

I.O.S.

SWANSEA BAY (SKER) PROJECT

by
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**PROGRESS REPORT
FOR THE PERIOD TO MARCH 1975
AND SUBSEQUENT DEVELOPMENTS**

REPORT NO 20

1975

**INSTITUTE OF
OCEANOGRAPHIC
SCIENCES**

**NATURAL ENVIRONMENT
RESEARCH
COUNCIL**

SWANSEA BAY (SKER) PROJECT

Progress Report
for the period to March 1975
and subsequent developments

IOS (Taunton) Project No. S31A

Report No. 20

1975

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Swansea Bay (Sker) : First Progress Report

1. Introduction

Early in 1973 Glamorgan County Council, as it then was, approached the former Unit of Coastal Sedimentation regarding erosion along the foreshore of the E part of Swansea Bay (Figure 1, which shows all sites mentioned in the text). Subsequently, it was agreed that the Institute of Oceanographic Sciences' Taunton Laboratory (into which the UCS had by then been incorporated), would write a preliminary report for the Council suggesting work which needed to be undertaken to assess the reality and extent of the erosion and its possible cause(s), the report being without a guarantee that IOS could undertake the work. The Summary and Conclusions of the report are attached as Appendix 1. IOS subsequently decided that the subject would be very suitable for a type study and that it could be fitted into its overall programme. The ultimate objective of such an investigation would be to produce a quantifiable assessment of sediment transport and mobility based on the results derived from measuring the various relevant parameters.

The Department of the Environment agreed that this project should be included in the commissioned work covered by Memorandum of Agreement Contract No. 481/50, covering the period April 1974 - March 1977.

The intention was for the first year's work (April 1974 - March 1975) to be mainly in the form of a project definition study: that is, that the aim would be as far as possible to collect and analyse information already available. Field work would only be undertaken when it was necessary to enable an assessment of the problems involved. The plans for the subsequent work would then be reviewed. In practice some other field aspects (for example, wave recording) were also initiated as soon as it became clear that failure to do so would delay the rest of the project thereafter. The review has been delayed for a few months so that information outstanding could be collated and analysed.

This document therefore has three sections:

- 1) A report of progress to 31 March 1975
- 2) Some details of further work to approximately 31 July 1975. Analysis of results, so far, serves to emphasise the complexity of the problems (para 3.9).
- 3) A brief outline of planned research. It is the intention that this Report will provide a basis for discussion following which more detailed future proposals will be formulated.

It is intended to provide a series of Progress Reports throughout the contract period. In addition, as specific aspects of the research either reach completion or a clearly defined point in their investigation, a Topic Report will be produced. It is envisaged that the first group of these will cover Observed Wave Data; Wave Refraction; the first Radioactive Tracer Study; and evidence provided by documentary sources. Towards the end of the research project there will be a series of reports which attempt to synthesize the data and apply it to the specific local problem.

2. Progress on the Swansea Bay project to 31 March 1975

2.1 Initial literature, document and cartographic search

A number of visits have been made to the joint Glamorgan County Records Office at Cardiff in order to examine records and maps held there. Because most of the literature sources for the Principality are kept centrally, however, a search has also been carried out for records, including original manuscripts, at the National Library of Wales, Aberystwyth. Particularly significant in this respect are the documents from the Penrice and Margam estates. The topographic maps remain to be examined in detail but the analysis of the hydrographic charts is complete (see below). Further studies will be concentrated at the British Museum, London.

In order to try to ascertain the amount of sediment extracted from the offshore banks and the foreshore various data sources were analysed. These included the records of the sand and gravel companies and the dock landing figures for the Bristol Channel ports. Unfortunately the gravel companies' records are far from complete because of the series of takeovers of the small, independent operators. Similarly, the port landing figures are neither specific as to the places of origin nor, for earlier periods, are the cargo categories sufficiently precise.

Nevertheless records show that over half a million tonnes of sand were removed from the beach between Port Talbot and Sker from 1967 to 1974 and, in addition, just under this figure from the neighbouring dunes. These figures can be compared with Crown Estates Commissioners' records which show almost 0.75×10^6 tonnes was extracted from Nash Bank from 1971 to 1973. Taking the South Wales port figures as a whole, 20 million tonnes of sand and gravel were landed between 1930 and 1974. Of this 1.6 million tonnes were unloaded at the nearby ports of Swansea and Briton Ferry between 1970 and 1974. It is not known from whence this material was derived.

2.2 Comparative analysis of Hydrographic charts

Fairly detailed hydrographic surveys of the bay date from 1827 to 1974. Of these the most useful are the surveys of Commander Alldridge (1858-60) and those of 1974. The latter are principally by HMS Woodlark although certain additional areas (between Swansea Docks, the Neath estuary and Port Talbot Harbour; and a sector E of Scarweather Bank) were surveyed by IOS using its inshore launch Sandpebbler, and controlled using the British Transport Docks Board's HiFix system. These two series of charts are essentially the only ones which cover the whole area of immediate significance. Earlier surveys are lacking in detail while intervening ones incorporate only partial revisions.

After careful standardisation of datums, and applying various external checks (such as the alignment of leading marks and plotting the positions shown during intervening partial surveys) there is little doubt as to the overall movement of the banks and channels. Indeed, Hugo Bank is now where the 1859 chart shows Shord Channel (Figure 2). This represents a lateral displacement of over 0.5km towards the S. Volumes of sediment for each survey are being calculated.

