JOHNSON PROPERTY GROUP

TRINITY POINT MARINA PROPOSAL COASTAL PROCESSES STUDY

FINAL

Issue No. 3
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Patterson Britton
& Partners Pty Ltd
consulting engineers

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EXECUTIVE SUMMARY

A development proposal is being prepared by Johnson Property Group (*JPG*) for the Trinity Point site on the south-western shore of Lake Macquarie (*refer **Figure 1***). The development proposal is currently in a conceptual stage and broadly consists of the following components:

- residential and tourism accommodation;
- a marina with wet berths;
- a combined marina/tourism village;
- foreshore jetties;
- a marine workshop;
- car parking; and
- a helipad.

The site is within the Lake Macquarie City Council Local Government Area *(LGA)*, however the proposal is to be assessed under Part 3A of the EP&A Act as a 'major project', and as such will be referred to the Department of Planning *(DoP)* for concept plan approval. The overall tourism project is currently in the conceptual development phase, and has been submitted as a 'concept plan' application under the Part 3A process.

JPG have engaged Patterson Britton & Partners (*PatBrit*) to design the marina and jetties for the Trinity Point development and provide design advice regarding the helipad. As a preliminary step in the design process, PatBrit have undertaken a coastal processes study to investigate the processes affecting the proposed site of these maritime facilities and determine design parameters for these structures. The helipad design will be dealt with in a separate report. The breakwater design will also be investigated further in another separate report. This report outlines the findings of the coastal processes study and will form part of the submission under the Part 3A process.

In conclusion, the investigation into coastal processes affecting the Trinity Point site indicates that the site is well suited to the development of maritime structures such as a marina and jetties, from a coastal processes perspective. The coastal processes study has shown that the conceptual marina design proposed is practically feasible with no required dredging to provide adequate water depths.

The marina will require a breakwater to reduce the wave climate to acceptable levels. Further investigations into the breakwater design are outlined in a separate report titled, Trinity Point Marina, Breakwater Design Study (*PatBrit, 2007*).

Swansea Channel is the limiting factor dictating the maximum vessel draught that can access the Lake from the ocean. It was determined that vessels up to 1.8m draught will be theoretically able to regularly navigate the channel, though vessels up to 2.4m draught are known (*anecdotally*) to make the passage through the channel occasionally, under ideal conditions. Further details

regarding the maximum design vessel and the berth size distribution proposed for the marina can be found in the Trinity Point Marina Berth Demand Study (*PatBrit, 2007*).

It is noted that this study has been undertaken to support the conceptual design of the proposed marina and jetties and that further investigation and detailed design are required to confirm the final layout and design of these maritime structures.

Further assessment and discussion of any potential impacts the marina development would have on the natural coastal processes and proposed mitigation measures, will be outlined within the Environmental Assessment submission to the Department of Planning.

1   INTRODUCTION

1.1   BACKGROUND

A development proposal is being prepared by Johnson Property Group (*JPG*) for the Trinity Point site on the south-western shore of Lake Macquarie (*refer **Figure 1***). The development proposal is currently in a conceptual stage and broadly consists of the following components:

- residential and tourism accommodation;
- a marina with wet berths;
- a combined marina/tourism village;
- foreshore jetties;
- a marine workshop;
- car parking; and
- a helipad.

The site is within the Lake Macquarie City Council Local Government Area *(LGA)*, however the proposal is to be assessed under Part 3A of the EP&A Act as a 'major project', and as such will be referred to the Department of Planning *(DoP)* for concept plan approval. The overall tourism project is currently in the conceptual development phase, and has been submitted as a 'concept plan' application under the Part 3A process.

JPG have engaged Patterson Britton & Partners (*PatBrit*) to design the marina and jetties for the Trinity Point development and provide design advice regarding the helipad. As a preliminary step in the design process, PatBrit have undertaken a coastal processes study to investigate the processes affecting the proposed site of these maritime facilities and determine design parameters for these structures. The helipad design will be dealt with in a separate report. The breakwater design will also be investigated further in another separate report. This report outlines the findings of the coastal processes study and will form part of the submission under the Part 3A process.

This report is structured as follows:

Section 1	Introduction including background and geographical setting.
Section 2	Previous coastal processes studies undertaken for Lake Macquarie.
Section 3	Data Acquisition, describing the data used within the report.
Section 4	Coastal Processes, providing a general discussion of tides, elevated water levels, bathymetry, flooding, wave climate, currents, and climate change issues within the Lake and at the site. Coastal processes within Swansea Channel are then discussed.
Section 5	Design Parameters and Issues for the Marina and Jetties, including establishment of design parameters such as wave climate, water depths, water levels and the maximum design vessel size.

The preliminary conceptual layout of the marina and jetties can be seen in **Figure 2**. It is noted that this layout is subject to further investigation and detailed design.

1.2   GEOGRAPHICAL SETTING

The Trinity Point site is located on the south-western shore of Lake Macquarie (*refer Figure 1*). Lake Macquarie is one of the largest coastal lakes in Eastern Australia and is located between Newcastle and Gosford on the NSW Central Coast some 125 km north of Sydney. The lake has a water surface area of approximately $110km^2$ and 170km of foreshore. The Lake extends about 22 kilometres from Cockle Bay in the north to Chain Valley Bay in the south, with a maximum width of about 10 kilometres. The lake is connected to the ocean through a narrow entrance channel located approximately midway along the lake extent at Swansea. A low level bridge with an opening double lifting span crosses Swansea Channel.

The lake has an average depth of around 8m. The entrance at Swansea has a minimum depth of approximately 2m. The lake is a major resource for water based recreation in the Lower Hunter region, as well as catering for a large influx of holiday makers particularly during the summer season. The Lake is also becoming a very popular 'sea change' retirement destination for people from Sydney.

The proposed concept site of the marina and jetties is in on the southern shore of Bardens Bay. The proposed layout of the marina and jetties are shown in **Figure 2.**

2 PREVIOUS STUDIES

A number of studies have been undertaken to date looking at various aspects of the coastal processes within Lake Macquarie. These include:

1. Lake Macquarie Marina Sites Study, Public Works Department NSW, (first draft) 1986
2. Lake Macquarie Fore-and-Aft Moorings Study, Patterson Britton, 1988
3. Lake Macquarie Flood Study Part 1 – Design Lake Water Levels and Wave Climate, Report MHL682, Manly Hydraulics Lab, 1998
4. Lake Macquarie Flood Study Part 2 – Foreshore Flooding, Report MHL682, Manly Hydraulics Lab, 1998
5. Lake Macquarie Estuary Process Study, Australian Water and Coastal Studies, 1995, Report 94/25
6. Lake Macquarie Estuary and Catchment Management Study, WBM Oceanics Australia, 1996
7. Lake Macquarie Estuary Management Plan, WBM Oceanics Australia, July 1997

A brief outline of the content and findings of each of these studies is given below. These reports are further referenced in relation to specific coastal processes in **Section 3.**

Lake Macquarie Marina Sites Study, Public Works Department NSW, (first draft) 1986
Public Works Department (*PWD*) commissioned Sinclair Knight and Partners, as part of the Waterways program established in the mid 1980's, to identify potential marina sites within Lake Macquarie and Swansea Channel and to assess these sites in terms of potential for development in the short and long term.

The Trinity Point site was not identified as a potential site as it would not have satisfied one of the main assessment criteria which was that the adjacent land be available and undeveloped at that time. The study provides a physical description of the waterway outlining in general terms the coastal processes within the lake.

