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Risk-based Framework for Considering Waterway Health Outcomes in Strategic Land-use Planning Decisions

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Achieving healthy waterways

Children at The Basin, Ku-ring-gai Chase National Park. Photo: D Finnegan/OEH

A healthy waterway provides essential services and functions to support environmental, social and economic outcomes, including more liveable cities and healthy, resilient communities.

The *Risk-based Framework for Considering Waterway Health Outcomes in Strategic Land-use Planning Decisions* (the Framework) is a protocol that decision-makers, such as councils and environmental regulators, can use to help manage the impact of land-use activities on the health of waterways in New South Wales.The Framework brings together existing principles and guidelines recommended in the National Water Quality Management Strategy, which the federal and all state and territory governments have adopted for managing water quality. It allows decision-makers to determine management responses, which meet waterway health outcomes that reflect the community's environmental values and uses of waterways.

Management responses could include specific development controls for stormwater management, informing license limits for waterway discharges, or programs that raise awareness of land use activities that protect and enhance the health of rivers and creeks. Where appropriate, the management responses can be implemented through regional and local planning instruments, environmental regulation, integrated water cycle management plans, Coastal Management Programs required under the *Coastal Management Act 2016* or other catchment management plans for restoring and protecting the health of waterways. Overall, the Framework can support decision making by any authority responsible for the management of land and waterways.

About this document

This document should be used as an introductory resource on the Framework. Further guidelines for implementing the Framework, including a range of case studies, will be available from the Coastal Management Manual – Toolkit.

The primary audiences for this document are natural resource managers, local and state government authorities and agencies, and water industry professionals.

The document includes:

- an overview of the five steps in the Framework
- a flow chart summarising the Framework
- a brief description of a case study on the application of the Framework for assessing the effectiveness of current stormwater management responses in the Lake Illawarra catchment. Full details of the case study will be available from the Coastal Management Manual – Toolkit
- a list of definitions that are specific to New South Wales (NSW) and consistent with the terminology used in the following:
  - Using the ANZECC Guidelines and Water Quality Objectives in NSW
  - Local planning for healthy waterways – using NSW Water Quality Objectives
  - The Treasury Risk Management Toolkit for NSW Public Sector Agencies.

The purpose of the Framework is to:

- ensure the community's environmental values and uses for our waterways are integrated into strategic land-use planning decisions
- identify relevant objectives for the waterway that support the community's environmental values and uses, and can be used to set benchmarks for design and best practice
- identify areas or zones in waterways that require protection
- identify areas in the catchment where management responses cost-effectively reduce the impacts of land-use activities on our waterways
- support management of land-use developments to achieve reasonable environmental performance levels that are sustainable, practical, and socially and economically viable.

About the Framework

The Framework was developed by the Office and Environment and Heritage and the NSW Environment Protection Authority in direct response to increasing urban development and a lack of integrated management of urban development, waterway health, and the community's expectations of the state's waterways. If not managed appropriately, urban development can increase the loads of pollutants and volume of stormwater and wastewater entering our waterways. Impacts may include erosion, sedimentation, habitat loss, algal blooms, excessive aquatic weed growth, altered flow regimes and reduced aquatic biodiversity. These impacts diminish the benefits communities derive from healthy waterways.

There are a growing number of management responses that can help mitigate or minimise the impacts of urban development and other land-use activities on the state's waterways (e.g. Blacktown Showground Precinct Water Sensitive Urban Design Redevelopment; Leura Falls Catchment Improvement Project; Blackmans Swamp Creek Stormwater Harvesting Scheme; Fish Friendly Farms; Smart Farms). The Framework allows decision-makers to determine management responses that meet waterway health outcomes which reflect the **community's environmental values and uses** of waterways – what the community believes is important for a healthy ecosystem, for public benefit, welfare, safety or health.

Waterway objectives

In NSW, environmental values and uses for all major waterways were identified through community consultation by the Department of Environment, Climate Change and Water (now Office of Environment and Heritage). These values and uses were adopted by the NSW Government in 1999 and are known as the NSW Water Quality and River Flow Objectives.

NSW Water Quality and River Flow Objectives

The Water Quality Objectives consist of three parts, following the recommended approach in the National Water Quality Management Strategy (NWQMS): environmental values and uses, their indicators and their guideline trigger values. The indicators and guideline trigger values are used to help assess whether a waterway will support a particular environmental value. For example, if the objective is to protect primary contact recreation (environmental value), we would need to manage the enterococci concentrations in the waterway (indicator) so they remained below a specified number/numerical criteria (guideline trigger value).

The River Flow Objectives are the agreed high-level goals for surface water flow management. They identify the key elements of the flow regime that protect river health and water quality for ecosystems and human uses.

The NSW Water Quality and River Flow Objectives are only one factor to consider when making decisions affecting the future of a waterway. Local objectives, identified through an appropriate cummunity consultation process, are preferable because they will reflect current environment values and uses, and the waterway's sensitivity to the land-use activity(ies).

