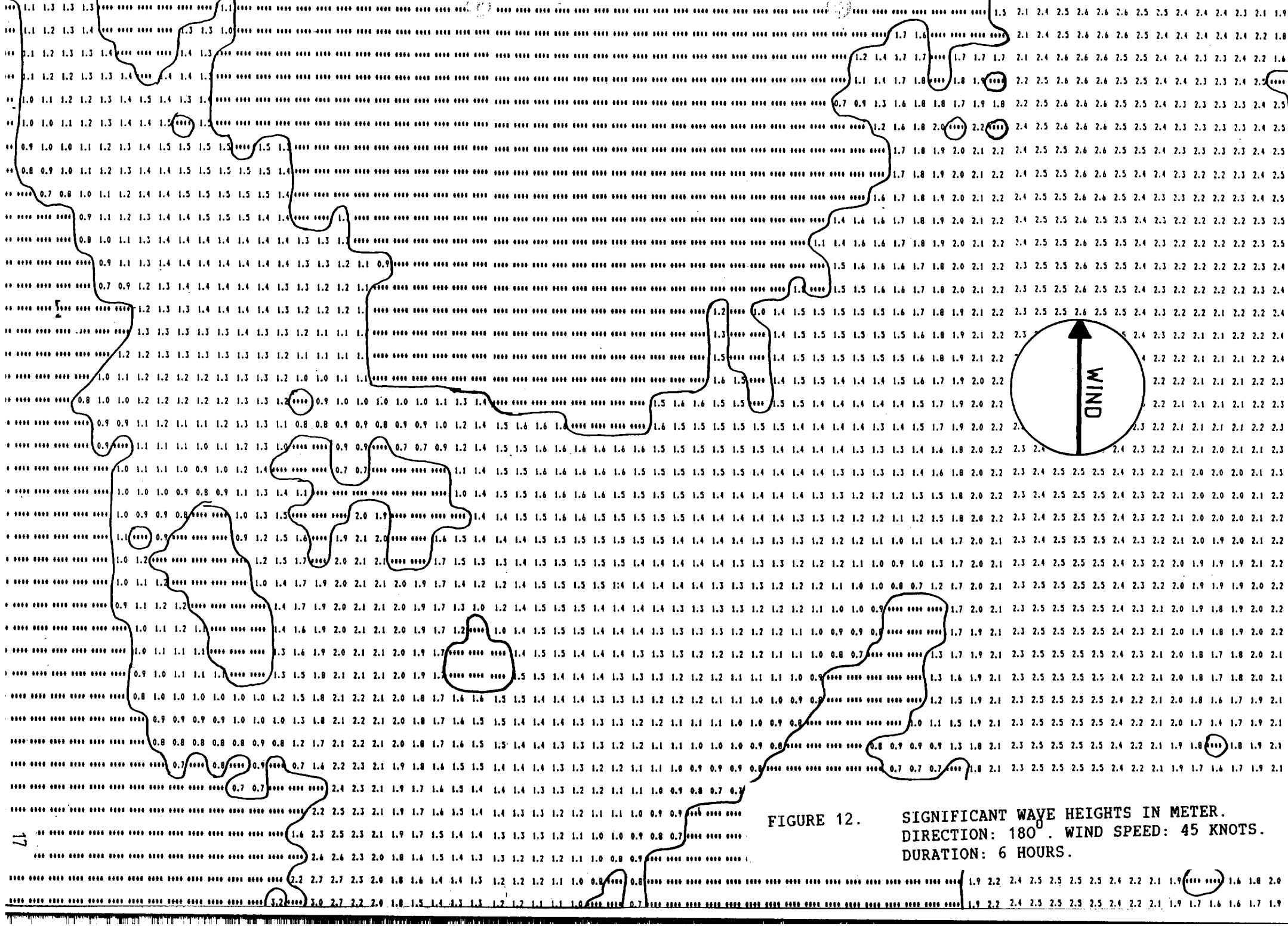

FIGURE 12. SIGNIFICANT WAVE HEIGHTS IN METER.
DIRECTION: 180°. WIND SPEED: 45 KNOTS.
DURATION: 6 HOURS.

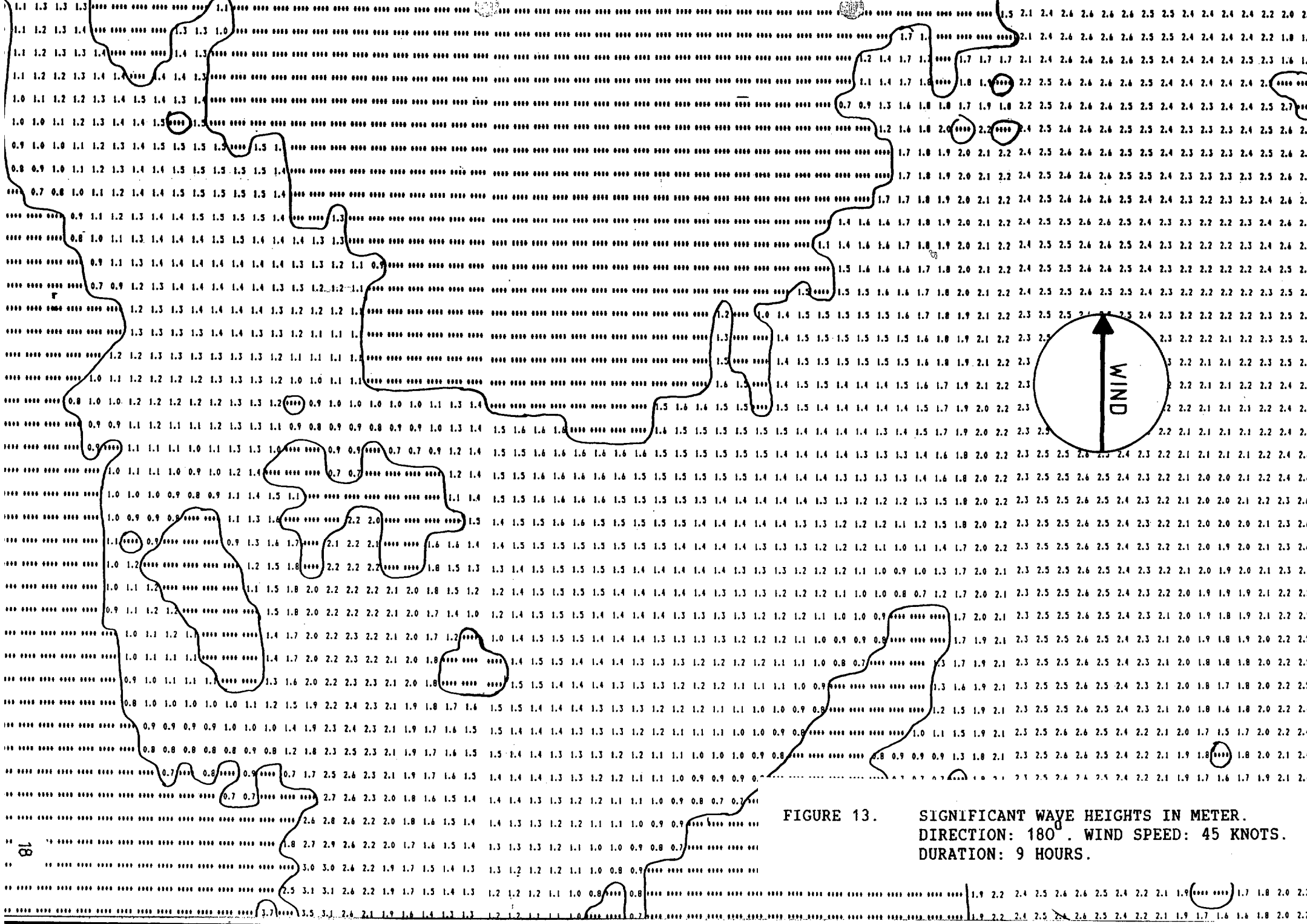

FIGURE 13. SIGNIFICANT WAVE HEIGHTS IN METER.
DIRECTION: 180°. WIND SPEED: 45 KNOTS.
DURATION: 9 HOURS.

