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# BEROWRA CREEK
# Estuary Management Plan Review

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# Berowra Creek Estuary Management Plan Review

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| Prepared For: | Hornsby Shire Council |
| Prepared By: | BMT WBM Pty Ltd (Member of the BMT group of companies) |


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**BMT WBM Pty Ltd**

BMT WBM Pty Ltd
126 Belford Street
BROADMEADOW NSW 2292
Australia
PO Box 266
Broadmeadow NSW 2292

Tel: +61 2 4940 8882
Fax: +61 2 4940 8887

ABN 54 010 830 421 003

www.wbmpl.com.au


| | |
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| ***Document :*** | R.N1252.002.00.BCEMP_review |
| ***Project Manager :*** | Philip Haines |
| ***Client :*** | Hornsby Shire Council |
| ***Client Contact:*** | Peter Coad |
| ***Client Reference*** | |

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| ***Title*** : | Berowra Creek Estuary Management Plan Review |
| ***Author :*** | Verity Rollason |
| ***Synopsis :*** | This report details the first review of the Berowra Creek Estuary Management Plan (EMP). The Berowra Creek EMP was developed between 1997 and 2002. This review assesses the completeness and effectiveness of actions outlined in the EMP to meet the prescribed objectives, and to learn where actions were successfully completed, modified, or found to be inappropriate. The review also includes recommendations for continuing actions to meet objectives. |

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# 1 INTRODUCTION

## 1.1 Background

The Berowra Creek and its catchment are located within the Hornsby Shire Council (HSC) Local Government Area. Berowra Creek connects to the Hawkesbury River 25 km upstream of the ocean at Broken Bay. The estuary extends south for 23 km to Rocky Rapid Falls, and 7km to the east along Marramarra Creek. The Berowra Creek catchment drains an area of some 310 $km^2$, of which more than 70% is natural bushland contained within reserves (WMA, 2002). Urban areas to the south and east, typically on the plateau above the creek, house the majority of the catchment's population. Berowra Creek is a drowned paleo valley with strong tidal flows and generally good water quality, although catchment development has diminished this to some degree, particularly through stormwater runoff and discharges from sewage treatment plants (STPs).

Preparation of the Berowra Creek Estuary Management Plan (BCEMP) preparation commenced in 1996, The actions within the BCEMP had originated from various sources including the Berowra Creek Water Quality Management Strategy, the Berowra Waters Plan of Management the Berowra Creek Estuary Process Study and Berowra Creek Estuary Management Study. The BCEMP was finalised and adopted by Council in 2002. The Plan commenced implementation as soon as a draft document was prepared (1997), and has continued since then. The executive summary to the BCEMP is provided in Appendix A.

This document forms the first formal review of an Estuary Management Plan in NSW that has developed in accordance with the NSW Government Estuary Management Manual (1992). Despite the Estuary Management Program being greater than 15 years old, and some 50 estuary management plans prepared during this time, no other plans have be reviewed.

## 1.2 Estuary Management Plan overview

Of the 139 actions outlined in the Plan, 112 have been implemented fully (and of which, 61 were implemented for the entire Hornsby Shire LGA). Only 13 actions were not implemented, of which a few are no longer relevant. In some cases the implementation of the action has resolved the problem, and no further work is required. More often, however, the actions require on-going commitment and maintenance.

Despite close to 100% implementation of proposed actions, some issues still pose a threat to the health and sustainability of Berowra Creek. Further, new aspects to some issues have become apparent. Thus, these outstanding issues will be addressed within the Lower Hawkesbury Estuary Management Plan (LHEMP) that is due for completion in 2008. Even though these issues have not been resolved, it is possible that the BCEMP has assisted in reducing the rate of degradation of the estuary over the past 5 – 10 years. Furthermore, the BCEMP has been the catalyst for improved environmental management of all waterways in Hornsby LGA, as many of the proposed planning, compliance and education activities performed cover the entire LGA, not just land within the Berowra Creek catchment.

There are many issues identified within Berowra Creek that are relevant to the entire Lower Hawkesbury River. As such, actions in the BCEMP that have been found to be successful in mitigating the issues will be adopted in the LHEMP. The LHEMP also provides an opportunity to expand on existing work and undertake new innovative actions to achieve a greater level of mitigation of existing threats to Berowra Creek, as well as the Lower Hawkesbury. It is hoped that the LHEMP will provide a platform to achieve an expansion of activities currently undertaken by HSC, other local councils and state agencies, as well as a transfer of knowledge between councils in the Lower Hawkesbury catchment for mitigating estuary issues.

## 1.3 EMP Review Process

The methodology used to conduct this review essentially involved contacting each of the stakeholders and agencies responsible for implementing the plan, followed by a meeting with Council. In addition, the Berowra Estuary Management Committee were also given a 3 month opportunity to comment on this review document which ended on the 13th December 2007 with no submissions being received.

The agencies contacted included National Parks & Wildlife Service (NPWS), Department of Primary Industries Fisheries (DPI Fisheries), NSW Maritime, Department of Natural Resources (DNR) for DLWC actions, the Civil Aviation & Safety Authority (CASA), the Berowra Valley Regional Park Trust (BVRPT), and Hornsby Shire Council (HSC). Various Landholders were also contacted.

Initially the state agencies, stakeholders, the Berowra Estuary Management Committee and Council were sent a letter and questionnaire-style tables for each action for which they were responsible. Each table listed one action and its timeframe, then questions to gauge the extent of implementation, the effectiveness of the action, any outstanding issues and possible improvements to be made. An example of a table presented is provided in Appendix B. Only one response to the letter and tables was received from the State agencies, namely, NSW Maritime.

Following this, an interview-style meeting was conducted with council staff, Dr Ross McPherson (Manager- Water Catchments) and Peter Coad (Team Leader- Estuary Management) of the HSC Water Catchments Team, both of whom were largely responsible for the initiation and managing the implementation of the BCEMP. During the meeting, every action outlined in the BCEMP was discussed to determine how and the extent to which an action was implemented, the effectiveness of the action, and outstanding issues or improvements to the action which could be made. Where an action was not implemented, the reasons for this, the future need for the action and possible improvements to aid its implementation were determined. In addition, to guiding this review document, the interview and discussion of the actions has also assisted in guiding the development of the Lower Hawkesbury EMP.

## 1.4 Outline of Report

An outline of this report is provided below.

Chapter 1 provides an introduction to the review of the BCEMP.

Chapter 2 lists each of the BCEMP management objectives, and provides a comprehensive review of how and if the objective was achieved, the effectiveness and completeness of the activities

undertaken, and recommendations for future action. A detailed list of the BCEMP actions, their completeness and future action to be taken is also provided.

Chapter 3 provides brief conclusions on the overall effectiveness of the BCEMP, and recommendations for future works.

# 2 REVIEW OF OBJECTIVES AND ACTIONS

## 2.1 Review of Objectives

The BCEMP was finalised in 2002, although a draft version of the plan was being implemented before 2000.

Each of the management objectives, which directly addressed each of the estuary's issues, have been listed below, along with a description of how, and if, the objective was achieved based on the completeness and performance of actions, and recommendations for further action.

### 2.1.1 Objective 1: Data Collection Co-ordination

***"ensure a coordinated and integrated water quality monitoring program is established for the catchment and the estuary which is easily accessible to waterway managers and users"***

**Comments**:

Objective not achieved.

A coordinated and integrated monitoring program or database has not been established. Only one of the five actions to achieve this objective was enacted.

While each of the separate agencies (Hornsby Shire Council (HSC), Sydney Water (SWC), NSW Food Authority (NSWFA), Department of Environment and Climate Change (DECC) (formerly EPA), Oyster Farmers Association (OFA)) has established their own water quality monitoring programs to a high standard, coordinated and integrated sharing of information (refer Actions DCC1, DCC3, DCC4 and DCC5) has not yet been achieved. Differing agendas and fear over intellectual property rights has hindered collaboration between the agencies. The need for a coordinated and managed data receptacle is still present. The former Hawkesbury-Nepean Catchment Management Trust (HNCMT, now Hawkesbury-Nepean Catchment Management Authority (HNCMA)) performed "data mining" of the agencies and collated this data onto a CD (refer Action DCC5). However another such exercise has not been performed, furthermore a continuously updated database is preferable to a one-off collection exercise.

The installation of in-stream flow gauges were completed, as required by Action DCC2 at Galston Gorge, Pyes, Waitara and Tunks Creek.

**Recommendations**:

- Establish a Memorandum of Understanding (MOU) between SWC, HSC, DECC (EPA), NSWFA, OFA, Gosford Shire Council, HNCMA and other relevant agencies to enable data sharing between these agencies. This could be coordinated and managed by HNCMA.
- Compile and maintain a database of all agency monitoring data, using methods such as data mining (which requires very little resources from the agencies), and for use by each agency in annual, state of environment (SoE) and other compliance reporting. It is suggested that the database could be held and maintained by the HNCMA, as part of maintaining the MOU.

- Make data from all agencies available to the public, either directly (through an internet viewing page) or indirectly through public reports (such as the SoE reports), as deemed appropriate by each agency.

### 2.1.2 Objective 2: Human Health and Safety

***"establish formal monitoring, identification and warning procedures as required, so as to safeguard public health and minimise disruption to recreational and commercial waterway users"***

**Comments**:

Objective achieved.

Monitoring, identification and warning procedures have been implemented. Further work to reduce catchment inputs may assist in safeguarding public health and commercial and recreational usage of the waterways, as per Objective 4: Catchment Sourced Pollution.

Actions implemented to achieve this objective ranged from real-time and periodic monitoring of algal concentrations, recreational water quality monitoring for pathogens and other contaminants and use of appropriate warning frameworks such as the Regional Algal Coordinating Committee. (RACC) Reducing concentrations in effluent from STPs and reducing sewer and septic system failures and overflows, which may assist in providing safe waterways for recreation and commercial activities, was also achieved to some degree (refer Objective 4: Catchment Sourced Pollution).

HSC currently conducts a recreational water monitoring program over the summer months, to address the issue of monitoring for faecal contamination and algal blooms (refer Action HHS1, HHS5). An estuarine health monitoring program is also in place. While this program is considered satisfactory, it has been suggested that recreational water quality monitoring should be managed by the EPA (DECC), as part of establishing a monitoring programs for swimming locations across the Lower Hawkesbury Estuary. This is currently in place for Sydney's beaches and harbour through the EPA's "Beachwatch" program. This would provide a more consistent resource for community members, and allow local councils to channel their resources into water quality issues for estuarine health.

HSC is informed by Sydney Water when local STPs begin bypassing (refer Action HHS4), although there is possibly a need to improve the recording of this data by HSC, perhaps into a computer database. Storm/event based monitoring in relation to this is not conducted (refer Action HHS5), as it is not a requirement of the ANZECC Guidelines for recreational water quality monitoring. As warnings are provided for pathogen contamination, this response is considered sufficient in addressing Action HHS5.

Warnings for pathogen contamination (refer Action HHS7, HHS9, HHS10) are provided through signage at recreational swimming locations and baths (warning of swimming for three days following rainfall) as well as appropriate radio and other advertising of warnings. Signage and advertisements are considered the most effective warning available, as recreational water quality monitoring tends to produce results retrospective of contamination events. However, HSC monitoring information is readily provided to community members who enquire as to the safety of swimming locations.

In the case of algal blooms, warnings are required not only for recreational users, but for oyster farmers, as blooms may require closure of harvest facilities until satisfactory water quality conditions return. A real-time chlorophyll-a probe was installed, and provides daily data on HSC's website (http://mhl.nsw.gov.au/projects/berowra/latest.php), for use by any community member (refer Action HHS2, HHS6). HSC provides warnings for algal blooms via the correct protocol, that is informing the RACC who then handle the delivery of warnings to the community (refer Action HHS3, HHS6).

The occurrence of aquatic stingers has rarely occurred in Berowra Creek since the completion of the BCEMP. HSC's response to this issue is that, when informed of the stingers by the community, the outbreak is assessed and notification provided to the wider community should the outbreak be found to be of concern (refer Action HHS4).

Actions prescribed in the BCEMP to reduce the input of pathogens and nutrients (which generate algal blooms) from the catchment, and subsequently reduce the risk to human health and safety, are reviewed and recommended further actions provided in Objective 4: Catchment Sourced Pollution.

**Recommendations:**

- Transfer of the recreational water quality monitoring program to the EPA (DECC) (as part of a recreational water monitoring program across the entire Lower Hawkesbury)
- Investigate the need for real time chlorophyll-a monitors at other known algal hot spots.

### 2.1.3 Objective 3: Estuary Management

***"ensure that Berowra Creek and surrounding estuaries are managed effectively and that the estuary management plans are properly produced and implemented"***

**Comments**:

Objective achieved.

An estuary manager has been employed to effectively manage EMP implementation. The Brooklyn EMP has been prepared and the Lower Hawkesbury EMP is due for completion in 2008.

Two main actions were stipulated within the BCEMP to meet this objective: the employment of an Estuary Manager (Action EM1), and the completion of an EMP for the entire Lower Hawkesbury (Action EM2). The first of these actions was completed successfully, and the second is currently underway.

It is suggested that many of the issues found in Berowra Creek exist across the entire Lower Hawkesbury. Actions, such as the planning, capital works, research, compliance and education activities which are already underway across the LGA, should be carried over into the Lower Hawkesbury EMP. Recommended further actions from this review should also be incorporated into the LHEMP.

**Recommendations:**

- Ensure actions shown to be effective in the BCEMP are carried over into the LHEMP
- Ensure actions not completed are carried into the LHEMP, as applicable

- Ensure the recommended actions from the review of the BCEMP are incorporated into the LHEMP.

### 2.1.4 Objective 4: Catchment Sourced Pollution

***"sufficiently reduce the level of catchment sourced pollutants so as to protect aquatic ecosystems, and allow for primary human contact and the production of edible fish, crustacea and shellfish"***

**Comments**:

Objective partly achieved, further work required.

The majority of actions relating to this risk have been implemented. This has reduced the level of risk associated with catchment sourced pollutants, so long as the measures devised to address this risk continue to be implemented. However, there is an opportunity to further reduce the risk of catchment sourced pollution, by enhancing and expanding upon activities currently undertaken.