In this document, objectives are referred to as **waterway objectives** to acknowledge both the existing environmental values and uses for the waterway, and to recognise the expanding range of indicators that can be used to assess whether the waterway will support a particular environmental value or use. These could be contemporary measures of waterway health such as macrophyte and fish abundance or biodiversity, or fringing and instream habitat measures (Roper et al. 2011). In more complex situations, they can also be a sustainable or target load for the waterway, a descriptive statement or an index. Choosing the appropriate indicator(s) is critical and the choice should be based on the key issues in the waterway and the main stressor(s) (e.g. pollutants) that might be generated by the activity(ies) under consideration. For example, streamflow indicators may be necessary to protect against erosion in freshwater tributaries under local urban development scenarios, but traditional water quality indicators (e.g. nutrients, turbidity, dissolved oxygen, chlorophyll *a*) may be needed to protect against eutrophication in a downstream estuary as a result of systemic catchment runoff and/or point source discharges. Multiple indicators may be needed to represent a range of environmental values and uses of the waterway.

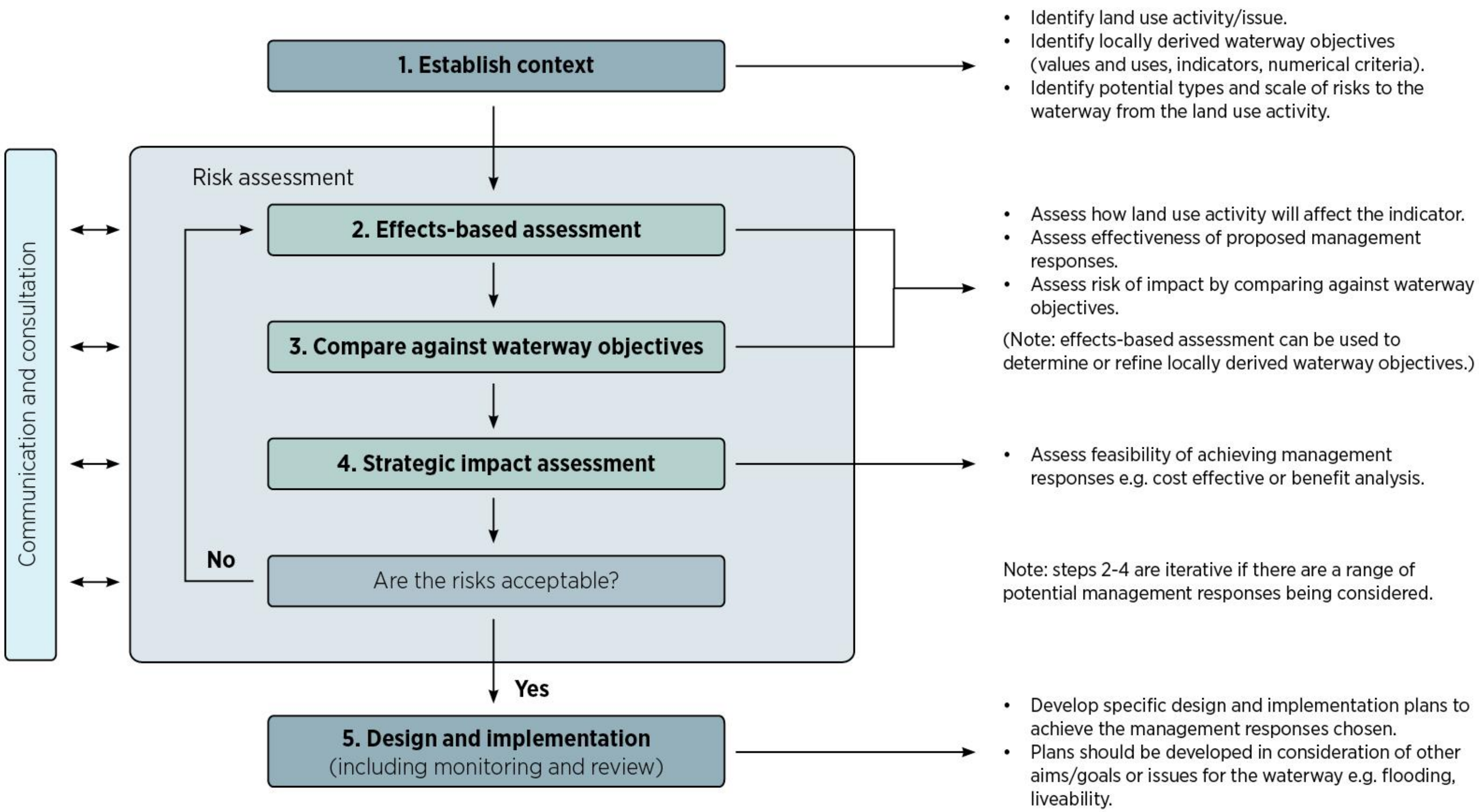
Scale of implementation

The Framework is best implemented at the catchment or subcatchment scale by an overall managing authority, such as a council, or regional or state agency. Most councils are already implementing some steps of the Framework, often in-house or in collaboration with state agencies, practitioners and industry experts. For example, Step 2 of the Framework is an effects-based assessment and is often undertaken by industry experts or water professionals on behalf of councils to inform decisions on large development applications. Ideally, the overall managing authority should implement the Framework in consultation or partnership with a range of stakeholders such as local residents, community groups, adjoining councils, state agencies and water authorities.