2.3 Photogrammetry and topographic surveying

Aerial photographs have been flown by Meridian Airmaps for the BTDB on a number of occasions. Copies of flights dated 12 April 1968, 21 June 1970, 25 April 1971 and 25 April 1975 are held at IOS (Taunton). All these are on the 1:6000 scale, that for 1975, (like the 1965 flight not held) only covers part of the relevant coastal area, but is due to be extended. IOS also holds prints from the 1971 Ordnance Survey flight on a scale of approximately 1:12000. Diapositives have been obtained for the BTDB 1968 and 1970 flights for use on the Nature Conservancy Council's Kern PG2 plotter.

Prints for 1970 have been baselined, minor controlled, and used for slotted template assembly. This has formed a base for plotting detail by the PG2. The complete beach has been drawn and contoured at metre intervals on Ozatex and is available for comparisons with other plots.

Some topographic survey has been carried out but, so far, this has been primarily for photogrammetric control.

2.4 Wave data

A Waverider buoy was deployed at the western, outer end of Scarweather Bank on 21 June 1974 and has been serviced at approximately bimonthly intervals since that date. The purpose was to provide a record of waves unimpeded or modified by the sea bed topography. The data are sampled for 20 minutes every three hours and are relayed to a shorebased station where the signal is electronically processed and recorded onto magnetic tape cassettes for subsequent laboratory analysis. Apart from a few fairly brief periods when the data acquisition equipment failed, records have been continuous since the date of deployment. The appropriate wave statistics, zero crossing period (T_z) and significant wave height (H_s) have been computed. One of their uses has been to provide input data for a computer-based wave refraction program.

2.5 Fluorescent tracer studies

Little progress has been made on this aspect of the research so far.

This is because:

- 1) Knowledge was needed to satisfactorily match the tracer to the beach sediment size range.
- 2) Maximum value of the tracer work would be obtained by simultaneously measuring the nearshore physical parameters (notably currents). Suitable instrumentation was not immediately available.

2.6 Liaison

Various meetings have taken place to discuss both the scientific programme and administrative considerations relating to the project. While, so far, the majority of the discussions on the research programme and its timetable, have been co-ordinated within IOS, various visits have been made to external organisations such as the BTDB, the British Steel Corporation and the Department of Geology and Oceanography, University College of Wales, Swansea (see below).

Other meetings have been held, notably at Cardiff, between representatives of the various interested local authorities. Staff from IOS(T) have been present at two of these, at one of which the Welsh Office was also represented.

3. Résumé of progress in the further period to 31 July 1975

3.1 Photogrammetry

Prints from the 1968 BTDB survey are in the process of being baselined and minor controlled. Time has been booked for plotting diapositives of this survey on the PG2.

The 1975 aerial survey of the coastline has now been extended to Sker Point through a flight by Meridian Airmaps for BTDB. Unfortunately the photography is again unsatisfactory for photogrammetric purposes and is to be reflown. It will be plotted by IOS as soon as it is available.

3.2 Wave data

Satisfactory results continue to be received from the Waverider buoy E of Scarweather light. Replacement of the mooring, and other necessary servicing, continues to be carried out at bimonthly intervals.

As part of a comparison between these wave data and attenuated values influenced by the sea bed topography inshore, two self-contained pressure wave recorders were deployed in May during a research cruise in the NERC Research Vessel Edward Forbes. One was located near Kenfig Patches buoy, and the other just S of the Port Talbot Tidal Harbour. Both were serviced at the end of the Forbes cruise without incident. However, by the time of the next monthly service, using the same ship, the Port Talbot wave recorder could not be located. Furthermore, that at Kenfig was lost as a result of the mooring fouling the ship's propeller. Attempts have been made to find the recorders and a possible object has been located by sidescan sonar in the Port Talbot area. Since it is some distance away from the last known co-ordinates it appears likely that if it is the recorder, the surface mooring must have been fouled, or vandalised, or the sea bed recorder unit trawled up by a fishing vessel. Poor visibility prevented divers investigating the object but a further limited search will be carried out when it can be conveniently combined with other work. Meanwhile a spare wave recorder unit has been deployed off Port Talbot with a modified mooring system.

In order to get information about direction of wave approach in Swansea Bay a 3.2cm X-band radar has been installed at the coastguard station at the Mumbles. This site is something of a compromise. The radar's operation has been delayed by an excessively long wait for planning permission by Swansea Corporation and certain instrumental troubles since then. However the system operated satisfactorily at Start Bay before its transfer to Swansea Bay and it is anticipated that reasonable coverage will be obtained of this winter's wave direction outside of, and in the western part of, the Bay.

Two series of wave refraction plots have been computed using different wave periods and directions of approach associated with the sea bed bathymetry as depicted on the 1859 and 1974 hydrographic charts. There are some differences between these two series but both indicate a focus of energy along the shoreline near to Sker Point, as Figures 3 and 4 demonstrate.

3.3 Current Meters

Two Plessey MO21 continuous recording current meters were deployed on seabed rigs at the same sites as the self-contained wave recorders for the second half of May. Both appear to have functioned satisfactorily and it is planned to have a more extensive series of observations - both in number and duration - later this year and again in 1976. The May data are in process of being analysed.

Some direct reading current meter observations have also been taken on recent cruises.

