



# **Draft Final for Public Exhibition**

**Port Macquarie-Hastings Council**

Broadwater Canal  
Canal Maintenance Plan

May 2016



# Executive summary

The Broadwater Canal Estate, located approximately 3 km north west of the Port Macquarie CBD, was constructed in the 1990's and is managed by Port Macquarie – Hastings Council (Council).

The Broadwater Canal is subject to a Waterway Maintenance Plan (WMP) which defines the requirements for both routine and flood damage maintenance and is linked to the titles of all properties falling within the canal area.

As part of the WMP, Council is required to prepare a forward maintenance and dredging plan, referred to as a Canal Maintenance Plan (CMP), and engaged GHD to assist in the preparation of the CMP.

In preparing this CMP, GHD completed a hydrographic survey and waterway condition assessment of the Broadwater Canal. Bed levels and associated areas of erosion and accretion were investigated by comparing the results of the recent hydrographic survey to the initial canal design (given that no previous surveys of the canal area were available). The condition of the canal above water level was investigated through a site inspection and examination of aerial imagery.

Key outcomes of the CMP include the following:

- Sedimentation and scour has been identified throughout the canal waterway, though the quantities of sedimentation and resulting reductions in available draft do not warrant dredging (in accordance with the EMP) at this stage. Consequently, no sediment sampling and analysis was undertaken during the preparation of the CMP.
- There exists localised areas of damage and erosion to foreshore shingles and rock armour;
- Areas have been identified in which property owners have undertaken works for maintenance, aesthetic or practical purposes contradicting the conditions set out in the WMP; and
- Growth of vegetation along the canal foreshores is not in accordance with the design intent of the original WMP.

Recommendations are primarily in accordance with the original design intent and are based on the information provided in the WMP. Where no guidance is offered in the WMP, then recommendations have been based on the knowledge ascertained by GHD and consultation with Council representatives. Key recommendations include:

- Dredging is not required at this point in time. It is recommended that Council consult with local residents regarding the outcomes of this study and the need for future survey and dredging works;
- A follow up hydrographic survey should be undertaken within five years to confirm that elevated bed levels adjacent to foreshore areas are the result of construction variations from the initial design rather than sedimentation;
- Repairs should be undertaken to damaged shingles and rock armour along foreshore areas;
- Council to continue to liaise with property residents and encourage property owners to be proactive in monitoring the condition of the canal and liaise with Council on issues as they arise;
- Council to enforce maintenance works that contravene the requirements of Memorandum AA703324B, if deemed appropriate, following appropriate consultation; and
- The immediate priority actions identified should be included in Council's 2017/2018 maintenance works plan, with all work proposed to be completed by June 2018.



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# 1. Introduction

The Broadwater Canal is subject to a Waterway Maintenance Plan (WMP) which is linked to the titles of all properties falling within the canal area.

The WMP defines requirements for both routine maintenance and flood damage maintenance mechanisms for the waterways, beaches, rock protection, revetment walls and structures such as the flow deflectors, flood control weir and Park Street Bridge.

Under the WMP, Port Macquarie-Hastings Council (Council) is required to co-ordinate a hydrographic survey and condition assessment of the Broadwater Canal to define the extent of canal siltation / erosion, and to provide an assessment of the condition of the waterways and foreshore rock protection approximately every 5 years. This will then inform the preparation of a forward maintenance and dredging plan in accordance with the WMP.

GHD has been engaged by Council to undertake the abovementioned hydrographic survey and waterway condition assessment, and to prepare a forward maintenance and dredging plan for the Broadwater Canal as per the requirements of the WMP.

## 1.1 Project Background

Since the 2002/2003 rating period, Port Macquarie-Hastings Council has imposed a special rate on the residents of the Broadwater Canal.

The Broadwater Special Rate was developed as part of the final stage of the Settlement Shores Canal Development and is intended to cover the canal specific maintenance costs.

As part of the development application process the developer, Port Shores Pty Limited, was required to put in place a WMP for the canals being constructed.

The WMP defined requirements for both routine maintenance and flood damage maintenance mechanisms for the waterways, beaches, rock protection, revetment walls and structures such as the flow deflectors, flood control weir and Park Street bridge.

While damage may occur due to major event flooding, it was also recognised that there would be ongoing sedimentation of the canals, wind and wave erosion of foreshore areas and other routine maintenance activities, together with inspection and survey activities.

The WMP defined the anticipated maintenance tasks and responsibilities associated with the Broadwater Canal and estimated the annual cost for maintenance.

Actions completed by Council since construction of the Broadwater Canal include post flood cleaning up and removal of large debris. No hydrosurvey has been completed, despite being constructed well over five years ago, as it has been deemed unnecessary thus far. This is based on anecdotal evidence acquired from site inspections and communication with property owners.

## 1.2 Project Area

The land to be covered by the hydrographic survey and maintenance plan is generally referred to as the Broadwater Canal Estate and consists of The Main Canal, which is split into the Eastern and Western Canals by the flood control weir, and the Northern and Southern Lagoons. The Broadwater Canal Estate is located approximately 3km to the north west of the Port Macquarie CBD.

The canals themselves are classified as drainage reserves under the care and control of Port Macquarie-Hastings Council. The extent of the project area is depicted below in Figure 1.



**Figure 1 Broadwater Canal Study Area**

### **1.3 Project Objectives**

The principle objectives of the project are defined as follows:

- Undertake a hydrographic survey of the Broadwater Canals to define the extent of canal siltation or erosion, and to assess the condition of the canals (and rock protection) in accordance with the parameters within the WMP.
- Utilising the results of the hydrographic survey and site inspection, prepare a forward canal maintenance plan in accordance with the WMP.

## **1.4 Canal Maintenance Plan**

The development of the Canal Maintenance Plan (CMP) will identify actions to address ongoing maintenance of the canals and rehabilitation and maintenance of associated infrastructure. The maintenance plan provides Council and property owners with guidance for the future maintenance of the canals by identifying the current condition of the canal, and identifying proposed canal maintenance actions including dredging, foreshore restoration and repairs.

It should be noted that the CMP does not supersede the existing WMP, which has been attached for reference purposes in Appendix F. Rather the actions identified in the CMP should be implemented in addition to those in the WMP. Hence, GHD has adopted maintenance measures from the existing WMP where possible. Additional actions have been included only if required.

Investigations undertaken for the CMP were:

- Identification of the current condition of the canal infrastructure. A damages audit and condition assessment was undertaken to provide an assessment of the various infrastructure elements of the canals including revetment walls, stormwater outlets, foreshore zones and footpaths. Private infrastructure such as jetties, boat ramps and pontoons were not considered as they are the responsibility of proprietors.
- Assessment of current canal bed levels. A hydrographic survey was undertaken to provide an accurate record of current canal bed levels which was then compared to the as-constructed design to determine the extent of sedimentation and scouring within the canals;
- Identification of any non-council construction or maintenance works that do not adhere to the guidance set out in the WMP, and recommendations on how to proceed; and
- Recommendation of canal maintenance actions including dredging, foreshore restoration, removal of vegetation and repairs. The CMP describes the maintenance necessary, prioritises the maintenance actions and provides guidelines to Council and to property owners to assist with implementing the recommended maintenance.

## **1.5 Purpose of this Report**

The purpose of this document is to document the investigations undertaken to define the monitoring and maintenance requirements for the Broadwater Canal. This document is supported by the Maintenance Works Schedule which identifies any issues with the current condition of the canal and recommends appropriate actions.