Lake Macquarie Fore-and Aft Moorings Study (Patterson Britton, 1988)
The Maritime Services Board of New South Wales (*MSB*) commissioned PatBrit to undertake an engineering study of the various bays used for moorings in Lake Macquarie, to assess the appropriateness of converting single buoy swing moorings to fore-and-aft moorings. This study included an assessment of the maximum wind and wave regime for each bay potentially suitable for fore-and-aft moorings as well as consideration of factors such as water depth, bottom contour, tide, flood and current conditions. Bardens Bay was not directly assessed in this study. Sugar Bay located to the north of Bardens Bay and with a similar exposure to the south-east (*fetch length of 2.9m*), was assessed and was found to have a 1 in 50 year significant wave hight of 1.04m from the south east.

In determining the wave climate within each bay, wave hindcasting methods using wind records were used. Although local wind data was available from a number of stations, a longer more reliable record was available from Sydney Airport and this data was therefore adopted. It was

noted in the study that boat wash did not play a dominant role in determining the critical wave heights at each location since most areas are not near regular ferry routes and are subjected to moderate wash from local traffic only.

Lake Macquarie Flood Study, Department of Public Works, 1998
The Lake Macquarie Flood study was prepared for Lake Macquarie Council by Manly Hydraulics Lab (*MHL*), to define flood behaviour under the current conditions at the time. The flood study was undertaken in two parts:

Part 1: Design lake water levels and wave climate, and
Part 2: Foreshore flooding

Part 1 of the study considered the tide sequence, oceanic storm conditions, catchment rainfall runoff and local wind setup to estimate design water levels in Lake Macquarie using computer based numerical models. In addition the local wind wave climate was estimated at selected locations around the foreshore of Lake Macquarie.

Part 2 involved combining the design water levels and wind wave climates estimated in Part 1 to estimate the design flood levels at selected foreshore locations. This included assessment of the local site conditions such as bathymetry and foreshore structures.

Lake Macquarie Estuary Process Study, Australian Water and Coastal Studies, 1995, Report 94/25
The aim of the study was to synthesise existing information on Lake Macquarie and establish the baseline conditions of the various processes and their interactions to enable the preparation of an Estuary Management Study.

Estuarine hydraulics and sediment transport characteristics were analysed using RMA models.

Lake Macquarie Estuary and Catchment Management Study, WBM, 1996
This study assessed potential management strategies to address issues of water quality, ecology, fisheries and foreshore erosion and public amenity based on the findings of the Estuary Process Study (*AWACS, 1995*).

3 DATA ACQUISITION

3.1 WIND DATA

Wind rose records are available for Nobby's Head, Norah Head, Williamtown Airbase and other local stations near Newcastle (*refer **Figure 1***). Long term records in the correct format, from which directional probability of exceedance distributions can be calculated, however, are only available for Williamtown Airbase and Sydney Airport. As a longer more reliable record is available from Sydney Airport the appropriateness of adopting Sydney data for Lake Macquarie was investigated.

Continuous recording of wind data began at Williamtown Airbase in 1988, so datasets from 1988 to 2006 were obtained from the Bureau of Meteorology for Sydney and Williamtown airports. **Tables A.1** and **A.2** in **Appendix A** show the direction-speed exceedance data for Sydney and Williamtown respectively.

A comparative assessment of this data was undertaken to determine the appropriateness of using Sydney airport data for Lake Macquarie. The data comprised recordings of half hourly wind speeds and directions. Probability of exceedance plots were developed for the average wind direction and the north-east to south-eastern quadrant (*to which the Trinity Point site is exposed*), to compare the Williamtown and Sydney data. These plots are attached in **Appendix A**. The comparative probability of exceedance plot for average wind direction indicates that Sydney and Williamtown wind conditions are generally very similar with Sydney values tending to be on the high side. The comparative probability of exceedance plots for winds emanating from the north-east to south-eastern quadrant again show that the two locations are very similar with Sydney tending to be on the high side for the north-easterly winds.

Based on the general consistency in the wind conditions at Sydney Airport and Williamtown Airbase over the eighteen year period from 1988 to 2006, it was deemed appropriate to adopt the Sydney Airport data for the study area. The longer record available from Sydney Airport (*dating back to 1939*) would result in more reliable predictions of severe events.

The adopted wind speeds for use in wave hindcasting and other design issues are as set out in **Table 3.1** below.

Table 3-1: Adopted wind speeds for use in wave hindcasting, V (m/s)

Direction	V, 10min wind speed, at 10m elevation (m/s)		
	1 year ARI	20 year ARI	50 year ARI
N	14.72	21.15	23.11
NE	18.09	23.22	24.85
E	15.48	21.91	23.87
SE	18.10	25.00	27.10
S	21.04	27.69	29.65

3.2   HYDROGRAPHIC DATA

A localised hydrographic survey was undertaken on 22 November 2006 by Hydrographic Surveys Pty Ltd, extending some 250m seaward from the shore of the Trinity Point site. The survey was undertaken to a 0.1m vertical accuracy. The hydrographic survey is attached in **Appendix B.**

3.3   TIDAL DATA

Tidal data was obtained from the Department of Commerce, Manly Hydrographics Lab (*MHL*) for local tide gauge stations at Marmong Point, Belmont and Swansea (*refer **Figure 1***). The data comprised annual average tidal plane information from 1986 to 2005.

4   COASTAL PROCESSES

4.1   SUMMARY OF COASTAL PROCESSES

Coastal processes affecting the Trinity Point Marina site and Lake Macquarie generally, are detailed below in **Section 4.2**. The following coastal processes are covered:

- tides;
- bathymetry and bottom sediments;
- elevated still water levels;
- wave climate;
- currents and water circulation;
- sediment transport and foreshore stability; and
- climate change.

In summary, the findings were as follows:

- there is limited tidal range at the site (*approximately 0.2m*) with an estimated average mean sea level of approximately 0.05m AHD;
- the bathymetry of the site is suitable to accommodate the marina development with depths varying from 0m AHD to 5.8m AHD over the footprint of the proposed marina layout;
- the bottom sediments are muddy sand;
- the elevated still water levels at the site, for a 1 year AEP and a 100 year AEP are 0.4m AHD and 1.4m AHD respectively;
- the maximum significant wave heights and peak wave periods at the site for a 50 year ARI determined using hindcasting methods from Shore Protection Manual (*CERC, 1984*) were 1.3m and 3.6s respectively emanating from a bearing of 158 degrees;
- currents at the site are likely to be shore-parallel and dominantly generated by wind rather than tide or other effects;
- some longshore transport (*from south-east to north-west*) of shoreline sediment occurs along the marina foreshore though the rate is likely to be very low and the foreshore is considered to be generally stable; and
- an estimate of sea level rise within Lake Macquarie of 0.2m by 2050, and 0.5m by 2100 as a result of climate change, was adopted.

Section 4.3 then outlines the coastal processes occurring within Swansea Channel. In summary, the findings were as follows:

- the channel is a very dynamic sediment transport environment;
- tidal levels vary along the length of the channel with a tidal range of approximately 1.7m at the entrance, decreasing to 1.3m at Swansea Bridge and decreasing further to less than 0.2m beyond Coon Point at the western extent of the channel (*refer **Figure 3***);
- depths in the channel are generally 2m to 3m below Indian Spring Low Water (*ISLW*) though shoaling can reduce depths and dredging is relied upon to maintain navigability of the channel;

- the significant wave height at Mats Point (*downstream of the bridge*) is 0.9m for a 20 year ARI event and waves from greater return interval events would not be significantly larger due to depth limiting effects;
- the wave climate upstream of Swansea Bridge is dominated by wind generated waves; and
- flood tide flows have higher velocities than ebb tide flows contributing to the net upstream transport of sediment.

