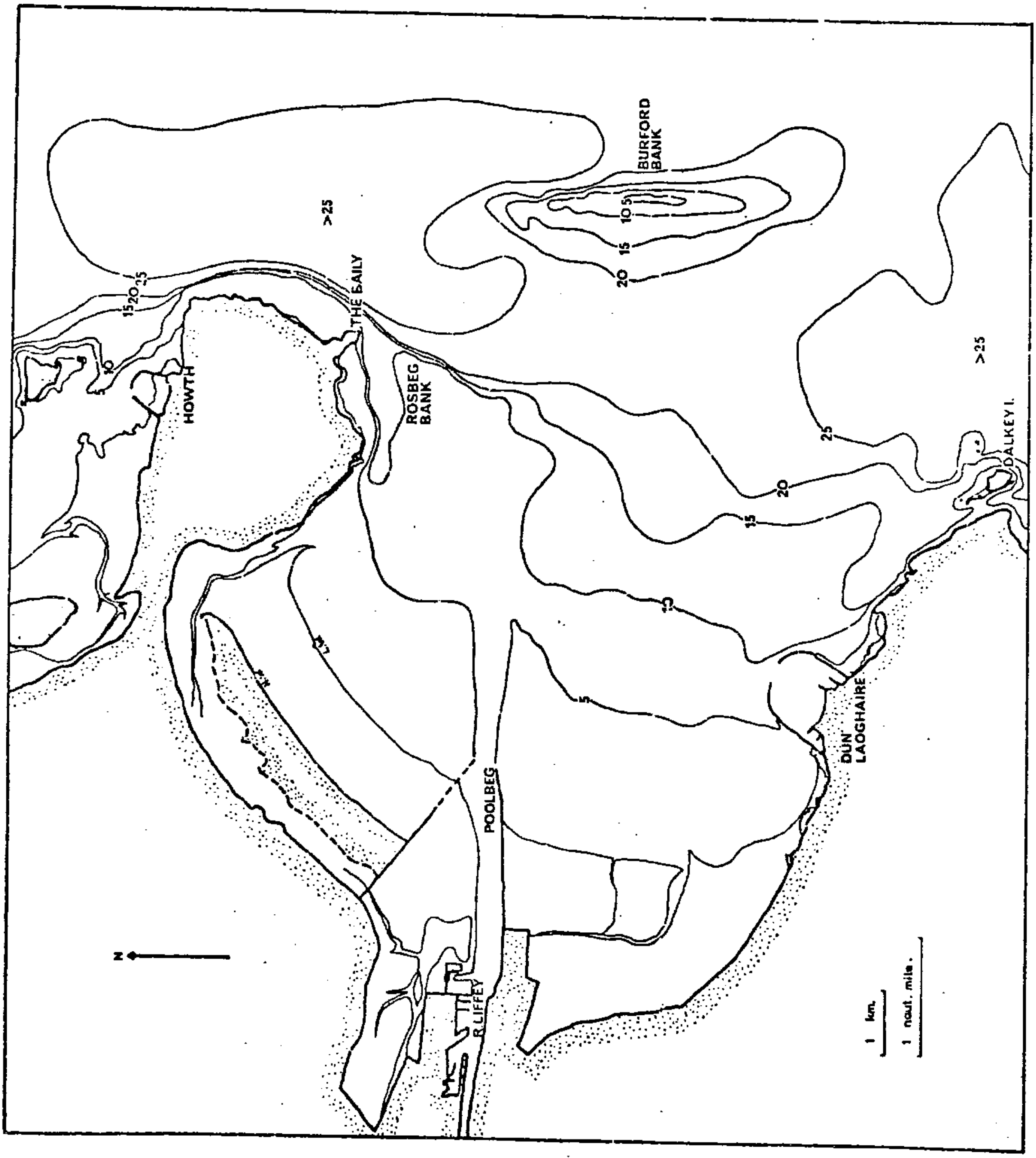
MORPHOLOGY OF THE BAY

Dublin Bay is a shallow east facing bay bounded by the rocky headlands of Howth Head and Dalkey into which the estuary of the River Liffey emerges. It is about 10 km wide at its mouth and has an area of about 100 sq. km. (Fig. 1). The Liffey estuary, channelled by long breakwaters, emerges through extensive intertidal sand flats into the middle of the bay. In places these intertidal flats are over 2 km wide. Bottom contours are shown in Fig. 2.

The bed of the bay slopes gently seawards from low water to a depth of about 12 metres; thereafter it slopes more steeply to reach 20 - 25 metres approximately on the line between the headlands. About 2 km seaward of this line there is a linear sand bank (Burford Bank) which rises to within 5 metres of the surface. This partly closes the mouth of the bay and forms a natural seaward boundary. Only in the south eastern corner of the area, between Burford Bank and Dalkey, do depths reach 30 metres.

Both the north and south sides of the bay have rocky shores, but there are differences between the two sides. Howth Head extends slightly further seaward than even the islands off Dalkey. Thus the mouth of the bay is effectively aligned at 20° to the principal line of the east coast of Ireland and hence to the tidal currents. On the north side there is also a sandbank (Rosbeg Bank) running south from the Baily at the southern tip of Howth Head, though there is a deeper channel between the land and the bank.

Fig. 2. Bottom topography. Depth contours in meters.
Adapted from Admiralty Chart 1415 (corrected to 1969)



TIDES AND TIDAL STREAMS

The range of the tide at Dublin is only moderate reaching 11.3 ft. (3.5 metres) on mean spring tides and 6.0 ft. (1.9 metres) on mean neap tides. The neighbouring ports of Howth and Dun Laoghaire have virtually the same range. There is however a difference between the time of high water in Dublin and the time the tidal current turns in the adjacent part of the Irish Sea. The tide at Dublin is about 1½ hours later than at sea. This type of delay is typical of situations where the tide flows into a constricted estuary.

Tidal streams in this part of the Irish Sea run north on the flood and south on the ebb. That is, roughly parallel with the coastline. The nearest tidal stream notations given on Admiralty charts are for a position 1.3 km NNE of the Kish Light where the directions are 002° on the flood and 182° on the ebb. For areas within the bay, the Port and Dock Board have assembled a tidal stream atlas from various series of float tests that have been done since 1887. In addition, current meter observations were made for this study at four positions within the bay during the summer of 1972. These show that as the flood tide runs north across the mouth of the bay, it spreads out and then flows out again round the Baily. The current meters at Rosbeg Buoy showed considerable variations in direction on the flood suggesting that the flood flow out of the north side of the bay sometimes extends to the south side of Rosbeg Bank. The meeting of tidal streams may account for the steep seaward face of Rosbeg Bank. The tidal atlas also shows that the flow across the bay extends into the bay at least as far as the Bar buoys (2½ km off Poolbeg). Only landward of this position does the flood into the estuary and over the sand flats become the dominant influence.