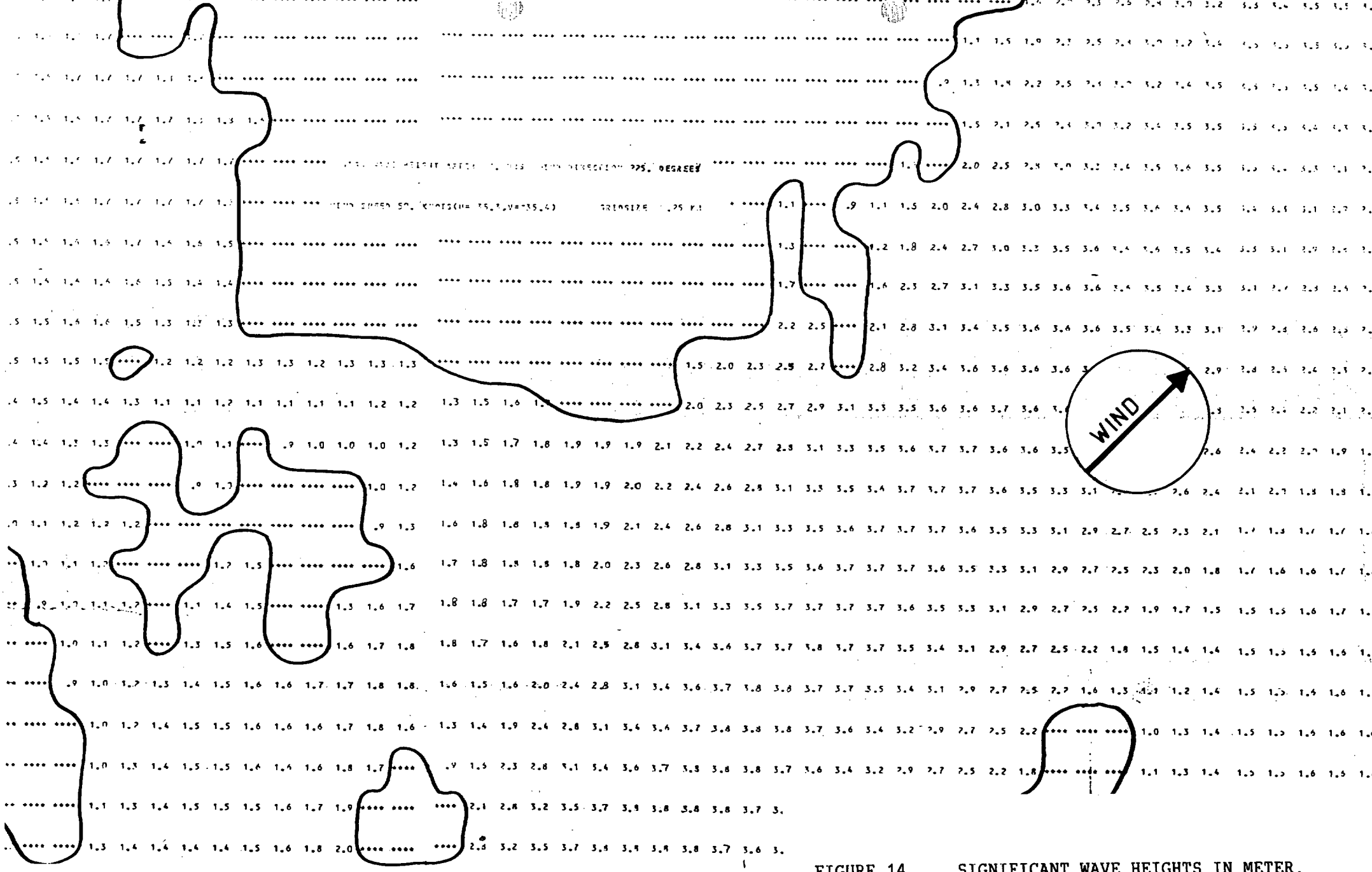

FIGURE 14. SIGNIFICANT WAVE HEIGHTS IN METER.
DIRECTION: 225°. WIND SPEED: 50 KNOTS.
DURATION: 3 HOURS.

