REPORT

Gladesville Bridge Marina Development

Foreshore Geomorphology Report

Client: Gladesville Bridge Marina

Reference: PA1891-RHD-ZZ-XX-RP-Z-0003

Status: S0/P01.01

Date: 22-Oct-19

Royal HaskoningDHV
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1 Introduction

1.1 Overview

Royal HaskoningDHV (RHDHV) was commissioned by Gladesville Bridge Marina to undertake a foreshore geomorphological assessment for a proposed redevelopment of the existing marina at No. 380 Victoria Place, Drummoyne. This Geomorphology Report has been prepared as part of an Environmental Impact Statement (EIS) to accompany a Development Application (DA), lodged with Canada Bay Council under Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

The SEARs assessment (ref. SEAR 1268) received from NSW Department of Planning and Environment (dated 15/11/2018) indicated a number of items further consideration. This report addresses the following SEARs requirements:

Soil and Water

- A description of local soils, topography, drainage and landscapes;
- Benthic morphology, water flow in and around the development, flushing, and wave bounce.

This study and assessment incorporate a review of available information, including concept design plans and is informed from a detailed site inspection and historical trend analysis.

This report documents the existing geomorphology of the site and asses potential change as a result of the potential development. More detail concerning physical processes (hydrodynamics, waves, tides) is presented in a further report by MetOcean Solutions entitled Alterations and Additions to the Gladesville Bridge Marina (MetOcean, 2019). The (MetOcean, 2019) report is appended and summarised within the EIS. The two reports should be read in conjunction.

1.2 Background

The Gladesville Bridge Marina includes a water-based structure and a land-based building, which is located at 380 Victoria Place, Drummoyne within the Canada Bay Local Government Area (LGA). The site is located on the southern foreshore of the Parramatta River, to the west of the Gladesville Bridge.

The site is approximately 19,720 m^2 in area, comprising an approximate 1,740 m^2 land based component and an approximate 18,000 m^2 of lease area, which accommodates the water-based component. An aerial photo of the existing marina is shown in Figure 1-1.

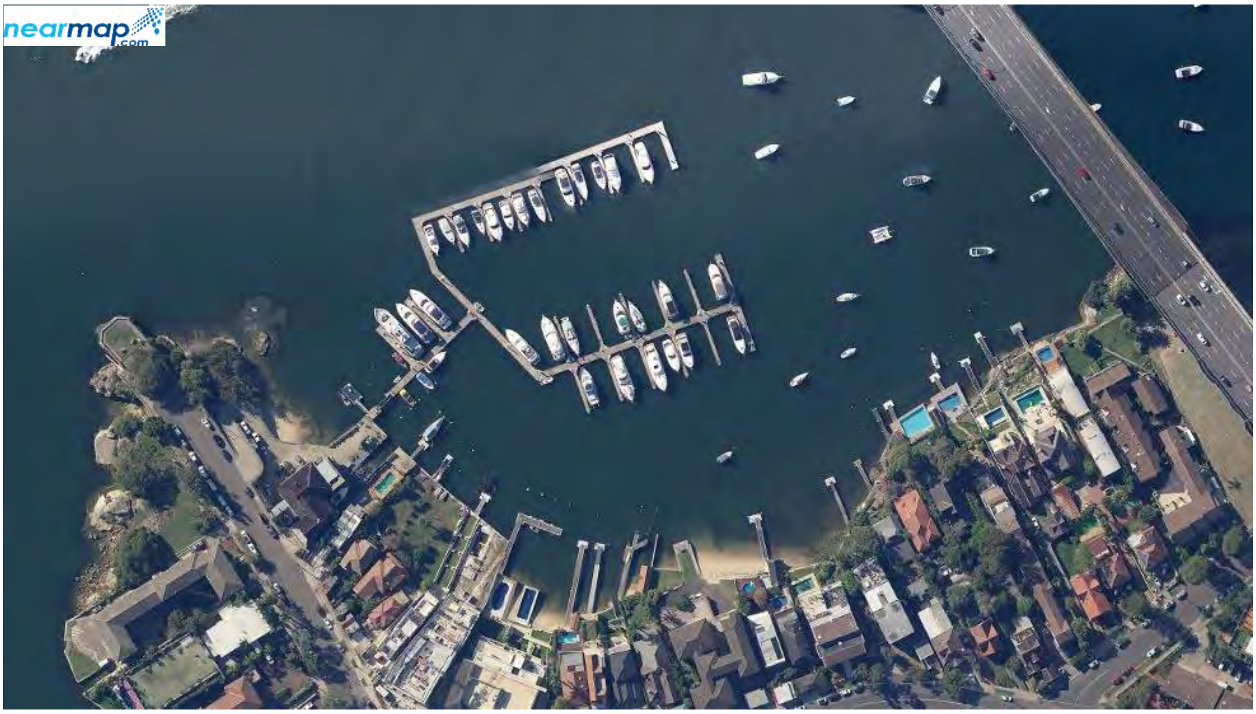

Figure 1-1. Aerial photograph of the existing marina site

The site is currently used by members of the Gladesville Boat Marina and landowners of the surrounding waterfront properties. The Parramatta River is utilised frequently by various marine users, including RiverCat, monohulled and catamaran charters, power craft, jet skis and local rowing clubs.

The proposed development constitutes alterations and additions to the marina berth layout to provide overall storage for 130 vessels comprising 15 swing moorings and 115 floating berths. The works include:

- removal of 29 existing moorings and retention of 15 existing swing moorings;
- construction of 65 new floating berth spaces of varying sizes, that increases the number of floating berths from 50 to 115;
- cessation of slipway activities;
- demolition of the slipway rails and demolition of the internal office mezzanine structure within the covered slipway area; and
- provision of 8 new valet car parking spaces within the existing slipway area.

The proposed marina layout is presented in **Appendix A**.