On the ebb the south going flow seems to be deflected by Howth Head, particularly at the Baily, in such a way as to draw water out of the bay between Rosbeg Bank and the shore. Thus there are parts of the northern section of the bay where the flow is nearly always in the same general direction. The south going ebb stream spreads into the bay to a far less extent than the flood. In the middle of the bay the two long breakwaters direct the ebb from the estuary into a narrow stream that seems to extend seaward almost to the Rosbeg Buoy. This seaward extension of the estuary ebb at low water is assisted by the flood stream starting to run out of the north side of the bay.

The tidal currents off the Kish reach 2.1 knots on the flood and 2.2 knots on the ebb at mean spring tides. The 1972 current meter observations and the Dublin Bay Tidal Atlas show that current speeds are slightly higher close to the headlands than at the Kish, but they are generally much lower within the bay. To illustrate this a contour diagram has been drawn to show the approximate mean maximum velocities at spring tides (Fig. 3). This shows that much of the bay experiences currents of less than a knot and near the beaches on either side of the estuary mouth currents are less than 0.5 knots. The current speeds tend to differ on the flood and ebb tides so they are compared in Fig. 4 and 5.

Residual currents

There is a slight difference between the strength and duration of the flood and ebb tidal streams at this part of the Irish Sea. Off the Kish the ebb is slightly stronger but the flood lasts longer. This more than compensates for the stronger ebb and gives a net residual of about ½ a mile per tide on springs in the flood direction. In the channel between Rosbeg and Burford Banks vector plots of the 1972 current meter data show the same pattern with a stronger ebb but a longer flood. Extrapolation of the current meter data was necessary because the observations were made on a series of days on which the tide ranges varied and none covered a full tidal cycle. To bring them all to a common basis it was necessary to assume that tidal current speeds at the particular spots were proportional to the tidal range. Then all the observations were converted to the current speed that should occur on mean maximum spring tides (range 11.7 ft.). Observations taken on different days were then brought together and average speeds and directions were calculated for each 20 minute period of the tidal cycle relative to the time of high water at Poolbeg. The results of these calculations have been plotted as a series of progressive vector diagrams (Figs. 6, 7, 8, 9). The vectors start at the time of low water slack at the observation point rather than at a particular time relative to high water at Poolbeg.

At the end of the flood tide the clockwise flow round the bay which mainly comes out between the Baily and Rosbeg Bank seems to impart an easterly movement to the water north of Burford Bank. This can be seen in the vector diagram for a station 200 ft. off the Baily in the sludge dumping area. The easterly movement takes place between HW-3hr and HW-1hr Poolbeg tide time, and is more pronounced in the bottom water than the surface. This suggests that the surface water from the sludge disposal area is apt to ebb between Rosbeg and Burford Banks but that some of the bottom water is likely to take the channel east of Burford Bank.

Near the Rosbeg Buoy the tidal currents are predominantly to the

NE during the flood and SW on the ebb, but the direction is much more consistent on the ebb. Tidal flow durations are assymetrical with the flood lasting about 1 hour longer than the ebb. Peak ebb velocities are 1.7 kts at the surface and 1.6 kts 10 ft. above the bottom on mean springs and are slightly greater than the flood (1.6 kts surface 1.4 kts bottom). The resulting residual vectors on mean springs are 1.6 miles at 54° near the surface and 2.13 miles at 80° near the bottom. At the current meter station in the south of the bay the tide was shown to flood toward the north west but to ebb to the south. This suggests that although on the flood the station site is within the area from which water flows into the bay, on the ebb it is the area covered by the south going Irish Sea flow and any water carried out of the bay is either closer inshore to the south or further north. This assymetry gives a strong apparent residual flow into the bay (5.3 miles at 265° on the surface and 2.2 miles at 254° near the bottom). The flood is less strong than the ebb (1.5 - 1.0 knots) at mean springs.

At position 4, between Dun Laoghaire and Poolbeg, the assymetrical current pattern is similar to position 3 but velocities are lower. The residual vector is 3.1 miles at 255° on springs. Peak velocities are only 0.7 kts and the flood at 0.5 kts as the ebb.

To try to supplement the current meter data an attempt has been made to analyse the water movement through the bay from the Tidal Atlas float drift data. This was done by dividing the bay on a grid basis. Average current velocities and directions were then taken from the drift charts of each of the hours in the tidal cycle and for each grid square. Vector diagrams were then constructed for each square where there was sufficient data. From these vector diagrams surface residual currents were found (Fig. 10.). These show a strong clockwise circulation through the bay.

It is apparent that there are discrepancies in the grid vector analyses between the amount of water flowing into the south of the bay and the amount apparently flowing out on the north side of the bay. There are also discrepancies between the residual vectors found from the 1972 current meter measurements and the residuals found from the grid analysis of the drift charts. This applies particularly in the south of the bay where the meters showed much stronger inward residuals. Near the Rosbeg Buoy there was remarkably close agreement between the two methods. If the drift analysis residuals are taken to represent average tide conditions the comparative figures for the residual are 0.7 miles from the floats and 0.77 miles from current meters.

An attempt was made to try to find the source of the anomalies by trying to calculate the volume of water that has to pass across a line drawn from Dun Laoghaire Pier to the Baily on each tide to raise the water level inside a given amount and to cover intertidal sand flats. Rough measurements indicate that the area of water is about 37 sq. km. at low water and 56 sq. km. at high water springs. The average flow across the boundary which was taken as 8.1 km wide and 12 metres deep on spring tides would need to be about 7.75 cm/sec. On neap tides it would need to be about 4.3 cm/sec. By comparison it was estimated from the series of grid vector diagrams on the boundary line that on the flood the net flow into the bay after the flow out on the north side had been subtracted was about 5.4 cm/sec. This is lower than the figure of about 6.4 cm/sec that might be expected on the surface on an average tide when bottom drag is taken into account. Ebb calculations from the drift grid give a much higher figure of 15.2 cm/sec to seawards and so are nowhere near being in balance with the flood.

Reference back to the current meter and grid drift vector plots suggest where the anomoly arises. The two current meter stations in the south of the bay both showed angular vector plots whereas the plots derived from the drifters were nearly eliptical. The flood directions agree but the ebb directions differ markedly. This suggests that the seaward component in the ebb was overestimated from the drift data.