## 1.6 Scope and Limitations

*This report: has been prepared by GHD for Port Macquarie-Hastings Council (Council) and may only be used and relied on by Port Macquarie-Hastings Council for the purpose agreed between GHD and Port Macquarie-Hastings Council as set out in section 1 of this report.*

*GHD otherwise disclaims responsibility to any person other than Port Macquarie-Hastings Council arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.*

*The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.*

*The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.*

*The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report (refer section 2 of this report). GHD disclaims liability arising from any of the assumptions being incorrect.*

*GHD has prepared this report on the basis of information provided by Port Macquarie-Hastings Council and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.*

*GHD has prepared the preliminary order of magnitude estimates of probable construction costs set out in section 3.10 of this report ("Cost Estimate") using information reasonably available to the GHD employee(s) who prepared this report; and based on assumptions and judgments made by GHD.*

*The Cost Estimate has been prepared for the purpose of prioritising maintenance actions and tender comparison, and must not be used for any other purpose.*

*The Cost Estimate is a preliminary estimate only. Actual prices, costs and other variables may be different to those used to prepare the Cost Estimate and may change. Unless as otherwise specified in this report, no detailed quotation has been obtained for actions identified in this report. GHD does not represent, warrant or guarantee that the [works/project] can or will be undertaken at a cost which is the same or less than the Cost Estimate.*

*Where estimates of potential costs are provided with an indicated level of confidence, notwithstanding the conservatism of the level of confidence selected as the planning level, there remains a chance that the cost will be greater than the planning estimate, and any funding would not be adequate. The confidence level considered to be most appropriate for planning purposes will vary depending on the conservatism of the user and the nature of the project. The user should therefore select appropriate confidence levels to suit their particular risk profile.*

*The opinions, conclusions and any recommendations in this report are based on information obtained from, and surveying and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.*

*Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.*

*Site conditions (including the presence of hazardous substances and/or site contamination) may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.*

*GHD excludes and disclaims all liability for all claims, expenses, losses, damages and costs, including indirect, incidental or consequential loss, legal costs, special or exemplary damages and loss of profits, savings or economic benefit, Port Macquarie-Hastings Council may incur as a direct or indirect result of the Maintenance Works Schedule, for any reason being inaccurate, incomplete or incapable of being processed on Port Macquarie-Hastings Council's equipment or systems or failing to achieve any particular purpose. To the extent permitted by law, GHD excludes any warranty, condition, undertaking or term,*

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*GHD does not guarantee that the Maintenance Works Schedule is free of computer viruses or other conditions that may damage or interfere with data, hardware or software with which it might be used. Port Macquarie-Hastings Council absolves GHD from any consequence of Port Macquarie-Hastings Council's or other person's use of or reliance on, the Maintenance Works Schedule.*

## **1.7 Enforceability of the Restrictions of Memorandum AA703324B**

There are a number of works / activities that have been undertaken by residents within the waterway frontages of their property that contravene the requirements of Memorandum AA703324B (Appendix I). The details of these are described in Section 3. In relation to the unapproved works, options for Council enforcement are as follows:

*As a beneficiary of the positive covenant registered pursuant to s88B of the Conveyancing Act, 1919 on the title of all lots within the Broadwater Estate, Council has the power to enforce the terms of the covenant (namely the requirement that "The proprietors of the lots burdened will at all times comply with the provisions of Memorandum AA703324B) in the Local Court in its civil jurisdiction.*

*Alternative enforcement avenues exist in instances where environmental damage or pollution is occurring or likely to occur (Protection of the Environment Operations Act 1997), or where the works undertaken contravene relevant planning laws applicable to the site (Environmental Planning & Assessment Act 1979).*

As such, Council has the power to enforce any maintenance works that contravene the requirements set out within Memorandum AA703324B. However, given the sensitivity of some of the issues that have arisen as a result of the CMP, it is recommended Council undertake detailed consultation with residents and the community prior to undertaking maintenance works to ensure a balanced outcome is achieved.

## 2. Condition Assessment Methodology

### 2.1 Site Inspection

GHD undertook a site visit to the Broadwater Canal on 14/11/2014 between 10 am and 1 pm. In attendance was Mark Edenborough from Port Macquarie-Hastings Council and GHD team members Craig Dengate and Amylia Fletcher. Conditions were calm with a light North Easterly breeze. A low tide of 0.7 m occurred at 8:22 am and was followed by a high tide of 1.4 m at 2:38 pm.

The site visit involved a visual inspection of all accessible foreshore areas within the canal's boundaries. A thorough photographic record was kept of this visual inspection identifying defects, required maintenance or observations of interest. Each piece of this photographic record, attached in Appendix F, was classified under the following headings:

- Area of deposition/infilling noted
- Area of erosion noted
- Area of erosion noted at revetment
- Council footpath cracking / separation
- Council repair works
- Debris/waterway obstruction noted
- Disturbance of foreshore due to construction activities
- Disturbance/damage to shingle
- Erosion of non-council works
- Exposed pipe
- Introduction of new material
- Loss of shingle and exposure of geotextile
- Non-council repair works
- Potential access point for repair works
- Profile looks too steep – check design
- Stormwater culvert noted
- Undermining / differential settlement of boat ramp
- Vegetation growth
- Waterway obstruction (boat)
- Wrack/rubbish collection point

Any classification heading listed above was allocated against the relevant photograph, forming the basis of the Maintenance Works Schedule that accompanies this report in Appendix E.

A street address reference has been attached to the corresponding photograph using Google Maps and knowledge obtained from the site visit.

Some foreshore areas within the Southern Harbour were inaccessible on the day of the site visit as residents had not been notified of the works and it was deemed best practice to delay the inspection of these properties until consultation had been made. Fortunately, Mark Edenborough from Port Macquarie-Hastings Council was able to inspect these foreshore areas on 16/06/2015. Photos were also provided and as such, Appendix E and Appendix F were updated accordingly.

## 2.2 Hydrographic Survey

The hydrographic survey provides an accurate record of the current canal levels from which the extent of sedimentation and scouring within the canals can be determined.

Astute Surveying completed the hydrographic survey on the 16<sup>th</sup> November, 2014. The results of this survey are described in Section 3.3.2 and attached in Appendix A.

### 2.2.1 Equipment and Methodology

The hydrographic survey vessel was provided by Astute Surveying with the following equipment installed:

- R2Sonic 2022 Multibeam Echo Sounder System
- PosMV Wavemaster
- Hypack Acquisition and Processing Software (2013)
- Leica RTK Radio
- Hemisphere VS111 DGP Heading Sensor
- AML Sound Velocity Probe (SVP)
- Odom CVM Single Beam Echo Sounder (200kHz)
- 2 x Panasonic Toughbook's

### 2.2.2 Method of Comparison

Ideally, the hydrographic survey would be compared to an original post construction survey to determine the extent of siltation or erosion throughout the canal since its construction. However, such a survey does not exist. As an alternative, the hydrographic survey results have been compared to the canal design drawings to determine the variation in bed levels since construction. The accuracy of this comparison depends on the precision of the Broadwater Canal's construction relative to the design specification. The results of this analysis are described in Section 3.3.2. Reference should be made to Appendix B which forms the basis of the analysis.