2 Site Description

2.1 Preamble

The site is located on the southern side of the Paramatta River, directly upstream (west) of the Gladesville Bridge. The marina is along a stretch of the river, on an inner section of Port Jackson (Sydney Harbour), that is sheltered to the west by Five Dock Point. The marina is located along the waterfront comprising private properties situated on Victoria Place and Drummoyne Avenue, Drummoyne. The location of the GBM is displayed in Figure 2-1.

Figure 2-1. Gladesville Bridge Marina site location

2.2 Topography and General Foreshore Character

The general topography of the catchment area is illustrated by the digital elevation model (DEM) presented in Figure 2-2. The DEM highlights the natural crest in the headland that continues to Five Dock Point, with an elevation of approximately 8m AHD. The properties along the north of Victoria Place and Drummoyne Avenue form the catchment that flows towards the site. The high point in the catchment is around the abutment of Gladesville Bridge, at an elevation of approximately 20m AHD (shown in red in Figure 2-2).

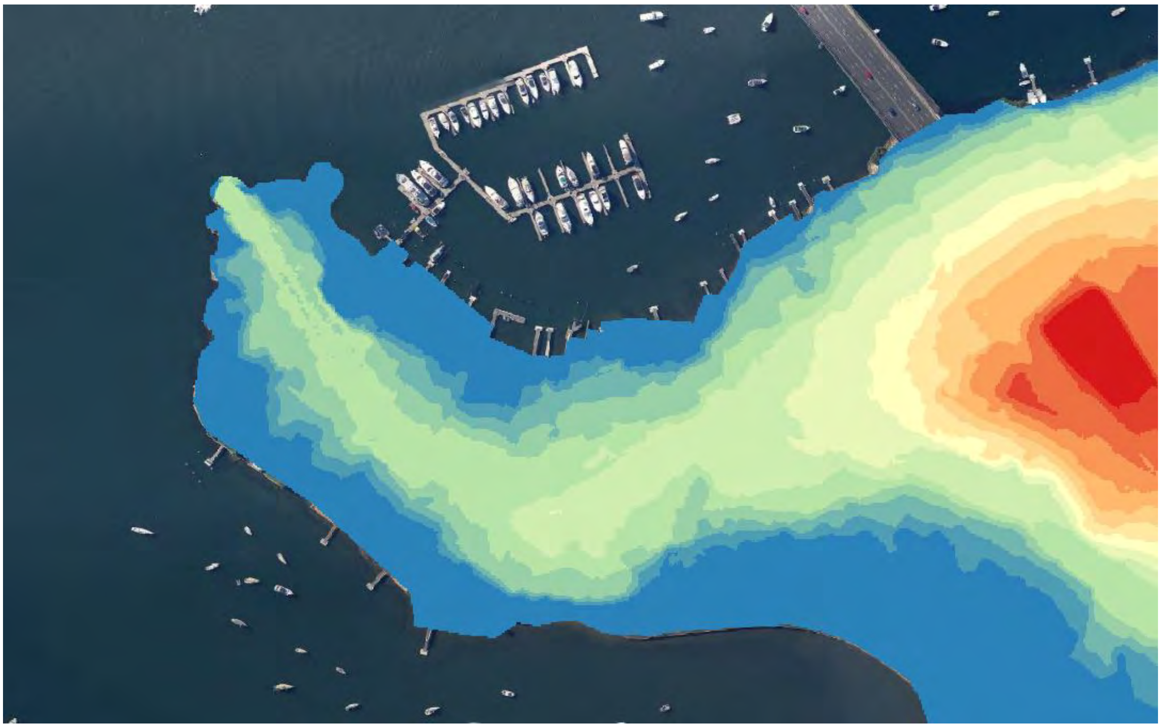

Figure 2-2. Map of Gladesville Bridge Marina with Digital Elevation Model

The foreshore directly to the north of the site comprises a sand beach overlaid on the sandstone outcrop that forms Five Dock Point, shown in Figure 2-3. This sand beach fronts the marina driveway.

The foreshore of the Victoria Place properties, to the south and east of the marina, is heavily modified from the natural form with sea walls and private jetties (see Figure 2-4). Near Gladesville Bridge, there is a sandstone rock scarp that forms the waterfront at this end of the site.

Figure 2-3. Sand beach and rock outcrop near marina driveway

Figure 2-4. Heavy modified foreshore near marina

2.3 Bathymetry

Seabed levels in the vicinity of the site are defined approximately in MetOcean Solutions report (2019) and are shown below in Figure 2-5. The seabed levels in the vicinity of the marina range from 0.0m (MSL) at the foreshore to approximately 8.0m depth below MSL, at the offshore extent of the proposed marina extension.

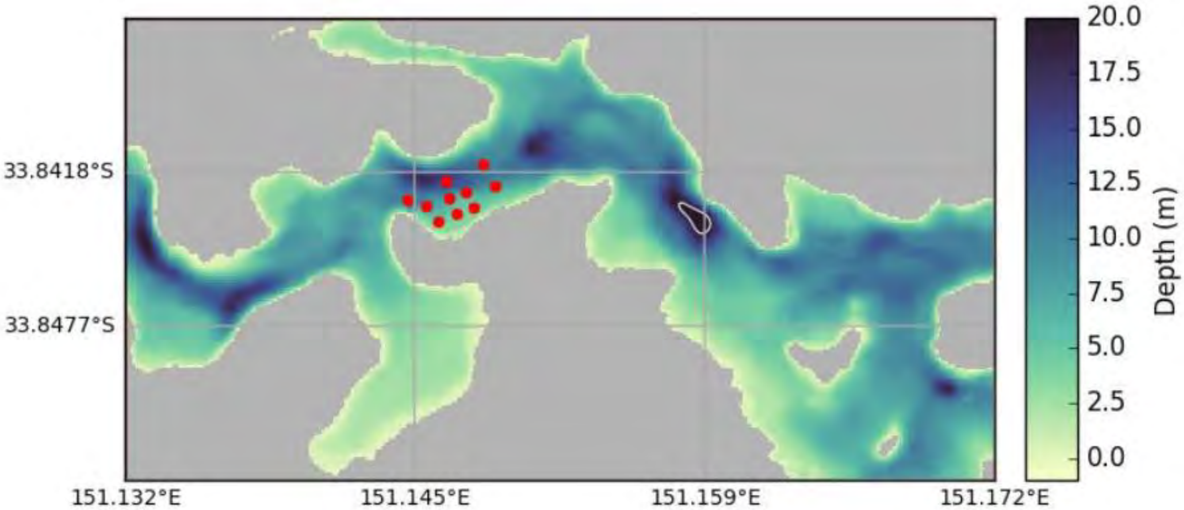

Figure 2-5. Bathymetry of site (Source: MetOcean, 2019)

