VOLUME 4

Appendix L2
Surface water quality

Department of Infrastructure and Regional Development

Western Sydney Airport EIS
Surface Water Quality Assessment

October 2015

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Executive Summary

An assessment of the potential impacts of the proposed Western Sydney Airport (proposed airport) on surface water quality has been undertaken for both the Stage 1 and, at a preliminary level, for the longer term development. The assessment was undertaken on the basis of the Draft Airport Plan and concept design available for the study.

Available baseline water quality data for the airport site and surrounding areas have been reviewed. The results indicate that nutrient loads in the existing waterways are generally high and do not achieve Australian and New Zealand Environment and Conservation Council (ANZECC) water quality objectives for total phosphorus and total nitrogen. However, total suspended solids loads are generally low and below ANZECC Guideline levels.

A Model for Urban Stormwater Improvement Conceptualisation (MUSIC) water quality model was developed and calibrated to the available baseline data. Additional models were then developed to represent Stage 1 and the longer term development phases of the project and on which to identify potential impacts of the proposed airport.

Bio-retention basins proposed as part of the airport concept design were incorporated into the modelling. This consisted of eight bio-retention basins located along the perimeter of the airport site. Basins 1, 2, 3, 4, and 5 were placed along the southern boundary to provide water quality treatment of the stormwater flows prior to discharge to Badgerys Creek. Similarly, Basins 6 and 7 were situated along the northern boundary to manage the flows discharging into Oaky Creek and Cosgroves Creek, while Basin 8 was positioned to manage flows discharging into Duncans Creek. All the basins are proposed for construction during Stage 1 of the project, except for Basin 5, which would be constructed during the longer term development phase.

The calibrated MUSIC water quality models were simulated over an extended rainfall time series to assess the pollutant loads and potential impacts of the proposal. In evaluating the effectiveness of the proposed measures, the treatment targets for total suspended solids, total phosphorus, and total nitrogen were assessed on the basis of i) comparison with existing or pre-development pollutant loads (NORBE); ii) Water Sensitive Urban Design (WSUD) Guidelines; and iii) ANZECC Guidelines (2000).

The Neutral OR Beneficial Effect (NORBE) concept for water quality management compares pollutant loads derived under post-development conditions to those obtained under existing conditions and seeks to maintain or improve the existing loads, in order to minimise any downstream impacts. By comparison, the WSUD concept aims to manage water quality by reducing the post development pollutant loads by set percentage targets. It is noted that the WSUD approach does not explicitly take into account the water quality pollutant loads under existing conditions. ANZECC Guidelines provide water quality objectives with the aim to limiting the pollutant loads to those required to sustain the environmental health and assimilative capacity of receiving waterways. The Guidelines apply to both the existing and post-development environment.

Under the proposed Stage 1 development conditions, with the proposed bio-retention basins in place, the results indicate that reduction of the post-development loads to pre-development loads (NORBE) would not be achieved, except for suspended solids.

Similarly, the results indicate that Stage 1 of the development, with the bio-retention basins in place, would be unable to satisfy WSUD targets, except for flows discharging from the site into Oaky Creek and Cosgroves Creek. For Badgerys Creek where the percentage retention targets are not met, it is considered that additional design measures would be required, particularly in the residual catchment areas associated with Basin 2, Basin 4, and Basin 5.

The results indicate that for Stage 1 of the development, ANZECC water quality objectives would not be achieved, except for suspended solids. This is notwithstanding the general improvements in water quality concentrations relative to the existing environment, particularly in Badgerys Creek and South Creek.

Under the longer term development, the results indicate that reduction of the post-development loads to pre-development loads (NORBE) would not be achieved, except for suspended solids.

The results for the longer term development indicate that the WSUD percentage retention targets for total suspended solids, total phosphorus, and total nitrogen are generally satisfied for flows discharging from the site into Oaky Creek, Cosgroves Creek, and Badgerys Creek. However, at basin outlet locations for Basins 1, 5 and 6, where the targets are not satisfied, it is considered that supplementary design measures would be required during detailed design.

Under the longer term development conditions, the concentrations for suspended solids, total phosphorus and total nitrogen are found to generally improve, relative to existing conditions in Oaky Creek, Cosgroves Creek, Badgerys Creek, and South Creek. The exceptions are those at Duncans Creek for suspended solids, phosphorus and nitrogen, and at the Basin 2 and the Basin 3 outlets, for total phosphorus, where the concentrations are estimated to increase. The results also indicate that ANZECC water quality objectives would not be achieved, except for suspended solids. This is the case even with the general improvements in water quality relative to the existing environment.

Overall, the results indicate that the bio-retention basins currently proposed in the Draft Airport Plan and concept design would not be adequate in treating the water quality to NORBE, WSUD or ANZECC water quality targets or objectives for the proposed Stage 1 phase. For the longer term development, the bio-retention basins would also be inadequate for NORBE and ANZECC water quality objectives, but would generally be adequate in meeting WSUD targets.

It is considered that additional design measures would need to be assessed and designed for implementation during the detailed design phase. This includes the provision of enhanced bio-retention swales along the drainage lines, the provision of diversion drains to convey flows from residual sub-catchment areas to the proposed bio-retention basin, and enlarging some of the bio-retention basins, where necessary. Additional mitigation and management measures, including water quality monitoring, should also be implemented during the construction and operational phases of the project.

With the implementation of the above additional measures, it is expected that the proposed airport will have no adverse impact on downstream water quality.

Terms and abbreviations

Term	Usage
AEPR	Airport Environmental Protection Regulation (1997)
Airport	Western Sydney Airport
Airport site	The airport site is the total of all properties that may become part of Western Sydney Airport. The airport site includes existing Commonwealth land and land to be acquired by the Commonwealth, such as The Northern Road.
Airport features	Specific features of the proposed airport, such as runways, taxiways, terminal buildings or hangars.
Australian Height Datum (AHD)	A common national plane of level approximately equivalent to the height above sea level.
Badgerys Creek	Badgerys Creek is a suburb of Sydney about 50 kilometres west of the Sydney central business district, and the general locality of the airport. Badgerys Creek is also the name of a waterway which is referred to in this report.
Catchment	The area drained by a stream or body of water or the area of land from which water is collected.
Datum	A level surface used as a reference in measuring elevations.
DEM	Digital elevation model
Discharge	Quantity of water per unit of time flowing in a stream, for example cubic meters per second or megalitres per day.
Erosion	A natural process where wind or water detaches a soil particle and provides energy to move the particle.
Flood	For the purposes of this report, a flood is defined as the inundation of normally dry land by water which escapes from, is released from, is unable to enter, or overflows from the normal confines of a natural body of water or waterway such as rivers, creeks or lakes, or any altered or modified body of water, including dams, canals, reservoirs and stormwater channels.
Geomorphology	Scientific study of landforms, their evolution and the processes that shape them. In this report, geomorphology relates to the form and structure of waterways.
Groundwater	Subsurface water stored in pores of soil or rocks.
Hazard	The potential or capacity of a known or potential risk to cause adverse effects.
Hydraulic conductivity	The rate at which water at the prevailing kinematic viscosity will move under a unit hydraulic gradient through a unit area measured perpendicular to the direction of flow, usually expressed in metres per day (this assumes a medium in which the pores are completely filled with water).
Hydraulics	The physics of channel and floodplain flow relating to depth, velocity and turbulence.
Hydrology	The study of rainfall and surface water runoff processes.
Infiltration	The downward movement of water into soil and rock, which is largely governed by the structural condition of the soil, the nature of the soil surface (including presence of vegetation) and the antecedent moisture content of the soil.
Landform	A specific feature of the landscape or the general shape of the land.
Light Detection and Ranging (LiDAR)	LiDAR is a remote sensing method used to examine the surface of the Earth. LiDAR has been used in this study to define the topography of the airport site and surroundings.

Term	Usage
Longer term development	The longer term stage in the development of the proposed airport, including parallel runways and facilities for up to 82 million passengers annually (nominally occurring in 2063).
LPMA	New South Wales Land and Property Management Authority
Meteorology	The science concerned with the processes and phenomena of the atmosphere, especially as a means of forecasting the weather.
MIKE21 modelling	MIKE21 is a two dimensional hydraulic modelling software program used to simulate surface flow and estimate flood levels and flow velocities.
MUSIC modelling	Model for Urban Stormwater Improvement Conceptualisation (MUSIC) is a software program used to estimate the performance of stormwater quality management systems.
NORBE	Neutral OR Beneficial Effect is a term used to describe the treatment of water quality pollutant loads to either maintain or improve those generated under existing conditions.
Permeability	The capacity of a porous medium to transmit water.
Pluviograph	A rain gauge with the capability to record data in real time to observe rainfall over a short period of time.
Reach	Defined section of a stream with uniform character and behaviour.
Riparian	Pertaining to, or situated on, the bank of a river or other water body.
Risk	The chance of something happening that will have an impact measured in terms of likelihood and consequence.
Runoff	The amount of rainfall which actually ends up as streamflow, also known as rainfall excess.
Salinity	The total soluble mineral content of water or soil (dissolved solids); concentrations of total salts are expressed as milligrams per litre (equivalent to parts per million).
Sediment	Material of varying sizes that has been or is being moved from its site of origin by the action of wind, water or gravity.
Stage 1 development	The proposed initial stage in the development of the airport, including a single runway and facilities for up to 10 million annual passengers (for assessment purposes 10 million annual passengers is assumed to be reached in 2030).
Surface water	Water that is derived from precipitation or pumped from underground and may be stored in dams, rivers, creeks and drainage lines.
Surface water features	These include waterways and wetlands and their attributes (water quality and geomorphology). The term is generally used in this report to describe natural resources, but may also extend to artificial surface water features including lakes, dams and man-made wetlands.
Study area	The subject site and any additional areas which are likely to be affected by the proposal, either directly or indirectly. The study area extends as far as is necessary to take all potential impacts into account.
Topography	Representation of the features and configuration of land surfaces.
Water quality	Chemical, physical and biological characteristics of water. Also the degree (or lack) of contamination.

Term	Usage
Water sharing plan	A legal document prepared under the Water Management Act 2000 (NSW) that establishes rules for sharing water between the environmental needs of the river or aquifer and water users and also between different types of water use.
Waterway	Generic term for a river, creek or waterway.
Western Sydney Airport	The proposed airport at the Commonwealth owned land at Badgerys Creek which is assessed in accordance with the Western Sydney Airport environmental impact statement

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1. Introduction

1.1 Background

Planning investigations to identify a site for a second Sydney airport first commenced in 1946 with a number of comprehensive studies—including two previous environmental impact statements for a site at Badgerys Creek—having been completed over the last 30 years.

More recently, the *Joint Study on Aviation Capacity in the Sydney Region* (Department of Infrastructure and Transport, 2012) and *A Study of Wilton and RAAF Base Richmond for civil aviation operations* (Department of Infrastructure and Transport, 2013) led to the Australian Government announcement on 15 April 2014 that Badgerys Creek will be the site of a new airport for Western Sydney. The airport is proposed to be developed on approximately 1,700 hectares of land acquired by the Commonwealth in the 1980s and 1990s. Construction could commence as early as 2016, with airport operations commencing in the mid-2020s.

The proposed airport would provide both domestic and international services, with development staged in response to demand. The initial development of the proposed airport would include a single, 3,700 metre runway coupled with landside and airside facilities such as passenger terminals, cargo and maintenance areas, car parks and navigational instrumentation capable of facilitating the safe and efficient movement of up to 10 million passengers per year. While the proposed Stage 1 development does not currently include a rail service, planning for the proposed airport preserves flexibility for several possible rail alignments including a potential express service. A final alignment will be determined in consultation with the New South Wales Government, with any enabling work required during Stage 1 subject to a separate approval and environmental assessment process.

In the longer term, approximately 40 years after operations commence and in accordance with relevant planning processes, the airport development could include parallel runways and additional passenger and transport facilities for around 82 million passenger movements per year. To maximise the potential of the site, the airport is proposed to operate on a 24 hour basis. Consistent with the practice at all federally leased airports, non-aeronautical commercial uses could be permitted on the airport site.

On 23 December 2014, the Australian Government Minister for the Environment determined that the construction and operation of the airport would require assessment in accordance with the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act). Guidelines for the content of an environmental impact statement (EIS) were issued in January 2015. Approval for the construction and operation of the proposed airport will be controlled by the *Airports Act 1996* (Cth) (Airports Act). The Airports Act provides for the preparation of an Airport Plan which will serve as the authorisation for the development of the proposed airport.

The Australian Government Department of Infrastructure and Regional Development is undertaking detailed planning and investigations for the proposed airport, including the development of an Airport Plan. The Draft Airport Plan is the primary source of reference for, and companion document to, the EIS. The Draft Airport Plan identifies a staged development of the proposed airport. It provides details of the initial development being authorised, referred to as Stage 1, as well as a long-term vision of the airport's development. This enables preliminary consideration of the implications of longer term airport operations. Any stages of airport development beyond Stage 1 would be managed in accordance with the existing process in the Airports Act. This includes a requirement that for major developments (as defined in the Airports Act), a major development plan be approved by the Australian Government Minister for Infrastructure and Regional Development following a referral under the EPBC Act.

The Airport Plan will be required to include any conditions notified by the Environment Minister following this EIS. Any subsequent approvals for future stages of the development will form part of the airport lessee company's responsibilities in accordance with the relevant legislation.

1.2 Scope of the assessment

This study assesses the impact of the proposed airport on surface water quality. Hydrological, flooding, geomorphological, and groundwater impacts are assessed in separate reports.

The key aspects of this study were to:

- describe the existing environment with respect to surface water quality;
- assess the likely impact of the proposed airport on these features in the context of the Commonwealth legislation, EIS guidelines, national, regional and local industry practice and guidelines; and
- identify measures to mitigate or manage the proposed impacts.

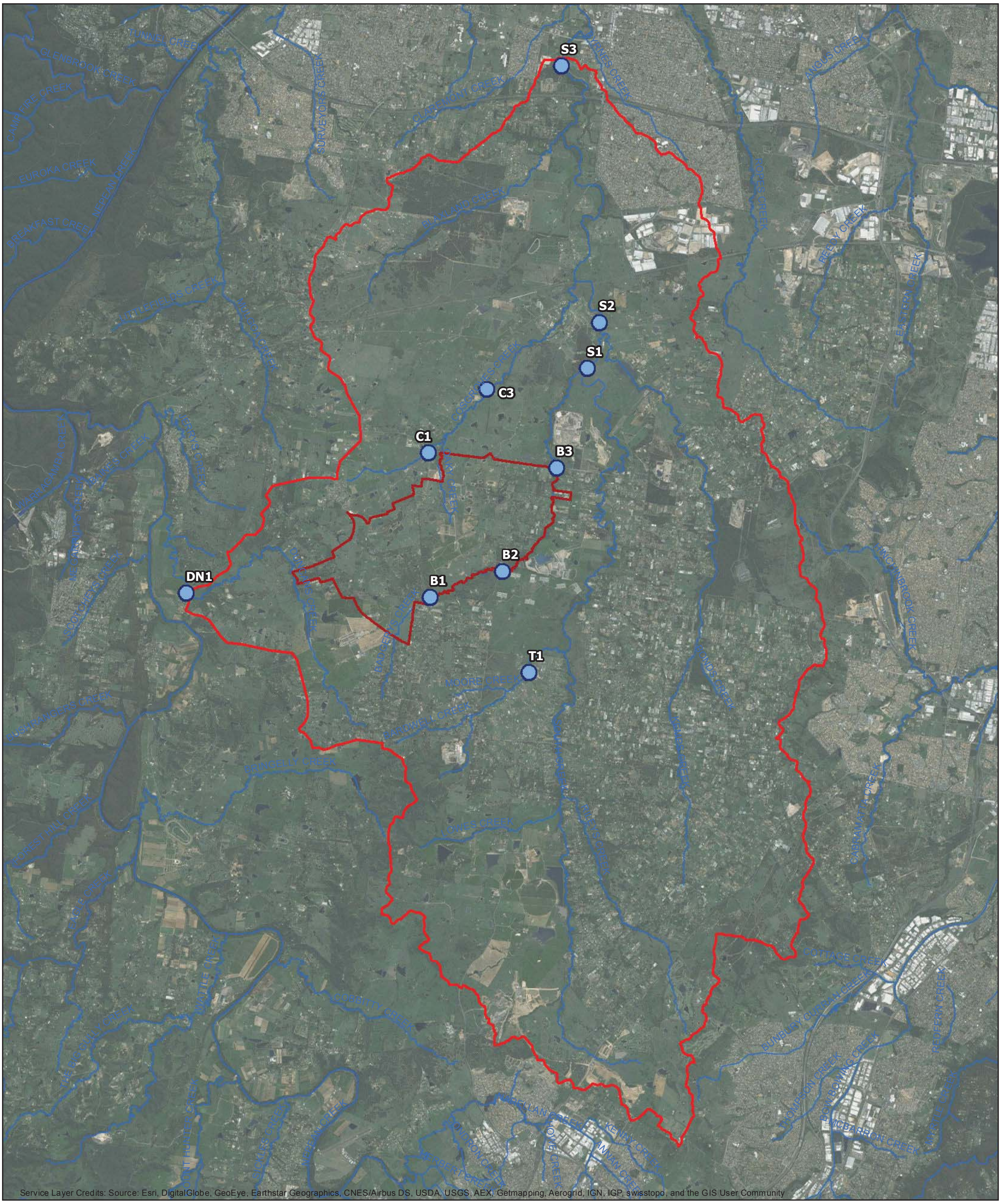
1.3 Study area

The study area for both Stage 1 and the longer term development scenarios consists of the airport site as well as the hydrological catchments of Duncans Creek, Cosgroves Creek, Oaky Creek, and Badgerys Creek. Duncans Creek discharges to the Nepean River. Oaky Creek discharges to Cosgroves Creek, while Cosgroves Creek and Badgerys Creek both discharge to South Creek. The study area is shown in Figure 1-1.

1.4 Structure of this report

The following summarises the content of the various sections of this report:

- **Section 2**: Describes the available data and reference legislations and documents;
- **Section 3**: Describes the existing surface water quality environment, including the existing land use and surface water quality pollutant export rates;
- **Section 4**: Describes the potential impacts of the airport proposal on surface water quality, including local and regional impacts;
- **Section 5**: Assesses the potential impacts during the construction phase;
- **Section 6**: Describes the mitigation and management measures to reduce the potential impacts; and
- **Section 7**: Summarises the findings and conclusions of the study.



LEGEND

- The airport site
- Water sampling site (Draft EIS)
- Watercourses
- Water Quality Study Area

Paper Size A3

0 800 1,600 3,200

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Surface water quality study area and key features

Figure 1-1

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2. Methodology

2.1 Legislation and guidelines

Key federal, state and local legislation, guidelines, and policies considered in this study include the following:

- *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act);
- *Airports Act 1996* (Cth) and *Airport (Environment Protection) Regulations 1997* (Cth);
- *Water Management Act 2000* (NSW) (WM Act);
- *National Water Quality Management Strategy* (ANZECC and ARMCANZ 1994) (NWQMS)
- *Australian and New Zealand Guidelines for Fresh and Marine Water Quality: Volume 1 – The Guidelines* (ANZECC and ARMCANZ 2000) (ANZECC Guidelines);
- Hawkesbury Nepean Catchment Action Plan (NSW Government 2014);
- Lower Hawkesbury-Nepean River Nutrient Management Strategy (NSW Government 2010);
- NSW Water Sharing Plans under the WM Act;
- Managing Urban Stormwater: Soils and Construction Volume 1(Blue Book, NSW Government 2004); and
- *Water Sensitive Urban Design Technical Guidelines for Western Sydney* (Upper Parramatta River Catchment Trust 2004) (WSUD Guidelines).

2.1.1 Environment Protection and Biodiversity Conservation Act 1999

The objective of the EPBC Act is to provide for the protection of the environment, especially those aspects of the environment that are matters of national environmental significance (MNES) and to promote the conservation of biodiversity.

MNES are relevant to surface water where:

- surface water features form part of the natural environment associated with a MNES; or
- a MNES is dependent on surface water features.

For the purposes of the EPBC Act, the proposed action is to be taken by the Commonwealth. The matter protected for actions taken by the Commonwealth under Part 3 of the EPBC Act is the environment. Under the Act, the definition of the environment is broad and includes ecosystems and their constituent parts, natural and physical resources, and qualities and characteristics of locations, places and areas. Surface water features are natural resources and are an integral part of the environment.

In response to a referral submitted by the Department in 2014, the Australian Government Department of the Environment has issued EIS guidelines which outline the matters that must be addressed in the EIS. *The Guidelines for the Content of a Draft Environmental Impact Statement, Western Sydney Airport* (Australian Government, 2015), identify that changes to water quality on site and downstream of the site need to be assessed as an impact on the environment.

This report has been prepared in accordance with the guidelines.

Other related surface and groundwater issues are addressed in separate reports.

2.1.2 Airports Act and Airports (Environment Protection) Regulations

Part 6 of the Airports Act deals with environmental management at airports. This Part will apply at the airport site after an airport lease is granted. It sets up a framework for making, monitoring and enforcing environmental standards at airports. Schedule 2 of Airports (Environment Protection) Regulations (AEPR) sets out acceptable limits for water pollution which apply to the exclusion of any state laws. AEPR guidelines for typical physical and chemical stressors are shown in Table 2-1. It is noted that the AEPR Guidelines are more stringent than ANZECC 2000 for total phosphorus and total nitrogen.

The regulations make provision for setting airport specific standards in certain circumstances.

Table 2-1 Airport Environmental Protection Regulation (AEPR) Water Quality Guidelines (1997)

Parameter	AEPR Guideline
Total phosphorus (TP)	< 0.01 mg/L
Total nitrogen (TN)	< 0.1 mg/L
Dissolved oxygen (DO)	80% of average level for a normal 24 hr period or < 6 mg/L
Total suspended solids (TSS)	change not more than 10% from seasonal mean
Turbidity	a reduction of 10% clarity in the euphotic zone from the seasonal mean
pH	6.5 – 9.0
Salinity	> 1000 mg/L or an increase of > 5%

2.1.3 Water Management Act 2000

The WM Act is administered by the NSW Department of Primary Industries (DPI) Water (formerly NSW Office of Water) and is intended to ensure that water resources are conserved and properly managed for sustainable use benefitting both present and future generations. The WM Act is also intended to provide a formal means for the protection and enhancement of the environmental qualities of waterways and their in-stream uses as well as to provide for protection of catchment conditions. The intent and objectives of the WM Act have been considered as part of this assessment.

