Regional Basin I

Surface Water Quality

June 2018

Lendlease

Project Name

Project No:	IA016600
Document Title:	Surface Water Quality – Basin I
Document No.:	1
Revision:	2
Date:	June 2018
Client Name:	Lendlease
Client No:	
Project Manager:	John Constandopoulos
Author:	Sarah Douglass
File Name:	I:\ENVR\Projects\EN04189\Technical\Regional Park Basins 2017\2018 papers for EIS WQ and ESC\Surface water quality report Jacobs format Basin I - June 2018 Ver2.docx

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Document history and status

Revision	Date	Description	By	Review	Approved
1	May 2018	Draft paper for review and comments	John C		
2	June 2018	Working paper report for inclusion in the EIS (Keylan)	John C		

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Contents

Document Set ID: 8944780
Version: 1, Version Date: 28/11/2019

Executive Summary

This report has been prepared to support the Environmental Impact Assessment of regional Basin I, which is located in the Regional Park to the south of Jordan Springs and to the north of the Central Precinct (Jordan Springs East).

This report describes the surface water quality strategy and provides a guide for effective water quality controls for the operational phase of this regional basin.

The construction of proposed Basin I would not impact on downstream creeks and on South Creek provided the basin is adequately maintained.

Surface Water Quality - Regional Basin I

1.1 Introduction

This report has been prepared to support the Environmental Impact Assessment of regional Basin I which is located in the Regional Park to the south of Jordan Springs. The main purpose of this basin is to provide water quality treatment and detention for peak flow mitigation. This paper provides an assessment of the surface water quality within the proposal area.

A review of existing literature relating to the proposal, available water quality data and existing conditions was conducted, using available literature to obtain background information on catchment history and land use. Literature sources included data obtained from Sydney Water monitoring from 2010-2013. Existing waterway condition was visually inspected during site visits by Cumberland Ecology (2017), and based on the site observations, habitat condition was assessed against the Department of Primary Industries Policy and Guidelines for Fish Habitat Conservation and Management (2013) and likelihood for threatened fish as required under the Fisheries Management Act 1994. The potential water quality impacts associated with the construction and operation of the proposal are identified and discussed, along with provision of mitigation measures to address the potential impacts.

1.1 Environmental Values

Environmental values are particular values or uses of the environment that are important for a healthy ecosystem or for public benefit or health. They are values that require protection from the effects of pollution and waste discharges and provide goals that help in the selection of the most appropriate management options (ANZECC/ARMCANZ 2000).

The applicable environmental values applying to the waterways within this catchment are:

- Protection of aquatic ecosystems
- Visual amenity

These environmental values are discussed below.

1.1.1 Aquatic Ecosystems

Aquatic ecosystems comprise the animals, plants and micro-organisms that live in water and the physical and chemical environment in which they interact. Aquatic ecosystems have historically been impacted upon by multiple pressures including changes in flow regime, modification and destruction of key habitats, development and poor water quality.

There are a number of naturally occurring physical and chemical stressors that can cause degradation of aquatic ecosystems. These parameters include, nutrients, dissolved oxygen, pH, salinity and turbidity (suspended solids). Where data is available, these have been considered in the assessment of existing water quality and potential impacts as a result of the proposal.

- **Nutrients** in aquatic environments promote the growth of algae and increase turbidity which in turn reduces light and may affect plant growth. Excessive nutrient inputs may lead to excessive algal growth and formation of nuisance blooms. Nutrients consist of nitrogen (including total nitrogen (TN), oxidised nitrogen and ammonia) and phosphorus (including total phosphorus (TP) and filterable reactive phosphorus (FRP)).

- **Dissolved oxygen** (measured in per cent saturation and milligrams per litre (mg/L)) is a measure of the amount of oxygen dissolved in water. Dissolved oxygen is vital for many forms of estuarine biota including native fish and is also vital for the functioning of healthy aquatic ecosystems
- **pH** is a measure of the acidity or alkalinity of a water body. Changes in pH can impact the ability of aquatic organisms to maintain basic functions such as respiration. pH also controls the bioavailability of metals, nutrients and other organic molecules. Changes to pH can be triggered by changes in the level of organic matter within the system, agricultural runoff from low pH soils (e.g. acid sulphate soils (ASS)) and changes in salinity
- **Turbidity** is a measure of the optical clarity of a water body which is important in characterising the health of a water body. Changes in the availability of light can affect the distribution of animals and potentially alter the chemical characteristics of the water body. Suspended solids (measured as total suspended solids (TSS)) from runoff or land disturbance can impact aquatic ecosystems by increasing turbidity, thereby reducing light penetration, modifying physical habitat and smothering biota.