In detail, catchment sourced pollutants from existing developments, and managing sediment and litter pollution in stormwater is largely dealt with by HSC's Catchment Remediation Rate (CRR) program. The CRR program provides for the installation, maintenance and upgrade of the stormwater treatment network throughout the LGA, including stormwater treatment devices at the outlets into waterways of the LGA (refer Action CSP10). HSC has also undertaken mapping of the stormwater network throughout the LGA (refer Action CSP6). Stormwater Management Plans (SMPs) have been completed for the Berowra as well as Cowan and Lane Cove catchments (refer Action CSP9). Stormwater treatment devices have been placed at outlets into Berowra Creek through the CRR program (refer Action CSP16).

The actions provided by the CRR program have been successful in reducing stormwater impacts, however, they should be maintained to ensure that impacts remain reduced. In addition, the CRR program should continually strive to improve the level of stormwater treatment provided. Stormwater devices at outlets to all waterways in the LGA (as a priority) should be installed or upgraded and maintained. Stormwater treatments which provide the highest level of pollutant removal, such as for nutrients, oils etc in addition to litter and sediment, should be installed in preference to other treatment devices.

The CRR program also manages leachate and runoff from former and existing landfill sites in the LGA (refer Action CSP5). Of the 20 former landfill sites, three were found to be leaching (Fox Glove, Dartford Road and Arcadia), and drainage works, collection pits and treatment of runoff/leachate for re-use have been undertaken at these sites.

HSC's Development Application (DA) approval process stipulates the use of Soil and Water Management Plans for developments > 2500 $m^3$ or Sediment and Erosion Control Plans for developments < 2500 $m^3$ (as per Action CSP7). The DA process also utilises the Water Sensitive Urban Design (WSUD) Policy and stipulates the style and size of stormwater treatment to be used on the new development (as per Action CSP10).

HSC completed a Sustainable Total Water Cycle Management Strategy (STWCMS) for the LGA at the end of 2005, which effectively addresses Action CSP1 and CSP3. The STWCMS enables HSC to

assess and provide the most effective option for maintaining the water balance in the LGA. The strategy consists of two components. One is the strategy itself, which details HSC's vision for the total water cycle, the methods to achieve the vision, and monitoring programs to measure performance. The second component is a suite of models (E2, EUM, MUSIC) which allow HSC to assess development scenarios, experiment with different management options, and determine the most effective scenario to achieve their total water cycle aims. The models are said to contain the best available knowledge about the LGA's water balance, and enable Action CSP3 to be implemented (ISF & SKM, 2005).

The BCEMP has also outlined a number of actions to reduce catchment runoff, which will assist in reducing catchment sourced pollution. These actions are detailed in Objective 5: Freshwater Inputs below, and include requirements for the percentage of pervious area on new developments (refer Action FI5 and FI7), encouraging water reduction devices (refer Action FI3), onsite collection of rainwater (refer Action FI3 and FI6), greywater re-use (refer Action FI4) and effluent re-use (refer Action FI1 and FI2).

Urban design and development on sensitive lands (refer Action CSP11, RSP10 and SN9), which may impact pollutants in runoff, is managed through the DA process, and the Sensitive Urban Lands DCP which protects foreshore areas. It is suggested that new DCPs and review of existing DCPs should incorporate the highest environmental standards to reduce catchment sourced pollution, and also, to meet other objectives outlined in the BCEMP. New and existing DCPs should stipulate the highest environmental standard for stormwater and sewage design, percentage pervious area, water reduction measures (also in Objective 5: Freshwater Inputs), vegetation preservation (Objective 17: Mangroves and Saltmarsh), indigenous planting and weed management (Objective 19: Weeds) and energy efficiency.

Assessments of land capacity for developments (Action CSP11) have been conducted variously in the past (for example, the Hornsby Shire Waterways Review by SJB, 2005). However, Hornsby LGA is required to house an additional 10,590 people between 2004 and 2010, an increase of 6.97% (ISF & SKM, 2005). The viability of this within the LGA's existing lands requires re assessment as per Action CSP11, for the entire LGA. The finite nature of land and waterways resources suggest that a comprehensive assessment of the carrying capacity of all land in the LGA (based on water, air and land capability) to support further development needs to be completed. Furthermore, HSC should be permitted to update and rezone under the LEP to restrict further development where it is considered to be beyond the capacity of the land and waterways of Hornsby LGA.

While many of the actions outlined in the BCEMP to address faecal contamination were enacted, this issue remains for Berowra Creek and other waterways in the LGA. The actions were not so much ineffective in achieving their aims as, now that they are complete, other factors contributing to faecal contamination can and should be addressed. The actions and recommendations addressing remaining factors are outlined below.

Sydney Water (SWC) conducted a $26 million upgrade of their treatment facilities, providing a vastly improved effluent quality to be discharged to Berowra Creek (refer Action CSP4). In addition, SWC has upgraded pumping stations in order to meet their EPA license requirements, which allow no overflows from pumping stations during dry weather and only one overflow during wet weather annually (refer Action CSP8).

However, sewer overflows from other components of the system remain an issue within Berowra Creek catchment, and indeed the entire LGA. Sewer overflows due to mushrooms and sewer chokes in the sewage pipe network in Hornsby LGA are not scheduled for upgrade as part of SWC's SewerFix program (SWC, 2007). It is suggested that the pipe network of Hornsby LGA should be added to the SewerFix program.

Compliance audits of the private sewer system, which is estimated to cover a similar distance as the public pipe network, were specified as an action in the BCEMP (refer Action CSP15), but have not been conducted. Such audits should be initiated, such as by re-instating the Pipeworks program formulated by the NSW Government.

Hornsby LGA has initiated compliance audits of all on site sewage management (OSSM) systems as part of its OSSM Strategy (refer Action CSP13, RSP1). The 2004-06 OSSM Strategy was completed, and the draft 2007-09 Strategy is currently underway. Compliance monitoring has ensured many systems have been improved from a standard of high risk to low risk. However, OSSM systems in river settlements are still considered high risk, because riverside locations are unsuitable for such systems and are of particular concern where settlements are in close proximity to Priority Oyster Aquaculture Areas. This, and the possible provision of a pumpout facility for riverside developments (Action RSP4), are discussed further in Objective 7: River Settlement Sourced Pollution.

To lend support to the planning and other actions outlined above, compliance audits are conducted for new developments, Soil and Water / Sediment and Erosion Control Plans and for OSSMs as part of the OSSM strategy. An expansion of existing compliance activities, especially with the employment of a 'Riverkeeper' would further strengthen the effectiveness of planning controls. In particular, developments are inspected during and immediately following construction for compliance with pervious area, stormwater and design requirements. However audits in the years after construction could ensure that onsite stormwater systems are maintained, and pervious areas and other environmental factors are retained at the development.

A number of education activities are being undertaken by HSC, as outlined in Objective 10: Estuary Recreation Facilities, which further support the above actions. In particular, leaflets and pamphlets on a range of water catchment issues (refer Action ERF11), and an internet website (refer Action ERF12) are available to community members, and for school projects. An expansion of education activities, such as site visits with local schools and/or community to educate on the interaction between catchment activities and the estuary, may further enhance catchment pollution reduction outcomes.

In order to assess water quality in the estuary (refer Action CSP2), HSC conducts an estuarine health monitoring program. Pollutant loads from Sydney Water STPs (refer Action CSP3), are monitored and available to HSC from Sydney Water. In addition, water quality monitoring is also conducted by OFA and NSWFA as part of the Safe Food program (refer Objective 2: Human Health and Safety). The existing water quality monitoring is considered satisfactory.

**Recommendations:**

- Complete Action CSP15: Conduct compliance audits of the private sewer network to eliminate sewer overflows.

- Undertake the SewerFix Program in Sydney Water's reticulated sewage pipe networks, to eliminate sewer overflows.
- Increase provision of compliance audits for OSSMs throughout the LGA.
- Conduct a comprehensive assessment of the carrying capacity of all land in the LGA (based on water, air and land capability) to advise planning on appropriate areas for development potential .
- Gain permission for HSC to update and rezone the LEP to restrict further development in its LGA where it is considered to be beyond the capacity of the land and waterways.
- Ensure continuous inspection, maintenance and upgrade of the stormwater treatment network, particularly at outlets to the waterway, to provide the highest level of pollutant removal (such as for nutrients, oils and other contaminants, in addition to litter and sediment).
- Ensure all DCP reviews incorporate a high standard of environment protection for the estuary.
- Increase existing compliance activities and expand activities to include audits of developments in the years following approval.
- Ensure models used as part of the STWCMS are kept up to date with the best available knowledge of the LGA's water balance.
- Increase educational activities to further promote understanding of the relationship between catchment activities and water quality in the estuary.

### 2.1.5 Objective 5: Freshwater Inputs

***"reduce the volume of catchment sourced freshwater to a level suitable for the restoration of aquatic ecosystems in the upper estuary"***

**Comments**:

Objective partly achieved, further work required.

Half of the actions required to achieve this objective were implemented. Those not implemented are still relevant and should be pursued within the LHEMP.

Actions to encourage reuse of STP effluent by Sydney Water (refer Action FI1 and FI2) were not implemented. It is suggested that, especially in lieu of the current installation of an STP at Brooklyn, this action should continue to be pursued.

The action of encouraging and expanding recycling and re-use of water, which may also assist to reduce catchment pollution, is currently only covered by planning controls. In addition to the STWCMS (refer Objective 4: Catchment Sourced Pollution), HSC has a Sustainable Water DCP which outlines HSC policy on greywater re-use (refer Action FI4), and rainwater tanks (refer Action FI3 and FI6).

Greywater reuse has recently changed as per the March 2007 release of the NSW Guidelines for Greywater Reuse in Sewered, Single Household Residential Premises by the Department of Energy, Utilities and Sustainability (DEUS). Greywater reuse is not permitted on premises with more than one dwelling (eg, apartment blocks). However, diversion devises are now permitted to be installed in

homes without council approval, so long as certain conditions are met. HSC should encourage the installation and correct use of diversion devices for greywater reuse as per the new Guidelines.

Sydney Water also supports the use of water reduction devices (refer Action FI3), through incentive schemes for rainwater tanks, front-load washers and water-saving shower and tap heads. However, further incentives and stricter planning controls could expand the uptake of water reduction devices.

HSC's Sustainable Water DCP encourages infiltration to groundwater where appropriate (refer Action FI5), and stipulates percentage of pervious area (refer Action FI7) in new developments. In addition, the STWCMS enables Council to assess the impact of development on the total water cycle, and therefore, freshwater inputs. One improvement to the above actions may be larger requirements for percentage pervious land area and the inclusion of landscaping in calculations of impervious area for new developments.

Education to encourage onsite collection of rainwater (refer Action FI6) has been provided via factsheets and workshops to local community, and to new developers during the DA process. Increased education activities may be coordinated with incentives and planning provisions to increase the uptake of water reduction devices and re-use opportunities.

**Recommendations:**

- Continue to pursue the recycling of treated effluent from STPs, including the pending Brooklyn STP.
- Increase the uptake of water reduction devices (rainwater tanks etc) through greater incentives and planning controls.
- Increase education activities to support incentives and planning provisions to increase the uptake of water reduction devices and re-use opportunities.
- Encourage the appropriate installation and usage of diversion devises for the reuse of greywater as per DEUS, 2007.
- Increase the percentage of pervious area and include landscaping (paving) in the calculation of impervious area for new developments.

### 2.1.6 Objective 6: Boat Sourced Pollution

***"eliminate boat sourced pollutants by providing appropriate infrastructure and controls"***

**Comments**:

Objective partly achieved, further work required.

Actions within the BCEMP addressed a significant number of boating issues within the creek, and many of the actions were implemented. These actions were effective in reducing the level of risk associated with boat sourced pollutants, so long as the actions continue to be implemented. However, the risk of boat sourced pollutants remains, and there is a need to implement new actions in addition to continuing existing actions, to mitigate this risk further.

Boat sourced pollutants are mostly due to the discharge of sewage and greywater from boats in the waterway. As such, the major actions to address discharge involve the installation of pumpout

facilities (Actions BSP2, BSP5 and BSP6). HSC has installed a pumpout facility for boats at Kangaroo Point, Brooklyn.

Action BSP6 also stipulated the installation of a pumpout at Berowra Waters Marina. While a pumpout was proposed to be installed as part of the Marina's Development Application, the application was not approved and as such, the pumpout has not been installed. It has been suggested that the Marina could be made to install a pumpout by making this a requirement of the renewal of the EPA Licence for the Marina's STP with DECC (EPA).

NSW Maritime prohibits the discharge of untreated sewage into waterways (refer Action BSP9) under the Protection of the Environment and Operations Act, 1997. NSW Maritime can issue an on-the-spot fine of $750 for individuals and $1500 for companies for any offence relating to the pollution of NSW waters (NSW Maritime, 2006).

The *Marine Pollution Amendment (Waste Discharge and Oil Spill Response Plans) Regulation* 2003 established 'no discharge zones' for treated sewage. The discharge zones apply to waters within 500 metres of aquaculture, bathing, mooring and anchoring areas, persons in the water, beaches and marinas. This effectively means all waters in Berowra Creek may be classed as a 'no discharge zone' (NSW Maritime, 2007).

Additionally, the *Marine Pollution Amendment (Waste Discharge and Oil Spill Response Plans) Regulation* 2003 stipulates that certain classes of vessels (Class 1 passenger carrying and Class 4 hire and drive) must have toilets with holding tanks (NSW Maritime, 2007). Certain classes of commercial vessels are additionally required to have greywater holding tanks (essentially those built after 1 January 2005 and of Class 1 or 4) (NSW Maritime, 2006). This will assist in reducing pollution discharges from those vessels with the likely greatest impact due to the number of people typically utilising commercial vessels.

Unfortunately, these stipulations for holding tanks do not apply to recreational vessels, and while it is an offence to pollute waterways, the illegal discharge of blackwater and even the legal discharge of greywater may still threaten the health of Berowra Creek. Regulations should be strengthened to require holding tanks for both sewage and greywater and should be applied to both recreational and commercial vessels.

NSW Maritime regulations also prohibit the permanent occupation of boats (refer Action BSP1).

Solid-waste management for localities servicing boat users (such as marinas and boat ramps) is provided by HSC's Waste Division (refer Action BSP3, BSP4 and BSP5). Further impetus for boat users to collect their rubbish whilst utilising the waterway may be encouraged through the provision of litter bins in all hire boats, and perhaps to all boaters using the waterway.

