Tides and their calculation

(Material contains extracts intended for study and research only-
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Contents

Theory of Tides.

The factors which cause tides

Tides are caused by the attractive forces of the sun and moon. Due to its closeness to the earth the effect of the moon is far greater than that of the sun. Therefore the moon largely controls the time of high and low waters. The relative position of the sun and moon will determine whether the sun's force increases the moon's effect on the tide or decreases its effect.

When the sun and the moon are working together to distort the envelope of water surrounding the earth, they are either in opposition or conjunction and spring tides are the result. When the effects are opposing each other the sun and moon are said to be in quadrature and neap tides result. Opposition occurs with a full moon and conjunction with a new moon as shown in Figure 1.

The shape of the envelope of water is highly exaggerated in the diagram. In reality the rise and fall of tides in the middle of the oceans is barely noticed. It is only when the movement builds up approaching a coastline that the effect is significant. It can therefore be seen that the shape of the coastline will also have considerable effect on tidal patterns and heights. Shallow funnelling estuaries with low change in depth gradients may develop higher tidal ranges, and areas behind obstructing islands may experience double tides for each side.

Strong onshore winds will tend to hold the tide up, and abnormally low atmospheric pressure will further increase the height of the tide. When both of these meteorological effects occur together, as they may do with a tropical cyclone, the effects from storm surge and flooding can be devastating.

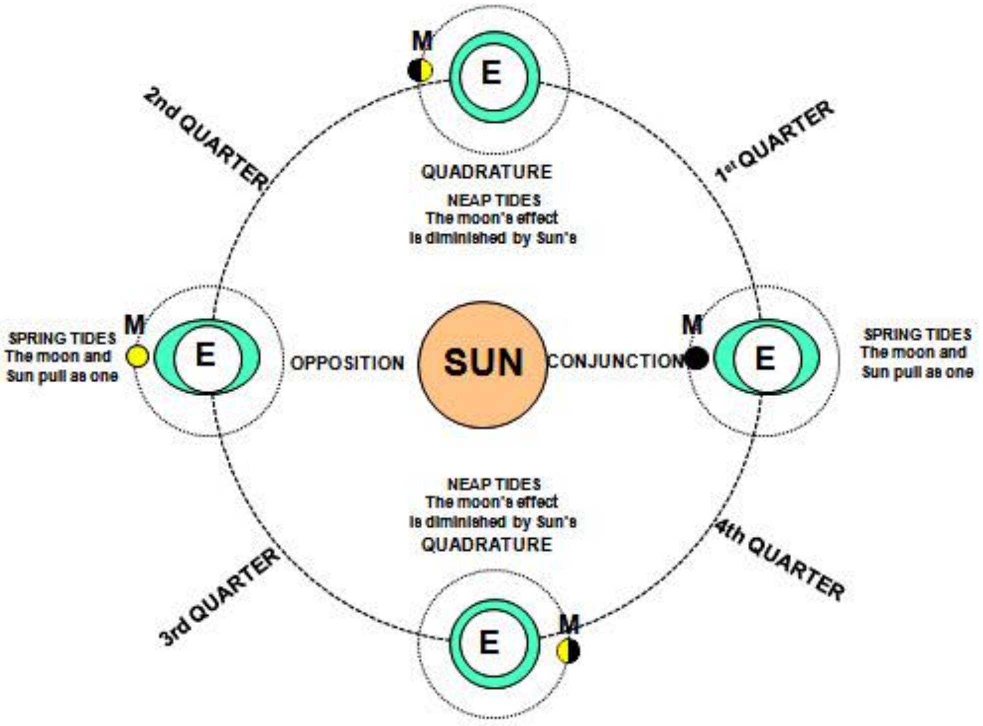


Figure 1: Effect of celestial bodies on tides

(Link to animation-Courtesy RNLI)

Tides and Chart datum

Due to the complexity of the cause of tides, tidal predictions are based on the most frequent set of conditions. They are related to a standard level called Chart Datum. Chart Datum is selected at a level below which the tide will seldom fall. Older Australian Charts used the chart datum of the mean of the lower low water springs (MLLWS). Since there were still a considerable number of occasions when tidal heights fell below this level, charts are now produced with the datum of Lowest Astronomical Tide (LAT), being the lowest the tide that can be predicted due to the effects of celestial bodies' gravitational attraction under average meteorological conditions.

Soundings on charts are given below Chart Datum. Drying heights of rocks and banks are given above Chart Datum. Heights of land and land based structures on charts are expressed as above Mean High Water Springs.

The heights of High and Low water on tide tables are the heights of water above the chart datum.

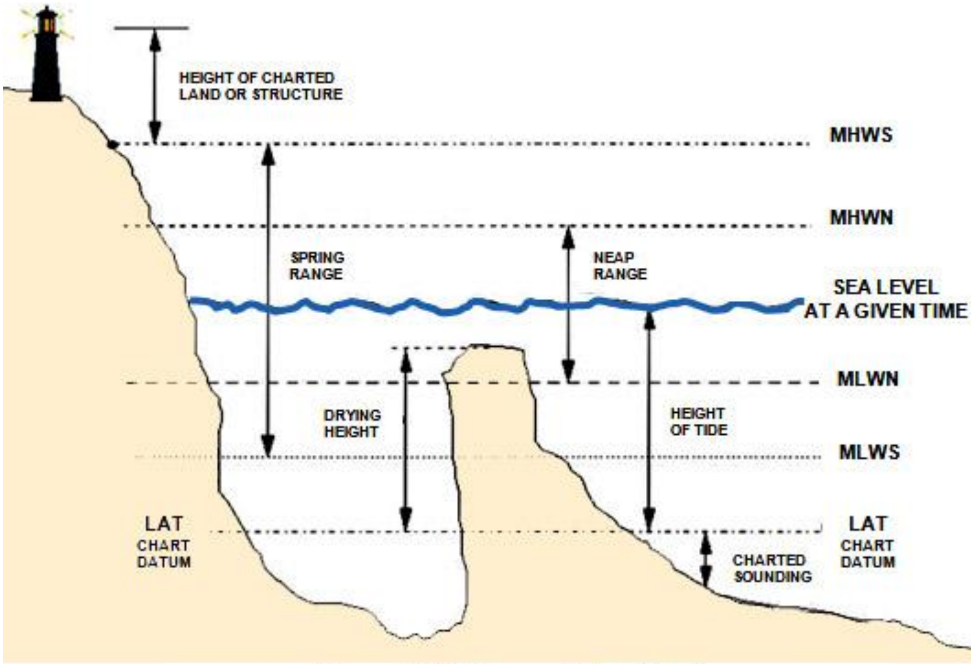


Figure 2. Tides and Chart Datum

- *Range of Tide is the difference in height between Low and High Water.*
- *The Duration of Tide is the time interval between successive High Waters.*
- *The Duration of Rise (flow) is the time interval from Low Water to High Water.*
- *The Duration of Fall (ebb) is the time interval from High Water to Low Water.*