4.2   COASTAL PROCESSES AT TRINITY POINT MARINA SITE

4.2.1   Tides

Swansea Channel, the ocean inlet to the lake, while only some 4km long, is narrow and shallow, thereby constricting conveyance of astronomical tide[1] into the lake, resulting in relatively small tidal variation in the lake. The tidal range therefore reduces significantly from the ocean entrance of the Swansea Channel to the main body of the Lake. Broadly speaking, the tidal range varies from approximately 1.7m at the breakwater, to 1.3m at Swansea Bridge, and reduces to less than 0.2m beyond Coon Point at the western extent of the channel (*refer **Figure 3***).

The characteristics of the tidal hydraulics of Lake Macquarie were described in the Lake Macquarie Estuary Process Study (*AWACS, 1995*) from a review of past field data acquisition programmes and from a numerical model. In this study it was found that maximum spring tidal ranges within the lake typically reached about 0.2m. Of further interest, however, the study identified that there are some lower frequency oscillations (*approximately fortnightly*) of the Lakes water surface elevation of about 0.1 to 0.2m. Harmonic analysis of long term Lake tidal records collected at Marmong Point (*refer **Figure 1***) predict a bi-monthly signature in the Lake tidal oscillations having an amplitude of about 0.046m associated with a period of about 14 days. At this time certain constituents (*MSF and MF*) are seen to have a combined amplitude larger than that for the ocean tidal gauge at Fort Denison (*0.028m*). This is due to a tidal pumping effect which occurs over periods of maximum spring tidal ranges.

Tidal plane data was obtained from MHL for Marmong Point and Belmont for the period from 1986 to 2005 for this study. **Table 4.1** provides the average for each tidal plane for Marmong Point. Given the variation in the tidal levels on the Lake it can be misleading to discuss average levels. For this reason, an envelope or range within which this tidal level has varied over the last 19 years is therefore also given. **Table 4.2** similarly provides average tidal planes and the range for each tidal plane for Belmont.

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[1] Astronomical tide is the regular rise and fall of sea level in response to the gravitational attraction of the sun, moon and planets, and the rotational effect due to the spin of the earth on its axis. Tides along the NSW coastline are semi-diurnal, with high and low water approximately equally spaced in time and occurring twice daily (that is, on average, there are two high tides and two low tides in any 24 hour period). There is also significant diurnal inequality in NSW coast tides, a difference in height of the two high waters or the two low waters of each tidal day.

Table 4-1: Tidal plane data for Marmong Point

Tidal planes	Average Level (mm AHD)	Range of levels recorded between 1986-2005	
		Min. (mm AHD)	Max. (mm AHD)
Higher high water summer solstice (H.H.W.S.S.)	162	75	245
Mean high water springs (M.H.W.S.)	107	27	184
Mean high water (M.H.W.)	99	19	174
Mean high water Neaps (M.H.W.N.)	90	12	165
Mean Sea Level (M.S.L.)	56	-18	128
Mean low water neaps (M.L.W.N.)	22	-48	91
Mean low water (M.L.W.)	13	-55	82
Mean low water springs (M.L.W.S.)	5	-62	72
Indian spring low water (I.S.L.W)	-34	-97	29

Source: MHL

Table 4-2: Tidal plane data for Belmont

Tidal planes	Average Level (mm AHD)	Range of levels recorded between 1986-2005	
		Min. (mm AHD)	Max. (mm AHD)
Higher high water summer solstice (H.H.W.S.S.)	143	84	216
Mean high water springs (M.H.W.S.)	88	36	156
Mean high water (M.H.W.)	80	29	146
Mean high water Neaps (M.H.W.N.)	72	23	137
Mean Sea Level (M.S.L.)	38	-7	100
Mean low water neaps (M.L.W.N.)	4	-38	63
Mean low water (M.L.W.)	-4	-46	54
Mean low water springs (M.L.W.S.)	-12	-54	45
Indian spring low water (I.S.L.W)	-51	-92	2

Source: MHL

It can be seen that the minimum values for each tidal plane for Belmont are approximately 10mm higher than those for Marmong Point and the maximum values are approximately 30mm higher, which is to be expected given that Belmont is significantly closer to the channel than Marmong Point. Whilst this slight variation is evident it can also be seen that the tidal levels do not vary significantly between these two locations. Anecdotally, it is said that tidal levels do not vary significantly throughout the main body of the Lake. The Trinity Point site is a similar distance from Swansea Channel as the Marmong Point site and would therefore be expected to experience similar tidal levels.

4.2.2 Bathymetry and Bottom Sediments

Bathymetry of a waterway area would normally be described by giving seabed levels relative to Chart Datum (*or the zero tide level*) as this then indicates the minimum water depth likely to occur. As noted in **Section 4.2.1**, the tidal planes within the Lake vary, with the recorded zero tide level or ISLW (*at Marmong Point*) varying between -0.1m AHD and 0.03m AHD. It is therefore difficult to define a Chart Datum (*or zero tide*) below which to measure the seabed level. The bathymetry will therefore be described in this section relative to Australian Height Datum (*AHD*) as this is a land based datum that does not vary. The water depths at zero tide would then be between 0.1m below and 0.03m above the AHD level described.

The open areas of Lake Macquarie are generally of uniform depth at 10m to 11m below AHD. The bed slope in the embayments is generally mild, with depths ranging from 3m to 4m below AHD.

A hydrographic survey of the Trinity Point frontage was undertaken in November 2006 (*refer Appendix B*). From this survey it can be seen that the bathymetry of the seabed along the proposed frontage of the marina comprises a shallow section with depths varying from 0m to 3m below AHD over approximately 30m (*i.e. sloping at approximately 1 in 10*). Beyond this the slope flattens to approximately 1 in 40 out to depths of approximately 5.4m below AHD. The slope then flattens further with maximum depths of 5.8m below AHD at the seaward extent of the footprint of the proposed marina.

Further around to the south east, the east facing shoreline has a shallow shelf extending out some 30 to 40m with a maximum depth of 1.2m below AHD. The seabed then deepens at a slope of approximately 1 in 20 to a depth of 3.4m below AHD then flattens off to a 1 in 50 slope out to a depth of 6m, below AHD at the seaward extent of the survey, some 250m offshore.

The bathymetry and bottom sediments of Lake Macquarie have been investigated by the NSW Geological Society (*Roy & Peat, 1973; Roy & Crawford, 1984*). The shoreline deposits generally comprise muddy sands and sandy muds which thinly mantle the bedrock valley sides (*refer Figure 4*). The Lakes eastern shoreline adjacent to the ocean inlet comprises fairly clean quartzose marine sands forming a bank some 1km wide and covered with seagrasses. The Trinity Point shoreline on the western shore comprises muddy sand.

4.2.3   Elevated Still Water Levels

Elevated still water levels within Lake Macquarie are caused by a combination of the following potential factors:

- astronomical tide;
- storm surge (*barometric setup[2] and oceanic and local wind setup[3]*);
- ocean wave setup (*caused by breaking waves[4]*); and,
- catchment runoff, which is dependant on catchment rainfall and catchment conditions;

MHL modelled the lake as part of the Lake Macquarie Flood Study, Part 1 – Design Lake Water Levels and Wave Climate (*MHL, 1998*). A numerical hydrologic model was developed for the various Lake Macquarie catchment areas to estimate the runoff resulting from rainfall on the catchment. This model was calibrated using historical rainfall and flood records. A range of

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[2] Barometric setup is a localised vertical rise in the still water level due to a reduction in atmospheric pressure. The increase in water level is approximately 0.1m for each 10 hectopascal drop below normal barometric pressure of 1013 hPa (MHL, 1992). Note that hectopascals are approximately equivalent to millibars.

[3] Wind setup is the vertical rise in the still water level on the leeward side of a body of water caused by wind stresses on the surface of the water.