Another major source of pollutants from boats is anti-fouling paints and maintenance activities, which may involve striping of paints and other debris. Paints and maintenance are typically associated with heavy metal contamination of sediments. An investigation to determine the contamination of sediments in all Lower Hawkesbury waterways managed by HSC (Action BSP8) is currently underway. This study will assess both heavy metal contaminants as well as algaecides, which became an ingredient of anti-foul paints following the ban on tributyl tin (TBT) in the 1980s. Heavy metals are discussed further under Objective 8: Heavy Metal Accumulations.

NSW Maritime has produced a number of educational brochures detailing correct environmental practice for boaters (refer Action BSP7), in particular, the “leave nothing in your wake” brochure. These brochures are available to all boat users from NSW Maritime or at marinas, and include details of best waste management, boat wake, seagrass protection, noise reduction and boat maintenance practices (ie, maintenance activities out of the water and in an area where debris can be collected and appropriately disposed). A leaflet specific to Berowra Waters detailing methods to reduce boat wake and protect seagrass was produced by NSW Maritime, and is available at Berowra Marinas. Methods to increase the uptake of this educational material to the boating public are recommended, such as broader advertising campaigns.

Greater compliance activities for regulations that restrict pollution of the waterway (discharge, littering and boat maintenance activities) would assist in reducing boat sourced pollutants. A “River Keeper” for the Lower Hawkesbury (as recommended by the Brooklyn EMP) may assist NSW Maritime to enforce pollution but also other environmental regulations, such as speed zones, seagrass protection and noise considerations.

Furthermore, there are no requirements for auditing environmental practices on boats. While moorings (but not boats) are assessed at the time of their lease renewal (and fines relating to water pollution may be issued where an offence is seen or reported to NSW Maritime), the activities of boat owners and the environmental performance of the boat are not audited. This is particularly felt to be an issue for boat owners at moorings who may perform maintenance activities in the water and without containment of debris. Additionally, boats may be responsible for other pollutants namely, litter and effluent discharges (as noted above and in Objective 4: Catchment Sourced Pollution) and oil from automatic bilge pumps (Objective 9: Oil Spills). Audits could enable an assessment of environmental practices used on the boat, and assist in educating boat users.

**Recommendations:**

- Require Berowra Waters Marina to install a pumpout, such as by a requirement for the renewal of the EPA Licence for the Marina’s STP with DECC (EPA).
- Increase regulations to include holding tanks on recreational vessels as well as commercial vessels, and for both grey and black water.
- Greater policing of the waterways to reduce illegal discharges and / or littering, and other prohibited activities on boats, such as by employment of a River Keeper
- Initiate a program to audit the environmental performance of boats and boat owners (especially at moorings), particularly to ensure boat maintenance activities are carried out using correct environmental procedures and facilities, and all boat waste (litter, effluent, and oil discharges from automatic bilge pumps) is managed environmentally. The audit could reasonably be combined with mooring lease appraisals.
- Increase the distribution of educational material and educational activities about correct environmental practices for boaters using the Hawkesbury waterways.

### 2.1.7 Objective 7: River Settlement Sourced Pollution

***"eliminate pollution sourced from River Settlements by providing appropriate infrastructure, servicing and controls"***

**Comments**:

Objective not achieved, further work required.

Most of the actions were only partly implemented, and the actions have not been sufficiently effective in mitigating this risk due principally to insufficient resources (ie funding and staff availability). Full implementation of actions and additional works are required.

The audit of OSSMs on river settlements (Action RSP1) is conducted as part of the OSSM strategy. As part of such audits, required maintenance and alternatives to OSSM systems at inappropriate locations are recommended (Action RSP2). However, riverside OSSMs are still considered to be high risk due to their location on the riverside.

A cost/benefit analysis to provide a pumpout service for riverside settlements was conducted (Action RSP4). It was found that the service would not be economic because too few of the settlements utilised a pumpout on-site system. It is possible that a pumpout service could be made economic if compliance audits required all riverside settlement OSSMs to be desludged immediately (and more frequently than 3-5 years, as is presently recommended). Further to this, compliance audits that stipulate converting all existing riverside OSSMs to pumpout would ensure that a pumpout service be supplied to the settlements (by creating a market for the service), and thus achieve a reduction in pathogen inputs to the waterway. A reduction in pathogens is also a requirement for achieving Objective 2: Human Health and Safety and Objective 4: Catchment Sourced Pollution.

The issue of OSSMs on riverside settlements (Action RSP2) is addressed for new developments through the DA process, and the River Settlements DCP. This process determines the appropriateness of using OSSM systems based on soil and vegetation types, topography and land constraints for new riverside developments.

The River Settlements DCP and the DA process stipulate the use of Soil and Water Management / Sediment Erosion Controls at development sites (Action RSP3).

The River Settlements DCP also outlines the requirements for design and construction of River Settlements, and associated catchment pollution and runoff. This DCP is currently under review. As noted in Objective 4, it is important that this DCP be updated to include the highest standard for environmental protection of the estuary. The updated DCP should include the considerations outlined in the BCEMP for sewage management (Objective 2, Objective 4, Actions RSP1-6), stormwater runoff (Objective 4: Catchment Sourced Pollution, Actions RSP3), urban design (Objective 4: Catchment Sourced Pollution, Action RSP10), water reduction measures (Objective 5: Freshwater Inputs), vegetation preservation (Objective 17: Mangroves and Saltmarsh), weed management (Objective 19: Weeds) and energy efficiency.

Litter/ solid waste pollution outlined in Action BSP4 is also relevant to riverside developments. There are currently discussions within HSC to provide a solid waste collection service to riverside developments, which will further reduce the potential for litter/solid waste pollution of the waterway.

**Recommendations:**

- Ensure the updated River Settlements DCP contains the highest standard of environment protection for the estuary and waterways through stringent stipulations for stormwater / runoff control, sewage management requirements, urban design, vegetation preservation, weed management, water reduction devices and energy efficiency.
- Require all riverside settlements to convert OSSMs to pumpout, and provide a pumpout service to riverside settlements as per Action RSP4, with the State agency support to off set costs involved.
- provide a solid waste collection service to riverside developments, to further reduce the potential for litter/solid waste pollution of the waterway

### 2.1.8 Objective 8: Heavy Metal Accumulations

***"control inputs from known sources such as boat slipping antifouling activities and road surface runoff. Any other major sources of sediment pollutants are also to be identified and managed so as to prevent ongoing accumulations"***

**Comments**:

Objective mostly achieved, further work required.

The actions undertaken have greatly reduced the incidence of heavy metal contamination from boat maintenance, as the first significant step for this objective. There is now an opportunity to attempt reductions in heavy metal inputs beyond the marina facilities, and this will be well supported by completion of current studies into heavy metal and other contaminants from boats.

The actions outlined in the plan typically aimed to reduce inputs from boat maintenance works, and reduce sediment inputs from nearby roadway so as to reduce heavy metals which typically attach to sediments.

An audit of BIA Marinas recommended two actions, as the outcomes required the installation of appropriate slips, water containment areas and dry docks for boat maintenance activities at the Marina (Action HMA1 and HMA2). However maintenance activities on boats at moorings may still be conducted without collection of debris or runoff. As recommended in Objective 6: Boat Sourced Pollution, audits are required to ensure maintenance activities performed on boats at moorings do not contribute to heavy metal and other contamination of the waterway.

Sediments eroding from Kirkpatrick Way were addressed by the sealing of the road rather than drainage improvements as suggested in Action HMA3. Similarly, sealing of the road was seen to achieved sediment reduction outcomes, but not oil separation for runoff from the eastern car parking area (Action HMA4). The installation of an oil water separator may still be required and should be investigated for this location.

Dusthole Bay has had a Rocla system at the car park and a pit insert with pit bull litter basket for sediment installed, as per Action HMA5. Similar sediment capture devices should be investigated for all direct outlets to the estuary, as noted in the recommendations for Objective 4: Catchment Sourced Pollution. Maintenance of all sediment traps and oil water separators (Action HMA6) is completed

under the CRR program. Additional stormwater treatment devices are being considered as part of the CRR program for this area.

The correct usage of herbicides on reserves and parks (Action HMA7) is performed by HSC, with Council parks officers, bushcare volunteers and contractors trained in correct application of herbicides, as part of the Bushcare program or by Bushland and Biodiversity Officers with HSC.

The action of ferry maintenance (HMA8) was completed with the former operators informing HSC of any maintenance activities. However since RTA assumed operation of the ferry, this information has no longer been provided to HSC. This action should be re-enacted by HSC with the new ferry operators, RTA.

As noted in Objective 8: Heavy Metal Accumulations, the identification of heavy metal sources and existing sediments (Action HMA9 and HMA10) is currently underway.

**Recommendations:**

- As per Objective 6: initiate a program to audit the environmental performance of boats and boat owners (particularly at moorings), for boat maintenance activities etc.
- Investigate the need for an oil water separator at Kirkpatrick Way (and other relevant direct outlets to the estuary).
- Resume the informing of HSC by ferry operators of the occurrence of all maintenance activities.

### 2.1.9 Objective 9: Oil Spills

***"identify the source of the oil spills and implement measures to manage and prevent further spills"***

**Comments**:

Objective mostly achieved.

The main suspected source of oil spills has been removed, and the other main suspected source needs to be investigated for mitigation.

Oils spills in Berowra Creek were suspected to be sourced from either an underground storage tank (UST) at the eastern Marina at Berowra Waters, or from automatic bilge pumps discharging water from boats during rainfall. The marina removed the UST however investigations into oil slicks due to automatic bilge pumps from boats has not been investigated (Action OS1).

An incident and emergency action plan held by HSC included provisions for oil spill incidents in Berowra Creek (refer Action OS2). The emergency action typically involves aeration of the water containing the spill through use of power boats (typically from the Fire Brigade).

**Recommendations:**

- Investigate the potential for oil spills due to automatic bilge pumps on moored boats, and manage as required.

### 2.1.10 Objective 10: Estuary Recreation Facilities

***"meet the reasonable requirements of recreational users of the waterway in a way that facilitates use whilst minimising the impacts on the environment, residents and users"***

**Comments**:

Objective achieved, further works may be investigated.

A number of the actions prescribed in the BCEMP for this objective are now considered to be community issues rather than direct estuary issues. However, the majority of actions have been implemented, with a focus on the welfare of the creek rather than ancillary issues such as the provision of car parking.

The actions spanned such activities as the provision of radio controlled signage at Berowra and Berrillee to inform of road closure and parking (Action ERF1), which was completed insofar as portable signage is utilised to inform of road closure but not the daily availability of parking, which is not considered an issue for estuarine health. Similarly the action of decking for Dust Hole Bay carpark (Action ERF2) or increasing the parking at the public jetty (Action ERF3) have not been completed, and further, while such actions may be completed as part of another program by HSC, these actions are no longer considered an estuarine health issue.

The Crosslands Master Plan addressed a number of the recreational facility actions, such as provision of shade trees and seating in foreshore and picnic areas (Actions ERF9 and ERF10), the provision of heritage and interpretive signage (Action ERF8 and ERF13), improved maintenance of Sommerville Road (Action ERF15), restricting use of the boat ramp at Crosslands (ERF17) and consideration of educational facilities at Crosslands (Action ERF16), which was found to be inappropriate, and educational signage erected instead. The Bushcare program has also assisted in the provision of shade trees, plants and seating throughout the entire LGA, in addition to Berowra Creek. Implementation of the Crosslands Master Plan is likely to continue for the next few years, and will provide further benefits to the recreational facilities of Berowra Creek.

While there is no official "ban" on personal water craft use except for through passage upstream of Neverfail Bay (as per Action ERF18), NSW Maritime advises that "irregular driving" within 200 metres of the shoreline is not permitted (penalties apply). This effectively enforces a ban on "irregular driving" throughout the creek, because the creek is less than 400 m wide. Compliance and enforcement of this restriction by NSW Maritime is not known.

Educational actions (ERF11 and ERF12) have been completed, through the provision of educational brochures at Berowra Regional Park and for school projects or general use through Council's website (the estuaries homepage). Better promotion of the website and brochures would further the effectiveness of this action.

Surveys for visitor numbers (Action ERF14) were completed for trailable boats only. HSC contracted the Ecology Lab to conduct a survey of recreational and commercial fishers (numbers and activities) in the Creek. However, only details for recreational fishers were obtained, as commercial fishers refused to cooperate with the Ecology Lab. The need to determine commercial fishing numbers and activities in Berowra Creek as a separate component of the Hawkesbury Trawl Association (indeed,

separately for each tributary in the Lower Hawkesbury) and including the activities of commercial fishers outside of the Association remains and should be pursued in a manner which encourages the cooperation of commercial fishers.

Surveys of recreational usage of Ku-ring-gai Chase NP are compiled by NPWS from time to time, and include all recreational activities (ie bushwalking, picknicking, riding, boating, barbequing, sight seeing etc). Surveys for all components of recreational usage in all areas should be completed in addition to recreational fishing information and usage of Ku-ring-gai Chase NP. Recreational usage of the estuary is responsible for a large number of potential and actual issues, in particular: recreational boating due to discharges, boat wake etc as outlined in Objective 6: Boat Sourced Pollution; and foreshore usage, which may result in littering and degradation of foreshore habitats and reserves, as outlined in Objective 4: Catchment Sourced Pollution and Objective 13: Sedimentation/Navigation.

The remaining actions, such as rock trimming at Berowra (Action ERF4) and improved safety for pedestrian access to the ferry (Actions ERF5, ERF6 and ERF7) were also implemented, and no further action is required in this regard.

**Recommendations:**

- Determine commercial fishing numbers and activities in the Creek as separate from the Hawkesbury Prawn Trawl Fishery (indeed, within each tributary of the entire LH estuary) in a manner which encourages the cooperation of commercial fishers.
- Develop a Management Plan to address commercial and recreational fishing activity.
- Surveys for all types of usage of recreational areas/reserves should be completed, to gauge numbers and usage.
- Employ a River Keeper to assist in the enforcement of PWC (and other) regulations in LH waterways.
- Continued and increased activities for tree planting and recreational improvements as per Bushcare programs.
- Complete implementation of the Crosslands Master Plan.
- Interpretive signage should be provided at strategic locations throughout the Lower Hawkesbury estuary.
- Greater promotion of Council's estuaries homepage and brochures.

### 2.1.11 Objective 11: Estuary Tourism Facilities

***"provide increased opportunities for estuary based tourism by improving the available facilities and access/parking arrangements in a way that ensures safety and minimises adverse impacts on the environment, residents and users"***

**Comments**:

Objective achieved.