1.1.2 Visual Amenity

The aesthetic appearance of a waterbody is an important aspect with respect to visitation and recreation. The water should be free from noticeable pollution, floating debris, oil, scum and other matter. Substances that produce objectionable colour, odour, taste or turbidity and substances and conditions that produce undesirable aquatic life should not be apparent (NHMRC 2008). The key aesthetic indicators are transparency, odour and colour. These have been considered in the assessment of existing water quality and potential impacts as a result of the proposal.

Limited water quality data has been available for this assessment, however existing literature on the downstream waterways has assessed water quality against the ANZECC/ARMCANZ (2000) default trigger values for physical and chemical stressors for 'South-East Australian slightly to moderately disturbed lowland rivers' and the HRC nutrient guidelines (1998) as appropriate. Recommended limits for metals are in accordance with ANZECC/ARMCANZ (2000) trigger values for toxicants for the protection of 95% of freshwater aquatic species.

1.2 Water Quality Objectives

There is the potential for the current water quality to not meet the existing guidelines and trigger values for protecting nominated environmental values. Irrespective of the current condition of waterways, the proposal should not further degrade water quality. As such the key objective of the proposal is to have a neutral or beneficial impact on downstream receiving waters.

1.3 Existing environment

Basin I is located in north-western Sydney within the Hawkesbury Nepean River Catchment. Within the broader study area, the proposal is located in areas of increased urbanisation with new and ongoing development occurring. This often results in increased sedimentation and the potential for poor water quality associated with increased stormwater discharges into creeks. Downstream of the proposal area, the catchment contains residential, industrial and commercial developments.

Proposed Basin I, is located immediately downstream of the Weerington Downs and Cambridge Gardens urban areas. It receives runoff from an existing open channel that conveys untreated runoff from the Penrith City Council catchment area. The basin is located on a minor, unnamed first-order drainage line with minimal channel definition. Runoff will enter the basin for treatment, before it is discharged back into an existing, first order, unnamed watercourse prior to entering South Creek. The basin will provide detention, facilitate nutrient removal and provide habitat for wildlife. When built, the basin will contain a permanent water body

2m deep with a volume of approximately 68.3ML. A shallow vegetated bench will be planted around the waters edge. The current Basin I location includes an area of weedy Freshwater Wetlands, small patches of exotic grassland as well the Threatened Ecological Community (TEC) - River-flat Eucalypt Forest (in the form of Alluvial Woodland).

Sensitive receiving environments are measured using aquatic habitat as an indicator and assessed against the *Department of Primary Industries Policy and Guidelines for Fish Habitat Conservation and Management* (2013). Site inspections of the waterways and proposed Basin I location were conducted by Cumberland Ecology in October 2017.

At proposed Basin I, the unnamed channel is classified as Type 3 – minimally sensitive fish habitat (DPI 2013) as it is a first order stream with minimal channel definition, limited instream habitat and not mapped as potential habitat for threatened fish under the *Fisheries Management Act 1994*.

Downstream at the unnamed waterway adjacent to Basin I, the unnamed tributary is classified as Type 2 – moderately sensitive fish habitat (DPI 2013) as it is a fourth order stream with a defined channel, and the provision of some instream habitat including overhanging riparian vegetation and instream woody snags limited instream habitat (Plate 1).

Plate 1 – Basin I location – Weedy Freshwater Wetland (Cumberland Ecology, 2017)

1.4 Existing Water Quality

No water quality data is available within the unnamed waterways at the proposed locations for Basin I, however, Sydney Water monitored water quality 39 occasions between 2010 to 2013 within South Creek. Site NS26 is located upstream the unnamed waterway discharge at Dunheved Golf Club, whilst NS23 is located at Shanes park, downstream of the proposed basin discharges.