[4] Wave setup is defined as the superelevation of the mean water level caused by wave action alone. The phenomenon is related to the conversion of the kinetic energy of wave motion to quasi-steady potential energy. It is manifested as a decrease in water level prior to breaking, with a maximum set down at the break point; from the break point the mean water surface slopes upward to the point of intersection with the shore (Coastal Engineering Research Center, 1984).

design flood hydrographs were estimated for different storm duration rainfalls to allow a combination of events to be tested to determine the critical case.

A hydraulic numerical model was developed using RMA-2 to simulate the flooding behaviour of Lake Macquarie under various combinations of local wind, astronomical tide; storm surge; ocean wave setup; and catchment runoff. Based on the RMA-2 model results, design levels were adopted for the entire lake. In undertaking the hydraulic modelling of Lake Macquarie it was also important to develop an understanding of the Swansea Channel entrance behaviour, and to develop suitable ocean tailwater conditions, taking into account oceanic wave setup, for use in determining design lake water levels.

Table 4.3 summarises the still water levels determined from the modelling for various annual exceedance probabilities (*AEP's*). The results have been given to two decimal places for comparative purposes though the accuracy of the model would only justify one decimal place.

Table 4-3: Lake Macquarie Design Still Water Levels (m AHD)

Extreme	1% AEP	2% AEP	5% AEP	100% AEP
2.63	1.38	1.24	0.97	0.40

4.2.4   Wave Climate

The incident wave climate at the Trinity Point site is a direct consequence of the local wind climate; no ocean wave penetration occurs through the Swansea Channel into the Lake.

Using local wind data the wave climate at various locations around the foreshore of Lake Macquarie were estimated by MHL using hindcasting methods as part of the Lake Macquarie Flood Study, Part 1(*MHL, 1998*). The closest location to the Trinity Point site was on the western shore of Bardens Bay just south of the end of Lakeview Road , some 700m further into the bay than the Trinity Point marina site *(refer Figure 2)*. At this location it was determined that the maximum wave height emanated from the east-south-east, across a fetch length of 3.7 kilometres. The significant wave heights and peak wave periods determined for this locations for various average recurrence intervals (*ARI's*) are presented in **Table 4.6** below.

Table 4-4: Significant wave height and peak period hindcast for the western shore of Bardens Bay (MHL, 1998)

Approx. depth	Max fetch	Dir	20yr ARI		50yr ARI		100yr ARI	
			Hs (m)	Tp (s)	Hs (m)	Tp (s)	Hs (m)	Tp (s)
2m	3700m	ESE	0.9	2.9	1.0	3.0	1.1	3.1

As discussed in **Section 3.1**, Sydney Airport wind data has been adopted for use in wave hindcasting for the Trinity Point marina site as Sydney and Newcastle have been found to experience very similar wind conditions and the Sydney data set is longer and more reliable.

The site is exposed to winds emanating from all eastern sectors from the north through to the south. The maximum fetch length in the north eastern quadrant is 4.26km at a bearing of 80 degrees north. The maximum fetch length in the south eastern quadrant is 6.33km at a bearing of

158 degrees north. The narrow fetch and obstruction created by Black Neds Point and Bluff Point (*refer Figure 1*) have been taken into account in determining the wave height from this direction. The significant wave heights and peak wave periods were determined at the site for 1 year, 20 year and 50 year ARI's using hindcasting methods from Shore Protection Manual (*CERC, 1984*) based on Sydney wind data and are summarised in **Table 4.7** below.

Table 4-5: Significant wave height and peak wave period hindcast for the Trinity Point Marina site

Direction (degrees)	Fetch length (m)	Average Depth (m)	1 yr ARI		20yr ARI		50yr ARI	
			Hs (m)	Tp (s)	Hs (m)	Tp (s)	Hs (m)	Tp (s)
0	948	3.5	0.3	1.6	0.46	1.8	0.51	1.9
45	732	4.5	0.35	1.6	0.47	1.8	0.51	1.8
80	4260	6	0.66	2.7	0.95	3.0	1.05	3.1
90	3920	7	0.61	2.5	0.91	2.9	1.00	3.0
135	2024	6	0.60	2.3	0.88	2.6	0.96	2.7
158	6330	5	0.86	3.1	1.17	3.5	1.27	3.6
180	3000	5	0.75	2.6	1.02	2.9	1.1	3.0

4.2.5   Currents and Water Circulation

Currents can be created by the following mechanisms:

- tides;
- artificial discharging (*e.g. power station operations*);
- wind; and
- waves.

Tidal currents are strong in the Swansea entrance channel, reaching a maximum of approximately 2 m/s at the Swansea Bridge during spring tides. Tidal currents within the lake however, are reported in (*Ward, 1981*) to be less than 0.01m/s.

The Trinity Point site is not likely to be appreciably influenced by currents associated with power station operations, or fresh water discharge. These types of currents can be significant in other parts of the Lake, near the cooling water outlets. The closest power stations to Trinity Point are located at Eraring to the north and Vales Point on the southern shore of the Lake.

Longshore currents at the shoreline are generated by wave breaking at an angle to the shoreline. Longshore sediment transport is discussed further in **Section 4.2.6.**

There is no field data specifically available for Lake Macquarie relating winds to currents. A water surface current of 2% to 3% of the wind velocity is typically adopted as an upper limit estimate for open water (*CERC, 2002*). It is noted though that, where lengths of open water are limited, (*e.g. in harbours or lakes*) it is likely that the resulting current velocity will be less than this magnitude. Therefore adopting 2% as a upper estimate (*noting that this is likely to be highly conservative*), and based on the wind speeds presented in **Table 3.1**, the wind induced surface currents at the site would generally be less than 0.5m/s. Wind generated currents would therefore

dominate tidal currents. Wind currents are likely to create a circulating current within Bardens Bay with the direction dependant on the prevailing wind direction. The dominant current or circulation flow affecting the marina area would therefore generally be shore-parallel.

4.2.6   Sediment Transport and Foreshore Stability

The marina and jetty foreshores described within this section are shown in **Figure 2**.

The marina foreshore comprises a narrow beach of approximately 1m width backed by a low embankment and a relatively flat grass berm. The foreshore is lined with a number of large casuarina trees. Surface sediments along the marina foreshore comprises fine to medium sand with evidence of shells, pebbles and silts. Much of the beach is often covered with dried seagrass. The narrow beach shows little evidence of an erosion escarpment or erosion at the base of the trees which are located on the foreshore.

The marina shoreline is only directly exposed to waves from the window between north and south-east. The fetch to the north and north-east is relatively short (*less than 1 kilometre*). The fetch from the east-north-east around to the south-east is more significant (*up to 4.3 kilometres*). These waves would approach the marina shoreline at an oblique angle and would therefore cause some degree of longshore sediment transport. Evidence of longshore transport (*from south-east to north-west*) can be seen along this frontage where sediment has built up against a fallen tree or other obstacles. A small spit formed at the western end of the marina frontage is also evidence of south-east to north-westerly longshore transport. From the available evidence the sediment transport rate appears to be low. This is likely to be the case as there is only a narrow sandy beach width and the shallow foreshore zone below this is vegetated with seagrass which effectively binds the seabed material reducing potential transport.

The jetty foreshore is oriented approximately north-south and is therefore exposed to waves emanating from all eastern sectors from north through to south. There is no evidence of a significant sediment transport trend on this shoreline. There is potential for sediment to be transport both north (*by the south-easterly waves*) or south (*by the north-easterly waves*) and it appears that this results in a relatively balanced shoreline. There is a slightly wider beach along the jetty foreshore than the marina foreshore which is a reflection of the higher degree of exposure of the jetty shoreline. The jetty foreshore also has a much wider shallow shelf extending some 30m to 40m offshore at a depth of only a metre below AHD where water depth would generally only be in the order of a metre. This shallow shelf limits wave heights reaching the shoreline providing a degree of protection to the foreshore. The seagrass vegetation within this shallow zone also reduces the potential transport by binding the seabed material.