## 2.3 Evaluation of Aerial Imagery

The extent of the Broadwater Canal is displayed below in Figure 2. Clearly visible is the Main Canal, which is split into Eastern and Western segments by the flood control weir. The Main Canal is straight with a near-uniform width. This results in relatively even flow along the extent, excluding the impact of the weir. East of the weir is the Park Street Bridge which is the eastern extent of the Broadwater Canal. Adjoining the Western Canal are the Northern and Southern Lagoons. These have a narrow entrance to the Main Canal and are non-uniform in shape resulting in uneven flows and distribution of sediment. Further west of the two lagoons, the canal joins the Hastings River. Its flow is regulated by the entrance flow deflectors. The western boundary of the Broadwater Canal is the Hastings River foreshore.

The entrance flow deflectors at the confluence of the Western Canal and the Hastings River are designed to direct flow downstream, minimising the disruption caused to the flow of the Hastings River. They are also designed to collect debris, preventing it from travelling downstream which could be a safety hazard or disrupt flow.



**Figure 2 Aerial Image of Broadwater Canal (PMHC, November 2012)**

## 2.4 Review of Historical Flood Observations

The flood control weir and entrance flow deflectors collect a significant amount of debris during flood events due to their ability to capture material in downstream flowing water. The Northern and Southern Lagoons also retain large amounts of debris due to the reduced water velocities within the lagoons, and the relatively small entrances to the Western Canal. The Western and Eastern Canals appear relatively free from debris as their straight nature does not allow for accumulation but rather funnels water and debris downstream.

In 2006, the Hastings River Flood Study was completed by Patterson Britton and Partners on behalf of Port Macquarie-Hastings Council. Within this study, peak design flood levels were predicted for multiple locations along the Hastings River. One of these locations, Kings Point, is situated directly across the river from the Broadwater Canal. The predicted levels for Kings Point are provided below in Table 1.

**Table 1 Predicted Peak Design Flood Levels at Kings Point, Hastings River (Patterson Britton and Partners, 2006)**

Flood Event	Peak Level (m AHD)
Probable Maximum Flood	6.2
200 Year Recurrence Event	3.1
100 Year Recurrence Event	2.8
50 Year Recurrence Event	2.5
20 Year Recurrence Event	2.3

The report included multiple submissions from the public. A general theme was that water levels had risen up to a metre within the canal during flood events although properties had never been flooded. The study also found that in moderate to severe storms, floodwaters peak at Port Macquarie less than 72 hours after the commencement of rainfall.

In recent years, multiple flood events have elevated water levels and left debris on the foreshore areas of the Broadwater Canal. These flood events occurred in:

- June 2008
- February 2009
- February 2013

A visual comparison of the effects of flooding is provided in Appendix C. Photos taken from near identical locations show a comparison between February 2013 flood conditions and present day conditions taken during GHD's site visit. There is a variation in water level of more than a metre in these photos, although the effect of tides has not been taken into account.

## 3. Monitoring and Maintenance Requirements

The monitoring and maintenance requirements for each stretch of waterway foreshore are detailed below. For each maintenance activity, the immediate priority actions outlines the current maintenance required, while recommendations for future monitoring and maintenance are included to compliment the long term maintenance requirements outlined in the existing WMP (attached in Appendix F).

All information provided in this section is supported by the recommendations of the Maintenance Works Schedule in Appendix E.

### 3.1 Foreshore Erosion

#### 3.1.1 Overview

The foreshores of the Broadwater Canal are protected by either rocks or shingles depending on location. Generally, rock protection is provided on the slopes of the Main Canal while the lagoons are protected by river shingles. Details of the specific foreshore armouring and required grading are provided in the original design specification, which has been attached for reference in Appendix F.

Due to the exposure of the foreshore to varying water levels as a result of tidal, flood, wind and wave actions, there is a high potential for erosion of unprotected foreshore slopes. Maintaining foreshore protection in the form of shingles or rock armouring is vital to preserving the canal system.

#### 3.1.2 Immediate Priority Actions

The visual inspection undertaken by GHD identified a number of locations where the foreshore material has been sufficiently depleted such that replacement is required. A map detailing the location of areas requiring additional foreshore material has been provided in Appendix D. Please note the locations identified in this map are approximate. For further detail on specific locations, refer to the attached Maintenance Works Schedule in Appendix E.

As stated in the existing WMP, any maintenance with regards to replacement of foreshore armour will require material complying with the specification requirements detailed within the original design. Repairs to rock scour protection and beach shingle armouring should be carried out before the damage due to loss penetrates to 50% of the thickness of the rock or shingle as specified in the original construction works. These repairs should be carried out to a minimum level of the adjacent, undamaged profile plus 50 mm tolerance above.

Another issue noted during the site visit was the exposure of the revetment wall due to depletion of foreshore armour. Additional material is required when there is at least 150 mm of the revetment wall exposed, as specified in the original design. Locations where this is an issue is illustrated in Appendix D.

#### 3.1.3 Recommendations for future monitoring and maintenance

Any maintenance requirements would be detected during the monitoring inspections and surveys required every five years as specified by the WMP. This period of five years should remain unchanged unless deemed inadequate in the future.

The WMP also specifies that a visual inspection of the foreshore should take place after an extreme flood event. An extreme flood event represents an approximate 1 in 30 year ARI flood

where waters reach 2.25 m AHD at the upstream junction of the Western Canal and the Hastings River.

It was noted on the site visit that there are currently no flood level markers throughout the canals. It is recommended that flood markers be installed within the canal when funding permits. These markers would enable an easy assessment of the magnitude of any particular flood event.

In addition, it is recommended that Council encourages property owners to alert Council if they encounter erosion on the foreshore of their property. Property owners should be especially vigilant in monitoring the level of exposure of the revetment wall as the condition of the revetment is responsibility of the property owner. This is further detailed in Section 3.8.

## **3.2 Introduced Foreshore Material**

### **3.2.1 Overview**

Council specifically prohibits the introduction of foreshore material in Part 4, sections f) and g) of the Memorandum on Titles of Properties (dated 19/05/2004). It can be seen in detail in Appendix I.

A number of items are included under introduced foreshore material. These include:

- Bricks, concrete and other building rubble;
- Alternative rock protection (size and grading);
- Rubber mats;
- Sand;
- Vegetation;
- Pipes; and
- Wooden posts and retaining walls.

These items are introduced to the foreshore for a number of reasons including protection, amenity, aesthetics, improved access, and for vessel tie up. All protection works, excluding the revetment wall and any structures such as jetties, pontoons or boat ramps that have been installed by property owners, should be undertaken by Council. If property owners are of the opinion that maintenance is required, Council should be notified so appropriate action can be taken. Individuals should not act on their own accord.

The potential implications of works not in accordance with original design specification include:

- Increased foreshore erosion;
- Addition of sediment to canal;
- Inconsistent appearance;
- Creation of navigation hazards; and
- Creation of habitat which encourages midgies / sandfly's.

### **3.2.2 Immediate Priority Actions**

The visual inspection undertaken by GHD identified a number of locations where it appears individuals have introduced material onto the foreshore. It is recommended that Council undertakes removal of these introduced materials in line with the advice presented in Section 1.7. A map detailing the location of areas requiring immediate action has been provided in

Appendix D. Please note the locations identified in this map are approximate. For further detail on specific locations, refer to the attached Maintenance Works Schedule in Appendix E.

It is possible some of the areas identified in Appendix D are either the work of Council maintenance or have been approved by Council. As such, an inspection would identify whether the locations identified are illegitimate and if so, evaluate the impact of these non-council works and consider their removal.

### **3.2.3 Recommendations for future monitoring and maintenance**

Any maintenance requirements would be detected during the monitoring inspections and surveys required every five years as specified by the WMP. This period of five years should remain unchanged unless deemed inadequate in the future.