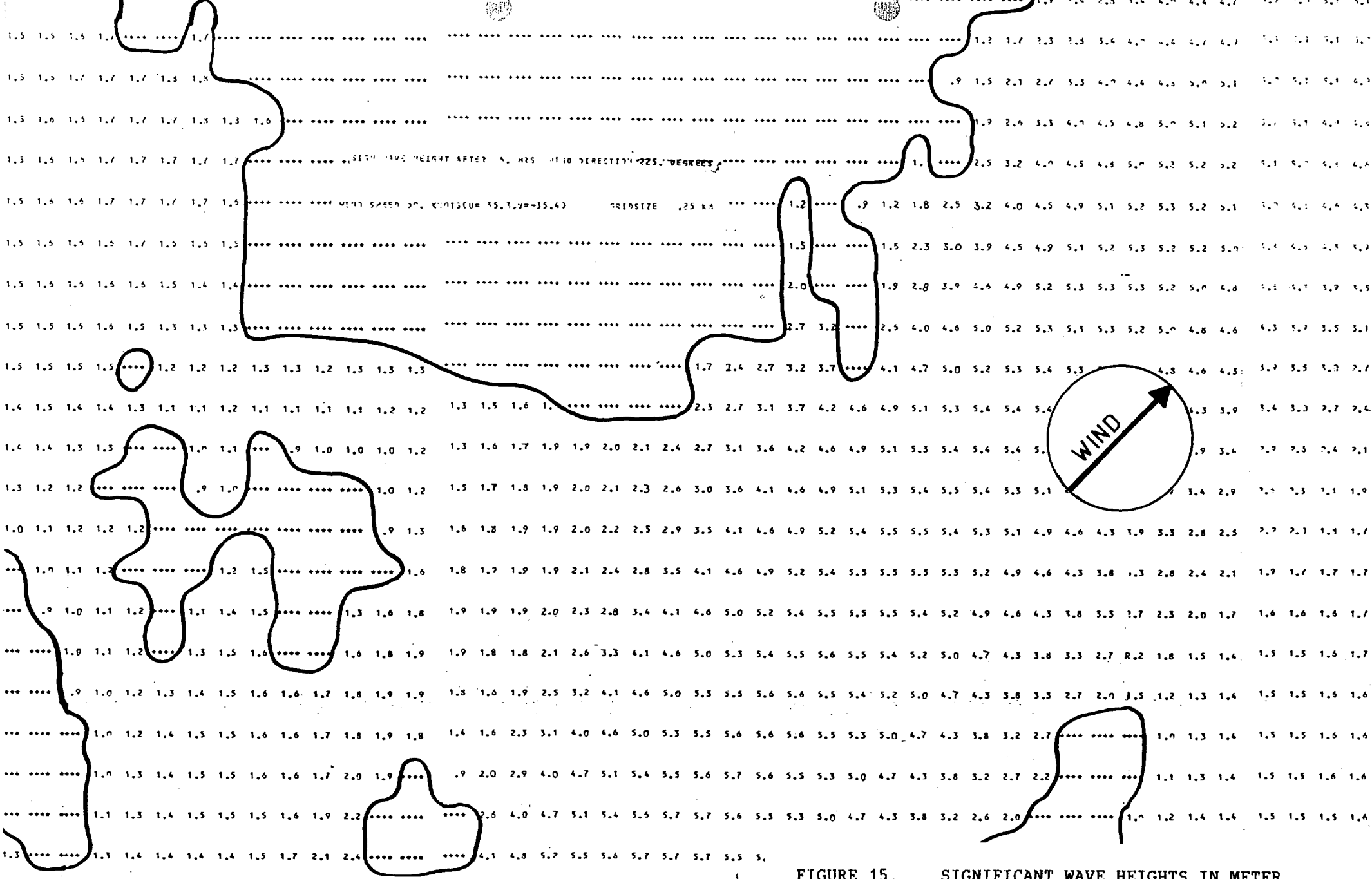

FIGURE 15. SIGNIFICANT WAVE HEIGHTS IN METER. DIRECTION: 225°. WIND SPEED: 50 KNOTS. DURATION: 6 HOURS.

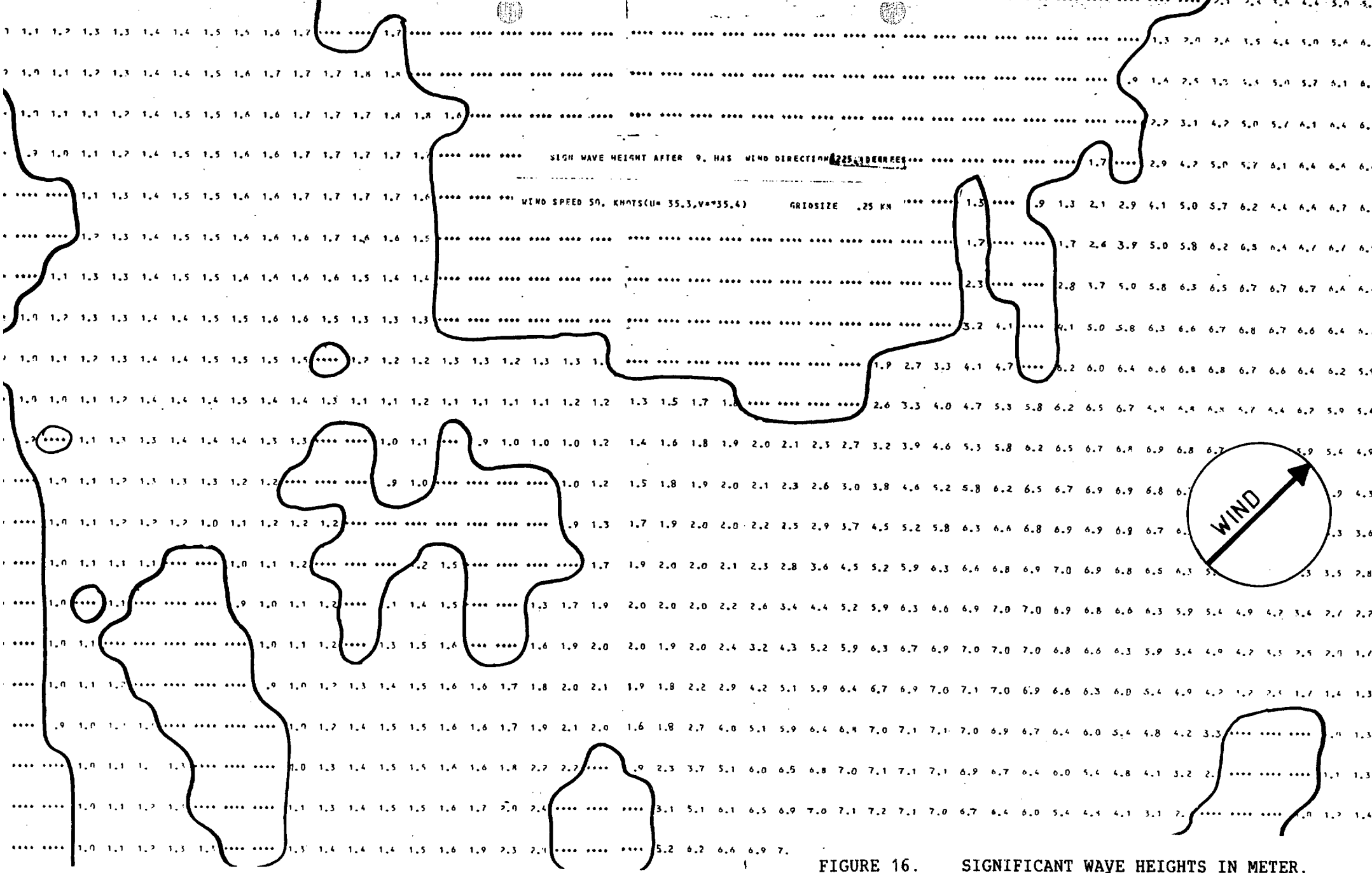

FIGURE 16. SIGNIFICANT WAVE HEIGHTS IN METER. DIRECTION: 225°. WIND SPEED: 50 KNOTS. DURATION: 9 HOURS.