3 Geology

3.1 Bedrock

Geological maps from the NSW Department of Planning's Environment Division of Resources and Energy indicate the site and surrounding area is underlain by Triassic sedimentary rocks of between 201-252 million years old, namely Hawkesbury Sandstone (see Figure 3-1). The bedrock can be classified as quartz –lithic to quartz rich sandstone with conglomerate, mudstone and siltstone, with very minor shale and laminate lenses, understood to have been deposited in a high energy braided river system.

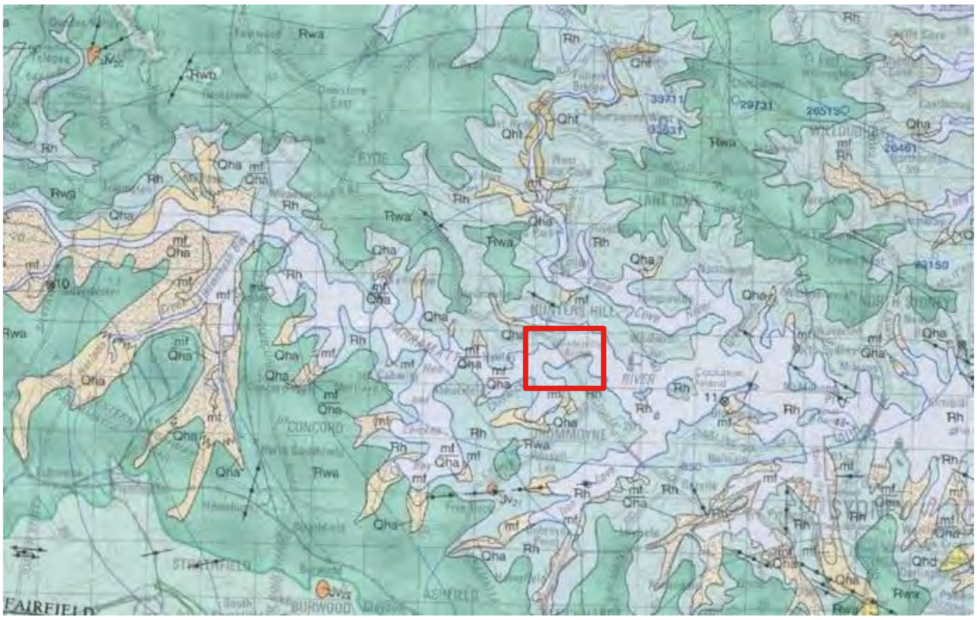

Figure 3-1. NSW Geological Maps 1:100 000 Sydney. Approximate location of the site is demarked by red box.

Observations made during site inspections, identified evidence of rocky outcrops, confirming the abovementioned site geology. The typical characteristics and location of rocky outcrops observed around the site are illustrated below in Figure 3-2. This type of bedrock is found extensively throughout the Sydney Basin and forms the escarpments and ridges visible around Sydney Harbour. Outcropping of rock is particularly evident at and adjacent (west) to the site.

Figure 3-2. Sandstone outcrops adjacent to site

3.2 Soils

The soil landscape surrounding the site (refer Figure 3-3) is defined as Lambert and is characterised by undulating to rolling rises and low hills on Hawkesbury Sandstone with local relief of 20-120m and slopes of up to 20%. Additionally, the natural vegetation adjacent to the site, specifically to the west, is characterised by open and closed-heathland, scrub and occasional low Eucalypt open-woodland.

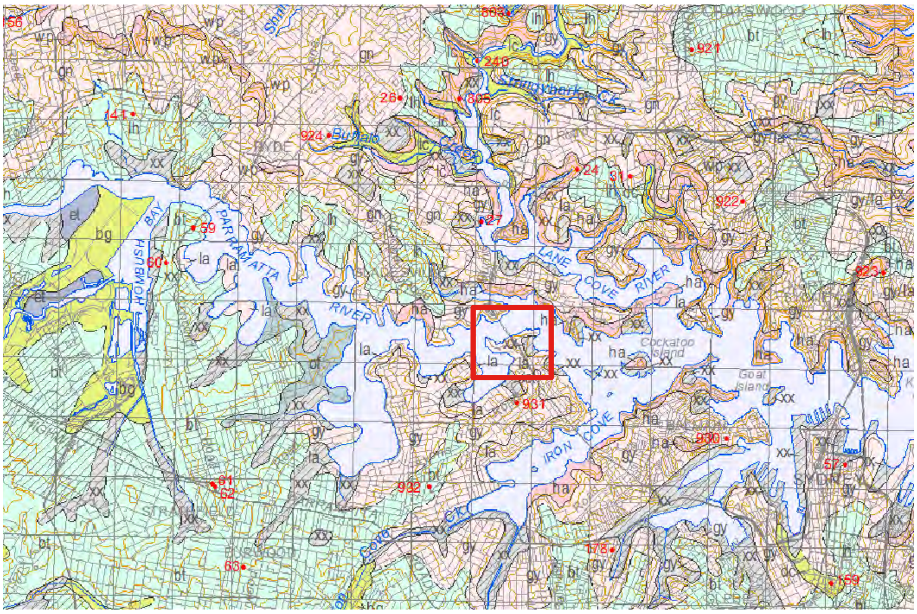

Figure 3-3. NSW Soil Landscapes Sydney 1:100 000. Approximate location of the site is demarked by red box

The soils consist of shallow, discontinuous Earthy Sands and Yellow Sands on crests and inside shallow (<20cm) benches. Siliceous Sands exist on leading edges of benches and localised Yellow Podzolic Soils are found on shale lenses. In poorly drained areas, Leached Sands, Grey Earths and Gleyed Podzolic Soils can be found. This type of soil landscape is found along the Parramatta River foreshore, exhibiting a very high soil erosion hazard, observable rock outcrops, seasonally perched water tables and shallow, highly permeable soil with very low soil fertility.