Many of the actions outlined for this objective (ie lease arrangements, parking, commercial floor space) are already performed as part of standard Council activities, and are not considered relevant

for an estuary management plan. Focus is given more to actions which will enhance the estuarine environment (for residents and users as well as habitats), rather than standard actions performed within the existing town planning process.

Council's LEP and DA process ensure that commercial development beyond existing zoned areas (Action ETF1) is restricted, commercial floor space is only increased where environmental performance is improved (Action ETF2), and commercial property are consistent with the urban design strategy (Action ETF5). Lease arrangements for commercial properties (Action ETF4 and ETF5) are addressed through HSC's lease renewal process. All of these actions are part of standard Council activity across the LGA and are not focussed on the needs of Berowra Estuary alone. It is suggested that assessment of tourism facility actions required for Berowra should be investigated, formulated and enacted.

Parking issues for Berowra Waters are managed by the Berowra Waters Plan of Management (Action ETF3), and no further action is required (parking is not considered an estuary issue). The Crosslands Master Plan covers actions such as eco-tourism facilities (Action ETF8) and tourism boardwalk (Action ETF9) at Crosslands.

Seaplanes have been banned from Berowra Waters, with planes required to land downstream and motor up to the Marina at Berowra Waters (Action ETF10).

At present, a program of spotlighting and wildlife trips are run through Chase alive (for Ku-ring-gai Chase NP) and HSC's Bushwalks program (Action ETF7). Further programs to promote education about the estuary should be pursued.

**Recommendations:**

- Investigate, formulate and implement actions for estuary tourism which are focused on the environment of Berowra Creek
- Expand the provision of programs (such as site visits, wildlife trips and spotlight tours etc) to promote education about the estuarine environment.

### 2.1.12 Objective 12: Boat Moorings

***"provide boat moorings with adequate safety/security but without significant adverse impact on the ecology of the waterway or visual amenity of the area"***

**Comments**:

Objective achieved.

This objective should be updated to achieve a reduction in impacts from moorings.

NSW Maritime administers the main actions associated with boat moorings, namely, no net increase in existing moorings/berthings in Berowra Creek and maintenance of geographic and numerical limits (Action BM2), and increased marina spaces only to replace existing swing moorings (Action BM1). There may now be an opportunity to modify this action to reduce the number of moorings overtime as part of the appraisal of lease renewals. Also, as noted in Objective 6: Boat Sourced Pollution, the

lease renewal process could also incorporate an audit of environmental performance of boats and owners.

The issue of lighting for moorings (Action BM3) has been addressed with the Marina installing lighting, and there are no further issues in this regard.

The enforcement of existing no wash/wake zones (Action BM4) is undertaken by policing and education by NSW Maritime. As noted in Objective 6: Boat Sourced Pollution, a 'River Keeper' may assist in enforcing speed zones. The adequacy of existing speed zones to protect riparian environments from erosion is discussed in Objective 13: Sedimentation/Navigation.

**Recommendations:**

- Ensure there is no net increase and potentially reduce the number of boat moorings.
- As per Objective 6: initiate a program to audit the environmental performance of boats and boat owners at moorings, such as part of mooring lease renewal process.
- As per Objective 6: employment of a River Keeper to assist in enforcement of existing speed zones.

### 2.1.13 Objective 13: Sedimentation / Navigation

***"reduce catchment sediment infeed rates, and undertake remediation works (such as dredging) if feasible and desirable, in areas where navigation channels were available in the past"***

**Comments**:

Objective mostly achieved.

The navigational component of this objective was met, and actions outlined to meet the sediment infeed component were largely a repetition of actions outlined for Objective 4. In addition to those recommendations for Objective 4, which likewise apply to this Objective, actions relating to the preservation of vegetation were mostly achieved, with further work required, and new actions relating to bank erosion are also suggested.

Actions to achieve this objective largely addressed catchment sources of sediment in the waterway. The CRR program, DA process, Sediment and Erosion Control/Soil and Water Management Plans and WSUD Policy are enforced to reduce catchment sediment sources (Action SN1), as noted in Objective 4: Catchment Sourced Pollution. Similarly, these processes also assist to ensure new urban releases implement sound soil and water controls, which minimise nutrients, sediment and spread of weeds (Action SN2), also noted in Objective 4.

In fact, a number of actions are repeated directly from Objective 4, namely: SN4 repeats CSP6, SN5 repeats CSP7, SN6 repeats CSP9, SN7 repeats CSP10 and SN9 repeats CSP11, and need not be discussed again here. In addition, Action SN8 (ensuring BMPs are applied in controlling stormwater pollution) is also covered by actions undertaken as per CSP10 and through the Sustainable Water DCP.

Preventing the loss of vegetation, which may increase the delivery of sediments to the estuary (Action SN10) is said to be managed through the Sensitive Urban Lands DCP which protects foreshore areas, LEP zonings, the DA process which restricts development, a Bush Regeneration program and some education activities. The CRR program supports stream and riparian rehabilitation, and bushland programs, which are said to reduce sediments in runoff from degraded urban and peri-urban bushland (Action SN11). Such programs should be continued and expanded where possible. It is suggested that greater protection for foreshore/riparian vegetation is required, and this is discussed further in Objective 17: Mangroves and Saltmarsh.

The additional issue of bank erosion, which may also contribute to sedimentation of channels, was not specifically addressed in actions relating to this objective. In particular, the causes of bank erosion and the relative contribution of boat wash to erosion should be investigated for the estuary. It has been suggested that a study into the relative contribution of various causes of bank erosion, including boat wash, needs to be conducted. The outcomes of such a study should guide the review and modification of existing boat speed zones to protect estuarine environments. Furthermore, investigation and action to remediate existing areas of erosion should be performed.

A Works Maintenance Program has been completed for fire track maintenance and is implemented subject to funding (Action SN3).

Dredging for sand extraction upstream of Woolwash was previously permitted under a license with the former DNR (now DECC). This license was surrendered by HSC to DNR, who then agreed to discontinue the licence, in accordance with Action SN12.

Minor dredging for navigation channels only is supported by HSC, subject to an SEE for <1000 $m^3$ or an EIS for dredging of > 1000 $m^3$ of material (Action SN13).

**Recommendations:**

- Perform a study to identify all causes of bank erosion, including boat wash.
- Modify existing boating zones, particularly no wash/wake zones, to address bank erosion caused by wake, as well as the impacts of wake on other estuarine environments and recreational safety requirements.
- Investigate and remediate areas of bank erosion and reduce the likely recurrence of bank erosion in these areas.
- As per Objective 17: Mangroves and Saltmarsh, provide for greater protection of riparian habitats from clearing and removal.
- Recommendations as per those actions repeated from Objective 4: Catchment Sourced Pollution.

### 2.1.14 Objective 14: Commercial and Recreational Fishing

***"identify commercial and recreational fishing methods and assess catch levels through Council's current fishing survey, and prepare a Fishery Management Plan specifically for Berowra Creek that addresses the issues of concern"***

**Comments**:

Objective not achieved.

The lack of ability to coordinate commercial fishers cooperation was found to be an issue which needs to be addressed in order to meet this objective.

As noted previously, a study involving numbers and activities of commercial and recreational fishers by the Ecology Lab was not completed due to the lack of cooperation of the commercial fishing sector. As such, a management plan could not be compiled (Action CRF1). This survey and management plan should be completed.

**Recommendations:**

- As per Objective 10: Estuary Recreation Facilities: survey and management plan for commercial fishers in Berowra Creek.

### 2.1.15 Objective 15: Aquaculture

***"ensure aquaculture in the estuary is ecologically sustainable"***

**Comments**:

Objective achieved

Actions prescribed to meet this objective are in place through Councils participation in implementing local government obligations as stipulated within the NSW Government Sustainable Aquaculture Strategy.

Action A1 specified that any new aquaculture development proposed must require an EIS and DPI Fisheries approval. There have been no new aquaculture development applications. Furthermore, any such proposal would require an EIS, as per SEPP-62. No further actions are required.

**Recommendations:**

- None

### 2.1.16 Objective 16: Heritage Protection

***"prevent further damage to the middens, either by controlling the damage source or by providing physical protection to the middens."***

**Comments**:

Objective has not been achieved.

The protection of middens outside of the NPs with respect to erosion has not been investigated.

An investigation and implementation of appropriate protection measure for middens around the Estuary has not been completed (Action HP1) by HSC. NPWS provides protection to middens in National Parks and Nature Reserves, although the provision of protection measures is unknown. Works recommended in Objective 13: Sedimentation/Navigation relating to bank erosion are also applicable here, and should combine with the completion of Action HP1.

The action relating to existing no wash/wake zones (Action HP2) is a direct repeat of Action BM4, and recommendations are the same.

**Recommendations:**

- An investigation and protection of middens should be completed (Action HP2).
- Recommendations for bank erosion, as per Objective 13: Sedimentation/Navigation.
- Recommendations for Riverkeeper, as per Objective 6: Boat Sourced Pollution.

### 2.1.17 Objective 17: Mangroves and Saltmarsh

***"ensure that mangroves and saltmarsh generally, and the ecology of Big Bay in particular, are protected and conserved."***

**Comments**:

Objective partly achieved, further work required.

Most actions were completed, but there is a need for mapping, monitoring, expansion of conservation zonings and stricter development controls in order to meet this objective. Further, these actions are required for all habitats, not simply riparian habitats.

The conservation and protection of flora and fauna in public and private ownership (Action M1) and minimising vegetation fragmentation (Action M2) is governed by the Sensitive Urban Lands DCP, LEP zonings, the DA process to restrict development, a Bush Regeneration program and some education activities. However, greater protection for foreshore and riparian vegetation habitats from vegetation removal and development is required. Increased compliance would also assist in ensuring vegetation is preserved, and could be assisted by a River Keeper.

The extent of mangrove and saltmarsh habitats in Berowra Creek have been mapped (Action M4), but there is a need to expand on this initial mapping. In fact, flora and fauna mapping for all habitats (riparian and terrestrial) needs to be updated and expanded and areas of significant habitat value determined. Areas of significant habitat outside of reserves should be investigated for rezoning to provide conservation. Periodic re-mapping is also required to enable changes in extent and condition over time to be monitored.

The sub tidal and tidal areas of Big Bay have not been incorporated into the Marramarra Nature Reserve (Action M3), and remain as Crown land. There is some question as to whether these areas would be afforded greater protection if made part of the Nature Reserve. This should be investigated with recommendations based upon the greater level of protection.

**Recommendations:**

- Increased compliance to detect the removal of vegetation on public or private land, particularly riparian habitats on foreshores, and prosecute offenders accordingly. A River Keeper may assist in detecting non-compliance along foreshores.
- Flora and fauna mapping of terrestrial and riparian habitats updated and expanded, and areas of significant value, such as EECs.
- Investigate rezoning to provide protection for significant habitat areas that are not located within existing reserves.
- Periodically re-map terrestrial and riparian habitats to monitor changes in extent and condition over time.
- Investigate the potential for better protection of Big Bay subtidal and tidal areas under relevant ownership (ie Crown or NR zoning).

### 2.1.18 Objective 18: Seagrasses

***"preserve existing seagrass beds and encourage the colonisation of suitable areas by improving water quality and reducing sedimentation"***

**Comments**:

Objective mostly achieved, further work required.

The protection of seagrass habitats from boat activity particularly needs to be addressed.

The main action outlined for this objective was to support other actions that aimed to improve water quality and reduce sedimentation (Action S1). Likewise, activities undertaken in this regard are outlined in Objectives above as appropriate.

The implementation of Habitat Protection Plan No.2: Seagrass, is carried out, as appropriate, by NSW DPI Fisheries (Action S2).

The marking of seagrass on boating maps was not completed (Action S3). NSW Maritime stated that seagrass areas details provided by NSW DPI Fisheries were too small to be effectively displayed on boating maps. Furthermore, it was suggested by NSW Maritime that it would not be cost effective to attempt to keep maps up to date with the frequency of changes in seagrass areas overtime. It has been suggested that if seagrass areas cannot be effectively marked on maps, the areas should be marked with buoys, to alert boaters of the presence of seagrass. Furthermore, seagrass areas could be monitored overtime, and the buoys relocated appropriately, to provide continued protection to seagrass habitats.

**Recommendations:**

- Seagrass areas to be marked with buoys, to alert boaters of the presence of seagrass.
- Areas of seagrass monitored over time, and marker buoys relocated as appropriate, to provide continued long term protection to seagrass habitats.

### 2.1.19 Objective 19: Weeds

***"restore and maintain healthy native vegetation within the riparian zone"***

**Comments**:

Objective achieved across the LGA, not only the riparian zone with all actions completed.

Existing actions must remain ongoing and programs broadened to continue to improve the mitigation of weed spread.

There were a number of actions outlined in the BCEMP to mitigate weed impacts, particularly along the foreshore. A Noxious Weeds Strategy was completed for the Hornsby LGA, and a Noxious Weeds Officer employed by Council (Action NW1and NW2). Further actions undertaken to control and remove weed sources and infestations particularly in residential properties and along road reserves (Action NW2), include a corridor grant to remove weed sources, a contract bush regeneration program and installation and maintenance of sediment basins (which capture weeds seeds and sediment in which they may propagate) through the CRR program. To complement these actions, new developments should be required to use only endemic species in landscaping and household gardens to reduce weed impacts.

The Rural Lands Incentive Scheme has supported education activities undertaken by the Noxious Weeds Officer (Action NW3), which included the gardens for wildlife, bushcare and weed specific eradication programs. Further, an indigenous planting guide, "creating a native garden" brochure, "indigenous plants of the bushland shire" playing cards, webpage with planting lists, and audits of local nurseries, have assisted in providing information to local residents and encourage the removal of weed/exotic species and planting of indigenous species (Action NW4 and NW5).

In addition to the above education activities, the bushcare and tree management programs have been initiated in most schools, environmental audits of schools and a one-day workshop on estuary management are currently underway (Action NW6). Local residents have also been encouraged to take part in bushcare programs, with thousands of volunteers in Hornsby Shire (Action NW7). The initiation of further education programs regarding catchment impacts upon the estuary (as outlined for Objective 4: Catchment Sourced Pollution) should incorporate the impacts of weeds.

Weed management in Crosslands (as part of the Master Plan) has been implemented, predominantly through saltmarsh rehabilitation and bushfire management (Action NW8).