The limited available water quality data within the study area was assessed against the ANZECC/ARMCANZ (2000) guidelines default trigger values for physical and chemical stressors for 'South-East Australian slightly to moderately disturbed lowland rivers' (Table 1). These downstream waterways provide a general approximation of the likely water quality conditions within the unnamed waterways in proximity of the proposed basins.

Table 1 Median water quality within South Creek between 2010-2013 (Sydney Water)

Site	Total Nitrogen (mg/L)	Oxidised Nitrogen (mg/L)	Ammonium (mg/L)	Total Phosphorus (mg/L)	Dissolved oxygen (mg/L)	pH	Turbidity (NTU)	Conductivity (uS/cm)
South Creek Upstream (NS26)	**1.36**	**0.295**	**0.05**	**0.094**	5.0	7.4	26	1115
South Creek Downstream (NS23)	**2.73**	**1.83**	**0.02**	**0.07**	7.70	7.58	15.50	961.00
ANZECC Guidelines	0.35	0.04	0.02	0.025	No guideline	6.5-8.5	6-50	125-2200

**Bold shaded text indicates exceedance of ANZECC/ARMCANZ guidelines.*

Sydney Water monitoring within South creek indicates high nutrient concentrations with median concentrations of total nitrogen, oxidised nitrogen, ammonium and total phosphorus outside the ANZECC guidelines (ANZECC/ARMCANZ 2000). These elevated nutrient concentrations suggest South Creek is eutrophic given the elevated nutrient concentrations. South Creek receives overflows and storm water which is most likely the cause for the poor water quality. Additionally, South Creek is known to suffer from bank erosion, weed proliferation and accumulation of rubbish and sediment during stormwater events.

Generally, the poor water quality within the broader study area indicates the waterways are impacted by the surrounding urban landuse, overflows and stormwater discharges. These impacts are also likely to occur upstream within the unnamed tributaries associated with both proposed basins prior to their construction.

1.5 Potential impacts

1.5.1 Construction phase

Construction of the proposal presents a risk to degradation of downstream water quality if management measures are not implemented, monitored and maintained throughout the construction phase.

If unmitigated, the highest risk to water quality would occur through the following construction activities:

- Removal of vegetation and general earthworks, including stripping of topsoil, excavation or filling
- Stockpiling of topsoil and vegetation
- Transportation of cut and/or fill materials and the movement of heavy vehicles across exposed earth

Additional details on these risks are provided below.

1.5.1.1 Removal of vegetation & general earth works

Removal of vegetation and general earthworks will occur within 500m of both waterways. General earthworks including vegetation removal, stripping of topsoil and filling has a risk of disturbance or mobilisation of sediment into the surrounding waterways, resulting in a potential to increase turbidity, mobilisation of contaminants and nutrients into the downstream waterways.

1.5.1.2 Stock piling of topsoil and vegetation

Stockpile sites would be used to temporarily store excess spoil and wastes such as concrete from demolition before their reuse on-site or disposal off-site. Stock pile sites would also include environmental protection measures such as sediment basins and hoardings to minimise impacts on sensitive receivers from dust and receiving waters from erosion and sedimentation. Stockpiles sites would be established and managed in in accordance with the Soil and Water Management Plan.

1.5.1.3 Transportation of cut and/or fill materials and the movement of heavy vehicles across exposed earth

Construction activities adjacent to waterways could introduce contaminants such as oil or greases and disturb contaminated sediments, potentially having an adverse impact on water quality. Accidental leaks or spills of chemicals, fuels and oils could occur from construction plant or construction materials.

1.5.2 Operational phase

Following the end of the construction phase, the basins would be filled with stormwater runoff and the macrophyte zone would start to establish. Typically, no exposed topsoil would remain as the basin batters above the water edge would be landscaped with terrestrial vegetation.

Once the basin becomes operational it will start to treat runoff that enters the basin. Water quality treatment in the basins takes place through settlement of suspended solids, and any associated pollutants such as nutrients and through uptake by the macrophyte aquatic planting system.

Any potential impacts during the operational phase would be from lack of adequate maintenance.

1.6 Water Quality assessment

1.6.1 Construction phase

The construction phase assessment and mitigation strategies are described in a separate Erosion and Sediment Control strategy paper

1.6.2 Operational phase

There are two components that have been assessed, these are for water quality and water quantity. Water quality (Section 1.6.2.1) addresses the quality of surface runoff, and water quantity (Section 1.6.2.2) addresses the flow rates of surface runoff.