A schematic of the cross-section of the Lambert soil landscape which illustrates the occurrence and relationship of the dominant soil material is presented below in Figure 3-4.

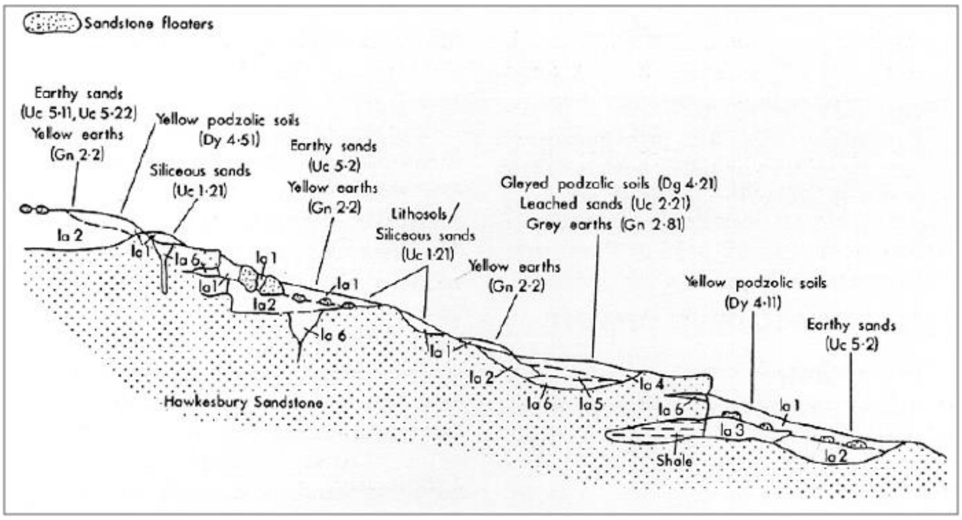

Figure 3-4. Schematic cross-section of Lambert soil landscape (source: NSW DPI)

4 Physical Processes

This assessment describes the current understanding of coastal processes within the project area based on available information and provides a reasoned qualitative assessment of the potential impacts and interaction of the project proposal with these processes.

4.1 Tides

The lower Parramatta River is subject to semi-diurnal tides (ie. two high tides and two low tides per day) that propagate along the Parramatta River from the estuary mouth at Sydney Harbour.

The predicted tides for Uhrs Point (to the west of the subject property) derived by the MSB Sydney Ports Authority in 1995 are presented below in Table 4-1. Predicted tidal planes for Uhrs Point (MSB, 1995). High and low tides at Uhrs Point were reported to lag the corresponding high and low tides at Fort Denison by approximately 12.5 and 9.7 minutes respectively. In place of accurate tide measurements at Gladesville Bridge, the lag times for Uhrs Point can be observed as upper limits for the site.

Table 4-1. Predicted tidal planes for Uhrs Point (MSB, 1995)

Tidal Plane	Water Level (m CD)	Water Level (m AHD)
Highest Astronomical Tide (HAT)	2.1 (Fort Denison)	1.18
Mean High Water Springs (MHWS)	1.60	0.68
Mean High Water (MHW)	1.46	0.54
Mean High Water Neaps (MHWN)	1.34	0.42
Mean Tide Level (MTL)	0.94	0.02
Mean Low Water Neaps (MLWN)	0.48	-0.45
Mean Low Water (MLW)	0.35	-0.58
Mean Low Water Springs (MLWS)	0.23	-0.70
Lowest Astronomical Tide (LAT)	0.0 (Fort Denison)	-0.925

4.2 Wind Climate

The wind climate at the subject site was modelled by MetOcean (2019). As seen by the study's annual wind rose results in Figure 4-1, the annual predominance of winds come from the S and NE quadrants.

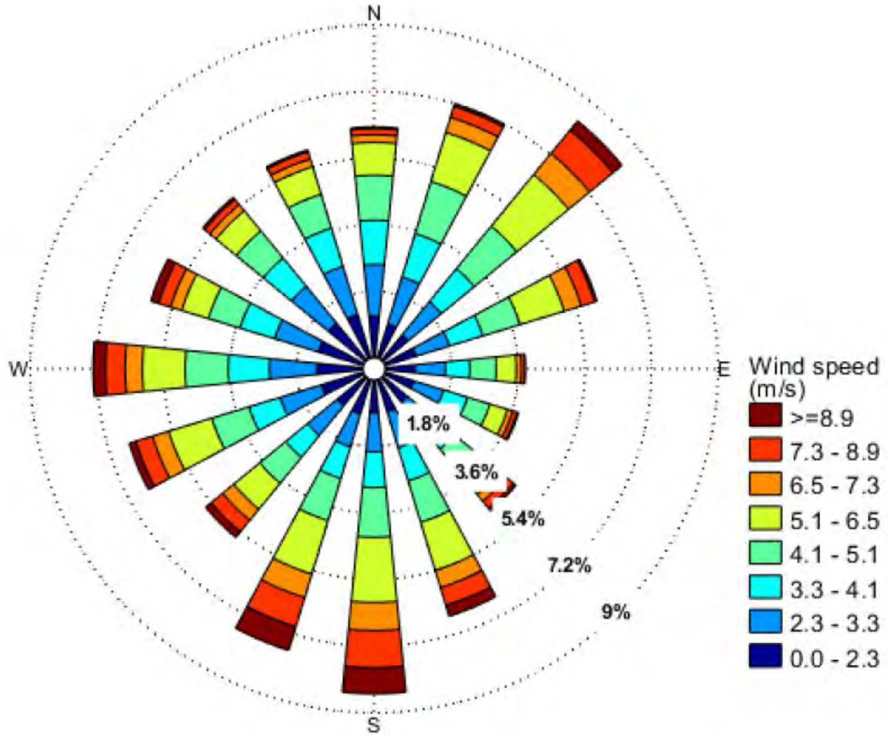

Figure 4-1. Annual wind rose plot (10-minute mean at 10 m AMSL). (Source: MetOcean, 2019)

4.3 Wave Climate

The wave climate at the subject site is influenced by wind waves and boat generated waves. The magnitude of these contributions is presented by MetOcean Solutions (2019) and summarised below.

