VI. *Report of Observations made upon the Tides in the Irish Sea, and upon the great similarity of Tidal Phenomena of the Irish and English Channels, and the importance of extending the Experiments round the Land's End and up the English Channel. Embodied in a letter to the Hydrographer. By Captain* F. W. Beechey, *R.N., F.R.S. Communicated by* G. B. Airy, *Esq., F.R.S. &c., Astronomer Royal.*

Received March 22,—Read March 29, 1848.

Sir, London, February 19th, 1848.

It is with much pleasure I lay before you the result of observations which have been made upon the tides in the Irish Sea, during the execution of the survey which has been entrusted to my charge.

The stream in the Irish Channel hitherto misunderstood.

Up to the period of these observations the set of the tides in the Irish Sea had been greatly misunderstood, owing to the association of the turn of the stream with the rise and fall of the water on the shore; and it was generally understood that as Holyhead was three hours later in its tides than places at the entrance of the channel, a vessel starting with the first of the flood would carry nine hours' tide in her favour in her run up channel and *vice versâ*.

This was an error sufficiently great in itself, but it was liable to be increased by an entire ignorance as *to the time* when a vessel would take any particular tide; for the times of high water by the shore were very various on different sides of the channel.

Turn of the stream simultaneous throughout north and south channels.

Meeting of tides.

The present inquiry, I am happy to inform you, has set these errors and doubts at rest. The observations have shown that, notwithstanding the variety of times of high water throughout the channel, the turn of the stream is *simultaneous*; that the northern and southern streams in both channels commence and end in all parts (practically speaking) *at the same time*, and that time happens to correspond with the time of *high and low water* on the shore at *Morecombe Bay*; an estuary rendered remarkable as being the point where the opposite tides coming round the extremities of Ireland, finally meet. So that it is necessary only to know the times of high and low water at Morecombe Bay to determine the hour when the stream of either tide will commence or terminate; a fact which will, I am sure, be fully appreciated by every person navigating the Irish Channel at night, or in thick weather.

The chart of curves or lines of *direction of the stream*, Plate II., which accompanies this report, will show at once the effect of the tide upon a vessel wherever she may be placed in the channel, and especially direct her where, with a beating wind, she will be benefited by standing in shore or otherwise; and will warn her of the danger of drawing near the shores of Cardigan or Caernarvon Bays, with particular tides and scant winds, and so likewise of the danger of standing close to the banks skirting the Irish coast in light winds.

But it is not to the navigator alone that these observations will, I hope, be found useful: they will, I think, be interesting to men of science. Taken in connection with the very valuable series of observations which were carried round Ireland by the Ordnance at the suggestion of Professor AIRY, we are made acquainted with several curious facts: first, that whilst it is high water at one end of the channel, it is low water at the other; that the same stream makes both high and low water at the same time; that there are two spots in the channel, in one of which the stream runs with considerable velocity without the water either rising or falling, and in the other, that the water rises and falls from sixteen to twenty feet without having any visible horizontal motion of its surface; and that during the first half of the flowing, and last half of the ebbing, tide-wave, the stream in the south channel runs in a contrary direction to the wave, and goes up an ascent of about one foot in $4\frac{1}{2}$ miles. (See Plate IV.)

Peculiar feature of the tides.

To the lines of direction of the stream I have added the rate of the tide at its greatest velocity on the day of syzygy, and have reduced all to the same standard.

I shall now proceed to describe the general course of the streams throughout the channel; point out the situations in which the meeting of the tides occurs; and offer such remarks on the course of the stream and upon the tidal phenomena of this sea, as will, I conceive, benefit the navigator, and be interesting to science.

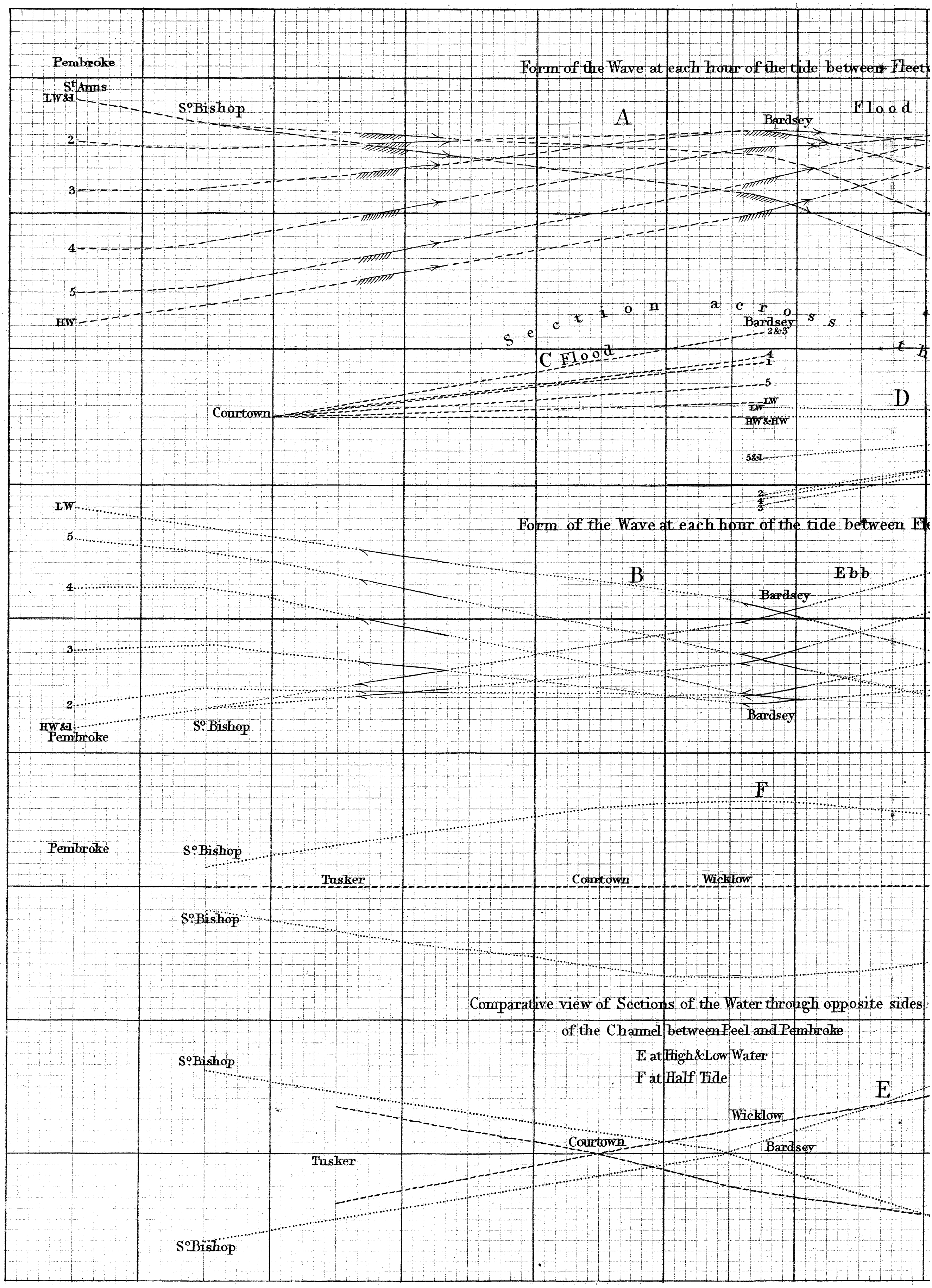
An inspection of the chart (Plate II.) will show that the tide enters the Irish Sea by two channels; of which Carnsore Point and Pembroke are the limits of the southern one, and Rathlin and the Mull of Kintire the boundaries of the northern.

The stream in the southern channel (as before stated) has been ascertained to move *simultaneously in one vast current throughout*; running six hours nearly each way, at an average rate of from two to three knots per hour at the height of the springs, increasing to four knots and upwards near the banks and at the pitch of the headlands; its *times of slack water* corresponding sufficiently near for all practical purposes, with *the times of high and low water for the day at Morecombe Bay*, or more correctly *at Fleetwood*, which is twelve minutes earlier than Liverpool.

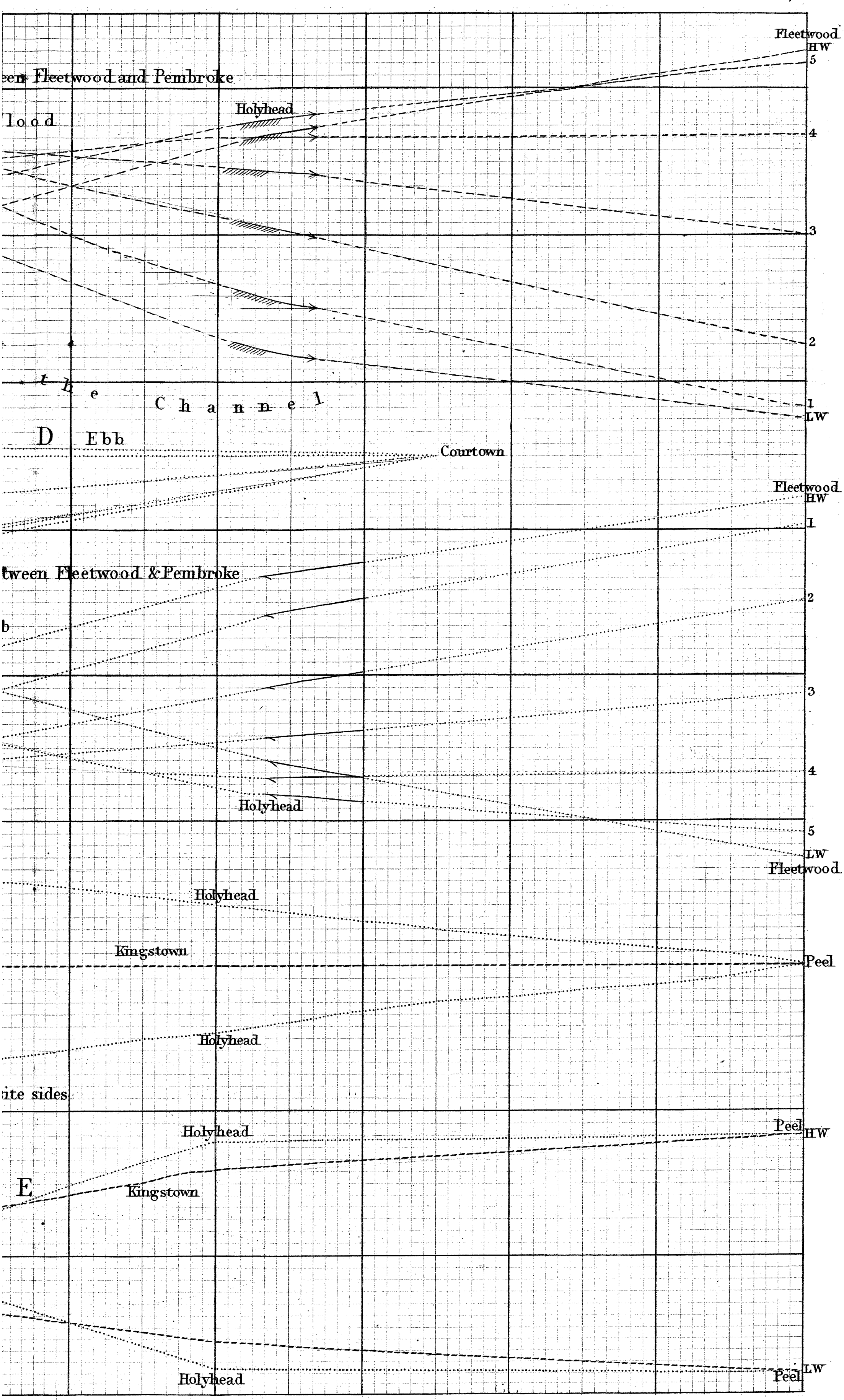
Times of slack water throughout the channel.

Course of the central portion of the stream in the south channel.

The *central portion* of the stream of *flood* or *ingoing stream*, runs nearly in a line from a point midway between the Tuskar and the Bishops, to one six miles due west of Holyhead; beyond which it begins to expand eastward and westward, but its main body preserves its direction straight forward for the Calf of Man, which it passes to the eastward with increased velocity as far as Langness Point, and then at a more moderate rate on towards Maughold Head. Here it is arrested by the flood or southern stream from the north channel coming round the Point of Ayre, and



Form of the Wave at each hour of the tide between Fleetw
Pembroke
St Anns
LW&1
S° Bishop
A
Flood
Bardsey
2
3
4
5
HW
Section across th
Bardsey
2&3
C Flood
4
1
5
Courtown
LW
LW
HW&HW
D
5&1
2
4
3
Form of the Wave at each hour of the tide between Fl
LW
5
4
B
Ebb
Bardsey
3
2
HW&1
Pembroke
S° Bishop
Bardsey
F
Pembroke
S° Bishop
Tusker
Courtown
Wicklow
S° Bishop
Comparative view of Sections of the Water through opposite sides
of the Channel between Peel and Pembroke
E at High & Low Water
F at Half Tide
S° Bishop
E
Wicklow
Courtown
Bardsey
Tusker
S° Bishop


Fleetwood
HW
5
een Fleetwood and Pembroke
Holyhead
lood
4
3
2
the Channel
1
LW
D
Ebb
Courtown
Fleetwood
HW
1
tween Fleetwood & Pembroke
2
b
3
4
Holyhead
5
LW
Fleetwood
Holyhead
Kingstown
Peel
Holyhead
ite sides
Holyhead
Peel
HW
E
Kingstown
Holyhead
Peel
LW

is first swayed round to the eastward by it, and then goes on with it at an easy rate direct for Morecombe Bay.

The *outer portions* of the stream are necessarily deflected from the course of the great body of the water by the impediments of banks on the Irish side of the Channel, and by the tortuous form of the coast on the Welsh. The eastern portion passing Linney Head rushes with great rapidity between the Smalls, Grassholm, and Milford Haven, towards the Bishops, which it passes at a rate of between four and five knots; sets sharply round those rocks in an E.N.E. direction, right over the Bass bank, and into Cardigan Bay; makes the circuit of that bay; and sets out again towards Bardsey at the other extremity of it; then sweeping to the N. by W. past the island and through the sound, it gradually takes the course of the shore, round Caernarvon Bay, filling the Menai Strait as far as Bangor; but the stream still continuing outside towards the South Stack, which it rounds, setting towards the Skerries at a rate of upwards of four knots; and finally, turns sharply round those rocks for Liverpool and Morecombe Bay; completing in its way the high water in the Menai, and filling the Dee, Mersey and Ribble.

Course of the eastern portion of the stream in the south channel.

The *western* portion of the stream, after passing the Saltee, runs nearly in the direction of the Tuskar, sets sharply round it, and then takes a N.E. $\frac{1}{2}$ N. direction, setting fair along the coast, but over the banks skirting the shore, so that vessels tacking near the edge of the sands, have been carried upon them and lost, especially upon the Arklow and Codlin. Abreast of the Arklow is situated that remarkable spot in the Irish Channel, which I have before mentioned as a place where *the tide neither rises nor falls*. The stream notwithstanding sweeps past it at the rate of four knots at the springs, and reaches the parallel of Wicklow Head. Here it encounters an extensive bank recently known; and whilst the outer portion takes the circuit of the bank, the inner sweeps over it, occasioning an overfall and strong rippling all round the edge, by which the bank may generally be discovered; beyond this point the streams unite and flow on towards Howth and Lambay, growing gradually weaker as they proceed, until they ultimately expend themselves in a large space of still water situated between the Isle of Man and Carlingford.

Course of the western portion of the stream in the south channel.

Place of no rise or node of the tide-wave.

Here we have not been able to detect any tide; and here occurs that remarkable phenomenon before mentioned, of the water rising and falling without having any perceptible stream. This space of still water is marked by a bottom of blue mud. Such is the course of the flowing water in the *southern channel.*

Place of no stream.

In the north channel the stream enters between the Mull of Kintire and Rathlin *simultaneously* with that passing the Tuskar into the southern channel, but flows in the contrary direction. It runs at the rate of three knots at the springs, increasing to five knots near the Mull, and to four near Torr Head on the opposite side of the channel. The eastern branch of this stream turns round the Mull towards Ailsa and the Clyde, a portion passing round Sanda up Kilbrannin Sound and Loch Fyne.

Stream in the northern channel.

The *main body* sweeps to S. by E., taking nearly the general direction of the

Course of the main body of the stream.

channel, but pressing more heavily on the Wigtownshire coast; off which it has scooped out a remarkable ditch, upwards of twenty miles long by about a mile only in width, in which the depth is from 400 to 600 feet greater than that of the general level of the bottom about it. Near the Mull of Galloway the stream increases in velocity to five knots, the eastern portion turns sharply round the promontory towards the Solway, and splits off St. Bee's Head; one portion running up the Solway, and the other towards Morecombe Bay.

Remarkable ditch.

Eastern portion of the stream.

Central portion of the stream.

The *central portion* from a midway between the Mull of Galloway and the Copeland Islands, presses on towards the northern half of the Isle of Man, and while one portion of it flows toward the Point of Ayre, the other makes for Contrary Head, and is there turned back at a right angle nearly to its early course. Passing Jurby it reunites with the other portion of the stream, and they jointly rush with a rapidity of from four to five knots round the Point of Ayre, and directly across all the banks lying off there, and catching up the stream from the south channel off Maughold Head, they hurry on together towards that great point of union Morecombe Bay. This bay, the grand receptacle of the streams from both channels, is notorious for its huge banks of sand heaped up in terrible array against the mariner unacquainted with its locality, and also remarkable for a deep channel scoured out by the stream, and known as the Lune Deep, which to the wary navigator is the great hidden beacon of his safety, and serves him, alike in fog or in sunshine, as a guide to his position, and to a harbour of safety in case of need.

Western portion of the stream.

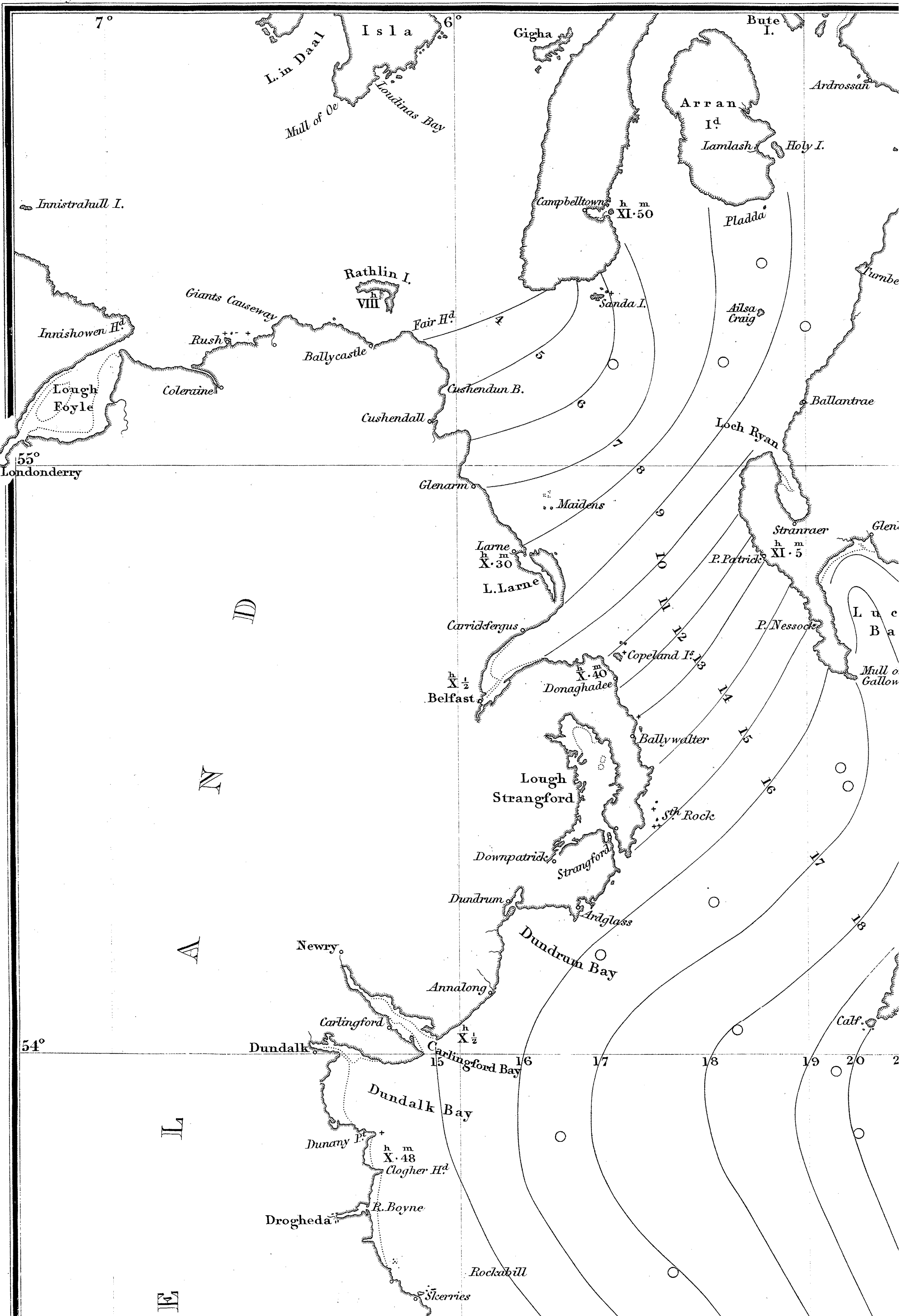
We have now only to speak of the *western limit* of the stream, which we left off Torr Head running at a rate of four knots off the pitch of the point. Hence it strikes directly towards the Maidens, boiling over the Highlander and Russell rocks, and other reefs in the vicinity of that dangerous group; and takes the direction of the coast again from Muck Island to Black Head, at the entrance of the Lough of Belfast, which it fills.

The portion of the stream which sets up the Lough, splits again off Grey Point; one portion flowing up towards Garmoyle, while the other bends back along the shore of Bangor, Grimsport and Orlock, and blends with the general stream which has come on from the Maidens and Blackhead, and passes with it through the sounds of the Copeland Islands. Hence it proceeds along the coast, brushes the South rock, and runs on towards St. John's Point; off which, the stream, like that coming from the southward, expends itself in a large space of still water, which remains undisturbed although pressed upon by streams from various quarters.

Such is a general description of the streams in both channels which attend the *flowing of the water*, or which, for the purpose of distinction, we may designate the *Ingoing stream.*

Ebbing or outgoing stream.

The ebbing or *Outgoing* streams do not materially differ from the reverse of these, except that in the southern channel they press rather more over towards the Irish coast.