2.1.4 National Water Quality Management Strategy

NWQMS has been developed by the Australian and New Zealand governments in cooperation with state and territory governments. The NWQMS aims to protect the nation's water resources, by improving water quality while supporting the businesses, industry, environment and communities that depend on water for their continued development. The NWQMS consists of three major elements: policy, process and guidelines.

The main policy objective of the NWQMS is to achieve sustainable use of water resources, by protecting and enhancing their quality, while maintaining economic and social development. The process strives to form a nationally consistent approach to water quality management through the development of high-status national guidelines. The guidelines provide the point of reference when issues are being determined on a case-by-case basis. These include guidance on regulatory and market-based approaches to managing water quality as well as regional water quality criteria.

2.1.5 ANZECC Guidelines (2000)

The ANZECC Guidelines for Fresh and Marine Water Quality (ANZECC & ARMCANZ, 2000) present numerical guidelines which can be used as a basis to assess the impact of the development of Western Sydney Airport against defined objectives or values for the receiving waters.

The core concept of the ANZECC Guidelines relates to managing water quality for environmental values. For each environmental value, the guidelines identify particular water quality characteristics or 'indicators' that are used to assess whether the condition of the water supports that value. The environmental values expressed as water quality objectives provide goals to assist in the selection of the most appropriate management options within a catchment. The guiding principles include that:

- where the environmental values are being achieved in a waterway they should be protected; and
- where the environmental values are not being achieved in a waterway, all activities should work towards their achievement over time.

The environmental values expressed as water quality objectives provide goals to assist in the selection of the most appropriate management options within a catchment. The ANZECC guidelines also advocate an 'issues-based' approach to assessing ambient water quality, rather than the application of rigid numerical criteria without an appreciation of the context. This means that the guidelines focus on:

- the environmental values we are seeking to achieve or maintain;
- the outcomes being sought; and
- the ecological and environmental processes that drive any water quality problem.

It should also be noted that the environmental values and respective numerical indicator values apply to ambient background water quality and are not intended to be applied to effluent quality or mixing zones associated with a release from a sewerage scheme. Discharges from the airport site therefore need to be considered on an individual catchment basis in recognition of other land uses within the catchment which also influence water quality.

The surface water features receiving water from the existing airport site and surrounding areas are located primarily within agricultural catchments and as such are considered to be "slightly modified fresh water systems". Based on this classification, a protection level of 95 per cent for freshwater ecosystems, as recommended in the ANZECC Guidelines, is considered to be suitable for toxicants. The airport site also has a 'lowland rivers' classification (NSW rivers, less than 150m in altitude).

Default ANZECC trigger values for physical and chemical stressors applicable to the airport site and adopted in this assessment are shown in Table 2-2. It is noted that these default trigger values are guideline values or water quality objectives only, and are not compliance standards.

Table 2-2 ANZECC Guidelines Default Trigger Values for NSW Lowland Rivers

Parameter	Default Trigger Value for Lowland Rivers
Chlorophyll a Chl a (mg/L)	0.005
Total phosphorus TP (mg/L)	0.05
Filterable reactive phosphate FRP (mg/L)	0.02
Total nitrogen TN (mg/L)	0.5
Oxides of nitrogen NOx (mg/L)	0.04
Ammonium NH4+ (mg/L)	0.02
Dissolved oxygen DO	85-110 %
pH	6.5 – 8
Salinity (µS/cm)	125-2200
Turbidity (NTU)	6 – 50

Source: ANZECC Guidelines (2000)

2.1.6 Hawkesbury Nepean Catchment Action Plan

The Hawkesbury-Nepean and Sydney Metropolitan Catchment Management Authority (CMA) regions were amalgamated in late 2012. Following this, a Catchment Action Plan (CAP) for the Hawkesbury-Nepean catchment was developed and later superseded by a *Greater Sydney Local Land Service Transition Catchment Action Plan* (NSW Government 2014).

Catchment Action Plans (CAPs) are ten-year plans to guide the management of water, land and vegetation by state government and local communities.

The catchments of Badgerys Creek, Oaky Creek, Cosgroves Creek and Duncans Creek fall within the *Greater Sydney Local Land Service Transition Catchment Action Plan*. The action plan has been considered with respect to any influence the proposed airport may have on the downstream catchments in relation to surface water and aquatic ecology.

Relevant strategies within the action plan include development of a more water sensitive city, promoting resilience through climate change adaptation and a number of strategies relating to the protection of aquatic ecosystems.

2.1.7 Lower Hawkesbury-Nepean River Nutrient Management Strategy

The *Lower Hawkesbury-Nepean River Nutrient Management Strategy* (NSW Government 2010) has been developed with the aim of reducing nutrient loads from existing sources and limiting the growth in nutrient loads from changing land uses (NSW Office of Environment and Heritage). The strategy includes development of a catchment-wide framework to coordinate and guide action on managing nutrients in the lower Hawkesbury-Nepean. The sources of nutrients identified as a priority are urban stormwater, agricultural practices, on-site sewage management systems, sewage treatment systems and overflows, and degraded land and riparian vegetation.

The nutrient management strategy report documents a number of mechanisms and related plans through which the strategy is proposed to be implemented.

2.1.8 NSW Water Sharing Plans

Water sharing plans are implemented under the WM Act and specify the rules for the sharing of water between the environment and water users and between water users themselves. Water sharing plans also specify rules for the trade and management of water access licences.

The Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources (the water sharing plan) commenced in 2011 and covers 87 management zones that are grouped into six water sources. The proposed airport is situated in the Hawkesbury and Lower Nepean Rivers catchment or source.

The Hawkesbury and Lower Nepean Rivers catchment is separated into management areas, which include amongst others the Upper and Lower South Creek Management Zones and the Mid Nepean River Catchment Management Zone. Badgerys, Oaky and Cosgroves Creeks are interpreted to be within the Upper South Creek Management Zone, and Duncans Creek is interpreted to be within the Wallacia Weir Management Zone (one of the Mid Nepean River Catchment Management Zones).

Extraction from these zones currently occurs for irrigation and town and industrial water supply.

The water sharing rules listed in the water sharing plan for the Upper South Creek and Wallacia Weir Management Zones are summarised below.

- Upper South Creek Management Zone:
  - access rules stipulate the flow rates at which users must cease to pump from the creek, based on A and B flow classes; and
  - trading is permitted within the management zone (subject to assessment) but is not permitted into the management zone.
- Wallacia Weir Management Zone:
  - environmental flow protection rules apply when inflows to the dams are greater than the 80^{th} percentile, depending on the ability of the weir to pass flows released upstream;
  - trading is permitted within the management zone and is permitted into the management zone from upstream management zones (but not from other management zones);
  - limited access to very low flows is allowed for during water shortages depending on conditions that trigger a water shortage; and
  - lagoon rules prevent water trading onto a lagoon and application for new works on a lagoon.

Water sharing plans in relation to groundwater resources and groundwater recharge are discussed in the groundwater assessment report.

2.1.9 Managing Urban Stormwater: Soils and Construction – Volumes 1 and 2D

The NSW Government publishes the following documents about the management of erosion and sediment control during construction and other land disturbance activities.

- Managing Urban Stormwater: Soils and Construction – Volume 1 (Blue Book). The document provides guidance for local councils and practitioners on the design, construction and implementation of measures to improve stormwater management, primarily erosion and sediment control, during the construction phase of urban development.
- Managing Urban Stormwater: Main road construction – Volume 2D. The document provides guidelines, principles and recommended minimum design standards for managing erosion and sediment control during the construction of main roads. The construction of main roads and highways commonly involves extensive earthworks, with significant potential for erosion and sedimentation of waterways and the landscape, and the document therefore has been considered in the preparation of this report.

2.1.10 Water Sensitive Urban Design Technical Guidelines for Western Sydney

When urban development occurs, the change in land use and increased hardstand area due to development of the site may change the natural water cycle of the developed area. This typically results in increased runoff and increased contaminants flowing into the surrounding streams and waterways.

WSUD is increasingly being adopted by local and regional councils to provide water management strategy outcomes in urbanised environments in line with the various state planning instruments.

The objectives of WSUD policy are generally to maintain or replicate the predevelopment water cycle through the use of design techniques, with a particular focus on water quantity and quality. This is primarily achieved through the treatment of stormwater runoff through the use of on-site treatment measures that mitigate and limit the potential adverse effects on the downstream receiving waterways.

The WSUD Guidelines have been developed to assist the management of surface water quality attributed to the conversion of peri-urban and rural land use to urban land uses and residential development within the area. The document provides guidance on WSUD treatment measures as well as model parameters that may be adopted for the Western Sydney region.

It also specifies percentage reduction targets for total phosphorus, total nitrogen and total suspended solids for urban developments (Table 2-3). It is noted that these reduction targets are similar to those specified by the NSW Environment Protection Authority (EPA) Stormwater Management Handbook (1997). However the NSW EPA does not currently publish these targets.

Table 2-3 Reduction Targets (WSUD Guidelines)

	Total Suspended Solids (TSS)	Total Phosphorus (TP)	Total Nitrogen (TN)
% Reduction Targets	80%	45%	45%

Source: WSUD Technical Guidelines for Western Sydney (Upper Parramatta Trust 2004)

2.2 Previous studies

The following documents provide information on the state of the Hawkesbury-Nepean river system and its tributaries, including South Creek. It is noted that Duncans Creek, Badgerys Creek and Cosgroves Creek are also located within the upper reaches of the catchment. Key findings from these documents relevant to this study are summarised below.

2.2.1 Lower Hawkesbury-Nepean Nutrient Management Strategy (DECCW 2010)

This document analyses the major land uses within the catchment, and identifies a number of key pollutant sources within the catchment for which poor water quality could be attributed. The South Creek catchment was found to be a significant contributor of nutrients (phosphorus and nitrogen) into the overall river system. These nutrient loads were found to derive predominantly from grazing, urban environment, rural residential, intensive animal production and intensive horticulture land uses.

2.2.2 Hawkesbury-Nepean River Environmental Monitoring Program (DECCW 2009)

This technical report reviewed available water quality data in order to investigate long-term trends and biological patterns in the river ecosystem.

The report described many areas of the Hawkesbury-Nepean river system as being stressed, with some areas being eutrophic. Large amounts of water were found to be diverted from the water system for water supply and irrigation purposes and nutrient levels were often high, with algal blooms common.

A broad scale analysis of available water data was undertaken as part of this study and compared against ANZECC Guideline levels. The results for the South Creek catchment indicated that the minimum recorded values, for total phosphorus (TP) and total nitrogen (TN), generally do not achieve ANZECC water quality objectives and were identified as an important issue for the catchment.

Historical trends suggest that there may have been a reduction in pollutant loads in recent years due to possible changes in land management practices. However, extended monitoring data would be required before these results can be confirmed. It is intended that additional monitoring would be undertaken in the near future.

2.2.3 Water Management in South Creek Catchment (CRC 2007)

Similar to the Lower Hawkesbury-Nepean Nutrient Management Strategy, this study provides an analysis of land and water uses throughout the catchment and identifies a number of major environmental issues which are attributed to specific activities within the catchment.

A detailed breakdown of the estimated sources of phosphorus in the South Creek catchment indicated that 44 per cent was derived from agricultural land, 28 per cent from urban runoff, 18 per cent from unused or cleared lands, 9 per cent from sewage treatment plants and 1 per cent from natural runoff.

This report also commented that whilst a number of nutrient abatement strategies had been implemented, these measures had not been able to keep pace with continuing population growth and urban development.

2.2.4 Second Sydney Airport EIS (1997-1999)

In December 1997, the then Department of Transport and Regional Development exhibited a Draft EIS for the second Sydney airport proposal and a Supplementary EIS was completed in 1999. The EIS included Technical Paper 7 which focussed on geology, soils and water and contained a study of the effects on water quality of the proposed airport development. This included a limited water quality sampling programme, the results of which are summarised in section 2.3.

2.2.5 SMEC Environmental Field Survey (2014)

SMEC completed a report entitled *Environmental field survey of Commonwealth land at Badgerys Creek* (SMEC October, 2014), which included a review of both historical and more recent water quality sampling. The results of this survey by SMEC are included in Table 2-4.

A referral for the proposed airport was submitted by the Department of Infrastructure and Regional Development to the Department of the Environment in November 2014.

2.3 Historical surface water quality data

Historical water quality monitoring data available for the airport site and downstream areas include data from the Second Sydney Airport EIS and SMEC *Environmental Field Survey of Commonwealth Land at Badgerys Creek*. A summary of these data is presented in Table 2-4 for some key parameters. Figure 3-1 shows the locations where this monitoring was conducted.

In Table 2-4, ANZECC guideline default trigger values are also included for comparison. Both sets of data show that the nutrient loads (i.e. total nitrogen (TN) and total phosphorus (TP)) were elevated or significantly elevated above ANZECC water quality objectives for a number of the sampling locations. However, suspended solids, turbidity, and pH were found to be generally within acceptable values except for a few exceedances. Dissolved oxygen levels were found to be acceptable at the locations tested in Badgerys Creek, but were generally low for Cosgroves Creek, Thompsons Creek, and Duncans Creek. Full details of the data, including details of the sampling locations and other parameters sampled, are provided in the Appendices.

Table 2-4 Summary of Historical Surface Water Quality Data

Location	DO %S	pH	Turbidity NTU	TSS mg/L	TN mg/L	TP mg/L
ANZECC default values (2000)	**85-110%**	**6.5-8**	**6-50**	**<40***	**0.5**	**0.05**
Second Airport EIS (PPK 1997-1999)						
Badgerys Creek (B1, 1996)	63	6.9	1.1	2	-	<0.02
Badgerys Creek (B2, 1996)	150	7.3	7	33	-	1.2
Badgerys Creek (B3, 1996/1998)	13-107	6.7-7.2	5.1- 46	9-24	0.12-2.3	0.26-0.47
Cosgroves Creek (C1, 1996)	25	6.7	2.9	5	-	< 0.02
Cosgroves Creek (C3, 1996/1998)	2-65	6.7-7.4	2.9-16	5-12	1.23 – 1.7	0.02 – 0.07
Duncans Creek (D1, 1996/1998)	15-50	6.7-7.1	5.2-12	6-13	0.02 – 1.3	0.02 – 0.04
South Creek (S1, 1998)	83-105	7-7.2	15-65	9-56	0.49 – 1.6	0.01 – 0.14
South Creek (S2, 1998)	60-87	6.8-6.9	7-82	5-19	0.44 – 1.5	0.01 – 0.11
South Creek (S3, 1998)	39-79	6.9-7.4	12-40	4-14	0.8 – 1.52	0.05 – 0.5
Thompson Creek (T1, 1996/1998)	15-50	6.4-7.3	4.9-14	5-11	0.02 – 1.14	0.01 – 0.04
Badgerys Creek Environmental Field Survey (SMEC 2014)						
Cosgroves Creek (C1)			11	32	0.8	0.09
Badgerys Creek (B1)			3.2	10	2.8	1.6
Badgerys Creek (B2)			14	17	2.5	0.5
Badgerys Creek (B3)			11	16	2.6	0.5
Thompsons Creek (T1)			17	31	0.7	0.07
Duncans Creek (DN1)			35	30	1.5	0.1

TN: Total nitrogen TP: Total phosphorus TSS: Total suspended solids DO: Dissolved oxygen

* ANZECC Guidelines Professional judgement (aquaculture); 50 mg/L NSW Blue Book for Soils and Construction

Source: Collated from reports shown above

2.4 Design and other relevant project information

The following concept design information and other data were acquired or made available and reviewed and adopted for the purposes of this surface water quality study. These documents are summarised in Table 2-5.

Table 2-5 Key data sources for Western Sydney Airport

Document / dataset	Data source	Description	Date
Aerial imagery	NSW LPMA		2015
Airport Plan – Concept Plan - Longer Term	DIRD	Drawing of proposed longer term airport layout	May 2015
Airport Plan – Concept Plan - – Stage 1	DIRD	Drawing of proposed Stage 1 airport layout	May 2015
Airport Plan – Concept Plan - – Stage 1 Land Use Zoning Plan	DIRD	Drawing of proposed land use for Stage 1	May 2015
Airport Plan – Concept Plan - – Long Term Land Use Zoning Plan	DIRD	Drawing of proposed land use for longer term development	May 2015
Stage 1 Surface Water Management Layout Plan	DIRD / GHD design team	Drawing of proposed surface water management strategy for Stage 1	2015
Longer Term Surface Water Management Layout Plan	DIRD / GHD design team	Drawing of proposed surface water management strategy for the longer term development	2015
Draft Airport Plan	DIRD	Draft plan report as at the time of conducting the surface water assessment	May 2015
SMEC Environmental Field Survey of Commonwealth Land at Badgerys Creek	DIRD	Documentation of water quality sampling data collected by SMEC	2014
Hydrology models	DIRD / GHD design team	RAFTS model of the existing airport site and longer term development	2015
Hydraulic models	DIRD / GHD design team	MIKE 21 models of the existing airport site and longer term development	2015
LiDAR	NSW LPMA	Topographical LiDAR outputs at 1 metre and 5 metre intervals	2015
Updated South Creek Flood Study	Worley Parsons	Flood study of South Creek and its contributing catchments	2015
Water quality models	DIRD / GHD design team	Preliminary Model for Urban Stormwater Improvement Conceptualisation model of the Stage 1 airport site and longer term development. No existing site model was prepared as part of concept design.	2015
Western Sydney Airport – Airport Land Use Master Plan – Feasibility Design Version 0.01	DIRD	Draft report as at time of conducting surface water assessment	March 2015
Western Sydney Airport Climatological Review	Bureau of Meteorology	Report containing analysis of climatic data from Badgerys Creek gauge	2015
Western Sydney Airport Usability Report	Bureau of Meteorology	Report documenting the meteorological parameters affecting the usability of the airport site	2015

2.5 MUSIC water quality modelling approach

The Model for Urban Stormwater Improvement Conceptualisation (MUSIC) water quality model was used to estimate pollutant loads in the catchment under existing and proposed development conditions, including suspended solids, total phosphorus and total nitrogen. This model was chosen as it has the ability to estimate the quantity and quality of surface water generated at a site under a range of conditions, and to determine the effectiveness of potential mitigation measures.

MUSIC combines a rainfall-runoff and stochastic pollutant generation algorithm to estimate the quantity and quality of runoff generated, given the following inputs:

- a meteorological template which details rainfall and potential evapotranspiration inputs; and
- source nodes which define the catchment properties, including land use type (which in turn defines the water quality parameters), sub-catchment area, impervious fraction, and storage properties.

2.5.1 Meteorological template

The meteorological template specifies the rainfall and evaporation characteristics of the area. The rainfall input needs to be in the form of a time series, with a time-step representative of the smallest time of concentration for the catchment and/or the smallest notional detention time in treatment measures. Potential evapotranspiration data, on the other hand, can be in the form of a daily time-series or average monthly figures. These inputs were developed on the basis of available Bureau of Meteorology (BOM) data.

For this study, the rainfall gauge at Badgerys Creek (Station 067108, Figure 3-2) was adopted. This consisted of 1-minute data from December 1998 to May 2015. Monthly evaporation data were sourced from the Parramatta Gauge (Figure 3-4), which was the nearest station to Badgerys Creek that had evaporation data available.

2.5.2 Source nodes

MUSIC has three default land use types, namely Urban, Agricultural, and Forested Source Nodes. These source nodes differ only in their default base flow and stormflow pollutant concentrations. User defined source nodes may also be specified, which operates in exactly the same manner, but have no default water quality parameters included.

For this study, user-defined source nodes were adopted, in order to reflect the different types of land use within the catchment. This included nodes for rural residential, forest, horticultural, natural pastures and modified pasture areas.

2.5.3 MUSIC modelling under existing conditions

(a) Model set-up under existing conditions

The MUSIC model was initially set up to represent the existing airport catchment. A total of 39 individual sub catchments were delineated using 1 m contours generated for the site. Catchment boundaries were identified using hydro-line mapping of natural gullies and the Commonwealth land boundary in order to assess the site in isolation from the external catchment area.

Two additional external catchments were modelled to represent the area downstream of Elizabeth Drive down to the confluence of South Creek with Kemps Creek, and with Blaxland Creek respectively, in order to assess the impacts on downstream water quality at a more regional scale.

Each individual sub-catchment was broken down into five land use types to represent the existing land use. These were rural residential, forest, horticultural, naturalised pastures and modified pastures.

For convenience, junction nodes were also placed at all proposed bio-retention basin locations indicated in the Stormwater Management Plans provided by the Department of Infrastructure and Regional Development (see Table 2-5). Additional junction nodes were placed at known water quality monitoring locations for calibration purposes.

The parameters for rural residential source nodes were defined in accordance with the Draft NSW MUSIC Modelling Guidelines (Sydney Metropolitan CMA 2010). However, the default parameters for agricultural nodes in the NSW MUSIC Modelling Guidelines were not considered to be entirely appropriate for the range of land use within the catchment. Accordingly, guidance was also sought from the Technical Report "*A review of sediment and nutrient concentration data from Australia for use in catchment water quality models*" (E-Water CRC 2010). This document provides a statistical assessment of pollutant concentrations from some 750 records across 514 different geographical locations throughout Australia. This includes pollutant concentrations reported for catchments based on their Australian Land Use Mapping categorisations.

The MUSIC model set up for the existing catchment conditions was simulated for the full range of rainfall data available. A modelling time-step of six-minutes was found to be adequate and adopted for all modelling scenarios.

(b) Model calibration under existing conditions

The MUSIC model set up for the existing airport catchment was calibrated using recent sampling data obtained by SMEC 2014 (Table 2-4) and GHD 2015 (Table 3-6) at a number of locations along Badgerys Creek, Duncans Creek and Cosgroves Creek.