4.2.7   Climate Change

The possibility of global climate change accelerated by increasing concentrations of greenhouse gases, the so-called Greenhouse Effect, is now widely accepted by the scientific and engineering communities. This is predicted to cause globally averaged surface air temperatures and sea levels to rise. Water level gauge data indicates that the global average sea level rose between 0.1 and 0.2m during the 20th century. The latest Intergovernmental Panel on Climate Change (IPCC) estimates of the future globally averaged sea level rise are 0.09 to 0.88m between 1990 and 2100,

with a central value of 0.48m. This eustatic sea level rise is primarily due to thermal expansion of the ocean and loss of mass from glaciers and ice caps caused by global warming (*IPCC, 2001a*)[5].

The global average sea level rises predicted by the IPCC between 1990 and 2100 are shown in **Figure 5**. The different curves displayed represent six illustrative emission scenarios (*covering a wide range of the main demographic, economic and technological driving forces of future greenhouse gas and sulphur emissions*), assumed in the Atmosphere-Ocean General Circulation Models (*AOGCMs*) used to develop the sea level estimates. Note that global average temperature and sea level are projected to rise under all emission scenarios.
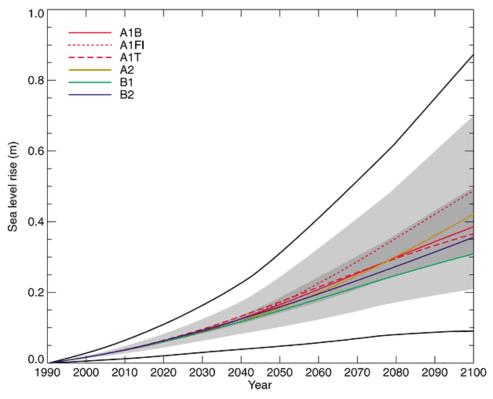
Figure 5:   Global average sea level rise predicted due to climate change from 1990 to 2100, based on various emission scenarios (IPCC, 2001b)

Based on IPCC (*2001b*), a brief summary of the inherent assumptions governing the six emission scenarios shown in **Figure 5** is given below:

- A1B – very rapid economic growth, global population that peaks in mid-century and declines thereafter, the rapid introduction of new and more efficient technologies, with substantial reduction in regional differences in per capita income, with a *balance* of fossil intensive and non-fossil energy sources; it produced the 3rd highest sea level rises at 2100.

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[5] The term "eustatic" implies a change in sea level due to alteration to the volume of the world ocean. Relative sea level change can also be caused by vertical land movements. Relative sea level rise occurs where there is a net increase in the level of the ocean relative to local land movements. Climate modellers largely concentrate on estimating eustatic sea-level change. Impact researchers focus on relative sea-level change (IPCC, 2001c).

- A1F1 – as above, but with an emphasis on *fossil intensive* energy sources; it produced the highest sea level rises at 2100.
- A1T – as above, but with an emphasis on *non-fossil* energy sources; it produced the 4th highest sea level rises at 2100.
- A2 – very heterogeneous world, continuously increasing population, regionally oriented economic development, and per capita economic growth and technological change more fragmented and slower than other scenarios; it produced the 2nd highest sea level rises at 2100.
- B1 – same population patterns as the A1 scenarios, but with rapid change in economic structures toward a service and information economy, with reductions in material intensity and the introduction of clean and resource efficient technologies; it produced the lowest sea level rises at 2100.

In **Figure 5**, the region in dark and light shading shows the range of the average and range respectively of AOGCMs for all 35 emission scenarios tested. The region delimited by the outermost lines shows the range of all AOGCMs and scenarios including uncertainty in land-ice changes, permafrost changes and sediment deposition. Note that this range does not allow for uncertainty relating to ice-dynamical changes in the West Antarctic ice sheet (*IPCC, 2001b*).

For the mid-range A1B scenario, the predicted sea level rise after 50 years, at the year 2054, is about 0.18m. For this scenario, the predicted sea level rise after nearly 100 years, at the year 2100, is about 0.38m. However, there is significant variability in these estimates, particularly at 2100, depending on the emission scenario selected. For example, the predicted sea level rise at 2100 for the A1F1 and A2 scenarios are about 0.49m and 0.42m respectively (*these are the highest predictions of the six illustrative emission scenarios*).

For this study, the adopted ocean sea level rise at 2050 was 0.2m, and the adopted ocean sea level rise at 2100 was 0.5m. The corresponding sea level rise within Lake Macquarie would be similar to the ocean sea level rise and has therefore been assumed to be the same. These values are consistent with the IPCC (*2001b*) predictions for the upper limit of the average of all 35 emission scenarios tested. However, it should be noted that there is considerable uncertainty regarding these predictions, and future sea level rise could be much smaller or larger than predicted, as indicated by the light shaded region in **Figure 5**.

4.2.7.1 Other Climatic Change Considerations

Another potential outcome of the Greenhouse Effect is an increase in the frequency and intensity of storm events.

Modest to moderate increases in average and maximum cyclone intensities are expected in the Australian region in a warmer world. However, cyclone frequency and intensity are strongly associated with the El Niño/Southern Oscillation (*ENSO*) phenomenon. How this phenomenon will vary in a warmer world is currently unknown (*CSIRO, 2001; CSIRO Marine Research, 2001*).

Mid latitude storms have been predicted to increase in intensity but decrease in frequency with global warming (CSIRO, 2002), due to a reduction in equator to pole temperature gradients. However as with tropical cyclones, climate modelling at present lacks the resolution to accurately predict changes associated with global warming.

If overall weather patterns change as a result of global warming, there is potential for changes in the angle of approach of the predominant wave climate (*Moratti and Lord, 2000*). Within Lake Macquarie change in the wind and local wave climate may cause realignment of the shoreline, with resulting recession and accretion.

Given the above uncertainty and difficulty in quantitative prediction, no specific account was taken of any potential changes to storm frequency and intensity, or changes in wave directions.

4.3   COASTAL PROCESSES WITHIN SWANSEA CHANNEL

The lake is connected to the Pacific Ocean via the relatively narrow Swansea Channel (*refer Figure 1*). Swansea Channel is a dynamic environment along an approximate 4km length from the entrance breakwaters to the "drop over" into the lake (*refer Figure 3*). Increased efficiency of the entrance to propagate wave and tidal energy into Swansea Channel since the entrance training works (*circa 1880*) has lead to the continual changing of bathymetry and the recession of unprotected shoreline areas in response to a resultant net upstream movement of sediments. A significant proportion of the Channel foreshore is protected by rock training walls to prevent erosion.

Depths in the Swansea Channel are generally in the range of 2 to 3 metres below ISLW, however, shoaling is a continual problem along the length of the channel and periodic dredging is required to maintain navigation depths. Swansea Channel has been the subject of maintenance dredging in one form or another for the past 60 to 70 years. Often the deepening created by dredging within the Channel is short lived and has sometimes merely transferred navigation problems to other parts of the Channel. In recent years, a shoal developed on the western side of the main northern channel, and was steadily migrating northward and eastward. Adjacent to the southern entrance to Swan Bay, the migrating shoal introduced a 'dog leg' into the main navigation path, which was a significant navigation hazard. As a short-term solution, dredging of approximately 120,000m³ of sand from the channel, immediately adjacent to the southern Swan Bay entrance, was undertaken in 2003. Sand was deposited in relic holes in Swan Bay created from over-dredging by a commercial extractor. Dredging of a further 44,000m³ was undertaken in early 2006 between Pelican Marina and the drop-over.