The steps in the Framework are closely aligned with many activities required for the preparation of Coastal Management Programs under the *Coastal Management Act 2016*, such as characterising the current health of a waterway, assessing cumulative effects of land-use activities and assessing the sensitivity of a waterway to land-use activities. The Framework is also consistent with the key initiatives of the Marine Estate Management Authority, including recognising a need to communicate and develop an understanding of the environmental, social and economic values and threats to a waterway.

Framework flowchart

Risk-based framework for considering waterway health outcomes in strategic land-use planning decisions



Step 1: Establish context

The first step *establishes the context* for applying the Framework. It involves identifying the:

- land-use activity(ies), for example, urban residential and industrial developments, and/or agriculture
- waterway type, and how the waterway has responded to previous land-use activities and the likely trajectory of the waterway in response to future land-use activities
- waterway objectives, consisting of:
  - community's environmental values and uses of the waterway, as identified in the NSW Water Quality and River Flow Objectives and/or through locally-derived environmental values and uses
  - indicator(s) and corresponding numerical criteria to assess whether the waterway will support a particular environmental value or use. The selected indicator(s) should have a direct relationship to the risks/impacts posed by the land-use activity and be at the appropriate scale to manage those risks/impacts
- potential types of impact(s) of the land-use activity on the waterway objectives, and therefore which objectives may be most relevant to manage the activity

The above process should aim to derive local waterway objectives, either via the **referential approach** or by **direct measurements and/or the numerical modelling of impacts** of the land-use activity on the waterway.

- The **referential approach** is based on reference sites, where the waterway health is considered suitable for baseline or benchmark assessment. The numerical criteria for the indicator(s) of waterway health are typically based on percentiles (e.g. 80th percentiles) of data collected by monitoring the reference site, as outlined in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (the ANZECC guidelines).
- **Direct measurements and/or numerical modelling of impacts** of the land-use activity can be made in Step 2 of the Framework, where an effects-based assessment is tailored to the specific issue and waterway type.

Step 2: Effects-based assessment

An effects-based assessment is used to quantify how the land-use activity will change the health of the waterway, as given by the indicator(s) and numerical criteria used to assess whether the waterway will support a particular environmental value or use. Where appropriate, the effects-based assessment can be used to develop or refine the indicator(s) and numerical criteria to account for the natural local variation in the waterway. An effects-based assessment can also be used to quantify the effectiveness of any management responses intended to protect, maintain and/or improve the health of waterway.

A typical effects-based assessment:

a. determines whether the current health of a waterway is supporting the waterway objective(s), typically using data on indicators from local observations and/or monitoring programs
b. identifies a level of protection based on a level of quality desired by stakeholders and implied by the management goals and waterway objectives. For example, it is

common to protect waterways of high conservation value; to maintain and/or improve the health of slightly to moderately disturbed waterways; and to improve the health of highly disturbed waterways

c. quantifies the stressor(s) arising from the land-use activity that can affect the health of the waterway. For example, stormwater from urban developments can deliver relatively high loads of nutrients (stressor) to estuaries, and these directly impact on the ambient micro-algal concentrations (indicator) in the estuary. A list of stressors and associated land-use activities is available from the Marine Estate Management Authority Threat and Risk Assessments (TARAs). The TARAs show that multiple stressors can affect the health of the waterway, and are often interlinked. As with the selection of indicators, it is important to select stressors that are relevant to the land-use activity/issue being considered
d. quantifies the sensitivity of the waterway to the stressor(s). For example, intermittent estuaries are sensitive to land-use activities because they have limited connections to the sea, and as a result, are poorly flushed and retain a relatively large proportion of nutrient loads from land-use activities
e. quantifies the extent to which the stressor(s) affects the health of the waterway. For example, this might involve determining the amount of nutrients (delivered from stormwater) that will increase the micro-algal concentrations in the waterway above a certain numerical criterion
f. quantifies the effectiveness of the management responses in protecting, maintaining and/or improving the health of the waterway. For example, this might involve determining the extent to which a management response mitigates nutrients loads, and improves the ambient micro-algal concentrations in an estuary.

Effects-based assessments are increasingly implemented using numerical models, but can be implemented more simply via desktop assessments of readily available datasets. The type of effects-based assessment chosen will depend on the waterway type, the level of risk to the waterway, the complexity of the issue and/or the data and information available for the assessment. Examples of different types of effects-based assessments will be available in further guidelines for implementing the Framework in the Coastal Management Manual - Toolkit.