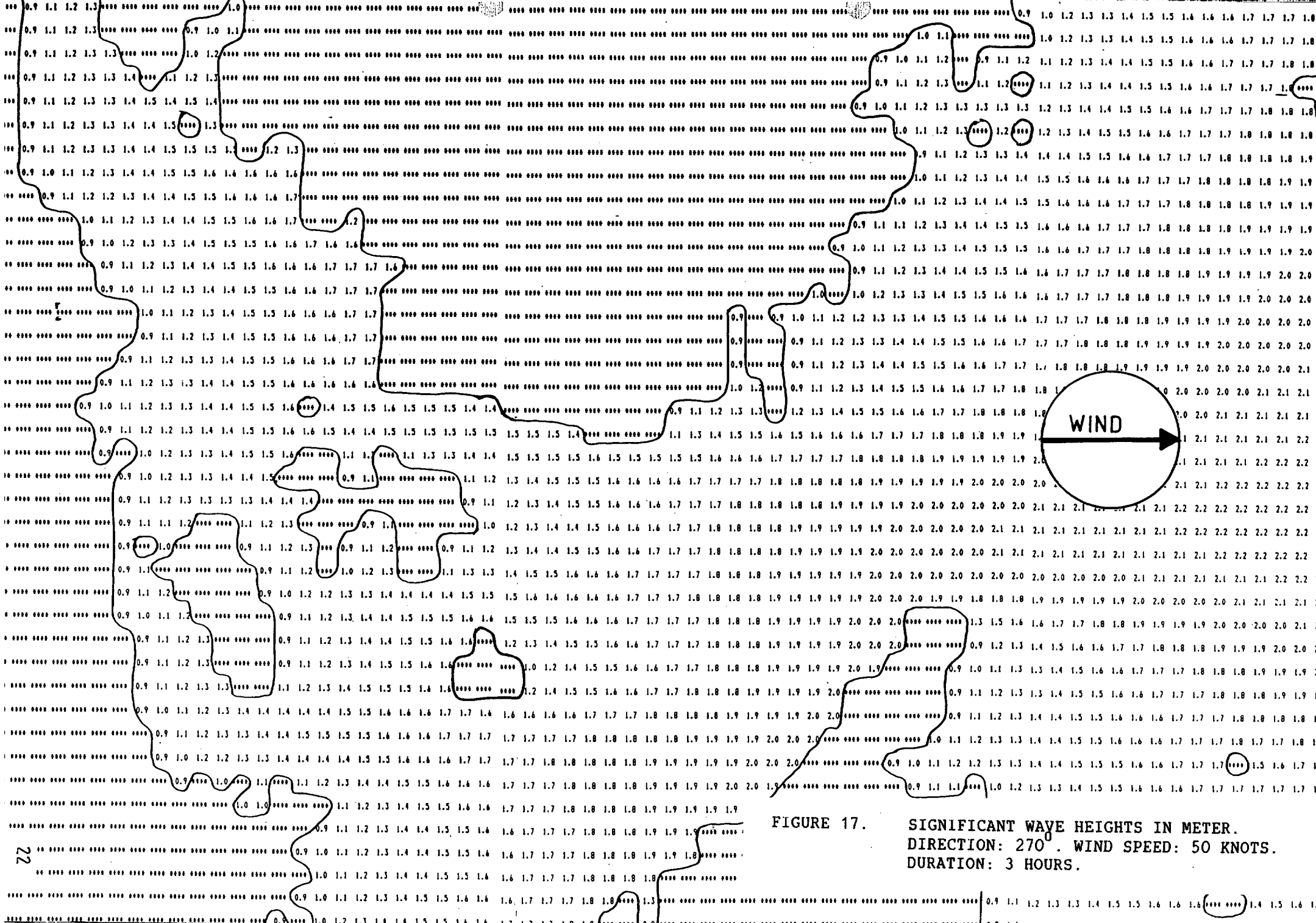

FIGURE 17. SIGNIFICANT WAVE HEIGHTS IN METER.
DIRECTION: 270°. WIND SPEED: 50 KNOTS.
DURATION: 3 HOURS.

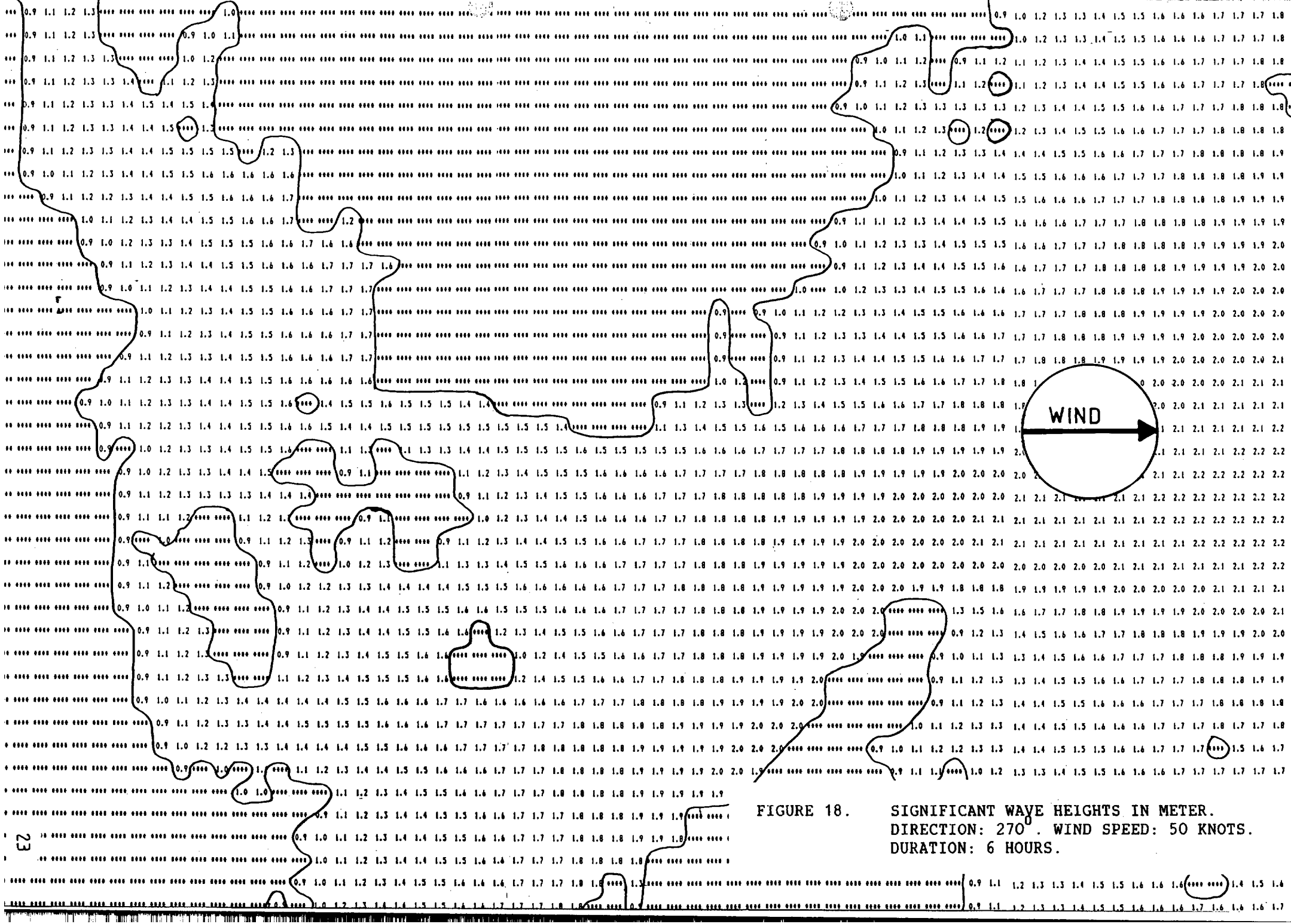

FIGURE 18. SIGNIFICANT WAVE HEIGHTS IN METER.
DIRECTION: 270°. WIND SPEED: 50 KNOTS.
DURATION: 6 HOURS.