3.4 Geophysics

The BTDB launch Soniarus has been used on two or three occasions to obtain sidescan records. These, together with certain earlier data obtained as a 'bonus' from IOS cruises primarily for other purposes, are beginning to provide a picture of the sedimentary structures on and between the offshore banks in the Kenfig-Hugo Banks area. It needs to be extended to the remainder of the Bay.

Several days of the May cruise in the Edward Forbes were devoted to obtaining continuous seismic profiling records using the Huntec Mk II system and ED10 boomer in the area between Port Talbot dredged channel and Scarweather Sands. A preliminary interpretation of the records has been completed but would be facilitated by vibrocoreing. The area appears to be complex with rock outcrops, buried channels, and sand banks as much as 10m thick, perched on rock or coarse gravels. There are some areas of sand waves. (Figure 5)

3.5 Grab sampling

A limited programme of sea bed sampling using a modified Van Veen grab was undertaken during the May Edward Forbes cruise. This was primarily to 'calibrate' the sidescan sonar records.

3.6 Radioactive tracer experiment

685 gms of Scandium 46 were injected at a site on Kenfig Patches on 20 May 1975. The material had a mean particle size of 170 μ and an activity of 20 Curies. Movement was followed for the next ten days and thereafter at monthly intervals until the beginning of August. It is hoped to repeat these surveys following periods of severe weather during the winter if activity levels remain high enough.

The preliminary results indicate a very rapid initial dispersal in a NW-SE direction so that within three days of injection travel exceeded 11 km in length but barely 200m in width (Figure 6). Subsequently, the tracer path broadened both in the W and, latterly, towards the N also in the general direction of the Tidal Harbour.

3.7 Liaison

During the past few months the opportunity has been taken to follow up new data sources. Amongst these are the boreholes for the M₄ motorway which help to provide details as to the thickness of sand cover along the inland edge of Kenfig dunes.

3.8 Research Contract

A three-year research contract is being negotiated with University College of Wales, Swansea. This is designed to provide supplementary information to that covered by the main IOS study. The UCS project is titled "Sediment transport through the area south of eastern Gower (to latitude 51°27'N), as related to the sediment budget of Swansea Bay". The summary terms of reference read: "To study, by means of all available appropriate techniques, the sedimentological and hydraulic parameters in an area immediately W of that part of Swansea Bay being examined by IOS. To use the resulting data to try and determine the mobility of the sea bed and the possible sediment paths within and through the area".

It is a pleasure to record our grateful thanks for the co-operation IOS has received from a large number of firms, organisations and individuals. Although it is somewhat invidious to single out any in particular the practical help of the British Transport Docks Board and the Steel Company of Wales must nevertheless be mentioned.

3.9 Results

By October 1975 a considerable body of data into the changes which have occurred, and the processes which are operating, within Swansea Bay, had been analysed. So far it has proved difficult to obtain clear evidence to demonstrate the reality of the trends indicated. For example, the apparent order of change along the beach between successive air surveys is comparable to the degree of error in the photogrammetric technique employed. Similarly, the difference in calculated volumes of sediment between successive hydrographic charts is within the range of uncertainty of the datums to which the surveys are related. Another discrepancy is provided between the evidence given by sidescan records for the Kenfig Patches area and the radioactive tracer experiment for the same site. The tracer work appeared to reflect the tidal streams rather than the sedimentary structures of the area.

It is hoped that the growing body of data will resolve the anomalies observed so far and, in due course, show which parameters are the most significant not only in this area but in analogous studies elsewhere.

4. Plans for work during the rest of the financial year 1975-76 and projected developments for 1976-77 and 1977-78

The accompanying Table 4.1 gives an outline of the proposed research programme for the three-year period April 1975 - March 1978. It is clear that this will need (and has already undergone some) modification in the light of results obtained; physical conditions encountered; and upon discussion with interested parties.

The order indicated for the various aspects of study is not necessarily that which would have been preferred. For example, the vibrocoring programme would be phased earlier if a suitable vessel were available.

For the remainder of the 1975-76 financial year field work is to be concentrated on the acquisition of recording current meter data at 8 sites within Swansea Bay. Profiles will be surveyed across the intertidal area between the Neath estuary and Sker Point each month. Foreshore sediment sampling will also be undertaken bimonthly along these same lines. As noted earlier in the Report it is hoped to continue to investigate the progressive dispersion of the radioactive tracer injected on Kenfig Patches. All these aspects, and others, will need laboratory processing of the data, and analysis of the samples acquired and results obtained.

PROVISIONAL RESEARCH PROGRAMME: SWANSEA BAY

APRIL 1975 - MARCH 1978

	1975			1976			1977			1978																	
	Ap	My	Ju	Jl	Au	S	Ap	My	Jn	Jl	Au	S	Ap	My	Jn	Jl	Au	S	O	N	D	Ja	F	Mr			
Recording current meters; long term moorings; calcs for residuals etc.	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Suspended sediment sampling (\pm velocity profiles)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Mechanics of sediment transport(desk study)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
e/m flowmeters for nearshore measurements	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Radioactive tracer work- offshore	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Fluorescent tracer & analysis - beach	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Beach profiles	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Beach sediment sampling	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Overseeing boreholes	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Hydrographic survey(changes in offshore banks)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Geophysics:sidescan CSP	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Wave data:observed computed(refraction)etc	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
radar data	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Offshore sediment sampling: grab	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
vibrocorer	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
boxcorer	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Map,chart,document & record analysis	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Reports, etc. (& specific scientific study papers etc)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Overall management	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