7°
6°
Isla
L. in Daal
Mull of Oe
Loudinas Bay
Gigha
Bute I.
Arran Id.
Lamlash
Holy I.
Ardrossan
Innistrahull I.
Campbelltown
h m XI·50
Pladda
Rathlin I.
VIII h
Giants Causeway
Sanda I.
Ailsa Craig
Innishowen Hd.
Rush
Fair Hd.
Ballycastle
Coleraine
Lough Foyle
Cushendun B.
Cushendall
Ballantrae
Loch Ryan
55°
Londonderry
Glenarm
Maidens
Stranraer
Larne
h m X·30
L. Larne
P. Patrick
h m XI·5
Carrickfergus
P. Nessock
Copeland Id.
h m X·40
Donaghadee
X ½ h
Belfast
Mull of Gallow
Ballywalter
Lough Strangford
Sth. Rock
Downpatrick
Strangford
Dundrum
Ardglass
Dundrum Bay
Newry
Annalong
Carlingford
h X ½
Calf
54°
Dundalk
Carlingford Bay
Dundalk Bay
Dunany Pt.
h m X·48
Clogher Hd.
R. Boyne
Drogheda
Rockabill
Skerries
I R E L A N D
4
5
6
7
8
9
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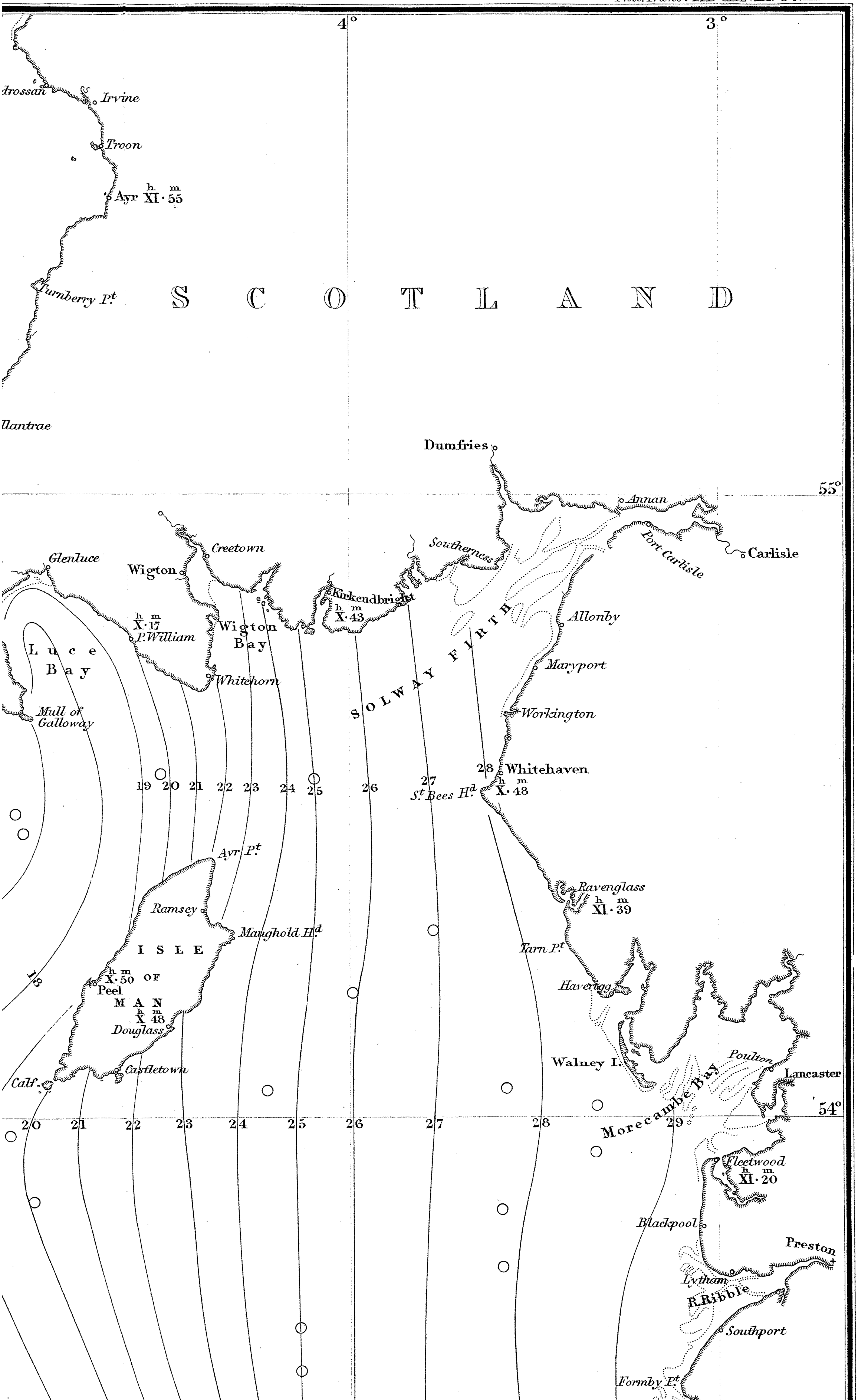
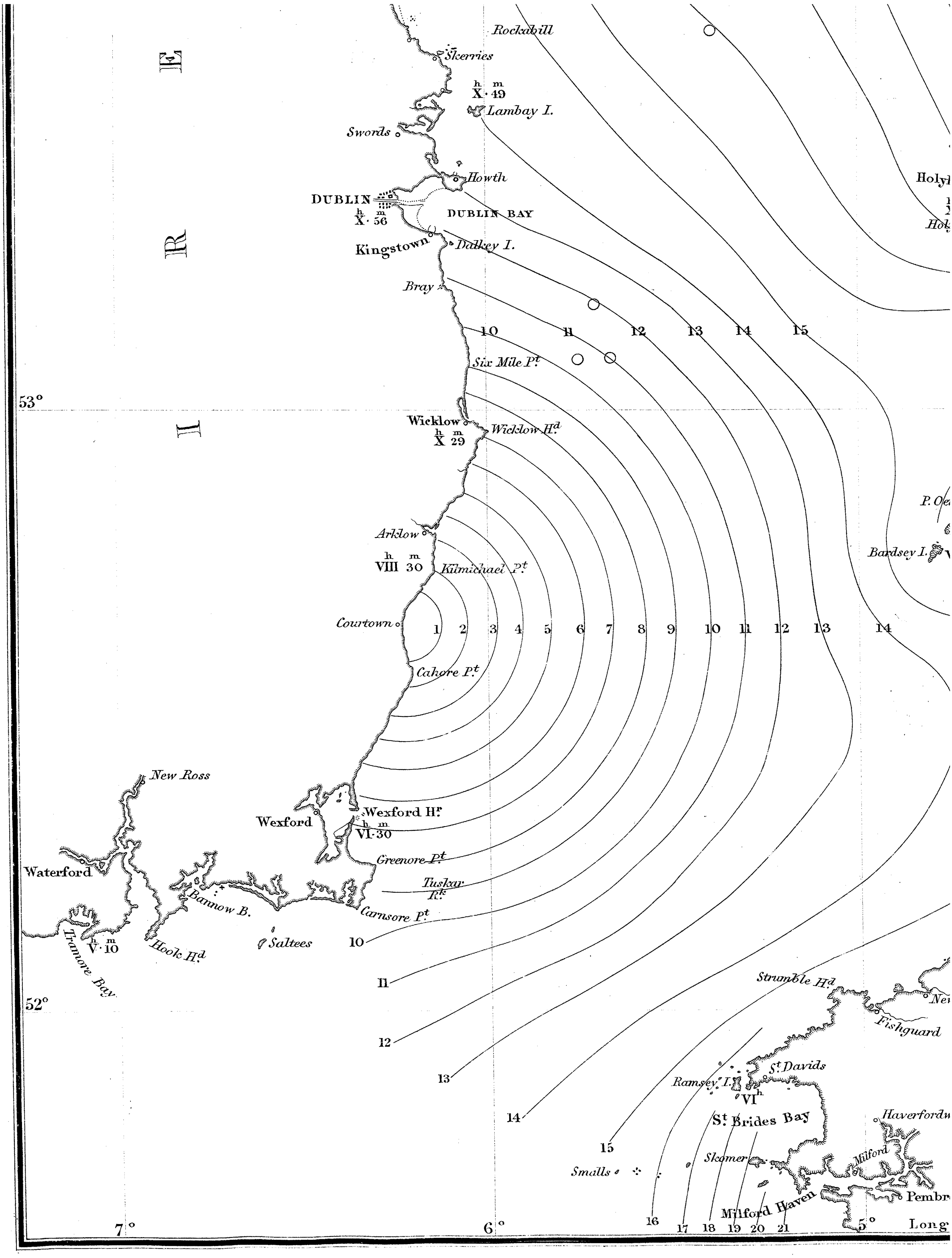
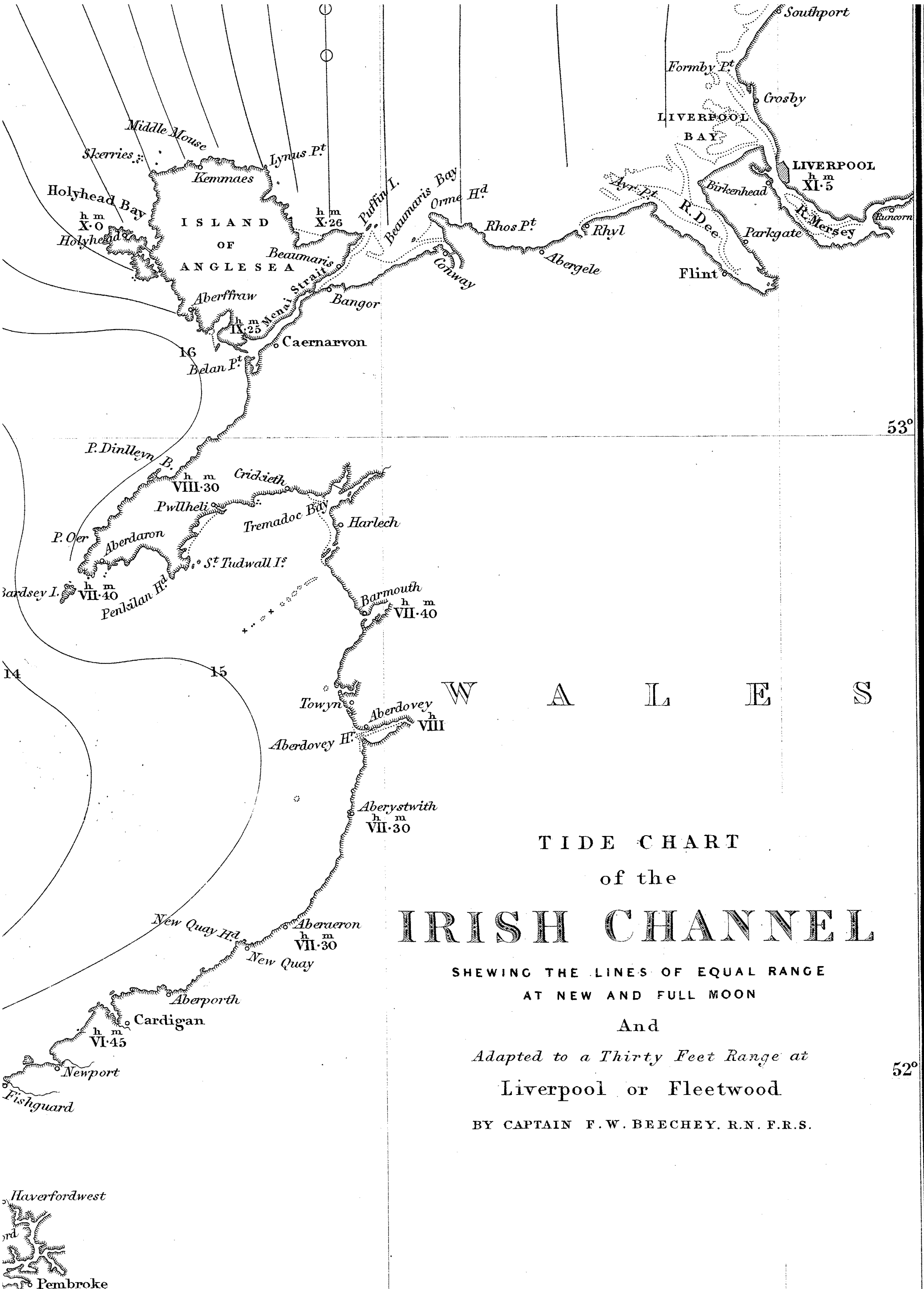
19
20


4°
3°
55°
54°
SCOTLAND
drossan
Irvine
Troon
Ayr XI·55 h m
Turnberry Pt
llantrae
Dumfries
Annan
Carlisle
Port Carlisle
Southerness
Creetown
Glenluce
Wigton
Kirkcudbright
X·43 h m
X·17 h m
P. William
Wigton Bay
Luce Bay
Whitehorn
Allonby
Maryport
SOLWAY FIRTH
Workington
Mull of Galloway
Whitehaven
St Bees Hd
X·48 h m
19 20 21 22 23 24 25 26 27 28
Ayr Pt
Ramsey
Maughold Hd
ISLE OF MAN
X·50 h m
Peel
X 48 h m
Douglass
Castletown
Calf
18
Ravenglass
XI·39 h m
Tarn Pt
Haverigg
Walney I.
Poulton
Lancaster
Morecambe Bay
20 21 22 23 24 25 26 27 28 29
Fleetwood
XI·20 h m
Blackpool
Preston
Lytham
R. Ribble
Southport
Formby Pt


Rockabill
Skerries
h m
X·49
Lambay I.
Swords
Howth
DUBLIN
h m
X·56
DUBLIN BAY
Kingstown
Dalkey I.
Bray
10 11 12 13 14 15
Six Mile Pt.
53°
Wicklow
h m
X 29
Wicklow Hd.
Arklow
h m
VIII 30
Kilmichael Pt.
Courtown
1 2 3 4 5 6 7 8 9 10 11 12 13 14
Cahore Pt.
New Ross
Wexford
Wexford Hr.
h m
VI·30
Greenore Pt.
Waterford
Tuskar Rk.
Bannow B.
Carnsore Pt.
h m
V·10
Saltees
10
Hook Hd.
Tramore Bay
11
52°
12
13
14
15
16 17 18 19 20 21
Strumble Hd.
Fishguard
St. Davids
Ramsey I.
VIh
St. Brides Bay
Haverfordw
Skomer
Milford
Smalls
Milford Haven
Pembr
Holy
P. Or
Bardsey I.
7°
6°
5°
Long
E
R
I



Engraved by J.& C.Walker.

These observations do not, however, extend beyond the point where the channels begin to open out, that is beyond a line joining Rathlin and the Mull of Kintire on the north, and the Saltee and Pembroke on the south. Outside these limits, the waters diverge right and left; that on the north joining the stream from Jura, and turning sharp round Rathlin; that on the south, speaking now of the outgoing stream, sweeps past Pembroke into the Bristol Channel on one side, and on the other rounds the Tuskar and passes on to Waterford.

I have now, Sir, endeavoured to convey to you a general idea of the course of the streams throughout the Irish Sea both in the centre and at the sides of the channel, as you will find them represented in the annexed chart, Plate II.; but besides these there are (as usual) at all the points and headlands, when abrupt, counter streams or eddies beginning at about two hours after the offing stream, increasing with the strength of the tide, and occasioning races and overfalls at the places marked on the chart. In the direction of the offing stream there is as little variation of the current at the different hours of tide as will be met with in any sea of similar extent, and indeed it is only with the slackening of the tide that the variations occur; so that, by a due attention to the lines I have given, the navigation may be as certainly conducted here as in any channel with which we are acquainted*.

Half-tide eddies.

During the time these observations on the stream were in progress, others were made upon the *rise* and *fall of the water* at several stations in the channel, and wherever practicable at places in the offing. By combining these observations with the range of tide on the coast of Ireland, published in Professor WHEWELL's admirable paper on the Tides in the Philosophical Transactions for 1836, Part II., and with observations made by Captains ROBINSON, DENHAM, FRAZER, SHERRINGHAM, WILLIAMS, &c., I have constructed a chart of lines of equal range of tide, Plate III., in order that the seaman may ascertain by a simple inspection of the chart, wherever he may be placed in the channel, the amount of spring range to which he has to adapt his soundings.

Chart of lines of equal range of tide.

In this chart the lines denote the range of tide at the places over which they pass, on a day when a spring tide at Liverpool rises thirty feet. In the channel between Holyhead and Tuskar, where it was impossible to get observations of this kind in the offing, the lines have been proportioned according to the known difference of range between the places.

In the sea to the northward of Holyhead the numbers have been compiled from observations made on calm days, at anchor, in connection with those made upon the shore around the places of observation.

The method of obtaining the range at sea was to moor a heavy weight with a small well-stretched line attached to it marked to feet, and to preserve as nearly as possible the same tension of line at the times when the depths were required, a loop was

Method of obtaining the range at sea.

* It is slack water from about forty minutes before to about forty minutes after high or low water at Morecombe Bay.

placed over the hook of a small hand steelyard, and the line brought tight until the index noted a given quantity, which was afterwards considered the standard; and by comparing the observations of several days obtained in this manner with the tide gauges on shore, a near agreement satisfied me that the results were to be depended upon. At the same time it is not pretended that the rise has been determined to any great accuracy, although I think it is within the foot, and quite near enough for the purposes of navigation for which the chart is intended.

Table for the reduction of soundings.

To make this chart useful for the reduction of soundings at intermediate times between high and low water, I have annexed a diagram, Plate VII., constructed from a vast number of observations, and have given directions for using it.

Unequal motion of the upper and lower half of the tide-wave, common to all the tides in Irish Sea and Bristol Channel.

I shall now notice some peculiarities in the tides which have fallen under our observation. In the construction of the Table, Plate VII., for the use of the seaman, in the Irish Sea it was found that the place of the *water at the half-tide interval* did not correspond with that of a mark at *the half range of the wave*, but that it was always below it, showing that the upper half of the wave rose and fell more rapidly than the lower. It was also found that the curve of the Irish Sea tide did not correspond with that of the Bristol Channel tide; that neither followed the law of the sines to corresponding arcs of tidal intervals, upon the falling water especially, as may be seen in Plate VIII., constructed for the purpose of showing the place of the water at corresponding intervals of a falling tide at places distantly situated.

It was also seen that, owing to the unsymmetrical form of the curves, it would be necessary to have tables for the reduction of soundings adapted to rising and falling tides respectively. In Plate VI. I have exhibited the discordance of the curves of the rising and falling wave in the Bristol Channel, where it will be seen that at one stage of the tide, the difference of similar tidal intervals amounts to about four feet.

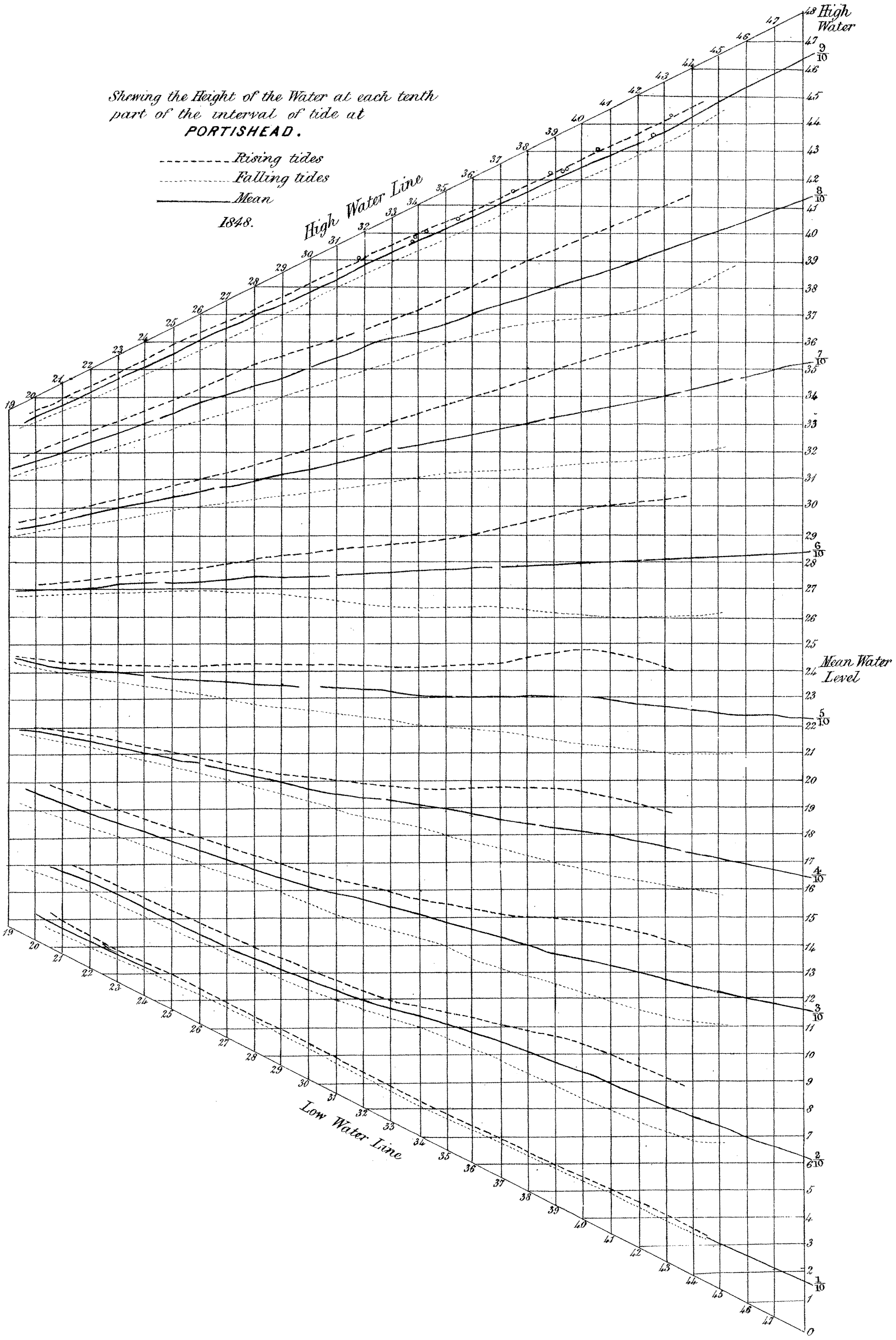
I may here mention that the Cumberland Basin Gauge (Mr. Bunt's), which has been frequently referred to in the Philosophical Transactions, corresponds very nearly with the Portishead Gauge with which the observations in Plate VI. were made.

Apparent mean elevation of the water.

In connection with the range of tide is that of the apparent mean elevation of the water. All the observations confirm the remark of Professor Airy*, viz. that this mean level is higher at the springs than at the neaps. The mean place of the water however for an entire lunation, during the summer months at least, is tolerably constant, and affords a fair standard to which the reductions used in our nautical surveys may be referred in the event of the gauge being removed by which the observations were made.

As an example, I annex the result of observations made at Holyhead during nearly four entire years.

* Philosophical Transactions, 1845, Part I. p. 31.


Shewing the Height of the Water at each tenth part of the interval of tide at
PORTISHEAD.
Rising tides
Falling tides
Mean
1848.
High Water Line
Low Water Line
High Water
Mean Water Level
9/10
8/10
7/10
6/10
5/10
4/10
3/10
2/10
1/10

To adapt Soundings taken at any time in the Irish Sea to the low water depths upon the Admiralty Charts.

Phil: Trans. MDCCCXLVIII. Plate VII. p. 110.

Table C.

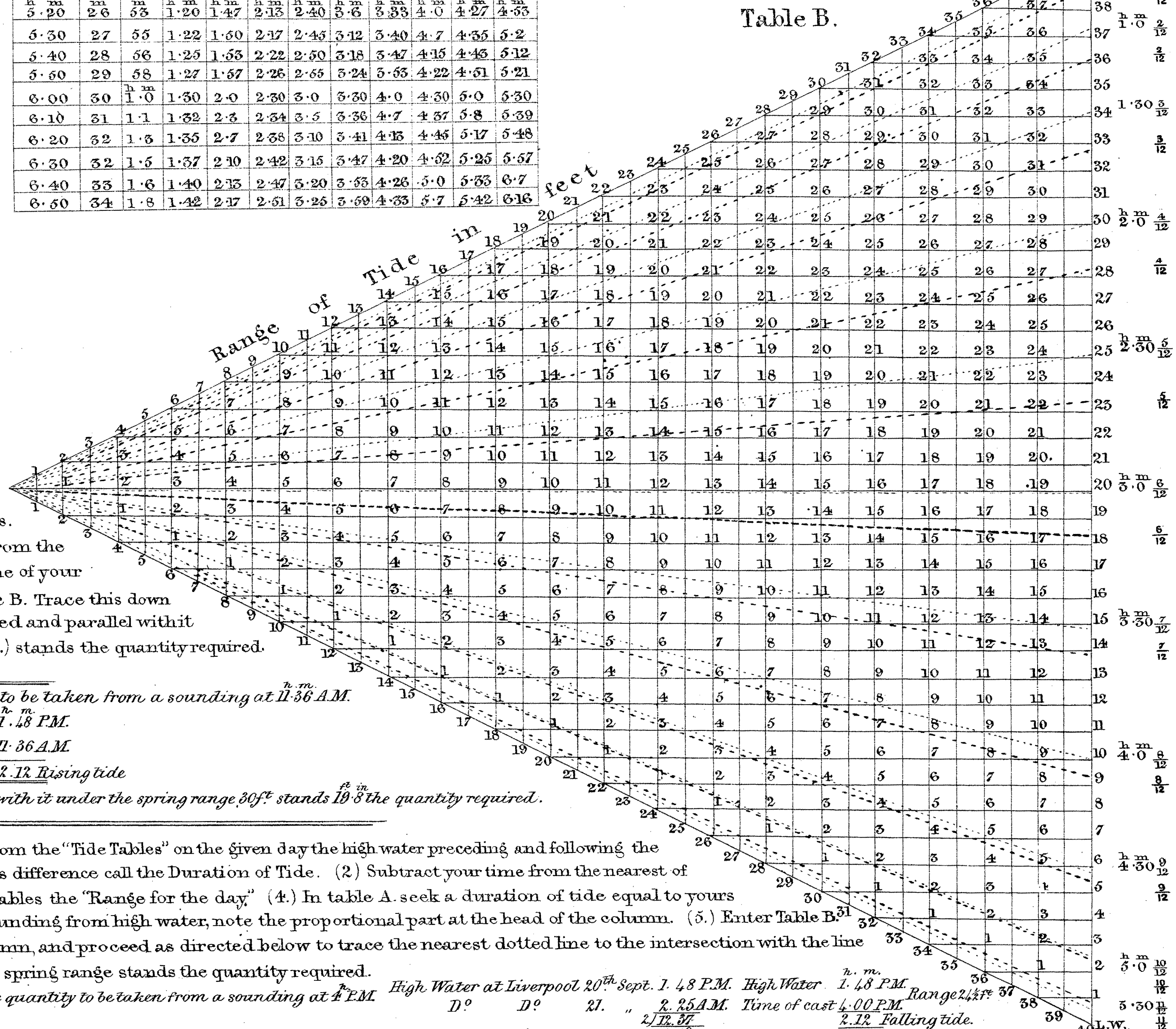
Names of Places.	*Range at Springs*	*Names of Places.*	*Range at Springs*
	feet		feet
Liverpool	30	*Killmore*	11
Holyhead	20	*Loughbar*	8
Fleetwood	28	*Dunmore*	13
Pembroke	22	*Ramsey I.M.*	22
Kingstown	13	*King Will.m Bank*	23½
Belfast	11½	*Ravenglass*	25
Bray	10	*Whitehaven*	25
Wicklow	8	*Donaghadee*	13½
Arklow	3	*Bardsey Id.*	16
Cahore	3	*Tusker*	9
Blackwater	6	*Calf*	15¾
Wexford	5½	*Peel I.M.*	16
Carnsore	8		

For other Places in the Irish Sea see the Tidal Chart Curves.