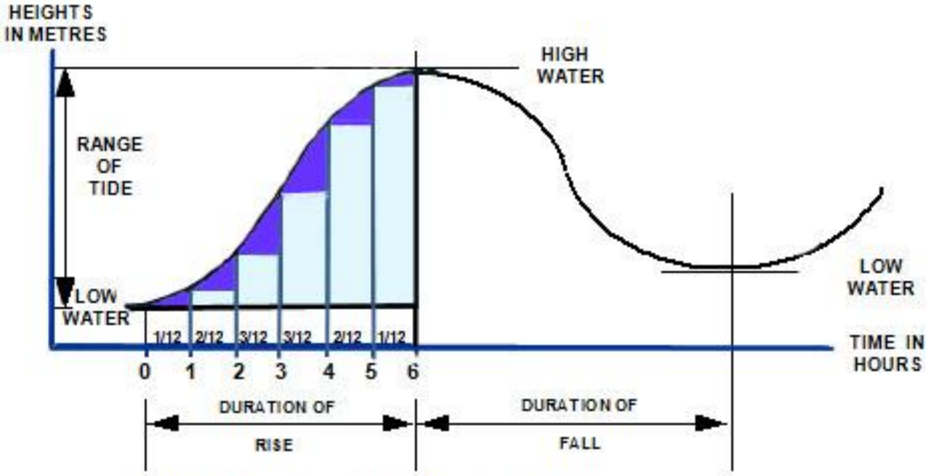


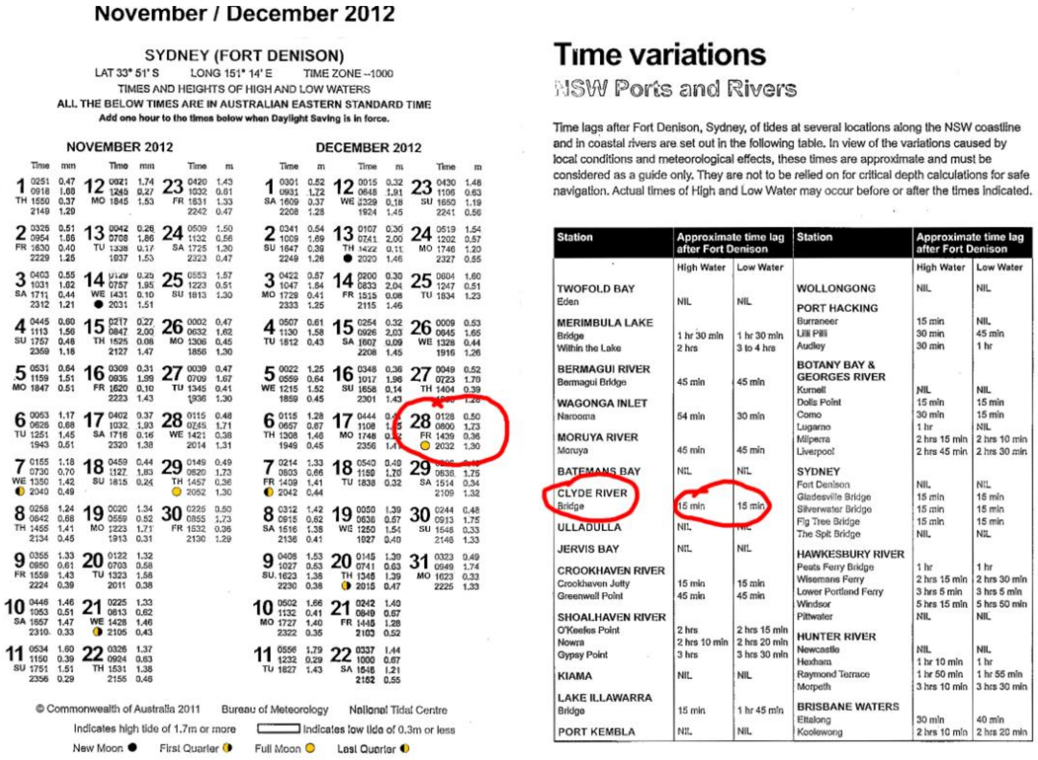
Figure 3. Tide duration and range

In most cases standard tides flow in/out in just over six hours. The flow rate approximates a sine curve, being initially minimal, then greatest at half tide then diminishing again at the top/bottom of the tide. An estimate of tide height at a time is possible using the "*rule of twelfths*". In this method the tidal range is divided by twelve and it is assumed that the 1/12 of the range flows in the first hour, another 2/12 in the second hour, another 3/12 in the third hour, and so on. The twelfths are summed to estimate the volume that has flowed at any selected time.

Using the tide tables

Basic tide tables

Many versions of tide tables are available in print and on the internet. Below are detailed the extraction of times and heights of high and low water for a Standard Port from a NSW Maritime (RMS) tide chart for Friday 28th December 2012.



November / December 2012

SYDNEY (FORT DENISON)
LAT 33° 51' S LONG 151° 14' E TIME ZONE –1000
TIMES AND HEIGHTS OF HIGH AND LOW WATERS
ALL THE BELOW TIMES ARE IN AUSTRALIAN EASTERN STANDARD TIME
Add one hour to the times below when Daylight Saving is in force.

NOVEMBER 2012

	Time	min		Time	min		Time	m
1	0251	0.47	12	0021	1.74	23	0420	1.43
	0918	1.68		1245	0.27		1032	0.61
TH	1550	0.37	MO	1845	1.53	FR	1631	1.33
	2149	1.20					2242	0.47
2	0326	0.51	13	0042	0.26	24	0509	1.50
	0954	1.66		0708	1.86		1132	0.56
FR	1630	0.40	TU	1338	0.17	SA	1725	1.30
	2229	1.25		1937	1.53		2323	0.47
3	0403	0.55	14	0129	0.25	25	0553	1.57
	1031	1.62		0757	1.95		1223	0.51
SA	1711	0.44	WE	1431	0.10	SU	1813	1.30
	2312	1.21	●	2031	1.51			
4	0445	0.60	15	0217	0.27	26	0002	0.47
	1113	1.56		0847	2.00		0632	1.62
SU	1757	0.48	TH	1525	0.08	MO	1306	0.45
	2359	1.18		2127	1.47		1856	1.30
5	0531	0.64	16	0309	0.31	27	0039	0.47
	1159	1.51		0935	1.99		0709	1.67
MO	1847	0.51	FR	1620	0.10	TU	1345	0.41
				2223	1.43		1936	1.30
6	0053	1.17	17	0402	0.37	28	0115	0.48
	0626	0.68		1032	1.93		0745	1.71
TU	1251	1.45	SA	1716	0.16	WE	1421	0.38
	1943	0.51		2320	1.38		2014	1.31
7	0155	1.18	18	0459	0.44	29	0149	0.49
	0730	0.70		1127	1.83		0820	1.73
WE	1350	1.42	SU	1815	0.24	TH	1457	0.36
◑	2040	0.49				○	2052	1.30
8	0258	1.24	19	0020	1.34	30	0225	0.50
	0842	0.68		0559	0.52		0855	1.73
TH	1455	1.41	MO	1223	1.71	FR	1532	0.36
	2134	0.45		1913	0.31		2130	1.29
9	0355	1.33	20	0122	1.32			
	0950	0.61		0703	0.58			
FR	1559	1.43	TU	1323	1.58			
	2224	0.39		2011	0.38			
10	0446	1.46	21	0225	1.33			
	1053	0.51		0813	0.62			
SA	1657	1.47	WE	1428	1.46			
	2310	0.33	◐	2105	0.43			
11	0534	1.60	22	0326	1.37			
	1150	0.39		0924	0.63			
SU	1751	1.51	TH	1531	1.38			
	2356	0.29		2155	0.46			

DECEMBER 2012

	Time	m		Time	m		Time	m
1	0301	0.52	12	0015	0.32	23	0430	1.48
	0931	1.72		0648	1.91		1106	0.63
SA	1609	0.37	WE	1329	0.18	SU	1650	1.19
	2208	1.28		1924	1.45		2241	0.56
2	0341	0.54	13	0107	0.30	24	0519	1.54
	1009	1.69		0741	2.00		1202	0.57
SU	1647	0.39	TH	1422	0.11	MO	1746	1.20
	2249	1.26	●	2020	1.46		2327	0.55
3	0422	0.57	14	0200	0.30	25	0604	1.60
	1047	1.64		0833	2.04		1247	0.51
MO	1729	0.41	FR	1515	0.08	TU	1834	1.23
	2333	1.25		2115	1.46			
4	0507	0.61	15	0254	0.32	26	0009	0.53
	1130	1.58		0926	2.03		0645	1.65
TU	1812	0.43	SA	1607	0.09	WE	1328	0.44
				2208	1.45		1916	1.26
5	0022	1.25	16	0348	0.36	27	0049	0.52
	0559	0.64		1017	1.96		0723	1.70
WE	1215	1.52	SU	1658	0.14	TH	1404	0.39
	1859	0.45		2301	1.43		[illegible]	[illegible]
6	0115	1.28	17	0444	[illegible]	28	0128	0.50
	0657	0.67		1108	[illegible]		0800	1.73
TH	1308	1.46	MO	1748	[illegible]	FR	1439	0.36
	1949	0.45		2356	[illegible]	○	2032	1.30
7	0214	1.33	18	0540	0.40	29	[illegible]	[illegible]
	0803	0.66		1150	1.70		0836	1.75
FR	1409	1.41	TU	1838	0.32	SA	1514	0.34
◑	2042	0.44					2109	1.32
8	0312	1.42	19	0050	1.39	30	0244	0.48
	0915	0.62		0638	0.57		0913	1.75
SA	1516	1.38	WE	1250	1.54	SU	1548	0.33
	2136	0.41		1927	0.40		2146	1.33
9	0406	1.53	20	0145	1.39	31	0323	0.49
	1027	0.53		0741	0.63		0949	1.74
SU.	1623	1.38	TH	1348	1.39	MO	1623	0.33
	2230	0.38	◐	2015	0.47		2225	1.33
10	0502	1.66	21	0242	1.40			
	1132	0.41		0849	0.67			
MO	1727	1.40	FR	1446	1.28			
	2322	0.35		2103	0.52			
11	0556	1.79	22	0337	1.44			
	1232	0.29		1000	0.67			
TU	1827	1.43	SA	1648	1.21			
				2152	0.55			

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Indicates high tide of 1.7m or more ▭ Indicates low tide of 0.3m or less

New Moon ● First Quarter ◐ Full Moon ○ Last Quarter ◑

Time variations

NSW Ports and Rivers

Time lags after Fort Denison, Sydney, of tides at several locations along the NSW coastline and in coastal rivers are set out in the following table. In view of the variations caused by local conditions and meteorological effects, these times are approximate and must be considered as a guide only. They are not to be relied on for critical depth calculations for safe navigation. Actual times of High and Low Water may occur before or after the times indicated.