TABLE 4.1

Appendix 1

Summary of original proposals for this Project

The Summary and Conclusions of the Report to the County Council in November 1973 read as follows:

- (i) Existing reports on the coastal erosion problem are largely subjective in character, being based on expert opinion but supported by little quantitative data, and lacking even elementary calculations. For example, it is not recognised that the scale on which aggregate removal has been carried out by man over the past four decades is of an entirely different order of magnitude to the rate of long-term natural accretion which has taken place over the nearby dune systems. Nor do the reports adequately consider offshore implications.
- (ii) Any study undertaken must include the offshore banks in its remit as the County Planning Officer's Report on 12 January 1973 recognised.
- (iii) There already exist, or will soon exist, invaluable data and facilities which could provide a useful input to a research project at minimal cost. In particular, these include BTDB (British Transport Docks Board) aerial photography of the coastline and a new Hydrographic Office offshore survey. The former should be used for photogrammetry while the latter would serve as a base for tracer studies and as a source of comparative data with charts spanning over 100 years. The BTDB HiFix system in Swansea Bay can supply precision ship position-fixing when required.

The active co-operation of the University College of Wales, Swansea, would again reduce the extent of the resources otherwise necessary, for example in the field of offshore geophysics.

- (iv) Research should not only maximise the use of existing data, but gain information in a wider field. In particular studies should be directed to:
- (a) Acquisition and analysis of wave data, tidal currents, etc.
 - (b) Computations of wave energy and refraction in the light of (a) above.
 - (c) Tracer experiments both alongshore and offshore using fluorescent and radioactive labelling as appropriate.

These aspects should not exclude other techniques such as those listed in Table I (not included in the present Report).

(v) Research should be undertaken initially on the basis of a three-year programme. Even taking full advantage of the facilities potentially available, a sum of £104 - 121K (plus VAT) at 1973 prices should be anticipated. Work should be confined to the smallest area suggested, ie approximately a triangle bordered by Port Talbot Tidal Harbour, W Scarweather and Porthcawl with a possible extension north of the Tidal Harbour. The geographical area and field of study could be enlarged thereafter if desired.

In November 1973, it was decided that IOS would undertake an initial study mainly utilising the existing information available.

In the period up to 31 March 1975 the following aspects were to be investigated:

- (a) Initial literature, document and cartographic record search.
- (b) Comparative analysis of historical and contemporary hydrographic charts.
- (c) Contouring of exposed beach and dune face from 1965 and most recent BTDB aerial photography, together with the establishment of necessary ground control, heighting etc., and limited beach profiles.
- (d) Installation of a Waverider in the area W of the Scarweather Bank to start to obtain data on the wave climate of the area. Possible deployment of current meter rigs at end of year 1974-75 or beginning of year 1975-76 dependent upon ship-time, etc.
- (e) Fluorescent tracer studies simulating the sand fraction along the foreshore, with instrumental backup.
- (f) General project planning and critical path analysis for whole Sker project or parts in which IOS (Taunton) was to become involved. Meetings and discussions with external parties.

In practice previous commitments had to be completed and it was some months before effort on the project built up to the level anticipated.