**Recommendations:**

- New developments required to use only endemic species in landscaping and household gardens, to reduce weed impacts.
- Ensure existing programs are continued over the long term, and are expanded and continually improved to increase the success in eradicating weeds throughout the LGA, as well as Berowra Creek catchment.

## 2.1.20 Objective 20: Biological Monitoring

***"monitor the biological health of the estuary by establishing a focussed and cost effective biological monitoring program"***

**Comments**:

Objective partly achieved.

The actions should be completed and expanded to include biological assessments of all existing estuarine environments, particularly aquatic habitats, and to continue to monitor these over the long term.

Action BioM1 required establishment of a biological monitoring program to assess all seagrass, mangroves, saltmarsh habitats and the fauna it supports, with periodic mapping of aquatic habitats, and quantitative sampling of key indicators. A number of habitat types were mapped in various locations of Berowra Creek (including macro-fauna in mangroves and in artificial units of habitat on intertidal rocky shores). A small amount of saltmarsh and mangrove monitoring is undertaken as part of the Sediment Elevation Tables program.

Action BioM1, however, has not been fully completed. It is suggested that each of the five aquatic habitat types should be mapped for extent and condition, in addition to the habitat monitoring outline in Objective 17: Mangroves and Saltmarsh. Following this, a comprehensive monitoring program for all aquatic habitat types should be established and periodic re-mapping of habitats performed.

Programs (Action BioM2) with universities (UTS, UNSW, ANU, ACU) and the CSIRO have been established, and one MOU (Action BioM3) with UTS have been established. It is recommended that this MOU be re-instated, and further MOUs with other universities developed. There may be opportunities to establish an honours, masters or other research project with universities which involves either mapping or monitoring required for the estuary.

**Recommendations:**

- Mapping of extent and condition of all aquatic habitat types.
- Establish a comprehensive monitoring program for all aquatic habitat types.
- Specific and measurable estuarine indicators need to be determined and monitores accordingly
- Periodic re-mapping of aquatic habitats to determine changes over time.
- Complete recommendations for mapping and monitoring of riparian and terrestrial habitat types outlined in Objective 17: Mangroves and Saltmarsh.
- Complete Action BioM3, and encourage honours/masters research projects which involve mapping and/or monitoring of estuarine biology.

## 2.2 Review of Actions in the BCEMP

A detailed review of each of the 139 actions in the BCEMP (WMA, 2002) is provided in Table 2-1. It can be seen that of the 139 actions, 112 were completed (and of these 61 were completed for the entire Hornsby LGA), 14 were partly completed, and 13 were not completed. For each action, a description of the completeness of the action, how the action was implemented or the reasons for not being implemented, and recommendations for future action is provided in Table 2-1.

Overall review of the effectiveness of the actions has been discussed, refer Section 2.1.

**Table 2-1 Summary of Completeness of Actions in the BCEMP**

| Action Ref | Action Description | Action Completed | Method of completion / Reasons not completed / Comments | Recommendations and further works required |
|---|---|---|---|---|
| DCC1 | Develop a co-operative program to monitor results of STP upgrades and other catchment remediation works | No | The development of a cooperative between various parties was attempted, but unsuccessful due to disagreement intellectual property rights disagreement between various institutions and unresolved database issues. | as per DCC3 |
| DCC2 | Establish monitoring stations for in-stream flow gauging and sampling | Yes | Autosamplers were installed. A report for results taken in 95-97 was completed. Reports for recent probe results have been included into modelling with MUSIC, and a report released in 2006. Modelling with these results is continuing in 2007 | Action completed sufficiently. The use of probe data for modelling and reporting should be continued. |
| DCC3 | Establish joint records and database system | No | Refer notes for DCC2. In addition, centralisation of data was attempted by the former HNCMT (now HNCMA). This involved "data mining" where-by HNCMT would access data from council records without the need for presentation or formatting by HSC. | HNCMA to (again) attempt to compile all data resources (through use of data mining techniques) and create and manage a centralised data base (for use in HNCMA, SoE and other reporting/use as appropriate) |
| DCC4 | Present annual reports on the joint monitoring program to the community | Partly | There is no "joint monitoring program", however individual agencies produce reports (e.g HSC Estuary Management Annual report, State of Environment Report, etc). | as per DCC3 |
| DCC5 | Ensure data collected by HSC, SWC, EPA and other sources are compiled together and are easily accessible to public | Partly | Data from all groups was compiled onto a CD (“Waterman” developed by AWT Ensight). Further data compilation exercises have not been completed. | MOU to be established between SWC, HSC, EPA, NSW Food Authority, Oyster Farmers Association, GSC and HNCMA. This could be coordinated and managed by HNCMA in a centralised database, refer DCC3. |
| HHS1 | Council to monitor estuary surface waters and to be responsible for algal bloom testing. | Yes | A real time chlorophyll-a monitor has been deployed and maintained since 2002 and an estuarine health monthly sampling program is underway. | Action completed sufficiently and should remain ongoing |
| HHS2 | Put in place a method, such as a radio controlled chlorophyll-a monitor, that enables Council to remotely monitor the presence or otherwise of algal blooms. | Yes | As for HHS1. HSC is currently looking for a second probe site in proximity to priority oyster leases, in cooperation with the NSW Food Authority (NSWFA) and Oyster Farmers Association (OFA). The deployment of a second probe should be completed. | Action completed sufficiently. The probe should continue to be maintained, and monthly monitoring continued. |

| Action Ref | Action Description | Action Completed | Method of completion / Reasons not completed / Comments | Recommendations and further works required |
|---|---|---|---|---|
| HHS3 | In case of algal bloom, Council to report to RACC, DLWC and Health Dept. | Yes, entire LGA | Council reports to the Regional Algal Coordinating Committee (RACC). RACC have not finalised the Marine and Estuarine Algal Contingency Plan. Staff and structural changes within the now DECC (formerly DLWC, then DIPNR, then DNR) have made consistency in algal bloom management difficult. | Current action is sufficient and should remain ongoing |
| HHS4 | Sydney Water to continue to inform Council when STP's begin bypassing | Yes, entire LGA | Sydney Water Corporation (SWC) send a fax to HSC detailing bypassing events at time of occurrence. | Current action by SWC is sufficient. HSC may need to review its method of compiling this information (such as into a database). |
| HHS5 | Monitor recreational water quality after significant catchment rainfall or when notified of STP bypassing | Partly | A recreational water quality program (which complies with ANZECC Guidelines) is currently undertaken by HSC. However storm/event based sampling is not completed, and not considered necessary as per the ANZECC Guidelines. SWC do not currently monitor for recreational water quality. | Current monitoring by HSC is sufficient. This program may be more appropriately provided by relevant state authority, as recreational water quality may be considered a public health issue. Recreational water quality monitoring should be taken over by the DECC (EPA) as part of establishing a recreational water quality monitoring program for the Lower Hawkesbury. |
| HHS6 | In case of algal bloom, Council to inform Oyster Farmers' Association, NSW Fisheries and other relevant groups, possibly through use of a "phone-tree" | Yes, entire LGA | HSC have made daily data from the chlorophyll-a probe available on the HSC website (maintained by MHL). In addition, algal blooms are reported to the RACC, who then report to the required parties. A phone tree was not necessary. | Current action is sufficient and should remain ongoing |
| HHS7 | In case of faecal pollution, Council to inform Oyster Farmers' Association, NSW Fisheries and other relevant groups, possibly through use of a "Phone-tree" | Yes, entire LGA | HSC previously informed the OFA when faecal coliform (FC) levels were shown by the monitoring program to be consistently high. However this action was found to be unnecessary, as OFA have their own monitoring program. Hence, in 2002 OFA informed Council that monitoring was not required at lease areas. | As per HHS5. In addition, HSC should support the NSW Safe Food program in kind, rather than conduct a separate program. |
| HHS8 | During summer, Council to respond to community concerns of aquatic stingers and carry out follow up monitoring | Yes | Where stingers are reported by community members, HSC will assess the problem and notify the broader community if considered a concern. The issue of stingers has occurred during only two summers since the EMP's commencement. | Current action is sufficient and should remain ongoing. |
| HHS9 | Inform the community of algal blooms, faecal pollution and aquatic stingers through warning signs near waterway access locations. When appropriate Council to communicate warning through newspaper, radio and the Internet | Yes, entire LGA | Warning signs have been placed at appropriate locations throughout the LGA. Council communicates warnings through the RACC reporting process. Furthermore, advise against swimming for three days following rainfall to avoid potential pathogen contact is advised through appropriate media | Current action is sufficient and should remain ongoing. |
| HHS10 | Investigate the legal implications and responsibilities relating to warning signs | No | This was considered a potential "legal minefield". The current warning signs and processes were considered sufficient | This action no longer needs to be pursued. |
| EM1 | Council appoint an 'estuary manager' to develop future management plans, administer and update existing management plans and access State, Federal and private industry funding sources. The manager would be responsible for the ongoing development of the estuary management | Yes, entire LGA | This position was established by HSC in 2001. This action was considered highly effective by council for coordinating Estuary Management within Hornsby Shire. In addition, an assistant (environmental scientist) has now been employed, in recognition of the growing needs and requirements of the original role. | Action completed, no further issues |

| Action Ref | Action Description | Action Completed | Method of completion / Reasons not completed / Comments | Recommendations and further works required |
|---|---|---|---|---|
| | program within Council. | | | |
| EM2 | Council approach HNCMT to prepare an integrated Lower Hawkesbury Estuary Management Plan | Yes, entire LGA | HSC did approach HNCMT at time of the BCEMP's commencement, but the action was not pursued. However, the action is now currently underway, due for completion in 2008, with HSC being the lead agency. | Action is to be completed in 2007. |
| CSP1 | Develop and implement a Catchment Management Plan aimed at achieving water quality objectives | Yes, entire LGA | The Sustainable Total Water Cycle Management Strategy (STWCMS) has recently been completed, and covers this action. There are also other supporting management plans and instruments which complete this action (eg WQMS). The SOJI, discussed within the plan at the time, is now a historical idea and no longer an agency tool. | Action completed sufficiently. Regular review and update of the Strategy is recommended |
| CSP2 | Develop a water quality monitoring program | Yes, entire LGA | An estuarine health monthly monitoring regime has been established by HSC. In addition, a recreational water quality monitoring program and biological (chlorophyll-a) monitoring are conducted | as per HHS5 |
| CSP3 | Determine pollutant loads from STP's and other developments | Yes, entire LGA | Pollutant loads from STPs are known. E2 and MUSIC modelling has been conducted and is to be continued. Bayesian Decision Networks (BDN) have also been compiled. This action is also supported by the STWCMS | Current action (modelling with E2, MUSIC and BDNs) is sufficient and should remain ongoing. |
| CSP4 | Control pollutant loads from Sydney Water STP's | Yes | SWC conducted a $26 million upgrade of Hornsby Heights STP and West Hornsby STP to improve effluent quality. | Action completed sufficiently. Review of effectiveness of upgrade with respect to population increase is recommended at appropriate time in future. |
| CSP5 | Improve management of leachate and runoff from disused waste disposal | Yes, entire LGA | The 20 disused landfill sites were audited for impacts. Of these, three were found to be leaching. Drainage works, collection of leachate and treatment of waters for reuse were completed at the three problematic sites (Fox Glove, Arcadia and Dartford Road). Leachate and run-off from sites are managed on an ongoing basis through councils Catchment Remediation Rate (CRR) program. | Action completed sufficiently, continued monitoring of problematic landfill sites is recommended |
| CSP6 | Improve knowledge of existing stormwater drainage system | Yes, entire LGA | The headwalls, pipes, pits and flood history of the stormwater drainage system for the entire LGA has been mapped, and are available in GIS format. | Action completed sufficiently. Regular updates to mapping of stormwater system are recommended |
| CSP7 | Implement controls at building sites for stormwater and sediment control | Yes, entire LGA | Soil and Water Management Plans are required for building sites > 2500 m2; and Sediment and Erosion Control Plans are required for sites < 2500 m2. There are two council officers to check compliance with such plans. The Sustainable Water DCP is also implemented by HSC to address this action | Current action is sufficient and should remain ongoing. Compliance programs should be increased where possible. |
| CSP8 | Control pollution from sewer overflows | Partly | Overflows from pumping stations have been addressed. SWC Licence stipulates no dry weather overflows and only one wet weather overflow from pumping stations per year. However, mushrooms and sewer chokes resulting in overflows still occur. The SWC SewerFix program does not include areas in Hornsby LGA (refer SWC website) | Elimination of all types of sewer overflows should be completed |

| Action Ref | Action Description | Action Completed | Method of completion / Reasons not completed / Comments | Recommendations and further works required |
|---|---|---|---|---|
| CSP9 | Implement a plan of management for urban stormwater | Yes, entire LGA | Stormwater Management Plans (SMPs) were completed for Berowra, Cowan and Lane Cove Catchments in 1999, and these plans are currently under review to update future actions and strategies. These plans used AQUALM to determine water quality and data from drains to determine water quantity. The STWCMS also details urban stormwater management actions. Further, Councils CRR program implements a capital works program to improve stormwater quality. | Current action is sufficient and should remain ongoing. Regular review and update of SMPs is recommended |
| CSP10 | Reduce stormwater pollution from residential areas | Yes, entire LGA | The CRR program has allowed improvements in stormwater treatments throughout the LGA. New developments are subject to the DA process which requires appropriate stormwater treatment devices/ mitigation measures to be implemented | Current action is sufficient and should be ongoing. New developments should be required to use best practise stormwater treatments (WSUD) which enable the highest level of pollutant removal. Improvements to current stormwater treatments which provide the highest level of pollutant removal, that is for nutrients, oils etc in addition to litter and sediment, should be installed where possible |
| CSP11 | Restrict or prevent development of sensitive sites | Partly | DoP SREP 20 encourages sustainable and water sensitive development. Further, sensitive sites have been mapped at various times. The Waterways Review 2005 also assessed this issue. | Further assessments to determine the carrying capacity of land areas (based on water, air, land capabilities) are required. The assessments should enable development to be restricted accordingly, and outcomes incorporated into review and zoning in the LEP |
| CSP12 | Reduce pollution from agricultural sites | Yes, entire LGA | The Rural Lands Incentive Scheme assists landholders to reduce inputs. Further, the Hornsby Shire Rural Lands Study (1995) reviewed planning provisions in rural areas and provides a framework to guide future rural development. | Current action should be continued and expanded |
| CSP13 | Improve management of on-site sewage disposal in rural residential areas | Yes, entire LGA | HSC maintains a routine inspection program of on-site systems to ensure operational efficiencies are maintained. Upgrades to systems specified through this process are required by owners. A systems to assess requirements for new development is also in place. SWC has a priority sewage program to determine areas requiring connection to the reticulated system on a priority basis. | Current action is sufficient and should remain ongoing and compliance activities expanded where possible. |
| CSP14 | Control impact of farm animals on water quality | Yes, entire LGA | as per CSP12 | as per CSP12 |
| CSP15 | Minimise overflows from private sewer connections in the catchment | No | This action is being progressed through the Syndey Coastal Council's Group PipeCheck program. | This action should be completed, such as by reinstatement of NSW Governments "PipeCheck" program that involved compliance checking of pipes on private properties |
| CSP16 | Place nutrient/sediment and litter devices on major stormwater outlets into the estuary | Yes | Done for Berowra only, through CRR program | Action completed sufficiently. Ensure these devices are regularly maintained. The installation or upgrade of stormwater treatments at outlets to all waterways areas in the LGA should be completed and regularly maintained. Devices which provide the highest level of |

