12.7 Tides

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INTRODUCTION

1. The primary function of all NCI Watchkeepers is to spot any vessel or person in difficulty or at risk, whether on land or at sea, and immediately report the essential facts to HMCG.

2. It is essential that Watchkeepers understand:
   - the state of the tide
   - the general direction of sea flow in their area
   - local tide streams
   - position of tide races
   - the effect of the wind as it acts with or against the tide

SUPPLEMENTARY READING

3. In order to carry out the Incident Reporting procedure effectively, all Watchkeepers must possess a level of underpinning knowledge, comprising:
   - ✓ Watchkeeping – Section 12.1
   - ✓ Weather – Section 12.6
   - ✓ Chartwork – Section 12.8A

TIDES – basic information

4. Tides are the short-term periodic rise and fall of the sea. Around the UK there are mostly two high tides and two low tides in a lunar day, which is about 24 hours and 50 minutes duration. The difference between high tide and low tide is called the tidal range.

5. High tide, at any given place in the UK, occurs about 12 hours 25 minutes after the preceding high tide. High tide gets progressively later by almost an hour a day. Low tide also occurs at intervals of about 12 hours 25 minutes but not necessarily mid-way between high tides.

6. Tides change the state of the water – they affect the size of the waves, the direction in which the water moves and the flow strength of the water. The sea level can rise or fall several metres twice a day. This rise and fall generate currents, known as tidal streams.

RISE AND FALL OF TIDES

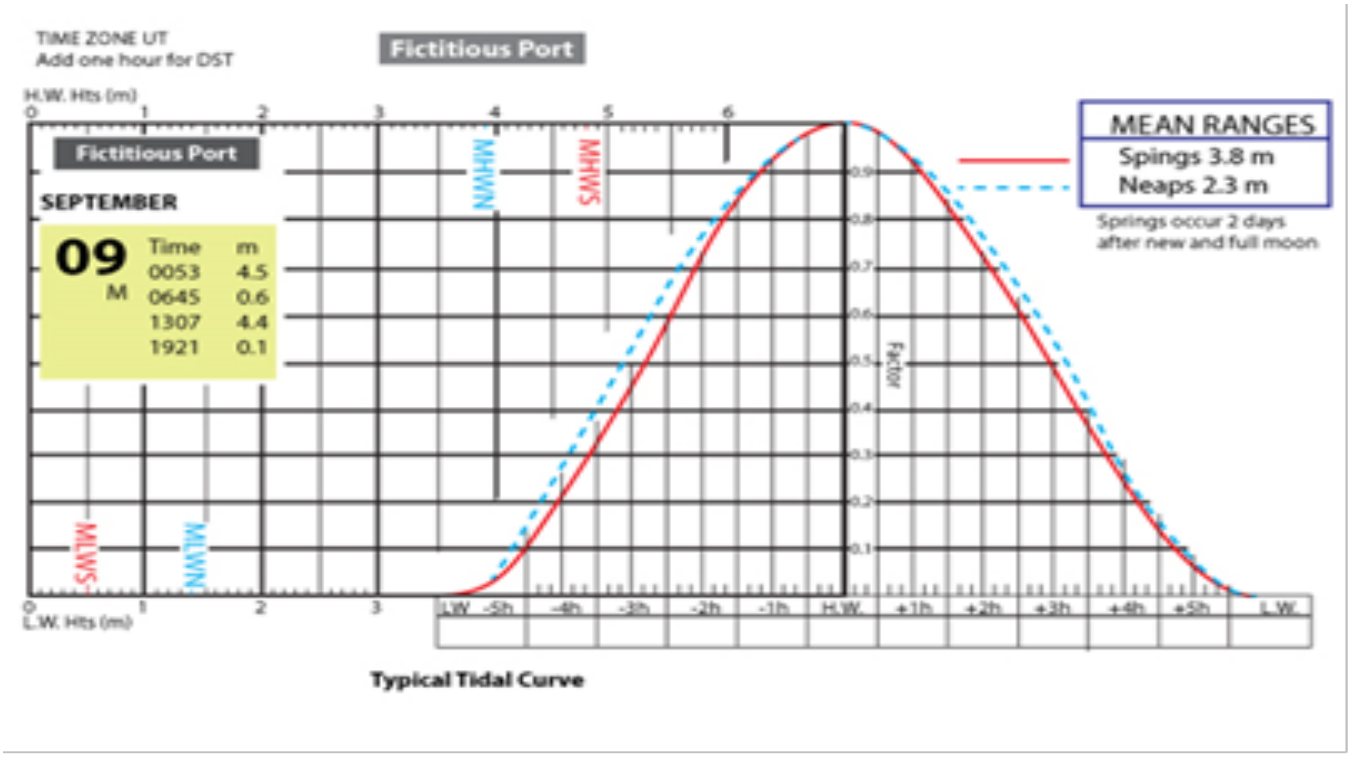
7. **Spring Tides** – when the moon and sun line up with the earth, their combined gravitational effect produces higher than average high tides and lower than average low tides. Spring tides have the largest range. They occur once every 14-15 days, 2-3 days after a full moon and a new moon. Particularly large spring tides occur around the equinoxes in March and September.

8. **Neap Tides** – when the sun and moon are not in line but at right angles, their reduced gravitational effect produces lower than average high tides and higher than average low tides. Neap tides have the smallest range. They occur once every 14-15 days, 4-5 days before full and new moon.

12.7 Tides

CALCULATING TIDE HEIGHT

9. Although tide tables indicate the height and time of high and low tides, they do not provide information on tide heights between high and low. The most accurate method of measuring such heights is by use of a tidal curve for the standard port. Tidal curves for standard ports are to be found in Reeds Nautical Almanac.



Typical Tidal Curve

10. A rough estimation of the height of the tide can be made using the 'Rule of Twelfths'. The rule assumes the duration of the rise or fall of a tide is approximately 6 hours (that is, 12 hours from one high/low tide to the next high/low tide) and that the first hour change in height is 1/12th ; the second hour change is 2/12^{ths}; the third and fourth by 3/12th each; the fifth by 2/12th and the sixth, by 1/12th as in the illustration below:

Example: First determine the range of the tide and divide by 12. Let's assume the range is 6 metres, which divided by 12 equals 0.5metres, and starting from the time of low tide the table below shows how the tide rises each hour until high tide.

hour	rise 12ths	rise height	total rise
First	1/12th	0.5	0.5
Second	2/12^{ths}	1.0	1.5
Third	3/12^{ths}	1.5	3.0
Fourth	3/12^{ths}	1.5	4.5
Fifth	2/12^{ths}	1.0	5.5
Sixth	1/12th	0.5	6.0

12.7 Tides

TIDAL STREAMS

11. A **tidal stream** is the name given to the horizontal flow of the sea, which is caused by the rise and fall of the tide.

12. Watchkeepers must be able to estimate the effect of the tidal stream on a vessel or individual in the water over the likely time it will take for assistance to arrive.

13. There are two sources of information that enable us to find tidal stream direction and speed:
    - Tidal Atlases, and
    - Tidal Diamonds

THE ADMIRALTY TIDAL STREAM ATLAS

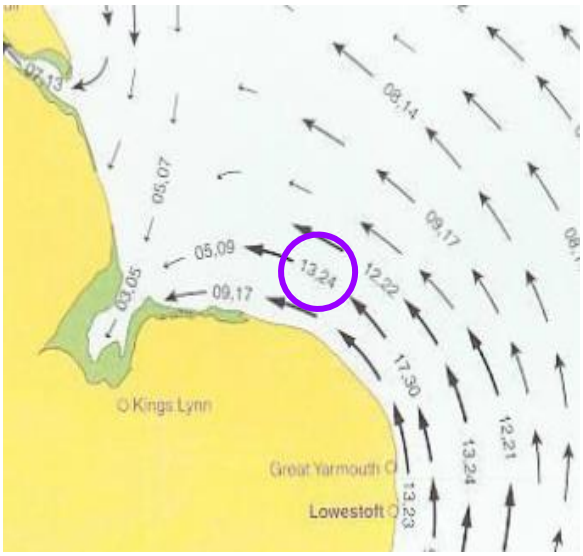
14. Admiralty Tidal Stream Atlases include detailed tidal stream direction and strength information which enable accurate calculation of tidal stream rates for a particular port. Each volume of Tidal Stream Atlases includes:
    - pictorial representations of tidal stream directions for each hour before and after high tide at the reference standard port
    - information on the direction and rate of tidal streams
    - mean neap and spring tidal rates in tenths of a knot

15. Each page represents an hour of tide related to the relevant nearest '*standard port*' (such as Dover, Plymouth or Immingham) and is clearly marked as covering which hour before or after high water.