Stratification could be a cause of such anomalies between flood and ebb surface velocities but there was no evidence for this either in the current meter data or the summer, dry weather, salinity measurements. Thermal stratification brought about by warmed water draining from the extensive intertidal flats and westerly winds could have affected the floats without influencing the surface current meter at 10 ft.

Fig. 3. Mean maximum tidal velocity contours during flood on springs. Derived from Port and Docks Board Atlas of drogue tracks.

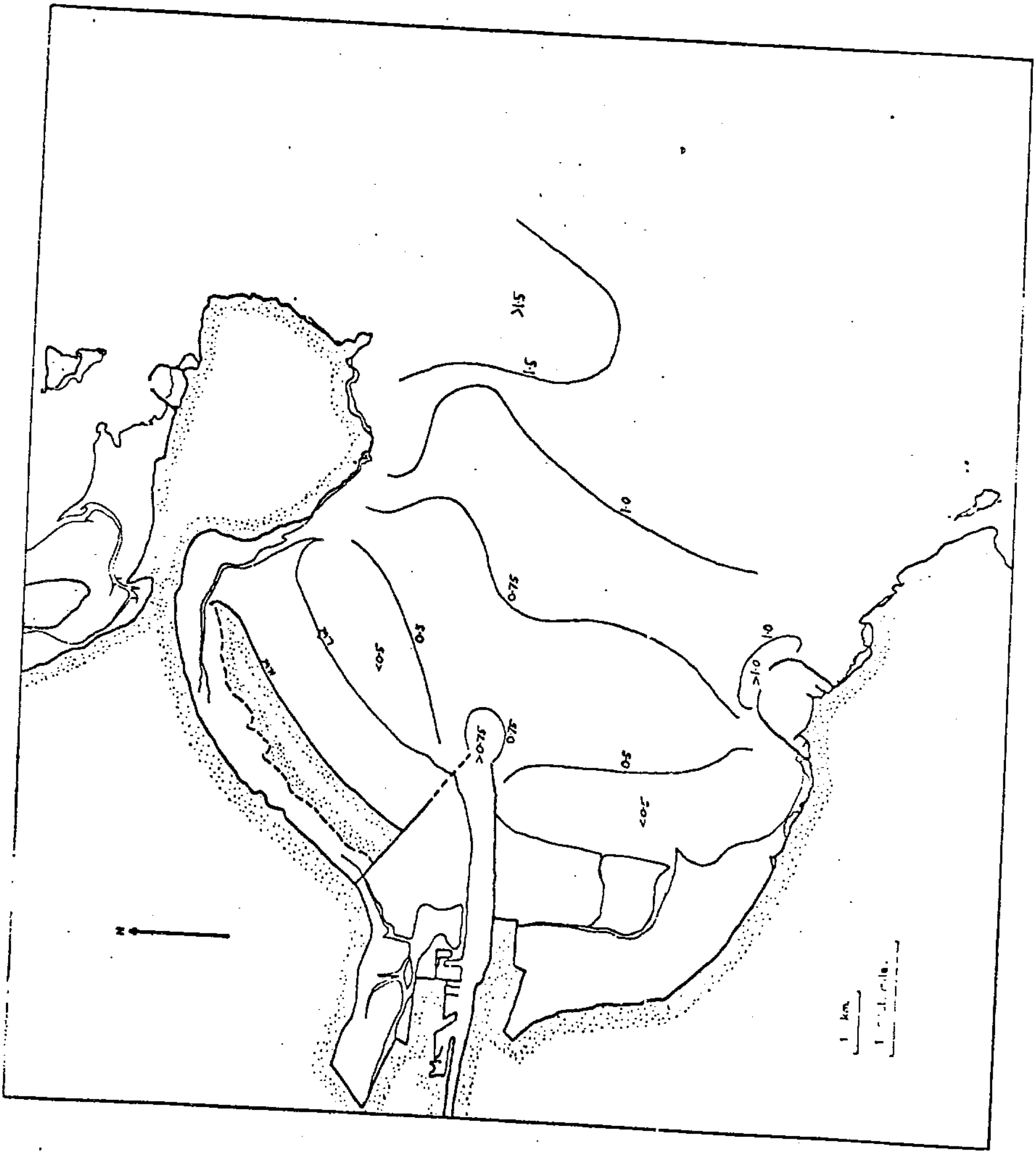


Fig. 4. Mean maximum tidal velocity contours during ebb on springs. Derived from Port and Docks Board Atlas of drogue tracks.