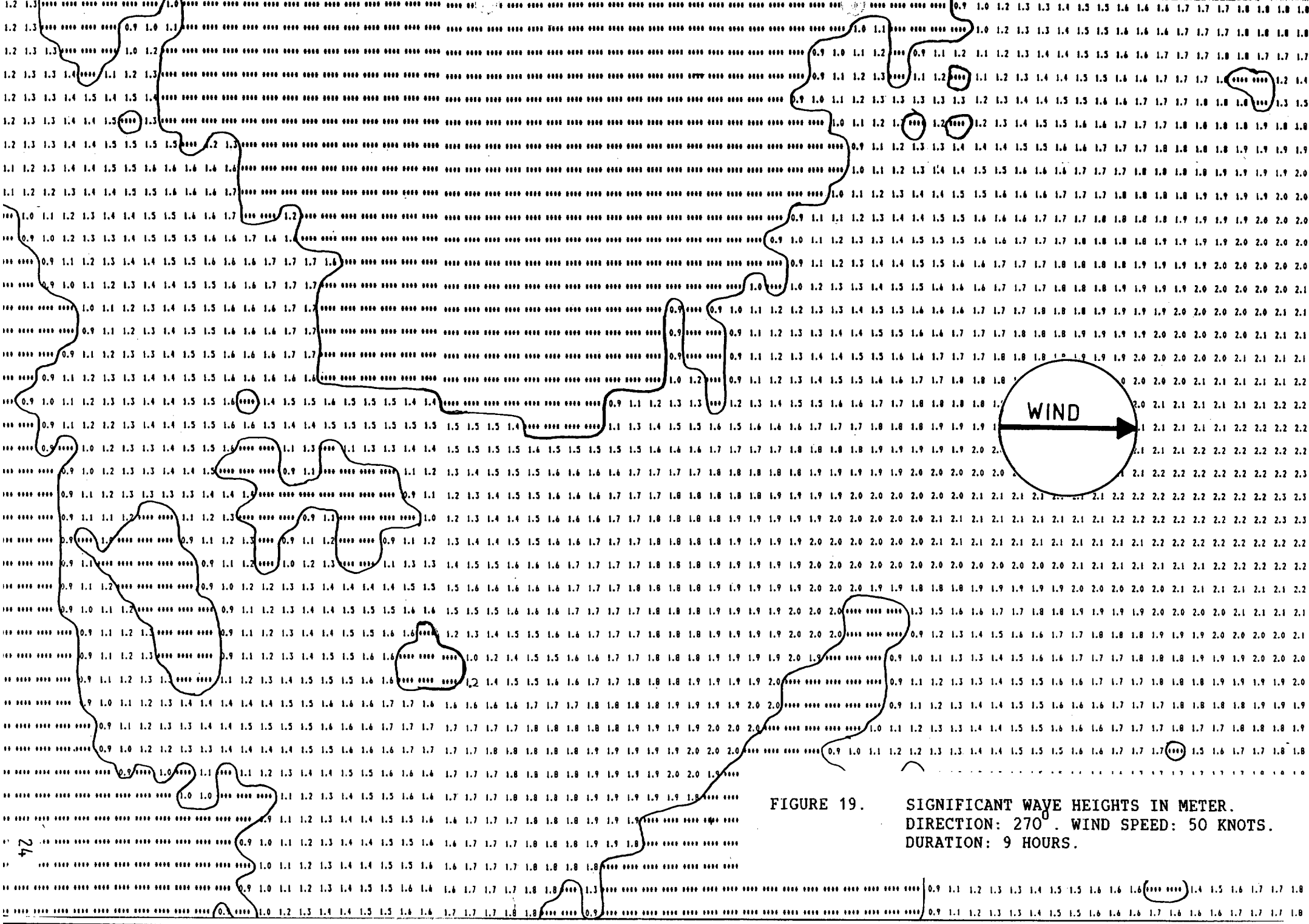

FIGURE 19. SIGNIFICANT WAVE HEIGHTS IN METER.
DIRECTION: 270°. WIND SPEED: 50 KNOTS.
DURATION: 9 HOURS.

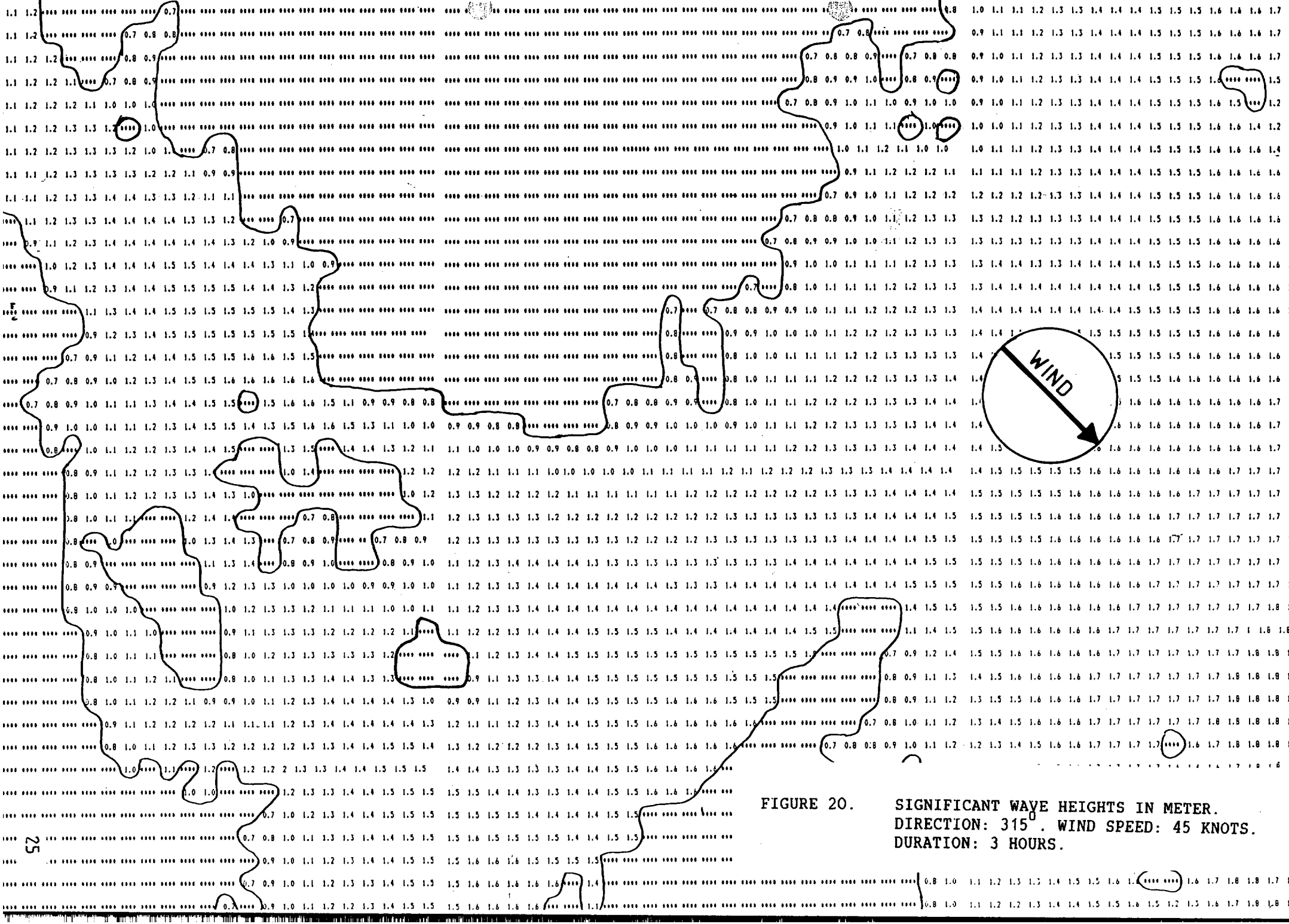

FIGURE 20. SIGNIFICANT WAVE HEIGHTS IN METER.
DIRECTION: 315°. WIND SPEED: 45 KNOTS.
DURATION: 3 HOURS.