    Example: using the atlas page shown right, the arrows show the direction of the tidal streams and their length and thickness are an indication of its rate.

    The rate is also generally shown in figures which are arranged in pairs, (13.24) as shown in the circle.

    The first pair is the rate if there is a neap tide and should be read as 1.3 knots. The second is the rate if there is a spring tide and should be read as 2.4 knots.



TIDAL DIAMONDS

16. A tidal diamond is a way of describing the average tidal currents for a location by referencing them to the time of high water (either at the same location or at a nearby standard port).

17. Tidal streams that have been measured are marked on Admiralty charts by a letter within a magenta or blue diamond shape. An associated table on the chart shows the direction and the speed of the streams at these positions for each hour, before and after high water, at the standard port specified above the table. Two speeds are shown, one for spring tides and one for neap tides. A mid-point should be chosen for periods between spring and neap.

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Example: this extract below from The Tidal Diamond Table shows the details for Tidal Diamond 'A' (in the top row, final column) with its geographical position.

The first column (second row) shows the hours before and after high water at the standard port of Victoria.

The fourth column (second row) shows the direction in degrees of the flow for each hour. In this case, the direction is 171 degrees at highwater and 113 degrees 5 hours after.

The rate of the flow is shown in the last column (second row). At six hours before high water, the first figure (1.8), shows the speed in knots when there is a spring tide and the second figure (0.8) when there is a neap tide.

Tidal Streams referred to HW at VICTORIA

Hours		Geographical Position		A	46° 20.5'N 5°50'0W
		Directions of streams (degrees)	Rates at spring tides (knots) / Rates at neap tides (knots)		
Before High Water	6			110	1.8 0.8
	5			108	1.0 0.5
	4			026	0.4 0.2
	3			297	1.4 0.7
	2			178	2.0 1.1
	1			274	1.7 0.8
High Water				171	1.1 0.5
After High Water	1			170	0.5 0.3
	2			111	1.6 0.8
	3			114	1.8 0.9
	4			113	2.2 1.2
	5			113	2.0 1.0
	6			110	1.8 0.9

This diagram courtesy of Sailtrain.co.uk

JUDGING TIDAL STREAMS FROM VISUAL OBSERVATION

18. Visual clues and local knowledge should be used alongside the tidal stream atlas and the Tidal Stream Guide when assessing local tidal streams:
    - water swirling around a buoy, for instance, will indicate the turn of the tide
    - lines of foam on the surface of the water trailing away from rocks

CALCULATING DRIFT

19. SAR organisations use highly accurate computer programmes to calculate the potential drift of a target due to tides and winds, and use that information to define the search area for rescue craft.

20. NCI Watchkeepers however, must be able to estimate the future position of a target by relying mostly on their trained eyes, powerful optics, local knowledge and the Station's elevated position. Your priority as a Watchkeeper is always to keep the target in visual contact.

21. If your Watch is **single-manned**, you should be keeping the target under continual observation rather than spending time referring to charts and tables. If the target is lost, you should initiate systematic scanning sweeps from the last known position.

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22. When **two or more** Watchkeepers are on duty, one should be plotting the drift on the chart whilst the other(s) continue to scan. If the target remains visual then its likely position when the SAR asset is due on scene, can be established by plotting its track and then extending the track line to the position at the end of the elapsed time.

    If visual contact is lost, it will then be necessary to establish an area of search by calculating the likely drift from the last known position. Again, it will be more effective for all Watchkeepers to re-establish contact with the target by visually searching the area.

USEFUL DEFINITIONS

23. **Chart Datum** – this is approximately the level of the Lowest Astronomical Tide (LAT) which is the lowest predictable water level due to the effect of sun and moon. The level will also be affected by atmospheric pressure and local winds.

24. **Charted Depth** – the vertical distance from chart datum to the seabed. This is shown on nautical charts as a number in italics such as '*6*'. A subscript number next to the large number measures tenths of a metre. 5_2 indicates a depth of 5.2 metres.

25. **Drying Heights** – areas coloured green on the chart indicate that the area dries out at low tide and the numbers have a line under them indicating how high they are above chart datum.

26. **Height of Tide** – the vertical distance between chart datum and sea level at a given time.

27. **Actual Depth** – the charted depth and the height of the tide added together. In effect, the depth that would be obtained by using a lead line.

PLEASE NOTE

THE FOLLOWING PAGES ARE NOT PART OF THE OFFICIAL TRAINING MANUAL BUT ARE LOCALLY PRODUCED ADDITIONS THAT COULD BE OF USE

What causes

High and Low Tides ?


What are Tides?
• Tides are the daily RISE and FALL of Earth’s waters.
• As the tide comes in, the water level rises and as the tide goes out the level falls
• Tides occur in ALL bodies of water, but they are most noticeable in the world's oceans and large lakes.

High Tide

Low Tide

So, what controls the tides?

The tide is controlled by a combination of the gravitational pull of both the moon and sun

As the moon is closer to the earth than the sun its gravitational pull has more of an effect on tides

Depending on the position of the moon, relative to the sun and earth determines whether we see “Spring” or “Neap” Tides

The Moon pulls on the water on the side nearest to it more strongly than it pulls on the center of the Earth. This pull creates a bulge of water, called a tidal bulge, on the side of the Earth facing the moon.

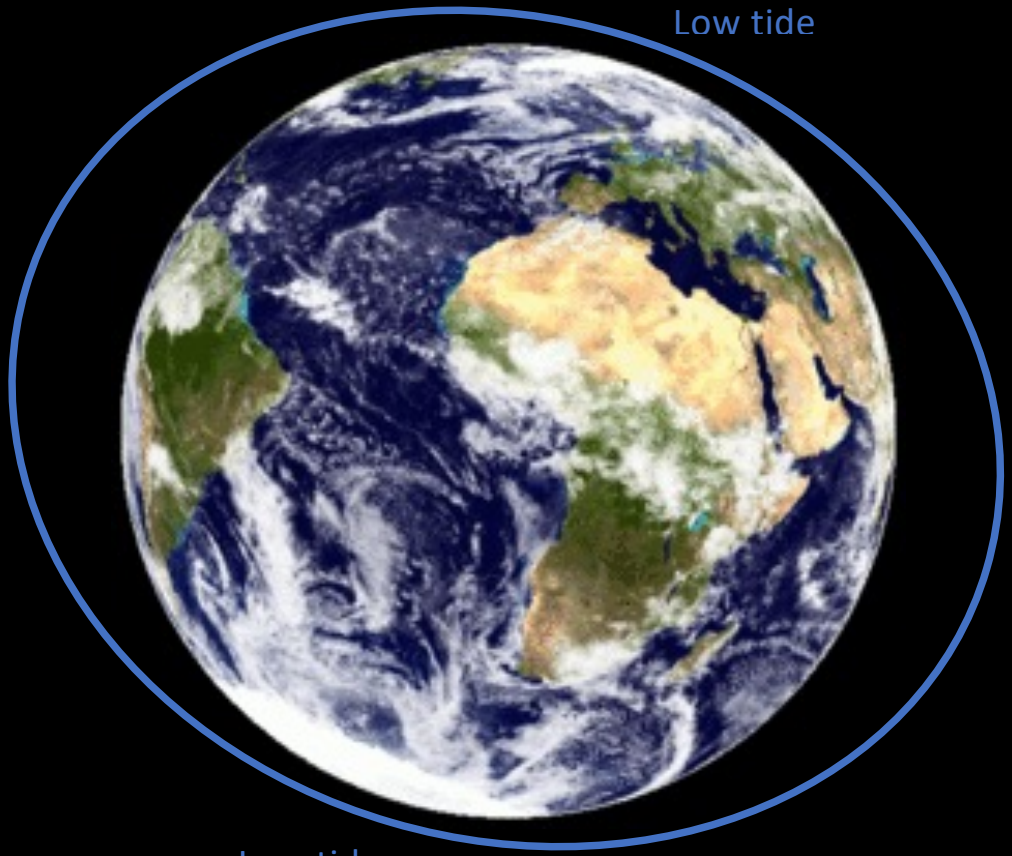
The moon has a less strong pull on the water facing away from the moon. This water is left behind and forms a second bulge. As the Earth rotates, different places on the planet's surface pass through the areas of the tidal bulges and see a change in water levels.