| Action Ref | Action Description | Action Completed | Method of completion / Reasons not completed / Comments | Recommendations and further works required |
|---|---|---|---|---|
| | | | | pollutant removal, that is for nutrients, oils etc in addition to litter and sediment should be used as a preference |
| FI1 | Sydney Water to investigate possible immediate implementation of re-use options | No | Sydney water is implementing WaterPlan 21 and prepared the "Berowra Effluent Reuse Report", which describes the potential for potable and non potable reuse | This action should be completed |
| FI2 | As a longer term solution, all STP discharge presently entering Berowra Creek be reused within the catchment or discharged outside the catchment | No | | This action should be completed |
| FI3 | Implement community water reduction schemes, possibly through the use of incentives | Yes | SWC has introduced rebates for rainwater tanks, rebates for front loading washing machines, and re-fit kits for shower and tap heads. Further DECC introduced BASIX in July 2004 which requires new developments to incorporate water and energy conservation initiatives. | Further action is required to increase uptake of reduction devices through planning controls and further incentives. |
| FI4 | Council to develop policy that new development, including redevelopment of rural areas, provides for re-use grey water | Partly | HSC endorses the current NSW Department of Energy, Utilities and Sustainability Guidelines for Greywater Reuse in Sewered, Single Household Residential Premises. Educational material such as fact sheets and workshops were also completed Action was completed. HSC to encourage installation and correct use of greywater diversion devices on single residential properties. | Action was completed. HSC to encourage installation and correct use of greywater diversion devices on single residential properties. |
| FI5 | Implement Sustainable Water DCP requirement to "incorporate relevant measures to promote infiltration and ground water recharge where the site contains appropriate soil landscapes" | Yes, entire LGA | A Sustainable Water DCP has been compiled. This is implemented through DA assessments, site assessments and standard conditions. The DCP is periodically reviewed. | Current action is sufficient and should remain ongoing |
| FI6 | Educate the community on the need for on-site collection and use of stormwater, in keeping with Council's rainwater tank policy | Yes, entire LGA | Encouraged through fact sheets, workshops, the DA process and as per BASIX & SEPP4 conditions. | This action needs to be continued and expanded. Issues have arisen relating to people attempting to drink tank water that has not been filtered, or odours from stagnant tank waters. This issue may be dealt with through compliance with health standards and education. |
| FI7 | Review Council's DA approval process to include use of permeable surfaces as default condition (particularly for driveways) | Yes, entire LGA | This is directed in the Sustainable Water DCP, and encouraged during the DA approval process. HSC has noted that the compliance with the percentage of permeable surface area required does not include landscaped areas. It also does not stop impervious surfaces being replaced once a development is completed and approved. | This action should be continued. The Sustainable Water DCP should be reviewed to include landscaped areas in percentage calculations for pervious area. Methods to require compliance with such percentages after completion of development should also be enacted. |
| BSP1 | Enforce limits on permanent occupation of boats | Yes | NSW Maritime has advised that regulations prohibit permanent occupation of boats, and all possible action is taken in this regard. | This actions needs to be continued and expanded. Compliance with such regulations may be assisted with the help of a "River Keeper" for the LH. |

| Action Ref | Action Description | Action Completed | Method of completion / Reasons not completed / Comments | Recommendations and further works required |
|---|---|---|---|---|
| BSP2 | Investigate provision of a pumpout facility for houseboats and other vessels | Yes | A pumpout facility was installed at Kangaroo Point in November 2002. | Action completed. Continue current investigation into a second pumpout facility |
| BSP3 | Establish litter control policy | Yes | Litter is collected and managed by HSC's Waste Division | Current action is sufficient and should be ongoing |
| BSP4 | Ensure solid waste collection is carried out regularly | Partly | Routine collections are undertaken, however HSC's waste division is currently developing a strategy for the collection of solid waste directly from river settlements | This action should be continued and expanded through collection from river settlements |
| BSP5 | Provide better waste disposal facilities for people aboard boats | Partly | as per BSP3 | Further action, such as installation of bins on hire boats is required |
| BSP6 | Provide appropriate sewage disposal facility for commercial and recreational vessels at Berowra Waters | No | As a condition of approval for the Development Application by Berowra Waters Marina, a pumpout was to be installed. However, the DA at the time of writing this review had not been approved, and hence this action has not been completed. | This action is recommended to be completed. |
| BSP7 | Produce a brochure outlining the legal responsibilities of boat users not to pollute and provide advice on how to best protect the environment. Brochure to be provided by hire boat operators and marinas to all boat users | Yes | NSW Maritime has numerous brochures aimed at environment protection. The brochures have been provided to and are available to all boaters and boat-related organisations. Brochures include "Don't make waves", "Leave only water in your wake", "Noise annoys", "Take charge of your discharge" and more. Further details on brochures can be found at www.maritime.nsw.gov.au/Publications. In particular, the Maritime office has produced an A4 sheet for boaters in the Berowra Creek area aimed at controlling vessel wash and seagrass protection. The leaflets are at all marinas and are available to boaters. A "No wash" campaign and signage was installed at a cost of $50,000. | Action completed. This educational material should be advertised more broadly |
| BSP8 | Investigate the environmental impacts of antifouling paints on Berowra Creek | Yes | To be completed in July, 2007. URS are currently engaged to perform sediment and antifoul monitoring (including a new sampling technique aimed at detecting algicides, which replaced TBT in antifoul paints in the 1980s) of the Lower Hawkesbury Region. | This action is to be completed in 2007. A means of auditing boats for oil discharge from bilge pumps, effluent discharge practises, rubbish disposal, controls for boat maintenance works and all other environmental issues associated with boat usage should be investigated. This could reasonably be combined with NSW Maritime audits of moorings. The audits should be performed once a method has been determined |
| BSP9 | If/when pumpout facilities are installed in the Berowra Creek area all the estuary be declared 'no discharge' | Yes | No pumpout has been installed. However it is illegal to pump untreated sewage into the waterway, with an on-the-spot penalty of $750. Treated sewage is not permitted to be discharged into "no discharge zones", which includes majority of Berowra Creek. Effluent is to be collected by holding tank on Class 1 and 4 commercial vessels, and additionally greywater on such vessels younger than Jan 1, 2005. Further information is available from the NSW Maritime website, refer Shipping, Security and Environment/Environment Protection/Sewage and Other Discharge/FAQs. | Action was completed. Recommend regulations be extended to both greywater and blackwater holding tanks for both recreational vessels and older commercial vessels |

| Action Ref | Action Description | Action Completed | Method of completion / Reasons not completed / Comments | Recommendations and further works required |
|---|---|---|---|---|
| RSP1 | Improve management of on-site sewage disposal by providing information to residents and establishing a regular inspection program | Yes, entire LGA | HSC completed its 2004-06 onsite sewage management strategy and has a draft strategy for 2007-09. The strategy covers approvals to operate OSSM systems. Educational material and fact sheets are available. Quarterly inspection programs are performed, as per the OSSM strategy | Current action should remain ongoing and compliance activities expanded where possible. |
| RSP2 | Promote alternatives to use of septic tanks in sensitive locations. Identify sites unsuitable for septic tanks and provide information and incentive for alternative disposal methods | Yes, entire LGA | Through the DA process, the use of OSSMs is assessed. The appropriateness of use of OSSM systems is based on soil and vegetation types and topography. This is performed in particular for constrained sites on steep topography or with limited septic disposal area. Inspection programs also provide advice on required works for an existing OSSM, and alternatives to inappropriate OSSMs. | Current action is sufficient and should remain ongoing. Incentives should be increased to increase uptake of alternatives where possible. |
| RSP3 | Update River Settlements DCP to include improved water quality controls and requirements to prepare, implement and maintain a Soil and Water Management Plan | Yes, entire LGA | Through the DA process, soil and water management plans are required, particularly due to the proximity of river settlements to the watercourse. The River Settlements DCP is being reviewed and updated in 2007. | Complete review and update of River Settlements DCP to include this action. Expand programs for compliance inspection where possible. River settlements DCP should additionally provide for protection of foreshore and other habitats, best practise sewage management, weed management and endemic species planting, water saving devices, pervious land areas, energy efficient design etc in line with appropriate actions in the BCEMP |
| RSP4 | Investigate feasibility of a pumpout facility at Berowra Waters for river settlements and boats | Yes | An economic cost/benefit study was undertaken, however it was found to be too expensive. This action refers to converting OSSM systems on river settlements to pumpout, due to soil and topography constraints on the majority of such developments which have meant that, in spite of the majority of such systems being appropriately maintained, they are still considered high risk due to their proximity to the waterway and oyster leases. There are currently too few new river settlements to make it economic for a private contractor to provide a service to new pumpout onsite systems. | Recommend increasing inspection strictness on current OSSM systems on river settlements to force de-sludging of such systems, which may increase the market to make it economic for a private contractor to perform desludging and in addition, pumpout services. If this requirement were expanded to entire Lower Hawkesbury, it may be even more marketable for a private contractor. |
| RSP5 | New septic systems to comply with Council standard and require a geotech / soils report to verify site suitability | Yes, entire LGA | refer RSP2. Further this is incorporated as a requirement of the River Settlements DCP. | Current action is sufficient and should remain ongoing. |
| RSP6 | Investigate conversion potential of existing and new septic systems to pumpout | Yes, entire LGA | refer RSP4 | Refer RSP4. The River Settlements DCP review and update should include the requirement for all new river settlements to only permit pumpout sewage systems, as applicable. |
| RSP7 | Continue audit of septic systems to ensure compliance | Yes, entire LGA | as per RSP1 | as per RSP1 |
| RSP8 | Ensure all septic systems are operating efficiently and are maintained through sludge removal on a 3-5 year basis | Yes, entire LGA | as per RSP1 and RSP4 | as per RSP1 and RSP4 |
| RSP9 | New development to provide for re-use of grey waters, where possible | Yes, entire LGA | as per FI4 | as per FI4 |

| Action Ref | Action Description | Action Completed | Method of completion / Reasons not completed / Comments | Recommendations and further works required |
|---|---|---|---|---|
| RSP10 | Best practice environmental management guidelines to be included in River Settlements DCP | Yes, entire LGA | as noted in RSP3, the River Settlements DCP is being reviewed and updated in 2007 | as per RSP3. Ensure update to DCP also complies with this action |
| RSP11 | Apply actions RSP3-RSP10 to all river settlements not just in vicinity of Berowra Waters | Yes | Refer RSP3-10 above | as per RSP3-10 |
| HMA1 | Commercial marinas to progressively update existing boat maintenance systems | Yes, entire LGA | An audit of BIA Marinas was completed in 2006, with recommended actions to be undertaken by BIA Marinas. This included the installation of appropriate slips, water containment areas and dry docks. | A follow-up audit to assess completeness of recommended actions is required. The outcomes of sediment monitoring (URS, 2007) should be incorporated into new audit recommendations |
| HMA2 | Ensure all boat service areas have containment areas for antifouling waste | Yes, entire LGA | as per HMA1 | as per HMA1 |
| HMA3 | Include drainage improvements on "Kirkpatrick Way". Install sediment traps at outlets as part of improvements | Yes | The improvements were investigated, and achieved through sealing of the road rather than providing drainage and outlets. | Action completed, no further issues |
| HMA4 | Provide drainage to eastern car parking areas and sediment trap/oil separator at drain outlets | Partly | Sealing of road (as per HMA3) achieved sediment reduction outcomes, but not oil separation. | Action completed was adequate for sediments. Oil/water separator and sediment trap for carpark should be investigated |
| HMA5 | Provide sediment trap and oil separation unit at Dusthole Bay car park | Yes | A Rocla system was installed at the boat ramp in July 2002, and a pit insert with pit bull litter basket for sediment and leaf litter was installed near the speed hump. Total cost was $70,000. | Action completed. Recommend ongoing maintenance of units. |
| HMA6 | Maintain all sediment/oil traps to ensure proper functioning | Yes, entire LGA | As part of CRR Maintenance program, regular inspection and maintenance is performed. | Current action was sufficient and should remain ongoing. Improvements to devices recommended where possible. |
| HMA7 | Use low residue herbicides and adopt practices to minimise inflow to the waterway | Yes, entire LGA | Noxious weeds officers, and bushcare volunteers and contractors are trained in herbicide use. Parks maintenance officers are also trained and advised by Bushland and Biodiversity officers. | Current action was sufficient and should remain ongoing. |
| HMA8 | Maintain and operate the ferry in a manner that prevents pollution | Yes | The ferry operator formerly informed council of maintenance activities (in particular, maintenance of boat ramp in environmentally safe manner), however this information has not been provided since RTA took over management of ferry. | Audit of adequacy of practices required, in particular the maintenance regime for the boatramps. There is also some confusion as to responsibilities for boatramp maintenance, (ie, is it RTA or HSC responsibility) which needs to be clarified. |
| HMA9 | Identify major sources of heavy metal contamination | Yes | as per BSP8 | as per BSP8 |
| HMA10 | Establish a sediment monitoring program for the estuary concentrating on the Berowra Waters area | Yes | as per BSP8 | as per BSP8 |
| OS1 | Initiate a program to source the origin of oil spills on Berowra Waters and educate boat users | Partly | The eastern marina at Berowra Waters removed its underground fuel storage tanks. However, overflows of oil from boats during rainfall when automatic bilge pumps operate has not been investigated. | Action to be completed through an investigation and implementation of recommendations to reduce oil in water from bilge pumps. |
| OS2 | Emergency spill management to be conducted as per HSC Emergency Spills Manual | Yes | The incident and emergency response plan covers this action. | Current action was sufficient and should remain ongoing. |