4.3.1 Wind Generated Waves

The site is subject to overwater wind directions (ie. wind fetches) in the sector from W and ENE. The results of the MetOcean study (2019) in Figure 4-2, show the predominance of waves incoming from the W and NE sectors (refer to MetOcean report for detailed results).

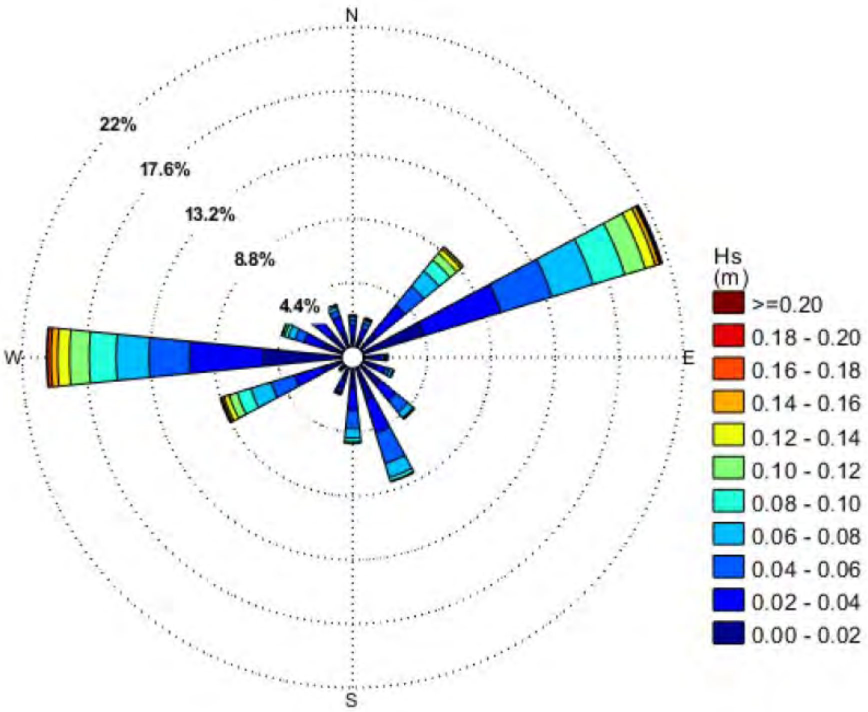

Figure 4-2. Annual wave rose plot for the total significant wave height at GBM1 (Source: MetOcean (2019))

Design wave modelling by MetOcean (2019), found the maximum total significant wave height to occur from incoming waves from the W and NE, at a height of 0.29m for a 100-year return period. The design wave conditions at GBM2 are presented below in Table 4-2, for return periods of 1, 10, 50 and 100 years.

Table 4-2. Directional design wave conditions at GBM2 (Source: MetOcean (2019))

	Return Period	Direction (from)								
	(years)	N	NE	E	SE	S	SW	W	NW	Omni
Wave Height (m)	1	0.1	0.18	0.12	0.09	0.11	0.12	0.21	0.09	0.21
	10	0.12	0.22	0.17	0.12	0.14	0.17	0.24	0.12	0.24
	50	0.13	0.25	0.2	0.13	0.16	0.2	0.26	0.13	0.26
	100	0.13	0.25	0.2	0.14	0.17	0.2	0.26	0.14	0.26
Wave Period (s)	1	1.1	1.5	1.3	0.9	1.1	1.1	1.6	1.2	1.7
	10	1.1	1.7	1.5	1.0	1.2	1.3	1.8	1.2	1.8
	50	1.2	1.8	1.6	1.1	1.2	1.4	1.8	1.2	1.9
	100	1.2	1.9	1.6	1.1	1.2	1.4	1.8	1.2	1.9

4.3.2 Boat Generated Waves

MetOcean undertook an analysis of boat wakes generated by the RiverCat, based upon MacFarlane (2012) Wake wave predictor. As outlined in MetOcean (2019), there are three wave types within the overall wave train generated by a vessel:

- **Wave A:** defined as the leading diverging wave, which is the wave that will possess the longest period. It is often the waves with long periods that create the greatest issues within sheltered waterways (particularly bank erosion), which makes the quantification of these waves very important.
- **Wave B:** defined as the most significant wave following the leading wave (Wave A). The period will be shorter than the leading wave, but often not by a large margin, whereas the height is very often greater than the leading wave.
- **Wave C:** it is common for a group of short period divergent waves to be generated and Wave C is defined as being the highest wave within this group. This wave always follows Waves A and B, hence will possess the shortest wave period of these three key waves.

The results of the MetOcean analysis is shown below in Table 4-3. The boat generated waves are of similar magnitude to the ambient wind generated waves at the site, however they are generally smaller than the extreme wave events. There is an existing vessel speed limit of 10 knots in the passage around and under Gladesville Bridge, which limits the wave energy at the site.

Table 4-3. Boat generated wave magnitudes (Source: MetOcean (2019))

Scenario	10 m water depth, 100 m distance to vessel, 10 knots vessel speed	
	Wave Height (m)	**Wave Period (s)**
Wave A	0.04	2.8
Wave B	0.10	2.5
Wave C	0.10	2.1
Scenario	10 m water depth, 100 m distance to vessel, 12 knots vessel speed	
	Wave Height (m)	**Wave Period (s)**
Wave A	0.06	4.1
Wave B	0.10	3.3
Wave C	0.13	2.1

5 Sedimentary Processes and Geomorphology

5.1 Sediment Sources

Sedimentary deposits at the site and adjacent foreshore are considered to originate from the following sources:

- mud (transported in suspension) from fluvial (Parramatta River) sources;
- erosion of residual foreshore material;
- landward transport of material from the riverbed; and
- sediment transported by rainfall runoff.