Station	Approximate time lag after Fort Denison	
	High Water	Low Water
TWOFOLD BAY		
Eden	NIL	NIL
MERIMBULA LAKE		
Bridge	1 hr 30 min	1 hr 30 min
Within the Lake	2 hrs	3 to 4 hrs
BERMAGUI RIVER		
Bermagui Bridge	45 min	45 min
WAGONGA INLET		
Narooma	54 min	30 min
MORUYA RIVER		
Moruya	45 min	45 min
BATEMANS BAY	NIL	NIL
CLYDE RIVER		
Bridge	15 min	15 min
ULLADULLA	NIL	NIL
JERVIS BAY	NIL	NIL
CROOKHAVEN RIVER		
Crookhaven Jetty	15 min	15 min
Greenwell Point	45 min	45 min
SHOALHAVEN RIVER		
O'Keefes Point	2 hrs	2 hrs 15 min
Nowra	2 hrs 10 min	2 hrs 20 min
Gypsy Point	3 hrs	3 hrs 30 min
KIAMA	NIL	NIL
LAKE ILLAWARRA		
Bridge	15 min	1 hr 45 min
PORT KEMBLA	NIL	NIL

Station	Approximate time lag after Fort Denison	
	High Water	Low Water
WOLLONGONG	NIL	NIL
PORT HACKING		
Burraneer	15 min	NIL
Lilli Pilli	30 min	45 min
Audley	30 min	1 hr
BOTANY BAY & GEORGES RIVER		
Kurnell	NIL	NIL
Dolls Point	15 min	15 min
Como	30 min	15 min
Lugarno	1 hr	NIL
Milperra	2 hrs 15 min	2 hrs 10 min
Liverpool	2 hrs 45 min	2 hrs 30 min
SYDNEY		
Fort Denison	NIL	NIL
Gladesville Bridge	15 min	15 min
Silverwater Bridge	15 min	15 min
Fig Tree Bridge	15 min	15 min
The Spit Bridge	NIL	NIL
HAWKESBURY RIVER		
Peats Ferry Bridge	1 hr	1 hr
Wisemans Ferry	2 hrs 15 min	2 hrs 30 min
Lower Portland Ferry	3 hrs 5 min	3 hrs 5 min
Windsor	5 hrs 15 min	5 hrs 50 min
Pittwater	NIL	NIL
HUNTER RIVER		
Newcastle	NIL	NIL
Hexham	1 hr 10 min	1 hr
Raymond Terrace	1 hr 50 min	1 hr 55 min
Morpeth	3 hrs 10 min	3 hrs 30 min
BRISBANE WATERS		
Ettalong	30 min	40 min
Koolewong	2 hrs 10 min	2 hrs 20 min

Figure 4.-Basic tide tables

Example 1:

Find the time and height of low water at Clyde Bridge on Friday 28th December 2012.

1.43				
	28	0128	0.50	
		0800	1.73	
	FR	1439	0.36	
	○	2032	1.30	
0.49	29	[illegible]	[illegible]	
1.70		0836	1.75	
0.32	SA	1514	0.34	
		2109	1.32	
1.39	30	0244	0.48	
0.57		0913	1.75	
1.54	SU	1548	0.33	
0.40		2146	1.33	

WAGONGA INLET		
Narooma	54 min	30 min
MORUYA RIVER		
Moruya	45 min	45 min
BATEMANS BAY	NIL	NIL
CLYDE RIVER		
Bridge	15 min	15 min
ULLADULLA	NIL	NIL

Figure 5.-Extracting data from basic tide tables

The HW at Sydney listed is 18:00 (UTC) + 00:15 later at the bridge = 18:15 (UTC).

Note that the times stated are Zone time (UTC). In NSW summertime daylight saving is in force between October and April so a local time is correction by adding one hour is necessary in December.

Therefore high water local (daylight saving) time of is 18:15 (UTC) + 1 hour = 19:15.

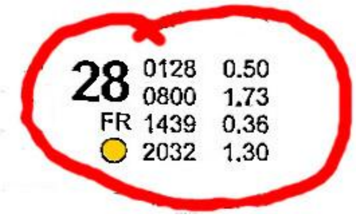
The yellow ball indicates that it is the time of the full moon in conjunction when spring tides are reaching their maximum. It is the reason that 1.73 metres of tide flow in over the chart's soundings on the Friday. More information is found at http://www.bom.gov.au/oceanography/projects/ntc/tide_tables.shtml

Intertidal heights and times

The tide height at a time will often be needed to ensure safe entry over a shoal patch or to anticipate how much rode is required to anchor. The simplest (and least accurate) way of estimating this is to make an assumption that the height and duration of tidal flow follows a sine curve. Clearly it will be wise not to rely on the estimates calculated, and to allow additional clearance for the vessel as circumstances require. The methods available are the Rule of Twelfths (described earlier) and the Tidal Graph (AH130).

Example 2.– Rule of Twelfths:

Find the time and height of 1.0 mtrs over LAT at Sydney on 28th December 2012.



28	0128	0.50
	0800	1.73
FR	1439	0.36
●	2032	1.30

Figure 6.-Times and heights of HW and LW

Over the six hours duration the tide will fall on the first hour, then 2/12, then 3/12, then 3/12, then, 2/12 and finally on the last hour before low tide, 1/12:

The range of tide is *1.73m – 0.36 m   = 1.37 m.*

1/12 of the range is *1.37m ÷ 12   = 0.114m.*

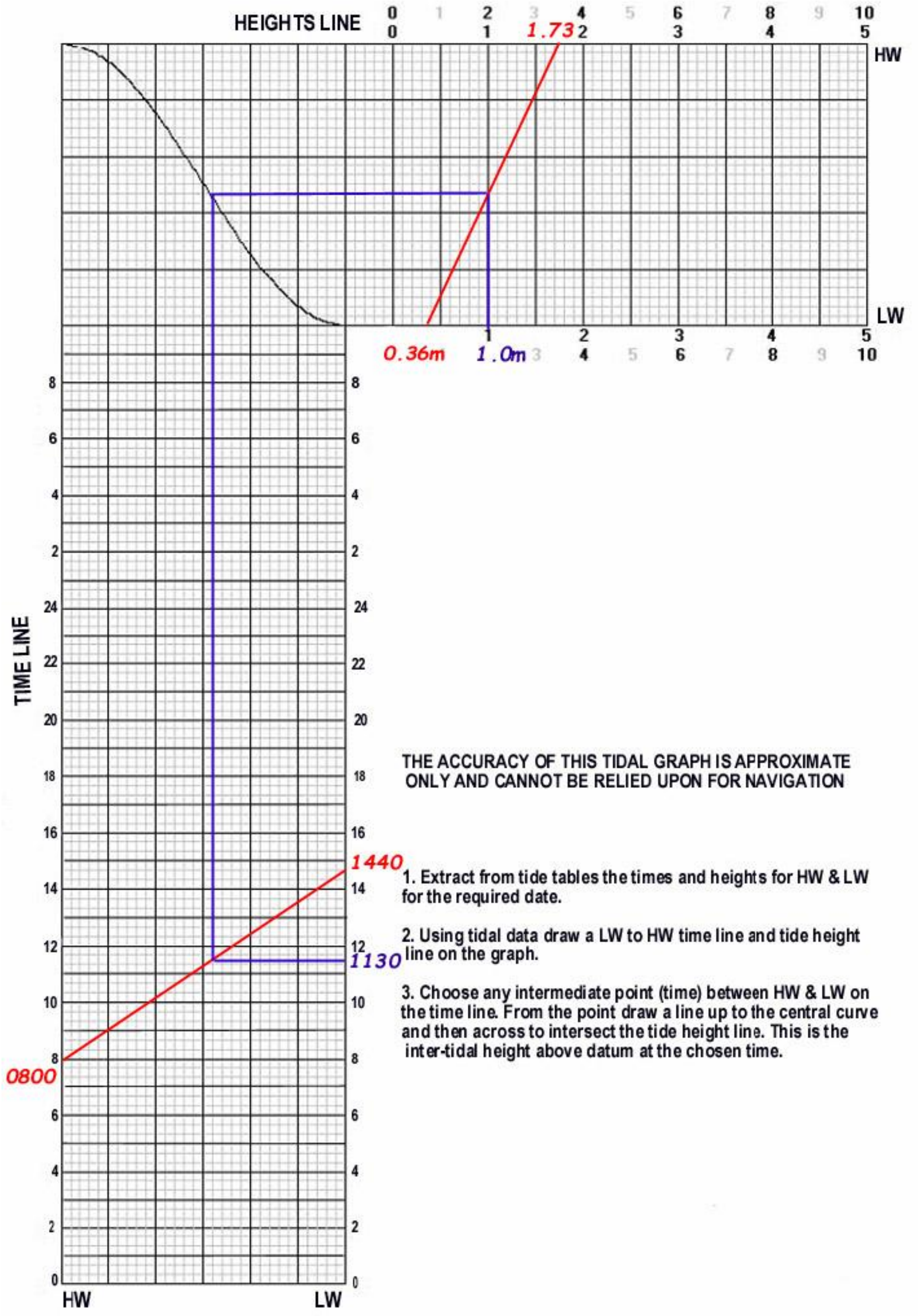
Therefore the tide will have fallen to 1.0m at:

1.00 ÷ 0.114m = 8.77 twelfths (approximately 1/12 + 2/12 + 3/12 + 3/12) and just before the fourth hour of the ebb.

0800 + almost 4 hours = at just before 1200. When daylight saving correction is added the time of 1.0m over LAT is estimated at just before 1300 (say 1245).

Example 3.–Use of tidal graph: (Link here to a blank Tidal Graph)

Find the time and height of 1.0m over LAT at Sydney on 28th December 2012.



THE ACCURACY OF THIS TIDAL GRAPH IS APPROXIMATE ONLY AND CANNOT BE RELIED UPON FOR NAVIGATION

1. Extract from tide tables the times and heights for HW & LW for the required date.
2. Using tidal data draw a LW to HW time line and tide height line on the graph.
3. Choose any intermediate point (time) between HW & LW on the time line. From the point draw a line up to the central curve and then across to intersect the tide height line. This is the inter-tidal height above datum at the chosen time.

Figure 7.-Tidal graph AH130

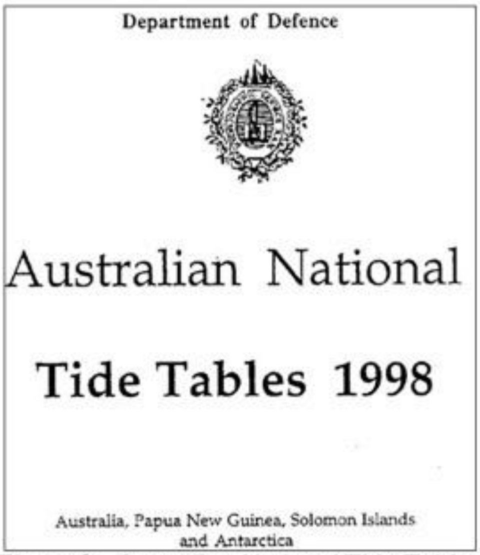
The tidal graph includes instructions for it use to find any intertidal time and height When daylight saving correction is added the time of 1.0m over LAT is estimated at just before 1130 + 1 hour = 1230.

Note - this calculation assumes the sine curve ideal of tidal flow, unlikely to be matched in reality so additional clearance should be allowed for.

Standard and Secondary Ports

Mariners that ply in more distant or remote areas will require the *Admiralty Tide Table* (worldwide) or the *Australian National Tide Tables* (Australian region). In order to provide tidal information for the hundreds of ports the ANTT provide detailed daily predictions for Standard (large) ports and tables to calculate the difference at a Secondary (smaller) port. The Standard Port acts as a reference station where predictions are based on continuous observation and contain changes in conditions due to meteorological conditions.

The information given in the ANNT for each standard port is the predicted times and heights of high and low water. Secondary Ports or Subordinate stations are based as near as practicable on Standard Port tidal characteristics in the area. The predictions for tidal times and heights for secondary ports are made by the application of time and height differences to the standard port.



Department of Defence

Australian National

Tide Tables 1998

Australia, Papua New Guinea, Solomon Islands
and Antarctica

Figure 8.- Australian National Tide Tables

More information is found at http://www.hydro.gov.au/prodserv/publications/antt.htm

Calculations involving a Standard and Secondary Port

While all tides are composed of both diurnal (once a day) and semi-diurnal (twice a day) components, the ANTT lists in *Table 1-Tidal Levels of Standard Ports* as either *Part 1 - Predominantly diurnal tides* or *Part 2 - Predominantly semi-diurnal tides*

Diurnal tides - A diurnal tide has one high water (tide) and one low water (tide) per day. Typically with a diurnal tide each successive high or low tide is 24 hours and 50 minutes apart, this is the length of one lunar day.

Semi-diurnal tides - A semi-diurnal tide occurs when there are two high waters (tides) and two low waters (tides) per day. Typically the time between each successive high or low tide is 12 hours 25 minutes, this is half of one lunar day.

When using the ANTT Standard and Secondary Port calculation forms it will be noted that there are two versions. The version for *Table 1-part 1-Predominently Diurnal Tides* is entered with MHHW and MLLW, whereas version for *Table 1-part 2-Predominently Semi-diurnal Tides* is entered with MHWS and MLWS.

For calculations you will need to access the calculation forms and the ANTT:

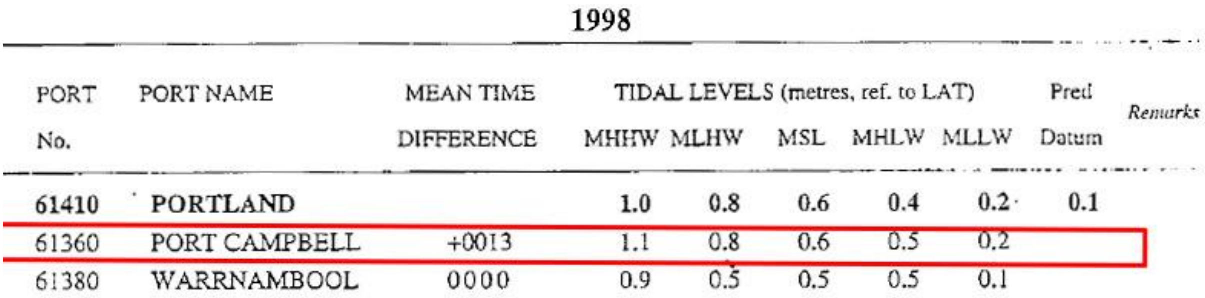
(Link to Standard/secondary Calculation forms -*Part 1 diurnal and Part 2 semi-diurnal*)

(Link to *Australian National Tide Tables* extracts *1998)*

Example 4.–Diurnal ports:

You require the times and heights of high and low water at Port Campbell for the 1st February 1998, using the *ANTT 1998:*

- First look up Port Campbell in the *Port Index* and find its number is *61360*.
- Next look for 61360 in *Part 3-Secondary Ports* and find its Standard Port is Portland.