Table A.

Duration of One Tide	$\frac{1}{12}$	$\frac{2}{12}$	$\frac{3}{12}$	$\frac{4}{12}$	$\frac{5}{12}$	$\frac{6}{12}$	$\frac{7}{12}$	$\frac{8}{12}$	$\frac{9}{12}$	$\frac{10}{12}$	$\frac{11}{12}$
h m 5·20	m 26	m 53	h m 1·20	h m 1·47	h m 2·13	h m 2·40	h m 3·6	h m 3·33	h m 4·0	h m 4·27	h m 4·53
5·30	27	55	1·22	1·50	2·17	2·45	3·12	3·40	4·7	4·35	5·2
5·40	28	56	1·25	1·53	2·22	2·50	3·18	3·47	4·15	4·43	5·12
5·50	29	58	1·27	1·57	2·26	2·55	3·24	3·53	4·22	4·51	5·21
6·00	30	h m 1·0	1·30	2·0	2·30	3·0	3·30	4·0	4·30	5·0	5·30
6·10	31	1·1	1·32	2·3	2·34	3·5	3·36	4·7	4·37	5·8	5·39
6·20	32	1·3	1·35	2·7	2·38	3·10	3·41	4·13	4·45	5·17	5·48
6·30	32	1·5	1·37	2·10	2·42	3·15	3·47	4·20	4·52	5·25	5·57
6·40	33	1·6	1·40	2·13	2·47	3·20	3·53	4·26	5·0	5·33	6·7
6·50	34	1·8	1·42	2·17	2·51	3·25	3·59	4·33	5·7	5·42	6·16

Table B.



To reduce Soundings roughly to low water springs.
Find the range for the day in the "tide tables".* From the time of high water at your station take the time of your sounding and seek a corresponding time in table B. Trace this down to the line of range for the day above mentioned and parallel with it under the range at springs for the place (table C.) stands the quantity required.

EXAMPLE.

Sept. 20th 1845 Off Liverpool. Require the quantity to be taken from a sounding at 11h 36m A.M.

High Water 1h 48m P.M.

Range for the 20th Sept 24¼ ft. *Time of Sounding* 11·36 A.M.

difference 2·12 *Rising tide*

In table B. under 24¼ feet range and 2h 12m and parallel with it under the spring range 30 ft. stands 19 ft. 8 in. the quantity required.

To reduce the Soundings accurately. (1.) Take from the "Tide Tables" on the given day the high water preceding and following the time of your sounding and subtract them, half this difference call the Duration of Tide. (2) Subtract your time from the nearest of these times of high water. (3) Find from the tide tables the "Range for the day." (4.) In table A. seek a duration of tide equal to yours above found, and opposite it the time of your sounding from high water, note the proportional part at the head of the column. (5.) Enter Table B. with this proportional part in the right hand column, and proceed as directed below to trace the nearest dotted line to the intersection with the line of range for the day and parallel with it under the spring range stands the quantity required.

EXAMPLE. Sept. 20th 1845. off Liverpool, Required the quantity to be taken from a sounding at 4h P.M.

High Water at Liverpool 20th Sept. 1. 48 P.M. *High Water* 1h 48m P.M.
Do. Do. 21. " 2. 25 A.M. *Time of cast* 4.00 P.M. *Range 24¼ ft.*
2) 12. 37 — 2.12 *Falling tide.*
Duration of tide 6.19

In table A. opposite 6h 19m. 2h 12m falls about half way between $\frac{4}{12}$ and $\frac{5}{12}$ at the head of the column. In table B. under 24¼ feet range of tide and half way between $\frac{4}{12}$ and $\frac{5}{12}$ and parallel with it under the spring range (from table C.) 30 feet stands 18 ft. 9 in. the quantity to be taken from the sounding.

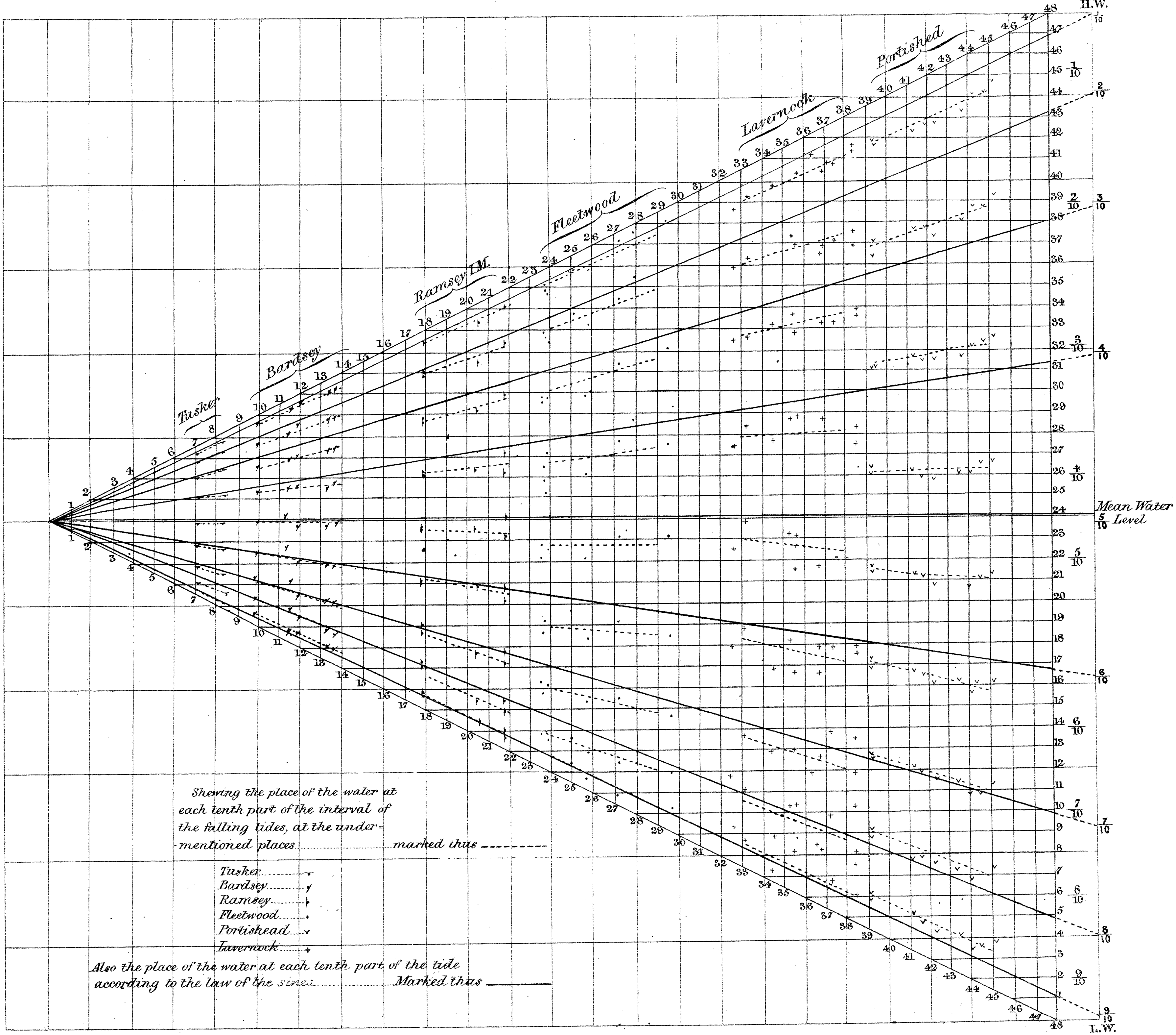
* Knowing the range for the day at Liverpool, the range for the day at any other place in the Irish Sea may be obtained approximately by the following rule.
As 30 feet, is to the range marked upon the Tide Chart, so is the range for the day at Liverpool, to the range for the day at the place of observation.

EXAMPLE. Required the range for the day at Bardsey on the 8th September 1847. as 30 ft. : 9 :: 22·

30) 198 / 6·7 *range for the day at Bardsey.*

NB. If the tide be falling use the strong dotted lines with the proportional part.
If the tide be rising use the light lines with the propl. part.

J. Basire lith.


H.W.
L.W.
Mean Water Level
Tusker
Bardsey
Ramsey I.M.
Fleetwood
Laverneck
Portished
Shewing the place of the water at each tenth part of the interval of the falling tides, at the under-mentioned places .... marked thus
Tusker
Bardsey
Ramsey
Fleetwood
Portishead
Lavernock
Also the place of the water at each tenth part of the tide according to the law of the sines .... Marked thus

At Holyhead.

Apparent mean place of the water.

Month.	1838. ft.	in.	1839. ft.	in.	1846. ft.	in.	1847. ft.	in.	Mean of months. ft.	in.	
January ...	11	$3\frac{1}{4}$	10	6	......		10	7	10	$9\frac{1}{3}$	
February ...	10	$6\frac{1}{2}$	10	3	......		9	10	10	$2\frac{1}{3}$	
March	10	1	10	2	......		10	4	10	$2\frac{1}{3}$	
April	10	1	9	10	......		9	11	9	$11\frac{1}{3}$	Summer months. (April–August)
May	10	2	9	9	10	$0\frac{1}{2}$	9	$11\frac{3}{4}$	9	$11\frac{3}{4}$	
June	......		10	1	10	4	9	$11\frac{3}{4}$	10	$1\frac{1}{2}$	
July	10	1	10	$1\frac{1}{2}$	10	$1\frac{3}{4}$	9	$10\frac{3}{4}$	10	$0\frac{3}{4}$	
August	10	6	9	10	10	1	9	$10\frac{3}{4}$	10	$0\frac{3}{4}$	
September .	10	4	10	7	11	1	10	$3\frac{1}{4}$	10	$6\frac{3}{4}$	
October ...	10	$6\frac{3}{4}$	10	$3\frac{1}{3}$	10	8	10	10	10	7	
November ..	10	7	10	$2\frac{1}{2}$	10	$7\frac{3}{4}$	10	$9\frac{3}{4}$	10	$6\frac{3}{4}$	
December ..	10	7	11	2	10	6	10	11	10	$9\frac{1}{2}$	
Mean of the year ...	10	5	10	$2\frac{3}{4}$	10	$5\frac{1}{2}$	10	$3\frac{1}{4}$	10	$3\frac{5}{6}$	

All the tides of the Irish Sea partake of the nature of river tides in having their ebb longer than their flood, except those of Tuskar and Holyhead, which are the reverse. The respective intervals are given in the order in which the places occur.

Duration of rising and falling tides.

Duration of tide.	Rising. h	m	Falling. h	m
Tuskar	6	27	6	08
Bardsey	5	24	6	52
Holyhead	6	18	6	00
Peel, Isle of Man .	6	00	6	15
Ramsay, Isle of Man	5	48	6	35
Fleetwood	5	46	6	39

All these are the mean of many observations.

Remarkable deviation at Holyhead.

The change at Holyhead is remarkable, and if we follow the durations up to Ramsay we shall see that Peel also, an intermediate station, is affected. The cause of this may possibly be connected with the effort of the water to maintain its level; for in projecting the curve of the wave on paper, this peculiarity, in connection with the very short flood of Bardsey, has the effect of reducing the curve from what it would assume, were Holyhead similarly influenced with other places.

Probable cause.

The next peculiarity to which I shall direct attention is that of the form of the surface of the opposite sides of the channel at the instant of half-tide, and at the times of high and low water respectively at the virtual head of the channel. In Plate IV. I have given these sections of the water for the purpose of comparison. E is a section of the tide-wave at the *instant of high and low water* at Fleetwood; the broken line being the *western* side of the channel, or a line drawn through Courtown on to Peel, Isle of Man; the dotted line being through the *eastern* limit of the channel, or from Peel through Bardsey to Pembroke. F is a section of the water through the same localities at the *third hour* of the tide at Fleetwood; the broken line in this case also representing the *western* portion of the channel, the dotted the *eastern*.

Form of the surface of the water on east and west sides of the channel at the same instants.

In these sections it will be seen what an unusual depression there is of the water-line between Holyhead and Bardsey, and as this occurs at the time of slack water throughout the channel, we may perhaps connect with it the inversion of the interval of tide before mentioned at the former place.

Curves of tide-waves of various ranges.

I conclude these remarks with directing your attention to another diagram, Plate V., exhibiting the curves assumed by the tide-wave in various parts of the Irish and Bristol Channels. They are given without any corrections having been applied to them.

Importance of the observations being extended.

Having now laid before you the result of our observations upon the tides of the Irish Sea, I wish to call your attention to the great importance of these observations being extended. Independent of the vast advantage of having a correct knowledge of the set of the stream at the entrance of two channels through which the greater part of the trade of this great maritime nation is conducted, I think I shall be able to show that in another point of view also, considerable interest attaches to the subject.

Attempt to trace the course of the stream, and connect the tides of the Irish Sea with those of the English Channel.

That you may meet the question at once, I lay before you the result of an attempt I have made with the aid of the data we already possess, and especially those of Capt. Martin White, R.N., to trace the course of the stream from Pembroke to the Land's End; to connect the tides of the Irish Sea with those of the Bristol and English Channels, and finally with those of the offing; or, in other words, to reconcile and reduce to a system the anomalous and apparently contradictory observations of our naval surveyors in that portion of our coast, by combining them with the information which the recent attention to the tides has already furnished.

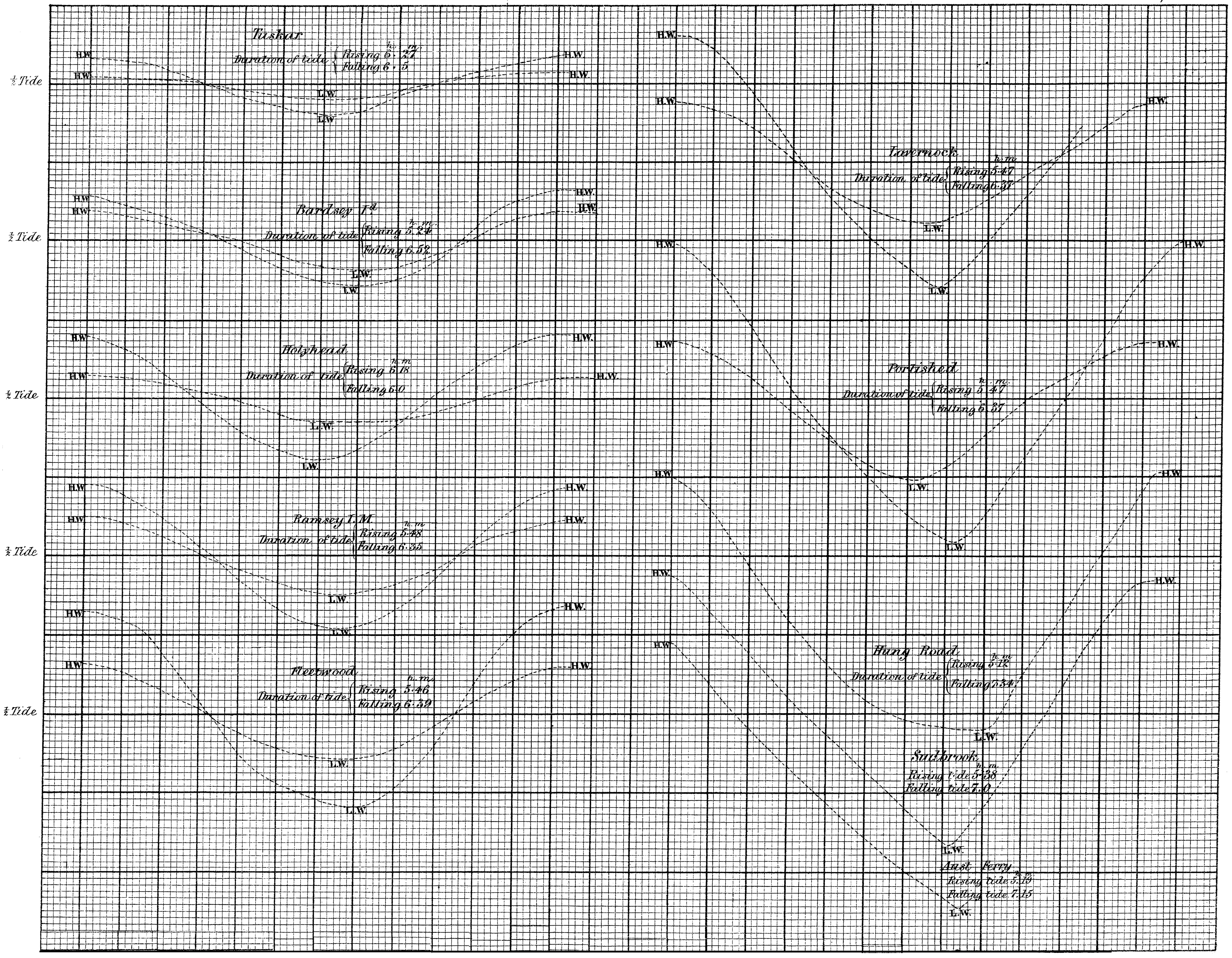
Difficulty of so doing.

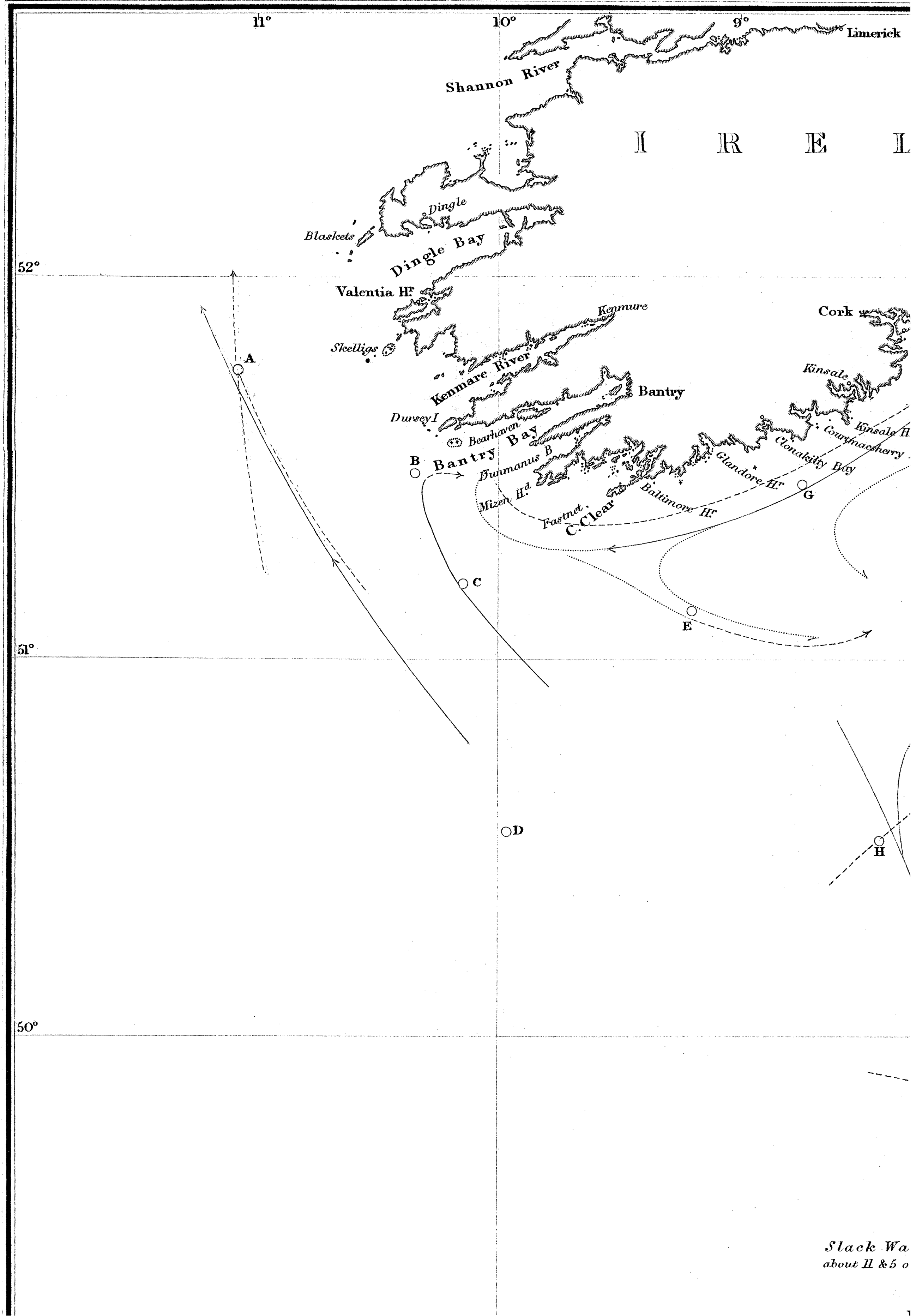
Discrepancies reconciled by the application of an offing stream setting in opposition nearly to that of the channel stream.

The first part of this attempt presented but few difficulties as the streams were tolerably regular, but for the last our data, at first sight, seemed to bar all progress. At the mouth of the English Channel especially, opposition presented itself at every step; the observations projected upon the chart exhibited a frieze of arrows pointing in all directions "in happy discordance," and certainly quite useless and unintelligible to the navigator. Relying however upon the general accuracy of the observations, I was encouraged to proceed. After some consideration it seemed evident that the water was influenced by forces acting in opposition nearly to each other, and that there was a tide in the offing whose streams of ebb and flood did not correspond with those of the channels. By applying this idea first to the English Channel, I found the observations responded to it; and carrying it to the offing of the Irish Sea, and considering that channel as comprising the Bristol Channel within its limits, as the English Channel does the Gulf of St. Malo, I had the satisfaction of finding the correctness of the idea confirmed so far as the observations themselves extended. This offing stream appears to be of great extent, setting to the north and south along the coast of Biscay and the British Isles, running six hours nearly each way, and exercising an influence with more or less effect over all the waters of the channels and estuaries it passes in its progress, diverting their courses, and in some

Shewing the curve of the Tide Wave at springs and neaps in the Bristol Channel and Irish Sea.

Phil: Trans: MDCCCXLVIII. Plate V. p. 112.