Processes leading to the deposition of material along the foreshore can be thought of as the:

- deposition of suspended solids from stormwater conveyed from the terrestrial side;
- erosion of the foreshore area from wave actions (both wind and boat generated);
- transport and deposition of materials from wave actions (particularly wind generated waves); and
- transport and deposition of materials from tides and tidal current actions.

5.2 Geomorphological Character

The existing foreshore of the site has several reaches of geomorphological character. Figure 5-1 identifies the location of the different reaches.

Figure 5-1. Geomorphological reaches at Gladesville Bridge Marina

(1) Rock Outcrops

The reach at Five Dock Point consists of exposed rock outcrops forming sandstone cliffs of greater than 6m in height. This foreshore is primarily a result of inherent topography and geology, along with ongoing exposure to waves, tidal currents and fluvial flows along the Parramatta River. The exposed rock outcrops can be observed in Figure 5-2.

Figure 5-2. Rocky outcrop at Five Dock Point

(2) Marina Foreshore – Five Dock Point

The reach of foreshore at the marina is sheltered to the west by Five Dock Point and to the south by the marina seawall. This has allowed a sandy beach to form over the rock outcrop of Five Dock Point (refer Figure 5-3).

Figure 5-3. Sandy beach at marina foreshore

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(3) Property Foreshore

Modifications to the existing foreshore, including seawalls and private jetties has altered the natural flow of sediments along the foreshore. This has resulted in several sand accumulations on the foreshore, as well as several exposed seawall locations. Site photos of the sand accumulations are shown in Figure 5-4 and Figure 5-5.

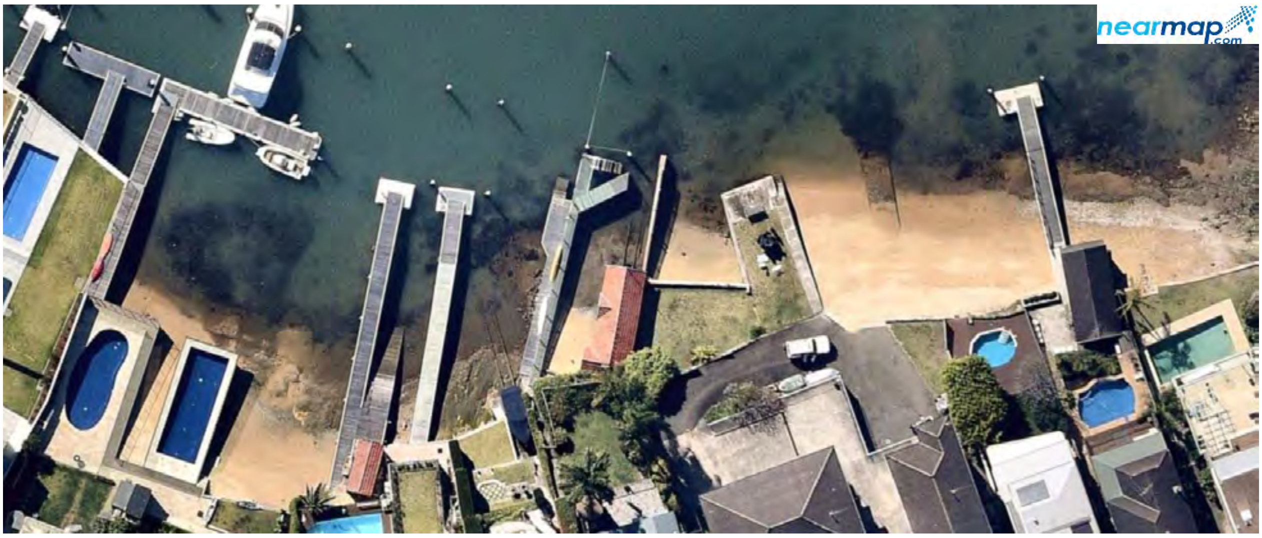

Figure 5-4. Aerial photo of property foreshore

Figure 5-5. Sand accumulations at property foreshore

(4) Rock Outcrops – Gladesville Bridge

The reach near Gladesville Bridge consists of exposed rock outcrops. This is primarily as a result of exposure of both these sites to waves, tidal currents and fluvial flows along the Parramatta River.

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6 Historical Change Analysis

Historical aerial photography of the foreshore at, and adjacent to, the site was obtained from NSW department of Land and Property Information (LPI) and Google Earth. These photographs provided a timeline of change for the site, particularly over the past 20 years. Figure 6-1 and Figure 6-2 depict the timeline of changes to the site.

There have been several modifications to the existing mooring berths and seawalls along the foreshore since 2009. Upon close inspection of the photographs, the site's geomorphology has been relatively stable, particularly since the existing waterfront and marine vessel operations have been in place.