Step 3: Compare against waterway objectives (analysing risks of impact)

The risk of not achieving the community’s environmental values and uses is considered high if the measurement or assessment of the indicator exceeds the numerical criterion or is outside the desirable range. A high risk indicates a potential for impact but does not provide any certainty that an impact will occur (or has occurred).

Determining an acceptable level of change from a numerical criterion depends on the extent and frequency of exceedance (Mawhinney & Muschal 2015; OEH 2016). The tendency of allowing waterways to be affected up to the numerical criterion should be avoided to reserve the maximum opportunity for other present and future uses of the waterway, and allow adoption of a precautionary approach where there is uncertainty about the environmental outcomes of the land-use activity.

Step 4: Strategic impact assessment (evaluating risks based on feasibility)

This step involves *evaluating the risks* of impacts of the land-use activity on the waterway based on the feasibility of achieving the intended outcomes of each management response. This step ensures that the selected management responses are reasonable, practical and cost-effective. 'Practical' means considering what will work in a given situation: for instance, it might be difficult to protect, maintain and/or improve waterway health with traditional stormwater management alone; more water-sensitive approaches might be required such as stormwater harvesting, re-use and use of green infrastructure. Cost-effectiveness analysis can be extended to a cost-benefit analysis to recognise the full suite of environmental, socio-economic co-benefits of the management response. Cost-effectiveness analysis should ideally include (but not be limited to) the life-cycle costs of infrastructure (including green infrastructure), changes to costs if the management response is deferred, and costs of clean-up where there has been no management intervention or only little.

As shown in the flowchart, Steps 2 to 4 of the Framework are iterative to allow several management responses to be considered. The strategic impact assessment informs the decision as to which management response(s) will best treat the risks of the land-use activity affecting the waterway. In some cases, the decision may involve reconsidering the land-use activity because of the sensitivity and high conservation or ecological value of the waterway, or because it is not possible to minimise the risks. In other cases, a compromise based on interim management responses that show progress towards achieving the waterway objectives may be considered. The overall decision on the degree of intervention should be commensurate with the level of the risk.

Communication and consultation is an integral part of steps 2 to 4, and involve providing information on any trade-offs that might be required to meet the waterway objectives. The level of communication and consultation will vary depending on the nature of the land-use activity under consideration. Guidance for effective consultation is available from a range of sources: for example, the International Association for Public Participation provides guidelines and strategies for involving those who are affected by a decision in the decision-making process. The strategies promote sustainable decisions by providing information to those affected by the decision in a meaningful way, and communicating how their inputs have affected the decision. Case studies of previous projects, such as those developed under the Coastal councils Initiative, show other approaches that have been effective (Tucker & Tuckerman 2012).

Step 5: Design and implementation

The last step of the Framework aligns with the practicalities of *risk treatment*, and involves detailed planning of specific controls or treatment measures to achieve the intended outcomes of the chosen management response. For example, the chosen management response for a greenfield development might be to ensure that the post-development total nitrogen (TN) loads in stormwater are the same as the pre-development TN loads. The pre-development TN load is used as a benchmark to determine the amount, type and location of stormwater infrastructure at the development site.

The detailed planning may also identify the need for environmental offsets that could arise through technological and/or site constraints. Water utilities and councils, for example, have a growing interest in stormwater offsets as a way of meeting stormwater-quality management targets (see, for example, Blacktown City Council water quality offset scheme for infill development or Melbourne Water stormwater offsets). As described in the case study (below), the outcomes of the Framework can be used to develop 'benefit maps' that help to identify the best sites for management or environmental offsets.

Land-use planning involves a broad range of constraints, and so the design and implementation step of the Framework should take into account other aims or issues for the waterway (for example, devices to improve stormwater quality may make an area more attractive, help address flooding, or help to manage wastewater). Again, the 'benefit maps' may be used as overlays on other strategic maps (such as flood-risk maps) to help guide land-use planning and development decisions.

The design and implementation step should set up a **monitoring and review** process. This will ensure that the intended outcomes of the Framework are implemented and achieved, and remain relevant. Several mechanisms can be used to monitor and review but a typical process involves monitoring the indicator(s) that supports the community's environmental values and uses, reporting on the indicator(s) to inform the community (for instance, through report cards), and using the outcomes of the monitoring and review to improve management of the waterway.

Applying the Framework

Case study: Stormwater management strategies and responses to accommodate urban growth in the Lake Illawarra catchment

The Framework was used to identify cost-effective stormwater management responses that accommodate urban growth in the Lake Illawarra catchment while maintaining and/or improving the water quality and health of the lake. Applying the Framework led to two Actions (5.4.2 and 5.4.3) in the Illawarra-Shoalhaven Regional Plan.