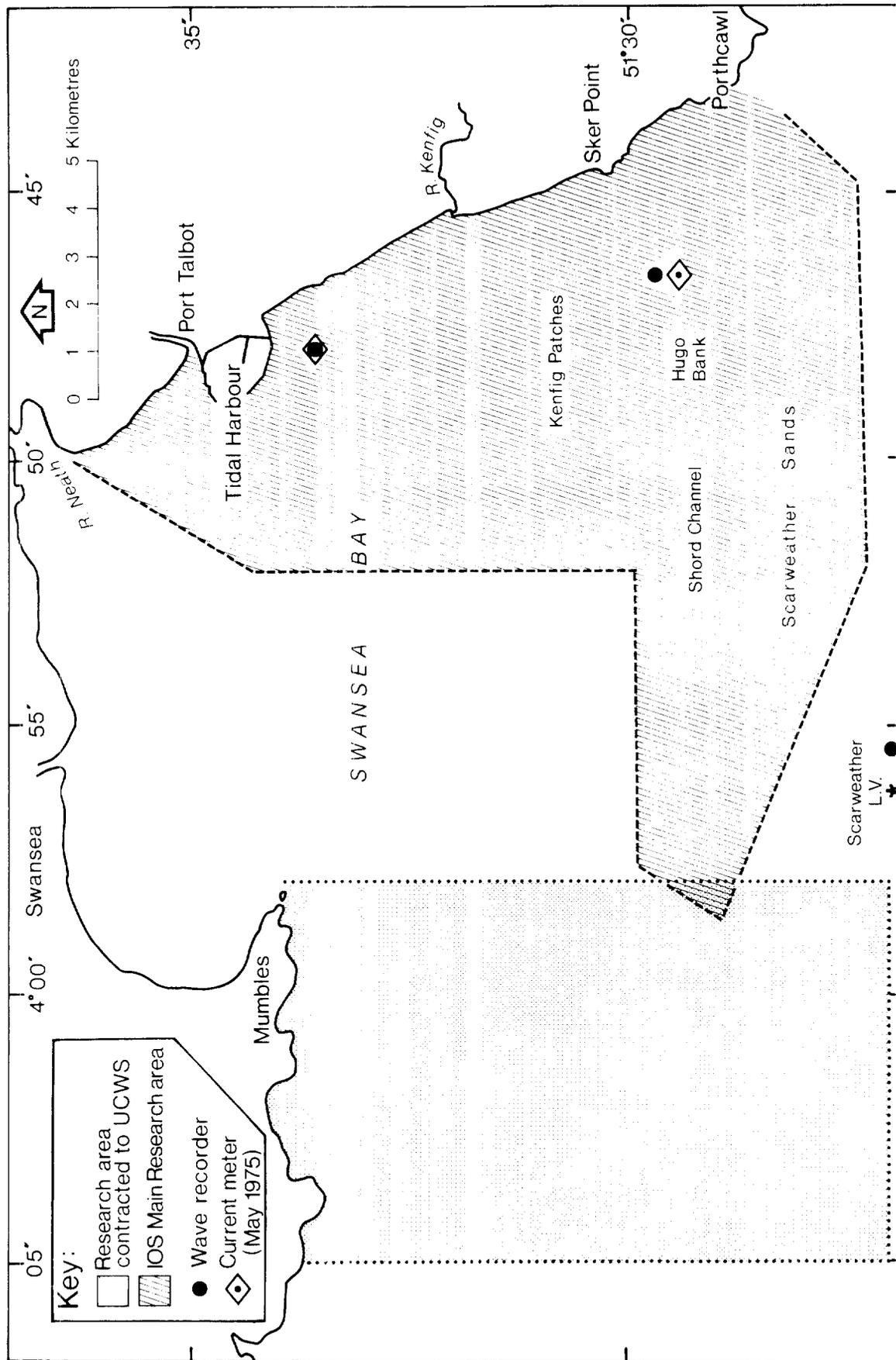


Figure 1. Site Map

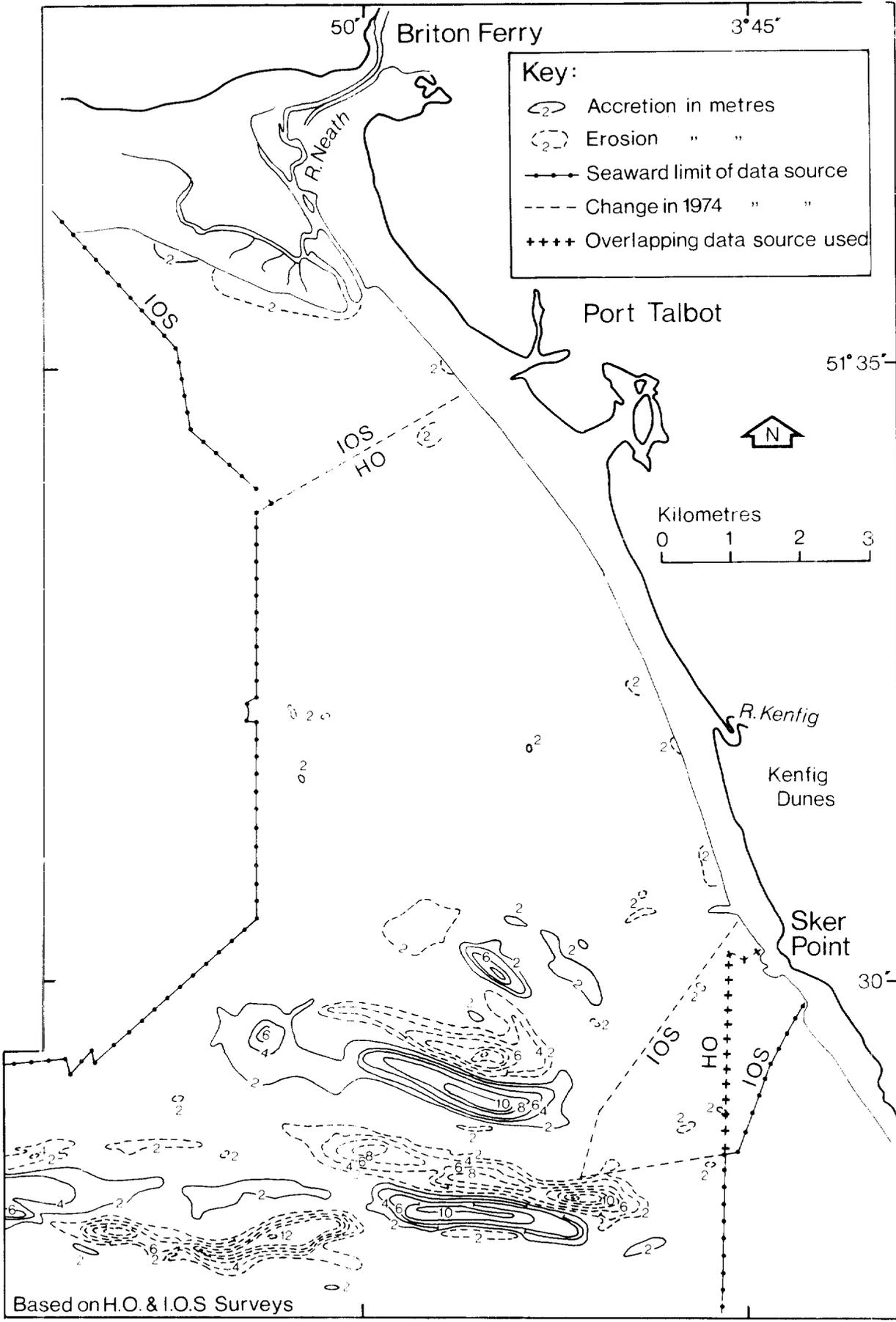


Figure 2. Comparison of 1859 and 1974 hydrographic surveys.