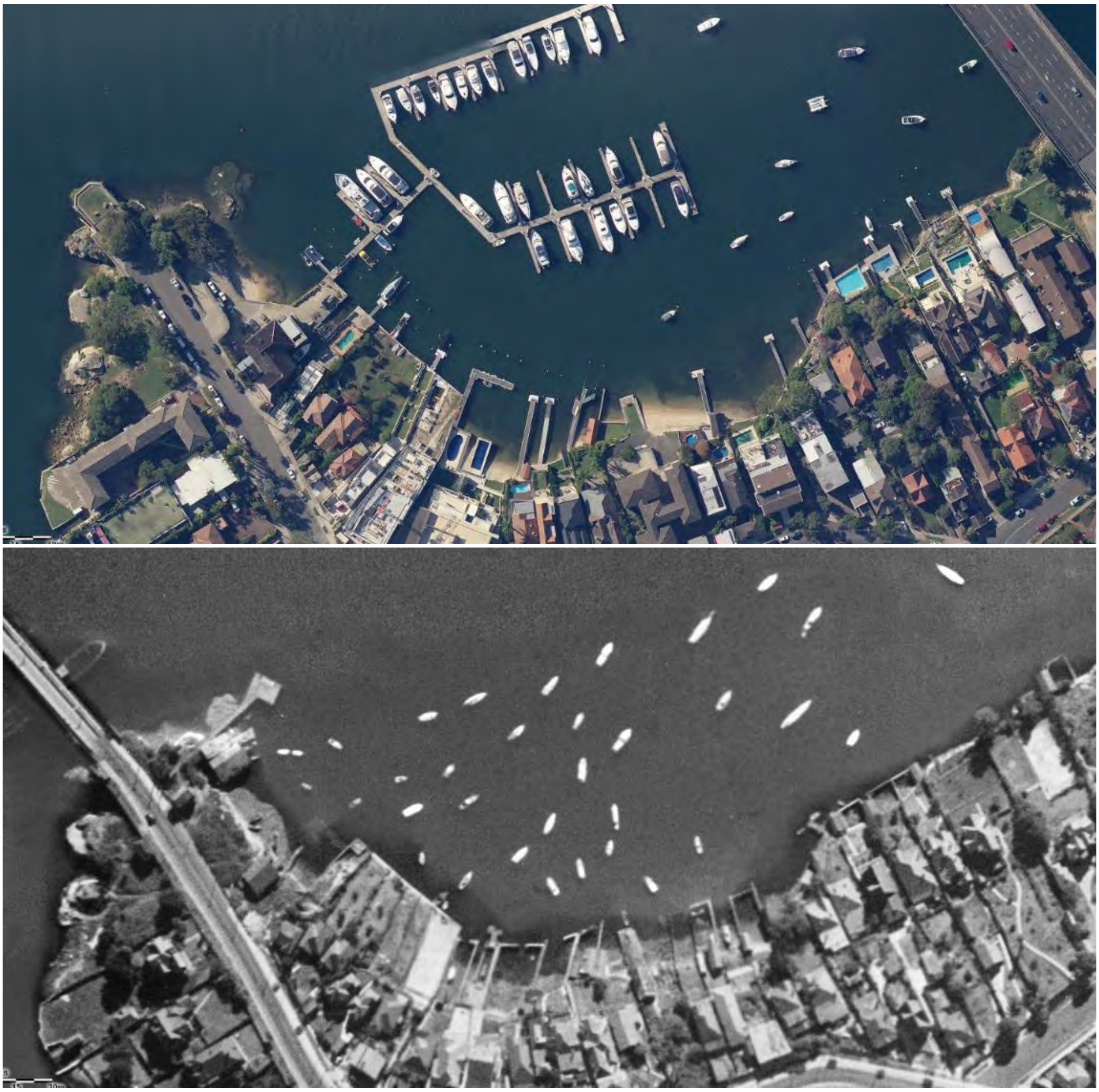

Figure 6-1. Historical aerial photographs; existing site (top); 1943 (bottom)

Figure 6-2. Historical aerial photographs; 2000 (top left); 2003 (top right); 2007 (middle left); 2009 (middle right); 2014 (bottom left); 2018 (bottom right)

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7 Potential Impacts

The proposed redevelopment of the Gladesville Bridge Marina is anticipated to have a minor impact, if any, on the geomorphological processes at the site due to the heavily modified condition of the foreshore, and minor changes to the existing marina vessel movements.

The extension of the marina is not anticipated to significantly obstruct or alter the existing currents at the site, as the proposed extension does not significantly increase the area occupied by floating pontoons and marina vessels, nor does it impede any further into the main waterway flow area than the existing site.

The sheltering effects of the additional marina pontoons is likely to reduce the wave energy reaching the foreshore in certain conditions, particularly along the southern waterfront. As outlined in Section 4.3 (and MetOcean, 2019), the dominant wave directions for the site are from the west, north-east and caused by boats travelling under the Gladesville Bridge in an east or west direction. The increase in pontoon area and number of moored vessels will provide sheltering on the leeward side of the marina (refer Figure 7-1).

The existing marina provides sheltering at the Marina sandy beach, from waves from the North-East sector and will continue to in the proposed redevelopment. In general, the reduced wave energy has the potential to decrease erosion along the adjacent shoreline and maintain existing sedimentary deposits (beaches).

Figure 7-1. Marina wave sheltering actions (dominant wind generated waves (red); dominant boat generated waves (orange))

The increase in boat traffic in the immediate vicinity of the site will increase the wave energy and frequency of waves at the marina. Considering the study results of MetOcean (2019), the magnitude of the boat generated waves will be similar to that of the ambient wind generated waves. The increase in wave frequency has the potential to reduce sedimentation along the adjacent foreshore.
In general, it is anticipated that any changes to sedimentary processes will be minor. There is little

potential for geomorphological change at the site, due to the stable environment provided by the rock outcrops. Accordingly, construction of the proposed development is not expected to have significant impacts on the geomorphological character of the site or the adjacent foreshore. Where minor effects are anticipated, these are not considered to be detrimental.

8 Synthesis of Geomorphological Processes and Impacts

The site is located within inner Port Jackson (Sydney Harbour) towards the downstream extent (influence) of Parramatta River. The geomorphological setting of the site and adjacent foreshore is characterised by a drowned river valley estuary, dominated by the presence of bedrock. At the site, and adjacent foreshore the shallow sandstone bedrock, which outcrops in places to form headlands, is overlain in places by deposits of sand, forming beaches of typically fine to medium sand.

The site is subject to wind generated waves primarily from the NE and W, where the longest wind fetches exist. The frequent boat traffic along the Parramatta River and around the marina also produce consistent wave energy towards the foreshore, however analysis undertaken by MetOcean (2019) highlights that the magnitude of boat generated waves is similar to that of the ambient wind generated waves at the site.