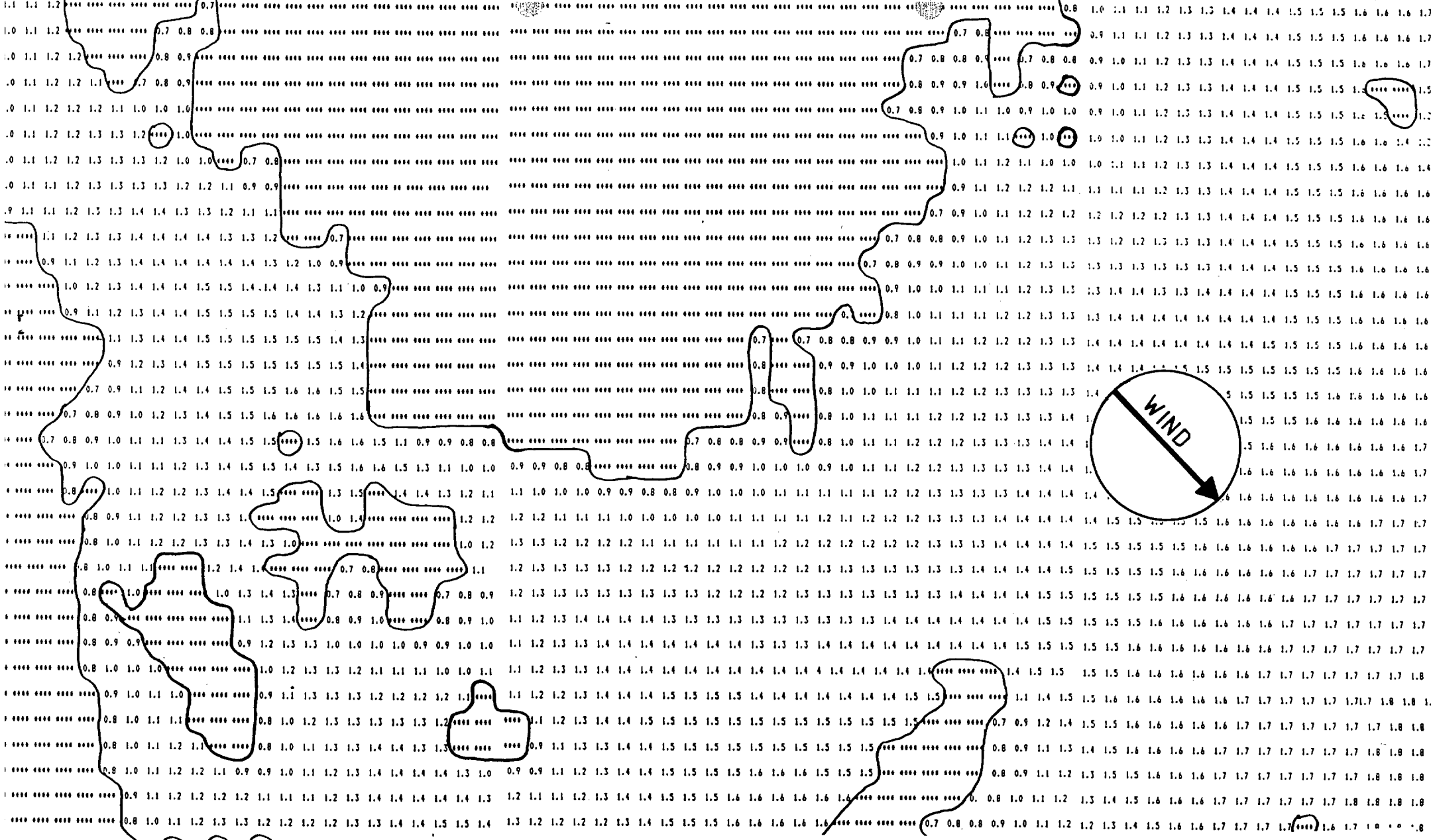

FIGURE 21. SIGNIFICANT WAVE HEIGHTS IN METER.
DIRECTION: 315°. WIND SPEED: 45 KNOTS.
DURATION: 6 HOURS.