The entrance to Swansea Channel is exposed to ocean waves, the worst exposure being from the north-east. The entrance is controlled by two rock training walls that were first constructed in the 1880's. There are shoals across the channel entrance that can limit the depth of water to about 1.5m at low tide.

The deepwater wave height climate for Sydney (*wave height in 80m to 100m depth of water*), which is also applicable in the vicinity of the entrance to Lake Macquarie, is as follows:

Table 4-6: Deepwater wave climate offshore of Lake Macquarie Entrance

Percentage of Time Wave Height is Exceeded	Significant Deepwater Wave Height (m)
84%	1.0
23%	2.0
0.2%	5.0
0.001%	7.0

Source: NSW Department of Public Works and Services

Nearshore wave heights will differ from the deepwater wave heights due to the effects of refraction, diffraction, shoaling and depth limited breaking. Simplistically, individual waves approaching the shoreline typically break when wave heights are approximately equal to 80% of the water depth.

The propagation of ocean waves through the entrance and along Swansea Channel has been found to be controlled by depth limited breaking at the entrance and bed friction effects. Wave modelling investigations to determine the design wave conditions at Mats Point (*refer Figure 3*) have indicated that the 20 year ARI significant wave height *(H_s)* is 0.9m (*PatBrit, 2006 – final draft*). As the inshore wave climate is depth limited by the Swansea Channel Entrance, inshore wave heights at greater return intervals than the adopted design return interval of 20 years ARI will not be significantly larger than the adopted design wave.

Further wave attenuation of ocean generated waves occurs upstream of the Swansea Bridge. Wind generated waves become the dominant source as the channel becomes more estuarine in nature.

As noted in **Section 4.2.1**, tidal levels vary along the length of the channel with a tidal range of approximately 1.7m at the entrance, decreasing to 1.3m at Swansea bridge and decreasing further to less than 0.2m beyond Coon Point at the western extent of the channel (*refer Figure 3*)**.**

Tidal flows are the dominant contributor to the currents in Swansea Channel. Hydrodynamic modelling of tidal flows has indicated that flood tide flows generally have a higher velocity than ebb tide flows within Swansea Channel (*WBM, 2004*). This contributes to a net upstream transport of sediments by tidal processes alone. Flow velocities are high in the channel and concentrated at the constriction in the channel at the Swansea Bridge. Flow velocities are highest within the main navigational channel which runs on the northern side of Swansea Channel in the vicinity of the constriction point that occurs underneath the Swansea Bridge. Peak Spring flow velocities at this location are in excess of 1.5 m/s and 1.0 m/s for the flood and ebb tide respectively.

Due to the relatively narrow nature of Swansea Channel, the entrance channel acts as a constriction to flow out of Lake Macquarie resulting in elevated lake levels during floods. The extent of constriction is generally a function of the bathymetry of the Swansea Channel and the coincident ocean water level.

5 DESIGN ISSUES/PARAMETERS FOR MARINA

The marina and jetties will be designed with a 25 year design life. The following design issues are discussed in this section of the report:

- wave climate;
- water depths;
- water levels;
- design vessel; and
- other constraints.

5.1 WAVE CLIMATE

In establishing the design wave climate for the design of the maritime structures, consideration needs to be given to both the:

- functional performance (*operational conditions*); and
- structural stability/integrity (*extreme conditions*).

These considerations will therefore be dealt with separately below in **Sections 5.2.1** and **5.2.2**.

5.1.1 Design wave climate for operational conditions

The design wave climate for operational conditions is set out in AS 3962 (*2001*), Guidelines for design of marinas. The criteria for a 'good' wave climate in small craft harbours, is provided in **Table 5.1.**

Table 5-1: Criteria for 'good' wave climate in small craft harbours, AS 3962(2001)

Direction and peak period of design harbour wave	Significant wave height (Hs)	
	Wave event exceeded once in 50 years	Wave event exceeded once a year
Head seas less than 2s	Conditions not likely to occur during this event	Less than 0.3m wave height
Head seas greater than 2s	Less than 0.6m wave height	Less than 0.3m wave height
Oblique seas grater than 2s	Less than 0.4m	Less than 0.3m wave height
Beam seas less than 2s	Conditions not likely to occur during this event	Less than 0.3m wave height
Beam seas greater than 2s	Less than 0.25m wave height	Less than 0.15m wave height

AS 3962 (*2001*) also states that criteria for an 'excellent' wave climate can be determined by multiplying the wave heights in **Table 5.1** by 0.75, and for a 'moderate' wave climate by multiplying by 1.25. For vessels of less than 20m in length, the most severe wave climate should satisfy moderate conditions. For vessels larger than 20m, the wave climate may be more severe.

Derivation of the wind generated wave climate at the Trinity Point marina site is discussed in **Section 4.2.4.** The highest significant 50 year ARI wave height affecting the site is approximately 1.3m from a bearing of 158 degrees north with a peak period of approximately 3.6 seconds. This

will be the adopted design wave climate for 'head seas' based on the proposed marina layout (*refer Figure 2*). The other wave direction that will influence the design of the marina is that emanating from a bearing of 80 degrees north. The significant 50 year ARI wave height is approximately 1.0m with a peak period of approximately 3.0 seconds. As this wave will approach the vessels (*in the proposed marina layout*) beam-on it will also be critical.

The wind generated wave climate at the proposed marina site exceeds the allowable wave climate for small craft marinas. A breakwater structure is therefore required to reduce the wave transmitted into the marina area to within the criterion set out in AS 3962 (*2001*). The predicted unattenuated wave climate for Trinity Point and the criteria for a 'good' wave climate (*in accordance with AS 3962(2001)*) are summarised in **Table 5.2**.

Table 5-2: Predicted (*unattenuated*) wave climate and design wave climate at Trinity Point

Direction	1 year ARI		50 year ARI	
	Predicted Hs (m)	Design Hs (m)	Predicted Hs (m)	Design Hs (m)
Head Sea > 2s	0.92	0.3	1.3	0.6
Beam seas >2s	0.35	0.15	0.5	0.25

Breakwater protection, with a transmission coefficient of 0.33 (*i.e. 0.3/0.92*) will therefore be required to attenuate head seas (*from a bearing of 158 degrees*), and 0.43 (*i.e. 0.15/0.35*) for beam seas (*from the north to north east*). Further investigation into the breakwater design will be covered in a separate report.

5.1.2   Design wave climate for structural design

For structural considerations of the breakwater an ARI design event of 1 in 200 years is considered appropriate for the extreme condition. This design event ARI was chosen following consideration of the:

- design life *(specified as 25 years)*,
- consequences of structural failure; and hence
- acceptable risk of failure for the breakwater structure.

AS/NZS 1170.2 *(2002)* describes design site wind speeds for extreme wind events. The design site wind speeds for the region including the Trinity Point site have been used to develop hindcast extreme wave events using algorithms based on those developed in Coastal Engineering Manual *(2003)* for deep-water, fetch-limited waves.

Table 5.3 summarises design wave events from all the directional sectors that the Trinity Point site is exposed to. The configuration of breakwater structures in the design may influence which directional event is critical as the incident wave direction influences the forces applied to structures.