The WMP also specifies that a visual inspection of the foreshore should take place after an extreme flood event. An extreme flood event represents an approximate 1 in 30 year ARI flood where waters reach 2.25 m AHD at the upstream junction of the Western Canal and the Hastings River. It is in response to a flood that property owners are most likely to undertake unapproved works. As such, the post flood inspection should be performed without delay to prevent property owners feeling the need to undertake maintenance of Council assets.

It is recommended that Council continues to educate the community regarding the potential impacts of introduced materials (as outlined above). This could be undertaken through presentations to the Reference Group, direct liaison with property owners that have introduced materials or through letterbox drops.

In addition, it is recommended that Council promotes property owners to alert Council if they have wrongfully introduced material on the foreshore of their property, or if adjoining properties have introduced material. If alerted, Council is to adequately deal with the issue in accordance with the approach presented in Section 1.7.

## **3.3 Sedimentation and Debris within Navigation Areas**

### **3.3.1 Overview**

Canals tend to gradually silt up due to surface run-off of fine sediments and sediments deposited by slow moving waters, especially within the lagoons. The Main Canal was constructed to a depth of -4.00 m AHD while the lagoons were constructed to -3.50 m AHD. The WMP specifies that the absolute minimum depth for vessels to navigate safely throughout the waterway is 2 m and as such the maximum amount of siltation acceptable is 2.00 m in the main channel and 1.50 m in the lagoons. However, Council should be aware that some boats moored within the canal may have a draft in excess of two metres. Community backlash could result if siltation is allowed to reach the maximum acceptable levels specified in the WMP. In order to maintain safe navigation and avoid community discontent, dredging may be required.

The Canal also has the potential to capture debris, especially during and after flood events. Such debris can obstruct navigation and be a safety hazard. It can also be deposited on canal foreshore areas restricting access to the waterway. The WMP notes that any foreign debris within the waterway must be removed to maintain safe navigation.

The WMP makes note of the distinction between small and large flood debris. Small flood debris can be handled and disposed of by one or two people, and can be transported by trailer or small truck. Large flood debris requires mechanical equipment such as loaders, barges and trucks for handling, disposal and transportation. The removal of small flood debris is the responsibility of property owners while large flood debris, such as tree trunks and large dead animals, are the responsibility of Council.

### 3.3.2 Immediate Priority Actions

#### Hydrographic Survey Results

As one would expect there has been some variation in the bed levels of the Broadwater Canal since its construction. There are some small, localised areas of scour. These exist mainly through the centre of the Main Canal, to the east and west of the weir, although the magnitude does not exceed 0.1 metres. There is also confined scour where the Northern and Southern Lagoons join the Main Canal. The extreme values are 0.1 metres in the Northern Lagoon and 0.3 metres in the Southern Lagoon. It is possible that these localised scour areas are a result of significant floodwaters, the most recent of which occurred in early 2013. The WMP, produced in 1998, predicted a deposition rate of approximately 3 mm per year. Even though this flood occurred some 20 months prior to the survey date, it is unlikely that any significant sedimentation has occurred in this timeframe allowing for the possibility that these small areas of scour are attributable to the aforementioned flood event. An alternative explanation is the canal was not constructed exactly according to the design specifications, and as such some initial over dredging occurred.

The volumes of scour and accretion have been calculated for each section of the Broadwater Canal. These figures are presented in Table 2, and discussed in detail below.

**Table 2 Volumes of accretion and scour of Broadwater Canal**

Area	Scour Volume (m <sup>3</sup> )		Accretion Volume (m <sup>3</sup> )	
	Banks*	Footprint	Banks*	Footprint
Richmond River Foreshore	3,100	1,100	<100	200
Northern Lagoon	3,100	400	4,900	6,800
Southern Lagoon	3,300	100	2,000	4,100
Western Canal	3,100	700	1,500	5,800
Eastern Canal	2,700	500	200	500
<b>Total Sum</b>	<b>15,300</b>	<b>2,800</b>	<b>8,600</b>	<b>17,400</b>

\* It is important to note that the bank volumes reported above are to be treated with caution for the reasons discussed below.

The survey results showed that a large proportion of the canal system has been subject to sedimentation. In the Eastern Canal, there is a minor amount of deposition adjacent to the weir. In the centre there is little sign of sedimentation, while at the channel's eastern boundary there are significant zones of accumulation.

In the Western Canal, there is sedimentation adjacent to the weir. The amount of deposition in this region varies between 0 and 0.4 m. Further west of the Main Canal where the channel approaches the Hastings River, the magnitude of deposition decreases although pockets of sedimentation exist, especially around the entrance flow deflectors.

The Northern Lagoon has the largest amount of sedimentation within the canal system. There is near uniform deposition in the main water body of 0 to 0.2 metres. Although the introduction of sand to the foreshore by residents would have contributed to sedimentation of the Northern Lagoon, the uniform nature of deposition indicates that the sediment build up is primarily attributable to natural processes.

The Southern Lagoon has less uniform sedimentation than its counterpart, although it is more voluminous than the Main Channel. This is most likely due to reduced exposure to flood waters than the Main Channel, and a lesser number of stormwater outlets than the Northern Lagoon.

Throughout the Broadwater Canal, greater levels of sedimentation and scour were indicated on the banks of the canal. Based on the patterns of sedimentation and scour, it is thought that these observations are a result of discrepancies between the original design and construction rather than a result of sediment transport. In addition, the majority of these areas are outside the key navigation channels and as a result are considered to be a low priority.

Within the two lagoons are a number of stormwater culverts. As stormwater accumulates sediment and other material, it would be justifiable to assume that areas of accumulation would surround these culverts. However, this does not appear to be the case. Results show elevated levels of accumulation within the lagoon body compared to the Main Canal, with variable rates of sedimentation in the vicinity of the stormwater outlets. An explanation for this is the high velocity of stormwater relative to the static waters of the lagoons allows for a higher than normal settling period and greater dispersion of sediment.

### ***Immediate Actions***

The hydrographic survey undertaken by Astute Surveying on behalf of GHD identified a number of locations where sedimentation has taken place between the time of construction and present day. However, as specified in the WMP, dredging should be carried out when deposition reaches 600mm. The maximum amount of deposition exceeded this figure, although this was only in localised locations near the foreshore. It should be noted that these figures are likely to be an overestimation of sediment levels, especially on banks and the entrance to the Northern Lagoon. The expected cause for such elevated levels is a variation between the original design and the constructed canal. As such, it is recommended that the results of the hydrographic survey be used primarily for assessing bed levels in the navigable areas of the canal. The majority of the Broadwater Canal has received between 0 and 400 mm of sedimentation since construction and as such, dredging is not required at this point in time. The results of this survey, and the accompanying comparison detailing the variation in bed levels since construction, are presented in Appendix A and Appendix B.

It is recommended another survey be undertaken within five years to confirm the information presented above. This is due to the lack of any existing survey undertaken prior to this project, and the assumption that the Canal design matched the post-construction bed surface levels.

The visual inspection undertaken by GHD found no locations where large flood debris was obstructing the waterway and required removal. As such, no action from Council on this matter is required at present.

A number of locations were identified to have been wrack or rubbish collection points, otherwise known as foreshore areas where small flood debris accumulates. The majority of these areas were minor and localised in nature such that they can be addressed by property owners. However, one area of note is the Eastern side of the Flood Control Weir which had accumulated a significant amount of small debris at the time of the site visit. As this structure is the property of Council, then it is Council's responsibility to remove the debris.