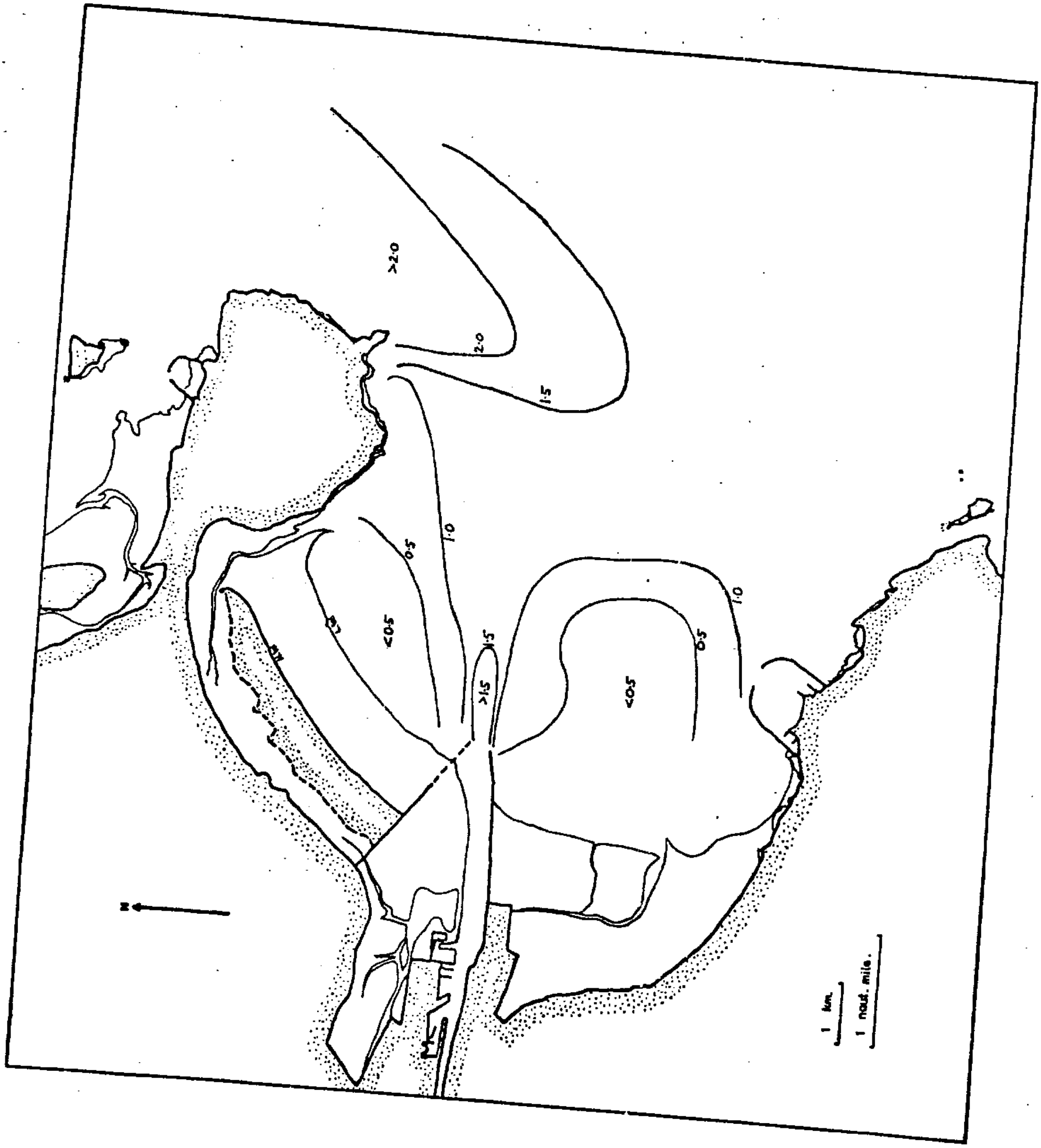


Fig. 5. Principle current directions during flood and ebb tides and approximate distance run. Derived by constructing vector diagrams for grid squares using data from the Port and Docks Board Atlas of drogue tracks.

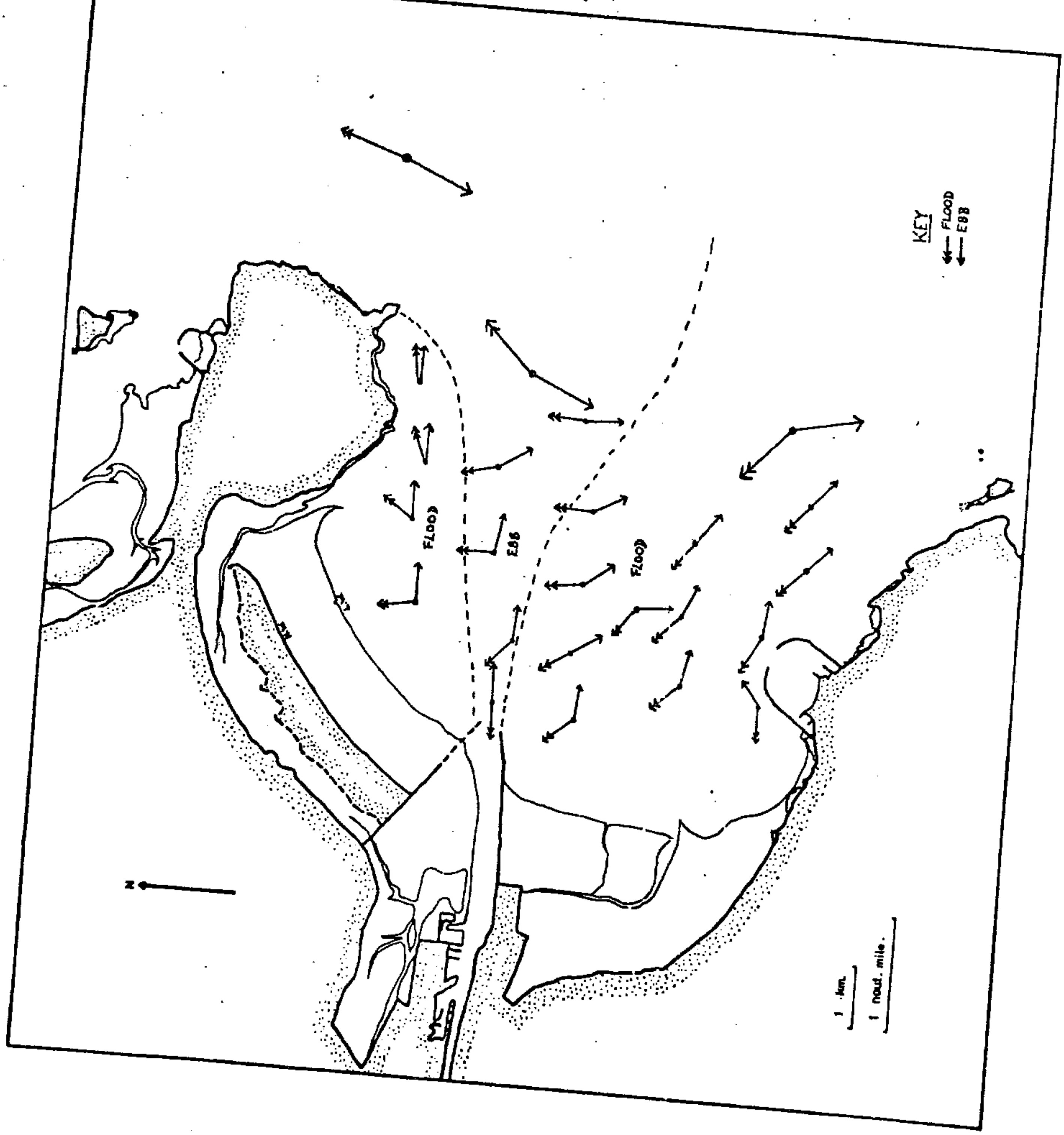


Fig. 6a. Tidal vector diagram for position 1, 2000 ft. off the Baily. Derived by standardising a series of current meter observations made on different days to a uniform tide range. Current meter 10 ft. below surface.