| Action Ref | Action Description | Action Completed | Method of completion / Reasons not completed / Comments | Recommendations and further works required |
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| ERF1 | Install radio controlled signage at Berowra and Berrillee to inform visitors of delays and parking restrictions | Yes | Portable, rather than radio controlled, signage with lights are used to indicate road closure. The signs are not used to control parking, however this is not considered a problem. | Action was completed to satisfactory standard, no further issues. |
| ERF2 | Deck rear portion of Dusthole Bay car parking area | No | Decking was found to be expensive. While this action is still on HSC's agenda, the issue of parking is not considered to be an estuary issue. However, were decking to be performed in the future, shading and water quality issues from the construction should be considered. | Action is no longer required. If decking is performed in the future, appropriate assessment of shading and water quality issues associated with the decking will need to be considered. |
| ERF3 | Investigate adequacy of public jetty on the western shore if parking is increased | No | Parking has not been increased, therefore the need for this action has not arisen. Furthermore, parking is not considered to be an estuary issue | Action is no longer required. |
| ERF4 | Undertake minor rock trimming of Berowra Waters Road and Bay Road | Yes | Stabilisation and vegetation cutback was performed. | Action completed, no further issues |
| ERF5 | Make areas around the ferry terminals “shared” pedestrian and vehicle zones | Yes | The area has been made a "shared" zone. | Action completed, no further issues |
| ERF6 | Investigate the possibility of “reversing” the ferry so pedestrians do not have to cross | Yes | The ferry has been turned around so that pedestrians no longer need to cross the traffic. | Action completed, no further issues |
| ERF7 | Provide a separate pedestrian pathway at ferry terminals to segregate from cars | Yes | Identified and designated areas have been provided for pedestrians accessing the ferry. | Action completed, no further issues |
| ERF8 | Provide heritage signage at strategic locations | Yes | Signage has been provided at McKell park and Crosslands | Action completed, no further issues |
| ERF9 | Provide additional shade trees to picnic areas | Yes, entire LGA | This is provided through bushcare programs, and as part of the Crosslands Master Plan. This plan will continue to be enacted over next few years. | Action completed sufficiently. Programs should remain ongoing. |
| ERF10 | Provide more planting and seating along foreshore | Yes, entire LGA | This is provided through bushcare programs, and as part of the Crosslands Master Plan. This plan will continue to be enacted over next few years. | Action completed sufficiently. Programs should remain ongoing. |
| ERF11 | Develop pamphlets suitable for general visitor information and school projects | Yes, entire LGA | There are brochures available through the Berowra Regional Park, and for school projects through HSC's website. | Action completed sufficiently. Programs should remain ongoing and information be regularly updated. |
| ERF12 | Provide information on the area on the Internet through Council’s home page | Yes, entire LGA | HSC's website provides and estuaries homepage (www.estuary.hornsby.nsw.gov.au) with information and details of all projects taking place in Hornsby LGA. | Action was completed, however greater promotion of the estuaries website (www.estuary.hornsby.nsw.gov.au) should be undertaken. |
| ERF13 | Develop interpretive signs to explain key features of the area | Yes | Interpretive signs have been provided particularly at Crosslands. | Action completed sufficiently. New areas requiring signage across the LGA should be investigated and provided |
| ERF14 | Undertake surveys during peak periods to record visitor numbers | Partly | The number of trailable boats was determined, and this was considered sufficient information. The Ecology Lab was engaged to assess the numbers and activities of recreational and commercial fisherman. Only statistics for recreational fishing activities were attained, due to a refusal to cooperate with the survey by commercial fishers. Surveys for recreational usage of the Ku-ring-gai Chase National Park are compiled by NPWS, and cover all aspects of recreation (including picknicing, bushwalking, riding, barbequing, sight-seeing etc). This does not incorporate parkland within the other NPs and NRs within Berowra Creek catchment. | There is a need to determine commercial fishing activities, and continue and expand knowledge of recreational fishing activities. This action should be undertaken by DPI Fisheries, which may achieve the required level of trust with fishers. Assessment of other recreational activities should be undertaken by Tourism agencies (within councils or state government). Details of other recreational activities, such as boating and foreshore usage should aslo be surveyed. |

| Action Ref | Action Description | Action Completed | Method of completion / Reasons not completed / Comments | Recommendations and further works required |
|---|---|---|---|---|
| ERF15 | Improve maintenance schedule for Sommerville Road | Yes | This action was completed as part of Crosslands Master Plan. | Action completed, no further issues |
| ERF16 | Consider improved recreation/education facilities at Crosslands, such as an information and education centre | Yes | This action was completed as part of Crosslands Master Plan. However, an education centre was found to be inappropriate for Crosslands, and educational signage, found to be appropriate, has been installed instead. | Action completed sufficiently. Ensure signage is maintained |
| ERF17 | The boat ramp at Crosslands be restricted for use by non-trailable boats only | Yes | This action was completed as part of Crosslands Master Plan. | Action completed, no further issues |
| ERF18 | Personal watercraft use, except for through passage is banned upstream of Neverfail Bay | Yes | Technically, there has been no ban. However, "irregular driving" of PWCs within 200m of shore is not permitted, and increased penalties exist. The 200 m ruling effectively enforces this action (ie, ERF18). The region has employed a Safety Education Compliance Officer whose duty is specific to PWCs in the Lower Hawkesbury River. | Action completed. Regular review of PWC zonings recommended |
| ETF1 | No commercial development to be permitted outside zoned areas, unless already approved | Yes, entire LGA | This is supported by the LEP and the DA process. | Current action is sufficient and should remain ongoing |
| ETF2 | Permit modification to commercial floor space where environmental performance is improved | Yes, entire LGA | Action is performed through the DA process. | Current action is sufficient and should remain ongoing |
| ETF3 | Parking for commercial use to be in accordance with car parking strategy for Berowra Waters | Yes, entire LGA | Berowra Waters Plan of Management refers to this issue, and is being enacted. | Current action is sufficient and should remain ongoing |
| ETF4 | Ensure commercial uses comply with lease restrictions and proposed management strategies. Review of Crown Land leases at expiry to ensure compliance with Plan visions & values | Yes, entire LGA | Commercial leases are managed through reviews by HSC. | Current action is sufficient and should remain ongoing |
| ETF5 | Ensure changes to commercial uses/leases conform to the proposed management study | Yes, entire LGA | Commercial leases are managed through reviews by HSC. | Current action is sufficient and should remain ongoing |
| ETF6 | New buildings to be consistent with urban design strategy | Yes, entire LGA | Action is performed through the DA process. | Current action is sufficient and should remain ongoing |
| ETF7 | Investigate program of spotlighting and wildlife field trips run by NPWS volunteers | Yes | This is performed through Chase Alive and HSCs Bushwalks program which includes spotlight walks | Current action is sufficient and should remain ongoing |
| ETF8 | Investigate the potential for tourist related eco-focused activities at Crosslands, such as canoe hire | Yes | This was completed as part of Crosslands Master Plan. | Action completed, no further issues |
| ETF9 | Construct an interpretive boardwalk through the wetland and mangrove areas in Crosslands Reserve, illustrating cultural and natural values | Yes | This was completed as part of Crosslands Master Plan. | Action completed, no further issues |
| ETF10 | Investigate safety aspects of seaplanes in Berowra Waters area | Yes | Seaplanes are no longer permitted to fly and land at Berowra Waters. Seaplanes must now land much further downstream, and motor up on water. | Action completed, no further issues |
| BM1 | Maintain geographic and numeric limits on boat moorings | Yes | This is maintained by NSW Maritime | Current action is sufficient and should remain ongoing. Recommend action be expanded |

| Action Ref | Action Description | Action Completed | Method of completion / Reasons not completed / Comments | Recommendations and further works required |
|---|---|---|---|---|
| | | | | to reducing the number of moorings across the LGA where appropriate |
| BM2 | No net increase in existing moorings/berthings to be permitted in Berowra Creek. Additional berthings in marina only to replace existing swing moorings | Yes | as per BM1 | as per BM1 |
| BM3 | Increase boat security through updated lighting at water access and mooring locations | Yes | The Marina has installed further lighting. | Action was completed, and there are no further issues. |
| BM4 | Enforce existing no wash/no wake zones in the estuary | Yes | NSW Maritime enforces such zones, and has supported this with education. | Current action should remain ongoing. Investigate possibility of River Keeper to assist with compliance. A study to determine the cause of bank erosion along creeks should be performed. Outcomes of this study should guide a review of boating zones/speed limits throughout the estuary. |
| SN1 | Ensure current catchment management practices are implemented for upstream development at Berowra & Berowra Hts | Yes | Catchment Management Practises are coordinated through the DA process, and council's Sediment and Erosion Control Plans and WSUD Policy. | Current action is sufficient and should remain ongoing. Recommendations as per CSP7, CSP9 and CSP10 |
| SN2 | Ensure new urban releases in catchment, implement sound soil and water controls, to minimise the transport of sediment, nutrients and weeds | Yes | as per SN1, as well as the CRR program which levies new releases, and provides for stormwater treatments for nutrients and weeds, etc | as per SN1 |
| SN3 | Ensure fire access track maintenance is undertaken in accordance with accepted soil conservation practices | Yes, entire LGA | A Work Maintenance Program for tracks has been completed and is implemented subject to funding. | Current action is sufficient and should remain ongoing |
| SN4 | Improve knowledge of existing stormwater drainage system | Yes, entire LGA | as per CSP6 (ie, is same action as CSP6) | as per CSP6 |
| SN5 | Implementation of appropriate controls at building sites | Yes, entire LGA | as per CSP7 (ie, is same action as CSP7) | as per CSP7 |
| SN6 | Implement a plan of management for urban stormwater | Yes, entire LGA | as per CSP9 (ie, is same action as CSP9) | as per CSP9 |
| SN7 | Reduce stormwater pollution for residential areas | Yes, entire LGA | as per CSP10 (ie, is same action as CSP10) | as per CSP10 |
| SN8 | Ensure application of BMP's to control stormwater pollution | Yes, entire LGA | as per CSP10, and through the Sustainable Water DCP. | as per CSP10 |
| SN9 | Restrict or prevent development of sensitive sites | Yes, entire LGA | as per CSP11 (ie, is same action as CSP11) | as per CSP11 |
| SN10 | Prevent loss of vegetation from highly sensitive sites | Yes, entire LGA | The Sensitive Urban Lands DCP 1996 protects foreshore areas, the DA process also restricts development, and there is some education. The bush regeneration program has also expanded to address this issue | Action was completed and should remain ongoing. Further compliance efforts to enforce this action, such as a River Keeper, are required. Recommendations for greater protection for foreshore habitats as per M2 apply to this issue. Bank erosion investigations as per BM4 are also recommended for this issue. |
| SN11 | Improve management of runoff from degraded urban and peri-urban bushland | Yes, entire LGA | Stream and riparian remediation, and bushland remediation programs, are in place as part of the CRR program. | Action was completed and should remain ongoing. |

| Action Ref | Action Description | Action Completed | Method of completion / Reasons not completed / Comments | Recommendations and further works required |
|---|---|---|---|---|
| SN12 | Prohibit sand extraction upstream of Woolwash as supported by Sydney REP20 | Yes | HSC surrendered their license and former DLWC (now DECC) agreed to discontinue the license. | Action was completed, and there are no further issues. |
| SN13 | Minor dredging of navigation channels is supported subject to appropriate environmental approvals | Yes | The HSC approval process requires an SEE for dredging of <1000m3 and EIS for dredging of > 1000m3. Minor dredging of existing navigation channels is supported by HSC. | Action was completed, and there are no further issues. |
| CRF1 | Prepare a management plan specifically for Berowra Creek that addresses local concerns regarding fishing practices, particularly visiting commercial fishers, overfishing and excessive bycatch | No | Following the failure of the commercial fishing survey by the Ecology Lab (refer ERF14), NSW DPI Fisheries did not have the data to support a management plan. | Action should be completed, in conjunction with fishing surveys as per ERF14. |
| A1 | Any proposed new aquaculture development in the estuary such as fish farming would require a thorough EIS and the approval of NSW Fisheries | Yes | There were no aquaculture developments proposed for Berowra. Were this issue to arise in the future, the development would be required to provide an EIS, as per appropriate SEPP for aquaculture. | Action was completed, and there are no further issues. |
| HP1 | Investigate and implement appropriate protection measures for middens subject to erosion in the estuary | No | HSC has not completed this action. However, this action may have been completed for those foreshores under NPWS management, as part of the reserves. | This action should be completed |
| HP2 | Enforce existing no wash/no wake zones in the estuary (same as BM4) | Yes | as per BM4 (ie, is same action as BM4) | as per BM4 |
| M1 | Conserve and protect flora and fauna in public and private ownership through appropriate zoning measures and development controls. Amend River Settlements DCP to include flora and fauna protection | Yes, entire LGA | as per SN10 | Action was completed and should remain ongoing. Greater protection, such as through LEP zoning and planning controls to protect significant habitats is required (see M2 below) |
| M2 | Protect significant flora and fauna habitats. Identify and protect all threatened fauna habitats and minimise vegetation fragmentation | Partly | as per SN10. Greater mapping of habitats is required to complete this action. | Mapping of all habitat communities (both riparian and terrestrial flora and fauna) needs to be expanded and updated to complete this action. Periodic remapping to monitor changes to extent and condition required. This will identify significant habitat communities outside of existing zones which require greater protection through LEP zoning and planning controls |
| M3 | The sub-tidal and tidal areas of Big Bay to be incorporated into Marramarra National Park or as a marine protected area | No | This area is still considered Crown Land. There is a question of whether Crown Land or National Park management will offer this area greater protection. Letter (Dec, 2003) from Ian McDonald, MLC Minister for Primary Indutries states "The assessment [for a Marine Park] of the Hawkesbury Shelf Bioregion in which Big Bay in Marramarrra Creek is found, is currently under review. These assessements aim to ensure that a range of marine ecosystems are protected in selected marine protected areas. Once assessments have been reviewed, community consultation and more detailed site assessments will take place to consider local social, economic and social issues." | This action should be completed following investigation of which zoning offers the greatest protection and the with knowedge of the NSW Government commitment for the Hawkesbury River to become a Marine Park. |