High tide

High tide

In places where there are tidal bulges High Tide is occurring along the coastlines.

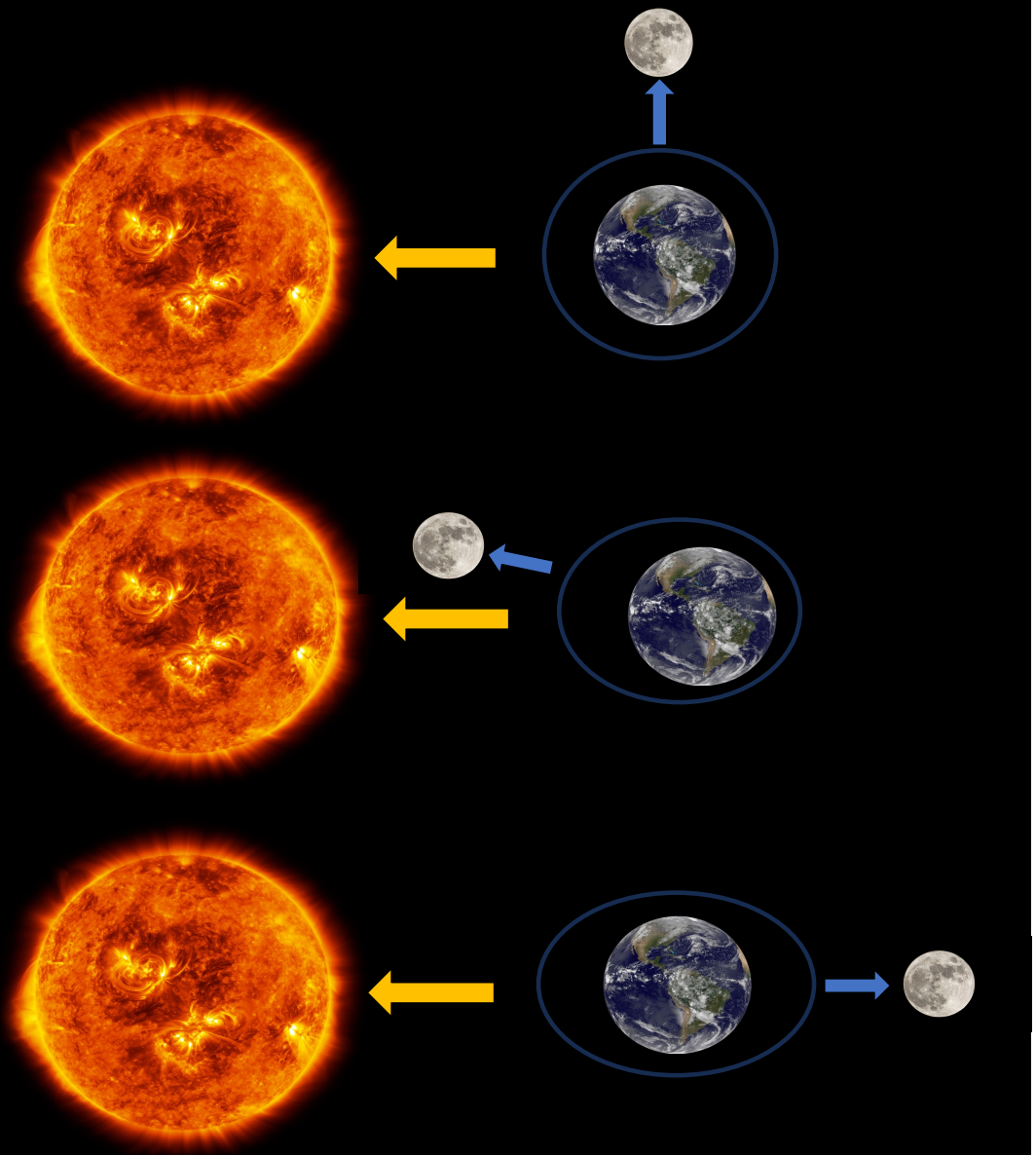
In places between the tidal bulges Low Tide is occurring along the coastlines.



The Sun is so large that its gravity also affects tides

At times, the Sun and Moon pull together on the Earth's waters in the same direction.

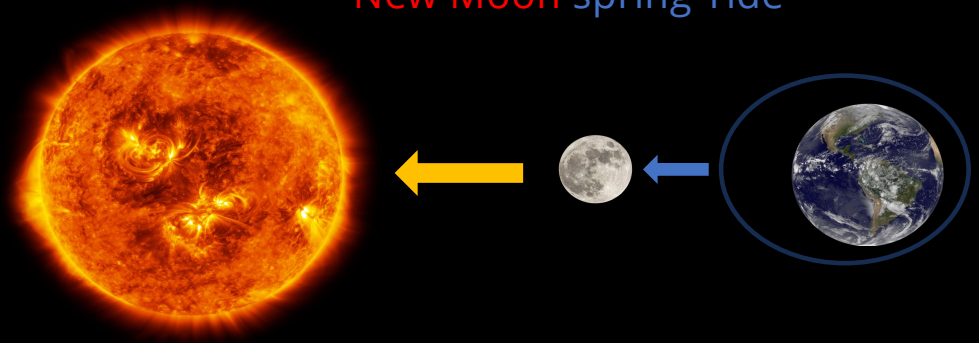
At other times they pull in different directions.



Spring tides occur twice a month during a New and Full Moon. This is where the Sun, Earth and Moon are lined up.

Spring tides are higher and lower than normal tides

New Moon spring Tide

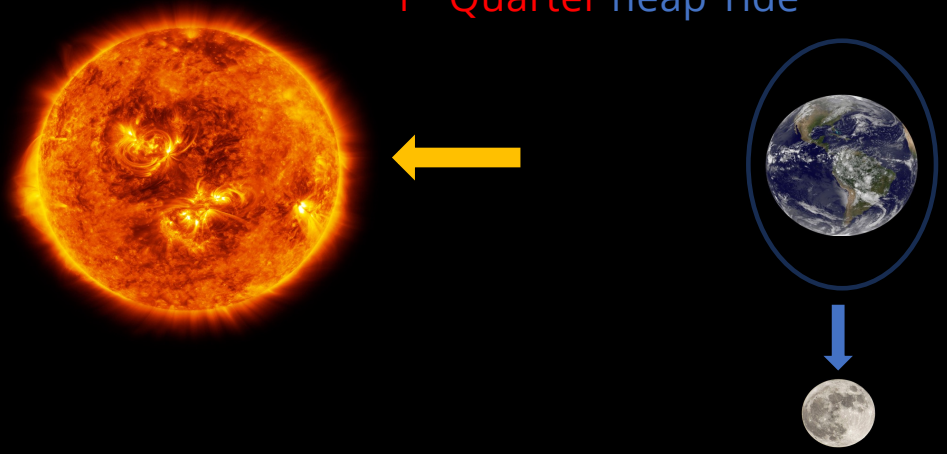


Full Moon spring Tide

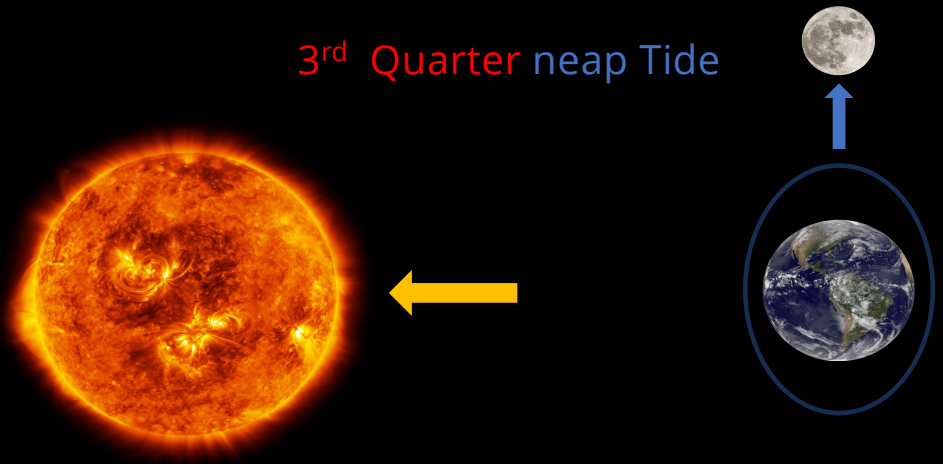
Neap tides occur at the first quarter and third quarter Moon. This is when the Sun and Moon pull at right angles to the Earth