### **3.3.3 Recommendations for future monitoring and maintenance**

It is recommended that monitoring of sedimentation and debris be undertaken in accordance with the original WMP. Specifically, monitoring should occur every five years as well as in response to an extreme flood event. An extreme flood event represents an approximate 1 in 30 year ARI flood where waters reach 2.25 m AHD at the upstream junction of the Western Canal and the Hastings River.

## **Survey**

Any maintenance requirements would be detected during the field surveys required every five years as specified by the WMP. This period of five years should remain unchanged unless deemed inadequate in the future.

The WMP also specifies that a survey of areas where scour or deposition is detected should take place after an extreme flood event.

As stated in Section 3.3.2, it is recommended an additional survey be undertaken in approximately five years to confirm the assumptions detailed above.

## **Dredging**

The WMP recommends that dredging of the Main Canal will not be required as the volumes of sand scour resulting from flood events will be greater than any gradual deposition. As a matter of caution, the main canal should still be surveyed during monitoring stages. There are currently areas in the Main Channel with up to 400 mm of accretion. Further sedimentation in the absence of a major flood event could see the need for dredging of the Main Channel.

The WMP recommends dredging should take place within the lagoons when sedimentation levels reach 600 mm. The absolute minimum depth required for boats in the waterway is 2 metres and as such, 1.50 metres of siltation is the maximum amount of sedimentation allowed in the lagoons prior to dredging. Due to the expense of setting up and operating dredging equipment and the relatively small size of the Broadwater Canal (Northern Lagoon is approximately 4 hectares and Southern Lagoon covers 2 hectares), it may be prudent for Council to delay dredging when sedimentation reaches 600 mm until it reaches a more significant figure that is still within the bounds of the upper limit (1.50m). Preliminary discussions between Council and the Reference Group indicate the latter is satisfied with the approach proposed.

Further recommendations include:

- Continued monitoring.
- Preparation of a dredging and disposal strategy. The strategy should be developed following consideration of the required dredging volume.
- Investigations into the geochemical properties of the proposed dredge material (contamination and acid sulphate soil).
- Investigations into available onshore dredge material management areas.
- Consideration of other opportunities and constraints presented at the time of dredging (including beneficial reuse in areas of scour in the Main Channel, and commercial partnerships for sale of sand).
- Remaining consistent with the aims and objectives of the WMP.

## **Debris Removal**

A flood event is also likely to deposit items of debris such as tree branches within the waterway. The post flood monitoring will identify any debris that requires removal. In accordance with the WMP, material classified as large flood debris will be removed by Council.

Property owners are required to clean up and remove small flood debris on their foreshore in order to maintain waterway access and foreshore amenity. In addition, it is recommended that Council encourages property owners to alert Council if they encounter large flood debris within the canal waterway.

## 3.4 Sedimentation associated with stormwater culverts

### 3.4.1 Overview

A number of stormwater culverts exist within the Broadwater Canal, the majority of which are located in the Northern and Southern Lagoons. These culverts deposit, amongst other things, sediment into the canal system. Due to low water velocities within the lagoons, these sediments do not settle far from the outlets potentially resulting in a disproportionate build-up of sediment in the vicinity of these culverts.

Raised bed levels as a result of sediment accretion have the potential to restrict or even block the flow of stormwater outlets. Each outlet has a pipe diameter in accordance with its design flow. The diameter of the pipe has an effect on the depth at which the bottom of the pipe joins the canal, as evident in Table 3. It should be noted that all information provided below has been derived from the original design drawings. Also, only the outlets identified on the site visit were included in Table 3, and have been numbered in accordance with Figure 3.

**Table 3 Bed Levels of Stormwater Outlets in the Broadwater Canal**

Outlet Number	Pipe Diameter (mm)	RL at Bottom of Pipe (m AHD)
1	450	-1.35
2	450	-1.35
3	525	-1.58
4	450	-1.35
5	450	-1.35
6	525	-1.58
7	600	-1.66
8	750	-1.82

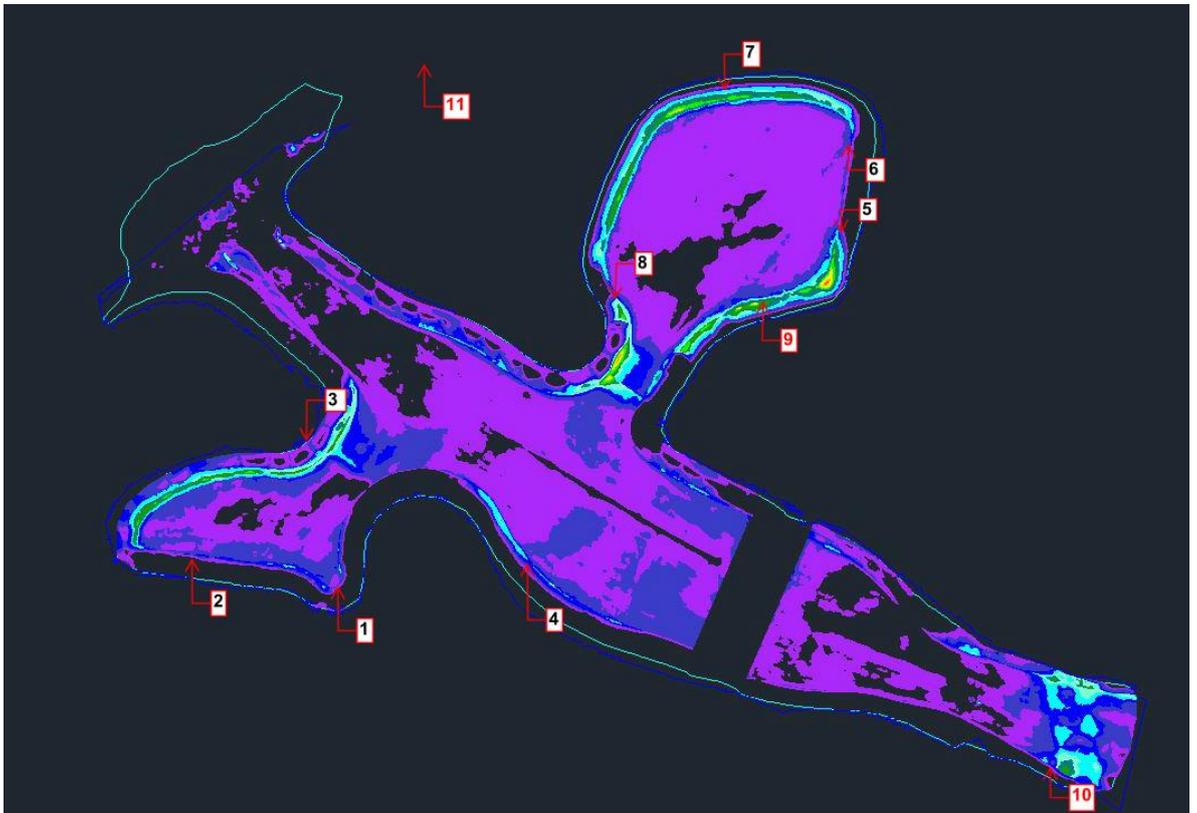
As specified above in Section 3.3.1, the absolute minimum depth for vessels to navigate safely throughout the waterway is 2 m. If water depths were to reduce to this level, vessel navigation would be inhibited however all of the stormwater outlets identified would remain unrestricted by sediment build up. This is because the deepest outlet is only 1.82 m below AHD. This statement is based upon uniform accretion across the canal which is clearly not evident upon inspection of the information provided in Section 3.3.2 and Appendix B. The current canal condition displays elevated levels on foreshore areas, and as such, there is the potential for stormwater culverts to be blocked.