The need for this case study arose from the current practice of using a general set of post-development stormwater pollutant-load reduction targets, which were developed in the late 1990s. The targets have led to clear improvements in water quality in some cases, such as that of Wallis Lakes (Weber & Tuckerman 2014), but there has not been enough data and information to determine if the targets have achieved waterway objectives for other estuaries. A growing body of literature indicates that the targets are ineffective in protecting freshwater ecosystems if other drivers of ecological health, such as stream flows and geomorphology, are not considered (Burns et al. 2012; Walsh et al. 2012; Walsh et al. 2016). The targets appear to be increasingly applied without considering the sensitivity of different waterway types to land-based pollutants, and the differing amount of pollutants generated by different types of development.

The Office of Environment and Heritage (Science Division and Regional Operations South Branch) conducted the case study on behalf of the NSW Environment Protection Authority. Steps 1–4 were carried out in collaboration with consultants in the stormwater industry and in consultation with Wollongong City Council and the Department of Planning and Environment. The data and models to inform the Framework were sourced from the Office of Environment and Heritage, Wollongong City Council, published scientific literature and readily available industry data. It took 2–3 months to do steps 1–4 of the Framework using existing data. Additional time was needed for consultation on the wider application of the Framework in the lead up to its adoption in the Illawarra-Shoalhaven Regional Plan.

Entrained entrance of Lake Illawarra. Photo: OEH

Step 1: Establish context for Lake Illawarra

Environmental values and uses

The Lake Illawarra catchment is located on the NSW south coast. The lake is a popular tourist destination, and supports a productive commercial fishery and numerous primary and secondary recreational uses. The lake is environmentally significant because it supports a range of endangered ecological communities (including coastal saltmarsh, swamp oak flood-plain forest, littoral rainforests) and many animal species.

Land-use activity/issue

Extensive urban developments are planned for west of the lake, covering a total of 13.5% of the catchment area. These developments form a significant component of the urban growth strategy for the region and the area of land is the second-largest released by the NSW Government in 2015. The developments include a range of housing and employment lands on a mixture of greenfield, brownfield, infill and re-development sites.

Potential risks

The planned developments have prompted some community concerns that the increased stormwater runoff could affect the lakes' water quality and health, and consequently affect their environmental values and uses including the protection of aquatic ecosystems, their visual amenity, and their use for boating, swimming and fishing.

Indicator(s) and numerical criteria

The micro-algal concentration in the water column (namely, chlorophyll *a*) is a specific indicator for aquatic ecosystems, and was considered to be appropriate in this case study because it:

- responds to nutrient loading from the catchment in a predictable manner
- is used as a representative waterway health indicator for estuaries in NSW, since it plays a key role in supporting and influencing the structure and function of aquatic ecosystems
- is used directly by the local council for reporting of lake health.

A numerical value (the criterion) of 3.6 µg/L chlorophyll *a* was selected because it is specific to open lakes ecosystems in NSW (Roper et al. 2011) and is already used by the local council for reporting on lake health.

According to the ANZECC guidelines, if water quality levels are met for local aquatic ecosystems, other environmental values and uses will usually also be protected. As a result, the micro-algal concentration in the water column was used as the representative indicator for assessing whether the lake is supporting the community's environmental values and uses, or will continue to support them under planned development.

Step 2: Effects-based assessment for Lake Illawarra

a. **Health of the waterway.** Water quality issues in the lake are long-standing and have led to the permanent opening of the lake entrance to the sea in 2007. Waterway health report cards for the lake indicate that the water quality, including micro-algal concentrations, at numerous monitoring sites exceed guideline values in ANZECC.

b. **Level of protection.** The lake can be classified as a moderately disturbed waterway, based on the current health. The optimal management response would be to maintain and/or improve the health of the waterway, while accommodating the urban developments planned for west of the catchment.

c-e. **Risk of impact of the land-use activity.** Risks of impacts were analysed through numerical models. Catchment models are commonly used by the stormwater industry to predict the amount of stormwater leaving the site of development, and to also plan stormwater infrastructure to meet development controls or other stormwater policies or objectives identified by the local council. In this case, the outcomes of the catchments models were used as inputs to hydraulic and ecological response models that predict the transport of stormwater out of the lake (flushing), and the subsequent risk of impacts of stormwater on the micro-algal concentrations in the lake, respectively.

Multiple model runs were completed to set a baseline of the current micro-algal concentrations in the lake, the projected impact on the micro-algal concentrations as a result of developments with no stormwater control/treatment, and the maximum catchment load that the lake can receive while still meeting or remaining below the micro-algal concentration (numerical criteria) value. This latter load is known as the sustainable load in the ANZECC guidelines, and was used in this case study to represent the maximum load that the lake can sustain to meet the community's environmental values and uses. While stormwater can introduce a range of pollutants (stressors), the sustainable load was based on the total nitrogen (TN) load because nitrogen is considered to be the primary limiting nutrient for micro-algae in Lake Illawarra.