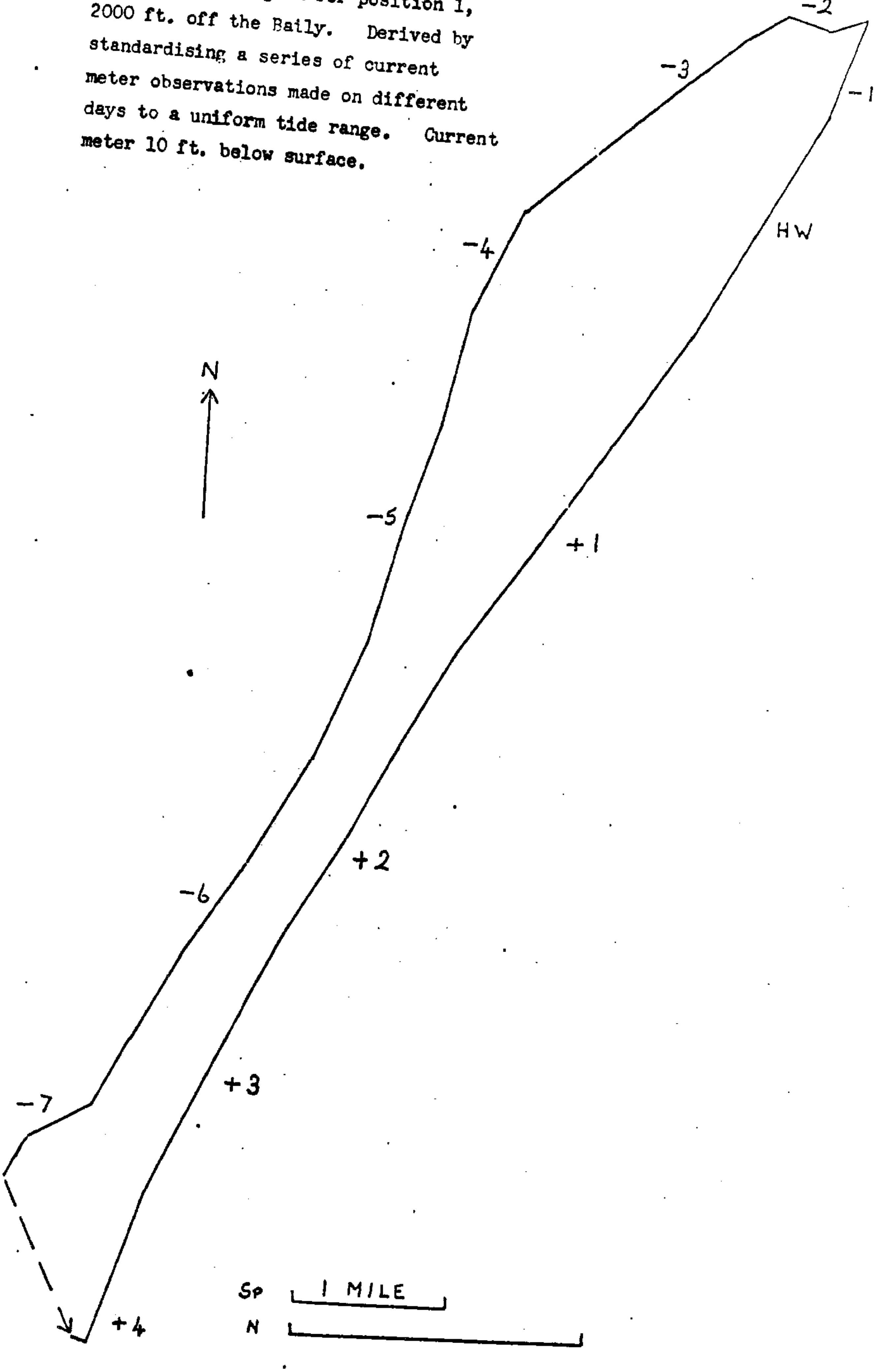


Fig. 6b. Tidal vector diagram for position 1, meter 10 ft. above bottom, standardised tide.