Table 5-3: 200 year ARI wave parameters

Direction (degrees)	Fetch length (m)	Average Depth (m)	200yr ARI	
			H_s (m)	T_p (s)
0	948	3.5	0.50	2.5
45	732	4.5	0.40	2.3
80	4260	6.0	1.00	3.6
90	3920	7.0	0.90	3.6
135	2024	6.0	0.90	3.2
158	6330	5.0	1.45	4.1
180	3000	5.0	1.00	3.5

In the analysis of structures for marinas, different design wave heights from the design wave spectrum should be considered for different applications, or expected failure modes. For failure due to fatigue or cyclical loading H_s should be design wave adopted. In the case of sudden failure or single wave loading a larger representative wave should be adopted *(e.g. H_1 or H_{max})*.

5.2   WATER DEPTHS AT MARINA SITE

Water depth requirements for marina berths and accessways are set out it AS 3962 (*2001*), Guidelines for Design of Marinas. The required depth for entrance channels to the marina is a combination of the following:

- vessel draught;
- half of the 50 year ARI significant wave height;
- an appropriate allowance for siltation;
- an under-keel clearance of at least 0.3m or 10% of the vessel draught (*whichever is greater*) where the seabed is soft material, or 500mm where the seabed is hard material.

Table 5.4 summarises the minimum water depth requirements for various vessel types and sizes based on:

- a 50 year ARI significant wave height of 0.6m (*the maximum design wave height permitted in the marina – refer **Section 5.1***);
- an allowance of 0.3m for siltation; and
- 0.3m clearance to the soft seabed.

Table 5-4: Minimum water depth requirements for entrance channels to the marina

Boat Length (m)	Vessel draught (m)*		Water depth requirement (m)**	
	Power boats	Yachts	Power boats	Yachts
8	1.2	1.8	2.1	2.7
10	1.3	2.1	2.2	3.0
12	1.4	2.4	2.3	3.3
15	1.5	2.5	2.4	3.4
20	2.0	2.8	2.9	3.7
25	2.5	3.0	3.4	3.9

* based on figures given in Guidance Note 8.3.02 (2002) by Waterways Authority (now NSW Maritime).

** based on a 50 year ARI significant wave height of 0.6m, an allowance of 0.3m for siltation and 0.3m clearance to the soft seabed.

Interior channels and fairways have the same depth requirements as the entrance channel except that the allowance for waves and siltation may be reduced. Depth requirements within the berths may be similarly reduced, ensuring that the deepest draught boat likely to use the berth does not touch bottom at low tide.

From **Table 5.4** it is evident that vessels can be berthed in depths starting from 2.1m (*suitable for 8m power vessels*). The bathymetry of the site is such that a gangway structure would be required to span across the shallow foreshore to the most landward floating berths in adequate water depths. As noted in **Section 4.2.2** the foreshore seabed slopes away at approximately 1 in 10 to a 3m depth, then a more gentle seabed slope extends out to depths of approximately 5.8m at the seaward extent of the marina footprint. There is therefore adequate area with depth ranging from 2.1m to 5.8m, without dredging, to accommodate a variety of power and sail craft ranging in size from 8m to 20m with the smaller vessels positioned in the inner berths and the larger vessel in the deeper outer berths.

5.3   WATER LEVELS

Water levels at the site will affect the design deck level of any fixed structures such as the jetties and the breakwater. Consideration of normal tidal levels as well as elevated water levels during storm events is required in adopting a design deck level for fixed structures.

Tidal plane data for Marmong Point was summarised in **Table 4.1** in **Section 4.2.1**.

In **Section 4.2.3**, the elevated water levels resulting from a combination of astronomical tides, storm surge (*barometric setup and wind setup*), ocean wave setup and catchment runoff were established for Lake Macquarie. These were summarised in **Table 4.3.**

Based on these tidal and extreme water level conditions it is proposed that deck levels for the jetties be set at 1.0m AHD. This level is considered to be an appropriate balance between having a sufficiently elevated deck to avoid regular submersion, without being visually inappropriate or unusable. A deck level of 1.0m AHD would generally be in the order of 1m above the mean lake water level and would become submerged in events more severe than a 1 in 20 year (*or 5% AEP*) event. It is noted that many other jetties around the Lake have deck levels at around 0.8m AHD, which are more frequently submerged. LMCC advised that Lake Macquarie jetties range from 0.65AHD to 1.3AHD. Decks would also be subject to wave activity causing overtopping in less extreme events.

The deck level of the breakwaters will be assessed further in the breakwater design investigation report to ensure that the breakwaters will provide appropriate wave attenuation.

5.4   DESIGN VESSEL

5.4.1   Navigability of Swansea Channel Entrance

A physical description of Swansea Channel is provided in **Section 4.3**. The navigability of the Channel will have a direct impact on the size of vessel able to regularly access the Trinity Point Marina from the ocean. As discussed in **Section 4.3**, Swansea Channel is a very dynamic sediment transport environment with regularly changing bathymetric characteristics. The navigability of the channel is dictated to a large degree by dredging activities. At present there is debate as to whose responsibility the dredging of the channel is. There are a number of local and state government agencies involved in the Channel including:

- Lake Macquarie City Council (*LMCC),* the Local Government Authority;
- Department of Natural Resources (*DNR*);
- Department of Lands (*LANDS*), responsible for management of the seabed as it is Crown Land;
- NSW Maritime, responsible for navigation; and
- Roads and Traffic Authority (*RTA*), responsible for Swansea Bridge.

The Lake Macquarie improvement project completed in 2006 was a \$1.5 million job to dredge 44,000m³ of sand from the channel to improve navigation. The project was paid for by LMCC and the State Government. It is yet to be resolved, however, who is going to take over the funding of future dredging activities. The Boat Owners Association of NSW would like to see a 'trigger' level established, at which dredging would be undertaken automatically.

Until this political issue is resolved it is considered appropriate to assume conservative water depths for the purposes of determining the maximum size vessel that can regularly enter the Lake through the Channel. The two critical locations for water depth are the bar or the 'coal-seam' at the ocean entrance to the channel and the 'drop-over' (*the transition from the relative shallows of the Channel to the main Lake, occurring at the western extent of the Channel, refer* **Figure 3**). The available water depths at these two locations is determined below to establish the maximum vessel draught that can regularly be accommodated in the Swansea Channel.

Based on the NSW Maritime hydrographic survey of Swansea Heads (*May, 2006 -refer* **Appendix C**), the minimum water depth at the entrance bar was 1.8m (*below zero tide*) at this time. This depth occurs just upstream of the cross-over leads (*where the orientation of the channel changes*). The calculated tidal planes at Swansea entrance (*from the Australian National Tide Tables, 2006*) are given below.

Table 5-5: Calculated tidal planes at Swansea entrance (Australian National Tide Tables, 2006)

Tidal plane	Water level (m chart datum)
Highest astronomical tide (HAT)	1.7
Mean high water springs (M.H.W.S.)	1.3
Mean high water Neaps (M.H.W.N.)	1.1
Mean Sea Level (M.S.L.)	0.8
Mean low water neaps (M.L.W.N.)	0.4
Mean low water springs (M.L.W.S.)	0.2
Indian spring low water (I.S.L.W)	0.0

It is considered reasonable to assume that large vessels would enter the channel at MHWN or higher water levels. The minimum water depth would therefore be 2.9m (*ie. 1.8m + 1.1m*).

The minimum water depth at the 'drop-over' and approaches, based on the NSW Maritime Hydrographic Survey of Swansea Channel (*October 2006 – refer **Appendix C***), was 2.4m at zero tide. The mean tidal range at Swan Bay , near the 'drop-over' is noted on this survey to be 0.2m with MSL at 0.08m. Again, assuming that large vessels would enter the channel at mean high tide or above the minimum water depth at the 'drop-over' would be 2.6m (*ie. 2.4m + 0.08 +0.1m*).

Based on a minimum depth of 2.9m at the entrance bar and 2.6m at the 'drop-over', the maximum vessel draught that can be accommodated at each of these locations has been determined below.