The effects-based assessment for this case study was specific to an assessment of stormwater impacts on the lake. A discussion on the risk of impacts of other sources of TN input such as wastewater discharges and overflows, and internal TN cycling processes within the lake will be provided in a full description of the Lake Illawarra case study in the Coastal Management Manual – Toolkit. Impacts of stormwater on the health of freshwater tributaries in the lake's catchment were not explicitly quantified in the effects-based assessment, but were qualitatively considered in Step 5 of the Framework through the integration of the River Styles stream fragility index in the benefit maps. Key fish habitats in lake and freshwater tributaries were also integrated into the benefit maps. An example of an effects-based assessment for freshwater ecosystems will be provided in detailed guidelines for implementing the Framework in the Coastal Management Manual – Toolkit.

f. **Management responses.** Three management responses were considered in this case study i) post-development stormwater TN load-reduction targets specified in the local council's Development Control Plan (DCP), ii) 'no net increase' or 'no worsening' of existing of TN loads exported from the catchment, and iii) post-development stormwater TN load-reduction targets that achieve the sustainable TN load (or better).

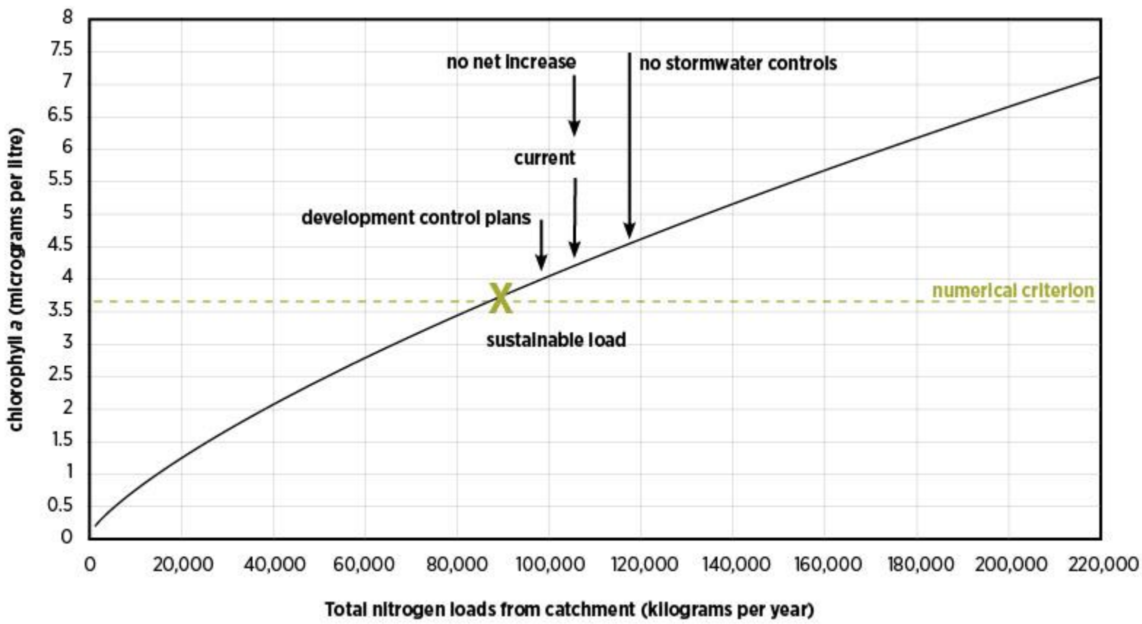


Figure 1 **Chlorophyll *a* concentration in Lake Illawarra as a function of TN (total nitrogen) load. The dotted green line denotes the numerical criterion for chlorophyll *a*, which was used to determine the sustainable TN load (X) for the lake. Arrows indicate the change to chlorophyll *a* concentrations under a range of management responses: TN load-reduction targets in Council's development control plan; no net increase in TN load target; no stormwater controls.**

Step 3: Compare against waterway objectives for Lake Illawarra

As shown in Figure 1, the post-development stormwater TN load-reduction targets specified in the local council's DCP improve the micro-algal concentration in the lake, but not enough to meet the sustainable TN load. The 'no net increase' or 'no worsening' management response provides no improvements, if used ubiquitously. To meet the sustainable TN load, post-development stormwater TN load-reduction targets must be at least 20 per cent less than the existing load from the planned sites of development.

Step 4: Strategic impact assessment for Lake Illawarra

The strategic impact assessment was designed around the council's concerns on the costs for stormwater management. The cost-effectiveness analysis showed that the feasibility of meeting the sustainable TN load was dependent on the development type.

The post-development stormwater TN load-reduction targets required to achieve the sustainable TN load may not be feasible for greenfield developments. The capital infrastructure and maintenance costs for traditional stormwater treatment (e.g. bioretention basins), as well as the land required for stormwater treatment would be relatively high/large for greenfield developments. These results point to a need to invesitage more water sensitive approaches to stormwater management, such as stormwater harvesting and re-use schemes and restoration of riparian corridors.