### 3.4.2 Immediate Priority Actions

The hydrographic survey undertaken by Astute Surveying on behalf of GHD identified isolated locations near some stormwater outlets where sedimentation appears to have taken place between the time of construction and present day. As specified in the WMP, dredging should be carried out when deposition reaches 600 mm. Figure 3 illustrates the amount of sedimentation since construction, assuming the canal was constructed according to the initial design, and the approximate locations of stormwater outlets. For further detail on this comparison and information regarding the significance of different colours, refer to Appendix B. Outlets 1 - 8 were identified on the site visit and via aerial imagery, while outlets 9 - 11 were not identified but are included in the Broadwater Canal construction drawings. Outlets 3, 5, 7, 8, 9 and 10 are all

located in regions where levels of sedimentation appear to be greater than the surrounding bed of the canal. However the validity of these levels is ambiguous due to the reasons outlined in Section 3.3.2.

In light of the above considerations, dredging is not required at this point in time.



**Figure 3 Approximate locations of stormwater outlets relative to amount of sedimentation**

### 3.4.3 Recommendations for future monitoring and maintenance

Any maintenance requirements related to stormwater outlets would be detected during the field surveys required every five years as specified by the WMP. This period of five years should remain unchanged unless deemed inadequate in the future.

The WMP also specifies that a survey of areas where scour or deposition is detected should take place after an extreme flood event. An extreme flood event represents an approximate 1 in 30 year ARI flood where waters reach 2.25 m AHD at the upstream junction of the Western Canal and the Hastings River.

The WMP recommends dredging should take place within the lagoons when sedimentation levels reach 600 mm. The absolute minimum depth required for boats in the waterway is 2 metres and as such, 1.50 metres of siltation is the maximum amount of sedimentation allowed in the lagoons prior to dredging. Due to the expense of setting up and operating dredging equipment and the relatively small size of the Broadwater Canal, it may be prudent for Council to delay dredging when sedimentation reaches 600 mm until it reaches a more significant figure that is still within the bounds of the upper limit (1.50 m). It is recommended that Council discusses this approach with the Reference Group.

It is recommended that dredging of the sediments surrounding any stormwater outlets be deferred until dredging of the lagoons (and potentially Main Canal) is required. In the event that localised sediment build up impacts the functioning of the stormwater outlets or navigation

within the canal, consideration could be given to localised dredging using a land-based or barge mounted excavator, or alternatively, diver operated air lifts.

If areas within the vicinity of stormwater outlets in the lagoons are to be dredged, the material should be relocated to areas of sand scour within the Main Channel, provided such areas exist at the time of dredging and the material is suitable for placing. If areas of scour do not exist or the material is unsuitable, then dredged material could be:

- Let to private contract on the basis that the material be retained for private use;
- Let to contract and stockpiled to predetermined areas such as building sites;
- Used for future flood mitigation works; or
- Transported to an appropriate facility and disposed of off-site.

In addition, it is recommended that Council encourages property owners to alert Council if they encounter areas of sediment build up in the vicinity of stormwater culverts.

### **3.5 Contamination of Canal Sediments**

#### **3.5.1 Overview**

Stormwater culverts deposit foreign material directly into the waterway. Foreign material is also introduced to the waterway from upstream areas of the Hastings River. Whilst there are no commercial or industrial activities in the immediate vicinity of the canal, it is possible that these introduced sediments could become contaminated. Such an outcome is unwanted and should be addressed immediately.

#### **3.5.2 Immediate Priority Actions**

Given that no immediate dredging activities are proposed, no sampling and analysis of sediments from the bed of the canal is required.

#### **3.5.3 Recommendations for future monitoring and maintenance**

The WMP provides no guidance on the monitoring and maintenance of canal sediments with respect to contamination. GHD recommend that site specific testing of any sediments requiring dredging be undertaken, using the process outlined below.

Surface sediment samples would be retrieved using a van veen grab sampler which would be lowered from a vessel at each location. For cost effectiveness, it can be assumed that sediment properties will not vary with depth. However, it should be noted that varying hydrodynamic conditions and beach restoration practices could result in deposition of different sediment types throughout the higher and lower flow regions of canals. The proposed sampling and analysis approach would define the sediment types within each area, which may enable various re-use / disposal strategies to be employed.

Sample retrieval, processing, handling, transportation, storage and labelling and analysis would be undertaken in accordance with the NAGD 2009, Acid Sulphate Soil Manual (ASSMAC, 1998), Water Quality Guidelines for Fresh and Marine Waters (ANZECC, 2000) and Sediment Quality Guidelines (CSIRO Handbook, 2000) as appropriate.

In order to characterise the properties and contaminant levels of the sediments, GHD recommends the retrieval of six surface samples in accordance with the Minimum Number of Sampling Locations specified in the *National Assessment Guidelines for Dredging* (NAGD 2009) and analysis in accordance with a typical suite of analytes, as listed in Table 4. The suite of analytes should be reviewed and customised following liaison with OEH.

**Table 4 Proposed Sediment Testing**

Sediment Properties	Proposed Testing
Geochemical	Total Organic Carbon Metals PAH TPH / BTEX Total Phenols Nutrients (nitrite/nitrate/TKN and P) Ammonia Total cyanide OCP and PCB Organotins
Geotechnical	Particle size distribution Hydrometer Moisture content
Acid Sulphate Soils	ASS Indicator Tests

It should be noted that some analytes have been excluded from Table 4 following consideration of the potential contaminants of concern. For example, no analysis for TBT is proposed since the canal contains only recently deposited sediments (significantly after TBT was banned from use in antifouling paint on vessels).

In addition, review of previous analysis results from similar canal systems such as the 2003 sampling of the sediments within the adjacent Settlement Shores Estate indicated the absence of actual acid sulphate soils and suggested a low potential for acid sulphate soils to be present within the sample sediments. This is likely due to the fact that the sediments requiring removal from canal estates such as these do not represent the natural estuarine sediments of the site, but those sediments that have been deposited within the canal system since the initial excavation of the site and/or previous dredging.

Consequently, detailed sampling and analysis for acid sulphate soils is not considered necessary, instead ASS indicator tests are proposed to confirm the absence of ASS/PASS.

## 3.6 Vegetation Growth

### 3.6.1 Overview

The growth of vegetation on foreshore areas is commonplace in canals, especially where the size of rock protection is smaller. Vegetation growth can be beneficial in binding together the soil beneath the rock protection. However, it also has the ability to disrupt and displace rock protection, exposing the foreshore to erosion. This vegetation growth can either be natural, or introduced by property owners. The latter is prohibited in the WMP without approval from Council. In either case, the impact of vegetation on the foreshore should be assessed with consideration given as to whether it should be removed or monitored.

The potential implications of works not in accordance with original design specification include:

- Increased foreshore erosion;
- Inconsistent appearance; and
- Creation of navigation hazards.

### 3.6.2 Immediate Priority Actions

The visual inspection undertaken by GHD identified a number of locations where there is natural vegetation growth on the foreshore. A map detailing the location of areas requiring attention has

been provided in Appendix D. Please note the locations identified in this map are approximate. For further detail on specific locations, refer to the attached Maintenance Works Schedule in Appendix E.