This was undertaken by making adjustments to the initial parameters defined in Section 2.5.2, and using an iterative process, until the modelled results were similar to the sampled data. The results of the calibration are presented in Table 2-6 and Figure 2-1.

In Table 2-6, the lower and upper range of results obtained from the MUSIC model is shown together with the sampled data. In general, the model results were found to be in good agreement with the sampled data, with the sampled concentrations generally falling within the range of results obtained. It is noted that the correlation was not particularly high at a number of locations. For example, at Badgerys Creek, the modelled total phosphorus concentrations are found to be relatively low compared to the field data.

Overall, however, the results were considered to be acceptable in view of the data and model limitations, and the inherent difficulties in water quality calibration. In particular, it is noted that the field data were discrete rather than continuous and little or no correlation to rainfall or flow conditions at the time of the sampling was available.

The MUSIC model parameters obtained from the above calibration process and adopted for the existing catchment environment are presented in Table 2-6 and Table 2-7.

Table 2-6 Calibration of MUSIC model under existing conditions

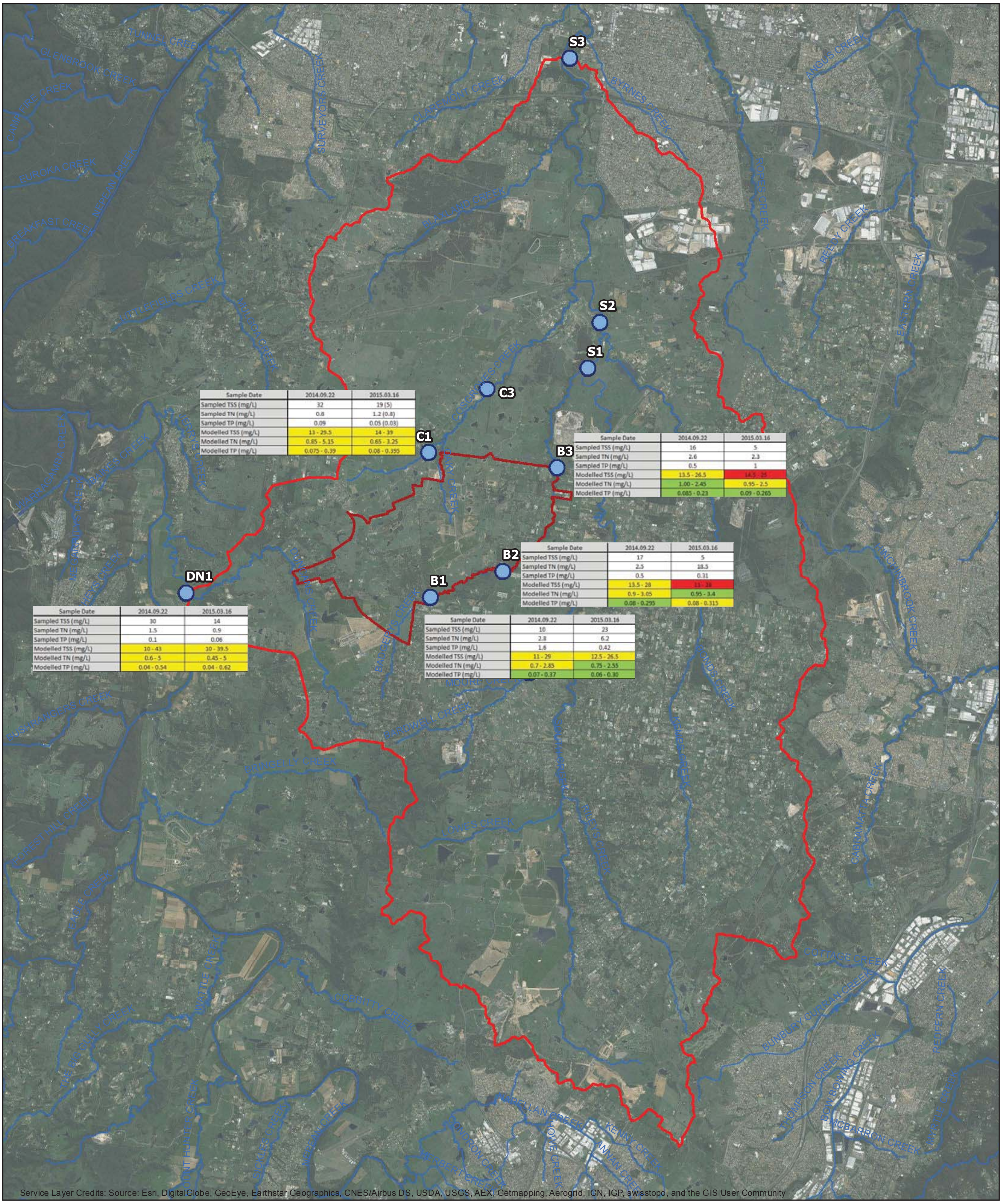
Location	Comparison of Sampled Data with Model Results (MUSIC)			
	Source	TSS (mg/L)	TN (mg/L)	TP (mg/L)
SMEC Data (22.9.2014)				
Badgerys Ck (B1)	Sampled Modelled	10 11-29	2.8 0.7-2.85	1.6 0.07-0.37
Badgerys Ck (B2)	Sampled Modelled	17 13.5-28	2.5 0.9-3.05	0.5 0.08-0.295
Badgerys Ck (B3)	Sampled Modelled	16 13.5-26.5	2.6 1-2.45	0.5 0.085-0.23
Cosgroves Ck (C1)	Sampled Modelled	32 13-29.5	0.8 0.85-5.15	0.09 0.075-0.39
Duncans Ck (DN1)	Sampled Modelled	30 10-43	1.5 0.6-5	0.1 0.04-0.54
GHD Data (16.3.2015)				
Badgerys Ck (BCUS)	Sampled Modelled	23 12.5-26.5	6.2 0.75-2.55	0.42 0.06-0.3
Badgerys Ck (BCMC)	Sampled Modelled	5 13-28	18.5 0.95-3.4	0.31 0.08-0.315
Badgerys Ck (BCDS)	Sampled Modelled	5 14.5-25	2.3 0.95-2.5	1 0.09-0.265
Cosgroves Ck (OCDS /CCUS)	Sampled Modelled	19 (5) 14-39	1.2 (0.8) 0.65-3.25	0.05 (0.03) 0.08-0.395
Duncan Ck (DCDS)	Sampled Modelled	14 10-39.5	0.9 0.45-5	0.06 0.04-0.62

Note: MUSIC model results are based on concentrations obtained at six-minute intervals over a 24-hour period

Table 2-7 Adopted Model Parameters under Existing Conditions

Parameters	Values
Impervious Area Parameters	
Daily Rainfall Threshold Values (mm)	1
Pervious Area Parameters	
Soil Storage Capacity (mm)	210
Initial Storage (% of capacity)	30
Field Capacity (mm)	80
Infiltration Capacity Coefficient – a	175
Infiltration Capacity Coefficient – b	3.1
Groundwater Properties	
Initial Depth (mm)	10
Daily Recharge Rate (%)	35
Daily Base flow Rate (%)	20
Daily Deep Seepage Rate (%)	0

Note: Parameter values are for non-urban source nodes > 10 Ha and mean annual rainfall <1000 mm



C1

Sample Date	2014.09.22	2015.03.16
Sampled TSS (mg/L)	32	19 (5)
Sampled TN (mg/L)	0.8	1.2 (0.8)
Sampled TP (mg/L)	0.09	0.05 (0.03)
Modelled TSS (mg/L)	13 - 29.5	14 - 39
Modelled TN (mg/L)	0.85 - 5.15	0.65 - 3.25
Modelled TP (mg/L)	0.075 - 0.39	0.08 - 0.395

B3

Sample Date	2014.09.22	2015.03.16
Sampled TSS (mg/L)	16	5
Sampled TN (mg/L)	2.6	2.3
Sampled TP (mg/L)	0.5	1
Modelled TSS (mg/L)	13.5 - 26.5	18.5 - 25
Modelled TN (mg/L)	1.00 - 2.45	0.95 - 2.5
Modelled TP (mg/L)	0.085 - 0.23	0.09 - 0.265

B2

Sample Date	2014.09.22	2015.03.16
Sampled TSS (mg/L)	17	5
Sampled TN (mg/L)	2.5	18.5
Sampled TP (mg/L)	0.5	0.31
Modelled TSS (mg/L)	13.5 - 28	11 - 28
Modelled TN (mg/L)	0.9 - 3.05	0.95 - 3.4
Modelled TP (mg/L)	0.08 - 0.295	0.08 - 0.315

DN1

Sample Date	2014.09.22	2015.03.16
Sampled TSS (mg/L)	30	14
Sampled TN (mg/L)	1.5	0.9
Sampled TP (mg/L)	0.1	0.06
Modelled TSS (mg/L)	10 - 43	10 - 39.5
Modelled TN (mg/L)	0.6 - 5	0.45 - 5
Modelled TP (mg/L)	0.04 - 0.54	0.04 - 0.62

B1

Sample Date	2014.09.22	2015.03.16
Sampled TSS (mg/L)	10	23
Sampled TN (mg/L)	2.8	6.2
Sampled TP (mg/L)	1.6	0.42
Modelled TSS (mg/L)	11 - 29	12.5 - 26.5
Modelled TN (mg/L)	0.7 - 2.85	0.75 - 2.55
Modelled TP (mg/L)	0.07 - 0.37	0.06 - 0.30

LEGEND
- The airport site
- Water sampling site (Draft
- Watercourses

LEGEND
- range higher than sample
- Sample in range
- range lower than sample

Paper Size A3
0 800 1,600 3,200
Metres
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

Job Number 21-24265
Revision A
Date 23 Jul 2015

Calibration of MUSIC model under Existing Conditions

Figure 2-1

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Data source: Created by: afoddy

Table 2-8 Adopted Base-flow and Stormflow Pollutant Concentrations

Source Node	Pollutant Parameters mg/L (log_{10}) under Existing Conditions					
	TSS		TP		TN	
	Mean	**Std Dev**	**Mean**	**Std Dev**	**Mean**	**Std Dev**
Rural Residential[1]						
Base Flow	1.15	0.17	-1.22	0.19	0.05	0.12
Storm Flow	1.95	0.32	-0.66	0.25	0.30	0.19
Forest[1]						
Base Flow	0.78	0.13	-1.52	0.13	-0.52	0.13
Storm Flow	1.60	0.20	-1.10	0.22	-0.05	0.24
Horticultural[2]						
Base Flow	1.28	0.17	-0.70	0.30	0.01	0.30
Storm Flow	3.49	0.32	0.16	0.30	1.51	0.30
Naturalised Pastures[2]						
Base Flow	1.28	0.17	-1.18	0.30	0.01	0.30
Storm Flow	2.92	0.32	-0.32	0.30	0.20	0.30
Grazing/ Modified Pastures[2]						
Base Flow	1.28	0.17	-0.52	0.30	0.36	0.30
Storm Flow	2.41	0.32	-0.25	0.30	0.83	0.30

1: Based on NSW MUSIC Modelling Guidelines

2: Based on Drewry et al. (2006) and Bartley et al. (2010)

2.5.4 MUSIC modelling under Stage 1 and longer term conditions

(a) Modelling methodology under Stage 1 and longer term conditions

The Stage 1 analysis was undertaken on the basis of the land use plan, surface water management plan and design basis report provided as part of the Draft Airport Plan (refer to Table 2-5). Water quality models for Stage 1 were developed during the course of this study.

The surface water management plans provided were based on an earlier version of the land use plan. As a result, there were minor inconsistencies between the data sources characterising the airport site. Where necessary, assumptions in the assessment were made to manage those discrepancies.

The methodology adopted for modelling Stage 1 of the proposed airport development was similar to that adopted for modelling the existing environment, as described in Section 0. However, the model was modified in order to represent the catchment conditions for the development.

Sub-catchment areas for the proposed Stage 1 Development were delineated using the following information:

- Stage 1 Stormwater Management Plan, to identify the treatment of runoff and the extent of earthworks and proposed drainage network through the site;
- Stage 1 design contour information, to identify the proposed ridgeline separating the Stage 1 runway and longer term second runway and the extent of earthworks proposed; and
- existing contour information, to identify the residual areas not picked up by swales and internal drainage through which runoff would bypass the proposed basin locations.

Land use types were derived using the indicative concept design in the Draft Airport Plan. On this basis, the site was categorised into the following land use types, as detailed in the preceding section of this report:

- Grassed areas;
- Paved/Hardstand areas; and
- Roof areas.

All the model source nodes were updated to reflect the modified land uses and catchment areas within the airport site for the proposed Stage 1 Development. For modelling and comparison purposes, it was assumed that the catchments outside the airport site would remain the same as under existing conditions. Consequently, no changes were made to those external catchments.

The indicative longer term development model was developed using the same approach as that for the proposed Stage 1 Development, but using the relevant catchment and land use plans for the longer term development.

The same rainfall data set used to assess the existing environment was adopted in modelling for both the proposed Stage 1 and longer term development stages.

(b) Modelling Parameters for Stage 1 and longer term conditions

In assessing the proposed Stage 1 and longer term development phases of the project, it was considered that the site would effectively be urbanised as a result of the proposal. Consequently, urban parameters were considered to be appropriate and were adopted in configuring the source nodes within the site boundary. This included parameters for grassed, paved, and roofed areas which are shown in Table 2-9 and Table 2-10.

Table 2-9 Adopted Modelling Parameters for initial and longer term development

Parameters	Values
Impervious Area Parameters	
Daily Rainfall Threshold Values (mm)	1.5
Pervious Area Parameters	
Soil Storage Capacity (mm)	170
Initial Storage (% of capacity)	30
Field Capacity (mm)	70
Infiltration Capacity Coefficient – a	210
Infiltration Capacity Coefficient – b	4.7
Groundwater Properties	
Initial Depth (mm)	10
Daily Recharge Rate (%)	50
Daily Base flow Rate (%)	5
Daily Deep Seepage Rate (%)	0

Note: Parameter values are for non-urban source nodes >10 Ha and mean annual rainfall <1000 mm

Table 2-10 Adopted Base-flow and Stormflow Pollutant Concentrations

Source Node	Pollutant Parameters mg/L (log_{10})					
	TSS		TP		TN	
	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Paved Areas						
Base Flow	1.2	0.17	-0.85	0.19	0.11	0.12
Storm Flow	2.43	0.32	-0.30	0.25	0.34	0.19
Roofed Areas						
Base Flow	n/a	n/a	n/a	n/a	n/a	n/a
Storm Flow	1.30	0.32	-0.89	0.25	0.30	0.19
Grassed Areas						
Base Flow	1.30	0.13	-1.05	0.13	0.04	0.13
Storm Flow	2.15	0.31	-0,22	0.30	0.48	0.26

Note: Above parameters are based on NSW Music Modelling Guidelines

2.6 Bio-retention basins sizing and treatment targets

The Draft Airport Plan for the airport (refer Table 2-5) included indicative sizes of bio-retention basins proposed for the site. These sizes were tested in the MUSIC model and assessed in terms of their effectiveness in managing the post-development water quality loads.

In evaluating the effectiveness of the proposed measures, three treatment targets were assessed, as follows:

- existing or pre-development pollutant loads for total phosphorus, total nitrogen, and suspended solids (NORBE);
- WSUD Guidelines; and
- ANZECC Guidelines.

The NORBE (Neutral OR Beneficial Effect) approach to water quality management requires that post development pollutant loads discharging from a site are managed such that the water quality is equal to or better than the pre-development or existing loads. The NORBE approach is described in *State Environmental Planning Policy (*SEPP*, Sydney Drinking Water Catchment)* 2011 and relates to development within Sydney Water's drinking water catchments. This approach is generally very difficult to comply with where the existing sites are pristine or of a rural nature, such as the airport site, but is relatively easy to comply with where the existing sites are already urbanised, semi-urbanised, or degraded. This is because the pristine or rural catchments generate much lower pollutant loads than those under urbanised conditions, thus requiring more extensive treatment measures in reducing the loads to pre-development levels.

It is noted that the NORBE approach to water quality management has been adopted in many development situations in Australia over the last 20 years prior to its inclusion in SEPP 2011. For example, it was also one of the design criteria adopted in the 1997 Airport EIS for Badgerys Creek.

The WSUD Guidelines specify pollutant reduction targets as a practical way of treating urban stormwater quality (refer Section 2.1.10). These targets recognise that, with most developments, pollutant loads are likely to increase, and the focus is therefore on managing the loads to acceptable levels, rather than maintaining the existing load levels. Consequently, these pollutant reduction targets apply only to urban or post-development pollutant loads, and do not take into account the existing or pre-development loads. The application of these guidelines is generally less stringent than the NORBE approach where the existing catchments are of a rural nature, as in the case of the airport site.

The recommendations of the ANZECC Guidelines have been noted in Section 2.1.5. These guidelines take into account the relative health and assimilative capacity of the receiving waterways and aim to keep the pollutant loads exported from a site to levels that the receiving waterways can sustain. They are also intended to be site specific, with water quality trigger levels established on the basis of long-term water quality monitoring data and ecological studies. In this study, in the absence of detailed site monitoring data, default trigger levels provided in the ANZECC Guidelines have been adopted.

It is also noted that where ANZECC water quality objectives are not achieved for nutrient concentrations they are also not achieved for AEPR Guidelines, which are more stringent.

The bio-retention basin sizes included in the Draft Airport Plan and Concept Design were assessed in the MUSIC model. The adopted bio-retention basin sizes are shown in Table 2-11. The surface areas of these basins correspond to about 0.4% to 0.8% of the catchment areas discharging to them.

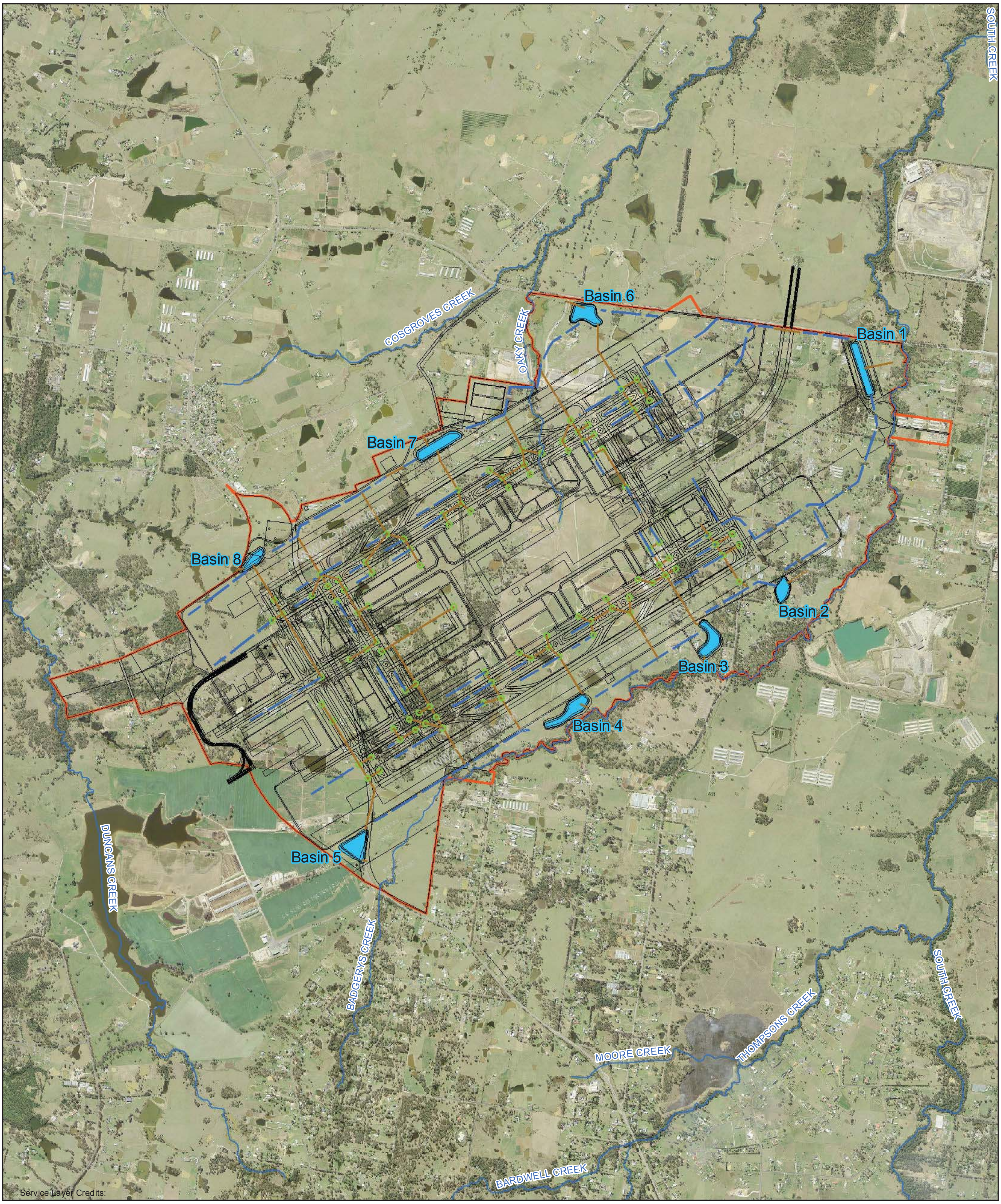
It is understood that the bio-retention sizes adopted in Table 2-11 in the Draft Airport Plan have been provided with the aim of satisfying WSUD Guidelines, rather than NORBE or ANZECC Guidelines. Accordingly, it is expected that supplementary design and management measures would be required during detailed design to further improve the water quality prior to downstream discharge (see Section 6).

Table 2-11 shows that all the bio-retention basins are proposed for construction in Stage 1 of the project, with the exception of Basin 5, which is only built in the longer term development phase. The locations of the proposed basins are shown in Figure 2-2.