From a historical trend analysis, it is observed that the foreshore at the site has undergone significant modification over the past 70 years. These modifications involve the construction of seawalls and revetments, private jetties, the marina and the construction of Gladesville Bridge. These changes have caused sedimentation processes to change, however this has been primarily caused by sheltering from wave, tidal and fluvial flows as there are no significant stormwater discharge outlets at the immediate site.

Construction of the proposed development is not expected to have a significant impact on the sediment sources at the site and the adjacent foreshore. The existing marina seawalls and drainage discharge points are not to be altered during the proposed works, and therefore there would be negligible change to the existing flow process along the foreshore of the site.

The extension of the marina pontoons and increase in moored vessels will act to shelter the foreshore from wave energy. This is expected to result in slight increases in sediment accumulation at the site, which is occurring at the site due to existing natural and manmade obstructions. The increase in boat traffic at the marina is expected to increase boat generated wave energy but the low speed operation within the marina will provide minimal increase to the existing boat generated wave energy at the site.

9 References

Herbert, C. (1983) Sydney 1:100 000 Geological Sheet 9130, 1st edition. Geological Survey of New South Wales, Sydney.

Chapman GA, Murphy CL, Tille PJ, Atkinson G and Morse RJ (2009) Ed. 4, Soil Landscapes of the Sydney 1:100,000 Sheet map, Department of Environment, Climate Change and Water, Sydney.

Chapman GA and Murphy C. L. (1989) Soil Landscapes of the Sydney 1:100,000 Sheet report, Department of Conservation and Land Management, Sydney.

MetOcean Solutions (2019) Alterations and Additions to the Gladesville Bridge Marina - Climate Change – Wave Climate Study. Prepared for Gladesville Bridge Marina, July 2019.

Appendix A – Proposed Marina Layout Plan

N

BERTH SCHEDULE

VESSEL LENGTH (m)	QTY	RATIO (%)	LINEAR METRES
8	1	0.9	8
12	18	15.7	216
15	30	26.1	450
17	16	13.9	272
18	4	3.5	72
20	35	30.4	700
25	2	1.7	50
30	5	4.3	150
35	3	2.6	105
45	1	0.9	45
TOTAL	115	100	2068

NOTES:

1. CADASTRAL INFORMATION FROM NSW DEPARTMENT OF LANDS, DCDB, 2012
2. ALL BERTH WIDTHS, FINGER LENGTHS, FAIRWAYS & CHANNEL WIDTHS AS PER AS 3962.
3. THE BERTH SCHEDULE IDENTIFIES CURRENT AND PROPOSED VESSEL SIZES. THE MARINA STRUCTURE (ARMS AND FINGERS) DIMENSIONS ARE AS PER AUSTRALIAN STANDARD AS 3962.
4. CONCEPT GEOMETRY ONLY, NOT FOR CONSTRUCTION
5. LOCATION OF NEW MOORING PEN APPROXIMATED FROM RMS DAXXXX, LARGEST ALLOWABLE VESSEL IS 10.36m AS PER DA.
6. LOCATION OF NEW MOORING PEN APPROXIMATED FROM RMS DA190303920, LARGEST ALLOWABLE VESSEL IS 21m.
7. BATHYMETRY TAKEN FROM HARVEY HYDROGRAPHIC SURVEY "GLADESVILLE MARINA DRUMMOYNE" 16/08/16. DATUM IS ZERO TIDE GAUGE FORT DENISON.
8. EXISTING MARINA HAS BEEN LOCATED BASED ON COORDINATES ON DP1019271.
9. NEARMAPS IMAGERY ACCURATE TO +-0.15 m
10. VESSELS IN PRIVATE BERTHS HAVE BEEN APPROXIMATED AS LARGEST CREDIBLE WRT ARRANGEMENT OF PENS AND MOORING PILES
11. ROWERS COURSE BASED ON DGW PROVIDED BY RMS ON 13.12.2018

LEGEND:

RMS MARITIME TITLE BOUNDARY

ROWERS COURSE

PRELIMINARY - NOT FOR CONSTRUCTION

No	Revision	Drawn	Job Manager	Project Director	Date
G	PRELIMINARY - NOT FOR CONSTRUCTION	HM	SG	JN	08.10.19
F	REVISED DRAWING NOTES	MR	SG	JN	03.09.19
E	PRELIMINARY - NOT FOR CONSTRUCTION - REVISED MOORING PEN 42 DRUMMOYNE AVE	MR	SG	JN	01.05.19
D	PRELIMINARY - NOT FOR CONSTRUCTION	MR	SG	JN	20.12.18
C	PRELIMINARY - NOT FOR CONSTRUCTION	MR	SG	JN	14.12.18

Note: * indicates signatures on original issue of drawing or last revision of drawing

0 7.5 15 22.5 30 37.5m
SCALE 1:750 AT ORIGINAL SIZE

gladesville bridge MARINA

GHD
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Drafting Check | Design Check C.ALFRED
Approved (Project Director)
Date
Scale 1:750
This Drawing must not be used for Construction unless signed as Approved

Client **GLADESVILLE BRIDGE MARINA**
Project **MARINA EXPANSION**
Title **CONCEPT LAYOUT**
Original Size A1 Drawing No: **21-27558-K101** Rev: G

Plot Date: 7 October 2019 - 8:00 PM Plotted by: Harry Mitchell Cad File No: G:\21\27558\CADD\Drawings\21-27558-K001.dwg

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Appendix B – Site Photographic Record

Site Photos (25/7/19)

Location of Site Images (Google Earth, 2019)

Site Photo at Location #1 (25/7/19)

Site Photo at Location #2 (25/7/19)

Site Photo at Location #3 (25/7/19)

Site Photo at Location #4 (25/7/19)

Royal HaskoningDHV

Site Photo at Location #5 (25/7/19)

Site Photo at Location #6 (25/7/19)

Royal HaskoningDHV

Site Photo at Location #7 (25/7/19)

Site Photo at Location #8 (25/7/19)

Site Photo at Location #9 (25/7/19)

Site Photo at Location #10 (25/7/19)

Royal HaskoningDHV

Site Photo at Location #11 (25/7/19)

Site Photo at Location #12 (25/7/19)