1.6.2.1 Water Quality

The SREP water quality objectives for Basins B and I are to achieve the reductions of pollutant loads generated from the fully developed Lendlease catchments located upstream and to the west of South Creek such that there is no increase in annual average pollutant loads when compared to the predevelopment conditions.

To assess the overall water quality objectives of the SREP, Basin I cannot be assessed in isolation and therefore both basin (Basin B and I) are discussed in this report.

The purpose of updating the location and sizes of these basins is:

- Basin B - to rationalise its size and retain valuable flora that was identified by Cumberland Ecology (Ecology Consultants);
- Basin I - to retain significant trees and to increase its size to compensate for the reduction in size of Basin B; and
- To provide overall improved environmental and water quality outcomes for the Regional Park.

Basin I

Following the site visits with PCC and NPWS, a revised basin layout has been produced for Basin I and it has been changed from its SREP footprint of 7.4ha to 5.73ha. This revised total footprint represents the land available where clearing of vegetation can occur and the minimum required basin area is smaller than that and can therefore fit within the footprint where vegetation can be cleared. The proposed layout has been modified to retain some significant trees that were recently identified on site by NPWS and higher value ecology identified by Cumberland Ecology. These significant trees would have been removed under the previous SREP Basin I zoned layout. The clearing for the proposed basin area will be obtained by using a largely cleared lower value grassland area. Basin I will continue to be an on-line basin which is similar to the previous Basin I layout.

The proposed Basin I is located immediately downstream of the Werrington Downs and the Cambridge Gardens existing urban area. It receives runoff from an existing open trapezoidal channel that conveys surface runoff from an urbanised Penrith City Council catchment area that does not currently have any water quality controls. Runoff enters the basins and receives treatment before it is discharged back into an existing creek in the regional park open space area. This basin will provide significant water quality improvements to the current untreated runoff from PCC's urbanised catchment that enters the Regional Park. This basin will facilitate nutrients and suspended solids removal and provide a habitat for wildlife.

The existing PCC gross pollutant trap (GPT) trash rack which is located immediately upstream of the proposed basin I will be retained. This GPT captures gross pollutants, coarse sediments and sediment bound nutrients and heavy metals from a large existing urban area.

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Water Quality modelling

A water quality re-assessment of the entire catchment of the Western and Central Precincts was undertaken using the eWater MUSIC model to assess the changes and to provide a preliminary design of the basins sizes that would ensure that the original SREP water quality objectives and design criteria continued to be met.

A water quality assessment was undertaken using the eWater MUSIC model to estimate the reduction in water pollution by the proposed basins. The main purpose of the modelling was to demonstrate that the proposed water quality management controls of the regional basins would meet the water quality objectives of reducing the annual pollutant loads generated from the fully urbanised Lendlease catchments.

The updated total footprint of Basin I is shown on Table 2. These surface areas represent the total footprint including cut and fill batters and space required for maintenance access tracks.

Table 2 - Basin I key design dimensions

Parameter	Basin I
Water surface area	37,850 m²
Overall total footprint area	5.73 ha
Permanent water Volume	68.3 ML

Water Quality Modelling Results

The water quality modelling results indicate that the SREP water quality objectives, requirements and design criteria will be met.

The benefits of the existing PCC GPT have not been included in the Music model which means that the results are slightly conservative.

The results indicate that there would be a net return to the Regional Park area and a significant retention of trees and flora which were identified on site as desirable to retain by NPWS and Cumberland Ecology.

This result was achieved without impacting on the SREP water quality requirements. It is therefore recommended that the proposed rezoning of the Stormwater Management footprints of Basin I be approved and implemented.

The Penrith City Council design criteria and target reductions for new urban areas have been achieved individually at each of the proposed West and Central Precincts. (Ref: *Penrith City Council's Water Sensitive Urban Design (WSUD) Policy, December 2013,* and *Technical Guidelines, Ver3, 2015).*

In conclusion, the water quality assessment demonstrates that the Lendlease proposed basin rezoning achieves its intended objective and continues to meet the water quality objectives of the SREP of improving on existing conditions for TSS, TP and TN.