Under brownfield and re-development scenarios, the post-development stormwater TN load-reduction targets required to achieve the sustainable TN load are feasible, and in some cases, present opportunities for less expenditure on stormwater management than current specifications in the council's DCP.

A cost benefit analysis showed that costs of stormwater management were outweighed by direct beneficial costs to the community, such as commercial and recreational fishing (BMT WBM & AR Volders Environmental Consulting 2015; Weber et al. 2015).

Step 5: Design and implementation for Lake Illawarra

Design and implementation plans were not developed as part of the case study but are currently being discussed by relevant stakeholders involved in managing Lake Illawarra.

The strategic impact assessment resulted in an extensive set of post-development stormwater load-reduction targets for management responses that achieve the no net increase in loads or sustainable load for the lake. The new targets cover the full range of urban-development scenarios proposed for the Lake Illawarra catchment. Wollongong City Council, and other councils within the catchment, can use the new targets to compliment or replace the general targets in their existing DCPs. As well or instead, the councils can use 'benefit maps' like those developed for this case study (see below), to assist with design and implementation plans (Figure 2). The benefit maps reflect a trade-off between meeting the sustainable load and the council's current management responses and concerns about the high costs of ongoing stormwater management.

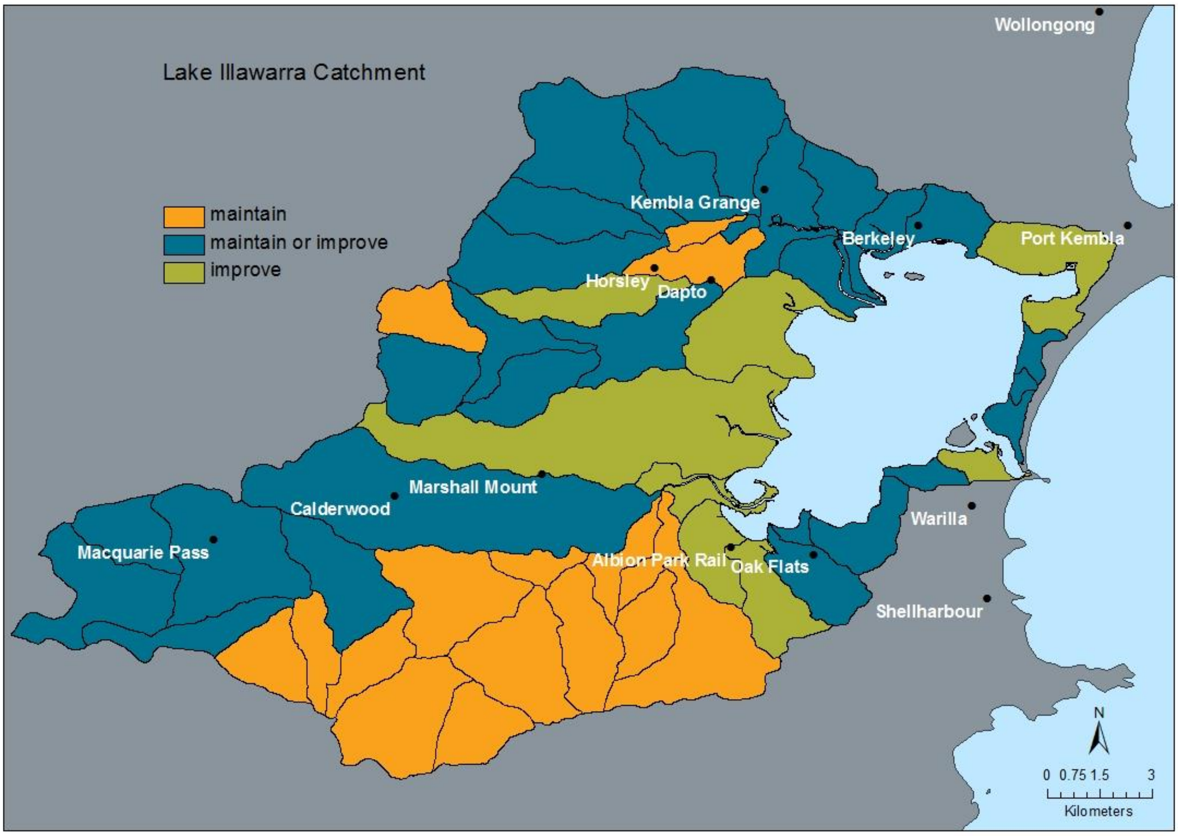


Figure 2 Benefit map identifying priority areas in the Lake Illawarra catchment for cost-effective stormwater management.