| Action Ref | Action Description | Action Completed | Method of completion / Reasons not completed / Comments | Recommendations and further works required |
|---|---|---|---|---|
| M4 | Monitor the extent of saltmarsh and mangrove areas and determine management actions | Yes | Saltmarsh and mangrove extents in Berowra Creek were mapped. | Action was completed, however update of mapping is required as per M2 |
| S1 | Improve water quality through management strategies addressed in previous actions | Yes | as noted in other actions | Action completed |
| S2 | Ensure the requirements of Fisheries HPP#2 (Seagrasses) are implemented and monitored | Yes | DPI conducts implementation of HPP No.2: Seagrass | Current action is sufficient and should remain ongoing |
| S3 | Seagrass beds to be indicated on boating maps. Maps to be distributed by Waterways and hire boat operators | No | Seagrass markers on maps were said to be difficult to read. NSW Maritime has noted that the areas of seagrass (as provided by DPI Fisheries) were too small to be clearly visible on Maritime maps. It was also felt to not be cost effective to keep maps up-to-date with the changing areas of seagrass (ie, increases and decreases over time). | Action should be modified to the provision of marker buoys and warnings around seagrass habitats to deter boaters from accessing/damaging these habitats |
| NW1 | The management objective is to restore and maintain healthy native vegetation within the riparian zone | Yes, entire LGA | A Noxious Weeds Strategy has been completed for the entire LGA. | Current action is sufficient and should remain ongoing. Bushcare programs should be expanded where possible |
| NW2 | Weed seed sources and infestations, particularly in residential properties and along road reserves to be controlled and action taken to remove | Yes, entire LGA | HSC has employed a Noxious Weeds officer, and has a Cowan Catchment Weed Strategy, a corridor grant to remove weed sources, and a contract bush regeneration programs, and sediment basins are installed as part of the CRR program. | Current action is sufficient and should remain ongoing. Programs should be expanded where possible. New developments should be required to use only endemic species in landscaping and household gardens. |
| NW3 | Undertake community education on the threat of weeds to bushland | Yes, entire LGA | Education is undertaken by the noxious weeds officer, and as part of Rural Lands Incentive Scheme, and the gardens for wildlife, bushcare and specific weed eradication programs. | Current action is sufficient and should remain ongoing. Programs should be expanded where possible |
| NW4 | Provide information to local residents on suitable indigenous plants for gardens | Yes, entire LGA | The indigenous planting guide, "create a native garden" brochure, "indigenous plants for the bushland shire" playing cards, webpage with planting lists, audits of nurseries for noxious weeds, are all actions taken by HSC. | Current action is sufficient and should remain ongoing |
| NW5 | Encourage the removal of exotic species and planting of indigenous species | Yes, entire LGA | As per NW3 and NW4 | As per NW3 and NW4 |
| NW6 | Liaise with local schools and educational establishments for students to undertake practical bush regeneration work in the park to assist in implementing the plan | Yes, entire LGA | Schools bushcare program, and tree management, bushcare program and environmental auditing of schools, estuary management programs runs a one day workshop. | Current action is sufficient and should remain ongoing. Programs should be expanded where possible |
| NW7 | Continue Council efforts in encouraging local residents to participate in environmental and bush regeneration schemes | Yes, entire LGA | Action enacted through methods noted above, and bush regeneration program which has thousands of volunteers in the LGA | Current action is sufficient and should remain ongoing. Programs should be expanded where possible |
| NW8 | Bush regeneration works be undertaken around the wetlands area in Crosslands Reserve | Yes | Action enacted through works focussed on saltmarsh regeneration and bushfire management. | Current action is sufficient and should remain ongoing |
| BioM1 | Establish a biological monitoring program to assess seagrasses, mangroves, saltmarshes and the fauna they support. Program should include periodical mapping of | Partly | Mangrove and saltmarsh mapping are undertaken in relation to the Sediment Elevation Tables. No monitoring of seagrass is undertaken. | Mapping of the extent and condition of all aquatic habitats (including benthos, intertidal zone, water column and water surface) is required, in addition to habitat mapping outlined in M2. A comprehensive biological |

| Action Ref | Action Description | Action Completed | Method of completion / Reasons not completed / Comments | Recommendations and further works required |
|---|---|---|---|---|
| | aquatic habitats and quantitative sampling of key indicators | | | monitoring program should be established for all aquatic habitat typesa |
| BioM2 | Investigate the possibility of involving universities, and/or the CSIRO in the monitoring program | Yes | Programs exist involving UTS, UNSW, CSIRO, ANU, ACU. | Action was completed however, programs should be expanded where possible |
| BioM3 | Establish MOU's (Memorandums of Understanding) between Council and universities and other research organisations to encourage research into the estuary | Partly | An MOU is established with UTS. In February 2004, universities and research organisations were sent letters offering collaborative research opportunities. Some interstate universities and CRCs indicated they would be unavailable for research within the Hornsby Shire. | The action should be re-established and with more universities to guide research initiatives that support implementation of the LHEMP |

# 3 CONCLUSIONS

The implementation of the BCEMP has been carried out well with the majority of actions being undertaken, largely by HSC through planning, research, capital works, compliance and education programs, which additionally apply to the entire Hornsby LGA. HSC should be commended for their dedication in implementing the Plan. Most of the issues outlined in the BCEMP, however, are still considered to threaten the long term health of Berowra Creek, namely: catchment sourced pollution, freshwater inputs, boat sourced pollution (effluent, waste, heavy metals, oil) and usage (fishing, moorings), sedimentation, foreshore habitat protection, weeds, recreational facilities and heritage. Furthermore, in recent Workshops conducted as part of the development of the Lower Hawkesbury Estuary Management Plan, close to all of those issues outlined in the BCEMP were again raised by the community and/or stakeholder representatives. Ostensibly, this suggests a lack of effectiveness in the actions completed to date. What should be emphasised, however, is that while the issues still exist, the extent of the threat posed by each issue has been greatly due to actions undertaken from the BCEMP. Similarly, if the actions were not implemented, the condition of Berowra Creek may have been diminished over this period.

There is currently no precise method to define the effectiveness of an EMP. Berowra Creek is known locally and regionally as a significant waterway. This is considered a major value given its proximity to the Sydney metropolitan area. Preservation of the creek's environmental values, whilst faced with the pressures of burgeoning urban development, is considered a defacto indicator of effective environmental management.

While this review cannot definitively say if improvements to the waterway are a direct result of implementing the BCEMP, it is far more likely that the controls introduced via the BCEMP have assisted in its preservation.

In light of the same environmental management issues outlined in the BCEMP being raised during the recent Lower Hawkesbury workshops, the following should be considered:

1. There is an opportunity for HSC to go beyond the level of their local government peers, and introduce stricter controls and develop new methodologies to address these persistent issues. The solid platform established with the BCEMP will enable such controls and actions to be undertaken far more easily.
2. There may be a need for greater education of the community as to the controls in place by HSC which reduce impacts on the waterway.
3. There is a need to investigate a measure of performance for an EMP that better determines the effectiveness of actions within it.

The review of objectives highlighted the remaining issues and actions, as summarised below.

- There is still work to be done to mitigate catchment sourced pollution. While planning and other controls have been relatively effective in reducing the threat to the Creek (and should continue to be performed), there is a need to strengthen existing controls and/or investigate new methods, in order to better mitigate this issue. In particular, ensuring new developments utilise the best environmental controls, followed by compliance audits to determine long term implementation of

these controls to mitigate new threats. Existing development may also need stronger at-source controls and end of pipe controls, in order to reduce existing impacts.

- Similarly, boat sourced pollution and usage remains an issue for Berowra Creek, and indeed the entire Lower Hawkesbury. While many of the related actions were implemented, there are still works to be done, which may require a stronger approach than has been used in the past. In particular, greater compliance, and potentially, audits of the environmental performance of boats (particularly for waste management and boat maintenance activities) may assist to reduce this threat to a tolerable level.
- Riverside settlements remain an issue, in spite of significant reductions in OSSM impacts in particular. In this case, existing actions in the BCEMP should now be expanded to eliminate the threat of OSSM overflows, provide greater protection for foreshore vegetation, achieve a higher level of environmental management in new developments via in the reviewed River Settlements DCP, and introduce new measures to mitigate impacts from existing developments, such as with pumpout and solid waste services.
- Ecological monitoring was also highlighted as a requirement of future work. In particular, extent and condition mapping for all habitat types (terrestrial, riparian, aquatic) is required, and a long term monitoring and mapping program should then be implemented. This will enable significant communities to be protected, and may assist in the long term measurement of performance of the EMP. In addition, better protection for seagrass, such as through marker buoys, is needed.
- Land capacity assessments, which assist in determining the overall capacity of the LGA to accept greater populations, is required. This should assist HSC to decide on the level of population acceptable for the LGA. Furthermore, new and updated DCPs should continually strive to achieve the highest level of environmental requirements, to reduce the impacts of all development upon the surrounding natural environment and waterways in particular. New housing strategy should provide information to assist with such an assessment
- New aspects of the issue of sedimentation have arisen, which were not noted in the original Plan. Specifically, bank erosion needs to be assessed, in terms of determining the major causes, and areas requiring remediation and long term management. This may also relate to other issues within the Creek, such as reviewing speed zonings for boats, and the protection of Aboriginal middens. Further, to protect estuarine values it is recognised that reclamation should be prohibited and dredging restricted to navigation channels.
- The activities of recreational and commercial fishers need to be better defined, and an appropriate management strategy for such activities, based on preserving the aquatic environment as paramount, should be established.

These recommendations are to be incorporated into the forthcoming LHEMP. As noted, the issues for Berowra Creek are also issues for the Lower Hawkesbury. The implementation of actions in the BCEMP and the above recommendations across the larger waterway would additionally provide significant benefits to Berowra Creek. Further, the positive and negative lessons learned from the BCEMP will assist in the development of a more effective EMP for the Lower Hawkesbury.

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# 5 ABBREVIATIONS USED

| ABBREVIATION | DESCRIPTION |
|---|---|
| BCEMP | Berowra Creek Estuary Management Plan |
| BDN | Bayesian Decision Network |
| BVRPT | Berowra Valley Regional Park Trust |
| CASA | Civil Aviation and Safety Authority |
| CRR | Catchment Remediation Rate |
| DA | Development Application |
| DCP | Development Control Plan |
| DECC | Department of Environment and Climate Change |
| DEUS | Department of Energy, Utilities and Sustainability |
| DNR | Department of Natural Resources |

| | |
|---|---|
| EMP | Estuary Management Plan |
| EPA | Environment Protection Authority |
| HNCMT | Hawkesbury Nepean Catchment Management Trust (now Hawkesbury Nepean Catchment Management Authority) |
| HSC | Hornsby Shire Council |
| ISF | Institute for Sustainable futures |
| LEP | Local Environment Plan |
| LGA | Local Government Area |
| LHEMP | Lower Hawkesbury Estuary Management Plan |
| MOU | Memorandum of Understanding |
| NPWS | National Parks and Wildlife Service |
| NSWFA | NSW Food Authority |
| OFA | Oyster Farmers Association |
| OSSM | On Site Sewage Management |
| RACC | Regional Algal Coordinating Committee |
| SKM | Sinclair Knight Mertz |
| SoE | State of Environment |
| STP | Sewage Treatment Plan |
| SWC | Sydney Water Corporation |
| WSUD | Water Sensitive Urban Design |

# APPENDIX A: BEROWRA CREEK ESTUARY MANAGEMENT PLAN EXECUTIVE SUMMARY

# APPENDIX B: ACTION REVIEW TABLE

**Issue**: DATA COLLECTION CO-ORDINATION

**Responsibility**: Sydney Water Corporation, EPA, HSC

**Action Reference**: DCC1 **Priority:** 1995-1996 Completed

**Action Description**: Develop a co-operative program to monitor results of STP upgrades and other catchment remediation works

**Has the action been completed** ? (indicate %age complete if not 100%) .....

**Was the action effective in addressing the issue** ? (if not, please explain) .....

.....

.....

**Are there any outstanding issues** ? (what hasn't been done and why).....

.....

.....

**Any further comments / consideration** ? (eg problems during implementation, future recommendations / advice, time or cost overruns).....

.....

.....

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**BMT WBM Brisbane**
Level 11, 490 Upper Edward Street Brisbane 4000
PO Box 203 Spring Hill QLD 4004
Tel +61 7 3831 6744 Fax +61 7 3832 3627
Email wbm@wbmpl.com.au
Web www.wbmpl.com.au

**BMT WBM Denver**
14 Inverness Drive East, #B132
Englewood Denver Colorado 80112 USA
Tel +1 303 792 9814 Fax +1 303 792 9742
Email wbmdenver@wbmpl.com.au
Web www.wbmpl.com.au

**BMT WBM Melbourne**
Level 5, 99 King Street Melbourne 3000
PO Box 604 Collins Street West VIC 8007
Tel +61 3 9614 6400 Fax +61 3 9614 6966
Email wbmmelbourne@wbmpl.com.au
Web www.wbmpl.com.au

**BMT WBM Morwell**
Cnr Hazelwood Drive & Miners Way Morwell 3840
PO Box 888 Morwell VIC 3840
Tel +61 3 5135 3400 Fax +61 3 5135 3444
Email wbmmorwell@wbmpl.com.au
Web www.wbmpl.com.au

**BMT WBM Newcastle**
126 Belford Street Broadmeadow 2292
PO Box 266 Broadmeadow NSW 2292
Tel +61 2 4940 8882 Fax +61 2 4940 8887
Email wbmnewcastle@wbmpl.com.au
Web www.wbmpl.com.au

**BMT WBM Perth**
1 Brodie Hall Drive Technology Park Bentley 6102
Tel +61 8 9328 2029 Fax +61 8 9486 7588
Email wbmperth@wbmpl.com.au
Web www.wbmpl.com.au

**BMT WBM Sydney**
Suite 206, 118 Great North Road Five Dock 2046
PO Box 129 Five Dock NSW 2046
Tel +61 2 9713 4836 Fax +61 2 9713 4890
Email wbmsydney@wbmpl.com.au
Web www.wbmpl.com.au

**BMT WBM Vancouver**
1190 Melville Street #700 Vancouver
British Columbia V6E 3W1 Canada
Tel +1 604 683 5777 Fax +1 604 608 3232
Email wbmvancouver@wbmpl.com.au
Web www.wbmpl.com.au