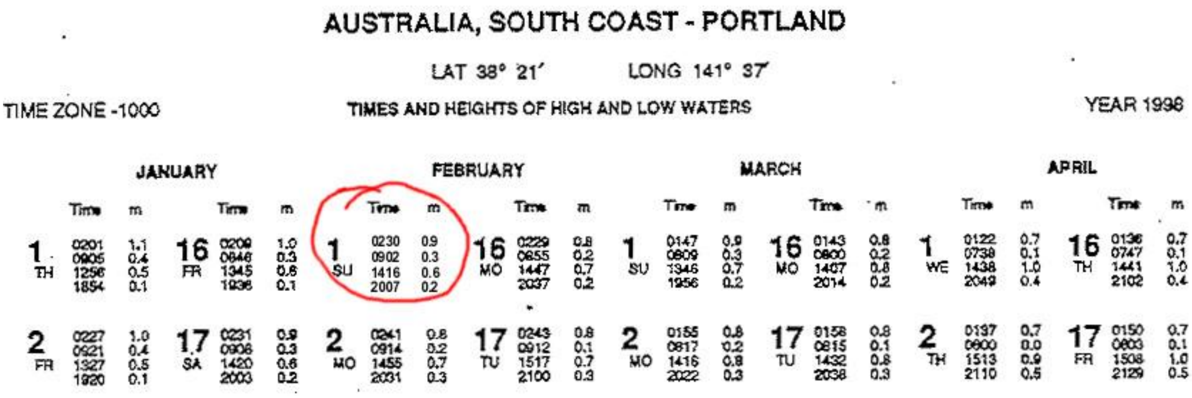


1998

PORT No.	PORT NAME	MEAN TIME DIFFERENCE	TIDAL LEVELS (metres, ref. to LAT) MHHW	MLHW	MSL	MHLW	MLLW	Pred Datum	Remarks
61410	PORTLAND		1.0	0.8	0.6	0.4	0.2	0.1	
61360	PORT CAMPBELL	+0013	1.1	0.8	0.6	0.5	0.2		
61380	WARRNAMBOOL	0000	0.9	0.5	0.5	0.5	0.1		

Figure 9.-Extract from ANTT Part 3-Secondary Ports

- Next look for Portland in *Part 1-Tidal predictions for Secondary Ports* and find the times and heights of tides on 1st February 1998.



AUSTRALIA, SOUTH COAST - PORTLAND

LAT 38° 21′ LONG 141° 37′

TIME ZONE -1000

TIMES AND HEIGHTS OF HIGH AND LOW WATERS

YEAR 1998

JANUARY						FEBRUARY						MARCH						APRIL					
	Time	m		Time	m		Time	m		Time	m		Time	m		Time	m		Time	m		Time	m
1 TH	0201 0905 1256 1854	1.1 0.4 0.5 0.1	16 FR	0209 0846 1345 1936	1.0 0.3 0.6 0.1	1 SU	0230 0902 1416 2007	0.9 0.3 0.6 0.2	16 MO	0229 0855 1447 2037	0.8 0.2 0.7 0.2	1 SU	0147 0809 1346 1956	0.9 0.3 0.7 0.2	16 MO	0143 0800 1407 2014	0.8 0.2 0.8 0.2	1 WE	0122 0738 1438 2049	0.7 0.1 1.0 0.4	16 TH	0136 0747 1441 2102	0.7 0.1 1.0 0.4
2 FR	0227 0921 1327 1920	1.0 0.4 0.5 0.1	17 SA	0231 0906 1420 2003	0.9 0.3 0.6 0.2	2 MO	0241 0914 1455 2031	0.8 0.2 0.7 0.3	17 TU	0243 0912 1517 2100	0.8 0.1 0.7 0.3	2 MO	0155 0817 1416 2022	0.8 0.2 0.8 0.3	17 TU	0158 0815 1432 2038	0.8 0.1 0.8 0.3	2 TH	0137 0800 1513 2110	0.7 0.0 0.9 0.5	17 FR	0150 0803 1508 2129	0.7 0.1 1.0 0.5

Figure 10.-Extract from ANTT Part 1-Standard Ports

- Next check if it is a Diurnal or semidiurnal listed port in *Table 1-part 1 or 2*

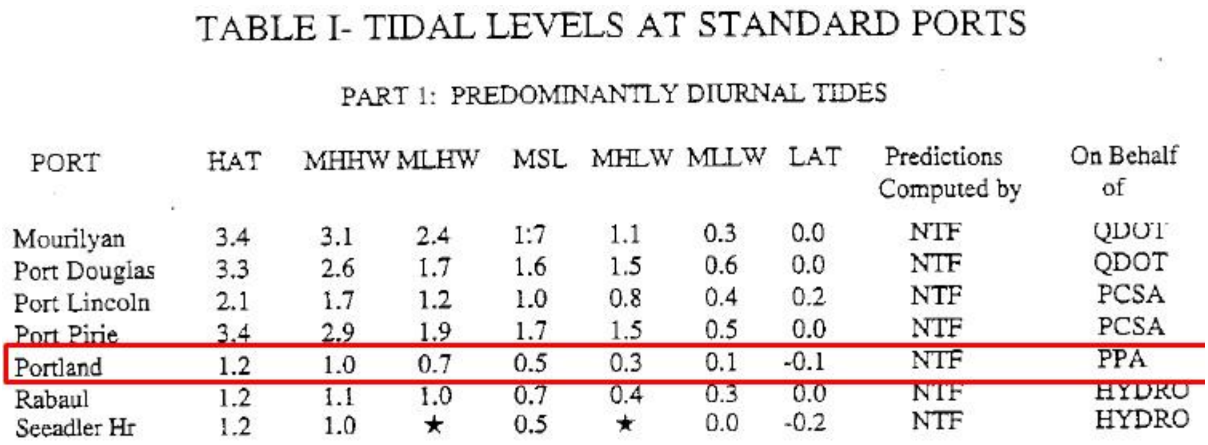


TABLE I- TIDAL LEVELS AT STANDARD PORTS

PART 1: PREDOMINANTLY DIURNAL TIDES

PORT	HAT	MHHW	MLHW	MSL	MHLW	MLLW	LAT	Predictions Computed by	On Behalf of
Mourilyan	3.4	3.1	2.4	1:7	1.1	0.3	0.0	NTF	QDOT
Port Douglas	3.3	2.6	1.7	1.6	1.5	0.6	0.0	NTF	QDOT
Port Lincoln	2.1	1.7	1.2	1.0	0.8	0.4	0.2	NTF	PCSA
Port Pirie	3.4	2.9	1.9	1.7	1.5	0.5	0.0	NTF	PCSA
Portland	1.2	1.0	0.7	0.5	0.3	0.1	-0.1	NTF	PPA
Rabaul	1.2	1.1	1.0	0.7	0.4	0.3	0.0	NTF	HYDRO
Seeadler Hr	1.2	1.0	★	0.5	★	0.0	-0.2	NTF	HYDRO

Figure 11.-Extract from ANTT Table 1-Part 1-predominantly diurnal ports

Instructions to complete Diurnal calculation form:

Now you can extract the above information from the ANTT to enter the Diurnal calculation form (MHHW and MLLW version).