Benefit maps

Benefit maps integrate the outcomes of the effects-based assessment and the strategic impact assessment, to identify priority areas in the catchment for cost-effective stormwater management. For example, the following map identifies **green** areas in the catchment that pose the highest risk to waterway health but are also where traditional stormwater management would improve the health of the lake cost-effectively. In these areas, reaching (or going beyond) the general set of stormwater load-reduction targets currently specified in the council's development control plan would improve the lake's health. The green areas are thus 'improvement catchments', where resources for stormwater management would achieve the best benefits for the lake and ideally be prioritised.

The **orange** areas in the catchment are where more water sensitive approaches to stormwater management would be needed to have any effect in maintaining or improving the health of the lake. The orange areas are where the existing land-use is of low intensity, indicating that the optimal management response for these areas would be the no net increase in loads or no worsening option. The orange areas could essentially be used or zoned as 'maintenance catchments'.

The **blue** areas were designed to provide more flexibility and be used as offset areas or areas for adaptive management, in cases where stormwater controls cannot be met in green or orange areas. At the bare minimum, the council should apply its general set of stormwater load reduction targets in the blue areas.

Definitions

Waterway

A waterway is any navigable body of water, but is specifically defined here as any body of water that can be affected by land-use activities.

National Water Quality Management Strategy

The National Water Quality Management Strategy is a joint national approach to improving water quality in Australia and New Zealand. The NWQMS was originally endorsed by two ministerial councils - the former Agriculture and Resources Management Council of Australia and New Zealand, and the former Australian and New Zealand Environment and Conservation Council. Ongoing development of the NWQMS is currently overseen by the Standing Council on Environment and Water and the National Health and Medical Research Council.

Environmental values and uses of waterways

Environmental values and uses of waterways are those that the community believes are important for a healthy ecosystem, for public benefit, welfare, safety or health. There are seven broad categories of environmental values and uses of waterways, as identified in the National Water Quality Management Strategy:

1. protection of aquatic ecosystems
2. aquatic foods
3. recreational water quality and aesthetics
4. primary and secondary contact, including visual appreciation
5. drinking water supply
6. agricultural water use
7. industrial water quality.

ANZECC guidelines, indicators, and guideline trigger values

The Australian and New Zealand Guidelines for Fresh and Marine Water Quality, widely referred to as the ANZECC guidelines, is the central technical document that underpins the National Water Quality Management Strategy. The ANZECC guidelines were published in 2000, and were informed by all relevant government jurisdictions, water quality experts, industry and conservation groups. The ANZECC guidelines describe a range of indicators to help assess whether the waterway will support a particular environmental value or use. For example, the presence of bacteria such as enterococci is an indicator for recreational and drinking water quality because they directly put those uses at risk, but is not an indicator for the protection of aquatic ecosystems.

The ANZECC guidelines also describe a range of methods and case studies for determining guideline trigger values for the indicators, which are referred to water quality guidelines in ANZECC. The guideline trigger values indicate whether further investigation or management is required to minimise the risk of impacts on the community’s environmental values and uses of the waterway. Guideline trigger values are expressed as a single number or a range of desired numbers, and are usually concentrations of an indicator, but can be a descriptive statement to support and maintain the community's environmental values and uses.

Guideline trigger values are available for some indicators in the ANZECC guidelines, predominantly for slightly to moderately disturbed ecosystems, or highly disturbed ecosystems. The ANZECC guidelines recognise that there is inherent variability among waterways that could affect their capacity to receive some level of human induced input without unacceptable changes occurring (viz. sensitivity or assimilative capacity). So it is important to consider that the guideline trigger values do not account for varying local conditions and are best refined with local information. The current review of the ANZECC guidelines seeks to incorporate the latest scientific assessments of site-specific trigger values and associated uncertainties (Warne et al. 2014).

NSW Water Quality and River Flow Objectives

Environmental values and uses, indicators and guideline trigger values for all major waterways in NSW have been identified through community consultation by the Department of Environment, Climate Change and Water (now Office of Environment and Heritage), and are known as the NSW Water Quality and River Flow Objectives. Current policy in NSW indicates that the NSW Water Quality and River Flow Objectives should be used when there is limited data available for local derivations of objectives.

Relationship to other management approaches

The ANZECC guidelines provide a national framework for managing water quality that can be adapted to state, regional and local scales to address specific issues and account for specific environmental conditions. The Framework described in this document is an adaptation of the national framework to specifically guide strategic land-use planning decisions that protect waterways at local scales (subcatchment, precinct and/or lot scale). The Framework integrates NSW Policy and is more operational than the national framework because it explicitly includes an effects-based assessment to assist decisions on identifying management options for a particular problem and waterway type. The Framework also has an explicit step (step 4) for evaluating the feasibility of meeting water quality objectives, such as through cost effectiveness and/or cost benefit analysis.

The five steps of the Framework are consistent with the risk assessment approaches described for the Marine Estate Management Authority Threat and Risk Assessment, and the Coastal Risk Assessments in the Coastal Management Manual. All follow the risk management process recommended in The Treasury Risk Management Toolkit for NSW Public Sector Agencies and the international standard for risk management (ISO 31000 – Risk Management).

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