Neap tides are not as high or low as normal tides

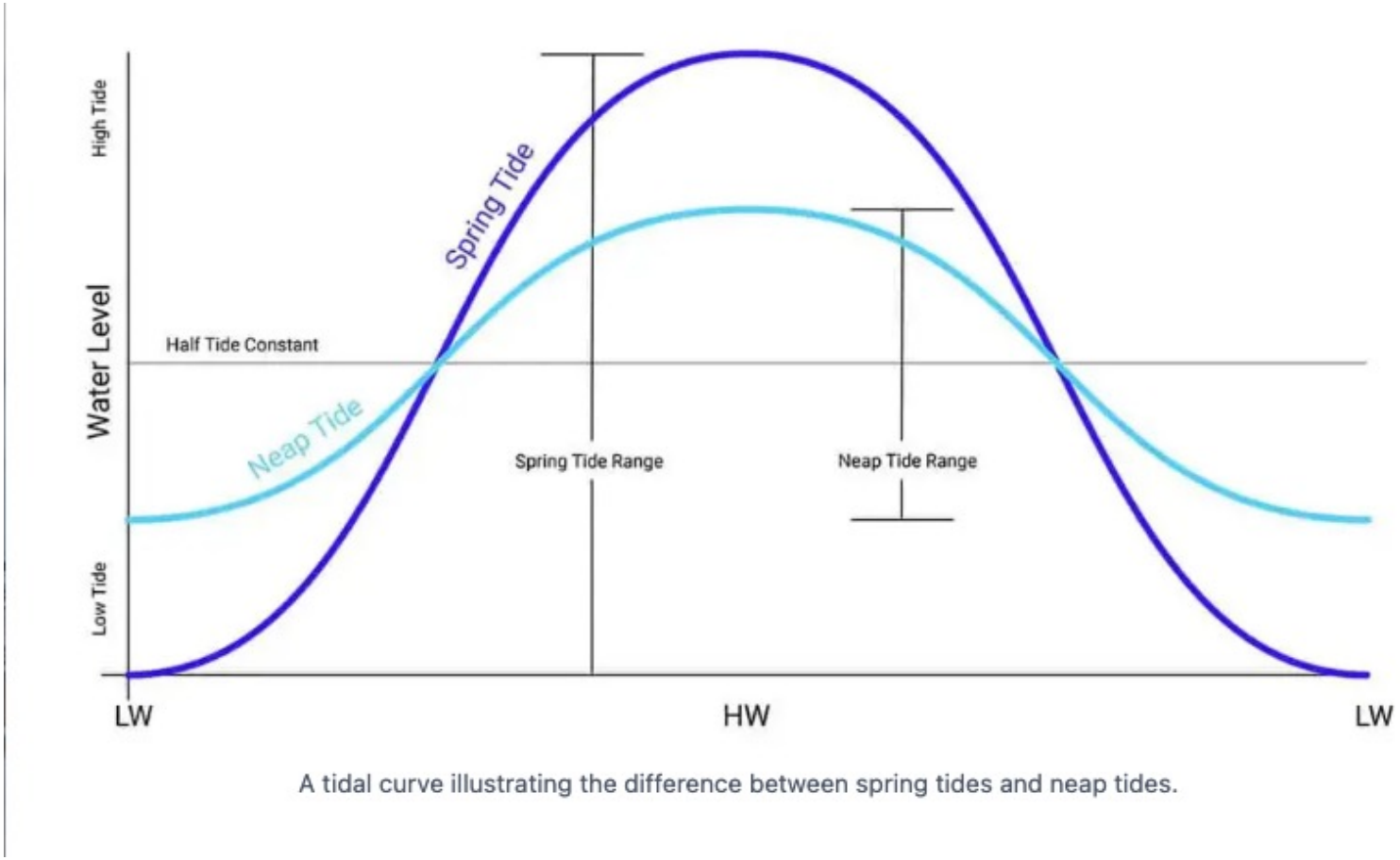
1st Quarter neap Tide



3rd Quarter neap Tide



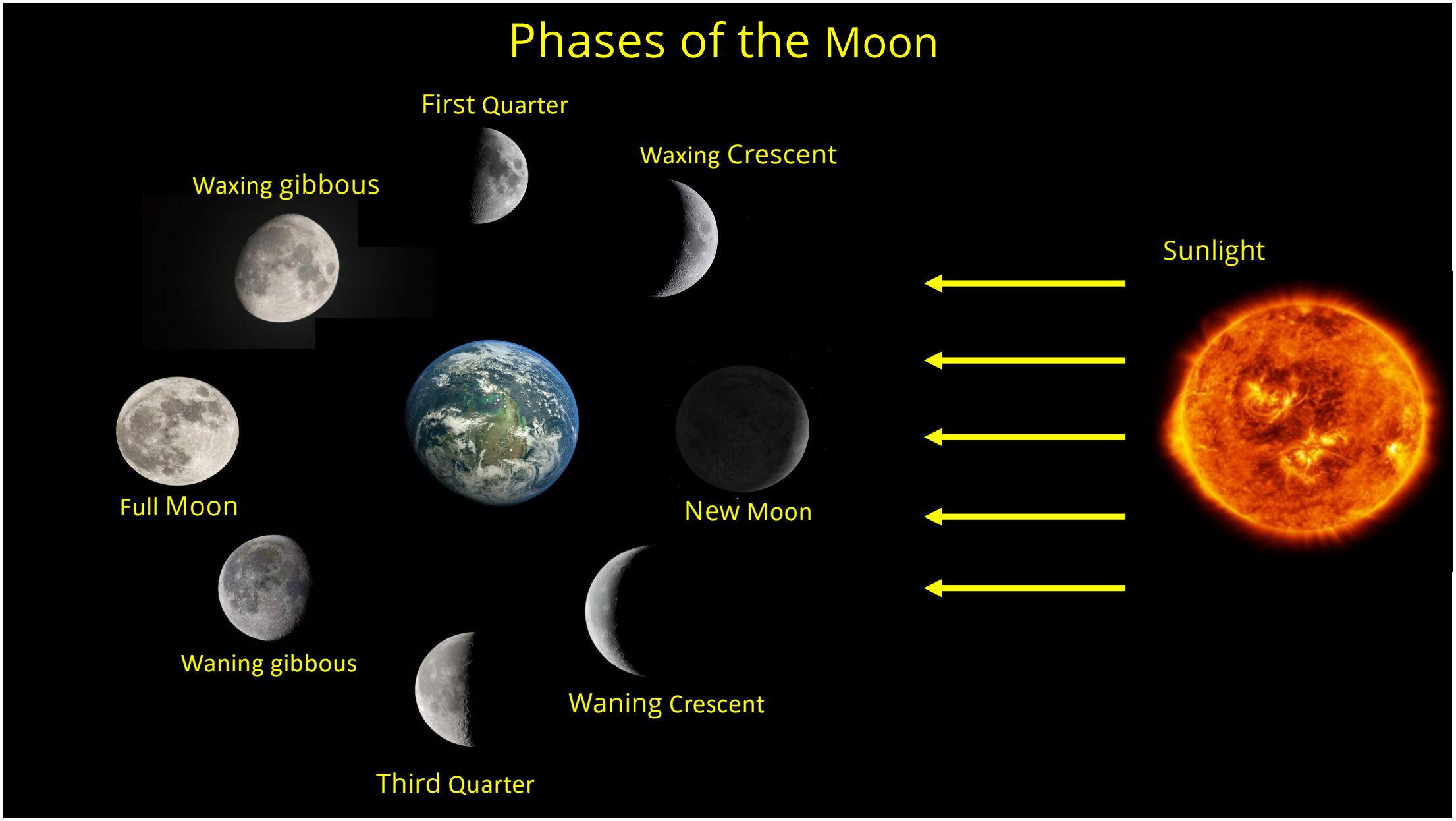
A Typical illustration of a standard sine wave tidal pattern