1.6.2.2 Water Quantity (Detention)

A hydrological and detention assessment has been undertaken by Cardno for the Jordan Springs East Precinct (*Stormwater Management Report* dated 13 January 2017). This assessment had identified a preliminary detention volume of 50,000m3 at Basin I and indicated that some additional work would need to be undertaken by the consultant designing Basin I to improve of some of the assumed parameters such as lag time and the actual proposed and designed outlet details that include the basin's throttled outlet and the slipway weir.

Jacobs have used the Cardno report and hydrological model which was approved by Penrith City Council to undertake further work and update the model to include the additional parameters needed. The original model used lagging links with lag times based on an assumed velocity. This was improved by using channel routing as it simulates attenuation due to floodplain storage. the channel geometry was also added to the model

The results of the updated model indicated that the detention required at Basin I is 60,000 m3 which is slightly larger than the previously proposed volume by Cardno of 50,000m3. The 60,000m3 detention volume will be situated above the permanent water level in the Basin.

The detention basin details represented in the XP-RAFTS hydrological model and required to mitigate an increase in peak flows are shown in Table 3.

Table 3 : Detention Basin I details

Detention storage depth (m)	1.7
Maximum available detention storage volume (m^3)	72,900
Low level spillway width, depth and side slopes	3m base width, 1.5m depth with V:H = 1:4
High level spillway width, depth and side slopes	27m total base width, 0.5m additional depth with V:H = 1:4
Spillway RL low and high levels	34m and 35.5m RL
Freeboard (100 YR ARI water level, m)	0.5

The hydrological modelling results shows that maximum storage available in Basin I (72,900m3 up to basin crest level) is above the maximum storage required in the 100 year ARI event (57,863m3). Basin I can therefore provide the required detention volume for storm events up to the 100 year ARI event.

Reuse

Water in the basin will not be used for any recycling or re-use purposes

1.7 Mitigation Measures

The mitigation measures to protect the downstream environment from any potential impacts during the construction and operational phases are quite different. The construction phase has a much higher potential for environmental impacts.

1.7.1 Construction phase

The construction phase assessment and mitigation strategies are described in a separate Erosion and Sediment Control strategy paper.

1.7.2 Operational phase

The mitigation measures to protect against any potential impacts involve adequate maintenance of the basin.

Maintenance is an essential part of a healthy water quality basin system that continues to provide an aesthetic environment as water quality treatment.

The proposed Basins will comprise of a deep water zone and a macrophyte zone which will consist of reed beds on the water edges around the perimeter of the basins. It will facilitate nutrient and suspended solids removal and provide a habitat for wildlife. Water quality ponds provide a very effective means of treating stormwater in urban areas. However, ongoing maintenance is essential in maintaining the water quality performance of the basins. Refer to Section 1.10 for the recommended maintenance procedures.

1.8 Mitigation measures for the identified potential impacts

Table 4 identifies suitable environmental safeguards for the potential impacts that have been identified. It also provides information on the timing and responsibilities for these safeguards.

Table 4 - Safeguards and management measures

Potential Impact	Environmental safeguards	Responsibility	Timing
Construction Phase General Construction Impacts	A soil and water management plan (SWMP) would be developed in accordance with the Blue Book – Soils and Construction – Managing Urban Stormwater Volume 1 (Landcom 2004) and Volume 2D (DEC 2008a). The SWMP would include but not be limited to: • An erosion and sedimentation control plan and maintenance schedule for ongoing maintenance of temporary erosion and sediment controls • An incident emergency spill plan which will include measures to avoid spillages of fuels, chemicals and fluids onto any surfaces or into any nearby waterways	Contractor	Pre-construction and construction
Construction phase Sedimentation and Erosion	• Adequate erosion and sediment controls such as a SWMP, diversion drains, sediment and barrier fences, stabilised access entrance points, drainage inlet pit protections and sediment sumps • Clearing of vegetation and site stabilisation of disturbed areas would be undertaken progressively to limit the time disturbed areas are exposed to erosion prices	Contractor	Pre-construction and construction