11°
10°
9°
Limerick
Shannon River
I R E L
Dingle
Blaskets
Dingle Bay
52°
Valentia Hr.
Cork
Kenmure
Skelligs
A
Kenmare River
Kinsale
Bantry
Dursey I
Bearhaven
Kinsale H
Courtmacsherry
Bantry Bay
Clonakilty Bay
B
Dunmanus B
Glandore Hr.
Mizen Hd.
Baltimore Hr.
G
Fastnet
C. Clear
C
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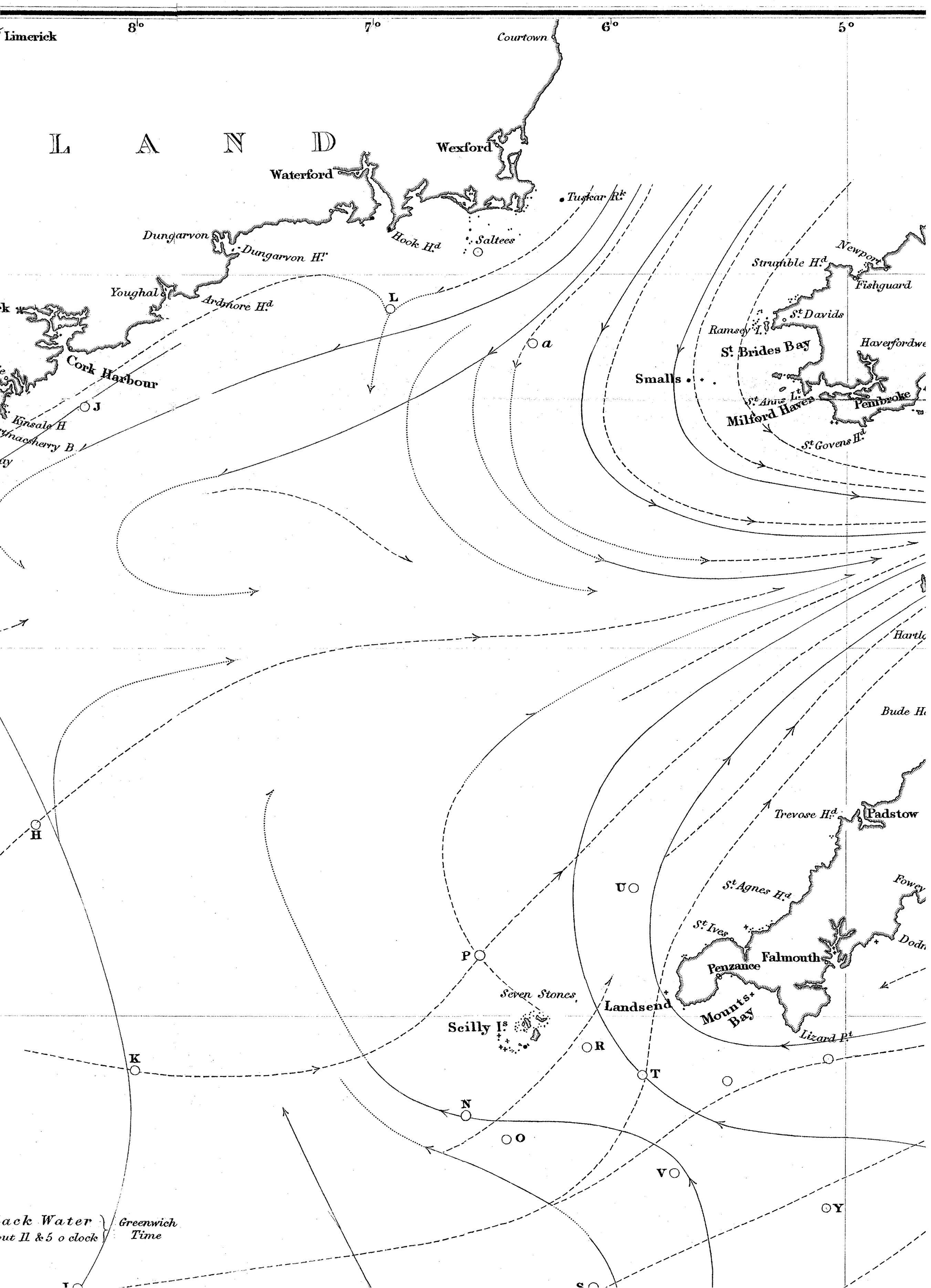
51°
D
H
50°
Slack Wa
about 11 & 5 o



Limerick
8°
7°
6°
5°
Courtown
L A N D
Wexford
Waterford
Tuskar Rk.
Dungarvon
Dungarvon Hr.
Hook Hd.
Saltees
Youghal
Ardmore Hd.
Newport
Strumble Hd.
Fishguard
St. Davids
Ramsey I.
Haverfordwe
St. Brides Bay
Smalls
Cork Harbour
St. Anns Lt.
Milford Haven
Pembroke
St. Govens Hd.
Kinsale H
Courtmacsherry B.
Hartl
Bude H
Trevose Hd.
Padstow
St. Agnes Hd.
Fowe
St. Ives
Dodm
Falmouth
Penzance
Seven Stones
Landsend
Scilly Is.
Mounts Bay
Lizard Pt.
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out 11 & 5 o clock
Greenwich Time
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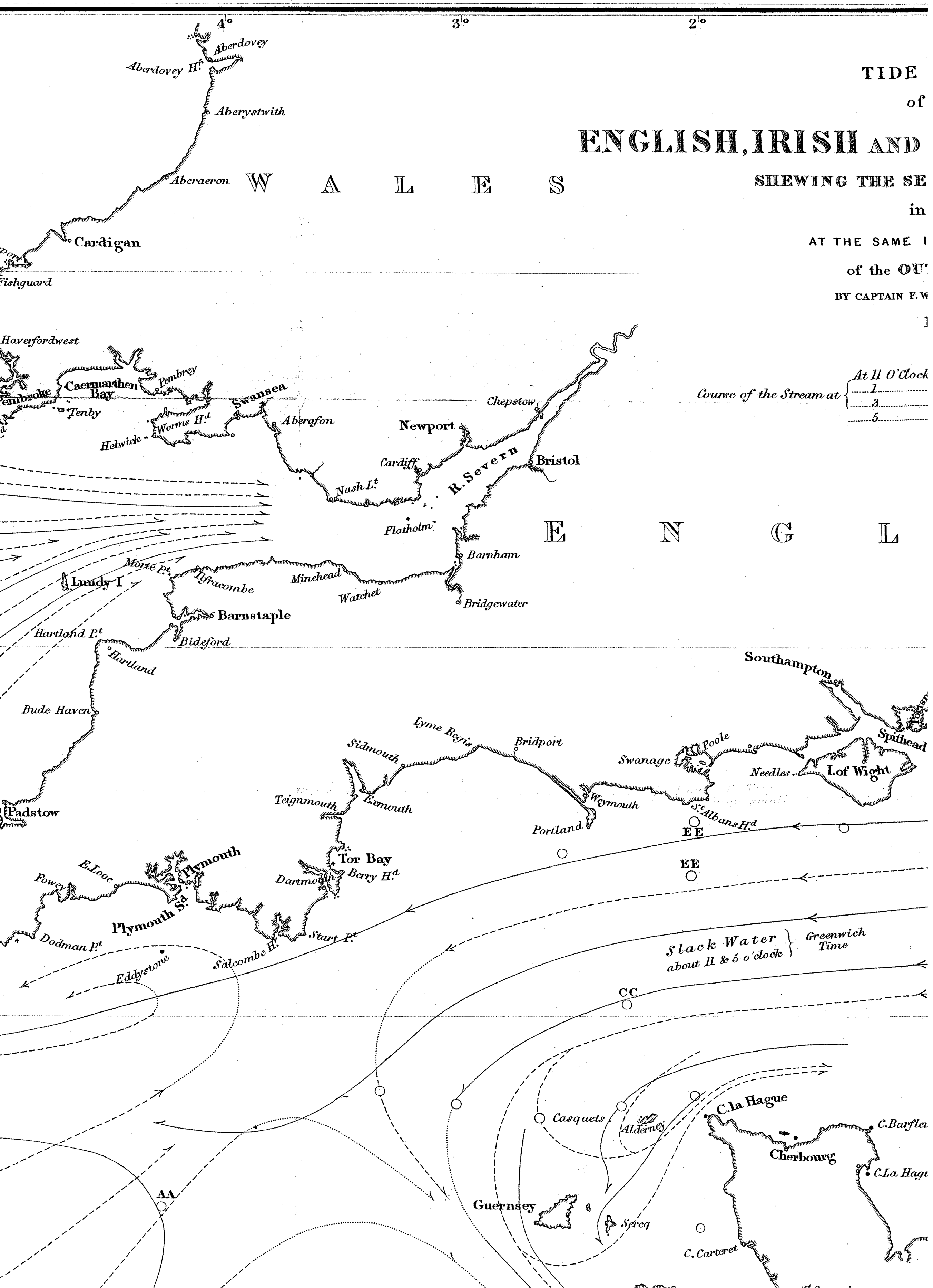
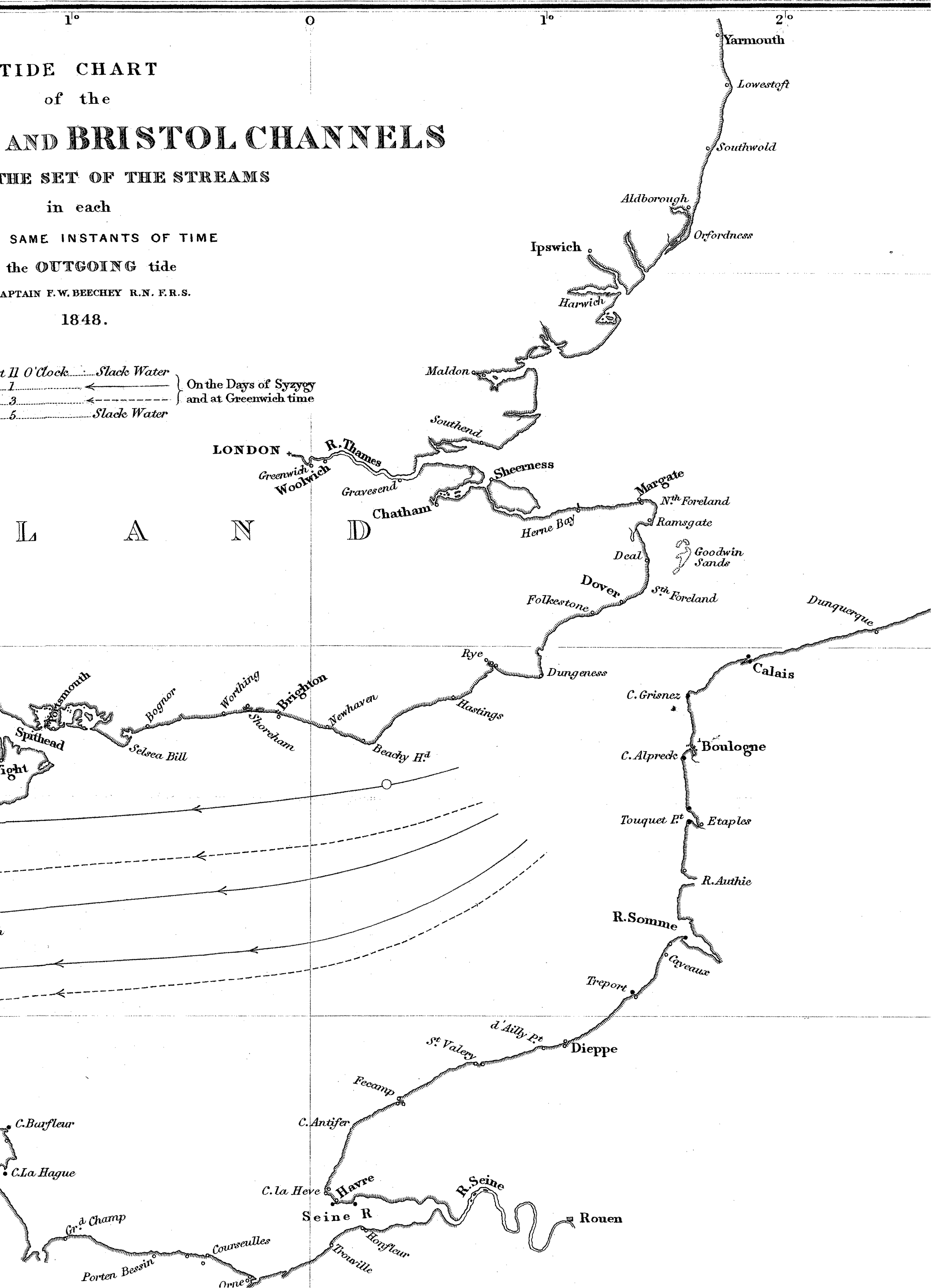
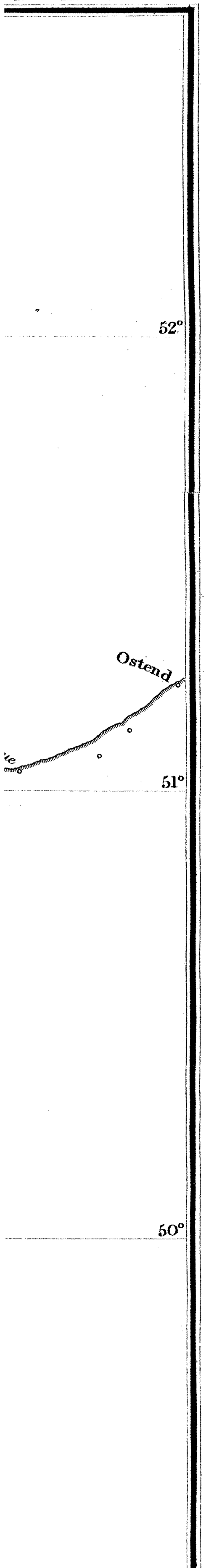
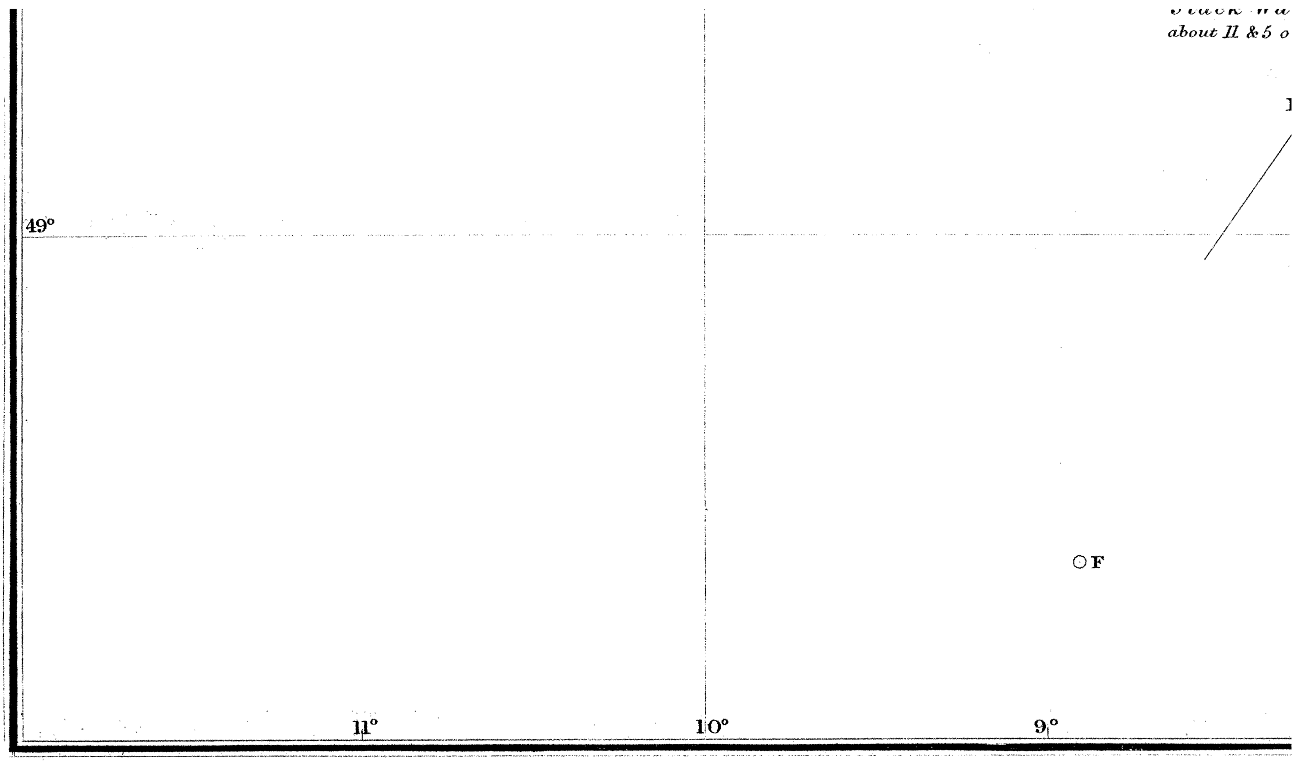


TIDE
of
ENGLISH, IRISH AND
SHEWING THE SE
in
AT THE SAME
of the OU
BY CAPTAIN F. W
4°
3°
2°
Aberdovey
Aberdovey Hd.
Aberystwith
Aberaeron
WALES
Cardigan
Fishguard
Haverfordwest
Pembroke
Caermarthen Bay
Pembrey
Tenby
Worms Hd.
Helwick
Swansea
Aberafon
Newport
Chepstow
Cardiff
Nash Lt.
R. Severn
Bristol
Flatholm
ENGL
Barnham
Morte Pt.
Ilfracombe
Minehead
Watchet
Bridgewater
Lundy I.
Barnstaple
Bideford
Hartland Pt.
Hartland
Bude Haven
Padstow
At 11 O'Clock
Course of the Stream at
1
3
5
Southampton
Spithead
Lyme Regis
Bridport
Sidmouth
Swanage
Poole
Needles
I. of Wight
Teignmouth
Exmouth
Weymouth
Portland
St. Albans Hd.
EE
EE
Tor Bay
Berry Hd.
Dartmouth
E. Looe
Plymouth
Fowey
Plymouth Sd.
Dodman Pt.
Start Pt.
Salcombe H.
Eddystone
Slack Water about 11 & 5 o'clock
Greenwich Time
CC
C. la Hague
Casquets
Alderney
C. Barfleur
Cherbourg
C. La Hague
AA
Guernsey
Sercq
C. Carteret



1°
0
1°
2°
TIDE CHART
of the
AND BRISTOL CHANNELS
THE SET OF THE STREAMS
in each
SAME INSTANTS OF TIME
the OUTGOING tide
APTAIN F. W. BEECHEY R.N. F.R.S.
1848.
t 11 O'Clock .... Slack Water
1
3
5 .... Slack Water
On the Days of Syzygy and at Greenwich time
Yarmouth
Lowestoft
Southwold
Aldborough
Orfordness
Ipswich
Harwich
Maldon
Southend
LONDON
R. Thames
Greenwich
Woolwich
Gravesend
Sheerness
Chatham
Margate
Nth Foreland
Ramsgate
Herne Bay
Deal
Goodwin Sands
Dover
Sth Foreland
Folkestone
L A N D
Dunquerque
Rye
Dungeness
Calais
C. Grisnez
Portsmouth
Spithead
ight
Bognor
Worthing
Brighton
Shoreham
Newhaven
Hastings
Selsea Bill
Beachy Hd
Boulogne
C. Alpreck
Touquet Pt
Etaples
R. Authie
R. Somme
Caveaux
Treport
d'Ailly Pt
Dieppe
St Valery
Fecamp
C. Antifer
C. Barfleur
C. La Hague
C. la Heve
Havre
R. Seine
Seine R
Rouen
Grd Champ
Courseulles
Honfleur
Trouville
Porten Bessin
Orne


52°
Ostend
51°
50°


about 11 & 5 o
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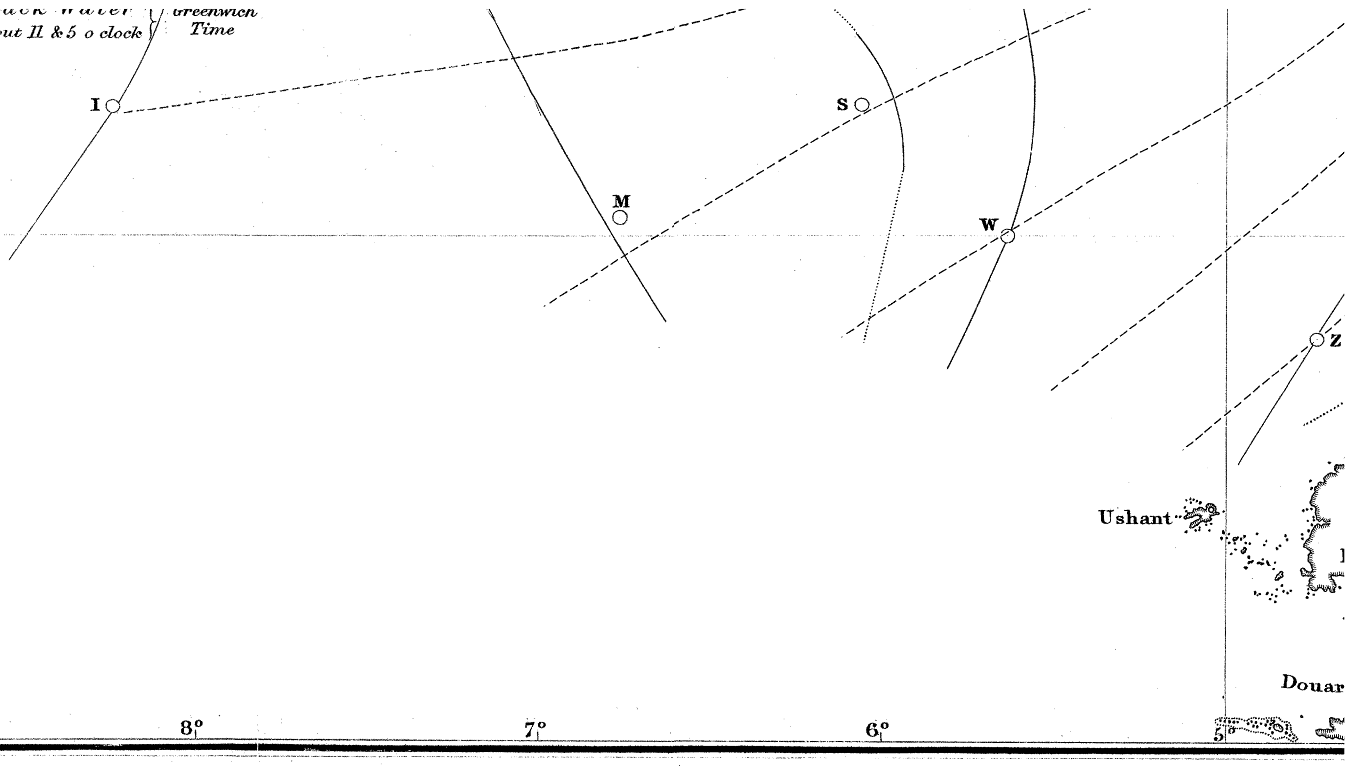

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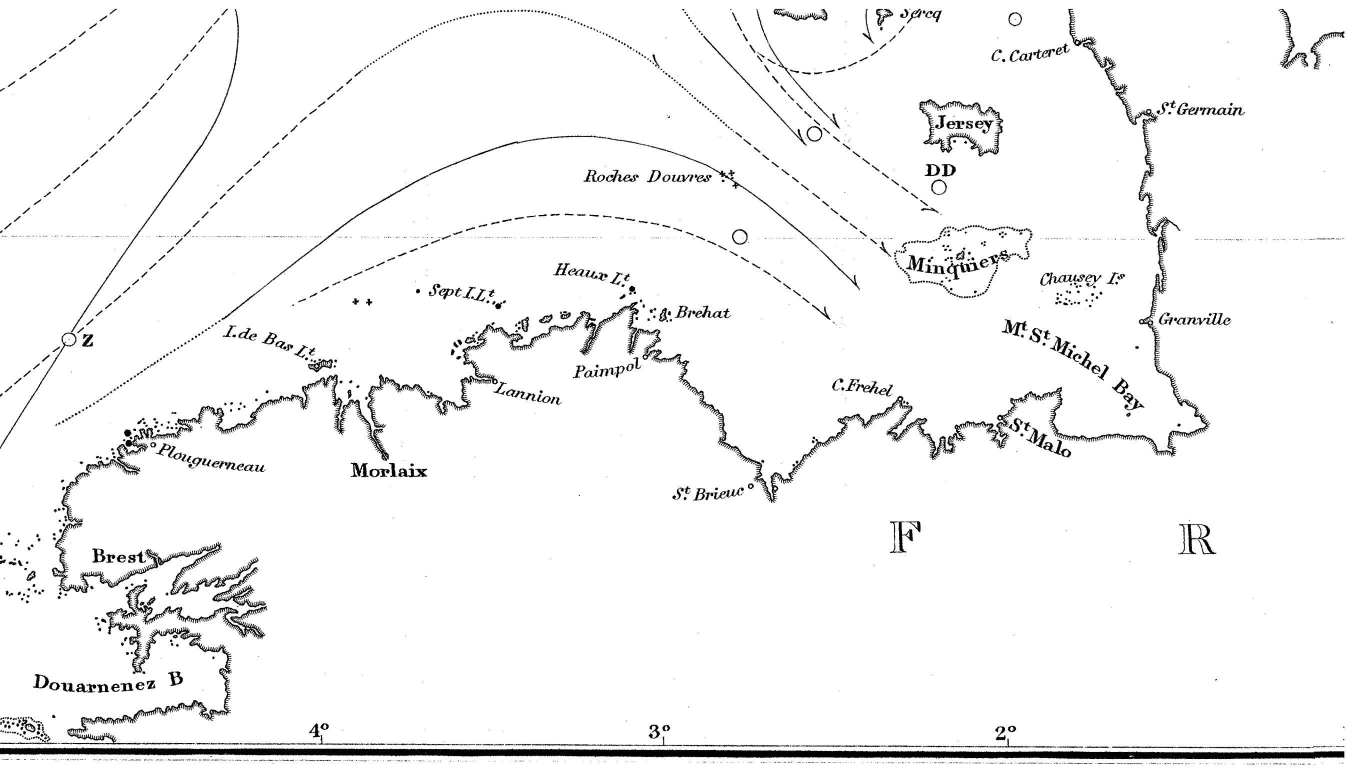