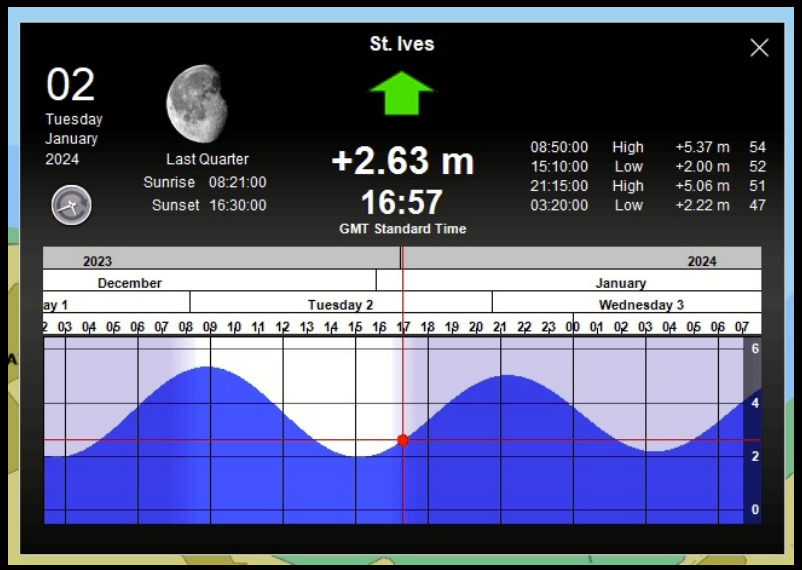
A tidal curve illustrating the difference between spring tides and neap tides.

During a SPRING tide the water reaches the highest point of the entire tidal cycle, and the low water reaches the lowest point

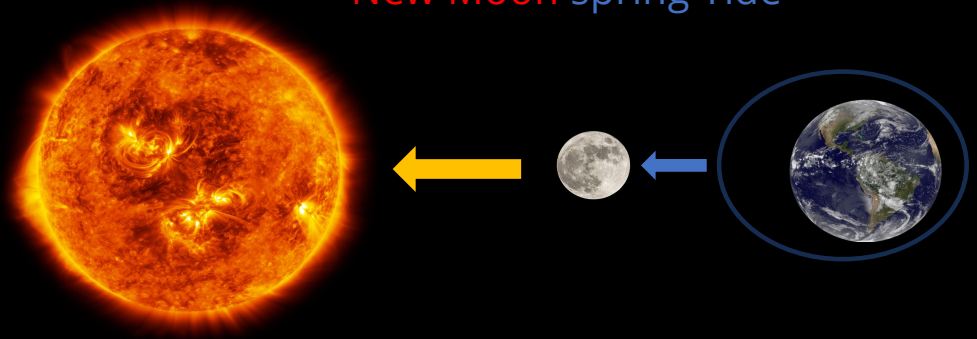
Phases of the Moon



Please note that for Logbook purposes we register the tide as a Spring tide if the height at high tide is above 5.5 m



New Moon spring Tide



Full Moon spring Tide

TIDES @ ST IVES

As we all know there are two different types of tides – springs and neaps. The former occurs at every full and new moon, neaps approximately 7 days after. Although the Lunar day is 12 hours & 50 minutes and the moon has an effect on tidal flow we use a standard 12 hour day for our calculations.

Tides in the Bristol Channel have a range of about 45ft, the second highest in the world behind the Bay of Fundy in Canada which has a 60ft range. Consequently tides run quite fast in our area. Although down in St Ives the range is nearer to 20ft. (The range being the difference between high and low spring tides).

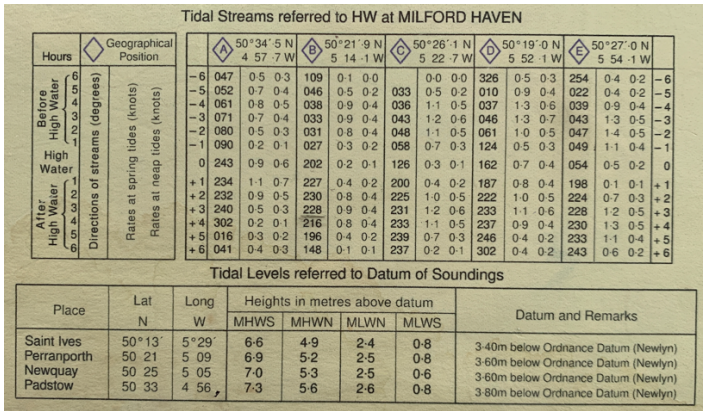
For the purposes of assessing the speed at which the tide flows we divide the flow of the tide over 6 hours (into 12ths) as shown in the following table;

TIDAL FLOW TABLE	
1st HOUR	1/12
2nd HOUR	2/12
3rd HOUR	3/12
4th HOUR	3/12
5th HOUR	2/12
6th HOUR	1/12

So the tide runs fastest during the 3rd and 4th hours slowing as we approach high water and vice versa when the tide is ebbing.

The prevailing weather conditions can have an effect on tidal height, high pressure will keep it lower than predicted whereas low pressure will allow it to be higher (although this may only be by a few centimetres). A strong onshore wind will help the tide rise and maybe stay up longer with a strong offshore wind having the opposite effect.

The tidal diamonds A- E on our chart give the tidal flow between 6 hours before and after high water at MILFORD HAVEN, the tide at St Ives is approximately 1 hour before Milford Haven.