Table 2-11 Bio-retention Basin Sizes Adopted

Parameter	Basin 1	Basin 2	Basin 3	Basin 4	Basin 5	Basin 6	Basin 7	Basin 8
Surface Area (Ha)	1.8	0.6	1.2	1.2	1.4	1.6	1.8	0.9
Extended Detention Depth (m)	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Surface Area as % of Catchment Area	0.5	0.6	0.7	0.4	0.8	0.6	0.8	0.5
Extended Detention Volume (m^3)	3600	1200	2400	2400	2800	3200	3600	1800
Filter Media Volume (m^3)	7200	2400	4800	4800	5600	6400	7200	3600
Proposed Construction Stage	1	1	1	1	longer term	1	1	1

Notes: 1) Filter area = surface area; 2) % catchment area = bio-retention surface area as percentage of catchment area



LEGEND

- Airport site
- Watercourses
- Longer term footprint
- Channel
- Culvert
- Pipe
- Pit
- Detention ponds

Paper Size A3

0 250 500 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

Job Number	21-24265
Revision	A
Date	14 Aug 2015

Locations of Bio-Retention Basins
(Stage 1 and longer term)

Figure 2-2

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Data source: Data source: General Topo - NSW LPI DTDB 2012, Imagery - ESRI 2015 Created by: afoddy

3. Existing conditions

3.1 Catchment description

The airport site is situated in the Hawkesbury-Nepean basin. The Hawkesbury-Nepean catchment is one of the largest coastal basins in NSW with an area of 21,400 square kilometres. The airport site is located approximately 12.7 km east of Warragamba Dam in a part of the catchment termed the lower Hawkesbury-Nepean.

The airport site drains partially to the Nepean River and partially to the Hawkesbury River via South Creek and a system of tributaries. South Creek drains a catchment of approximately 414 square kilometres and flows in a northerly direction. It has its headwaters near Narellan and flows for a length of around 70 kilometres to its discharge point into the Hawkesbury River near Windsor.

The catchment is shale-based and is characterised by meandering streams. It is also highly disturbed due to increasing urbanisation and associated land clearing.

Land topography within the airport site is characterised by rolling hills dissected by a number of drainage lines. The ridge system trends north-west to south-east in the vicinity of The Northern Road and reaches elevations of just over 120 m AHD. There are some other isolated ridge lines in and around the Luddenham Dyke and The Northern Road at elevations of slightly more than 100 m AHD. The terrain generally slopes away from these ridgelines to the south and east into Oaky, Cosgroves and Badgerys Creeks as part the South Creek catchment and to the north-west into Duncans Creeks as part of the Nepean River Catchment. The lowest points of the site are where Badgerys Creek exits the north eastern extent of the site, at about 44 m AHD.

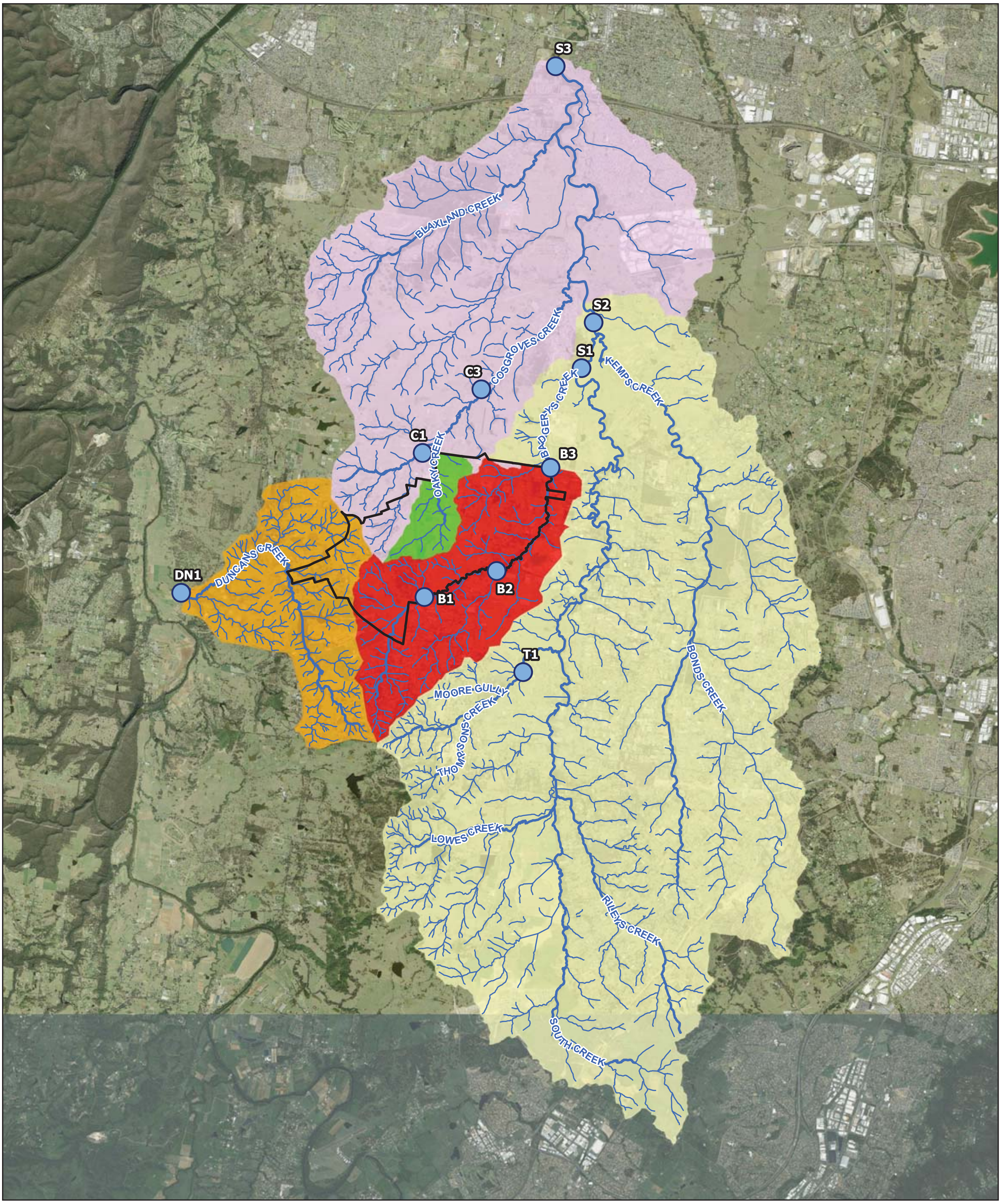
3.2 Major waterways

The major waterways within the airport site are Badgerys Creek, Cosgroves Creek, Oaky Creek and Duncans Creek. Oaky Creek is a tributary of Cosgroves Creek, while Badgerys Creek and Cosgroves Creek are tributaries of South Creek. South Creek is a tributary of the Hawkesbury River, while Duncans Creek is a tributary of the Nepean River. The catchments of Cosgroves and Oaky Creeks, Badgerys Creek, and Duncans Creek are shown in Figure 3-1. Sub-catchment areas located within and outside the airport site are presented in Table 3-1. Based on Table 3-1, the airport site has a total catchment area of about 1775 hectares.

Table 3-1 Waterway Catchment Areas

Waterway	Airport Catchment Area (Ha)	External Catchment Area (Ha)	Total Catchment Area (Ha)
Badgerys Creek (B3)	1056.1	1299.5	2355.7
Cosgroves Creek (C1)	514.7	406.9	921.6
Duncans Creek (DN1)	204.0	1851.9	2056.0
Badgerys Creek-Elizabeth Drive to South Creek confluence (S1)	0	16524.4	16524.4
South Creek confluence with Kemps Creek (S2)	0	6889.3	6889.3
Total	**1775**	**26972**	**28747**

Note: Distances between locations are as follows:
C1-C3 = 2.9 km; C1–S3 = 17 km; B3-S1 = 4 km; B3–S2 = 5.7 km; B3–S3 = 16.3 km



LEGEND

- Airport site
- Water sampling site (Draft EIS)
- Major waterways
- Minor waterways

Paper Size A3

0 800 1,600 3,200

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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GHD

Job Number	21-24265
Revision	A
Date	08 Oct 2015

Catchments in vicinity of the airport site

Figure 3-1

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Data source: DCDB AND DTDB, Aerial Photography - NSW LPI, ESRI Imagery 2015. Created by:jrichardson

3.2.1 Badgerys Creek

Badgerys Creek has its headwaters in the vicinity of Findley Road, Bringelly approximately two kilometres upstream of the airport site. It flows in a north to north-east direction. It passes through the airport site at its southern extent and continues for a distance of approximately 1.2 kilometres before its course returns to the airport site boundary. The creek then forms the south-eastern boundary of the airport site as far as Elizabeth Drive. Downstream of the airport site, Badgerys Creek continues for a further four kilometres until its confluence with South Creek.

Between the airport site and the confluence with South Creek, Badgerys Creek passes a landfill site operated by SUEZ Environment (previously operating as SITA).

Land use within the Badgerys Creek catchment consists of agricultural, landfill, as well as residential uses. Ecologically sensitive riparian vegetation also exists within the catchment.

3.2.2 Oaky and Cosgroves Creeks

Oaky Creek has its headwaters located at the airport site. The creek flows in a north-westerly direction for around two kilometres before it reaches the airport site boundary. From this point, it meanders away from the airport site boundary, through the Blue Sky Mining site for several hundred metres, before re-joining the site boundary and continuing for 400 metres along its north-western boundary as far as the north-west corner of the site at Elizabeth Drive. Downstream of Elizabeth Drive, Oaky Creek continues for a further half a kilometre before discharging into Cosgroves Creek.

Cosgroves Creek then continues for another seven kilometres before joining South Creek. In the reach between Oaky Creek and South Creek, Cosgroves Creek passes through rural lots, the Twin Creeks Golf and Country Club site and beneath an above-ground Sydney Water Corporation water mains pipeline.

Oaky Creek has a catchment area of 382 hectares (3.82 square kilometres). The total catchment area of Cosgroves Creek at the confluence with South Creek is approximately 2163 hectares (21.63 square kilometres).

The catchments are largely rural and without residential development downstream of the site, with the exception of the Twin Creeks residential estate downstream of the site towards Cosgroves Creek’s confluence with South Creek.

3.2.3 Duncans Creek

Duncans Creek has its headwaters in Bringelly and flows initially in a north-westerly direction. A number of unnamed tributaries of Duncans Creek are located on the airport site. A large water storage dam is located on the creek at the Leppington Pastoral Company site. Downstream of the dam, the creek continues, passing close to the southern tip of the airport site before turning sharply towards the south-west and later meandering north again before discharging into the Nepean River around nine kilometres downstream of the southern site extent. The Duncans Creek catchment downstream of the site is rural and zoned for primary production (plant or animal cultivation) according to the Liverpool City Council Local Environmental Plan.

The catchment area of Duncans Creek located within the airport site is 188.94 hectares (1.88 square kilometres).

3.3 Rainfall and evaporation

A rainfall gauge (Station No. 967108) operated by the Bureau of Meteorology (BOM) is located on the airport site. The data from this station have been analysed by the BOM (BOM 2015a) and the analysis is summarised in Table 3-2.

Monthly statistics, taken from Table 4-1 of the *Western Sydney Airport Usability Report, Meteorological Impacts* (BOM 2015b) are summarised in Figure 3-2. The BOM studies indicate that heavy rainfall events of probability 1 Exceedance Year (EY) and rarer are more likely to occur between the months of November and March.

It is noted that the median monthly rainfall at Badgerys Creek is significantly less than that at the existing Sydney Airport at Mascot (Figure 3-3).

Table 3-2 Rainfall Gauge at Badgerys Creek

Gauge name	Badgerys Creek AWS
Gauge Number	067108
Location	33.90^0 S, 150.73^0 E
Period of Data	December 1998 – Present
Data Set Completeness	93.9%
Data resolution	1 minute
Mean Annual Rainfall (mm)	676.4

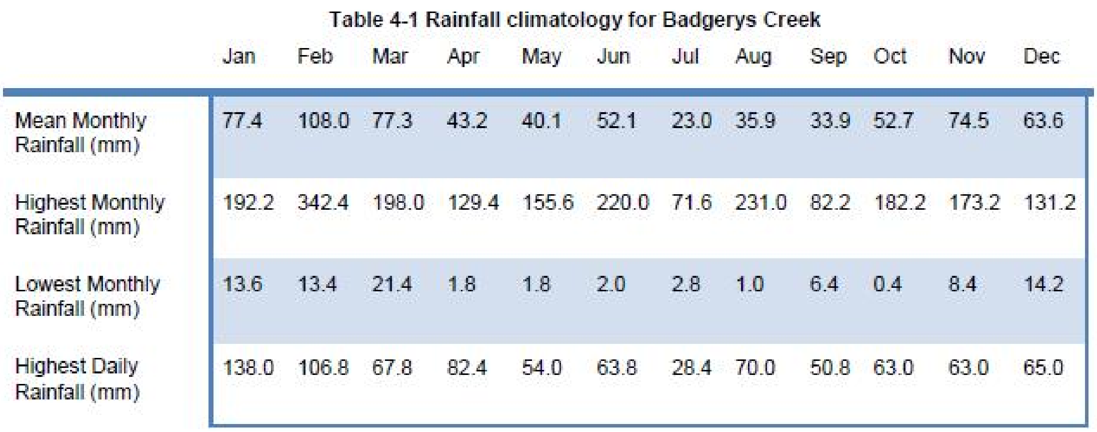


Table 4-1 Rainfall climatology for Badgerys Creek

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean Monthly Rainfall (mm)	77.4	108.0	77.3	43.2	40.1	52.1	23.0	35.9	33.9	52.7	74.5	63.6
Highest Monthly Rainfall (mm)	192.2	342.4	198.0	129.4	155.6	220.0	71.6	231.0	82.2	182.2	173.2	131.2
Lowest Monthly Rainfall (mm)	13.6	13.4	21.4	1.8	1.8	2.0	2.8	1.0	6.4	0.4	8.4	14.2
Highest Daily Rainfall (mm)	138.0	106.8	67.8	82.4	54.0	63.8	28.4	70.0	50.8	63.0	63.0	65.0

Figure 3-2 Monthly rainfall statistics at Badgerys Creek AWS

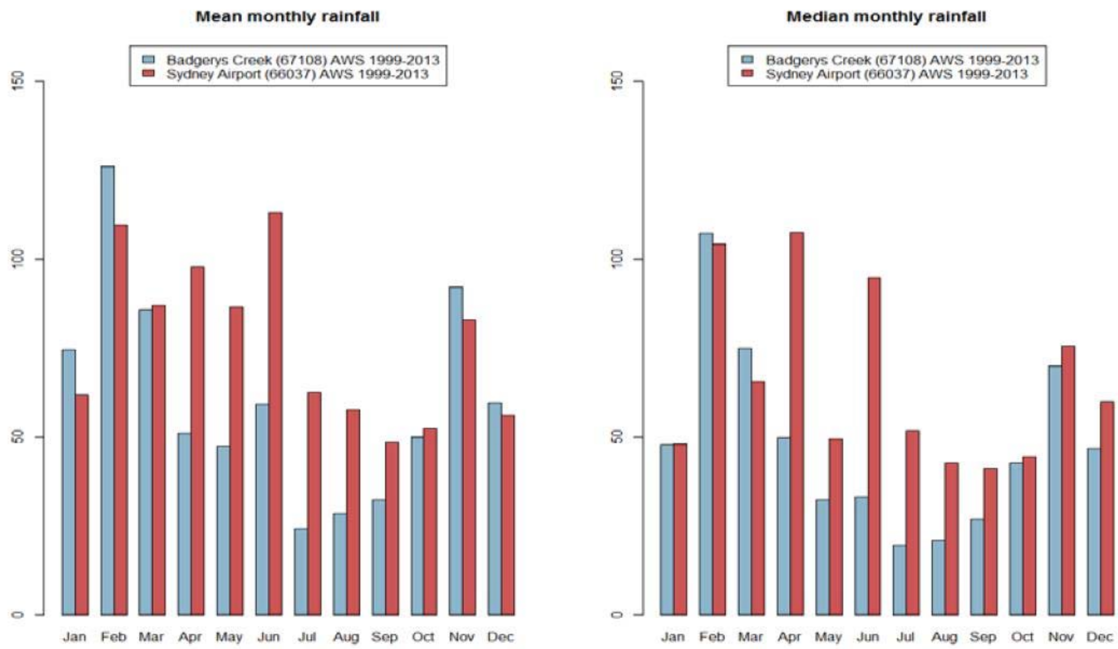


Figure 3-3 Comparison of rainfall at Badgerys Creek and Sydney (Kingsford Smith) Airport

Evaporation data is not collected at the Badgerys Creek automatic weather station. Data from the Parramatta gauge were instead adopted for the purposes of this study as Parramatta is the nearest representative location. The monthly evaporation data for Parramatta are shown in Figure 3-4.

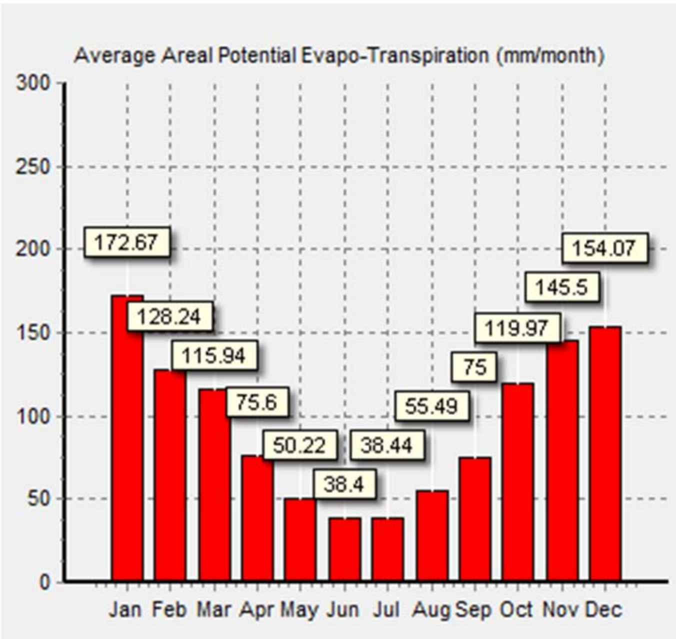


Figure 3-4 Evaporation data from Parramatta gauge

3.4 Existing land uses

Existing land use within the airport site is predominantly rural, with a mixture of pasture, agricultural, and rural residential areas. A large number of small farm dams are present across the airport site. Paved areas on the site are associated mainly with buildings and arterial and local roads.

Land use types within the airport site and downstream catchments are summarised in Table 3-3 and Figure 3-5. Overall, it can be seen that currently the airport site is approximately 68% pastures, 17% modified pastures, 11% rural residential, 4% forest, and the remaining 1% horticultural. Outside the airport site, within the South Creek catchment, residential land use is much higher with corresponding reductions in pasture and agricultural areas.

Land use within the catchments of Badgerys Creek, Cosgroves and Oaky Creek, and Duncans Creek are also summarised in Table 3-4. This table shows that rural residential areas tend to be concentrated within the Badgerys Creek catchment, while pastures and forests are fairly evenly distributed among the three major waterway catchments. A detailed breakdown of the waterway sub-catchment areas and land use types is presented in Table 3-5.