Sercq
C. Carteret
St Germain
Jersey
DD
Roches Douvres
Minquiers
Chausey Is
Granville
Heaux Lt
Sept I. Lt
Brehat
I. de Bas Lt
Z
Paimpol
Lannion
Mt St Michel Bay
C. Frehel
St Malo
Plouguerneau
Morlaix
St Brieuc
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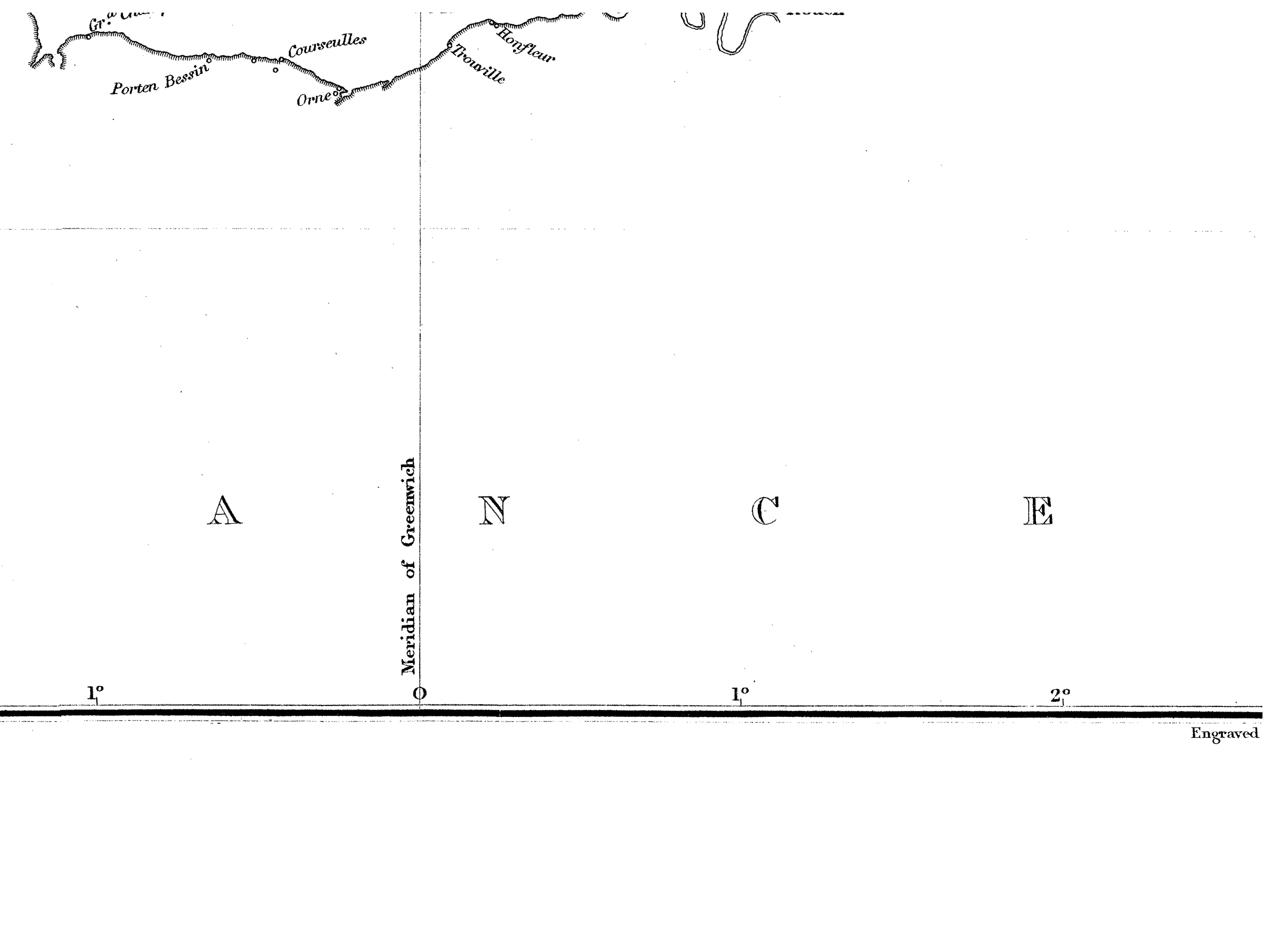
Porten Bessin
Courseulles
Orne
Trouville
Honfleur
A N C E
Meridian of Greenwich
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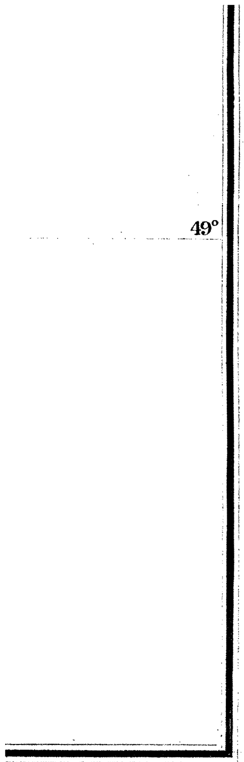
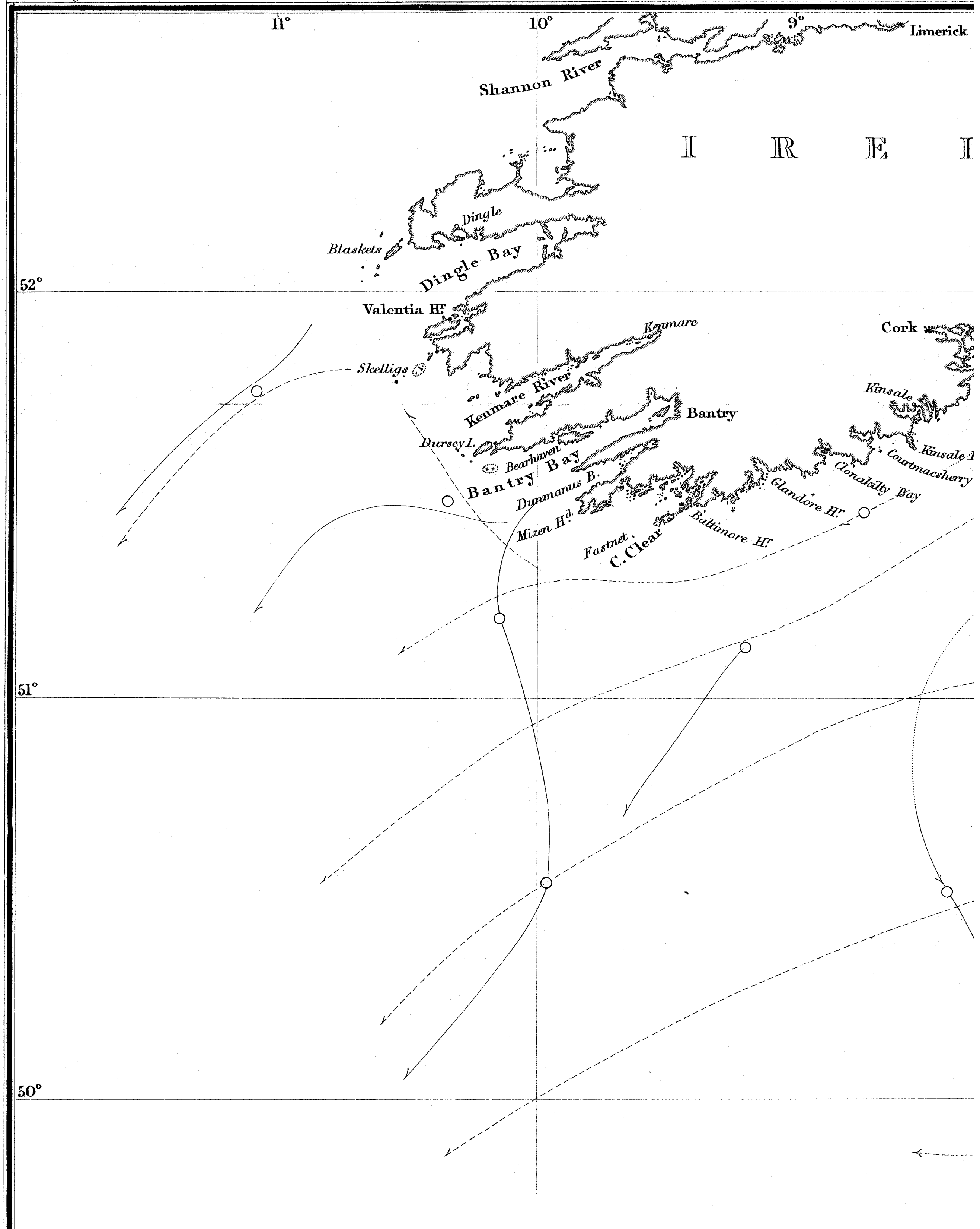
Engraved

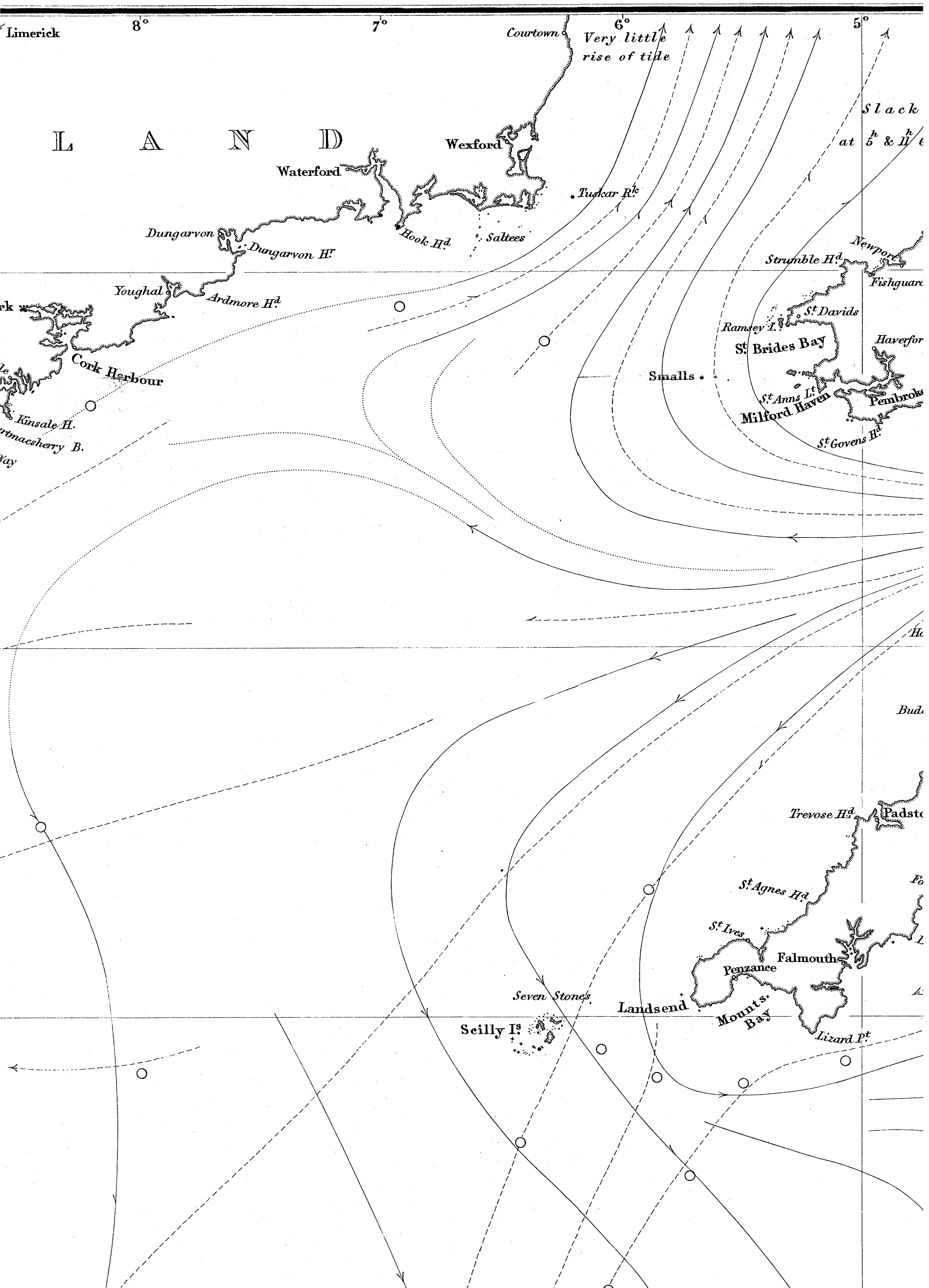


Engraved by J. & C. Walker.



Slack water

about 5 oclock } *Greenwich Time*
and 11 oclock }



Limerick
8°
7°
6°
5°
Courtown
Very little rise of tide
Slack
at 5h & 11h
L A N D
Wexford
Waterford
Tuskar Rk
Dungarvon
Dungarvon Hr
Hook Hd
Saltees
Newport
Strumble Hd
Fishguard
Youghal
Ardmore Hd
St Davids
Ramsey I.
St Brides Bay
Haverford
Cork Harbour
Smalls
St Anns Lt
Milford Haven
Pembroke
Kinsale H.
St Govens Hd
Bude
Trevose Hd
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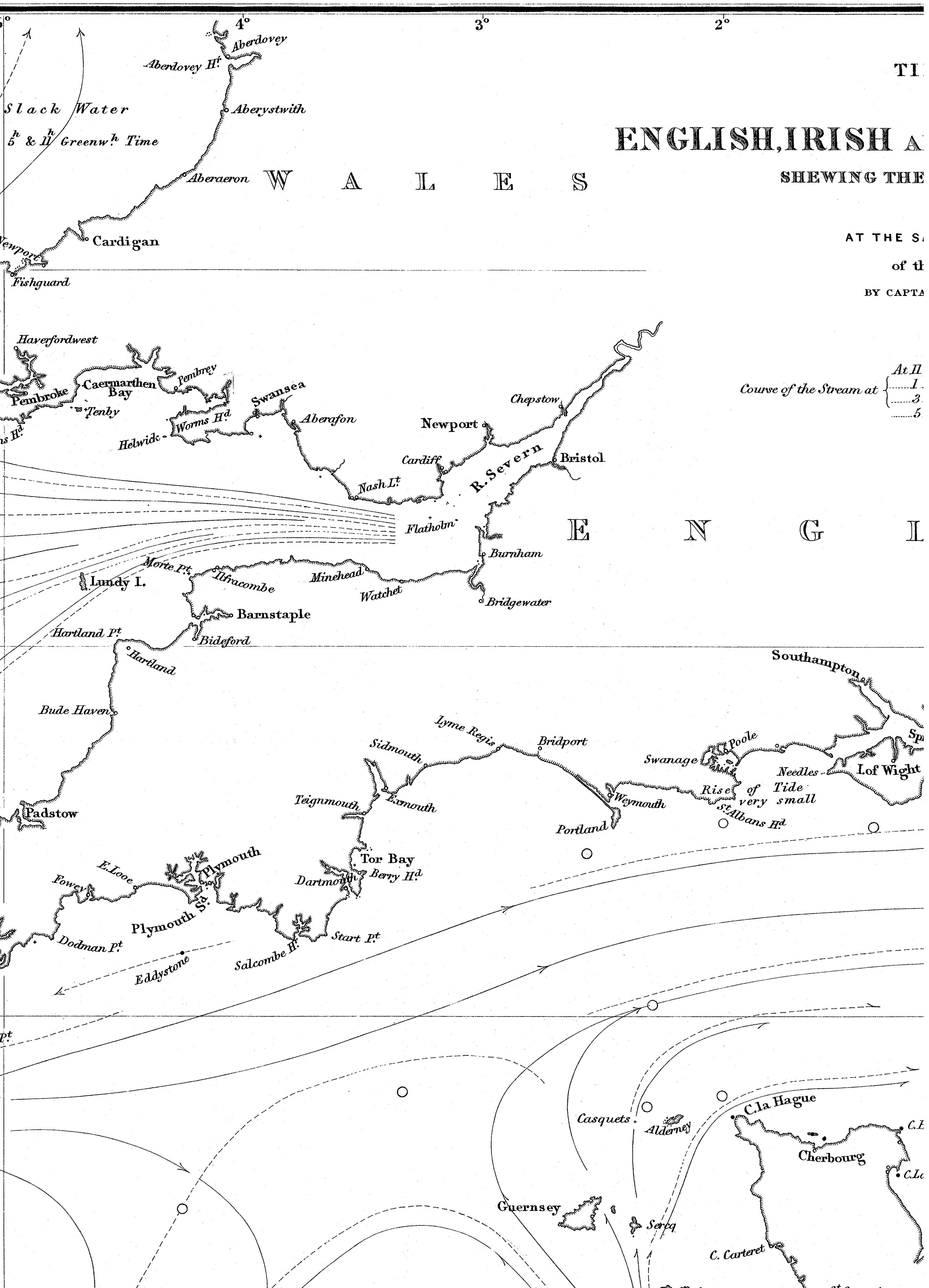
St Agnes Hd
St Ives
Falmouth
Penzance
Seven Stones
Landsend
Mounts Bay
Scilly Is
Lizard Pt



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Aberdovey
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Slack Water
5h & 11h Greenwh. Time
Aberaeron
WALES
Cardigan
Newport
Fishguard
Haverfordwest
Pembroke
Caermarthen Bay
Pembrey
Tenby
Worms Hd.
Helwick
Swansea
Aberafon
Chepstow
Newport
Cardiff
Bristol
Nash Lt.
R. Severn
Flatholm
Course of the Stream at
At 11
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ENGL
Burnham
Morte Pt.
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Minehead
Watchet
Lundy I.
Bridgewater
Barnstaple
Hartland Pt.
Bideford
Hartland
Southampton
Bude Haven
Lyme Regis
Bridport
Sidmouth
Poole
Swanage
Needles
I. of Wight
Rise of Tide very small
Teignmouth
Exmouth
Weymouth
St. Albans Hd.
Padstow
Portland
Tor Bay
Plymouth
E. Looe
Fowey
Dartmouth
Berry Hd.
Plymouth Sd.
Dodman Pt.
Start Pt.
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Casquets
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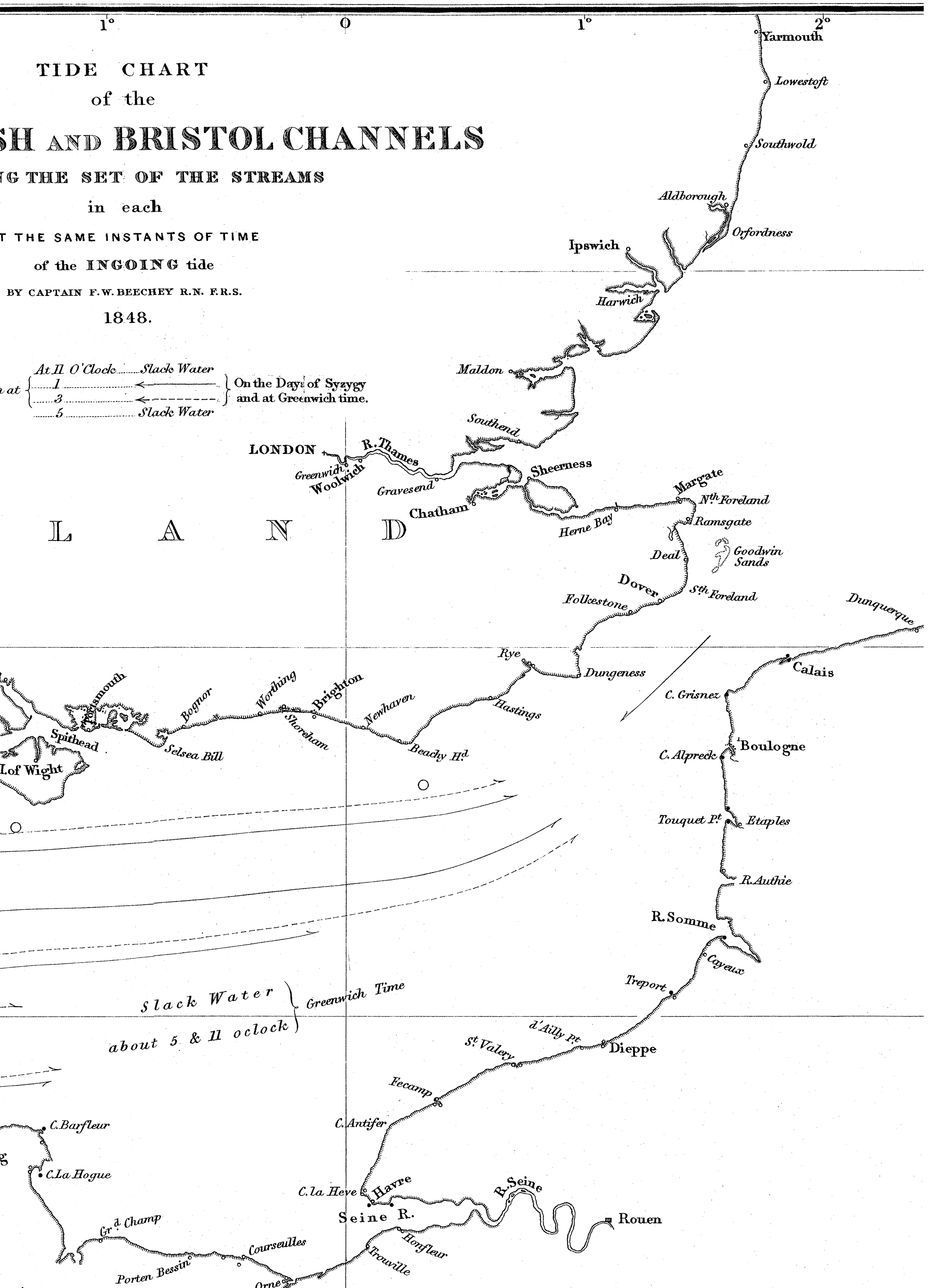
C. Carteret