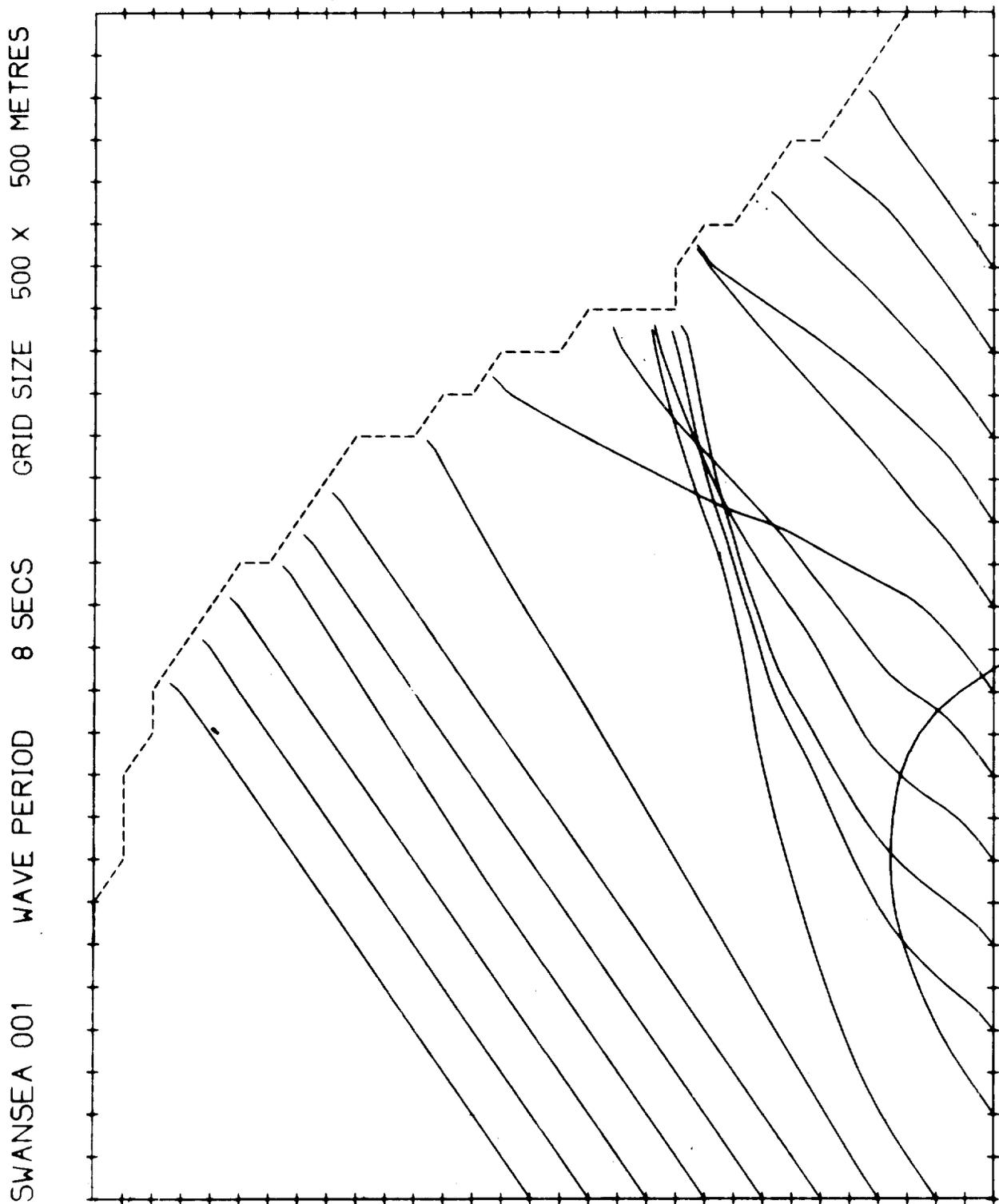


Figure 3. Provisional wave refraction plot, Swansea Bay. Based on 1859 hydrographic survey.