Table 3-3 Existing Land use within the airport site and downstream catchments

Catchment	Existing Land Use Types (Ha)					
	Rural Residential	Forest	Horticulture	Naturalised Pastures	Modified Pastures	Total
Airport Site	190 (11%)	64 (4%)	18 (1%)	1203 (68%)	299 (17%)	*1775*
External Site to S1	6539 (40%)	485 (3%)	1262 (8%)	6431 (39%)	1807 (11%)	*16524*
S1 to S2	3600 (52%)	51 (1%)	103 (1%)	2737 (40%)	398 (6%)	*6889*

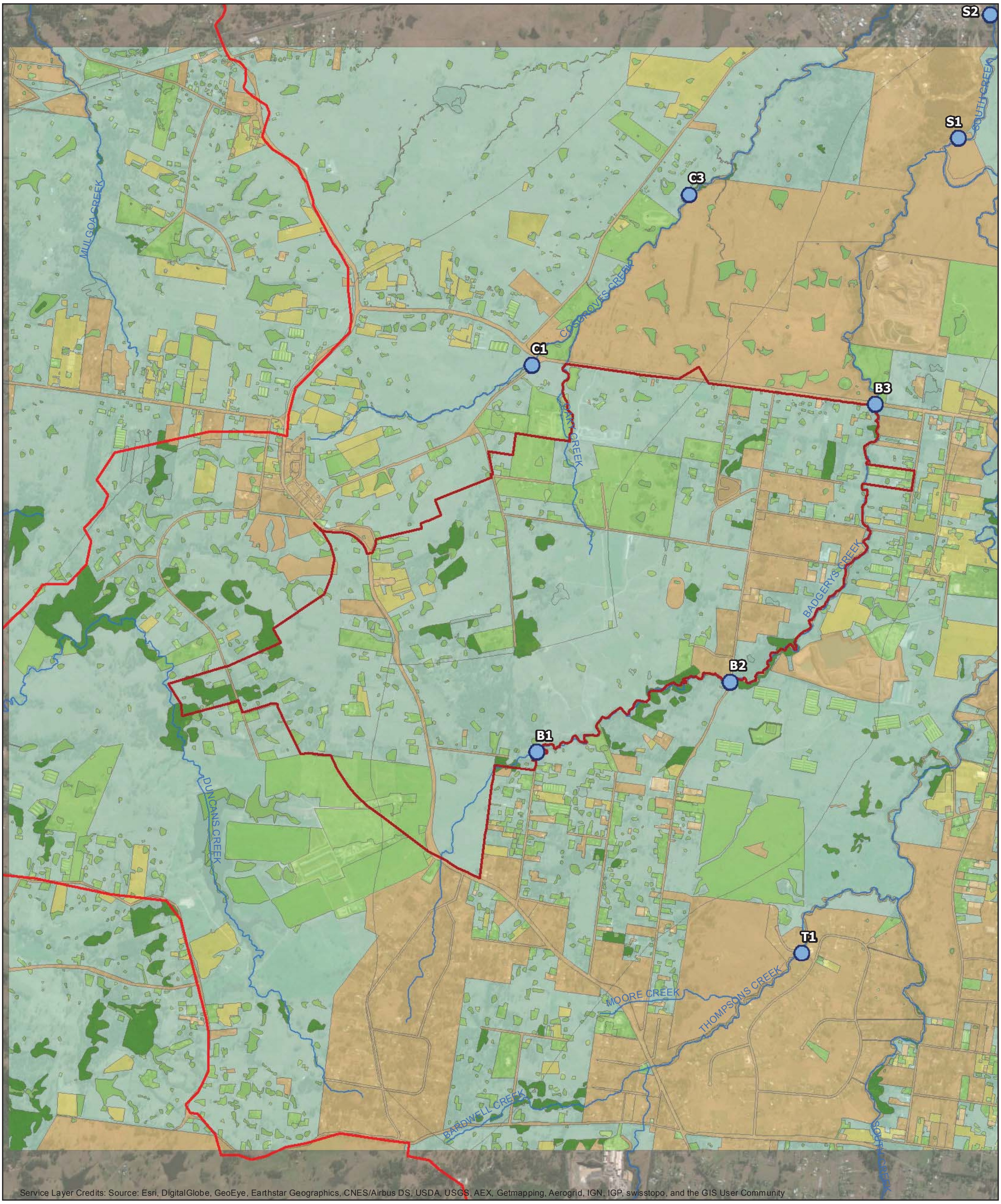
Note: Refer to Figure 3-1 for locations S1 and S2

External Site: South Creek catchment at location S1 excluding airport site

S1 to S2: South Creek catchment area between locations S1 and S2

Table 3-4 Land use within major waterway catchments

Waterway Catchment	Rural Residential (%)	Forest (%)	Horticultural (%)	Grazing (Naturalised Pastures) (%)	Grazing (Modified Pastures) (%)
Badgerys Creek					
- Airport Site	16	2	0	66	16
- External Site	33	2	3	44	19
- Catchment at B3	25	2	2	53	18
Cosgroves / Oaky Creek					
- Airport Site	3	5	3	69	20
- External Site	9	0	9	67	15
- Catchment at C1	6	3	5	68	18
Duncans Creek					
- Airport Site	4	7	0	75	14
- External Site	9	5	2	66	18
- Catchment at DN1	8	5	2	67	18



LEGEND

- The airport site
- Water sampling site (Draft EIS)
- Watercourses
- Rural Residential
- Intensive Agricultural
- Forest
- Horticulture
- Naturalised pastures

Paper Size A3

0 300 600 1,200

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

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Job Number	21-24265
Revision	A
Date	14 Aug 2015

Map of Existing Land Use Plan

Figure 3-5

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Data source: Created by: afoddy

Table 3-5 Detailed breakdown of land use within airport site waterways

Waterway	ID	Existing Land Use Types					
		Rural Residential	Forest	Horti	Naturalised Pastures	Intensive Agricultural Activities	Total
Duncans	0		2.0		6.2	0.8	9.0
Duncans	1	0.8	10.2		33.2	4.6	48.9
Duncans	2		0.1				0.1
Duncans	3		1.8		4.0	0.4	6.3
Duncans	4			0.6	49.3	9.2	59.1
Duncans	5	0.5			8.5	0.7	9.6
Duncans	6	6.6			26.4	5.9	38.9
Badgerys	7	11.9	1.0	1.6	154.7	65.2	234.3
Duncans	9					0.4	0.4
Duncans	10				1.4	1.5	3.0
Duncans	11				0.8	0.3	1.2
Duncans	12				10.5	1.6	12.0
Duncans	13	0.0			0.1		0.1
Duncans	14				13.1	2.5	15.6
Badgerys	16	54.6	0.6	0.9	15.6	1.0	72.7
Cosgroves	20	5.1	12.7	14.4	90.7	12.2	135.0
Cosgroves	21	1.3			4.0	10.9	16.2
Oaky Cosgroves	22	7.0	14.2		189.2	66.6	277.0
Badgerys	23	0.2	3.0		108.1	8.2	119.5
Badgerys	24				70.2	0.8	71.0
Badgerys	25	4.4	4.1		7.5	2.4	18.4
Badgerys	26	33.9	4.4	0.0	84.8	4.9	128.1
Badgerys	27	16.7		0.3	29.1	1.5	47.6
Badgerys	28	9.6		0.5	14.9	3.2	28.1
Badgerys	29	0.4	2.1		9.2	11.8	13.9
Badgerys	30	1.1	1.4	0.2	14.5	1.7	18.9
Cosgroves	31	2.0			10.5	1.1	13.6
Cosgroves	32	0.4			6.2	3.2	9.8
Badgerys	33	33.3	6.3		184.2	70.4	294.2
Cosgroves	34				2.3	0.9	3.2
Oaky Cosgroves	35	0.1			42.2	5.2	47.6
Oaky Cosgroves	36				12.0	0.4	12.4
Badgerys	37	83.5	19.1	8.4	303.4	77.5	491.8
Duncans	38	162.9	89.5	37.2	1230.2	332.2	1851.9
Badgerys	39	270.6	2.2	6.1	82.6	76.8	438.2

Waterway	ID	Existing Land Use Types					
		Rural Residential	Forest	Horti	Naturalised Pastures	Intensive Agricultural Activities	Total
Badgerys	40	74.2	2.5	24.2	179.4	89.2	379.2
Cosgroves	41	36.3		36.3	273.4	60.9	406.9
External site to S1	42	6538.9	485.0	1262.5	6430.9	1807.2	
S1 - S2	43	3600.1	51.1	103.1	2737.3	397.8	6889.3
Grand Total		***10956***	***713***	***1496***	***12440***	***3141***	***28747***

Note: Refer to Figure 3-1 for locations S1 and S2

Horti: Horticultural

External Site: Badgerys Creek (confluence with South Creek) at location S1 excluding airport site

S1 to S2: South Creek catchment area between locations S1 and S2

3.5 Recent water quality sampling

A limited scope of water quality sampling was undertaken by GHD during the aquatic ecology surveys on the 16 March 2015. Sampling results for some key parameters at sampling locations immediately surrounding the airport site are presented in Table 3-6 with the full results presented in Appendix A. The locations of the sampling points are shown in Figure 3-6.

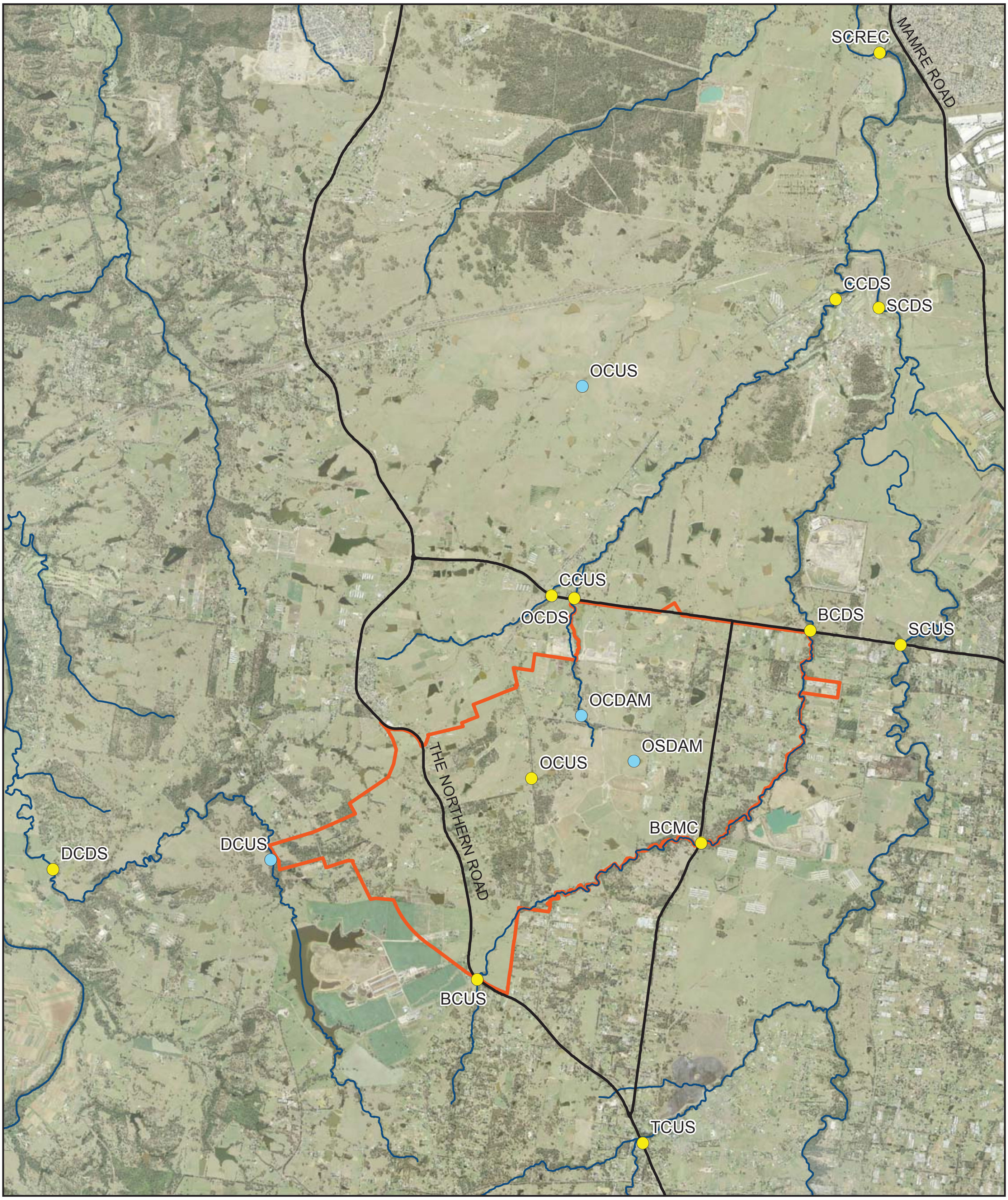
Table 3-6 indicates that the nutrient loads are generally high and elevated well above ANZECC water quality trigger values. Turbidity and total suspended solids were found to be generally within acceptable levels, while dissolved oxygen levels were found to be relatively low. These results are found to be fairly consistent with those obtained previously by PPK in 1997 and SMEC in 2014. The GHD data also indicate that conductivity levels were high and above those for typical lowland rivers.

Additional field visits to the airport site and surrounding areas were also conducted on the 6 May 2015 and 7 May 2015 by members of the surface water team. These field visits focused on the following:

- collection of details regarding key hydraulic structures (road bridge and culvert crossings);
- review of existing land use characteristics; and
- visual inspection of waterway condition at several locations.

There were limitations on accessibility to properties. This meant that full walkovers of all the waterway reaches on the site and downstream areas could not be undertaken.

The inspections confirmed that the majority of the airport site is currently used as farmland for various agricultural or grazing purposes, as indicated in Section 3.4. A number of the areas contained livestock and effluent irrigation also appeared to have been applied on some of the pastures. On this basis, it was considered not surprising that the water quality data sampled to date indicate typically high nutrient loads and low dissolved oxygen levels. Overall, the surface water quality data findings were considered to be consistent with the existing land use in the catchment.



LEGEND

Airport site

Monitoring Site

Additional Monitoring Site

Waterway

Road

1:70,000 @ A4

0 0.25 0.5 1 1.5 2

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: Custom

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GHD

Recent surface water
quality sampling locations

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Figure 3-6

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Table 3-6 Recent Surface Water Quality Data

Location	DO % sat	Conductivity uS/cm	Turbidity NTU	TSS mg/L	TN mg/L	TP mg/L
ANZECC Guidelines	85-110%	125-2200	6-50	<40	0.5	0.05
Badgerys BCUS	21.3	2710	12	23	6.2	0.42
Badgerys BCMC	36	3100	7.71	5	18.5	0.31
Badgerys BCDS	8.6	3050	13	5	2.3	1
Cosgroves OCDS (CCUS)	55.4 (73.6)	4320 (5020)	38.1 (4.25)	19 (5)	1.2 (0.8)	0.05 (0.03)
Duncans DCDS	52.5	847	89.2	14	0.9	0.06

DO: Dissolved Oxygen TN: Total nitrogen TP: Total phosphorus

Source: GHD March 2015

3.6 MUSIC modelling results under existing conditions

The results obtained from the MUSIC modelling for the existing environment are presented in Table 3-7 and Table 3-8 for key locations at and around the airport site. In Table 3-7, the results are presented for total phosphorus, total nitrogen, suspended solids and gross pollutants, in terms of annual loads, while the results in Table 3-8 are presented as concentrations.

The key locations selected include those where bio-retention basins have been proposed within the airport site (basin outlets 1 to 8) as part of the airport concept design (Table 2-5), as well as catchment locations downstream of the site. These locations are shown in Figure 1-1, Figure 3-1 and Figure 3-6.

Based on the results in Table 3.10, it is estimated that on average, the airport site (Basin Outlets 1 to 8) would contribute approximately 231,140 kg of suspended solids, 367 kg of phosphorus, and 3,303 kg of nitrogen each year to the downstream waterways. These loads are for the existing environment without the proposed bio-retention basins in place.

At the Elizabeth Drive crossing of Badgerys Creek (B3/BCDS), it is estimated that the average annual loads would be 316,000 kg for suspended solids, 557 kg for phosphorus and 5,230 kg for nitrogen. It is noted that these loads include those derived from catchment areas external to the airport site catchment.

Similarly, for Cosgroves Creek (C1), the average annual loads are estimated to be 171,100 kg for suspended solids, 325 kg for phosphorus and 3,050 kg for nitrogen.

At the downstream locations of Duncan Creek (DN1), South Creek confluence with Kemps Creek (S12), and South Creek confluence with Blaxland Creek, the estimated pollutant loads would be much higher. These downstream loads will be used to assess the potential impacts of the airport development proposal in the later sections of this report.

In Table 3.11, the estimated pollutant concentrations are also compared against ANZECC guideline default trigger values for lowland rivers. It can be seen from these results that the phosphorus and nitrogen concentrations modelled at all the locations do not achieve ANZECC objectives for water quality.

For total phosphorus, the mean concentrations are estimated to range from 0.06 to 0.38 mg/L, compared to an ANZECC guideline of 0.05 mg/L. Similarly, the mean concentrations for total nitrogen are estimated to range from 0.7 to 2.91 mg/L, compared to an ANZECC guideline level of 0.5 mg/L.

For total suspended solids, however, the estimated concentrations are estimated to achieve ANZECC water quality objectives at all the locations. The modelled concentrations are found to range from 10.3 to 23 mg/L, which are well below the ANZECC guideline level of 40 mg/L.

The above results are generally consistent with field measurements obtained by SMEC and GHD, as noted in Table 2-4 and Table 3-6. In terms of concentrations, the pollutant levels are found to be similar for both the airport site and downstream environment, with not a high degree of variation.

Table 3-7 Average Annual Pollutant Loads under Existing Conditions

Location	Average Annual Flow (ML/yr)	Average Annual Pollutant Loads (kg/yr)			
		TSS	TP	TN	Gross Pollutants
Basin 1 Outlet	505	59500	103	913	1050
Basin 2 Outlet	56.4	7280	8.68	82.9	178
Basin 3 Outlet	149	17900	23.5	218	361
Basin 4 outlet	77.9	4660	34.4	287	0
Basin 5 Outlet	260	34500	58.7	536	126
Basin 6 Outlet	372	58600	78.5	677	75.9
Basin 7 Outlet	171	30800	36.9	378	68.7
Basin 8 Outlet	120	17900	22.9	211	75.1
Total Basins 1 to 8 Outlets	**1711.3**	**231140**	**366.6**	**3302.9**	**1934.7**
Badgerys Creek B1 – BCUS	940	94800	182	1720	3010
Badgerys Creek B2 – BCMC	1600	171000	325	3050	3950
Badgerys Creek B3 – BCDS	2740	316000	557	5230	6330
Cosgroves Creek C1	999	171000	220	2060	532
Cosgroves Creek C3	1700	213000	367	3490	2450
Duncans Creek DN1	2300	308000	467	4240	1820
Kemps Creek Confluence S2	22500	2820000	4480	44000	76000
Blaxland Creek Confluence S3	31000	3640000	5820	57200	114000

Note: Refer toFigure 1-1, Figure 2-2 and Figure 3-1 for locations

S2: South Creek confluence with Kemps Creek

Blaxland Creek confluence S3: South Creek downstream of confluence with Blaxland Creek

Table 3-8 Average Pollutant Concentrations under Existing Conditions

Location	Average Pollutant Concentrations (mg/L)		
	TSS	TP	TN
Basin 1 Outlet	22.10	0.14	1.54
Basin 2 Outlet	22.10	0.09	1.25
Basin 3 Outlet	21.90	0.09	1.26
Basin 4 Outlet	20.70	0.38	2.91
Basin 5 Outlet	23.00	0.17	1.72
Basin 6 Outlet	22.50	0.15	1.60
Basin 7 Outlet	22.30	0.14	1.46
Basin 8 Outlet	23.20	0.13	1.51
Badgerys Creek B1 – BCUS	21.50	0.14	1.47
Badgerys Creek B2 – BCMC	21.80	0.15	1.54
Badgerys Creek B3 – BCDS	21.90	0.14	1.53
Cosgroves Creek C1	22.70	0.14	1.54
Cosgroves Creek C3	22.50	0.14	1.50
DN1	10.30	0.06	0.70
Kemps Creek Confluence S2	20.90	0.13	1.34
Blaxland Creek Confluence	20.80	0.12	1.31
ANZECC Guidelines	**< 40**	**0.05**	**0.5**

Note: Refer to Figure 1-1, Figure 2-2, and Figure 3-1 for locations

S2: South Creek confluence with Kemps Creek

Blaxland Creek confluence S3: South Creek downstream of confluence with Blaxland Creek

4. Assessment of operational impacts of proposal

4.1 Changes in land use types and areas

The proposed catchment and land use plans for the Stage 1 and longer term development are shown in the main document for the EIS. The waterway catchment areas within the airport site corresponding with the initial and longer airport development are shown in Table 4-1, for Badgerys Creek, Cosgroves Creek and Duncans Creek. Oaky Creek is included as part of Cosgroves Creek. It is estimated that, with the proposed development, the catchment of Badgerys Creek will increase by about 46 hectares, while those for Cosgroves Creek and Duncans Creek will reduce by about 31 hectares and 15 hectares, respectively.

Table 4-1 Comparison of Waterway Catchment Areas for Existing and Development Conditions

Waterway	Airport Site Catchment Areas (Ha)			Net Change (Ha)
	Existing Conditions	Stage 1	Longer Term	
Badgerys Creek	1056.12	1102.05	1102.05	+45.93
Cosgroves Creek	514.71	483.79	483.79	-30.92
Duncans Creek	204.01	189.00	189.00	-15.01
Total	**1775**	**1775**	**1775**	**0**

For the purposes of this study, the land use types for the proposed Stage 1 Development and longer term development have been classified into three main types, namely Grassed, Paved and Roofed. Essentially, they correspond to open space areas, paved areas and the roof surfaces of buildings. The results are shown in Table 4-2. These results show that the grassed areas will progressively decrease in each of the catchments, while the paved and roofed areas will increase, as development occurs.

Table 4-2 Land Use Types for Stage 1 and Longer Term Development

Waterway	Grassed (%)	Paved (%)	Roofed (%)	TOTAL (%)
Stage 1 Development				
Badgerys Creek	90.3	3.7	5.9	100
Cosgroves Creek	59.1	31.7	9.2	100
Duncans Creek	77.9	10.7	11.5	100
Longer Term Development				
Badgerys Creek	41.9	41.4	13.6	100
Cosgroves Creek	36.5	51.8	11.7	100
Duncans Creek	49.9	32.0	18.1	100

4.2 Treatment basins and residual catchment areas

As part of the Draft Airport Plan, a number of bio-retention basins have been proposed for water quality treatment purposes. The proposed locations of these basins are shown in Figure 3-6. The catchment areas and land use types discharging to these basins are shown in Table 4-3 for the Stage 1 development, and Table 4-4 for the longer term development.

Catchment areas discharging directly into these basins as well as residual areas are also included in both the above tables. The residual areas are those areas that cannot physically discharge into the basins due to the proposed landform. For modelling purposes, the residual areas have been modelled to discharge to the outlet of the bio-retention basin, thus bypassing the treatment zone of the basin itself. This effectively represents what would occur in the field, and captures the total pollutant loads discharging from the airport site.

Overall, it is estimated that 81%, 12%, and 7% of the airport site will be grassed, paved and roofed, respectively, following Stage 1 of the development. This will be modified to 43%, 43% and 14%, respectively, for the longer term development. In other words, the pervious areas (grassed) will reduce from 81% to 43%, while the impervious areas (paved and roofed) will increase from 19% to 57%.

Table 4-3 Basin Catchment Areas for Stage 1 Development

Basin Name	Basin and Residual Catchment Areas (Ha)			
	Grassed	Paved	Roofed	Total
Basin 1	182.1	29.7	39.8	251.7
Basin 1 Residual	129.5	0.3	0.0	129.8
Basin 2	36.4	1.0	5.7	43.0
Basin 2 Residual	57.9	1.1	0.0	59.0
Basin 3	94.6	6.8	18.9	120.3
Basin 3 Residual	53.2	0.0	0.0	53.2
Basin 4	136.1	1.0	0.8	137.9
Basin 4 Residual	132.3	0.0	0.0	132.3
Basin 5 Residual	173.6	1.3	0.0	174.9
Basin 6	114.2	105.	28.8	248.1
Basin 6 Residual	2.4	0.00	13.2	15.6
Basin 7	152.2	40.9	0.6	193.7
Basin 7 Residual	17.0	7.3	2.0	26.4
Basin 8	107.3	18.6	0.7	126.5
Basin 8 Residual	39.9	1.6	21.0	62.5
Total	**1428.7 (81%)**	**214.6 (12%)**	**131.5 (7%)**	**1774.8 (100%)**

Notes: 1) Residual areas cannot physically discharge into the basins due to landform constraints but are assumed to discharge downstream of the basins for modelling purposes; 2) Basin 5 is not constructed in Stage 1 but in longer term.