Tidal Streams referred to HW at MILFORD HAVEN

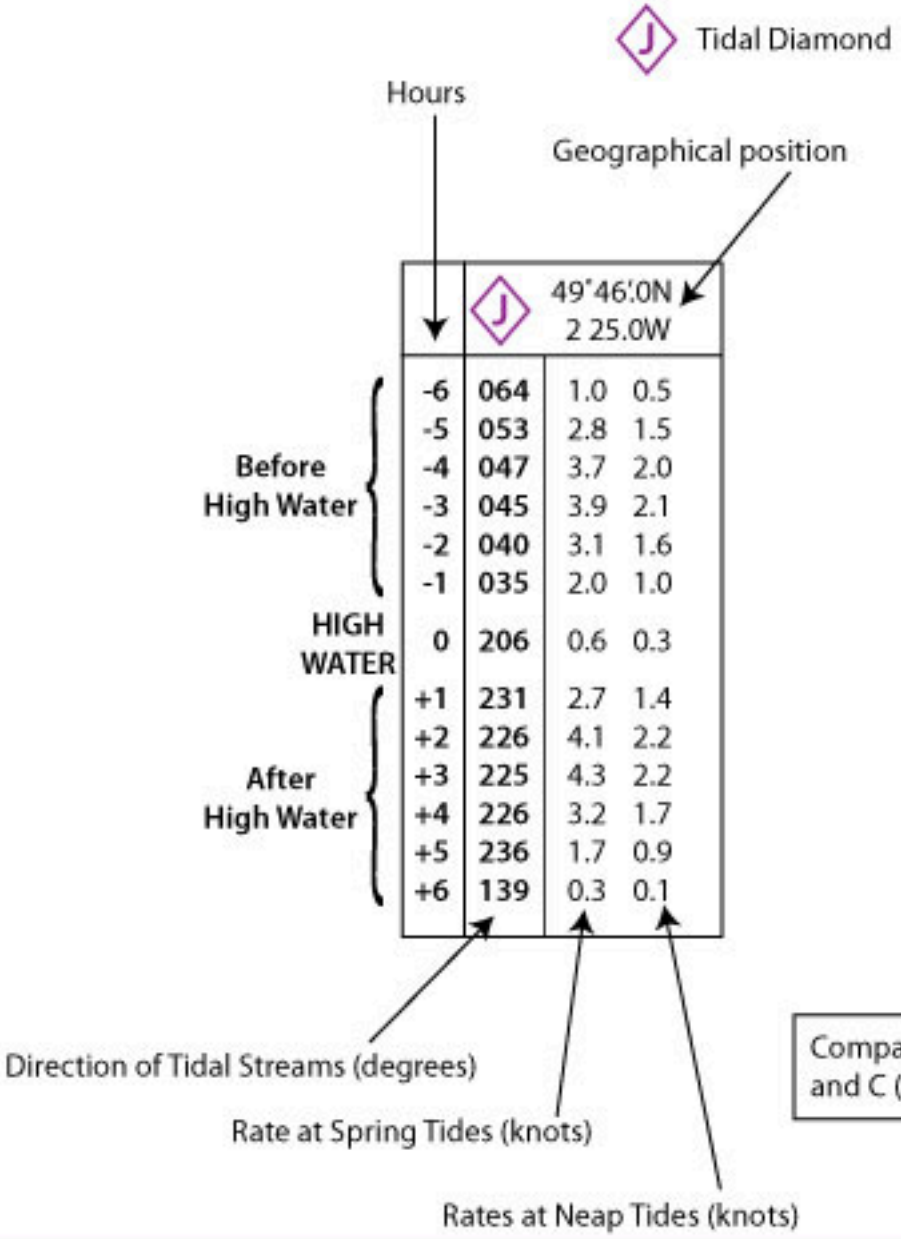
Hours	Directions of streams (degrees)	Rates at spring tides (knots)	Rates at neap tides (knots)	A 50°34′·5 N 4 57·7 W		B 50°21′·9 N 5 14·1 W		C 50°26′·1 N 5 22·7 W		D 50°19′·0 N 5 52·1 W		E 50°27′·0 N 5 54·1 W		
−6	047	0·5	0·3	109	0·1	0·0		0·0	0·0	326	0·5	0·3	254	0·4	0·2	−6
−5	052	0·7	0·4	046	0·5	0·2	033	0·5	0·2	010	0·9	0·4	022	0·4	0·2	−5
−4	061	0·8	0·5	038	0·9	0·4	036	1·1	0·5	037	1·3	0·6	039	0·9	0·4	−4
−3	071	0·7	0·4	033	0·9	0·4	043	1·2	0·6	046	1·3	0·7	043	1·3	0·5	−3
−2	080	0·5	0·3	031	0·8	0·4	048	1·1	0·5	061	1·0	0·5	047	1·4	0·5	−2
−1	090	0·2	0·1	027	0·3	0·2	058	0·7	0·3	124	0·5	0·3	049	1·1	0·4	−1
0	243	0·9	0·6	202	0·2	0·1	126	0·3	0·1	162	0·7	0·4	054	0·5	0·2	0
+1	234	1·1	0·7	227	0·4	0·2	200	0·4	0·2	187	0·8	0·4	198	0·1	0·1	+1
+2	232	0·9	0·5	230	0·8	0·4	225	1·0	0·5	222	1·0	0·5	224	0·7	0·3	+2
+3	240	0·5	0·3	228	0·9	0·4	231	1·2	0·6	233	1·1	0·6	228	1·2	0·5	+3
+4	302	0·2	0·1	216	0·8	0·4	233	1·1	0·5	237	0·9	0·4	230	1·3	0·5	+4
+5	016	0·3	0·2	196	0·4	0·2	239	0·7	0·3	246	0·4	0·2	233	1·1	0·4	+5
+6	041	0·4	0·3	148	0·1	0·1	237	0·2	0·1	302	0·4	0·2	243	0·6	0·2	+6

Tidal Levels referred to Datum of Soundings

Place	Lat N	Long W	Heights in metres above datum MHWS	MHWN	MLWN	MLWS	Datum and Remarks
Saint Ives	50°13′	5°29′	6·6	4·9	2·4	0·8	3·40m below Ordnance Datum (Newlyn)
Perranporth	50 21	5 09	6·9	5·2	2·5	0·8	3·60m below Ordnance Datum (Newlyn)
Newquay	50 25	5 05	7·0	5·3	2·5	0·6	3·60m below Ordnance Datum (Newlyn)
Padstow	50 33	4 56	7·3	5·6	2·6	0·8	3·80m below Ordnance Datum (Newlyn)

TIDAL DIAMONDS

Tidal Diamonds are shown on charts at locations where the tidal Set (direction) and Rate (speed) have been measured. The Set and Rate is tabulated as shown below.



C	50°18.0N 4 10.9W	
-6	236	0.7 0.4
-5	264	0.6 0.3
-4	316	0.6 0.3
-3	031	0.5 0.2
-2	047	0.7 0.4
-1	053	1.0 0.4
0	081	1.0 0.5
+1	111	0.8 0.4
+2	129	0.3 0.2
+3	235	0.3 0.1
+4	242	0.8 0.4
+5	236	0.8 0.4
+6	232	0.9 0.5

Compare the speeds of J (near Casquets) and C (off Plymouth)

The attached drawings are a **rough** estimate of the direction and flow of the tide at St Ives over a 12 hour period based on tidal diamonds B, C and D. The flow (speed of tide) is shown for spring tides in knots, neaps will be roughly half of that.

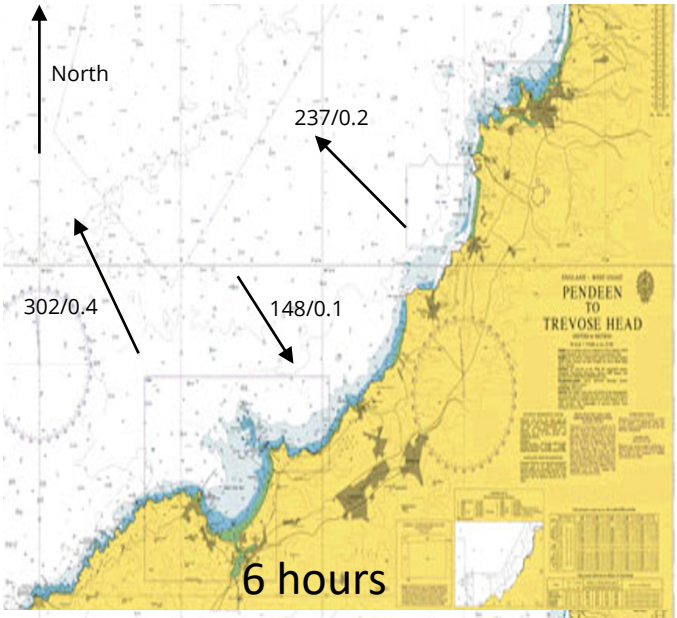
In St Ives Bay the tide can do various things, the bay acts like a gutter, in the road, as the tide flows down from Bristol it sweeps past Godrevy and into the bay. It then sweeps round the perimeter of the bay until it reaches St Ives and pushes back into the main stream again. Depending on the strength of the tide and prevailing weather it can move many hundreds of tons of sand overnight, hence Hayle Bar, and the fact that Carbis Bay, Porthminster and Porthgwidden can end up with large "steps" on the beach which can equally disappear on the next tide. Again see the diagrams attached at the end of the 12 hour tide chart which show the quirks of the tide in the Bay and around Porthmeor.