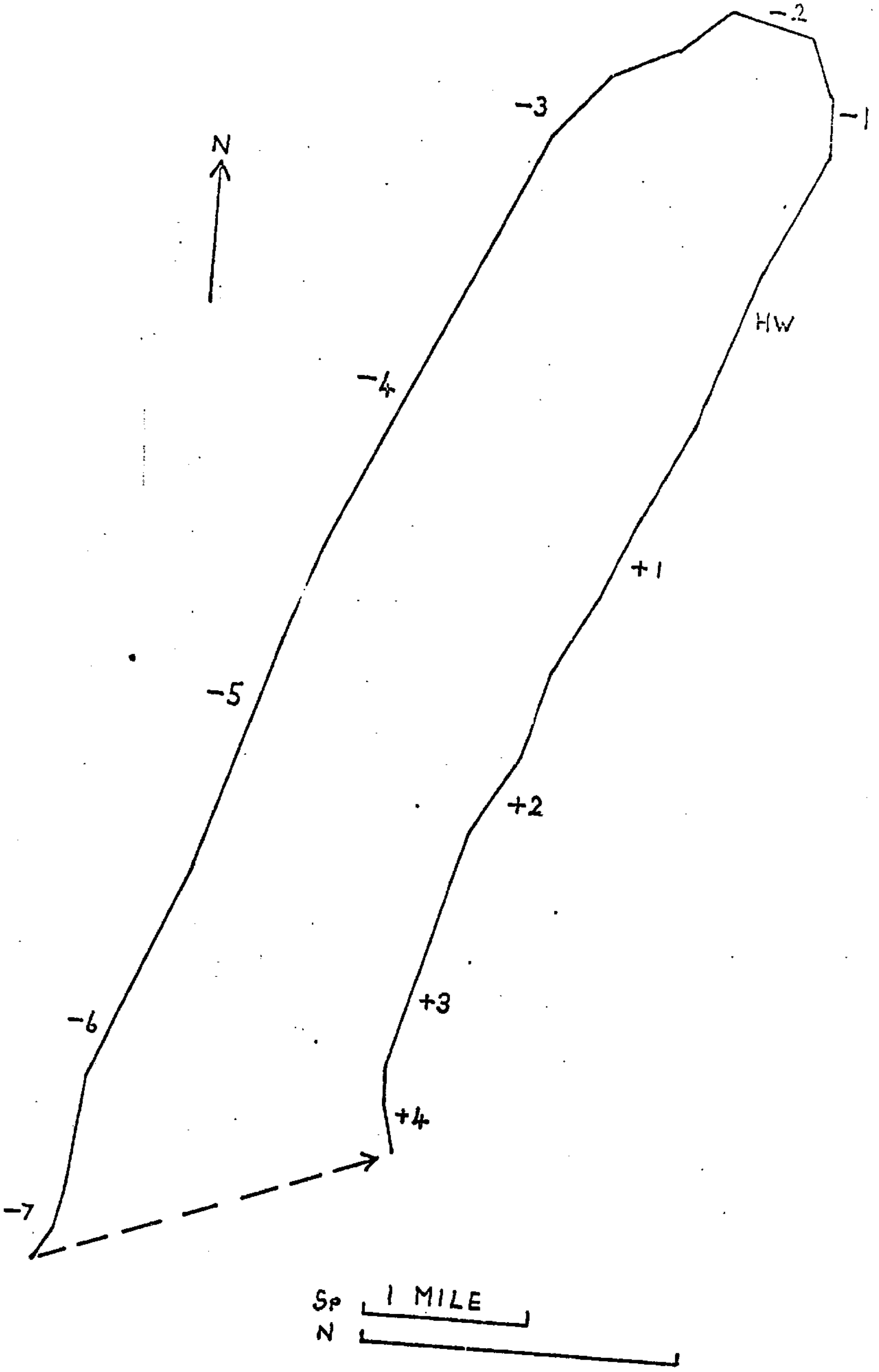


Fig. 7a. Tidal vector diagram for position 2, Rosbeg Buoy, meter 10 ft. below surface, standardised tide.

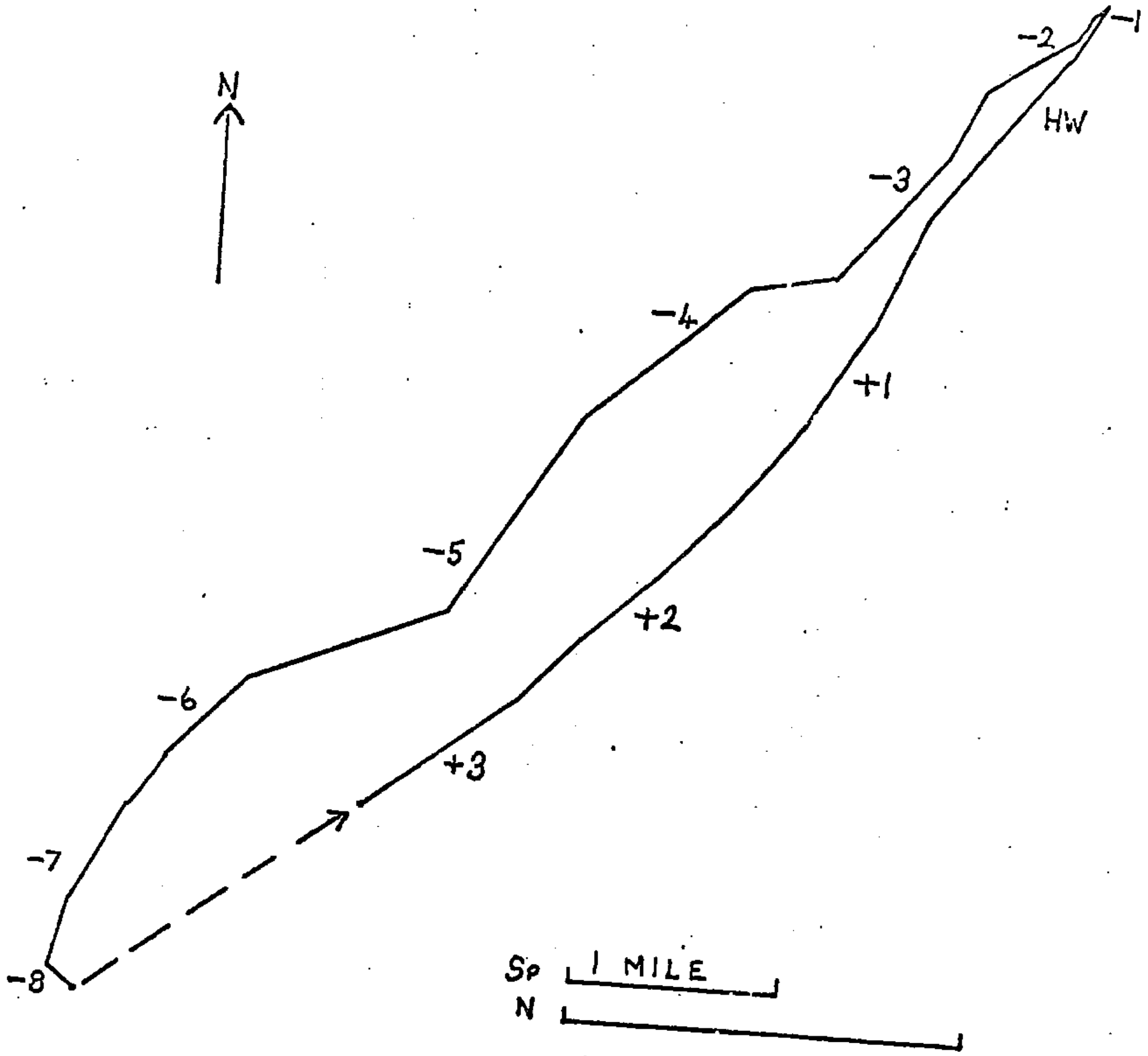


Fig. 7b. Tidal vector diagram for position 2, Rosbeg Buoy, meter 10 ft. above bottom, standardised tide.