The WMP provides no guidance on the issue of vegetation growth. It is advised that areas where significant growth and foreshore erosion exists should have vegetation removed and foreshore protection replaced. Areas where growth is limited or the foreshore is in good condition should be monitored but remain untouched.

The visual inspection also located areas where vegetation appears to have been introduced by property owners. Such locations are presented in Appendix D. It is possible some of the areas identified are either naturally occurring or have been approved by Council. It is recommended that a Council inspection be carried out to identify whether the locations identified are illegitimate. Discussions between Council and the Reference Group have led to a preferred approach involving the removal of all illegitimate vegetation from the canal foreshore. Council weed management staff would remove or spray most of the vegetation; however, a NSW Fisheries permit is required to remove mangroves. This permit would need to be for ongoing removal rather than one-off, and the cost of the permit would be borne by the Waterway Maintenance Fund.

The visual inspection also found nearshore locations where seagrass was growing, particularly the Western corner of the Southern Lagoon. Seagrasses are protected in NSW and a permit is required from NSW DPI to undertake works or activities that may harm them. It appears as though this seagrass is naturally occurring and hence, removal is not recommended.

### **3.6.3 Recommendations for future monitoring and maintenance**

The WMP provides no guidance on the monitoring and maintenance of disturbance to the canal from vegetation growth. GHD recommends adopting monitoring measures for other features of the waterway. That is, visual inspection of vegetation growth should take place routinely every five years.

It is recommended that Council continues to educate the community regarding the potential impacts of introduced vegetation (as outlined above). This could be undertaken through presentations to the Reference Group, direct liaison with property owners that have introduced materials or through letterbox drops.

Any maintenance requirements would be detected by Council during the monitoring inspections. However, five years is quite a large time frame. As such, it is recommended that Council encourages property owners alert Council if they are concerned with foreshore vegetation growth on their property or any adjacent properties.

## **3.7 Construction Disturbance**

### **3.7.1 Overview**

Undertaking construction activities on or adjacent to the foreshore has the potential to negatively impact on the waterway and surrounding foreshore areas. This may be in the form of sediment deposition, runoff of hazardous materials, removal of foreshore protection leading to scour on surrounding properties, or other issues. As such, any construction activities are required to be approved by Council such that the possible impacts of construction can be properly assessed.

### **3.7.2 Immediate Priority Actions**

The visual inspection undertaken by GHD identified a number of locations where construction is taking place and possible negative impacts could result. A map detailing the location of areas

requiring attention has been provided in Appendix D. Please note the locations identified are based on the site visit undertaken on 14/11/2014 and as such, may no longer be under construction.

Council's records should be consulted in order to confirm that a Development Approval has been granted by Council, and if the construction undertaken is in accordance with the DA. If this is not the case, or no DA has been granted, construction should cease. Further, Council is to undertake removal of unapproved introduced materials in line with the advice presented in Section 1.7.

### **3.7.3 Recommendations for future monitoring and maintenance**

The WMP provides no guidance on the monitoring and maintenance of disturbance to the canal from construction. GHD recommends adopting monitoring measures for other features of the waterway. That is, visual inspection of construction disturbance should take place routinely every five years. Additional monitoring should occur after an extreme flood event where the effects of construction disturbance are likely to be more pronounced, and property owners may feel the need to undertake ad-hoc repairs.

Any maintenance requirements would be detected by Council during the monitoring inspections. However, this is quite a large time frame. As such, it is recommended that Council encourages property owners to alert Council if they are concerned with construction activities on surrounding properties, or if they require maintenance on their property.

## **3.8 Revetment Walls and Footpaths**

### **3.8.1 Overview**

Footpaths, otherwise referenced as "concrete pathways located within an easement for Right of Footway which benefits Council and the public as invitees" are the responsibility of Council. This is despite being located landward of the concrete revetment wall which is the responsibility of the property owner.

Revetment walls are the initial barrier between the foreshore and any landward assets. The main threat to the structural integrity of a revetment wall is the exposure of the toe due to the erosion of foreshore protection. Hence a key method to maintaining an adequate revetment is to maintain a sufficient level of foreshore material.

Footpaths are most at risk to separation and cracking. This can lead to vegetation growth developing in these gaps which will exacerbate the issue. Another threat to footpaths is the condition of the revetment wall. A damaged revetment will allow for movement in the footpath and the development of cracks.

It should be noted that the condition of revetment walls and footpaths are outside the limit of investigations but have been provided for Council consideration. In particular, the condition of footpaths within the Broadwater Canal is due to be investigated as part of future works.

### **3.8.2 Immediate Priority Actions**

According to the WMP, the revetment walls have a design life of 100 years, and as such, it is anticipated that any repairs would be minor. The visual inspection found no evidence of damage to revetment walls

The visual inspection located a number of areas where footpaths were cracking, some of which displayed evidence of vegetation growth. A map detailing the approximate location of such foreshore areas has been provided in Appendix D. It is recommended that as part of Council's

ongoing monitoring that the condition of footpaths be inspected with consideration given to appropriate maintenance works.

### **3.8.3 Recommendations for future monitoring and maintenance**

With regards to revetment walls, any maintenance requirements would be detected during the monitoring inspections required every five years as specified by the WMP. This period of five years should remain unchanged unless deemed inadequate in the future.

The WMP specifies that an additional visual inspection should take place after an extreme flood event. An extreme flood event represents an approximate 1 in 30 year ARI flood where waters reach 2.25 m AHD at the upstream junction of the Western Canal and the Hastings River.

As the revetment wall is the responsibility of the proprietor, Council will alert property owners if maintenance is required. According to the original WMP, if property owners do not undertake the required maintenance after being alerted to by Council, then Council may enter the subject land and repair or replace the said wall and recover the cost from the proprietors.

With regards to the condition of the footpaths, the WMP provides no guidance on the monitoring and maintenance requirements. GHD recommends adopting monitoring measures for other features of the waterway. That is, visual inspection of the footpath condition should take place routinely every five years. Additional monitoring should occur after an extreme flood event.

Any maintenance requirements would be detected by Council during the monitoring inspections. However, this is quite a large time frame. As such, it is recommended that Council encourages property owners to alert Council if they are concerned with the condition of footpaths in the vicinity of their property.

## **3.9 Associated Infrastructure**

### **3.9.1 Overview**

The WMP states that property owners are entirely responsible for the maintenance, repair or replacement of structures including boat ramps. Due to hydrostatic and dynamic forces, these structures are susceptible to damage.

It should be noted that the condition of boat ramps is outside the limit of investigations but has been provided for Council consideration.

### **3.9.2 Immediate Priority Actions**

The visual inspection located one boat ramp that is experiencing differential settlement. It was also brought to Council's attention that a number of ramps in the Western corner of the Southern Lagoon were at risk to undermining due to erosion of foreshore shingles at the low water level. A map detailing the approximate location of the ramps identified has been provided in Appendix D. It is recommended that visual monitoring of ongoing settlement be undertaken by the relevant property owner. If repair or replacement is required, then this will be the responsibility of the property owner although Council consent will be required.

The replacement of foreshore shingles will be undertaken in the required areas as described in Section 3.1.2.

### **3.9.3 Recommendations for future monitoring and maintenance**

With regards to private structures, property owners are entirely responsible for their condition. This includes boat ramps as well as jetties, pontoons and any other form of private waterway structure. As such, property owners should regularly monitor the condition of their private assets, and undertake any works required subject to Council approval.