1°
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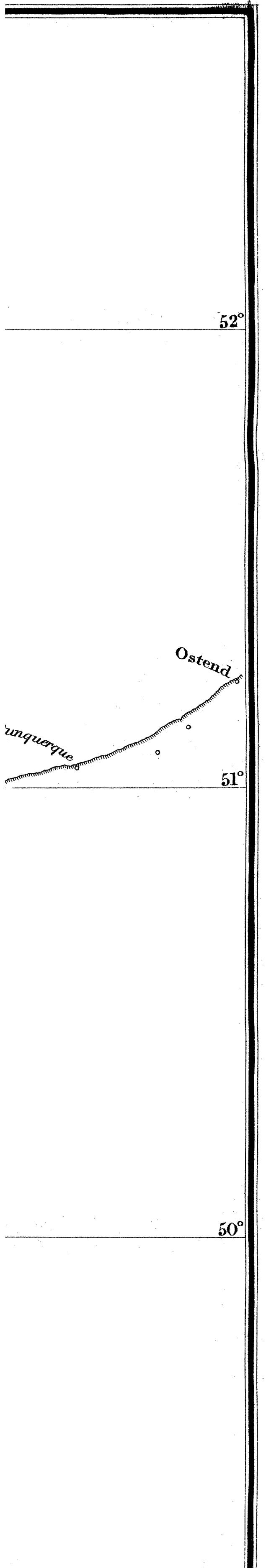
2°
TIDE CHART
of the
SH AND BRISTOL CHANNELS
NG THE SET OF THE STREAMS
in each
T THE SAME INSTANTS OF TIME
of the INGOING tide
BY CAPTAIN F. W. BEECHEY R.N. F.R.S.
1848.
At 11 O'Clock .... Slack Water
1
3
5 .... Slack Water
n at
On the Days of Syzygy
and at Greenwich time.
Yarmouth
Lowestoft
Southwold
Aldborough
Orfordness
Ipswich
Harwich
Maldon
Southend
LONDON
R. Thames
Greenwich
Woolwich
Gravesend
Sheerness
Chatham
Margate
Nth Foreland
Ramsgate
Herne Bay
Deal
Goodwin
Sands
Dover
Sth Foreland
Folkestone
L A N D
Dunquerque
Rye
Dungeness
Calais
C. Grisnez
Portsmouth
Bognor
Worthing
Brighton
Newhaven
Hastings
Shoreham
Spithead
Selsea Bill
Beachy Hd
I. of Wight
Boulogne
C. Alpreck
Touquet Pt
Etaples
R. Authie
R. Somme
Cayeux
Treport
Slack Water
Greenwich Time
about 5 & 11 oclock
d'Ailly Pt
Dieppe
St Valery
Fecamp
C. Antifer
C. Barfleur
C. La Hogue
C. la Heve
Havre
R. Seine
Seine R.
Rouen
Grd Champ
Honfleur
Courseulles
Trouville
Porten Bessin
Orne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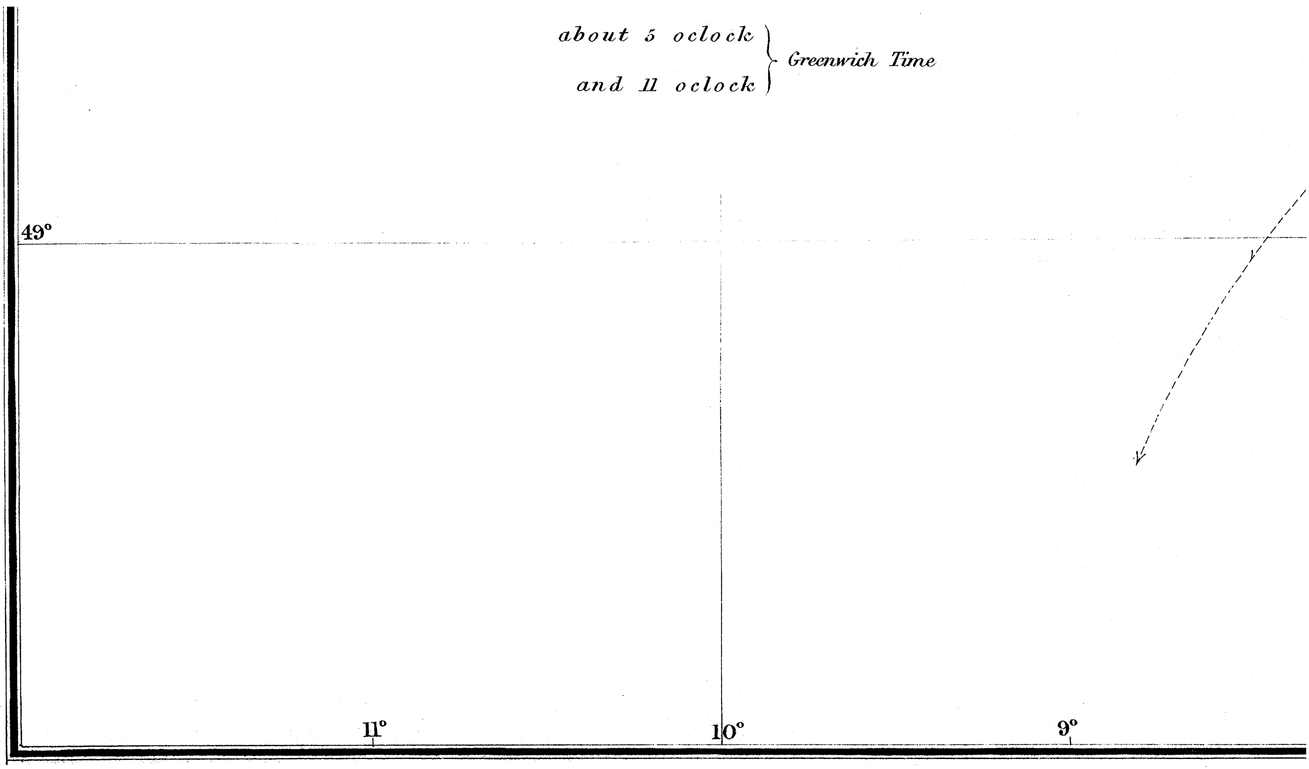
about 5 oclock
and 11 oclock
Greenwich Time
49°
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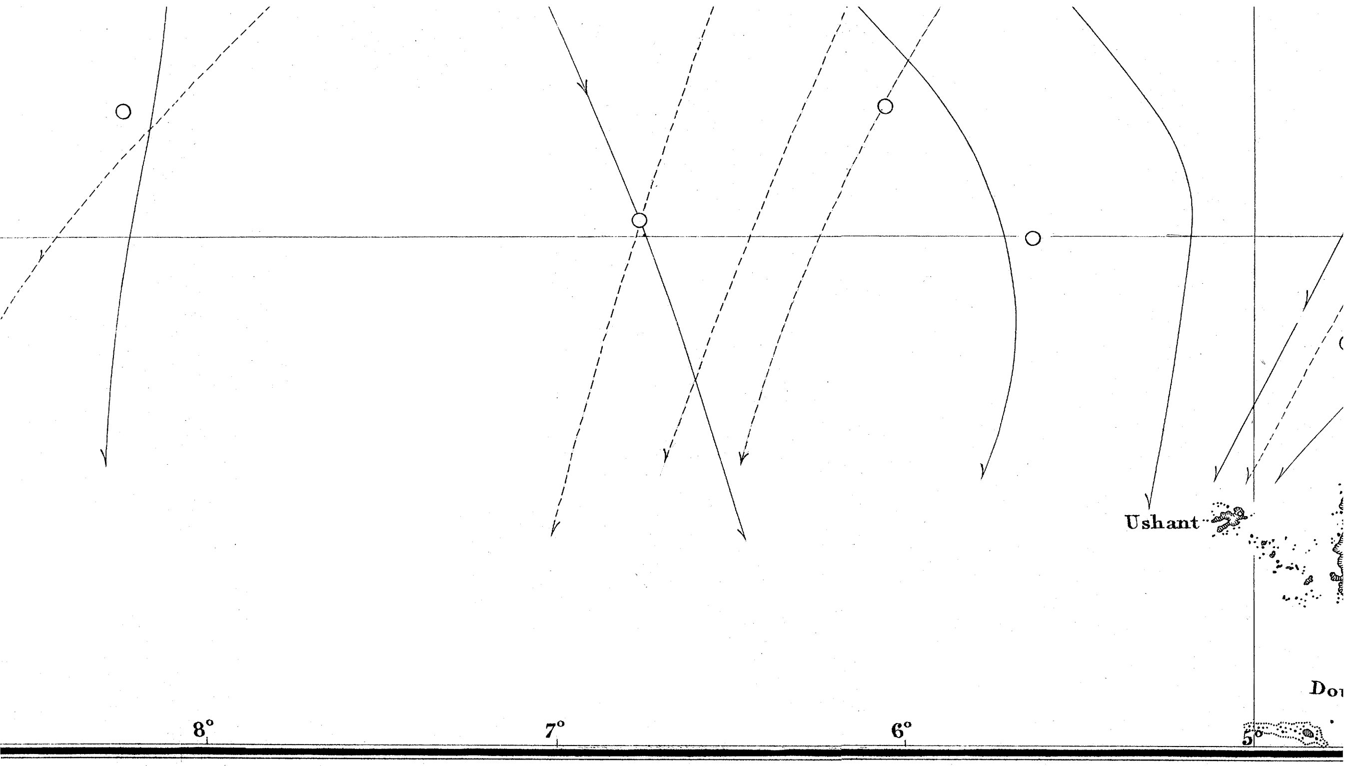
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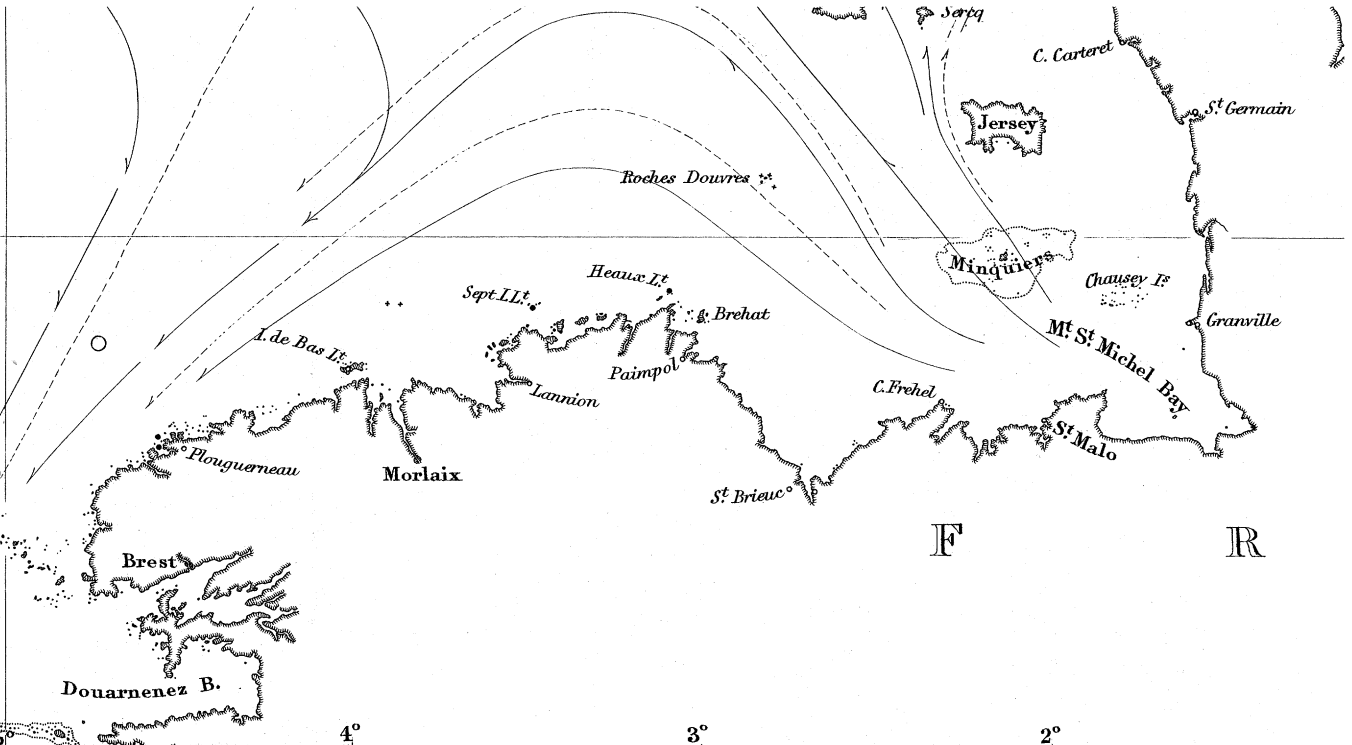

Serq
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Minquiers
Chausey Is
Granville
Heaux Lt
Sept I.Lt
Brehat
Mt St Michel Bay
I. de Bas Lt
Paimpol
Lannion
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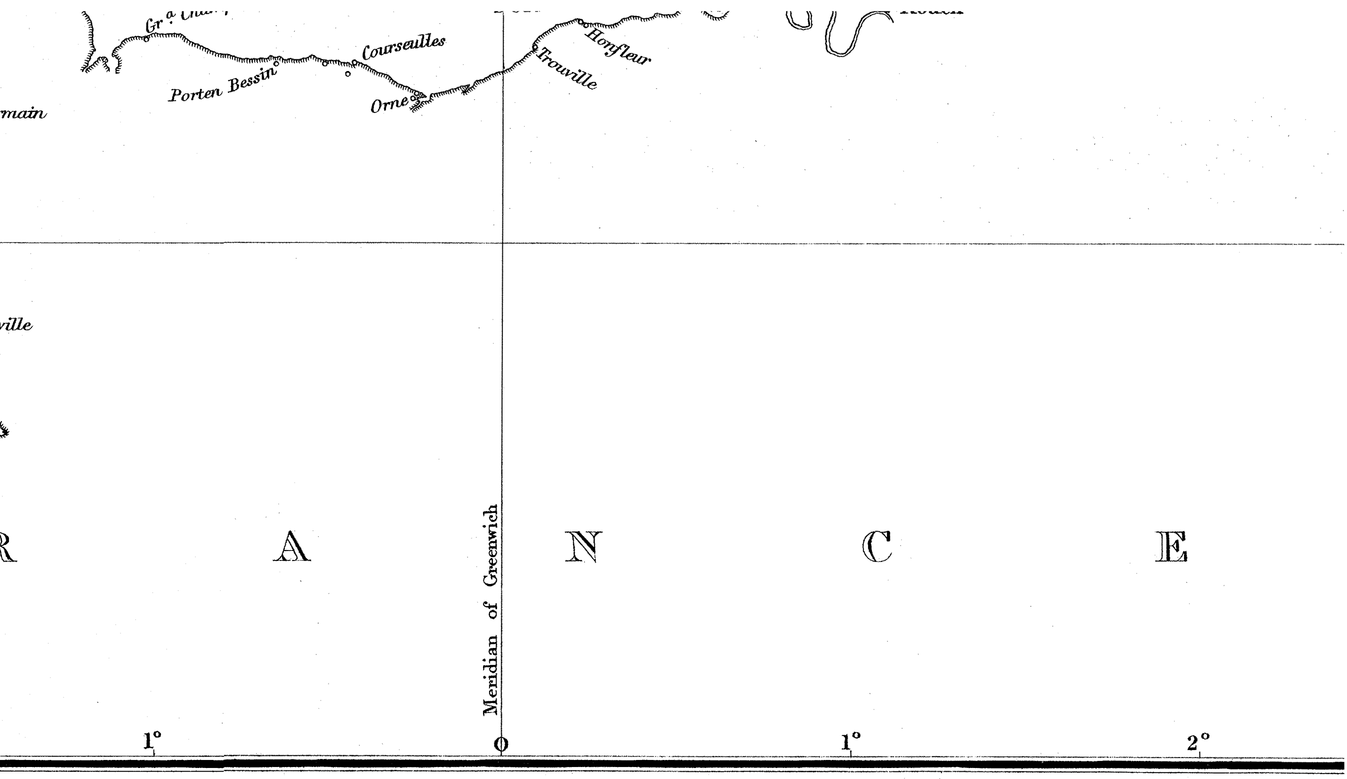

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Courseulles
Porten Bessin
Orne
Trouville
Honfleur
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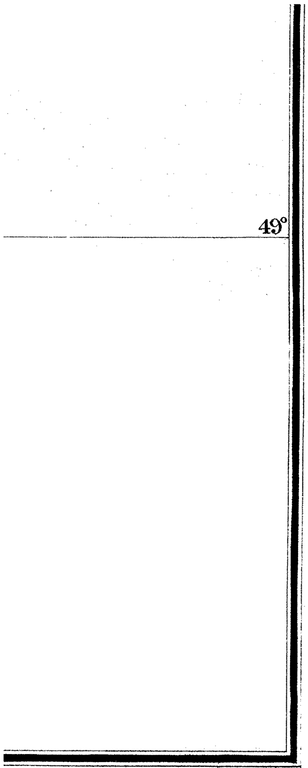
ville
F R A N C E
Meridian of Greenwich
1°
0
1°
2°



Engraved by J. & C. Walker.

cases, when the streams oppose, wholly overpowering or reversing their direction. That you may the more readily comprehend this explanation, I annex two charts, Plate IX. and X., upon which I have traced the course of the stream at *alternate hours* of a spring tide, each line representing the direction of the stream *at the same moment throughout both channels.* From the connection of the observations of the Irish Sea with those of the Bristol Channel, it is clear that the whole of the ebb or outgoing stream of the eastern half of the Irish Channel runs into the Bristol Channel, and forms the flood or ingoing tide of the northern half of that great estuary; and *vice versâ*, the ebb or outgoing stream from the northern half of the Bristol Channel, forms the flood of the Irish Sea, each tide passing to and fro with great rapidity round St. Govan's Head. The centre and southern half of the Bristol Channel receive their waters from the offing and the English Channel, the coast stream bringing the waters up from the Land's End and the English Channel, as the stream on the northern half did those of the Irish Channel, and *vice versâ*.

Influence of offing stream over that of the channel.

Courses of the stream at alternate hours of the tide, from Dungeness to the Irish Sea.

Tides of the Bristol Channel.

The great offing stream at the entrance of the English Channel extends its influence as far up as Cape La Hague, beyond which, owing perhaps to the sudden contraction which there occurs in the Channel, the stream suffers no interruption, but, as in the Irish Sea, passes up and down the Channel six hours nearly each way as far as a line joining Dungeness and Cape Grisnez, the apparent *virtual head* of the tidal channel. Here the influence of the North Sea stream begins to be felt, and here, as in the Irish Channel, again *the time of high and low water at the virtual head of the tide regulates the turn of the up and down stream along the whole channel* as far as the contraction. Beyond this the offing stream being governed by its own high water, and that occurring at about six hours earlier than that of the head of the channel, the offing stream either butts against the returning streams from the channels, or withdrawing its water, solicits their streams and thus alters their course, making them for the most part set across the Channel in curves more or less bent as the spot is more or less removed from the offing; so that there seems to be but one hour's tide each way that passes clean down the Channel from Beachy Head to Scilly, and round the Land's End to Bristol. The outgoing stream from Beachy Head encounters the ingoing stream of the offing tide somewhere about the Start Point, and both are turned down into the great Gulf of St. Malo, which seems to receive the accumulated waters of these opposite tides.

Effect of the offing stream upon the tide in the English Channel.

Meeting of the streams.

Whether or not this influx is instrumental in raising the water here to the extraordinary height of forty-seven feet perpendicular range at springs, or whether it be owing to its form and position as regards the advancing tide-wave, I leave to those who are competent to decide; but it is a coincidence that cannot escape observation, that this spot, like the Bristol Channel, is the concentration of streams from opposite directions; that it has its waters raised to the same extraordinary elevation nearly to a foot, and that its time of high water is nearly the same.

On the change of tide, this great bay, like the Bristol Channel, as it received so it

Gulf of St. Malo tide.

returns its waters in opposite directions; the tide splitting somewhere between Alderney and the Start. But here especially, as also in a similar locality in the Irish Channel, we are in want of observations, and it is very unfortunate that this spot, which from its peculiarity is the most interesting of any in the English Channel, should be so completely deficient; for it seems most evident that the tidal streams meet off here, running together at one time and separating at another.

Such appears to be the explanation of the complicated motion of the waters at the entrances of these two great channels, and of the course of the stream in the English Channel above the contraction of the strait.

In tracing these streams, it was impossible not to be impressed with the many coincidences which assimilate the tidal phenomena of the two channels, so much so as to render it probable that they are subjected to precisely the same laws. As I feel confident that the consideration of this subject will be both interesting and useful, I shall endeavour to trace the resemblance through its several varieties.

Comparison of the tidal phenomena of the English and Irish Channels.

First, I shall consider the Irish Channel to extend, as above mentioned, from a line joining the Land's End and Cape Clear to the end of the tidal flow, which is either at Morecombe Bay or Peel in the Isle of Man; and the English Channel as reaching from a line connecting Ushant with the Land's End, to the end of its tidal flow, or to Dungeness. We shall then see that the English Channel from its outer limit to the end of its tidal stream is 262 geographical miles, and that the Irish Channel from its western limit to the end of its tidal stream, is nearly the same, being about 265 geographical miles. In both channels the stream enters from the south-west, and flows up until stopped by a counter stream. In both channels there is a contraction of the strait almost midway, by the promontories of Cape La Hague in one instance, and St. David's Head in the other, and at very nearly the same distances from the entrance. This contraction is, in both cases, the commencement of the regular stream, which flows six hours nearly each way, the *turn of the stream throughout coinciding with the times of high and low water at the virtual head of the channel,* situated in both cases about 145 miles above the contraction, and that time being very nearly the same, viz. 10^{h} 50^{m} at F and C*. Below this contraction, away from the land, the stream in both cases varies its direction nearly every hour, according to the force exerted upon it by the opposing offing stream.

In both cases, between the contraction and the southern horn of the channel, there is situated a deep estuary, the Bristol Channel and the Bay of St. Malo, in which the times of high water coincide, and where, in both cases, the opposing streams meeting in the channel, pour their waters into these gulfs, and where the tides in both places rise to the extraordinary elevation of forty-seven feet at the syzygies. From the Land's End to the meeting of these streams in the Bristol Channel is seventy-five miles, and from Brest to the meeting of the streams off Guernsey the same. A still further coincidence is apparent between the phenomena of these channels. In one,

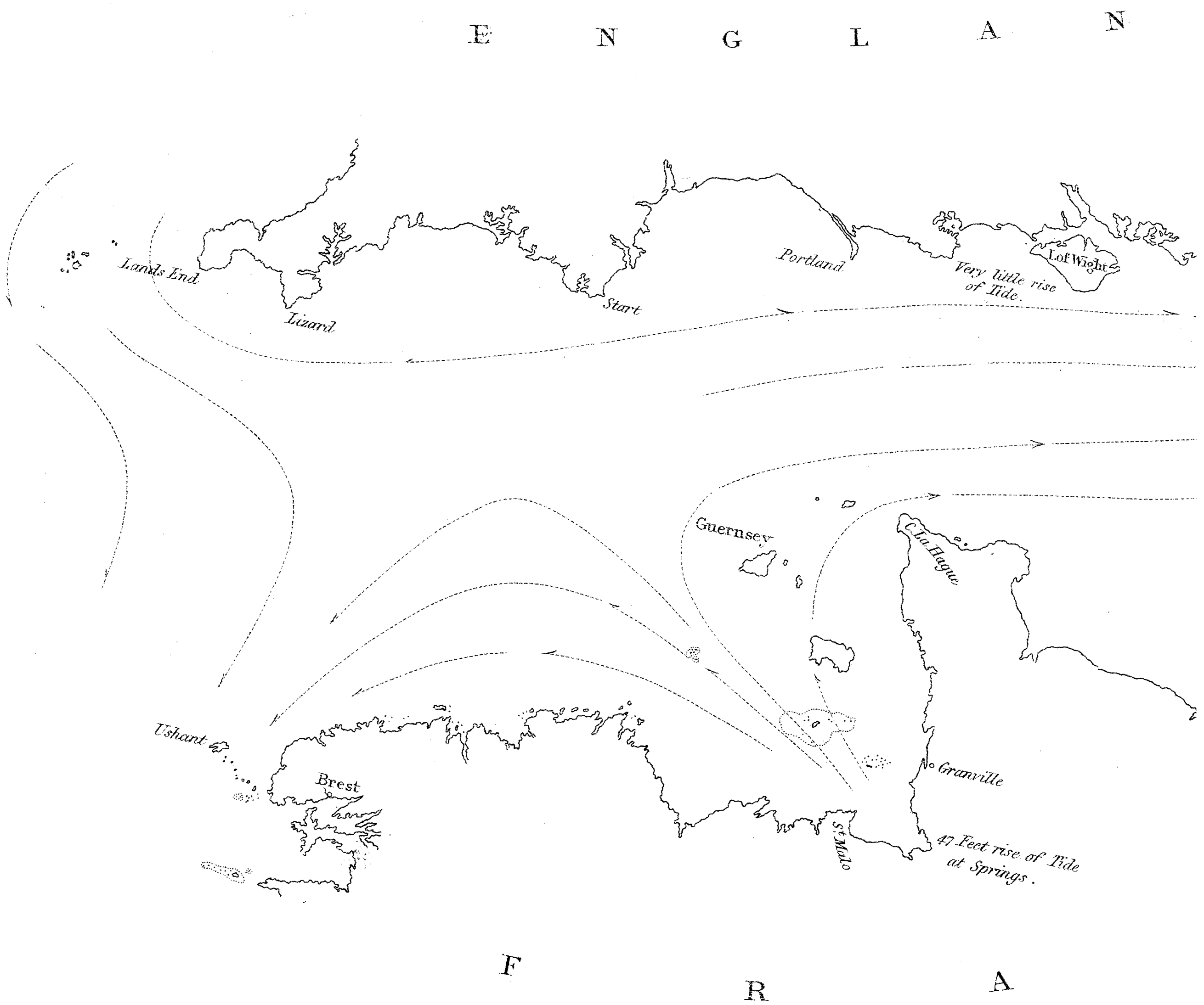
* See Plate XI.