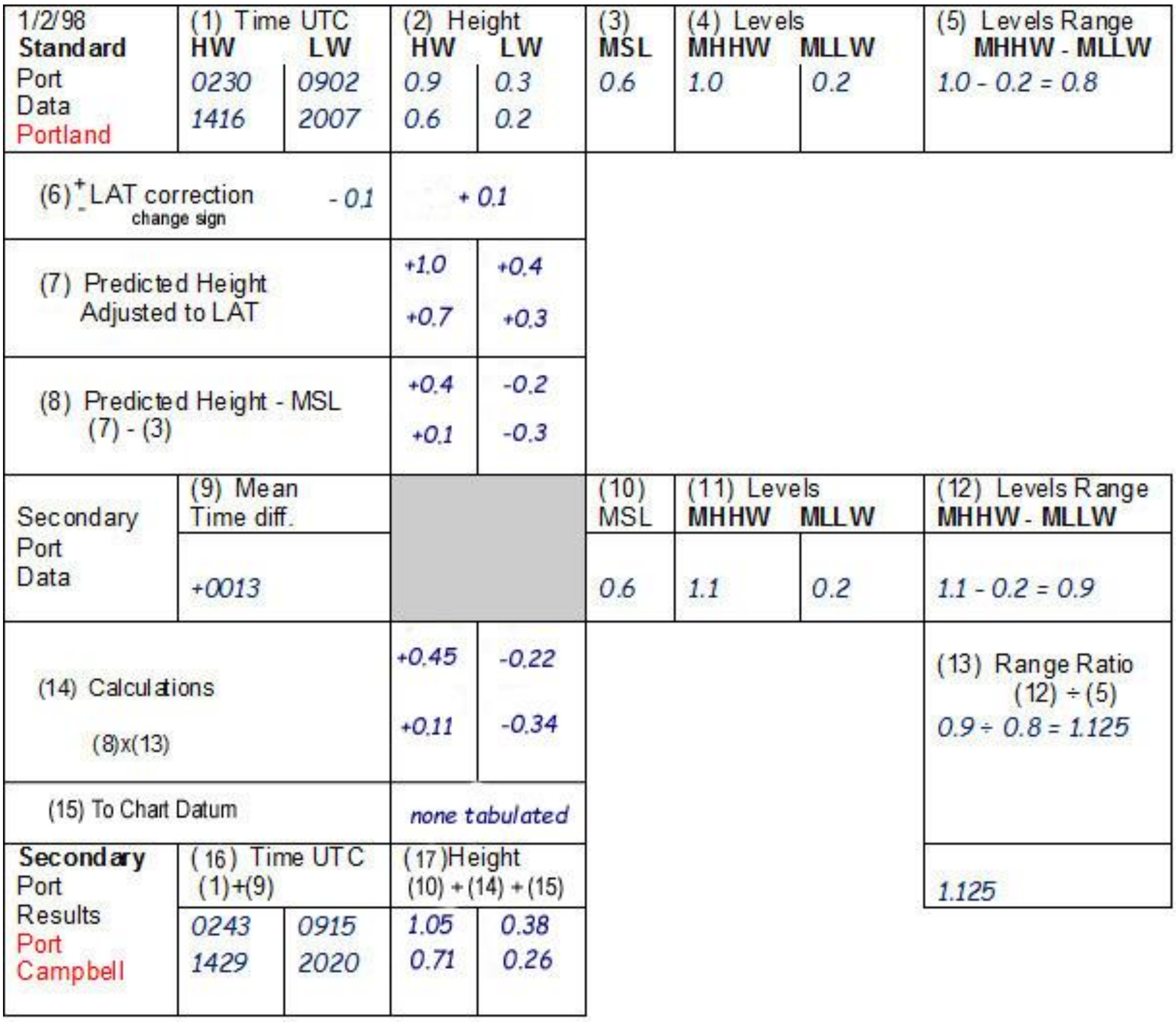
- From *Part 1* enter time and heights of HW/LW Portland on 1st Feb. (Box 1 & 2)
- From *Part 3* find MSL (Box MSL) & MHHW and MLLW (Box 4). Subtract (Box 5)
- From *Table 1-part 1* find LAT correction for (Box 6), reverse its tabulated sign from + or -, then arithmetically sum in (Box 7).
- Now subtract the MSL from heights in (Box 7) and enter results in Box 8 (Note, HW are normally positive, LW are negative).This completes Standard port data.
- From *Part 3* (Port Campbell No. 61360) extract the mean time difference in (Box 9), the MSL (Box 10), and MHHW, MLLW (Box 11)
- Box 12 is entered with the difference between MHHW and MLLW
- Box 13 Range Ratio is found by (Box 12) ÷ (Box 5)

  0.9 ÷ 0.8 = 1.125

- Box 14 multiply the heights in (Box 8) by (Box 13)

  +0.40 x 1.125 = +0.45
  +0.10 x 1.125 = +0.11
  -0.20 x 1.125 = -0.22
  -0.30 x 1.125 = -0.34

- Box 15 corrects the few secondary ports not referenced to LAT (In Part 4 ANTT)
- Add the mean time difference (Box 9) to times in Box 1 and enter in Box 16.
- Add the values of (Box 10) to (Box 14) to (Box 15)



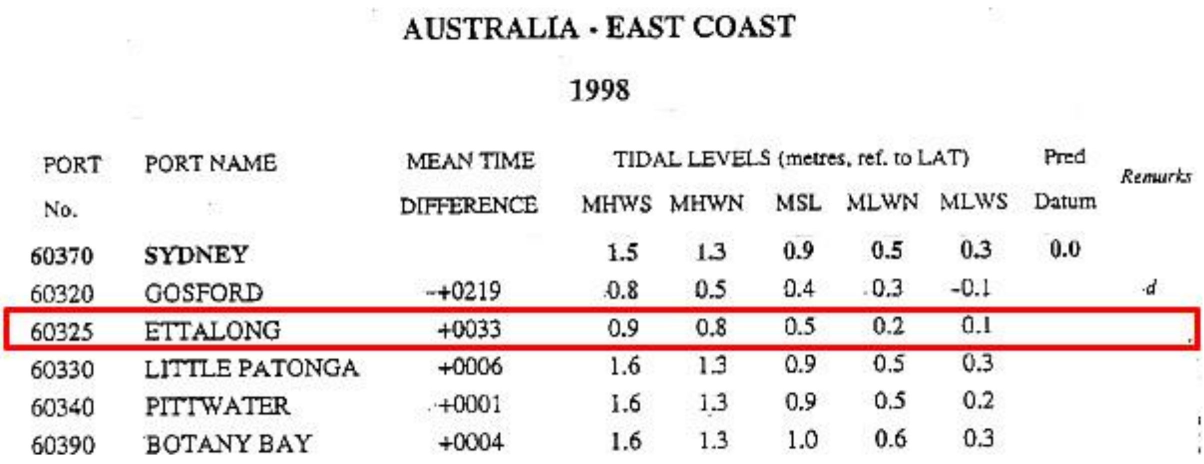
1/2/98 **Standard** Port Data Portland	(1) Time UTC **HW**	**LW**	(2) Height **HW**	**LW**	(3) **MSL**	(4) Levels **MHHW**	**MLLW**	(5) Levels Range **MHHW - MLLW**
	0230	0902	0.9	0.3	0.6	1.0	0.2	1.0 - 0.2 = 0.8
	1416	2007	0.6	0.2				
(6) ± LAT correction change sign		- 0.1	+ 0.1					
(7) Predicted Height Adjusted to LAT			+1.0 +0.7	+0.4 +0.3				
(8) Predicted Height - MSL (7) - (3)			+0.4 +0.1	-0.2 -0.3				
Secondary Port Data	(9) Mean Time diff.				(10) MSL	(11) Levels **MHHW**	**MLLW**	(12) Levels Range **MHHW - MLLW**
	+0013				0.6	1.1	0.2	1.1 - 0.2 = 0.9
(14) Calculations (8)x(13)			+0.45 +0.11	-0.22 -0.34				(13) Range Ratio (12) ÷ (5) 0.9 ÷ 0.8 = 1.125
(15) To Chart Datum			none tabulated					
Secondary Port Results Port Campbell	(16) Time UTC (1)+(9)		(17)Height (10) + (14) + (15)					1.125
	0243	0915	1.05	0.38				
	1429	2020	0.71	0.26				

Figure 12.- Diurnal calculation form

Example 5.–Semi-diurnal ports:

You require the times and heights of high and low water at Ettalong for the 16th June 1998, using the *ANTT 1998.*

- First look up Ettalong in the Port Index and find its number is *60325*.
- Next look for *60325* in Part 3-*Secondary Ports* and find its Standard Port is Sydney.



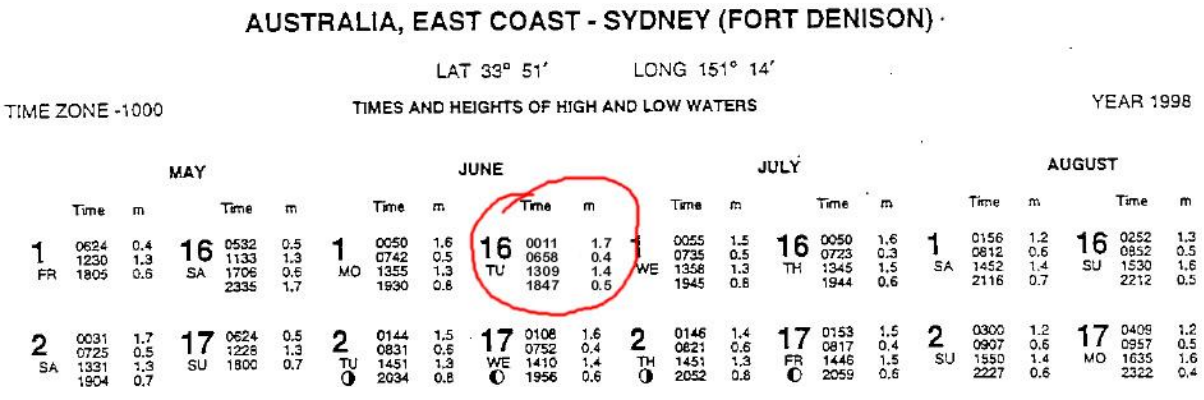
AUSTRALIA - EAST COAST

1998

PORT No.	PORT NAME	MEAN TIME DIFFERENCE	TIDAL LEVELS (metres, ref. to LAT) MHWS	MHWN	MSL	MLWN	MLWS	Pred Datum	Remarks
60370	SYDNEY		1.5	1.3	0.9	0.5	0.3	0.0	
60320	GOSFORD	+0219	0.8	0.5	0.4	0.3	-0.1		d
60325	ETTALONG	+0033	0.9	0.8	0.5	0.2	0.1		
60330	LITTLE PATONGA	+0006	1.6	1.3	0.9	0.5	0.3		
60340	PITTWATER	+0001	1.6	1.3	0.9	0.5	0.2		
60390	BOTANY BAY	+0004	1.6	1.3	1.0	0.6	0.3		

Figure 13.-Extract from ANTT Part 3-Secondary Ports

- Next look for Sydney in Part 1-*Tidal predictions for Secondary Ports* and find the times and heights of tides on 16th June 1998.