Table 4-4 Basin Catchment Areas for Longer Term Development

Basin Name	Basin and Residual Catchment Areas (Ha)			
	Grassed	Paved	Roofed	Total
Basin 1	105.8	105.4	89.9	301.0
Basin 1 Residual	79.3	3.0	0.0	82.3
Basin 2	30.8	35.3	1.1	67.2
Basin 2 Residual	39.1	0.5	0.0	39.6
Basin 3	51.0	87.3	10.9	149.2
Basin 3 Residual	17.4	0.3	0.0	17.7
Basin 4	72.9	165.5	15.7	254.1
Basin 4 Residual	16.1	0.0	0.0	16.1
Basin 5	49.7	58.6	5.6	113.9
Basin 5 Residual	33.1	0.9	27.1	61.0
Basin 6	83.2	131.5	33.4	248.1
Basin 6 Residual	2.4	0.0	13.2	15.6

Basin Name	Basin and Residual Catchment Areas (Ha)			
	Grassed	Paved	Roofed	Total
Basin 7	74.0	111.8	7.9	193.7
Basin 7 Residual	17.0	7.3	2.0	26.3
Basin 8	54.4	58.8	13.3	126.5
Basin 8 Residual	39.9	1.6	21.0	62.5
Total	**766.1 (43%)**	**767.6 (43%)**	**241.1 (14%)**	**1774.8 (100%)**

Note: Residual areas cannot physically discharge into the basins due to landform constraints but are assumed to discharge downstream of those basins for modelling purposes

4.3 Stage 1 development

4.3.1 Average annual pollutant loads compared to existing conditions (NORBE)

The average annual pollutant loads resulting from Stage 1 of the proposed development are presented in Table 4-5 for suspended solids, total phosphorus, total nitrogen and gross pollutants. The percentage change in these pollutant loads compared to existing conditions (pre-development) is also shown in brackets for comparison. Both local and regional impacts are summarised in this table. The local impacts relate to those immediately downstream of the airport site, while the regional impacts relate to those up to 16 km downstream of the site (refer to Table 3-1 footnote). In Table 4-5, the percentage change in loads for gross pollutants has not been calculated due to the fact that in practice, gross pollutants are readily controlled through the use of gross pollutant traps and other standard stormwater devices.

(a) Local Impacts

The results in Table 4-5 indicate that the pollutant loads generated from the site would increase significantly as a result of the change in land use from a rural agricultural setting to an urban airport, particularly for total phosphorus and total nitrogen, and even with all the proposed bio-retention basins in place, except for Basin 5. As noted earlier, Basin 5 is not expected to be developed in Stage 1 but in the longer term development.

Based on these results, the total phosphorus loads at the basin outlets are estimated to increase by between +108% to +624% compared to existing loads. Similarly, the total nitrogen loads are estimated to increase by between +42% to +308% relative to existing conditions. For total suspended solids, four of the outlet locations are estimated to have load increases of between +8% to +497%, while the remaining outlets are estimated to have reductions of between -28% to -40%. In other words, the proposed bio-retention basins would generally be unable to attenuate the pollutant loads to pre-development levels. The exception is suspended solids, where a reduction in loads is achieved at some of the locations compared.

One reason for the increase in total phosphorus and total nitrogen loads, other than land use change, is that due to the change in catchment areas associated with the proposed topography, it has not been possible to direct much of the flows to the proposed basin locations. While the flow paths are much improved in the longer term development, this is not the case for Stage 1.

It is concluded that the bio-retention basins proposed for Stage 1 for water quality management are not adequate in satisfying the NORBE or pre-development load targets. This is not surprising, considering that the NORBE targets are particularly difficult to comply with for rural sites, as noted earlier. It is considered that the NORBE targets may not be achievable without sterilising large sections of the airport site. Nevertheless, it is expected that there will be further improvements in water quality relative to NORBE targets with the implementation of additional design and management measures.

(b) Regional Impacts

In Table 4-5, the results indicate that despite the significant increase in pollutant loads generated and discharged at the bio-retention basins, the downstream regional impacts would be much smaller by comparison. This is evident at the downstream locations of Badgerys Creek at Elizabeth Drive (B3), Badgerys Creek at South Creek confluence (S1), South Creek at Kemps Creek confluence (S2), South Creek downstream of Blaxland Creek (S3), Cosgroves Creek at Elizabeth Drive (C1), Cosgroves Creek downstream of Oaky Creek confluence (C3), and Duncans Creek at downstream location DN1.

Badgerys Creek, on leaving the airport site at Elizabeth Drive (B3) is estimated to have increases of +38% (annual flows), -5% (reduction in suspended solids), +71% (total phosphorus), and +27% (total nitrogen) compared to pollutant loads under existing conditions. The impacts are then estimated to reduce to +4% (annual flows), -2% (suspended solids), +5% (total phosphorus), and +2% (total nitrogen) by the time the flows arrive at the South Creek - Kemps Creek confluence (S2). At South Creek downstream of Blaxland Creek (S3), the impacts would be further reduced to +3% (annual flows), -0.4% (suspended solids), +4% (total phosphorus), and +1% (total nitrogen).

It is noted, however, that the reduction in impacts further downstream of the airport is due to the larger loads derived from the other catchments outside of the airport site, rather than any additional treatment that has occurred in the waterways downstream of the site. This is not surprising due to the relatively large catchment areas associated with the downstream locations as well as the urbanised nature of those areas.

At the Elizabeth Drive crossing of Cosgroves Creek (C1), the increases of +104% (annual flows), -31% (reduction in suspended solids), +67% (total phosphorus), and +39% (total nitrogen) are observed to dissipate to +59% (annual flows), -22% (reduction in suspended solids), +36% (total phosphorus), and +20% (total nitrogen) by the time the flows arrive a short distance downstream at C3.

By comparison, at Duncans Creek at DN1, the results indicate that the airport development would result in an increase in annual flows of +11%, a reduction of 5% for suspended solids, a +14% increase for total phosphorus, and a +9% increase for total nitrogen.

Overall, the above results indicate that the NORBE targets are not fully achieved at the downstream regional locations assessed with the bio-retention basins in place. However, it is expected that these regional impacts would progressively decrease at locations further downstream of the airport due to the increasing loads derived from catchments outside the airport at those downstream locations.

Table 4-5 Stage 1 Average Annual Pollutant Loads

Location	Annual Flow (ML/yr)	Average Annual Loads (kg/yr)			
		TSS	TP	TN	Gross Pollutants
Local Impacts					
Basin 1 Outlet	919 (+82%)	35500 (-40%)	214 (+108%)	1300 (+42%)	3910
Basin 2 Outlet	195 (+246%)	13800 (+90%)	62.8 (+624%)	338 (+308%)	1910
Basin 3 Outlet	385 (+158%)	12100 (-32%)	82.2 (+250%)	493 (+126%)	1590
Basin 4 outlet	437 (+461%)	27800 (+497%)	145 (+322%)	805 (+180%)	3940
Basin 5 Outlet	300 (+15%)	35800 (+4%)	142 (+142%)	756 (+41%)	5390

Location	Annual Flow (ML/yr)	Average Annual Loads (kg/yr)			
		TSS	TP	TN	Gross Pollutants
Basin 6 Outlet	1040 (+180%)	18400 (-69%)	164 (+109%)	1240 (+83%)	2770
Basin 7 Outlet	538 (+215%)	22100 (-28%)	104 (+182%)	593 (+57%)	2160
Basin 8 Outlet	487 (+306%)	19400 (+8%)	107 (+367%)	800 (+279%)	5730
B1 – BCUS	849 (-10%)	77400 (-18%)	246 (+35%)	1720 (0%)	8280
B2 – BCMC	1850 (+16%)	176000 (+3%)	497 (+53%)	3530 (+16%)	13100
B3 – BCDS	3770 (+38%)	301000 (-5%)	953 (+71%)	6630 (+27%)	21300
Regional Impacts					
Cosgroves Creek C1	2040 (+104%)	118000 (-31%)	368 (+67%)	2860 (+39%)	5310
Cosgroves Creek C3	2710 (+59%)	213000 (-22%)	505 (+36%)	4190 (+20%)	7200
Duncans Creek DN1	2560 (+11%)	293000 (-5%)	531 (+14%)	4620 (+9%)	7470
Kemps Creek Confluence - S2	23500 (+4%)	2750000 (-2%)	4720 (+5%)	44700 (+2%)	91000
Blaxland Creek Confluence – S3	32000 (+3%)	3625000 (-0.41%)	6030 (+4%)	57800 (+1%)	129000

Notes: 1) Values in brackets show percentage increase (+) or decrease (-) in loads compared to existing conditions 2) The results at the location of Basin 5 are those without the basin being constructed, as Basin 5 is developed only in the longer term.

4.3.2 WSUD Technical Guidelines for Western Sydney

The potential impacts of the proposed Stage 1 Development, measured against the requirements of the WSUD Guidelines, are presented in Table 4-6. The targets are that 80% of suspended solids, 45% of total phosphorus, and 45% of total nitrogen should be retained on the airport site. In Table 4-6, it is noted that basin outlet flows and loads include areas that discharge directly into the basins as well as residual areas that cannot physically discharge into those basins. In addition, Basin 5 is not expected to be constructed in Stage 1 but in the longer term development.

It is noted that as the above WSUD Guidelines specify only the reduction targets that should be achieved on-site at the basin outlets, they cannot be meaningfully applied within the context of downstream regional impacts where there are no additional bio-retention basins or treatment measures constructed at those locations as part of this project.

In Table 4-6, the eight basin outlets effectively represent the locations where the pollutant loads generated from the proposed airport would discharge into the downstream environment. The results show that, in terms of suspended solids, only Basins 6 and 7 satisfy the 80% reduction target. For total phosphorus, Basins 1, 3, 6, 7 and 8 are close to or satisfy the 45% reduction target. For total nitrogen, Basins 3, 6 and 7 satisfy the 45% reduction target. The remaining basins do not satisfy the retention targets. As noted earlier, this is due to land areas modified for the proposed airport development, or residual areas, that cannot physically discharge into the basins under Stage 1 of the development. However, as the landform for the longer term is modified, a much higher rate of percentage retention would be achieved. This will be discussed in Section 4.4.2.

Other locations listed in Table 4-6 are situated outside the airport site, and therefore predictions for these locations include flows from large untreated catchment areas external to the proposed airport. Consequently, the net percentage retentions achieved at these locations are relatively low by comparison. The exception is Cosgroves Creek at C1. This is due to the high percentage retention achieved at Basins 6 and 7, and because, for modelling purposes, the outflows from Basins 6 and 7 both discharge into C1.

Overall, the results indicate that the WSUD Guidelines percentage retention targets are met for flows discharging from the site into Oaky Creek and Cosgroves Creek. For Badgerys Creek where the percentage retention targets are not met, it is considered that additional land management may be required, particularly in the residual areas associated with Basin 2, Basin 4 and Basin 5. This includes the provision of additional diversion drains, as discussed in Section 6.

Table 4-6 Stage 1 Percentage Pollutant Load Reductions

Location	% Reduction of Pollutant Loads		
	TSS (%)	TP (%)	TN (%)
Western Sydney Guidelines	**80%**	**45%**	**45%**
Basin 1 Outlet (to Badgerys Creek)	77.2	44.8	44.4
Basin 2 Outlet (to Badgerys Creek)	40.1	28.3	33.4
Basin 3 Outlet (to Badgerys Creek)	73.0	48.7	51.4
Basin 4 Outlet (to Badgerys Creek)	47.2	34.6	31.8
Basin 5 Outlet (to Badgerys Creek)	0	0.00	0
Basin 6 Outlet (to Oaky/ Cosgroves Creek)	92.4	66.7	51.5
Basin 7 Outlet (to Cosgroves Creek)	83.1	65.5	58.3
Basin 8 Outlet (to Duncans Creek)	73.7	49.0	34.8
Cosgroves Creek at Elizabeth Drive C1	73.8	58.8	42.9
Badgerys Creek B1	0	0	0
Badgerys Creek B2	12.4	13.3	9.59
Badgerys Creek B3	34.6	27	24.1
Cosgroves Creek at Elizabeth Drive C1	73.8	58.8	42.9
South Creek Kemps Creek Confluence S2	5.48	4.49	7.00
South Creek Blaxland Creek Confluence S3	4.15	3.51	5.56

Notes: 1) Basin 5 is not constructed in Stage 1 but rather in the longer term development. 2) Basin outlet loads include those from residual areas that cannot physically discharge to basins. 3) The treated loads from Basins 6 and 7 have been modelled to both discharge into Cosgroves Creek at C1.

4.3.3 ANZECC Guidelines pollutant concentrations

The results of the MUSIC modelling for Stage 1 are summarised in Table 4-7 for suspended solids, total phosphorus and total nitrogen, together with ANZECC guideline default trigger levels for slightly disturbed ecosystems in lowland rivers. Detailed results showing the pollutant concentrations obtained under Stage 1 conditions are presented in the Appendices.

(a) Local Impacts

Following the Stage 1 Development, the concentrations for suspended solids, total phosphorus and total nitrogen are found to generally improve, relative to those obtained under existing conditions. This can be seen in the results at the basin outlet locations in Table 4-7. The exceptions are those at Basin 3, where total phosphorus increases from 0.09 mg/L to 0.12 mg/L and at the Basin 5 location (without the basin), where suspended solids are estimated to increase slightly.

Overall, the results indicate that ANZECC objectives would not be achieved in Stage 1, with the exception of total suspended solids. This is notwithstanding the general improvements in water quality relative to the existing environment.

(b) Regional Impacts

The regional downstream impacts are similar to the local impacts. Most of the locations assessed were found to have improvements in water quality concentrations for suspended solids, total phosphorus and total nitrogen relative to existing conditions.

The exceptions are at Duncans Creek (DN1) where the concentrations are estimated to increase for all the three pollutants. At Duncans Creek, the impacts are a result of the proposed development along the western perimeter of the site.

As in the case of local impacts, the regional results indicate that ANZECC water quality objectives would not be achieved, despite the general improvements in water quality, with the exception of the level for suspended solids.

Table 4-7 Stage 1 Pollutant Concentrations

Location	Pollutant Concentrations (mg/L)					
	Existing			Stage 1		
	TSS	TP	TN	TSS	TP	TN
ANZECC Guidelines (2000)	**40**	**0.05**	**0.5**	**40**	**0.05**	**0.5**
Local Impacts						
Basin 1 Outlet (to Badgerys Creek)	22.10	0.14	1.54	12.90	0.11	0.91
Basin 2 Outlet (to Badgerys Creek)	22.10	0.09	1.25	16.50	0.11	0.99
Basin 3 Outlet (to Badgerys Creek)	21.90	0.09	1.26	12.20	**0.12**	0.88
Basin 4 Outlet (to Badgerys Creek)	20.70	0.38	2.91	15.90	0.11	1.00
Basin 5 Outlet (to Badgerys Creek)	23.00	0.17	1.72	**23.70**	0.10	1.19
Basin 6 Outlet (to Oaky/ Cosgroves Creek)	22.50	0.15	1.60	6.99	0.12	0.76
Basin 7 Outlet (to Cosgroves Creek)	22.30	0.14	1.46	10.60	0.12	0.81
Basin 8 Outlet (to Duncans Creek)	23.20	0.13	1.51	11.90	0.11	0.90
Badgerys Creek B1	21.50	0.14	1.47	**22.50**	0.11	1.21
Badgerys Creek B2	21.80	0.15	1.54	18.10	0.11	1.10
Badgerys Creek B3	21.90	0.14	1.53	14.80	0.12	1.00
Regional Impacts						
Cosgroves Creek at C1	22.70	0.14	1.54	10.20	0.12	0.88
Cosgroves Creek at C3	22.50	0.14	1.50	10.90	0.12	0.88
Duncans Creek at DN1	10.30	0.06	0.70	**13.20**	**0.11**	**0.96**
South Creek Kemps Creek Confluence S2	20.90	0.13	1.34	15.40	0.11	1.03
South Creek Blaxland Creek Confluence S3	20.80	0.12	1.31	15.50	0.11	1.02

Note: Locations where the mean concentrations have increased are shown in bold.

4.4 Longer term development

4.4.1 Average annual pollutant loads compared to existing conditions (NORBE)

The average annual pollutant loads obtained for the longer term development are presented in Table 4-8 for suspended solids, total phosphorus, and total nitrogen and gross pollutants. The percentage change in these pollutant loads compared to those for existing conditions is shown in brackets for comparison. Both local and regional impacts are summarised in this table. The local impacts relate to those immediately downstream of the airport site, while the regional impacts relate to those further downstream from the airport site. Gross pollutants are readily controlled through the use of gross pollutant traps and other standard stormwater devices and are not considered in this comparison, as noted earlier.

(a) Local Impacts

The results in Table 4-8 indicate that, under longer term development conditions, the annual loads for total phosphorus and total nitrogen will generally increase, compared to existing conditions. The average annual loads for total phosphorus are estimated to increase by 113% to 703% at the various basin outlet locations assessed. Similarly, the average annual total nitrogen loads are estimated to increase by 86% to 420%. For total suspended solids, the results indicate that some locations will be impacted by an increase of up to 306% in the average annual load, while other locations will have a reduction of up to 64%. Similar to the Stage 1 Development, the proposed bio-retention basins will generally be unable to attenuate most of the loads to pre-development or existing levels.

It is noted that the longer term development has less residual catchment areas than the Stage 1 Development (Table 4-3 and Table 4-4), resulting in more areas being directed to the bio-retention basins for water quality treatment. However, this is also offset by increases in pollutant loads attributed to additional areas being urbanised by the airport.

(b) Regional Impacts

As in the case of Stage 1, the regional impacts for the indicative longer term development, compared to existing conditions, are predicted to be much smaller.

Badgerys Creek, on leaving the airport site at Elizabeth Drive (B3) is estimated to have increases of +114% (annual flows), -10% (reduction in suspended solids), +96% (total phosphorus), and +61% (total nitrogen) compared to pollutant loads under existing conditions. These impacts are estimated to reduce to +14% (annual flows), -4% (suspended solids), +8% (total phosphorus), and +7% (total nitrogen) by the time the flows arrive at the South Creek - Kemps Creek confluence (S2). At South Creek downstream of Blaxland Creek (S3), the impacts are further reduced to +10% (annual flows), -1% (suspended solids), +6% (total phosphorus), and +5% (total nitrogen).

Similarly, at the Elizabeth Drive crossing of Cosgroves Creek (C1), the increases of +149% (annual flows), -26% (reduction in suspended solids), +96% (total phosphorus), and +63% (total nitrogen) are observed to reduce to +86% (annual flows), -21% (suspended solids), +56% (total phosphorus), and +35% (total nitrogen by the time the flows arrive at C3.

By comparison, at Duncans Creek at DN1, the results indicate that the proposed airport development will result in an increase in annual flows of +21%, an increase of +8% for suspended solids, a +20% increase for total phosphorus and a +18% increase for total nitrogen.

Overall, it is assessed that the regional impacts will progressively dissipate downstream of the airport site. The implementation of additional design and management measures during the detailed design phase is expected to further improve the water quality and result in a reduction of any potential impacts.

Table 4-8 Longer Term Average Annual Pollutant Loads

Location	Annual Flow (ML/yr)	Average Annual Loags (kg/yr)			
		TSS	TP	TN	Gross Pollutants
Local Impacts					
Basin 1 Outlet	1490 (+195%)	56900 (-4%)	312 (+203%)	2070 (+127%)	2860
Basin 2 Outlet	317 (+462%)	11400 (+57%)	69.7 (+703%)	431 (+420%	1250
Basin 3 Outlet	663 (+345%)	10500 (-41%)	102 (+334%)	692 (+217%)	571
Basin 4 outlet	1180 (+1415%)	18900 (+306%)	174 (+406%)	1300 (+353%)	479
Basin 5 Outlet	668 (+157%)	19100 (-45%)	125 (+113%)	995 (+86%)	6660
Basin 6 Outlet	1170 (+215%)	21300 (-64%)	182 (+132%)	1430 (+111%)	2770
Basin 7 Outlet	862 (+404%)	25400 (-18%)	147 (+298%)	910 (+141%)	2160
Basin 8 Outlet	713 (+494%)	27000 (+51%)	152 (+564%)	1130 (+436%)	5730
B1 – BCUS	1220 (+30%)	62500 (-34%)	226 (+24%)	1970 (+15%)	9540
B2 – BCMC	2950 (+84%)	146000 (-15%)	506 (+56%)	4290 (+41%)	10900
B3 – BCDS	5850 (+114%)	284000 (-10%)	1090 (+96%)	8440 (+61%)	16400
Regional Impacts					
Cosgroves Creek C1	2490 (+149%)	126000 (-26%)	431 (+96%)	3350 (+63%)	5310
Cosgroves Creek C3	3170 (+86%)	217000 (-21%)	574 (+56%)	4710 (+35%)	7200
Duncans Creek DN1	2790 (+21%)	333000 (+8%)	560 (+20%)	4990 (+18%)	7470
South Creek Kemps Creek Confluence - S2	25600 (+14%)	2710000 (-4%)	4820 (+8%)	47000 (+7%)	86100
South Creek Blaxland Creek – S3	34100 (+10%)	3590000 (-1%)	6180 (+6%)	60100 (+5%)	124000

4.4.2 WSUD Technical Guidelines for Western Sydney

The potential impacts of the longer term airport development, measured against the requirements of the WSUD Guidelines, are presented in Table 4-9. The targets are 80% for suspended solids, 45% for total phosphorus and 45% for total nitrogen to be retained on site. As previously noted, the basin outlet flows and loads include areas that discharge directly into the basins as well as residual areas that cannot physically discharge into those basins.

The WSUD Guidelines specify only the reduction targets that should be achieved on site at the proposed basin outlets, and as such cannot be meaningfully applied within the context of downstream regional impacts where there are no additional bio-retention basins or treatment measures constructed at those locations.

In Table 4-9, the eight basin outlets represent the locations where the pollutant loads generated from the proposed airport would discharge into the downstream environment. The results show that, in terms of suspended solids, all the discharges from the basins satisfy the 80% reduction target. The 79% achieved at Basin 1 is considered to be acceptable and within the limits of modelling error. Similarly, for total phosphorus, all the basins satisfy the 45% reduction target. For total nitrogen, all the basins satisfy the 45% reduction target, except for Basin 1, Basin 5, and Basin 8. This is due to a combination of factors, including residual areas that cannot physically discharge into the basins, as well as the development constraints.