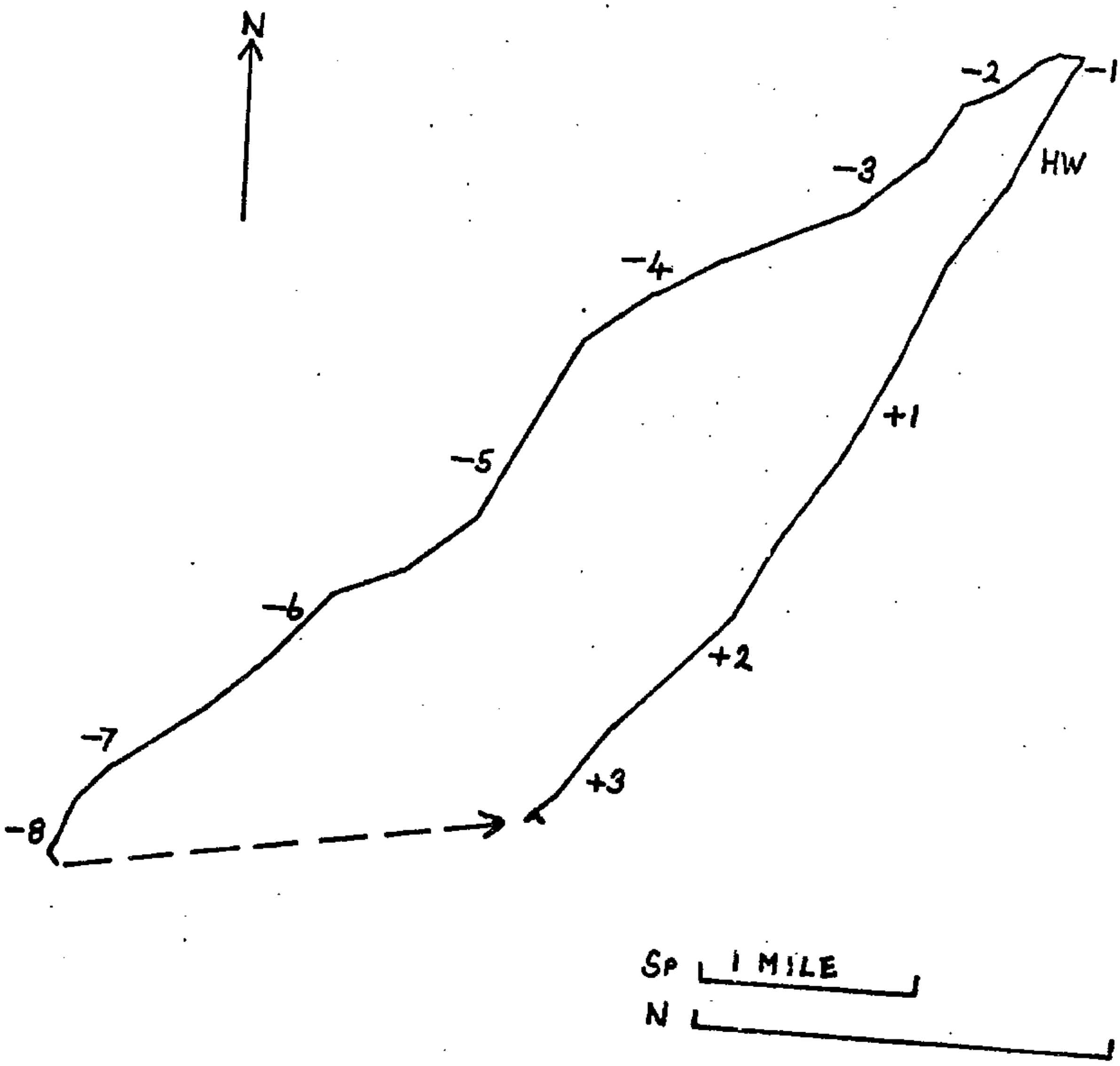


Fig. 8a. Tidal vector diagram for position 3, outer south bay, meter 10 ft. below surface, standardised tide.

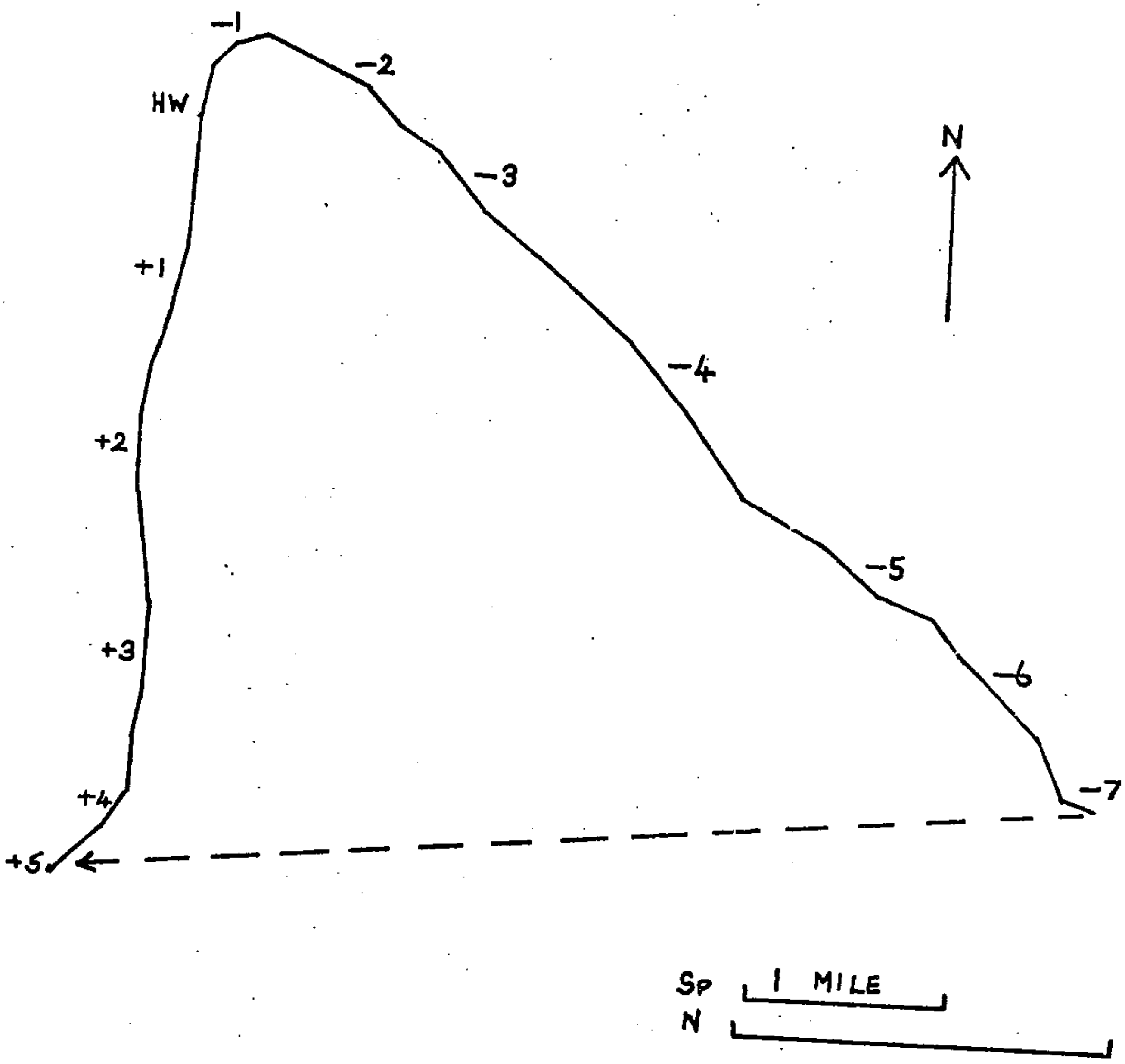


Fig. 8b. Tidal vector diagram for position 3, outer south bay, meter 10 ft. above bottom, standardised tide.