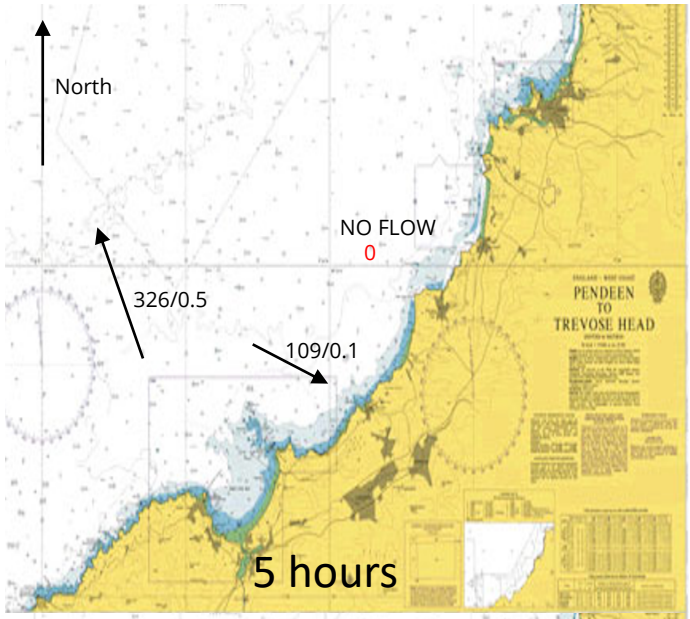
NOTE: All of these drawings are based on observations and interpretations of the chart at the station and should **not be relied upon for Navigational purposes**.

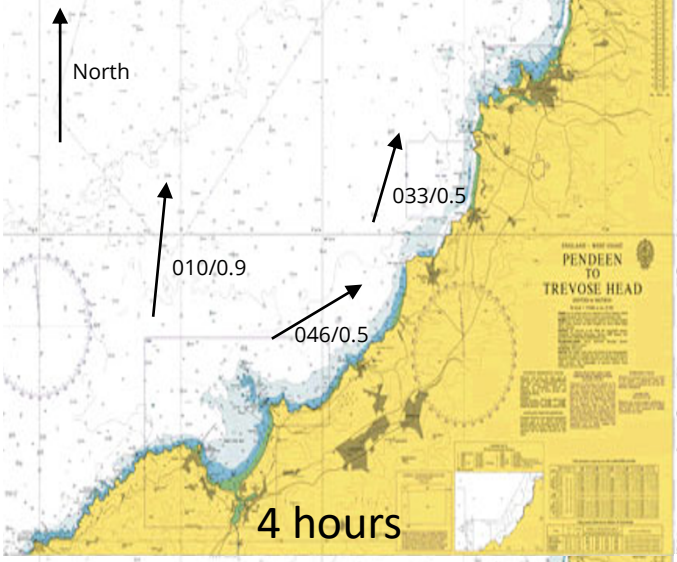
TIDES AT DIAMONDS ADJUSTED TO THE TIDE AT ST IVES						
TIDAL DIAMOND	B		C		D	
	DIRECTI0N	SPEED	DIRECTI0N	SPEED	DIRECTI0N	SPEED
- 6 HOURS	148	0.1	037	0.2	320	0.4
- 5 HOURS	109	0.1	0	0	326	0.5
- 4 HOURS	046	0.5	033	0.5	010	0.4
- 3 HOURS	038	0.9	036	1.1	037	1.1
- 2 HOURS	033	0.9	043	1.2	046	1.3
- 1 HOUR	031	0.8	048	1.1	061	1.0
HIGH WATER	027	0.3	058	0.7	124	0.5
+ 1 HOUR	202	0.2	126	0.3	162	0.7
+ 2 HOURS	227	0.4	200	0.4	187	0.8
+ 3 HOURS	230	0.8	225	1.0	222	1.0
+ 4 HOURS	228	0.9	231	1.2	233	1.1
+ 5 HOURS	216	0.8	233	1.1	237	0.9
+ 6 HOURS	196	0.4	239	0.7	246	0.4

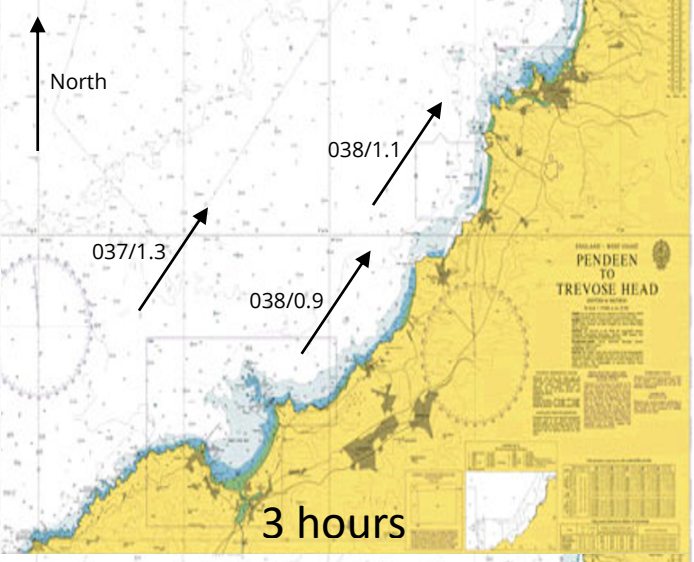
AT HIGH WATER IN ST IVES FLOW AT DIAMONS WILL BE..		
Tidal Diamond	DIRECTI0N	SPEED
B	027	0.3
C	058	0.7
D	124	0.5