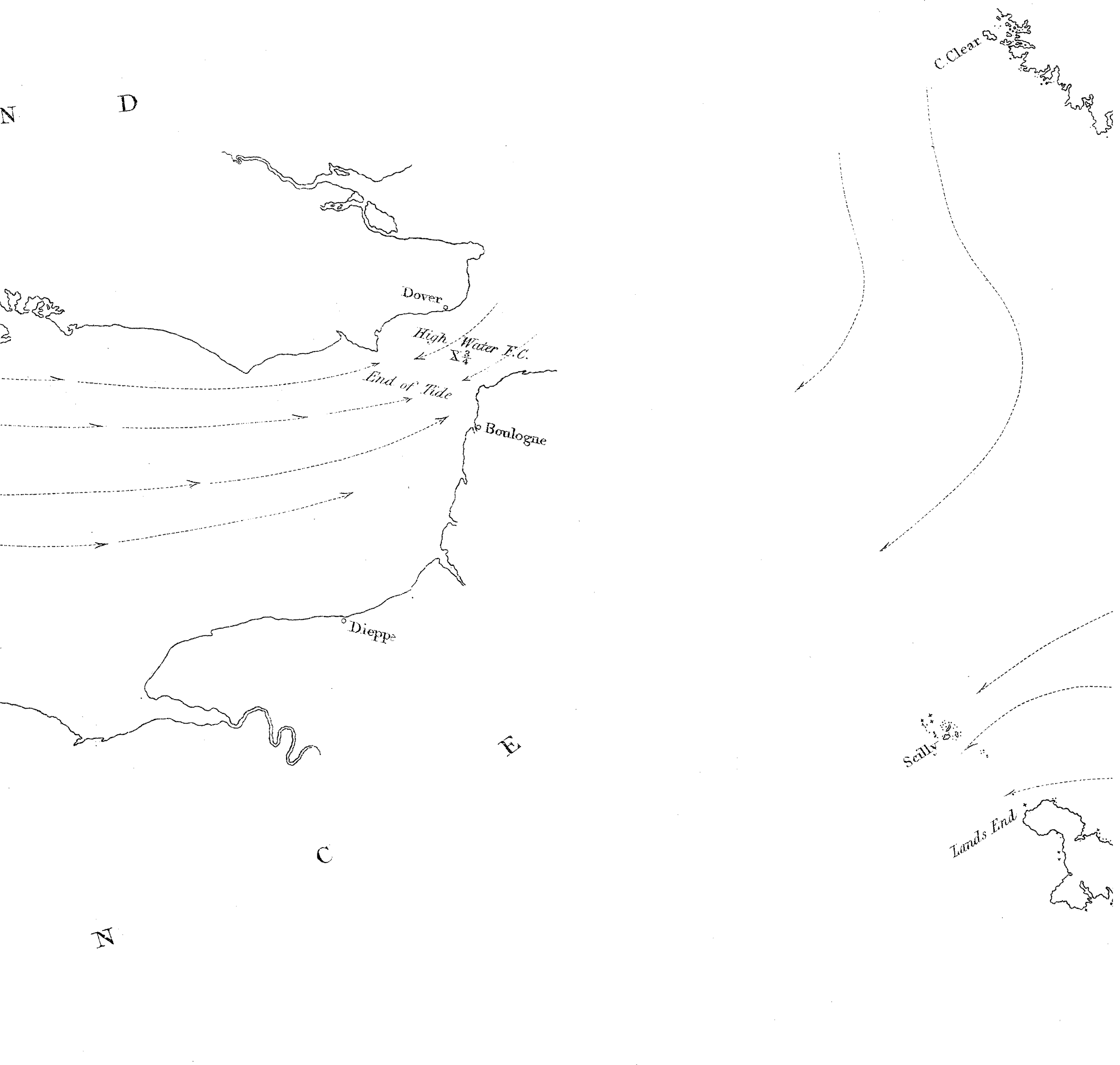
SKETCH
of the Course of the 7 o'Clock stream of Tide
in the
English and Irish Channels.

To accompany a letter to the Hydrographer.

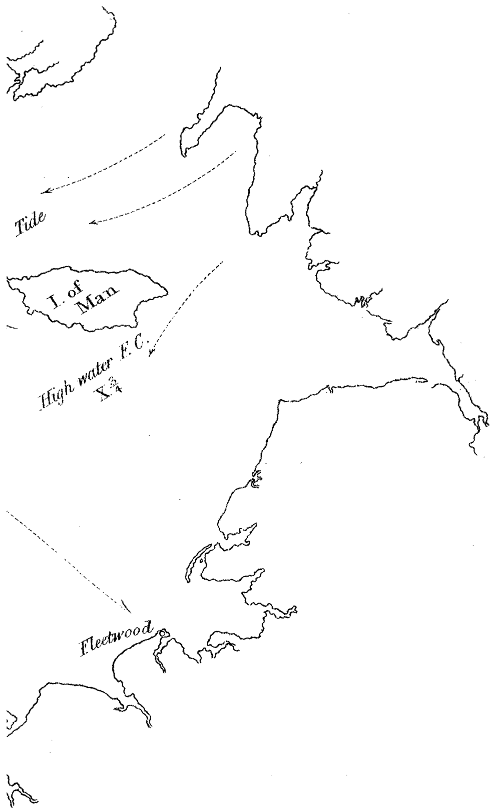
By Captain F. W. Beechey R.N.

1848.




N
D
Dover
High Water F.C.
$X\frac{3}{4}$
End of Tide
Boulogne
Dieppe
E
C
N
C. Clear
Scilly
Lands End
0
50
100
Scale of Miles.


IRELAND
Dublin
Courtown
Tuskar
Little or no rise of Tide
End of Tide
I. of
St Davids
BRISTOL CHANNEL
WALES
47 Feet rise of Tide at Springs



J. Basire sc.

Comparison continued.

at a place called Courtown, a little above the contraction of the strait, and at 150 miles from Cape Clear (its entrance), there is scarcely any rise or fall of the water; and in the other channel (about Swanage), situated also a little above the contraction of the strait, and just 150 miles from the Land's End (the entrance of the channel), there is only five feet rise of the water at a spring range*. In both cases these points of small range of tide are situated on the opposite side of the channel to that of the high elevation above mentioned, and in both cases these spots are the node of the tide-wave (on either side of which the times of high and low water are reversed). And again we trace a similarity in an increased rise of the water on the south-east sides of both channels abreast of the virtual head of the tide: at Liverpool in one case, where the range amounts to thirty-two feet, and at Cayeux in the other, where it is thirty-four feet.

It may also be shown that the progress of the tide-wave along the side of the channels opposite the node is not very dissimilar. Reckoning in both cases from the line which we have before drawn as the outer limits of the channel, we find that in the English Channel from this line to Cherbourg, opposite the small range of tide,—

	Miles per hour.		Miles.
The wave travels	50	and if complete would be in extent	616
In the Irish Channel, from a similar line to Bardsey, it travels	52		649
From Cherbourg to Havre	32		397
From Bardsey to Holyhead	16		193
From Holyhead to end of tide	78		959
Dieppe to the end of the tide	75		922

These numbers are given roughly, merely for the purpose of showing the general resemblance in the character and motion of the wave; and it is probable a more judicious selection of positions and numbers would give a still nearer coincidence. Besides which we are somewhat uncertain as to the establishment at our starting-point. As a comparison, however, the numbers run fairly together. In both cases the retardation of the tide-wave about mid-channel, and the great elongation of the wave towards the end of the strait are remarkable, especially in the Irish Sea.

Lastly, we may notice a singular coincidence in more respects than one, indeed, between the situation of the node placed by Professor WHEWELL† in the North Sea, and a corresponding point of small range and inversion of tide at the back of Kintire‡. The node or hinge of the tide in the North Sea is curiously enough situated as nearly as possible at *the same distance from the head of the tide off Dungeness, as the node at or near Swanage* is on the opposite side of it; and the node at Kintire communi-

* In 1834 it was 3 ft. 10 in.
In 1835 it was 6 ft. 4 in. } 5 ft. 1 in. mean. Philosophical Transactions, 1836, Part II. p. 320.

† Philosophical Transactions, 1835, Part II. p. 298.

‡ I have recently been apprised of this by Captain ROBINSON, R.N., who is surveying the coast of Scotland, but I have not seen the observations.

cated by Captain Robinson, is about the same distance from the meeting of the tide in the Irish Sea as the North Sea node is from the meeting of the waters off Dungeness, and is similarly *situated with respect to the node of Courtown as the North Sea node is with regard to Swanage.*

It appears therefore that the tidal feature of these two channels corresponds in almost every particular.

Further investigation of the tidal phenomena of English Channel urged.

I cannot but consider the identity very remarkable and interesting, and especially so as concerns the relative situations of the nodes of the wave, hinging (as those in the channel appear to do) upon a *single point*, and not upon a negative line across the channel, as may have been imagined. And it seems highly desirable that a critical investigation of the phenomena of this channel should be made; not only for the purposes of science, but especially on account of the navigation of the strait, for already we may trace the cause of vessels entering the channel, being set down upon the French coast about Heaux; and who can call to mind the lamentable loss of our Indiamen on the coast about Boulogne, and not be reminded that these disasters occurred very near the point where the stream may probably be turned down upon that shore by the meeting of the tides off there?

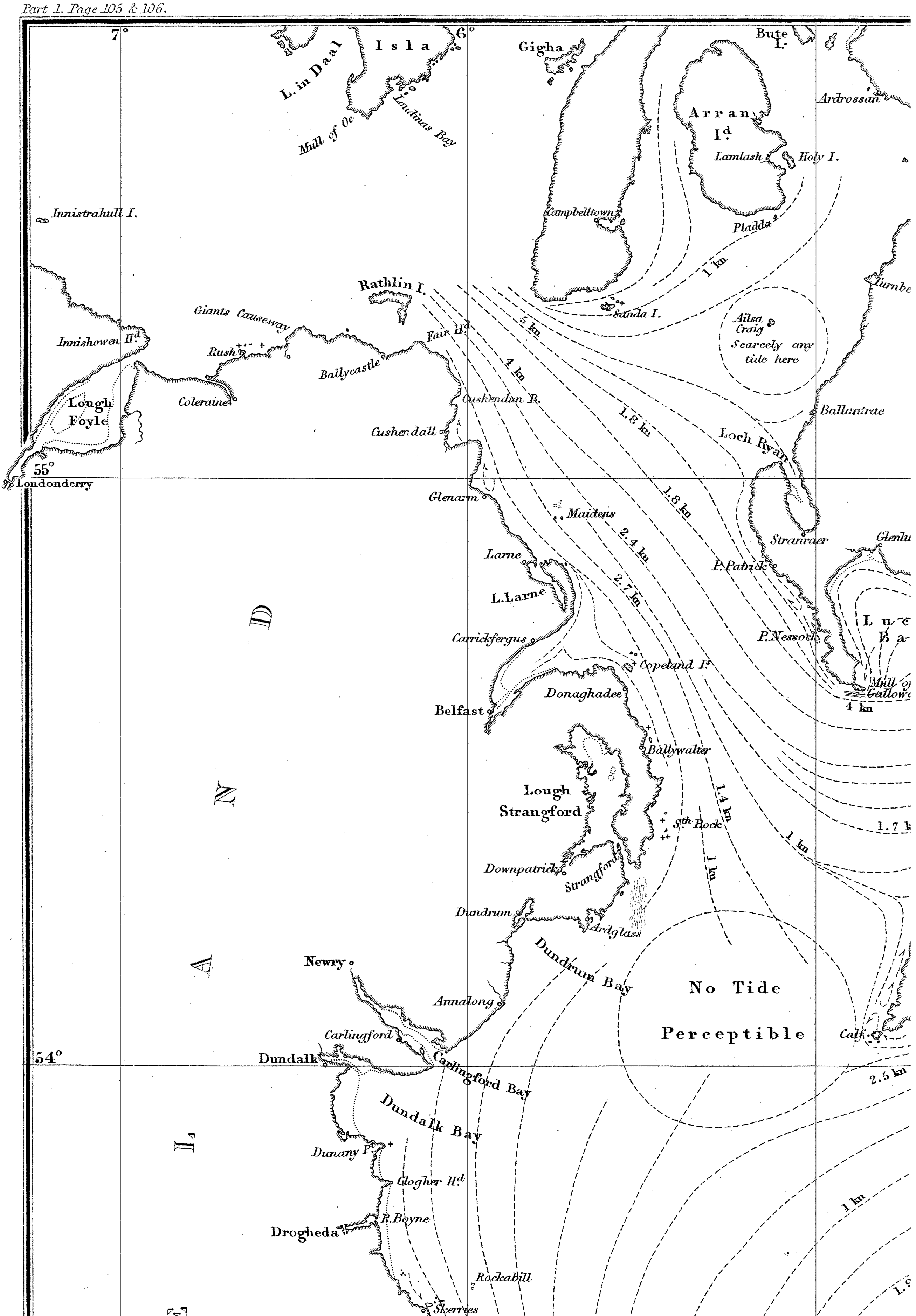
Having now, Sir, placed before you the result of our observations upon the tides of the Irish Sea, and shown the connection which exists between the phenomena of the Irish and English Channels, and the possibility there is of forming into a system the apparently contradictory directions of the stream, at the mouths of those estuaries, which is so very desirable, I have to request that, should you, after the perusal of this letter, approve of the observations being continued round the Land's End and up the English Channel, you will solicit the Lords Commissioners of the Admiralty to furnish the means of so doing.

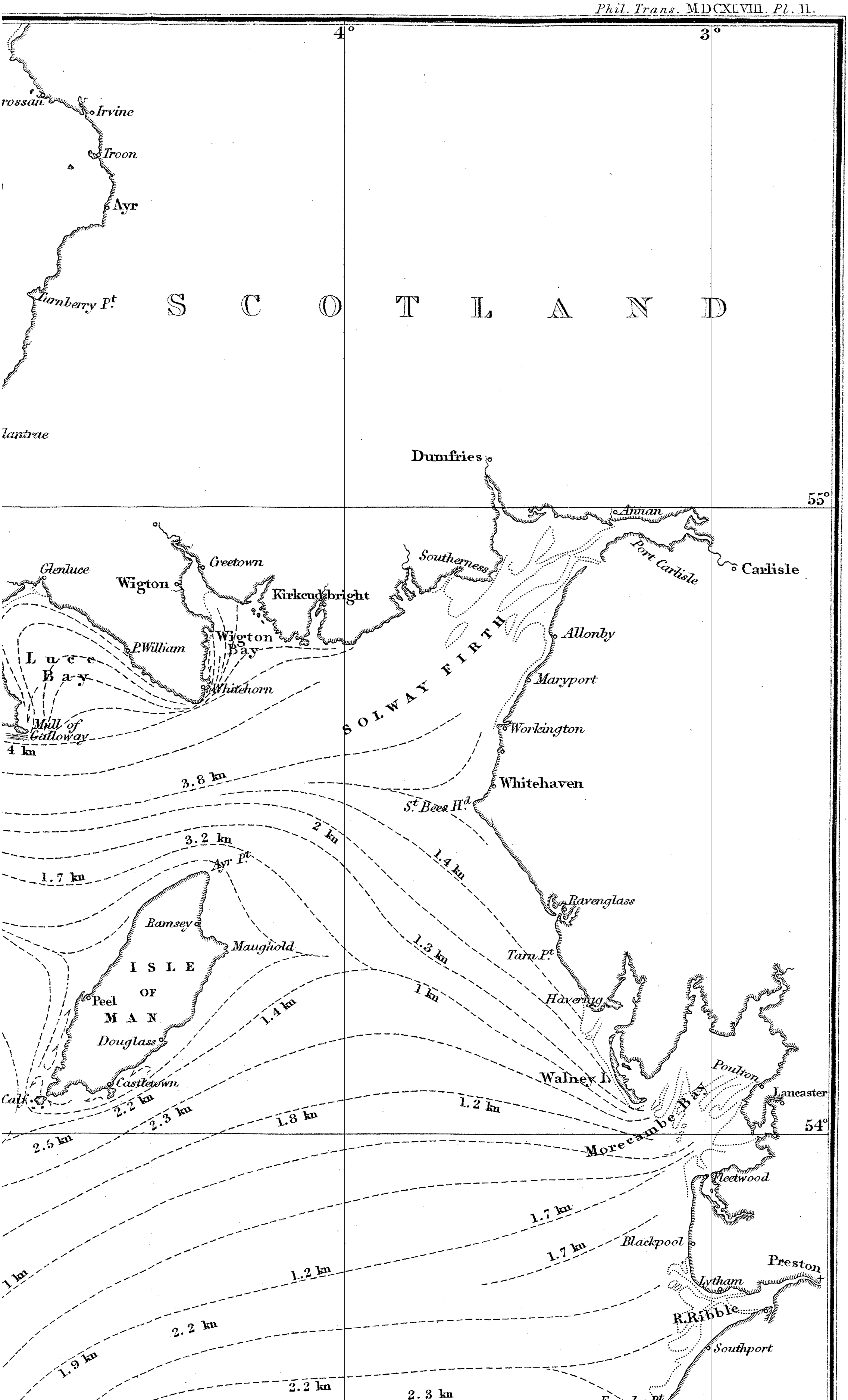
I have the honour to be, Sir,

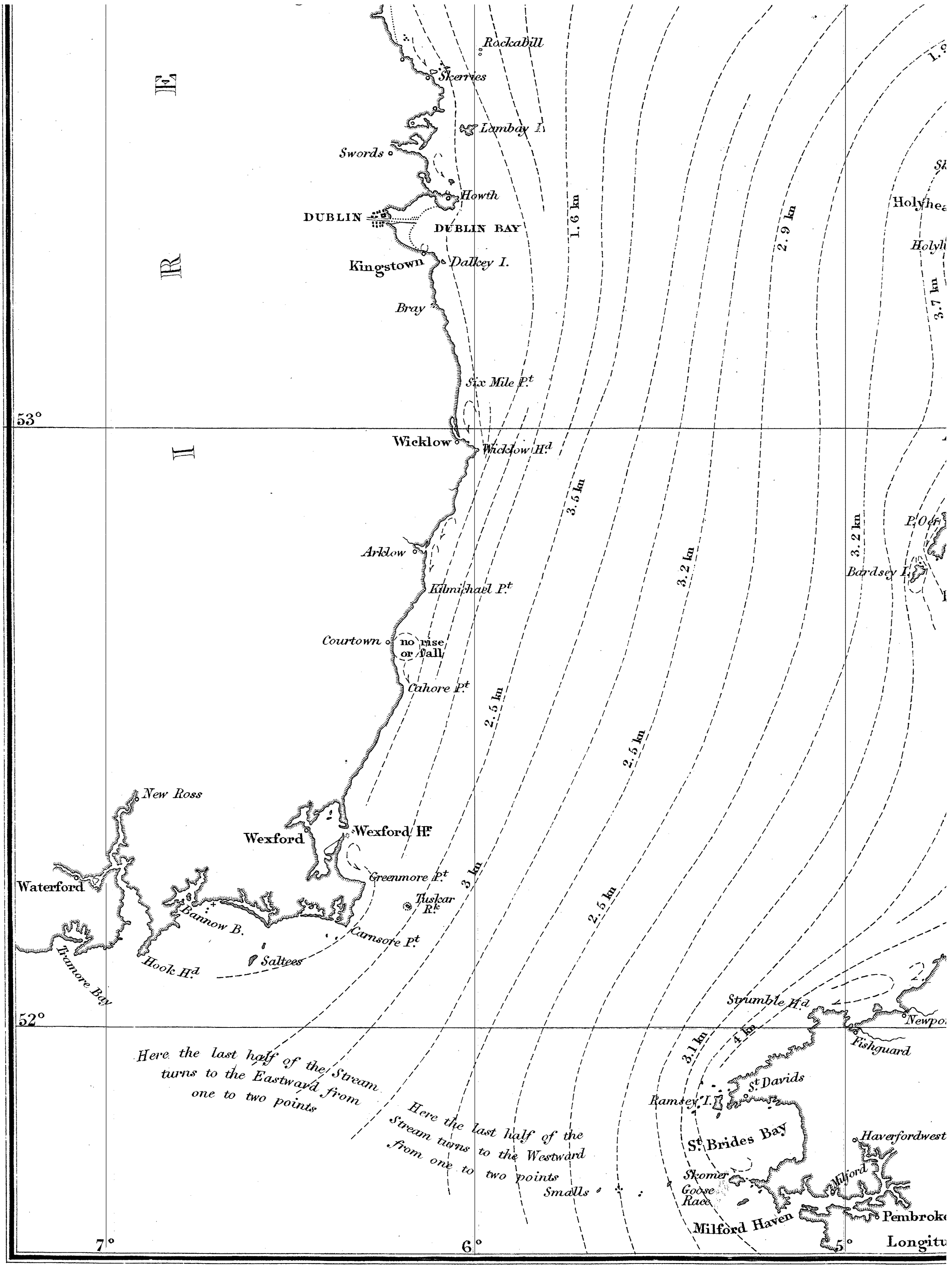
Your obedient humble Servant,

F. W. Beechey, Captain.

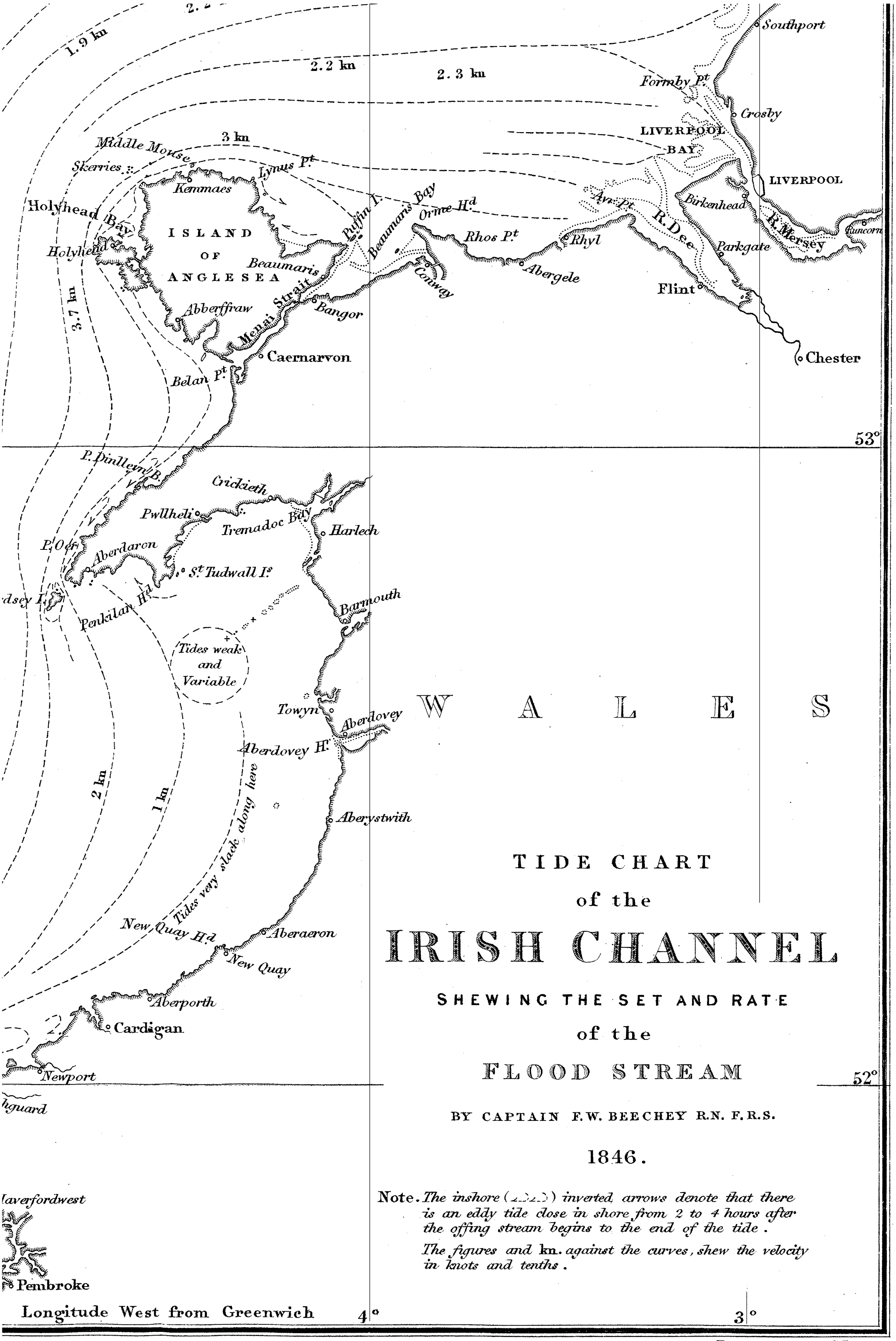
To Rear-Admiral Beaufort,
&c. &c. &c.,
Hydrographer.