The other locations listed in Table 4-6 are situated outside of the airport site, and include large untreated catchment areas. Consequently, the net percentage reductions achieved at these locations are relatively low by comparison. The exception is Cosgroves Creek at C1, which also satisfies the three reduction targets. This is due to the high percentage reductions achieved at Basins 6 and 7.

Overall, the results indicate that the WSUD Guidelines, in terms of reduction targets, are generally satisfied for flows discharging from the airport site into Oaky Creek, Cosgroves Creek and Badgerys Creek. At the basin outlet locations, where the targets are not satisfied, it is considered that additional land management may be required, particularly in the residual areas associated with Basin 1, Basin 5 and Basin 8. This includes the provision of additional diversion drains as discussed in Section 6.

Table 4-9 Longer Term Percentage Load Reductions

Location	% Reduction in Pollutant Loads		
	TSS (%)	TP (%)	TN (%)
Western Sydney Technical Guidelines	**80**	**45**	**45**
Basin 1 Outlet	**79**	49.0	**42.5**
Basin 2 Outlet	86.7	61.2	46.9
Basin 3 Outlet	94.6	71.8	58.3
Basin 4 Outlet	94.6	72.8	55.2
Basin 5 Outlet	86.6	58.4	**39.9**
Basin 6 Outlet	92.6	67.4	50.2
Basin 7 Outlet	90.2	70.1	58.6
Basin 8 Outlet	81.6	51.9	**35.5**
B3	66.4	43.7	25.2
B2	75.8	56.0	34.6
B1	76.6	54.7	37.9
C1	80.0	62.5	44.9
DN1	26.5	22.7	11.0
Kemps Creek Confluence S2	25.6	9.89	21.40
Blaxland Creek Confluence S3	20.70	7.90	17.6

4.4.3 ANZECC Guidelines pollutant concentrations

The results for the longer term development are summarised in Table 4-10 for suspended solids, total phosphorus and total nitrogen, together with ANZECC guideline default trigger levels for slightly disturbed ecosystems in lowland rivers. Detailed results showing the pollutant concentrations obtained under longer term development conditions are presented in the Appendices.

(a) Local Impacts

The concentrations for suspended solids, total phosphorus and total nitrogen are found to generally improve, relative to existing conditions. This can be seen in the results at the basin outlet locations in Table 4-7. The exceptions are those at Basin 2 and Basin 3, where total phosphorus increases marginally from 0.09 mg/L to 0.11 mg/L.

However, despite these improvements, the results indicate that ANZECC water quality objectives would not be achieved, except for suspended solids.

(b) Regional Impacts

The regional downstream impacts are found to be similar to the local impacts. Most of the locations assessed are found to have improvements in water quality concentrations for suspended solids, total phosphorus and total nitrogen relative to existing conditions. This is particularly the case in Cosgroves Creek, Badgerys Creek and South Creek.

The exception is Duncans Creek (DN1), where concentrations are estimated to increase for all the three pollutants. At Duncans Creek, the impacts are a result of the proposed development along the western perimeter of the site.

As in the case of local impacts, the regional results for the downstream areas indicate that ANZECC water quality objectives would not be achieved, despite the general improvements in water quality, except for suspended solids.

Table 4-10 Longer Term Development Concentrations at Key Locations

Location	Existing Conditions (mg/L)			Longer Term Development (mg/L)		
	TSS	TP	TN	TSS	TP	TN
ANZECC Guidelines	**40**	**0.05**	**0.5**	**40**	**0.05**	**0.5**
Basin 1 Outlet	22.10	0.14	1.54	12.40	0.11	0.90
Basin 2 Outlet	22.10	0.09	1.25	14.70	**0.11**	0.96
Basin 3 Outlet	21.90	0.09	1.26	10.50	**0.11**	0.84
Basin 4 Outlet	20.70	0.38	2.91	8.24	0.12	0.78
Basin 5 Outlet	23.00	0.17	1.72	13.20	0.11	0.94
Basin 6 Outlet	22.50	0.15	1.60	7.43	0.12	0.77
Basin 7 Outlet	22.30	0.14	1.46	10.90	0.12	0.83
Basin 8 Outlet	23.20	0.13	1.51	12.80	0.11	0.92
B1	21.50	0.14	1.47	14.40	0.11	1.02
B2	21.80	0.15	1.54	11.40	0.12	0.93
B3	21.90	0.14	1.53	12.00	0.12	0.94
C1	22.70	0.14	1.54	11.00	0.12	0.91
DN1	10.30	0.06	0.70	**13.60**	**0.11**	**0.98**
South Creek Kemps Creek Confluence S2	20.90	0.13	1.34	13.20	0.12	0.98
South Creek Blaxland Creek Confluence S3	20.80	0.12	1.31	13.40	0.12	0.97

4.5 Fuel jettisoning

The issue of potential adverse effects from fuel dumping (fuel jettisoning) has been addressed with reference to the regulations on fuel dumping (*Air Navigation (Fuel Spillage) Regulations 1999)* and the procedures for fuel dumping in Australia (Aeronautical Information Package (AIP) (Airservices Australia, 2014). The cause, frequency and volume of fuel jettisoned, as well as results from a prior scientific study on fuel dumping are outlined below.

Fuel jettisoning generally only occurs during an emergency, as a safety precaution when a plane must land prematurely. At take-off, aircraft are heavier than they are at landing due to the unburned fuel that is to be used during the flight. As aircraft can only safely land when the specified maximum landing weight is reached, weight must sometimes be removed from the plane during flight prior to an emergency landing. This occurs in the form of an expulsion of fuel from the plane’s wing tips, tail or fuselage (Aerospaceweb, 2005).

There are specific protocols in place to regulate fuel dumping in Australia in accordance with the *Air Navigation (Fuel Spillage) Regulations 1999*. The Aeronautical Information Package (AIP) (Airservices Australia, 2014) indicates that where possible, a pilot should obtain authority from Air Traffic Control (ATC) before commencing a fuel dump and receive instruction on where the fuel dump is to be performed. Fuel dumps are required to occur in clear air at 6,000 ft. (approximately 2,000 m) above ground level, and in an area nominated by the ATC to ensure that all fuel is vaporised before reaching the ground. The AIP also requires that reasonable precautions must be taken to ensure the safety of persons and property in the air and on the ground. There are currently no recorded cases of fuel from civil aircraft reaching the ground.

The amount of fuel that is dropped will vary with the size of the aircraft, the amount of fuel carried at the time, and the amount required to be jettisoned in order to reach their maximum landing weight. Data for annual frequency and amounts of fuel dumped near Australian airports is unavailable, however in total, it is estimated that up to 6800 tonnes of fuel was released over oceans in the 1990s (Aerospaceweb, 2005). The significant cost of fuel means that fuel dumps only occur when necessary. It is in the airlines' best interest to conserve fuel and consider alternate options prior to fuel dumping.

Fuel dumping events are extremely rare worldwide. For example, All Nippon Airways (Japan's largest airline by revenues and passenger numbers in 2012) experienced only three cases of fuel dumping during 2013. All of these occurred off the east coast of Japan away from urban areas (ANA Holdings, n.d). As fuel jettisoning is usually only a safety feature of new, large, long-range aircraft, most planes are forced to either burn excess fuel prior to landing by circling in the air or land overweight. In Australia, common aircraft such as the Airbus A320 and Boeing 737 are not capable of fuel jettisoning and thus fuel dumping is likely to be a rare occurrence.

Civilian aircraft generally use Jet-A1 grade fuel which contains up to approximately 20% by volume aromatic hydrocarbons (including benzene) and approximately 2% by volume of naphthalene's (including Polycyclic Aromatic Hydrocarbons) (IARC, 1989). This aircraft fuel is a source of volatile organic compounds (VOCs) and carbon dioxide (CO_2) when unburnt fuel droplets are released. Although all dumped fuel is vaporised before reaching the ground, it may have an impact on local air quality. This is particularly significant for pollutants with long residence times. For example, VOC's such as benzene can occur in a predominantly vapour phase with a residence time of between one day and two weeks depending on climate and other pollutant concentrations (Harrison et al, 2010). This may cause concern due to the known carcinogenic effect of benzene over long-term exposure (Harrison et al, 2010). However, since fuel dumping is a rare event and protocols are in place to ensure the safety of persons and property on the ground, fuel dumping is not likely to have significant impacts on local air quality or human health.

Due to improvements in fuel efficiency and lightweight aircraft material, the amount of fuel dumped from aircraft under emergency situations has decreased substantially, with this trend anticipated to continue. As fuel efficiency, technology and airspace management continue to improve, volumes of fuel required to be carried on planes will steadily decline in the future. Major Australian airlines already have goals in place to implement these improvements. Qantas, for example, is currently aiming to improve its fuel efficiency by 1.5 per cent per year until 2020 (Department of Resources, Energy and Tourism, 2013). The Qantas Group Fuel Optimisation Program also has strategies in place to reduce travel distance and unnecessary aircraft weight. These strategies will help to reduce the volume of fuel carried by aircraft and reduce the amount of fuel dumped in event of an emergency.

Based on the above considerations, fuel jettisoning is not expected to have any measurable impacts on surface water quality discharging from the airport site.

5. Assessment of construction impacts

5.1 Overview

The proposed airport has the potential to impact on surface water quality during both the proposed Stage 1 and the longer term construction phases of the project. Land clearing, the removal of existing vegetation, buildings and structures, major earthworks, the laying of airport services, and the movement of construction vehicles within the site would be expected to result in extensive disturbance to the existing soils. Rainfall events during the construction period may therefore lead to increased erosion and sediment deposition of the disturbed soils. This has the potential to result in the release of pollutants into the downstream waterways, including suspended solids, nutrients and other toxicants which may impact on the environment. There is also the risk that chemical or hydrocarbon spills may occur during the construction activities, which may discharge into the waterways, particularly during rainfall events.

Notwithstanding the above risks, potential construction impacts would mostly be mitigated through the implementation of a Soil and Water Management Plan (SWMP) and a Construction Environmental Management Plan (CEMP). A water quality monitoring plan would also be developed and implemented as part of these plans to monitor any potential impacts during the construction phases of the project. Management measures that would be expected to be included in these plans are highlighted in Section 6.

With the management plans in place, construction is not expected to have any significant impact on existing water quality concentrations in the receiving waters downstream of the site. Any exceedances would likely be localised and short term. In particular, it is noted that ANZECC water quality objectives are not achieved under existing conditions, but water quality would be improved substantially once the construction works are completed. Additional information on some of the potential impacts during construction of the project is noted below.

5.2 Duration of construction works

It is possible that a large rainfall event may occur during the extended construction phase for the proposed airport. Impacts from poor management of surface water on site could result in increased mobilisation of soils, flooding of equipment and increased risks associated with constructing in wet and muddy soils. There is also the potential for large quantities of sediments to be directed into the stormwater network, potentially resulting in siltation and blockage during the construction period. Where the construction period can be reduced, the risks would also be reduced.

5.3 Erosion and Sedimentation

Soil erosion and sedimentation are risks posed to surface water quality throughout the construction phase where earthworks, vehicle access and alterations to drainage lines and connections can lead to increased sediment loads entering downstream environments.

Disturbed areas with surface grades greater than 2.5 per cent and vehicle access tracks where the surface is frequently disturbed by traffic are typically high risk areas during construction. The locations of disturbed areas with grades greater than 2.5 per cent could change throughout construction and would need to be identified in the CEMP. Stockpiled soils can also erode during rainfall events and high winds and require careful on-site management. Other disturbed areas with exposed soils are also susceptible to erosion during rainfall events.

Construction of the longer term airport involves the disturbance of additional land surfaces as well as the installation of new connections between proposed drains and existing pits. During the construction of these connections there is an increased risk that disturbed soil will enter drainage lines and waterways.

Stormwater control and treatment measures would need to be located immediately downstream of the construction footprint. However, overland flow from the construction site may still enter the downstream waterways if not managed carefully. In the event that runoff from the site is permitted to leave the site in an uncontrolled manner and discharge into downstream waterways, localised scour could occur at the points of discharge.

With the provision of appropriate construction stage erosion and sediment controls, nutrient loads would be unlikely to increase significantly during the construction phase, however particulate phosphorous is likely to increase where erosion and scour is allowed to propagate.

5.4 Potential for spills

The release of potentially harmful chemicals and other substances in the environment may occur during construction. This would have the potential to impact on water quality in receiving waters downstream of the airport site. These potentially contaminating substances would include acids and chemicals from washing processes, construction fuels, oils, lubricants, hydraulics fluids and other chemicals. Release of these substances could occur due to spills, as a result of equipment refuelling, malfunction and maintenance, via treatment and curing processes for concrete, as a result of inappropriate storage, handling and use of the substances or from the disturbance and inappropriate handling of contaminated soils. These substances have the potential to be taken up in surface water runoff and transported downstream from the proposed works locations. Water quality and associated ecological impacts could result if these contaminants are transported into waterways downstream of the site.

5.5 Demolition and excavation works

The major civil construction works would require the demolition of existing buildings and infrastructure within the project site, though it is understood that much of the demolition works would be conducted separately to the works proposed as part of the proposed Stage 1 and the longer term development. Excavation works also have the potential to unearth contaminated land.

Examples of sources of pollutants that could affect water quality from demolition and excavation works are as follows:

- asbestos and other building materials;
- toxic or pollutant laden soils including fertilisers and pesticides;
- heavy metals;
- chemicals including hydrocarbons and fluids associated with demolition processes and machinery; and
- dust and airborne pollutants.

Typical impacts on the waterways would be through mobilised dust, litter and other building materials being deposited and picked up by surface water runoff, waterways or stormwater management infrastructure thereby degrading the quality of the natural receiving environment. The transportation of building waste from the demolition sites could potentially impact on the quality of the waterways through accidental spills/material drops. As identified above, some materials that are typically found in building demolition such as lead-based paints and chemicals can be easily transported from the demolition site through off-site stormwater runoff. There is also potential for pollutants to be ingested by aquatic fauna or terrestrial fauna.

6. Mitigation and management measures

6.1 Operational Phase Measures

During the operational phases of the project for both Stage 1 and the longer term, key water quality management measures proposed as part of the management strategy include the following:

(a) Design based measures

- During detailed design, additional water quality treatment measures, consisting of bio-retention swales, would be provided along all the drainage flow lines to cater for additional polishing of water quality prior to discharging to the bio-retention basins. Where necessary, the effectiveness of the swales would be enhanced with increased infiltration properties.
- During detailed design, diversion drains would be designed to convey flows from "residual areas" into the proposed basins. These residual areas are those areas that do not currently discharge to the basins due to topographical constraint. These diversion channels would be designed to have non-erosive velocities to minimise stream erosion.
- During detailed design, the proposed bio-retention basins would be increased in size where necessary, depending on the effectiveness of the above supplementary measures.
- During detailed design, the bio-retention basins would be separated from the flood control basins. The bio-retention basins would be designed to be offline such that design flows larger than the capacity of the bio-retention basins would bypass the system and discharge directly into the flood control basins. This would ensure that the pollutants within the bio-retention system are not re-suspended during large flow events.

(b) Management based measures

- Surface water quality would be maintained by implementing safeguards and procedures to prevent contaminants entering the drainage system and by treating all surface water in sediment basins prior to downstream discharge;
- The use of herbicides, pesticides and fertilisers would be controlled and the disposal of any unacceptable substances such as paint and oils into the drainage system would be prohibited;
- Pollutant traps would be provided at strategic locations to prevent debris and coarse sediment entering the drainage system. Inspections and monitoring activities of pollutant traps would be undertaken at regular intervals and after large storm events to check accumulation of material and evidence of overflows and blockages. Accumulated sediment and debris would be regularly removed from traps. Access to all structures would be provided for maintenance vehicles;
- Fuel storage, chemical facilities and any other similar storage or handling facilities with the potential to contaminate stormwater would be provided with perimeter bunds. Procedures should also be established to clean up spills as quickly as possible to reduce the potential for groundwater or surface water impacts;
- An operation and maintenance plan would be prepared for the sediment and water quality basins to ensure performance meets requirements;
- Operation and management activities would involve stream bank maintenance to prevent erosion, periodic trash, sediment removal, and monitoring of water quality indicators;

- Water quality basins would be inspected at regular intervals and after high flow events. The inspections would ensure that all components of the basins are functioning correctly and to determine the need for erosion control or sediment removal procedures;
- Sediment would be removed as required to restore basin operational depth using earth moving equipment. Testing for contamination would be carried out before any sediment is used in landscaping works around the site or transported to a suitable landfill;
- Regular monitoring of inflow and outflow water quality parameters would be carried out to provide information to assess the performance in meeting water quality objectives. An airport lessee company would undertake water quality monitoring in accordance with the *Airport (Environmental Protection) Regulations 1997*;
- Spillage control and containment areas would be provided to reduce the risk of spills discharging onto adjacent land, watercourses, or the bio-retention basin areas;
- Structures would be designed to limit potential for infiltration to the underlying groundwater system (i.e. they would be appropriately lined);
- Suitably sized temporary holding tanks would be included in the discharge lines to capture the expected volumes from cleaning activities and spills;
- A strategy would be implemented for off-site removal of the captured contaminated water by a licensed waste contractor; and
- Cleaning and spill response procedures would be documented in a site management plan to ensure that impacted water is contained, collected and managed appropriately.

6.2 Construction Phase Measures

Both the initial and longer term developments would face the same challenges in relation to mitigation and management of construction impacts. However, the airport site would become more constrained as construction progresses around existing infrastructure. Facilities constructed as part of the proposed Stage 1 Development of the site including bio-retention basins and open swale drains would bisect the construction site and these structures would need to be considered so that construction activities did not adversely impact their performance.

A Soil and Water Management Plan (SWMP) would be prepared and implemented in order to cater for the construction activities across the airport site. These measures would also be documented within the CEMP and approved by the relevant regulatory authorities. This should include procedures to minimise the risk of contamination.

The primary focus of the SWMP is erosion and sediment control during the land disturbance phases of the project. The SWMP should be prepared in accordance with the following guidelines:

- Soils and Construction, Managing Urban Stormwater series, including:

  - Volume 1 (Blue Book, Landcom, 2004);

  - Volume 2A (Installation of services, DECC 2008); and

  - Volume 2D (main roads construction, DECC 2008).

Important and additional considerations in surface water management and preparation of the SWMP are discussed below. These include potential site constraints and considerations for both the construction and operational phases of the project. Overall implementation of the above measures is expected to minimise any adverse impacts on the existing environment.

6.2.1 Sediment and Erosion Control

Sediment and erosion control measures that reduce the amount of sediment leaving the site should be included and implemented on-site before, during and after construction until the site conditions have settled and operational measures are established.

Erosion and sediment control measures, aimed at minimising the volume of sediment transported from disturbed areas and discharging from the site, are required. Potential measures include:

- careful design of the drainage system to minimise the lengths of drainage paths or watercourses that have to be filled, diverted and replaced;
- identification and implementation of temporary diversion channels and bunding, where necessary to prevent concentrated flow from causing scour of disturbed surfaces;
- identification of highly erodible soils and avoidance of activities involving disturbance of these areas where possible. Where avoidance is not possible, additional control measures would be planned for these identified areas;
- consideration of the possibility of staging works to minimise the extent of disturbance at any one time;
- construction and commissioning of all, or where sufficient for treatment purposes, part of, the sediment and water quality basins before any other major earthworks;
- all runoff leaving the construction site would be directed to a detention or water quality facility before downstream release;
- banks of temporary stream diversion channels would be stabilised with suitable materials to minimise scouring and erosion;
- temporary stabilisation or revegetation/rehabilitation works to reduce the extent of disturbed surfaces;
- stabilisation of disturbed areas with an appropriate cover where practicable until works can recommence or permanent vegetation can be established;
- application of temporary surface treatments or blanketing on exposed earth surfaces;
- installation of sediment barriers;
- graded access tracks and speed restrictions for vehicles on site;
- mandatory use of designated stations to wash all vehicles and machinery before exiting the site, including the appropriate capture and treatment of wash-down waters;
- rainfall and wind forecasts to inform on-site managers of daily risks;
- adaptable site activity scheduling to avoid periods of increased erosion risk due to wind, rain and runoff;
- preparation of vegetative buffer strips;
- installation of established drainage lines incorporating rock check dams at regular intervals;
- establishment of baseline environmental conditions and regular water quality monitoring of impacts for the duration of the construction works, in accordance with the requirements of the Construction Environment Management Plan;
- monitoring of discharge from sediment or detention ponds to mitigate the potential for impacts to surface water quality in the receiving environment;

- dosing of sediment ponds with flocculants where there are dispersive soils or excessive nutrients being discharged from the system;
- careful advanced planning and ongoing management of works and mitigation procedures to reduce erosion and pollutant loads;
- keeping clearance of vegetation to a minimum, particularly in the vicinity of streams;
- location of material, overburden and topsoil stockpiles on level ground and away from drainage lines and streams;
- drainage outlets would be provided with energy dissipators where appropriate to minimise water velocity and erosion;
- installation of gross pollutant traps to intercept and retain coarse sediment, rubbish and debris in storm water;
- all silt traps, gross pollutant traps, erosion control fencing, diversion drains, catch drains and other construction management measures would be implemented in accordance with industry standards and design guidelines for construction sites;
- dust control should be managed through the use of water sprays and stabilising or covering of stockpiles; and
- where space allows, construction works should consider the potential for locating sediment retention basins along the perimeters of the site upstream of the proposed bio-retention basins. These basins would reduce the volume of sediment and turbidity levels in runoff potentially discharging from the site.

6.2.2 Chemical Contamination

The SWMP and CEMP should include methods and procedures for reducing the risk of contamination.