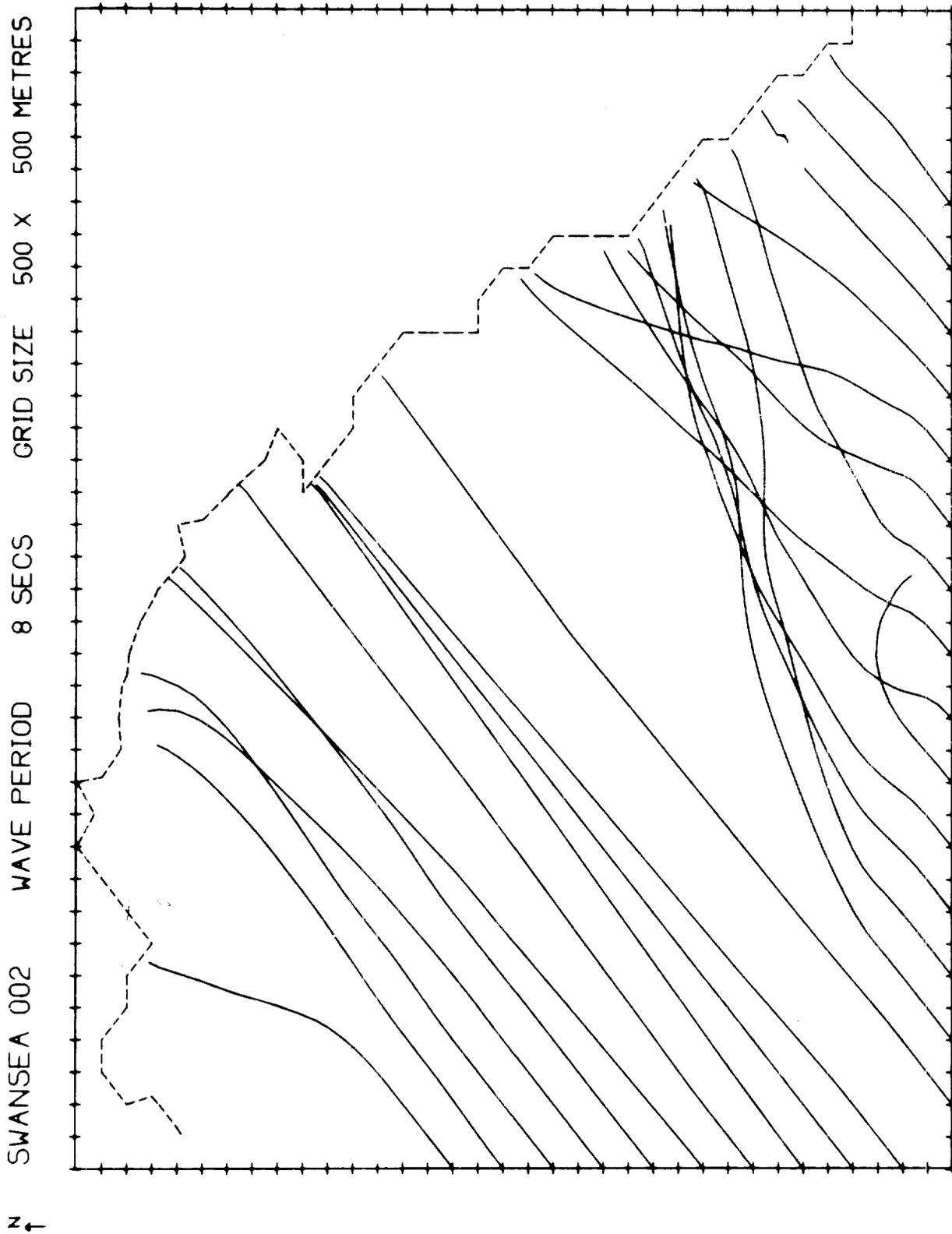
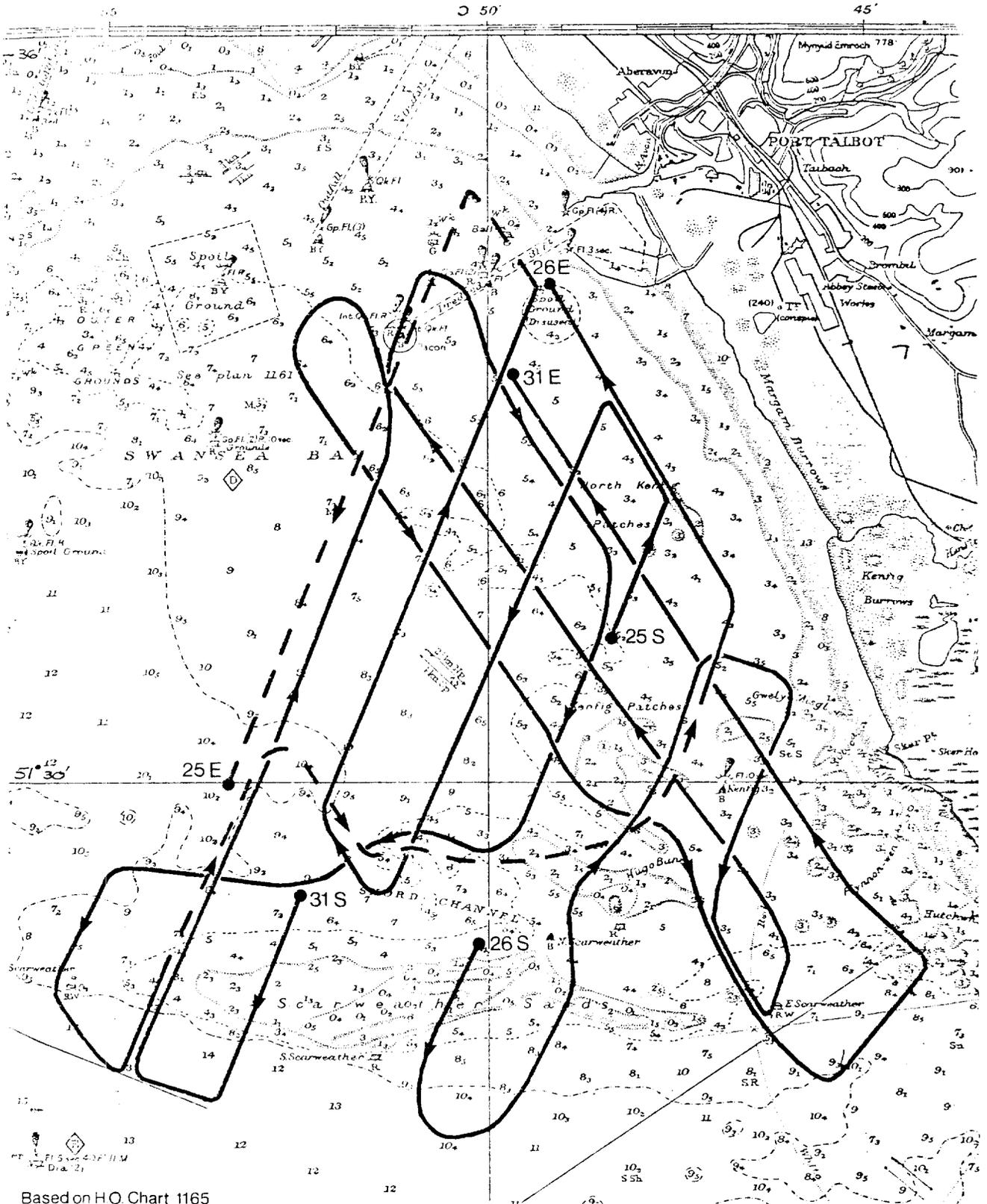