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Potential Impact	Environmental safeguards	Responsibility	Timing
	• High risk soil and erosion activities such as earthworks will not be undertaken immediately before or during high rainfall or wind events • Stockpiling of topsoil separately for potential reuse in landscaping and rehabilitation works		
Construction Phase Impacts to water quality	• All fuels, chemicals, and liquids would be stored at least 50 metres away from the existing stormwater drainage system and would be stored in an impervious bunded area within the compound sites. • The refuelling of plant and maintenance machinery would be undertaken in impervious bunded areas in the designated compound areas. • Vehicle wash downs and/or concrete truck washouts would be undertaken within a designated bunded area of an impervious surface or undertaken off-site		
Construction Phase Impacts to downstream water quality	Implementation of a visual water quality pre-construction and construction monitoring program.	Contractor	Pre-Construction, ongoing
Operational phase	Implementation of the maintenance tasks that have been identified in Table 5.	Owner	On-going after the construction period

1.9 Water Quality Monitoring Program

A surface water quality monitoring program would be undertaken immediately upstream and downstream of the proposed basins. Pre-construction monitoring will provide an appreciation of the existing water quality to ensure there is no further degradation in water quality during construction, and assess the water quality improvement during operation. Parameters to be collected include grab samples of total suspended solids, total nitrogen, total phosphorus, as well as *in-situ* monitoring of turbidity, pH, dissolved oxygen and conductivity. Pre-construction monitoring would be undertaken within 24hours of a wet weather rainfall event, defined as >10mm of rainfall at the closest Bureau of Meteorology Station (Shanes Park Station #067081). A minimum of two wet weather events are required prior to construction to provide an accurate representation of the baseline conditions.

Operational monitoring would be consistent with the pre-construction monitoring, however initially targeting a minimum of three wet weather sampling events within the first six months of operation, following which the monitoring program will be re-evaluated.

1.10 Maintenance procedure

A summary maintenance procedure has been prepared to outline the maintenance and operational requirements associated with the basins, noxious weeds management and routine inspections of the basins.

Routine inspection of the basins is required to be undertaken monthly and after storm events or any other events such as floods, fire and chemical spills that may affect the basin's function. It is recommended that most items be inspected monthly, however, some items only require attention three-monthly, bi-annually or annually. Table 5 below outlines the frequency at which each item should be inspected and the appropriate maintenance activities associated with that item.

Table 5 - Description of routine maintenance inspection tasks

Item	Inspection frequency	Maintenance required
Physical		
Debris and litter removal, including at the inlet, outlet and overflow structures	Monthly and immediately after storm events	Hand removal and appropriate disposal of material.
Signage	As required	Inspect signs for vandalism. Replace and/or repair signs as necessary.
Sedimentation	As required	Remove sediment from the basin when 0.3m deep using an excavator.
Erosion	Monthly or after storm events	Check the verges and record the location and extent of any erosion. Stabilise erosion sites as necessary.
Water Level	Monthly	Record any changes in water level.
Biological		
Weeds	Monthly or after storm events	Hand removal of any introduced species before the infestation becomes difficult to control.
Mosquitoes	Three-monthly	Check for presence of mosquitoes at dawn and dusk. Check for larvae in pooled water and in shallow sections of the basin. Check for the presence of invertebrates and small fish, which help to control mosquitoes.
Birds and other animals	Three-monthly	Record the presence of animals, including evidence of their existence such as droppings or tracks.

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Blue-green algae	Monthly	Check for presence of green surface film, scum, discolouration or new odours.
Water quality	Bi-annually	Take water samples every 6 months or as necessary, depending on water quality testing results.
Change in waterplants	Annually	Record diagrammatically the location and abundance of waterplants and compare with original records. Note any discolouration, disease or death.
Replanting	As required	Replace plants as necessary, according to location and abundance of species.

1.11 Conclusion

Limited existing water quality data were available for the assessment of potential water quality impacts, however given the ephemeral nature of these waterways and the existing poor water quality further downstream, construction of the proposed Basin I are unlikely to impact on South Creek downstream provided the mitigation measures above are implemented. Operation of the basin will result in improved water quality conditions due to the uptake of nutrients, and settling of sediments. Pre-construction and operational monitoring will aim to confirm the resulting water quality improvements.

1.12 References

ANZECC/ARMCANZ (2000) *National Water Quality Management Strategy Australian and New Zealand Guidelines for Fresh and Marine Water Quality.* Australian and New Zealand Environment and Conservation Council, Agriculture and Resource Management Council of Australia and New Zealand.

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