As described in **Section 5.3**, the required water depth at a marina entrance channel, as set out in AS 3962-2001, is a combination of the following:

- vessel draught;
- half the 50 year ARI significant wave height;
- an appropriate allowance for siltation;
- an under-keel clearance of at least 0.3m or 10% of the vessel draught (*whichever is greater*) where the seabed is soft material, or 500mm where the seabed is hard material.

For short term, temporary passage through the channel, a few exceptions to these criteria are deemed reasonable. The under keel clearance (*for soft seabed material*) has been reduced from 0.3 to 0.2m and due to the limited depths available in the channel it is acknowledged that large vessels would navigate the channel when the wave climate was more moderate than a 50 year ARI event. Given the dynamic nature of the channel and the unresolved dredging issues, the siltation allowance will be kept at 0.3m.

Based on wave modelling analysis of Newcastle Harbour entrance which has a similar configuration to Swansea Channel and is exposed to the same offshore wave climate, the 50% probability of exceedance significant wave height, Hs at the entrance was found to be 0.7m, with a corresponding peak period of approximately 9 seconds. The 50% probability of exceedance significant wave height is considered reasonable to allow for regular passage through the channel. As Swansea Channel is significantly shallower than the Newcastle entrance, an Hs of 1.0m (*to account for some shoaling*) is considered reasonable for determining the maximum vessel draught Therefore, based on a wave height of 1.0m, a clearance of 0.2m (*over the soft seabed*) and an allowance of 0.3m for siltation, the maximum draught that can be accommodated at Swansea Channel entrance is 1.9m (*ie. 2.9-1.0/2-0.2-0.3*).

At the 'drop-over', further wave attenuation is expected with wave heights from ocean generated waves upstream of the Swansea Bridge reducing markedly. Wind generated waves become the dominant source as the channel becomes more estuarine in nature. A significant wave height of 0.6m is therefore considered reasonable for determining the maximum vessel draught at the drop-over. Therefore based on a significant wave height of 0.6m, a clearance of 0.2m (*over the soft seabed*) and an allowance of 0.3m for siltation, the maximum draught that can be accommodated at is 1.8m (*ie. 2.6-0.6/2-0.2-0.3*). The critical vessel draught for the Swansea Channel is therefore 1.8m.

In accordance with typical vessel draughts set out in AS3962-2001 and revised in Guidance Note 8.3.02 by Waterways Authority (*now NSW Maritime*), the maximum boat length for a 1.8m draught is 18m for power vessels and 8m for yachts. The maximum size vessels that can readily pass through Swansea Channel on a regular basis are therefore 18m power vessels and 8m yachts.

This is considered to be conservative and it is noted that deeper draught vessels could navigate the channel under ideal conditions (*extreme high tides and calm wave conditions*) and may wish to do so to gain access to the Lake, with the intention of limiting future activities to the Lake itself. It is therefore suggested that a limited number of potential berths for larger vessels (*than the 8m yacht and 18m power vessel adopted*) could be accommodated in the marina if the demand is evident.

The two Swansea bridges located approximately halfway up the channel, open to allow vessels through. The bridge openings are operated by Lake Macquarie Coastal Patrol (*LMCP*). LMCP advised that the width of the opening (*at water level*) is 18m, and the width at the top of the opening is 14.3m. This is not likely to be a dictating factor in limiting vessel size entering the lake.

5.4.2   Other indications of maximum design vessel size

Other indications of an appropriate maximum design vessel for the Trinity Point Marina include:

- Existing maximum vessel size berthed in existing marinas on the Lake;
- Existing maximum vessel size moored on existing swing mooring on the Lake;
- Boat Owners Association of NSW advice;
- NSW Maritime advice; and
- Lake Macquarie Coastal Patrol advice.

These indicators are investigated and discussed in further detail in the Trinity Point Marina Berth Demand Study (*PatBrit, 2007*). In summary these indicators confirm that generally the maximum vessel draught currently navigating the channel safely is 2m with an absolute maximum draught of 2.4m getting through under optimum conditions. The 2m draught corresponds to vessel sizes of 20m for power vessels and 9m for yachts. The 2.4m draught corresponds to vessel sizes of 25m for power vessels and 12m for yachts.

5.5   OTHER CONSTRAINTS/ ISSUES

Another issue identified as potentially affecting the marina layout design is the presence of existing swing moorings within Bardens Bay. Four existing moorings are currently located on the south-western shore of the Bay directly west of the marina site (*refer **Figure 2***). The closest swing mooring is located approximately 45m from the proposed helipad pontoon location. Clearance requirements will be the subject of further investigations and discussions with NSW Maritime and a helipad consultant. The next closest mooring is some 60m from the helipad pontoon.

6 CONCLUDING REMARKS

In conclusion, the investigation into coastal processes affecting the Trinity Point site indicates that the site is well suited to the development of maritime structures such as a marina and jetties, from a coastal processes perspective. The coastal processes study has shown that the conceptual marina design proposed is practically feasible with no required dredging to provide adequate water depths.

The marina will require a breakwater to reduce the wave climate to acceptable levels. Further investigations into the breakwater design are outlined in a separate report titled, Trinity Point Marina, Breakwater Design Study (*PatBrit, 2007*).

Swansea Channel is the limiting factor dictating the maximum vessel draught that can access the Lake from the ocean. It was determined that vessels up to 1.8m draught will be theoretically able to regularly navigate the channel, though vessels up to 2.4m draught are known (*anecdotally*) to make the passage through the channel occasionally, under ideal conditions. Further details regarding the maximum design vessel and the berth size distribution proposed for the marina can be found in the Trinity Point Marina Berth Demand Study (*PatBrit, 2007*).

It is noted that this study has been undertaken to support the conceptual design of the proposed marina and jetties and that further investigation and detailed design are required to confirm the final layout and design of these maritime structures.

Further assessment and discussion of any potential impacts the marina development would have on the natural coastal processes and proposed mitigation measures, will be outlined within the Environmental Assessment submission to the Department of Planning.

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FIGURES

FIGURE 1

**Patterson Britton
& Partners Pty Ltd**

Port Stephens

Williamtown Airbase

Nobbys Head
NEWCASTLE

Lake Macquarie

Tuggerah Lake
System

Norah Head

Brisbane Waters

Broken Bay

SYDNEY

0   25   50
Kilometres

TORONTO

Marmong Point

BELMONT

Wangi Wangi

Eraring Power
Station

**LAKE
MACQUARIE**

Swansea Channel

SWANSEA

Bardens
Bay

Sugar
Bay

**Trinity Point
Marina Site**

Bluff
Point

**PACIFIC
HIGHWAY**

**SYDNEY
NEWCASTLE
EXPRESSWAY**

Black
Neds
Point

**PACIFIC
OCEAN**

Vales Point
Power Station

DOYALSON

0   2.5   5
Kilometres

SITE LOCATION PLAN

FIGURE 2

Patterson Britton & Partners Pty Ltd

Approximate foreshore
location for MHL Wave
Climate Study (MHL, 1998)

Bardens Bay

Swing Moorings

Helipad

Lakeview Road

Marina

Marina Foreshore

Jetties

Jetty Foreshore

N

```
0          200m
    1: 6000
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**CONCEPTUAL LAYOUT OF
TRINITY POINT MARINA, JETTIES AND HELIPAD**

FIGURE 3

Patterson Britton
& Partners Pty Ltd

FIGURE 4

Clean quartz sand

Muddy sand and sandy mud (<90% mud)

Mud (<10% sand)

Core Sites

Cores with radiocarbon dates on shell layers

BOTTOM SEDIMENTS AT LAKE MACQUARIE