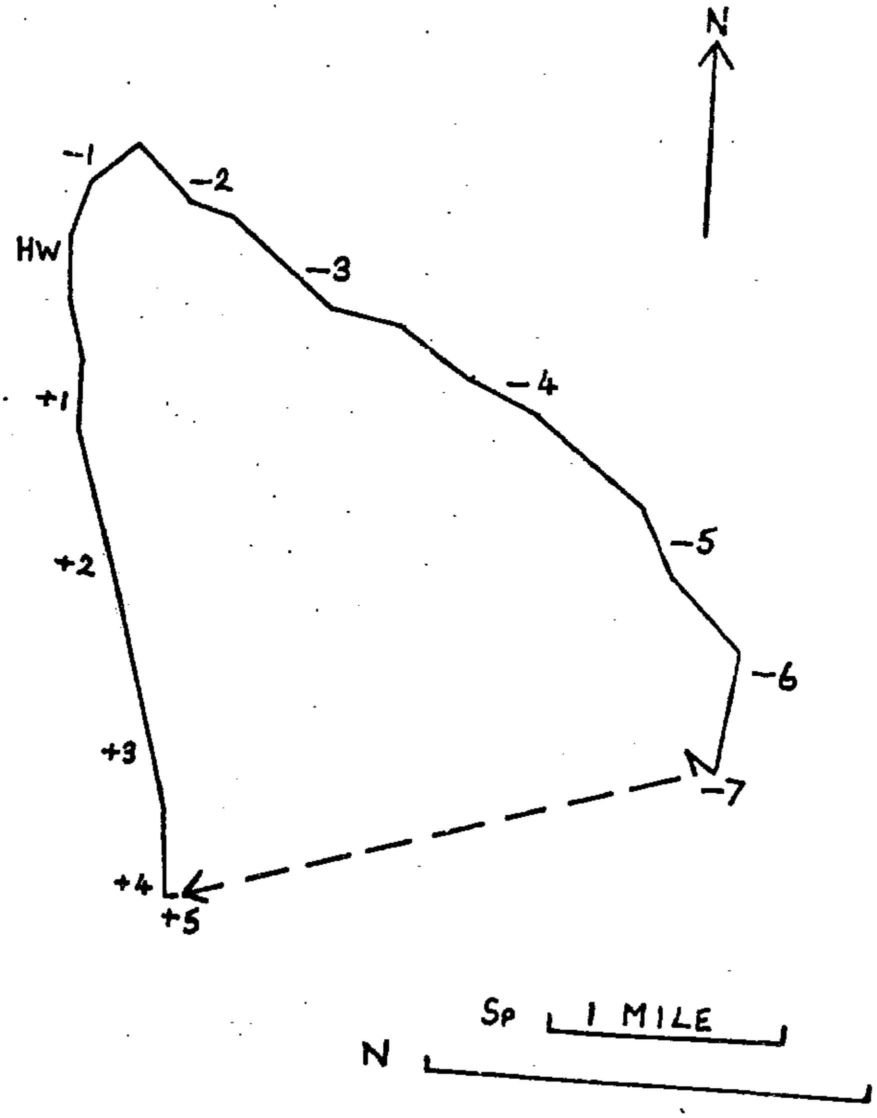


Fig. 9. Tidal vector diagram for position 4, inner south bay, meter 10 ft. below surface, standardised tide. Near bottom readings apparently below the reliability threshold of the meter.

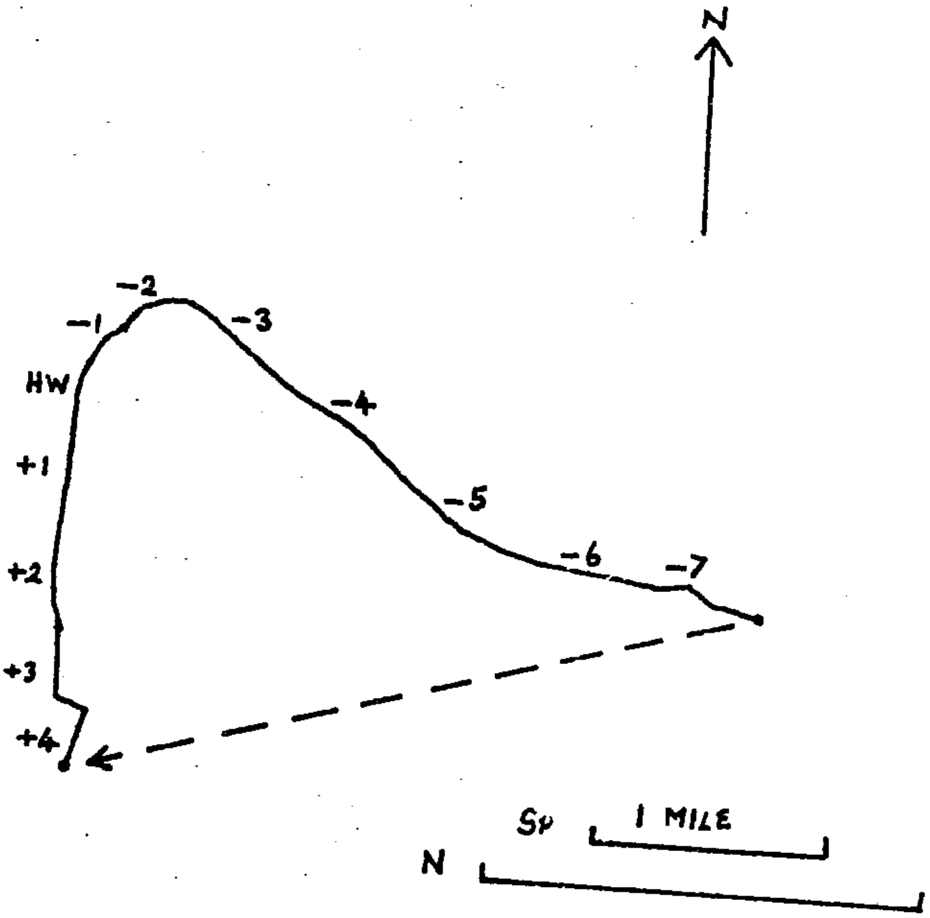


Fig. 10. Tidal residual current directions and distances. Single arrows derived from vector plots of grided drogue atlas data. Broad arrows derived from current meter vector diagrams, solid arrow surface, dashed arrow near bottom.