## **3.10 Cost Estimate**

The actual costs required to address the management requirements of the Broadwater Canal will ultimately be dependent on Council's preferred approach and timing in addressing the maintenance issues described above, as well as Council's approach to resourcing and procurement.

### **3.10.1 Preliminary Order of Magnitude Costs**

In order to inform Council's planning activities, preliminary order of magnitude costs to undertake the recommended monitoring and maintenance activities have been outlined in Table 5. Material cost estimates for rock protection and sand have been supplied by Sheridans Hard Rock Quarry, Hy-Tec Concrete and Aggregates, Sancrox (Hanson), and Midcoast Riverstone.

**Table 5 Order of Magnitude Costs for Actions Identified**

Maintenance Issue	Potential Action	Assumed Quantity	Indicative Costs (excluding GST)
Erosion of foreshore shingles	Replace	Approximately 950 metres of foreshore for an assumed width of 8 m and thickness of 150 mm. Assumed volume is 1140 m <sup>3</sup> . Quoted density of rock from a quarry near Port Macquarie is approximately 2600 kg/m <sup>3</sup> . Hence, quantity of shingles needed is 2,960 tonnes	\$23 - \$55/tonne
Erosion of foreshore rock armour	Replace	Approximately 180 metres of foreshore for an assumed width of 5 m and thickness of 150 mm. Assumed volume is 135 m <sup>3</sup> . Quoted density of rock from a quarry near Port Macquarie is approximately 2600 kg/m <sup>3</sup> . Hence, quantity of shingles needed is 350 tonnes	\$24 - \$55/tonne
Erosion or scour of sand	Replace	Approximately 50 metres of foreshore for an assumed width of 5 m and thickness of 100 mm. Assumed volume is 25 m <sup>3</sup> . Typical density of sand is 1600 kg/m <sup>3</sup> . Hence quantity of sand needed is 40 tonnes	\$31 - \$42/tonne
Sedimentation / scour	Ongoing survey monitoring	1	\$15,000 – 20,000
Routine monitoring	Monitoring of the canal for all issues identified every five years	N/A	No external expenditure. Requires commitment of internal council resources
Post flood monitoring	Monitoring of the canal for all issues identified after an extreme flood event	N/A	No external expenditure. Requires commitment of internal council resources
Post flood monitoring	Installation of flood level markers	8	\$150 per flood marker
Introduced Materials	Liaise and consider enforced removal	Approximately 410 metres of foreshore	No external expenditure. Requires commitment of internal council resources
Introduced Vegetation	Liaise and consider enforced removal	Approximately 160 metres of foreshore	No external expenditure. Requires commitment of internal council resources
Introduced Vegetation	Liaise and consider enforced removal of introduced mangroves	One property	\$168 minimum for annual permit to remove mangroves (Part 7 Fisheries Management Act permit)
Vegetation growth	Consider impacts and remove. If required use council resources	Approximately 660 metres of foreshore	No external expenditure. Requires commitment of internal council resources
Buildup of small debris around Council owned assets	Remove	N/A	No external expenditure. Requires commitment of internal council resources
Sediment quality	Sediment sampling and analysis prior to dredging	1	\$5,000 – 10,000

### **3.10.2 Funding Sources**

The existing WMP funding mechanism is derived from the Special Rate levied by Council on all rateable lands within the Broadwater Canal area. As stated in Appendix I, “one half of the income raised each year shall be allocated to monitoring and routine maintenance, and one half shall be allocated to a reserve within the fund to meet the cost of restoration of Extreme Flood event Damage, including the cost of insuring against such damage.”

The costs required for foreshore restoration works to be undertaken through the renewal of rock armour and appropriately sized shingles will far exceed the annual routine maintenance cost defined in the WMP. However, it is understood that past annual spending from funds gathered for routine maintenance has not equalled one half of that gathered by Special Rate contributions. As such, the Waterway Maintenance Fund has accumulated reserves sufficient to cover the cost of this foreshore restoration. Furthermore, it is likely that the restoration required is a result of previous flood events, and hence it is possible that funds could be sourced from the second half of the Waterway Maintenance Fund if required.

Additional works identified above are not expected to exceed the annual routine maintenance cost defined in the WMP, and accordingly could be undertaken using funds generated from the Special Rate.

Following a review of the information provided in the WMP and that obtained above, it is believed that the current funding mechanism is adequate for Council’s forward planning and maintenance purposes.

### **3.10.3 Prioritisation of Works**

It is recommended that the Reference Group utilise the information presented in Sections 3.1 to 3.9, the costs in Table 5, and their understanding of the present condition of the Broadwater Canal to prepare a priority schedule for maintenance works. This priority schedule would be used to inform Council’s future maintenance works plans.

### **3.10.4 Timeframes for Action**

It is recommended that the immediate priority actions identified in Section 3 be included in Council’s 2017/2018 maintenance works plan, with all work proposed to be completed by June 2018.

The items identified as recommendations for future monitoring and maintenance should be undertaken in accordance with the timeframes presented in Sections 3.1 to 3.9.

## **4. Environmental Considerations and Approvals Pathways**

As detailed in Section 3, a number of immediate priority maintenance actions have been recommended to maintain the condition and design intent of the Broadwater Canal. Council plans to undertake the immediate priority actions within a two year timeframe.

Consequently, a Minor Works Review of Environmental Factors (REF) has been prepared to describe the proposed maintenance works, to document the likely impacts of the proposal on the environment, to detail mitigation measures to be implemented and to determine whether the proposal can proceed. This REF can be found in Appendix J.

## 5. Summary of Recommendations

A summary of the recommendations arising from the investigations completed as part of this study is provided below. These should be read in conjunction with the Maintenance Works Schedule provided in Appendix E.

- Regular monitoring of the Broadwater Canal every five years as well as additional monitoring following extreme flood events. Undertake maintenance in accordance with observations from monitoring.
- Include the immediate priority actions recommended in Section 3 in Council's 2017/2018 maintenance works plan, with all work proposed to be completed by June 2018.
- Replenish foreshore areas identified as being subject to erosion with suitable shingles or rock armour.
- Undertake an additional hydrographic survey within five years to confirm rates and patterns of sedimentation and erosion, and associated need for dredging.
- Revisit the CMP following completion of future hydrographic survey(s) and ongoing monitoring and maintenance.
- Consult with foreshore property owners in the vicinity of riverbed areas above the original design levels (whether as a result of sedimentation of original construction discrepancies) and discuss implications for vessel access.
- If localised sediment build up impacts the functioning of the stormwater outlets or navigation within the canal, consideration could be given to localised dredging.
- Given that no immediate dredging activities are proposed, no sampling and analysis of sediments from the bed of the canal is required at this stage. However, it is recommended that consideration is given to analysis of the physical and chemical properties of the canal sediments in order to inform the planning of future maintenance dredging campaigns.
- Encourage property owners to be proactive in monitoring the condition of the canal and liaise with Council on issues as they arise.
- Liaise with property owners who have introduced material onto the foreshore of their property that contradicts the conditions set out in Memorandum AA703324B (Appendix I). Furthermore it is recommended that Council give consideration to the potential impacts associated with these materials and enforce their removal if deemed appropriate following consultation.
- Monitor natural foreshore vegetation and consider removal if it is deemed to be problematic with respect to aesthetics, collection of debris, damage to foreshore protection or providing habitat for pest species.
- Continue to monitor assets that are prone to accumulating small debris such as the flood control weir and entrance flow deflectors, and undertake necessary removal works.

## 6. References

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# Appendices