7°
6°
L. in Daal
Isla
Mull of Oe
Loudinas Bay
Gigha
Bute I.
Ardrossan
Arran Id.
Lamlash
Holy I.
Campbelltown
Pladda
1 km
Innistrahull I.
Rathlin I.
Giants Causeway
Innishowen Hd.
Rush
Fair Hd.
Sanda I.
5 km
Ailsa Craig
Scarcely any tide here
Ballycastle
Coleraine
Lough Foyle
4 km
Cushendun B.
Cushendall
Ballantrae
1.8 km
Loch Ryan
55°
Londonderry
Glenarm
Maidens
1.8 km
Stranraer
2.4 km
Larne
P. Patrick
L. Larne
2.7 km
I R E L A N D
Carrickfergus
P. Nessock
Luce Bay
Copeland Is.
Mull of Galloway
Donaghadee
4 km
Belfast
Ballywalter
Lough Strangford
1.4 km
Sth. Rock
1.7 km
1 km
1 km
Downpatrick
Strangford
Dundrum
Ardglass
Dundrum Bay
Newry
No Tide Perceptible
Annalong
Carlingford
Calf
54°
Dundalk
Carlingford Bay
2.5 km
Dundalk Bay
Dunany Pt.
Clogher Hd.
1 km
Drogheda
R. Boyne
Rockabill
Skerries


4°
3°
rossan
Irvine
Troon
Ayr
Turnberry Pt
S C O T L A N D
lantrae
Dumfries
55°
Annan
Carlisle
Port Carlisle
Southerness
Glenluce
Wigton
Greetown
Kirkcudbright
Allonby
Wigton Bay
P. William
Luce Bay
Whitehorn
SOLWAY FIRTH
Maryport
Workington
Mull of Galloway
4 kn
Whitehaven
3.8 kn
St Bees Hd
2 kn
3.2 kn
1.4 kn
Ayr Pt
1.7 kn
Ravenglass
Ramsey
Maughold
1.3 kn
Tarn Pt
ISLE OF MAN
1 kn
Peel
Havering
1.4 kn
Douglass
Walney I.
Poulton
Lancaster
Castletown
Calf
2.2 kn
2.3 kn
1.8 kn
1.2 kn
Morecambe Bay
54°
2.5 kn
Fleetwood
1.7 kn
Blackpool
1.7 kn
Preston
1 kn
1.2 kn
Lytham
R. Ribble
2.2 kn
Southport
1.9 kn
2.2 kn
2.3 kn



Rockabill
Skerries
Lambay I.
Swords
Howth
DUBLIN
DUBLIN BAY
Kingstown
Dalkey I.
Bray
Six Mile Pt
Wicklow
Wicklow Hd
Arklow
Kilmichael Pt
Courtown
no rise or fall
Cahore Pt
New Ross
Wexford
Wexford Hr
Waterford
Greenmore Pt
Tuskar Rk
Bannow B.
Carnsore Pt
Saltees
Hook Hd
Tramore Bay
E
R
I
53°
52°
7°
6°
5°
1. 6 km
2. 9 km
3. 7 km
3. 5 km
3. 2 km
3. 2 km
2. 5 km
2. 5 km
2. 5 km
3 km
3.1 km
4 km
Holyhea
Holyh
P. Ocr
Bardsey I.
Strumble Hd
Newpo
Fishguard
St Davids
Ramsey I.
St Brides Bay
Haverfordwest
Skomer
Goose Race
Milford
Milford Haven
Pembroke
Smalls
Longitu
Here the last half of the Stream turns to the Eastward from one to two points
Here the last half of the Stream turns to the Westward from one to two points



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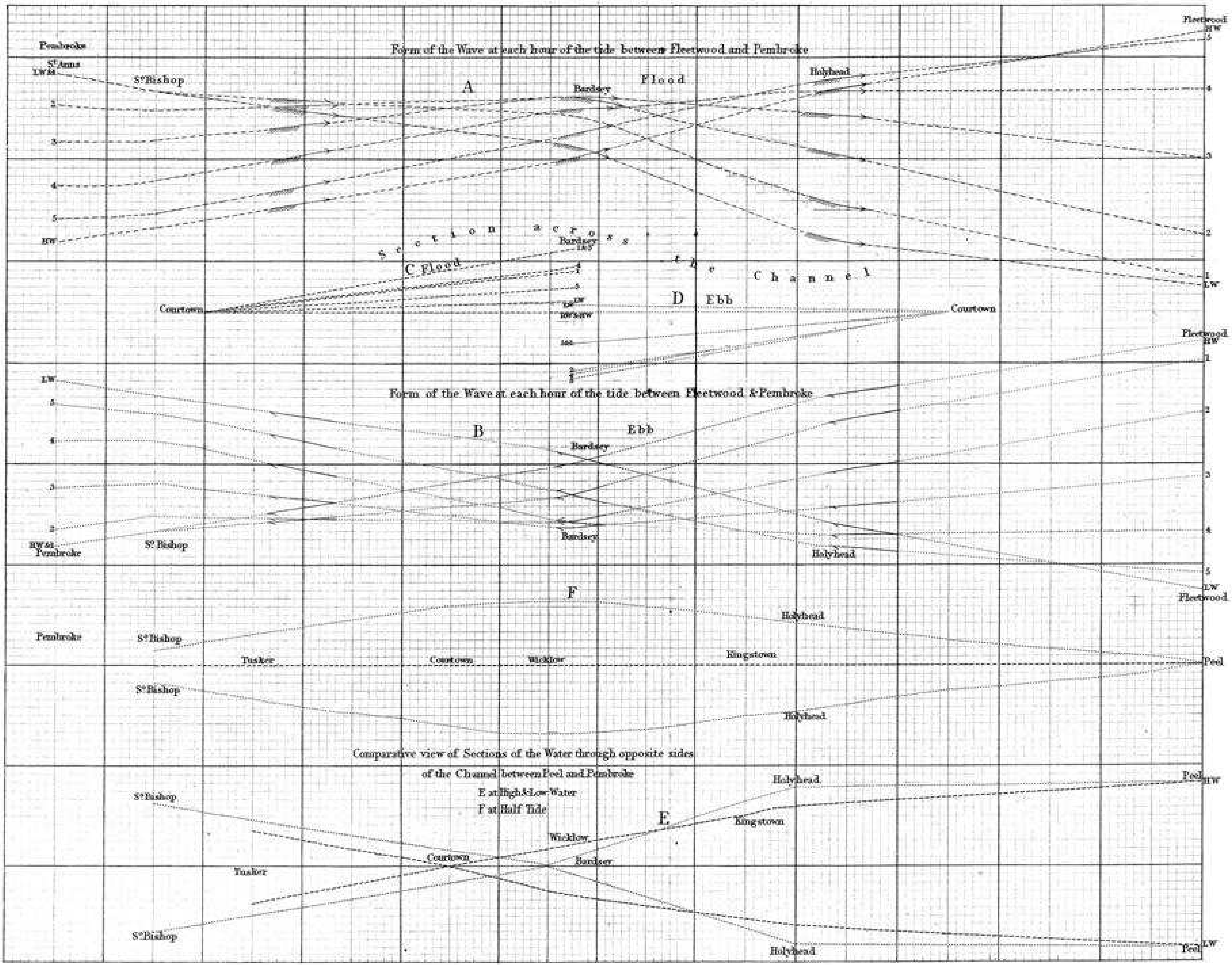
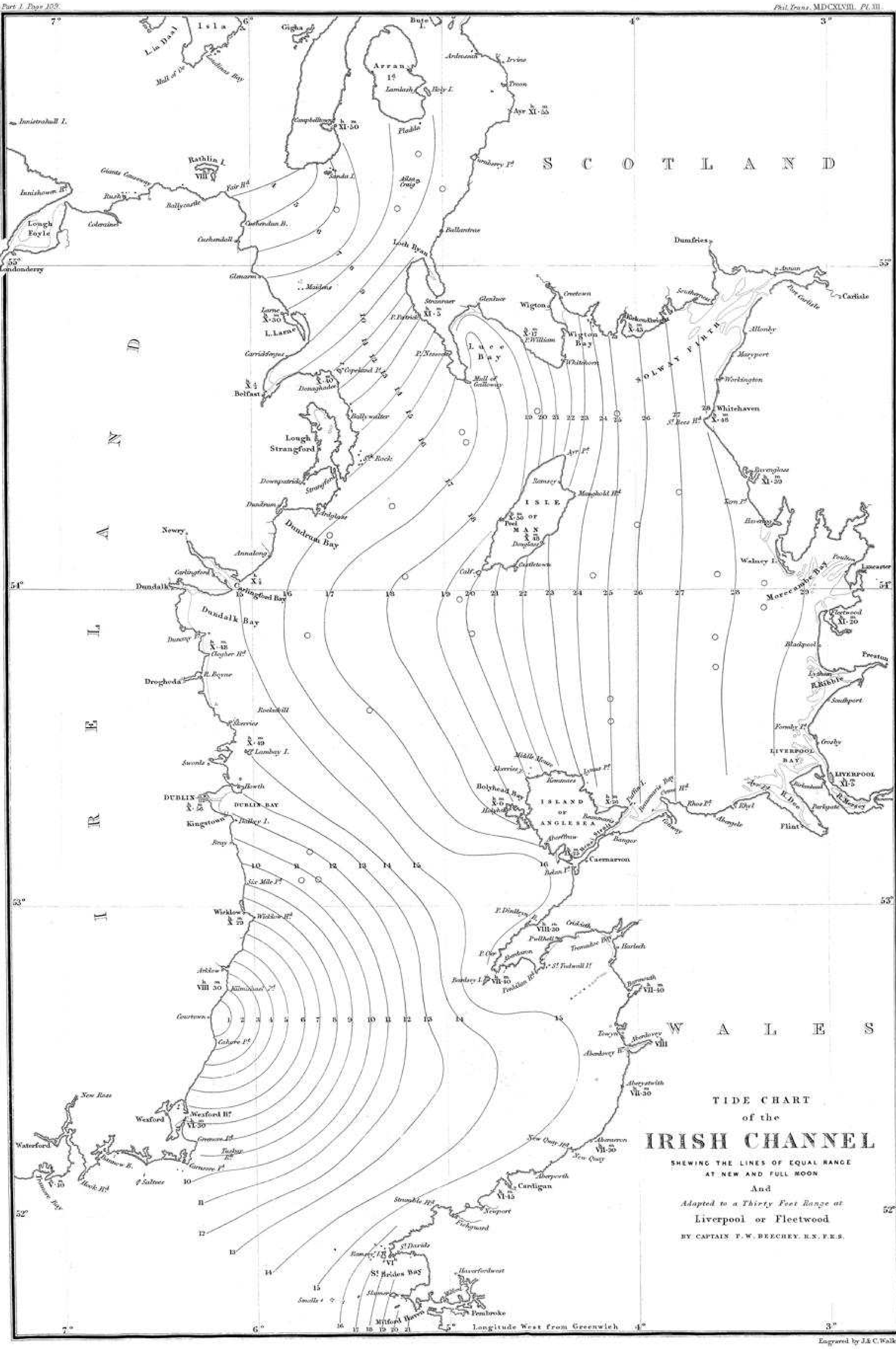

Form of the Wave at each hour of the tide between Fleetwood and Pembroke
Pembroke
St Anns
LW
St Bishop
A
Flood
Bardsey
Holyhead
Fleetwood
HW
Section across the Channel
C Flood
D Ebb
Courtown
Courtown
Fleetwood
HW
Form of the Wave at each hour of the tide between Fleetwood & Pembroke
B
Ebb
Bardsey
Bardsey
St Bishop
Pembroke
Holyhead
LW
Fleetwood
F
Holyhead
Pembroke
St Bishop
Tusker
Courtown
Wicklow
Kingstown
Peel
St Bishop
Holyhead
Comparative view of Sections of the Water through opposite sides
of the Channel between Peel and Pembroke
E at High & Low Water
F at Half Tide
Holyhead
Peel
HW
St Bishop
E
Kingstown
Wicklow
Courtown
Bardsey
Tusker
St Bishop
Holyhead
Peel
LW



TIDE CHART
of the
IRISH CHANNEL
SHEWING THE LINES OF EQUAL RANGE AT NEW AND FULL MOON
And
Adapted to a Thirty Feet Range at
Liverpool or Fleetwood
BY CAPTAIN F. W. BEECHEY, R.N. F.R.S.

Engraved by J.& C. Walker.


TIDE CHART
of the
ENGLISH, IRISH AND BRISTOL CHANNELS
SHEWING THE SET OF THE STREAMS
in each
AT THE SAME INSTANTS OF TIME
of the OUTGOING tide
BY CAPTAIN F. W. BEECHEY R.N. F.R.S.
1848.
Course of the Stream at
At 11 O'Clock ... Slack Water
1
3
5 ... Slack Water
On the Days of Syzygy and at Greenwich time
Slack Water about 11 to 5 o'clock
Greenwich Time
I R E L A N D
W A L E S
E N G L A N D
F R A N C E
Meridian of Greenwich
LONDON
Bristol
Cork Harbour
Cardigan
Swansea
Newport
Plymouth
Falmouth
Landsend
Scilly Is.
Southampton
Brighton
Dover
Calais
Boulogne
Dieppe
Havre
Rouen
Cherbourg
Jersey
Guernsey
Minquiers
Morlaix
Ushant
Brest
Douarnenez B
Ostend


TIDE CHART
of the
ENGLISH, IRISH AND BRISTOL CHANNELS
SHEWING THE SET OF THE STREAMS
in each
AT THE SAME INSTANTS OF TIME
of the INGOING tide
BY CAPTAIN F. W. BEECHEY R.N. F.R.S.
1848.
Course of the Stream at
At 11 O'Clock ...... Slack Water
1
3
5 ...... Slack Water
On the Days of Syzygy and at Greenwich time.
IRELAND
WALES
ENGLAND
FRANCE
Very little rise of tide
Slack Water at 5 & 11 Greenwich Time
Slack Water about 5 & 11 oclock Greenwich Time
Slack water about 5 oclock and 11 oclock Greenwich Time
Rise of Tide very small
Meridian of Greenwich
Limerick
Shannon River
Waterford
Wexford
Cork
Cork Harbour
Valentia H.
Dingle Bay
Bantry
Bantry Bay
Kenmare River
C. Clear
Cardigan
Fishguard
St. Davids
St. Brides Bay
Milford Haven
Pembroke
Caermarthen Bay
Swansea
Newport
Chepstow
Bristol
R. Severn
Lundy I.
Barnstaple
Bideford
Padstow
Falmouth
Penzance
Landsend
Scilly Is.
Seven Stones
Plymouth
Tor Bay
Weymouth
Portland
I. of Wight
Southampton
Brighton
Spithead
Hastings
Dover
Folkestone
Deal
Ramsgate
Margate
Goodwin Sands
Sheerness
Chatham
LONDON
R. Thames
Woolwich
Gravesend
Southend
Maldon
Harwich
Ipswich
Yarmouth
Lowestoft
Southwold
Aldborough
Orfordness
Ostend
Dunquerque
Calais
Boulogne
R. Somme
Dieppe
Havre
Seine R.
Rouen
Cherbourg
C. la Hague
Casquets
Alderney
Guernsey
Sark
Jersey
Minquiers
Mt. St. Michel Bay
St. Malo
Morlaix
Brest
Ushant
Douarnenez B.
Roches Douvres

SKETCH

of the Course of the 7 o'Clock stream of Tide

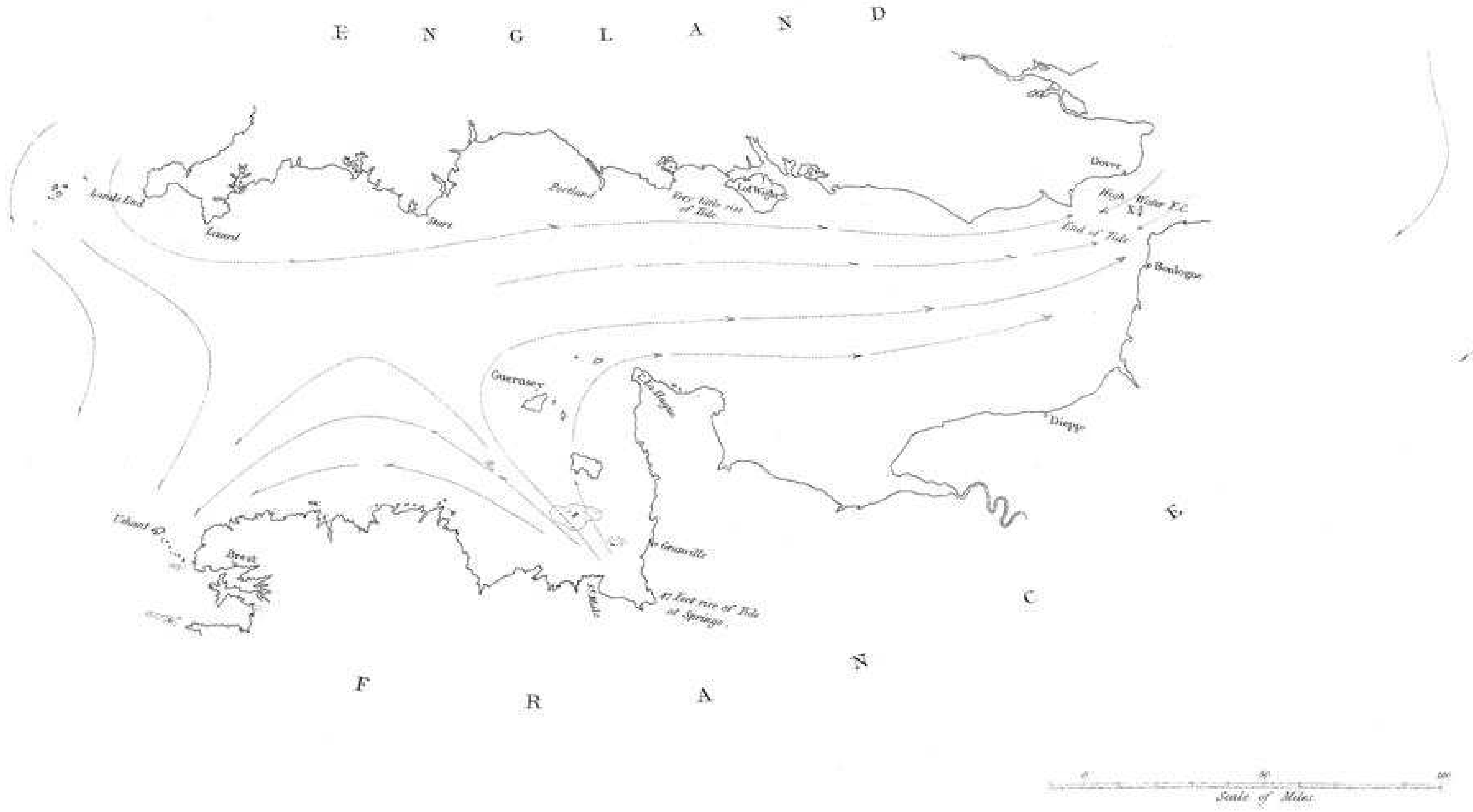
in the

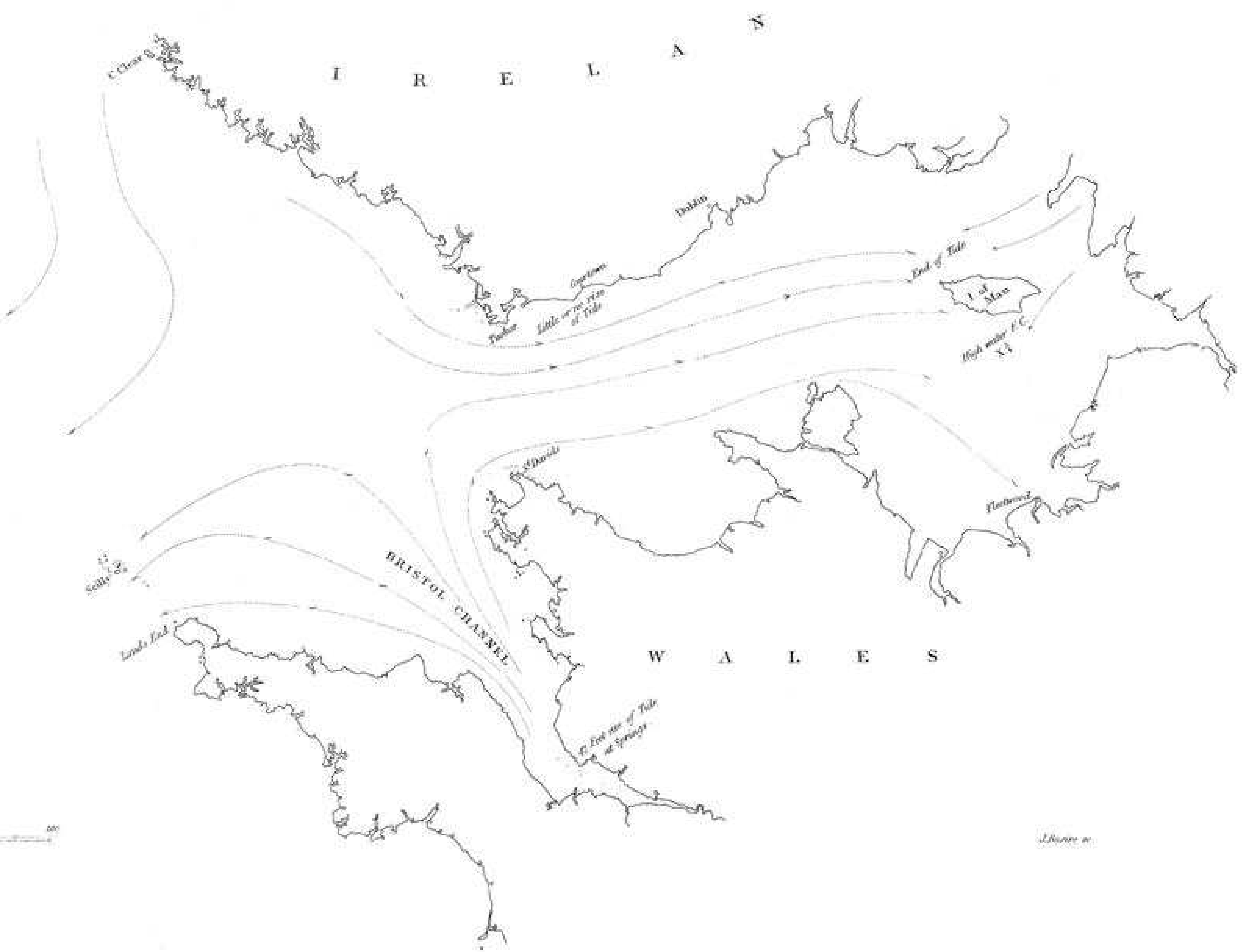
English and Irish Channels.

To accompany a letter to the Hydrographer.

By Captain F. W. Beechey R.N.

1848.





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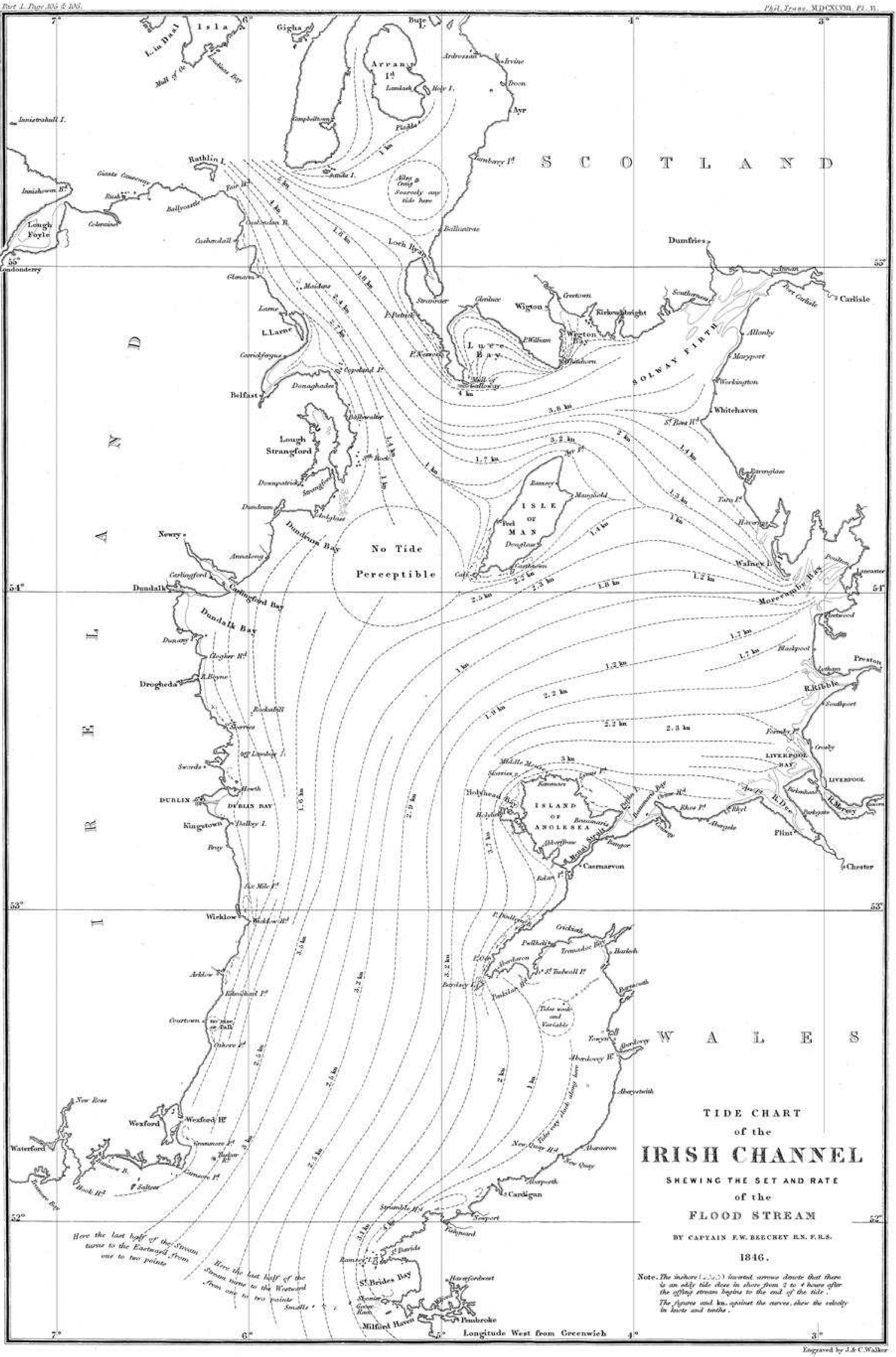

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