Figure 4. Provisional wave refraction plot, Swansea Bay. Based on 1974 hydrographic surveys.



Based on H.O. Chart 1165

CONTINUOUS SEISMIC PROFILING

———— Recording trace satisfactory
 - - - - - " " poor



depths in fathoms

C.S.P. runs made on 25, 26 & 31 May 1975. S.... Start, E.... End

Figure 5

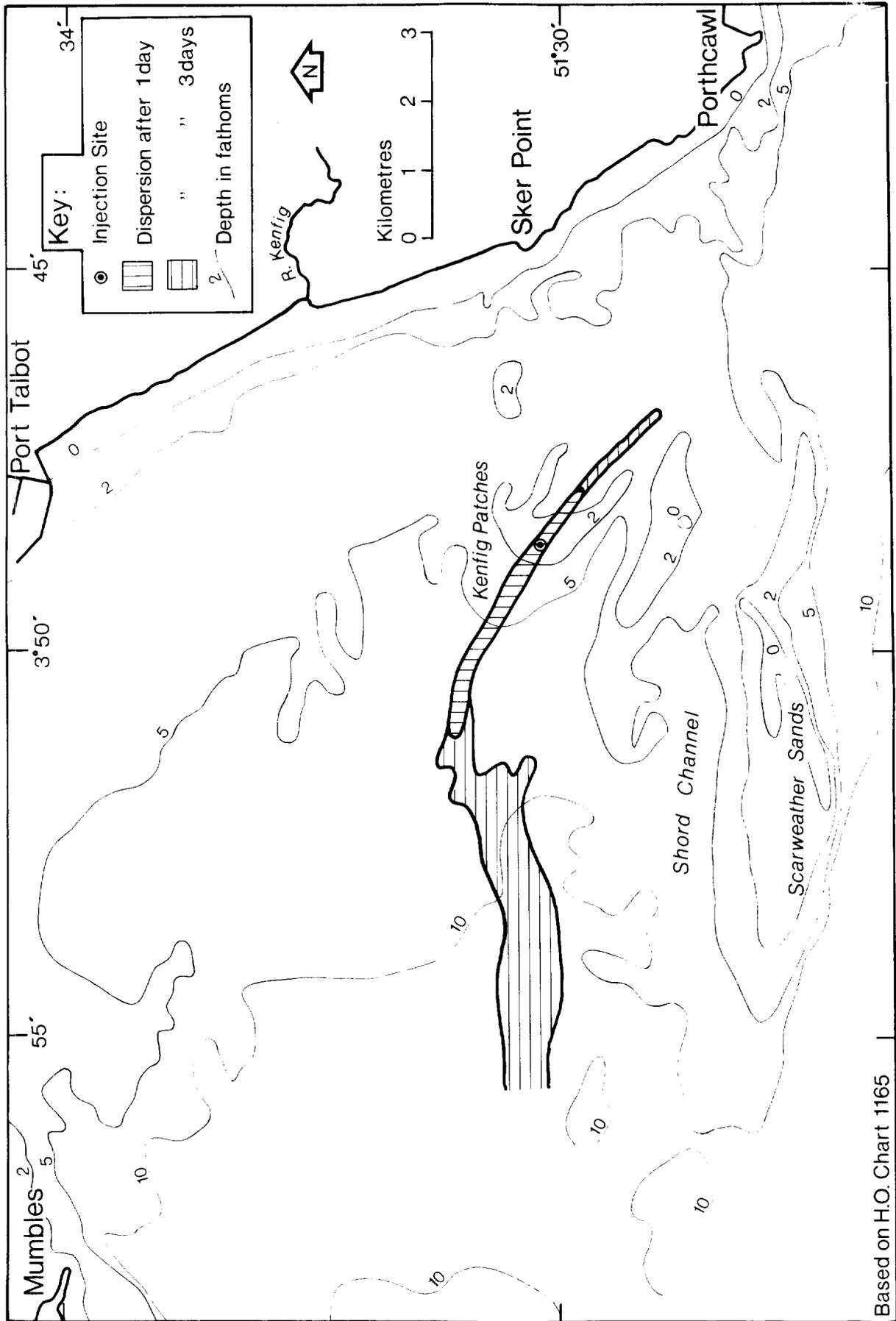


Figure 6 Radioactive tracer experiment, May 1975: initial dispersion