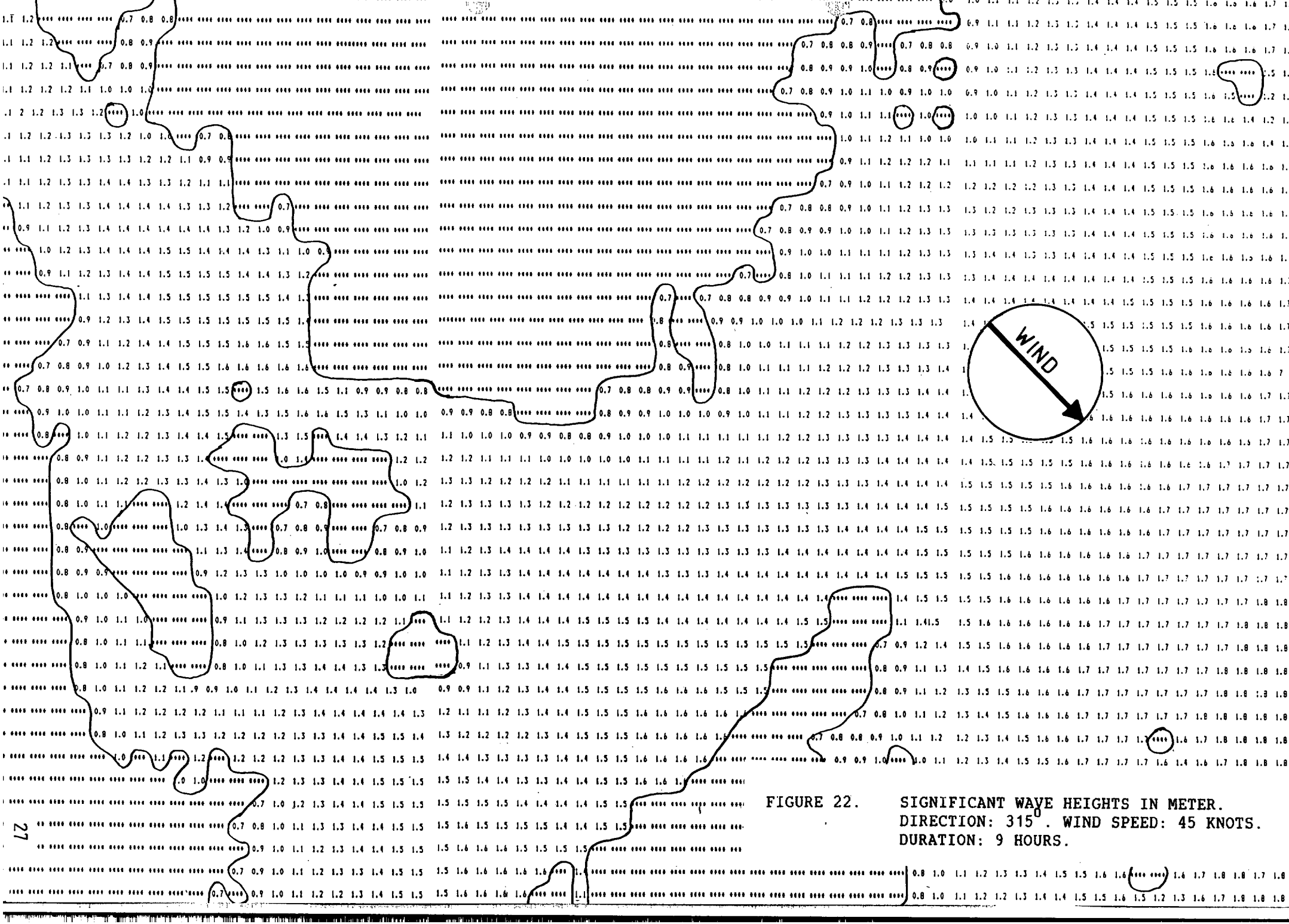

FIGURE 22. SIGNIFICANT WAVE HEIGHTS IN METER.
DIRECTION: 315°. WIND SPEED: 45 KNOTS.
DURATION: 9 HOURS.

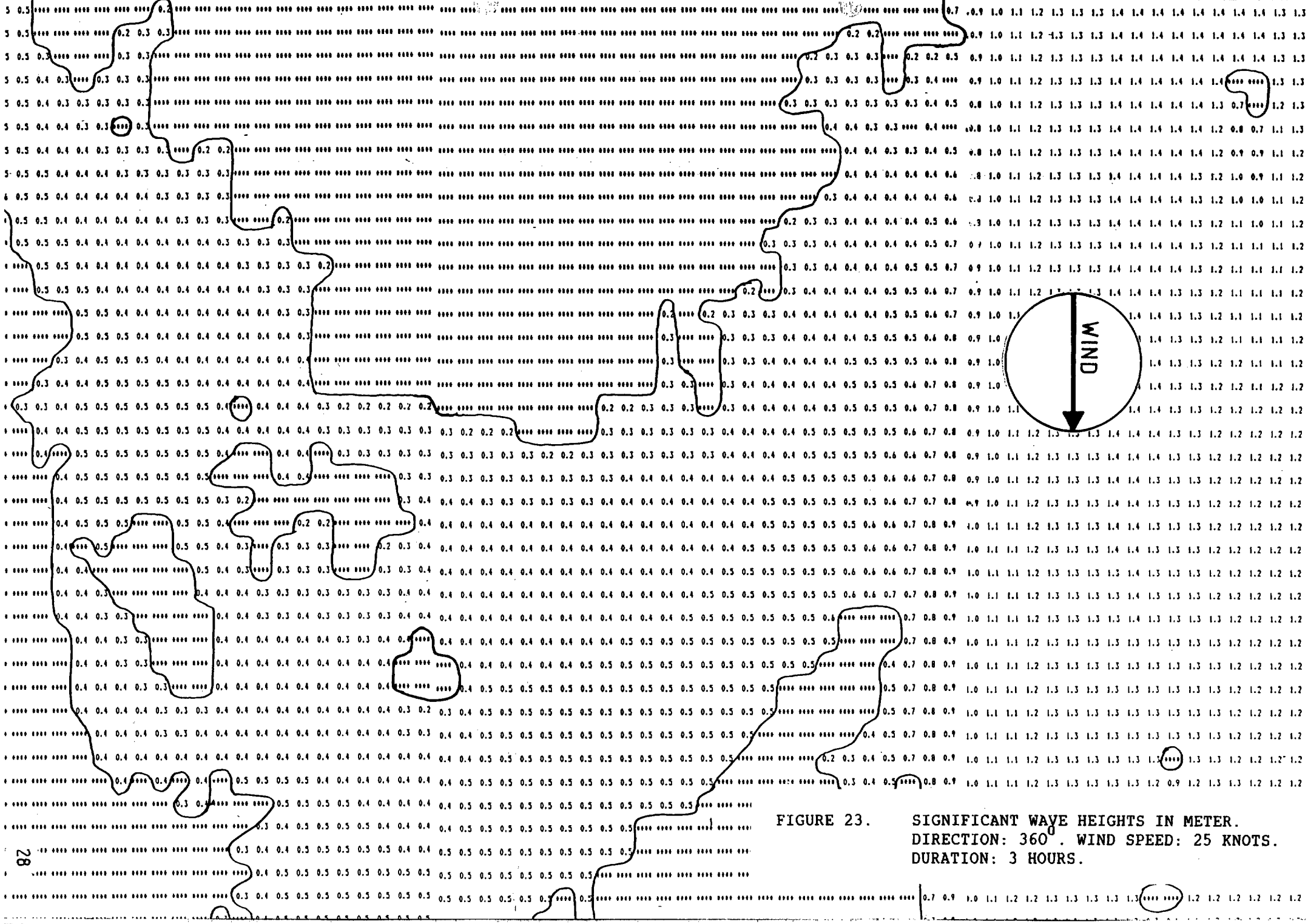

FIGURE 23. SIGNIFICANT WAVE HEIGHTS IN METER.
DIRECTION: 360°. WIND SPEED: 25 KNOTS.
DURATION: 3 HOURS.