AUSTRALIA, EAST COAST - SYDNEY (FORT DENISON)

LAT 33° 51′ LONG 151° 14′

TIME ZONE -1000

TIMES AND HEIGHTS OF HIGH AND LOW WATERS

YEAR 1998

MAY						JUNE						JULY						AUGUST					
	Time	m		Time	m		Time	m		Time	m		Time	m		Time	m		Time	m		Time	m
1 FR	0624 1230 1805	0.4 1.3 0.6	16 SA	0532 1133 1706 2335	0.5 1.3 0.6 1.7	1 MO	0050 0742 1355 1930	1.6 0.5 1.3 0.8	16 TU	0011 0658 1309 1847	1.7 0.4 1.4 0.5	1 WE	0055 0735 1358 1945	1.5 0.5 1.3 0.8	16 TH	0050 0723 1345 1944	1.6 0.3 1.5 0.6	1 SA	0156 0812 1452 2116	1.2 0.6 1.4 0.7	16 SU	0252 0852 1530 2212	1.3 0.5 1.6 0.5
2 SA	0031 0725 1331 1904	1.7 0.5 1.3 0.7	17 SU	0624 1228 1800	0.5 1.3 0.7	2 TU ◑	0144 0831 1451 2034	1.5 0.6 1.3 0.8	17 WE ◐	0108 0752 1410 1956	1.6 0.4 1.4 0.6	2 TH ◑	0146 0821 1451 2052	1.4 0.6 1.3 0.8	17 FR ◐	0153 0817 1446 2059	1.5 0.4 1.5 0.6	2 SU	0300 0907 1550 2227	1.2 0.6 1.4 0.6	17 MO	0409 0957 1635 2322	1.2 0.5 1.6 0.4

Figure 14.-Extract from ANTT Part 1-Standard Ports

- Next check if it is a Diurnal or semidiurnal listed port in Table 1-*part 1 or 2*

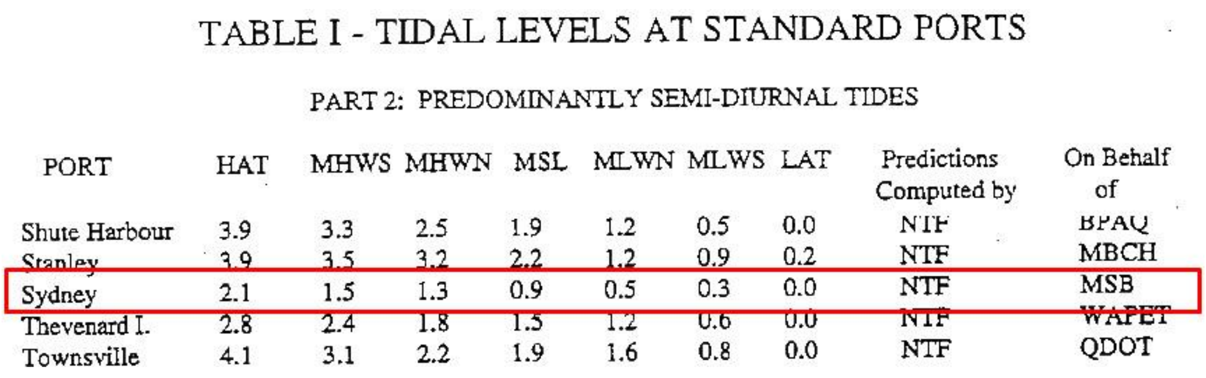


TABLE I - TIDAL LEVELS AT STANDARD PORTS

PART 2: PREDOMINANTLY SEMI-DIURNAL TIDES

PORT	HAT	MHWS	MHWN	MSL	MLWN	MLWS	LAT	Predictions Computed by	On Behalf of
Shute Harbour	3.9	3.3	2.5	1.9	1.2	0.5	0.0	NTF	BPAQ
Stanley	3.9	3.5	3.2	2.2	1.2	0.9	0.2	NTF	MBCH
Sydney	2.1	1.5	1.3	0.9	0.5	0.3	0.0	NTF	MSB
Thevenard I.	2.8	2.4	1.8	1.5	1.2	0.6	0.0	NTF	WAPET
Townsville	4.1	3.1	2.2	1.9	1.6	0.8	0.0	NTF	QDOT

Figure 15.-Extract from ANTT Table 1-Part 1-predominantly diurnal ports

Instructions to complete Semi-diurnal calculation form:

Now you can extract the above information from the ANTT to enter the Semi-diurnal calculation form (MHWS and MLWS version).

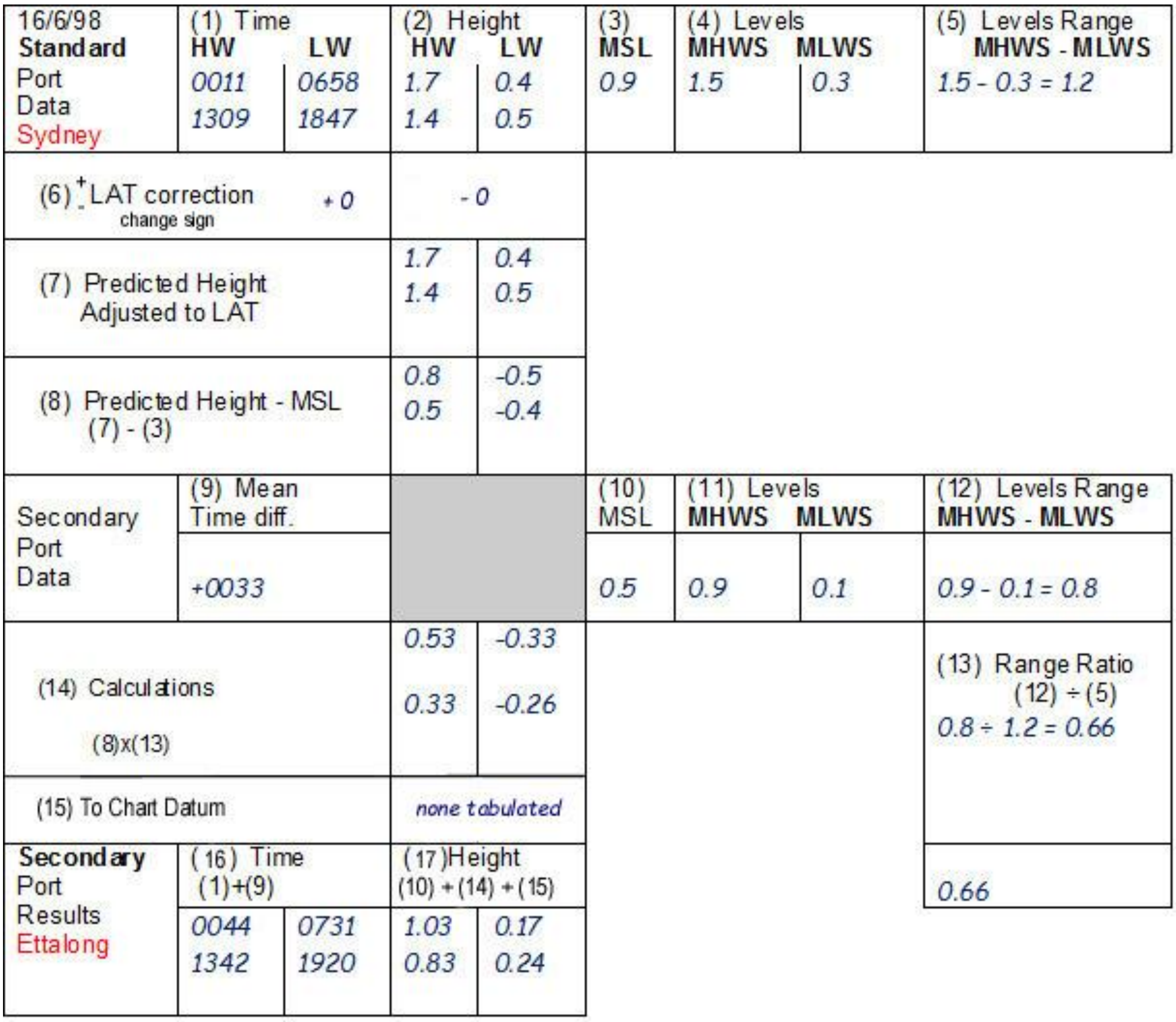
- From *Part 1* enter time and heights of HW/LW Sydney on 16th June. (Box 1 & 2)
- From *Part 3* find MSL (Box MSL) also the MHWS and MLWS (Box 4). Subtract MHWS from MLWS in (Box 5)
- From *Table 1-part 1* find LAT correction for (Box 6), reverse its sign from + or -, then arithmetically sum in (Box 7). The example given has a LAT correction of 0.
- Now subtract the MSL from heights in (Box 7) and enter results in Box 8 (Note, HW are normally positive, LW are negative) to complete the Standard port data.
- From *Part 3* (Ettalong No. *60325*) extract the mean time difference in (Box 9), the MSL (Box 10), and MHWS, MLWS (Box 11)
- Box 12 is entered with the difference between MHWS and MLWS
- Box 13 Range Ratio is found by (Box 12) ÷ (Box 5)