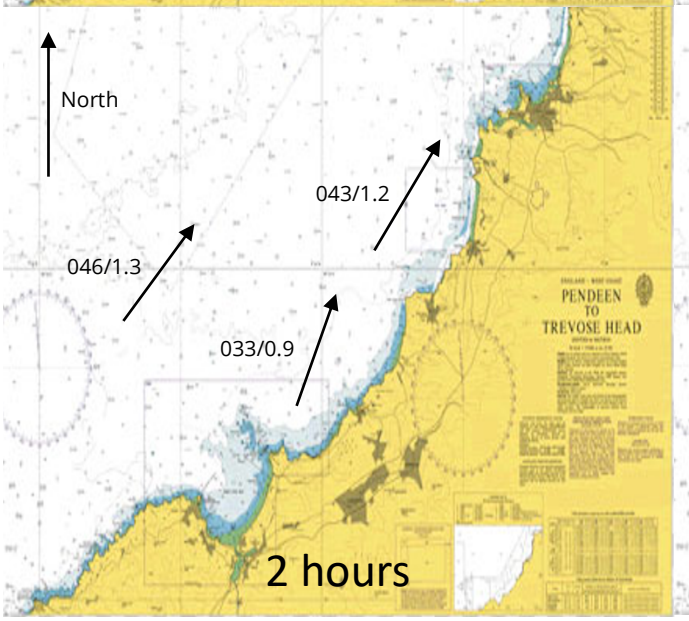
Direction and flow before high tide

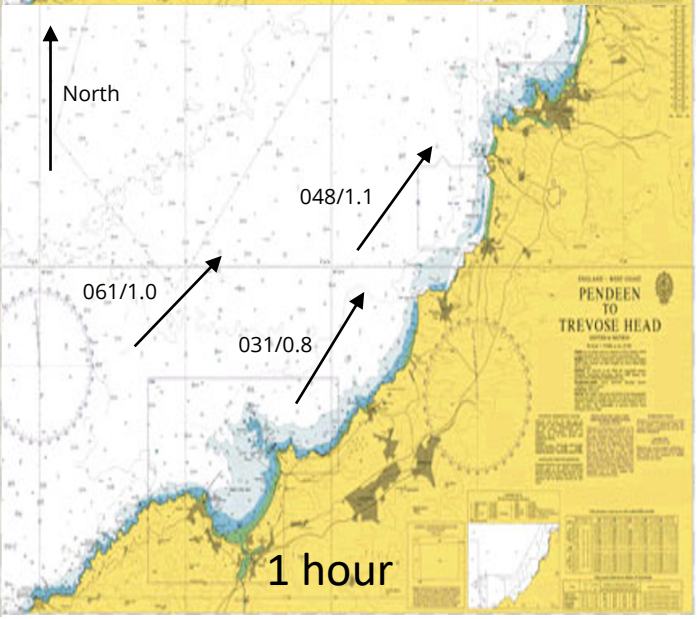




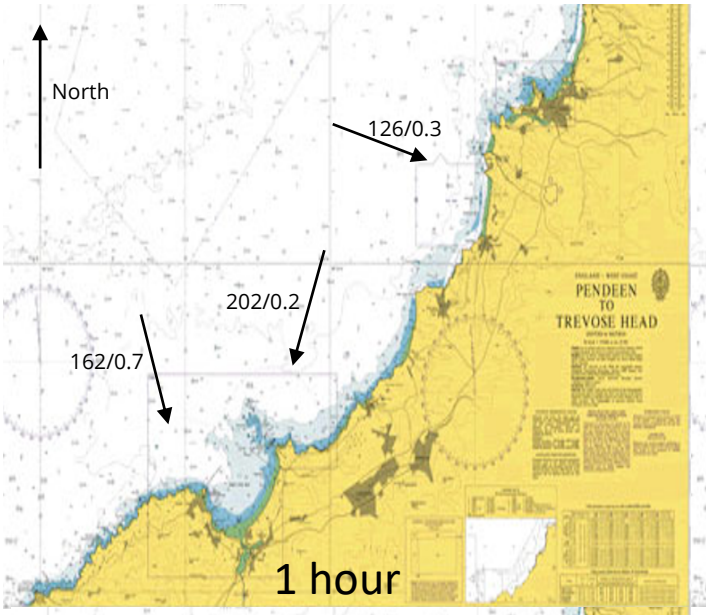


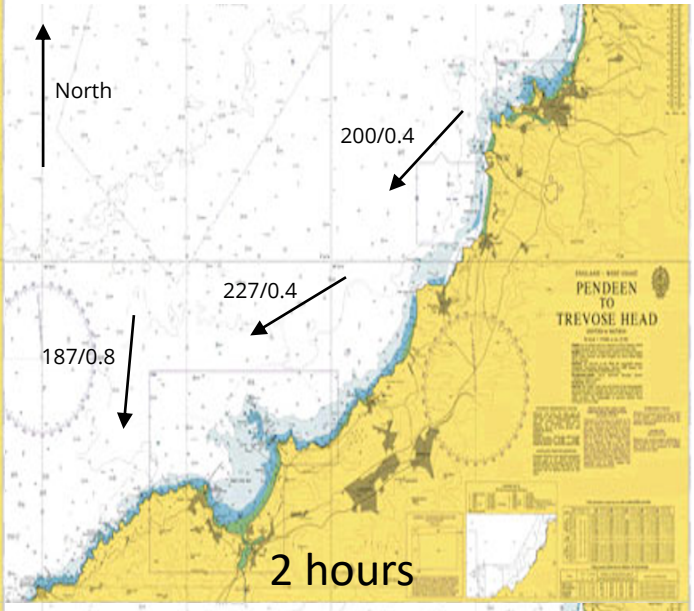


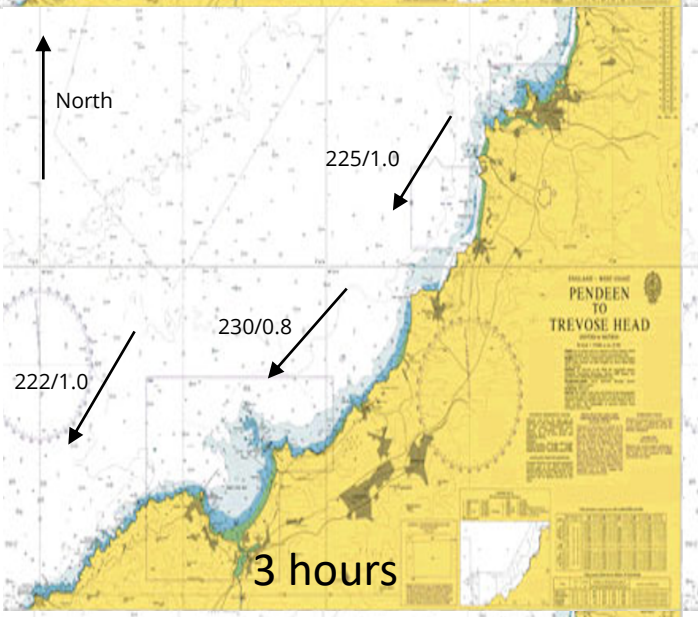


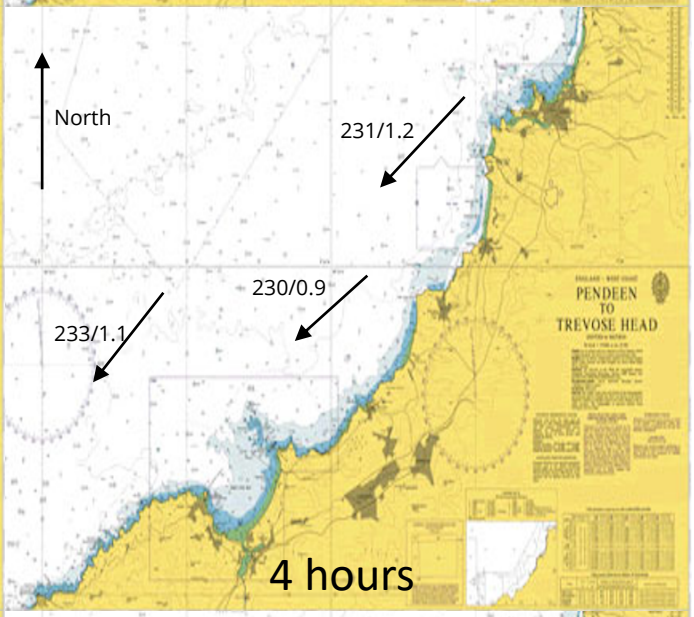


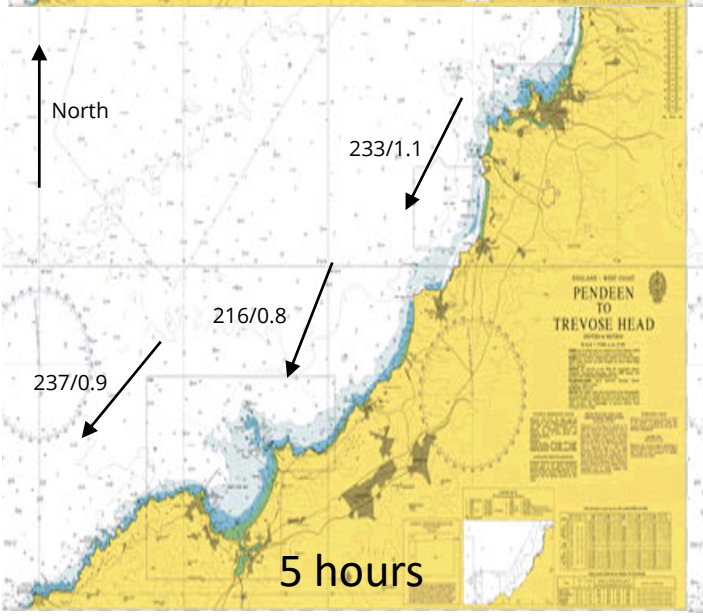
Direction and flow after high tide

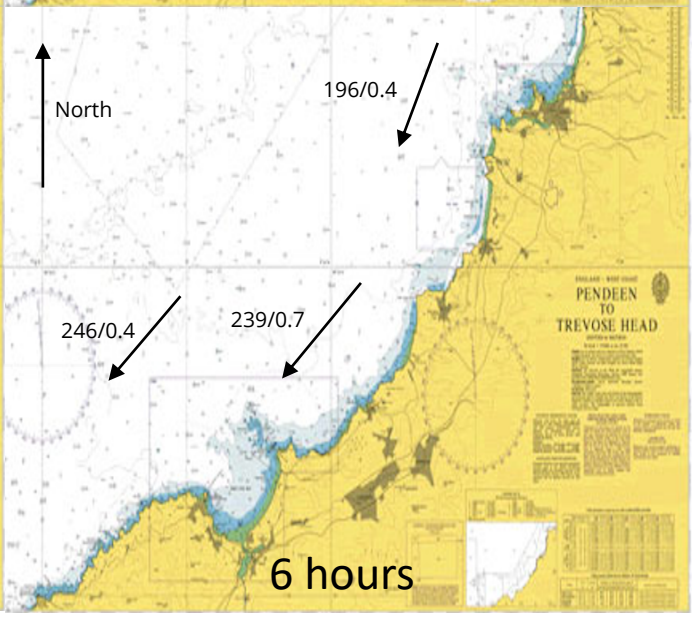












Written by Ieuan Gregory