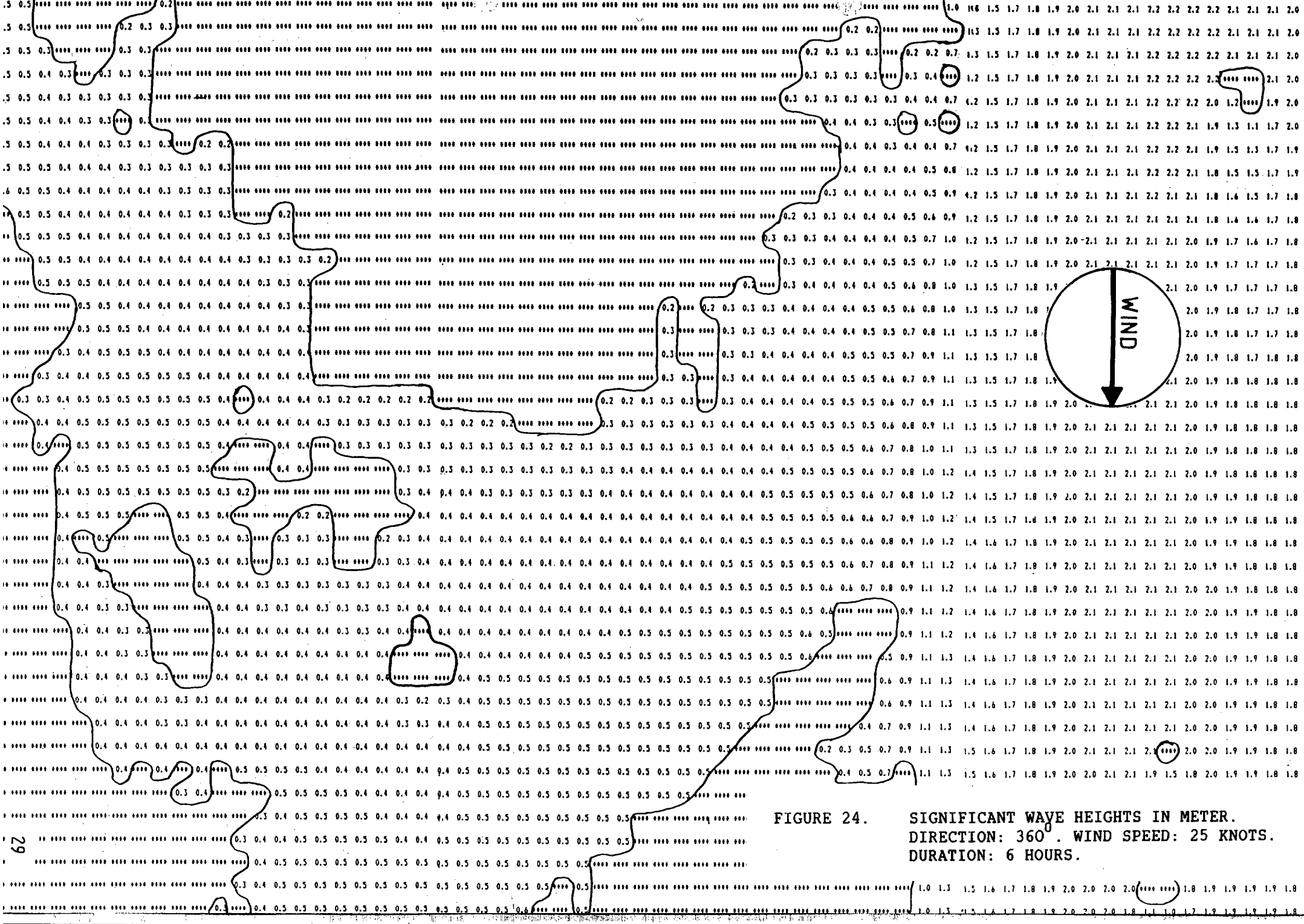

FIGURE 24. SIGNIFICANT WAVE HEIGHTS IN METER. DIRECTION: 360°. WIND SPEED: 25 KNOTS. DURATION: 6 HOURS.

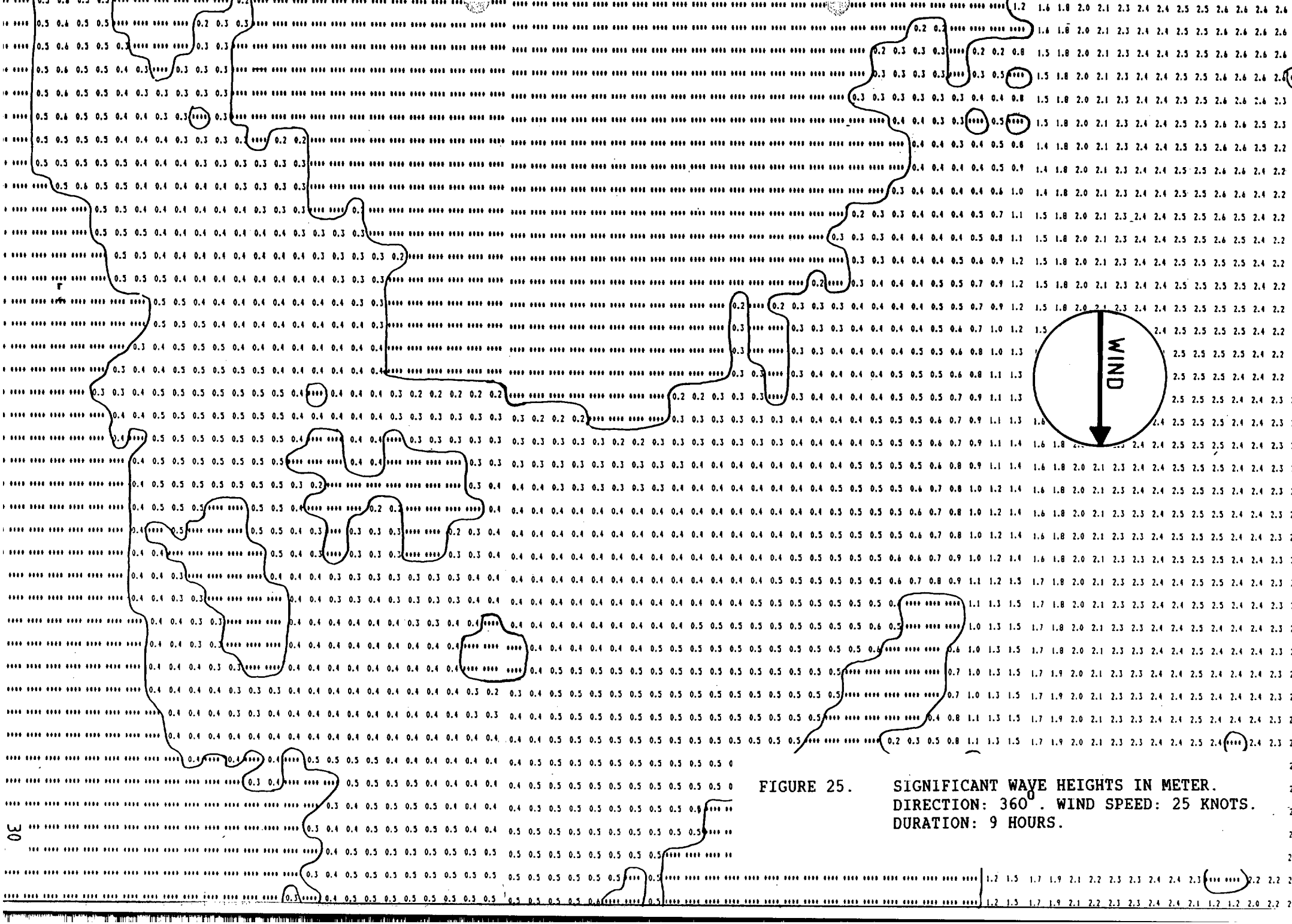

FIGURE 25. SIGNIFICANT WAVE HEIGHTS IN METER. DIRECTION: 360°. WIND SPEED: 25 KNOTS. DURATION: 9 HOURS.

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