  0.8 ÷ 1.2 = 0.66

- Box 14 multiply the heights in (Box 8) by (Box 13)

  +0.8 x 0.66 = +0.53
  +0.5 x 0.66 = +0.33
  -0.5 x 0.66 = -0.33
  -0.4 x 0.66 = -0.26

- Box 15 corrects the few secondary ports not referenced to LAT (In Part 4 ANTT)
- Add the mean time difference (Box 9) to times in Box 1 and enter in Box 16.
- Add the values of (Box 10) to (Box 14) to (Box 15)



16/6/98 **Standard** Port Data Sydney	(1) Time **HW**	**LW**	(2) Height **HW**	**LW**	(3) **MSL**	(4) Levels **MHWS**	**MLWS**	(5) Levels Range **MHWS - MLWS**
	0011 1309	0658 1847	1.7 1.4	0.4 0.5	0.9	1.5	0.3	1.5 - 0.3 = 1.2
(6) ± LAT correction change sign		+ 0	- 0					
(7) Predicted Height Adjusted to LAT			1.7 1.4	0.4 0.5				
(8) Predicted Height - MSL (7) - (3)			0.8 0.5	-0.5 -0.4				
Secondary Port Data	(9) Mean Time diff.				(10) MSL	(11) Levels **MHWS**	**MLWS**	(12) Levels Range **MHWS - MLWS**
	+0033				0.5	0.9	0.1	0.9 - 0.1 = 0.8
(14) Calculations (8)x(13)			0.53 0.33	-0.33 -0.26				(13) Range Ratio (12) ÷ (5) 0.8 ÷ 1.2 = 0.66
(15) To Chart Datum			none tabulated					
Secondary Port Results Ettalong	(16) Time (1)+(9)		(17)Height (10) + (14) + (15)					0.66
	0044 1342	0731 1920	1.03 0.83	0.17 0.24				

Figure 16.- Semi-diurnal calculation form

The use of High and Low Water to determine Keel Clearance

First you are required to know your deepest draft. This is usually at the stern of the vessel.

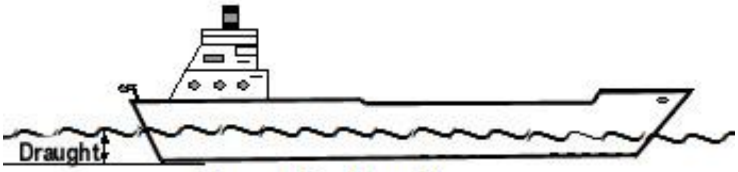


Figure 17.- Draught

Next find from the chart the soundings/drying heights. Remember these are below and above chart datum respectively.

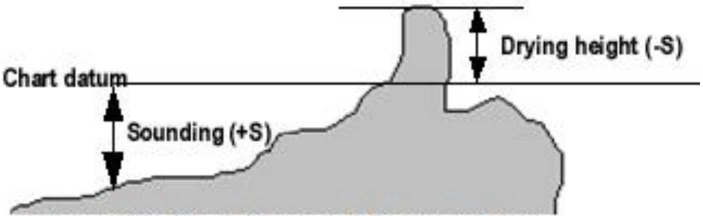


Figure 18. Soundings and Drying Heights

The datum for tides needs to be the same as the datum for soundings. In Australia the practice is to establish datum at the Lowest Astronomical Tide (L.A.T.).

Next find the heights of high and low water for the area.

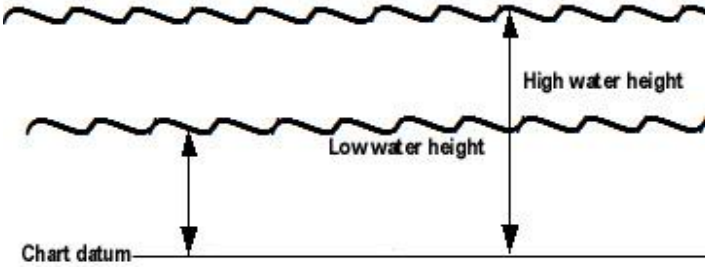


Figure 19. Height of Tides

The formula is:

Under keel = (Height of tide + Sounding) - (Vessel's Draught)

Remember that a drying height is a negative (-) sounding.

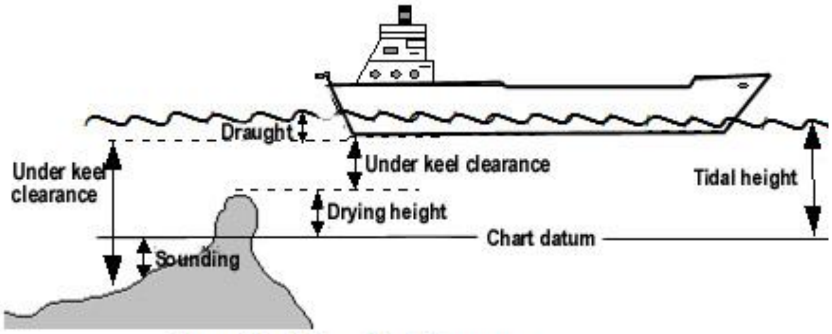


Figure 20. Under Keel Clearance

Example 6:

Consider a place in Sydney when the height of HW is 2.8m. The vessel's draught is 1.5 mtr. What is the under keel clearance over a rock of drying height 0.9 mtr?

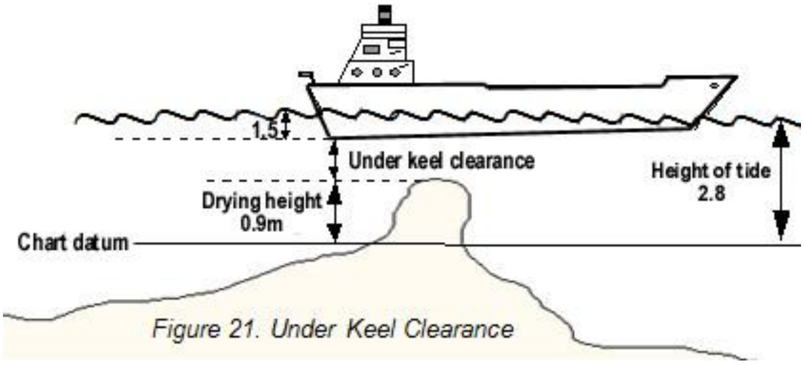


Figure 21. Under Keel Clearance

Under keel clearance = (Height of tide + Sounding) - (Draught)

(Drying height of 0.9 mtr as a negative sounding) *= (2.8 - 0.9) - (1.5)*

= 1.9 - 1.5

= 0.4m

Under keel clearance = 0.4 metres at High Water