Reducing the risk of chemical spill during the construction phase requires the planning and implementation of the following measures:

- preparation of an emergency response plan for spills and leakages of fuels and chemicals;
- installation of flame traps to limit the release of oils and fuels in stormwater;
- mandatory use of fenced and impermeable areas for washing machinery and equipment with collection and treatment systems downslope;
- mandatory use of fenced and impermeable refuelling stations (preferably off-site);
- storage of all chemicals and harmful waste products in secure designated areas (preferably off-site);
- regular maintenance of machinery and vehicles, checking for oil, fuel or hydraulic leaks;
- easily accessible chemical spill clean-up kits on site in case of emergency spills;
- enforcement of incident reporting procedures to record serious spills, the response measures used and their effectiveness; and
- testing of potential contaminated soils prior to excavation.

In addition, reducing pollutant loads sourced from demolition works requires the planning and implementation of the following on-site control measures:

- scheduling of works to avoid strong winds and rainfall;
- mandatory coverage of trucks carrying debris;
- temporary barriers or dust screens, as appropriate, to suppress the effect of dust movement to uncontrolled sites;
- dust suppression such as wetting measures; and
- fencing of temporary stockpiles on hardstands.

7. Summary and conclusions

An assessment of the potential impacts of the proposed airport on surface water quality has been undertaken for both the proposed Stage 1 and longer term development stages of the project.

Available baseline water quality data for the site and surrounding areas were reviewed. The results indicate that nutrient loads in the existing waterways are generally high and do not achieve ANZECC water quality objectives for total phosphorus and total nitrogen. However, total suspended solids loads are generally low and achieve ANZECC objectives.

A MUSIC water quality model was developed and calibrated to the available baseline data. Additional models were then developed to represent the proposed Stage 1 and the longer term development phases of the project and identify the potential impacts of the proposed development.

Bio-retention basins proposed as part of the Draft Airport Plan were incorporated into the modelling. Eight bio-retention basins would be located along the perimeter of the airport site. Basins 1, 2, 3, 4, and 5 were placed along the southern boundary to provide water quality treatment of the stormwater flows prior to discharge to Badgerys Creek. Similarly, Basins 6 and 7 were provided along the northern boundary to manage the flows discharging into Oaky Creek and Cosgroves Creek, while Basin 8 was provided to manage flows discharging into Duncans Creek. All the basins are proposed for construction during Stage 1 of the project, except for Basin 5, which would be constructed during the longer term development phase.

The calibrated MUSIC water quality models were simulated over an extended rainfall time series to assess the pollutant loads and potential impacts of the proposal. In evaluating the effectiveness of the proposed measures, the treatment targets for total suspended solids, total phosphorus and total nitrogen were assessed on the basis of: i) comparison with existing or pre-development pollutant loads (NORBE); ii) WSUD Guidelines; and iii) ANZECC Guidelines.

Under proposed Stage 1 Development conditions, with the proposed bio-retention basins in place, the results indicate that post-development loads would not be reduced to pre-development loads (NORBE), except for suspended solids.

Similarly, the results indicate that the Stage 1 Development, with the bio-retention basins in place, would be unable to satisfy WSUD guideline targets, except for flows discharging from the site into Oaky Creek and Cosgroves Creek. For Badgerys Creek, where the percentage retention targets are not met, supplementary design measures would be provided during detailed design, particularly in the residual catchment areas associated with Basin 2, Basin 4 and Basin 5.

The results indicate that for the Stage 1 Development, ANZECC water quality objectives would not be achieved, except for suspended solids. This is notwithstanding the general improvements in water quality concentrations relative to the existing environment, particularly in Badgerys Creek and South Creek.

Under the longer term development, the results indicate that post-development loads would not be reduced to pre-development loads (NORBE), except for suspended solids.

The results for the longer term development indicate that the WSUD percentage retention targets for total suspended solids, total phosphorus, and total nitrogen are generally satisfied for flows discharging from the site into Oaky Creek, Cosgroves Creek, and Badgerys Creek. At basin outlet locations for Basins 1, 5 and 6, where the targets are not satisfied, supplementary design measures would be provided during detailed design.

Under the longer term development conditions, the concentrations for suspended solids, total phosphorus and total nitrogen are found to generally improve, relative to existing conditions in Oaky Creek, Cosgroves Creek, Badgerys Creek, and South Creek. The exceptions are those at Duncans Creek for suspended solids, phosphorus and nitrogen, and at the Basin 2 and the Basin 3 outlets, with regards to the levels of total phosphorus, where the concentrations are estimated to increase. The results also indicate that ANZECC water quality objectives would not be achieved, except for suspended solids. This is notwithstanding the general improvements in water quality, in terms of concentrations, relative to the existing environment.

During detailed design, additional measures would be required for implementation with the aim of optimising the level of water quality treatment provided prior to downstream discharge. This would include the use of enhanced bio-retention swales along all the drainage lines for additional water quality polishing, the implementation of diversion drains to convey additional flows from the residual areas to the proposed basin locations, and enlarging some of the bio-retention basins where necessary.

Additional mitigation and management measures, as well as water quality monitoring, would also be required during the construction and operational phases of the project.

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Appendices

Appendix A – Water Quality Sampling Data

Matrix:	WATER	Sample Type:		REG	REG	REG	REG	REG	REG	REG	REG	REG	REG	REG
Workgroup:	ES1506236	ALS Sample numbe		ES1506236001	ES1506236002	ES1506236003	ES1506236004	ES1506236005	ES1506236006	ES1506236007	ES1506236008	ES1506236009	ES1506236010	ES1506236011
Project name/number:	WSA AE SURVEY	Sample date:		16/03/2015	16/03/2015	16/03/2015	16/03/2015	16/03/2015	16/03/2015	16/03/2015	16/03/2015	16/03/2015	16/03/2015	16/03/2015
		Client sample ID (1st		SCUS	BCDS	OCDS	SCREC	BCUS	TCUS	DCDS	BCMC	CCUS	CCDS	SCDS
		Client sample ID (2n												
		Site:												
EA010P: Conductivity by PC Titrator														
Electrical Conductivity @ 25°C		µS/cm	1	**1680**	**3050**	**4320**	**1540**	**2710**	**1640**	**847**	**3100**	**5020**	**1050**	**1900**
EA025: Suspended Solids														
Suspended Solids (SS)		mg/L	5	<5	<5	**19**	**10**	**23**	<5	**14**	<5	<5	**44**	**19**
EA065: Total Hardness as CaCO3														
Total Hardness as CaCO3		mg/L	1	**281**	**535**	**604**	**253**	**550**	**179**	**162**	**521**	**806**	**160**	**292**
EK055G: Ammonia as N by Discrete Analyser														
Ammonia as N	7664-41-7	mg/L	0.01	**0.30**	**0.22**	**0.22**	**0.14**	**0.17**	**0.04**	**0.23**	**0.28**	**0.14**	**0.04**	**0.06**
EK057G: Nitrite as N by Discrete Analyser														
Nitrite as N		mg/L	0.01	**0.02**	<0.01	<0.01	<0.01	**0.08**	<0.01	**0.01**	**0.08**	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser														
Nitrate as N	14797-55-8	mg/L	0.01	**0.08**	**0.10**	**0.06**	**0.12**	**4.56**	**0.01**	**0.19**	**15.5**	**0.15**	**0.03**	**0.10**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser														
Nitrite + Nitrate as N		mg/L	0.01	**0.10**	**0.10**	**0.06**	**0.12**	**4.64**	**0.01**	**0.20**	**15.6**	**0.15**	**0.03**	**0.10**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser														
Total Kjeldahl Nitrogen as N		mg/L	0.1	**1.1**	**2.2**	**1.1**	**0.9**	**1.6**	**1.0**	**0.7**	**2.9**	**0.6**	**1.3**	**1.0**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser														
Total Nitrogen as N		mg/L	0.1	**1.2**	**2.3**	**1.2**	**1.0**	**6.2**	**1.0**	**0.9**	**18.5**	**0.8**	**1.3**	**1.1**
EK067G: Total Phosphorus as P by Discrete Analyser														
Total Phosphorus as P		mg/L	0.01	**0.27**	**1.00**	**0.05**	**0.05**	**0.42**	**0.09**	**0.06**	**0.31**	**0.03**	**0.30**	**0.08**
EP005: Total Organic Carbon (TOC)														
Total Organic Carbon		mg/L	0.2	**10.1**	**12.7**	**19.3**	**14.4**	**10.2**	**20.3**	**6.3**	**31.7**	**8.9**	**10.5**	**16.6**
EP020: Oil and Grease (O&G)														
Oil & Grease		mg/L	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5

Appendix B – MUSIC Water Quality Results for Stage 1 Development

Plots of pollutant concentrations at various locations

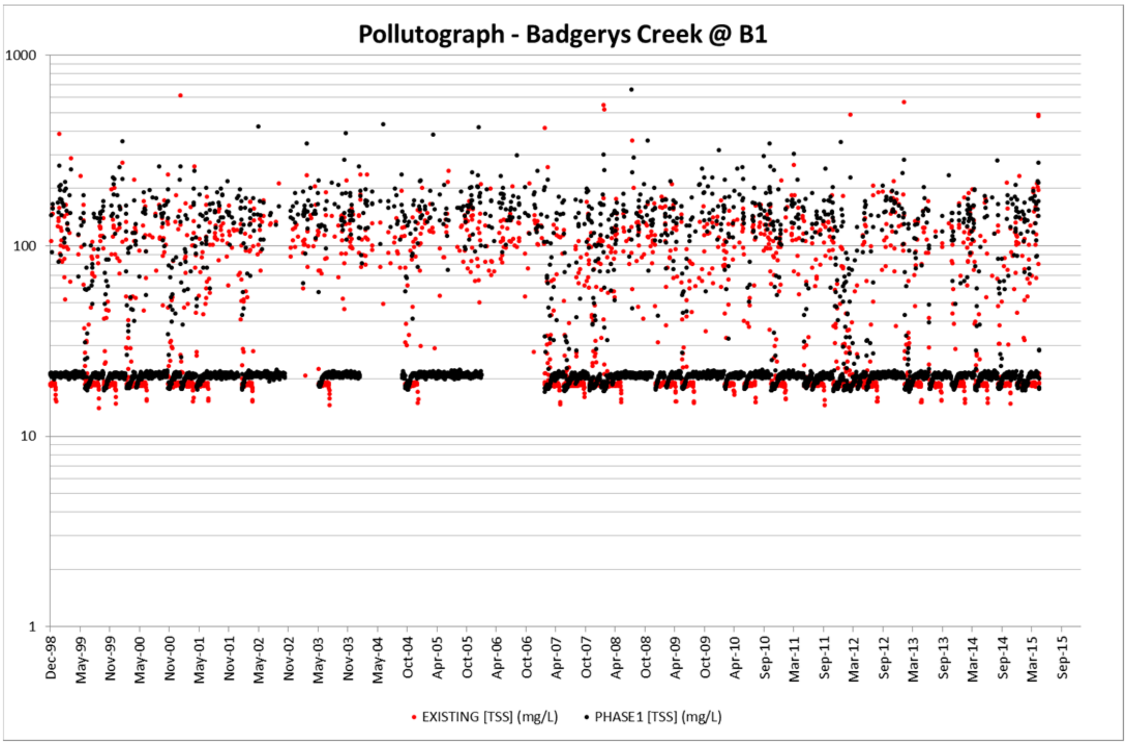

Figure B 1 Stage 1Total Suspended Solids at Badgerys Creek B1

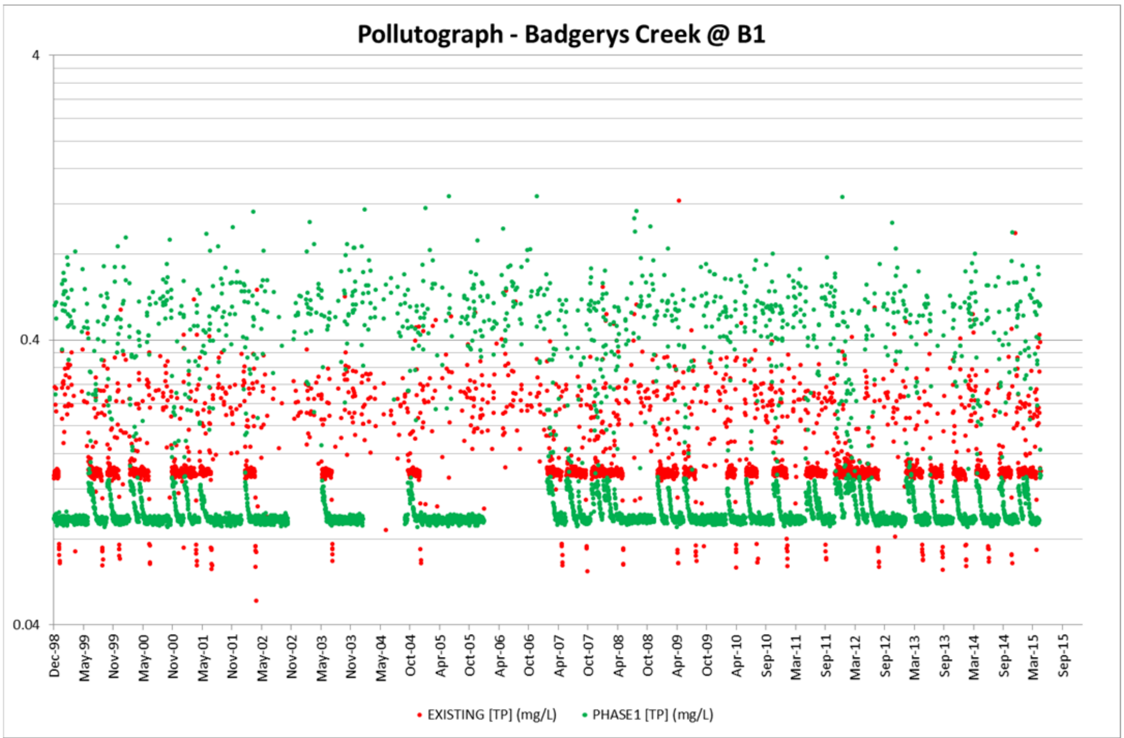

Figure B 2 Stage 1Total Phosphorus at Badgerys Creek B1

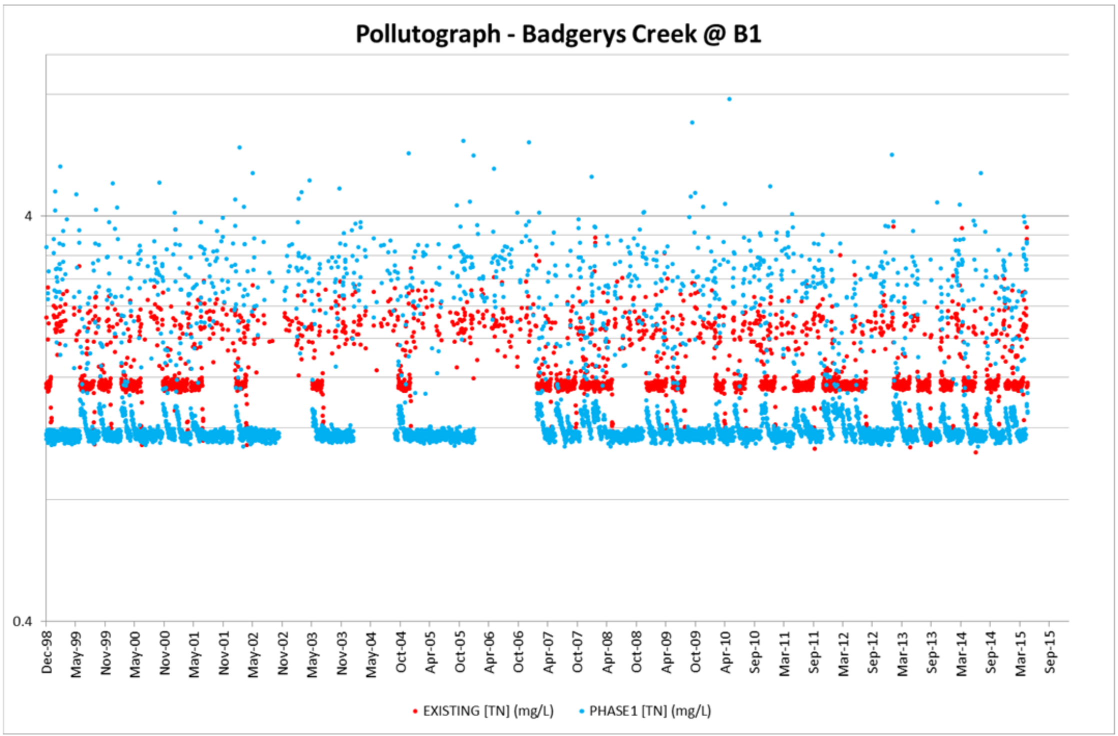

Figure B 3 Stage 1 Total Nitrogen at Badgerys Creek B1

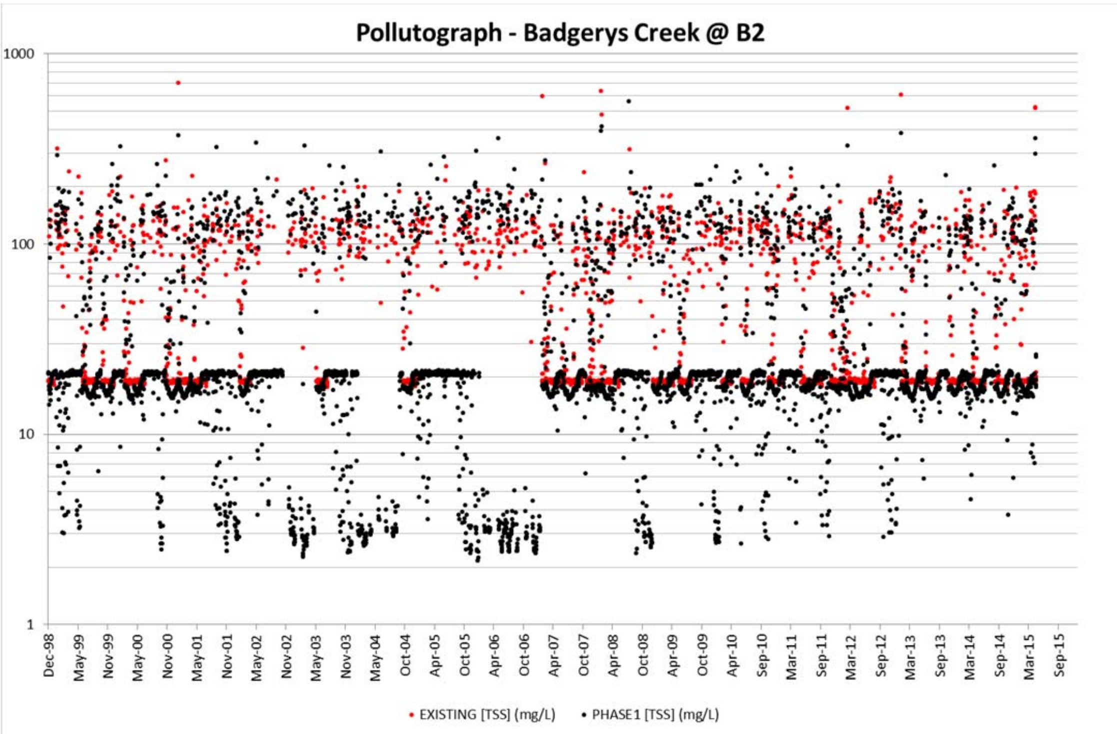

Figure B 4 Stage 1Total Suspended Solids at Badgerys Creek B2

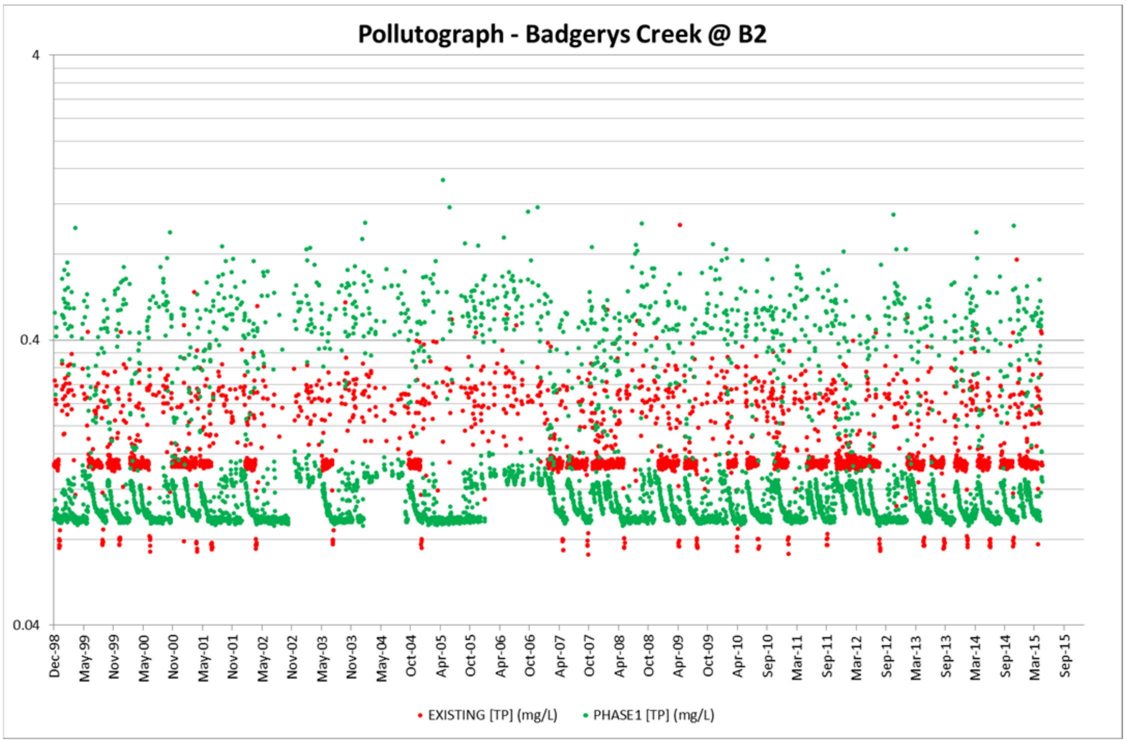

Figure B 5 Stage 1Total Phosphorus at Badgerys Creek B2

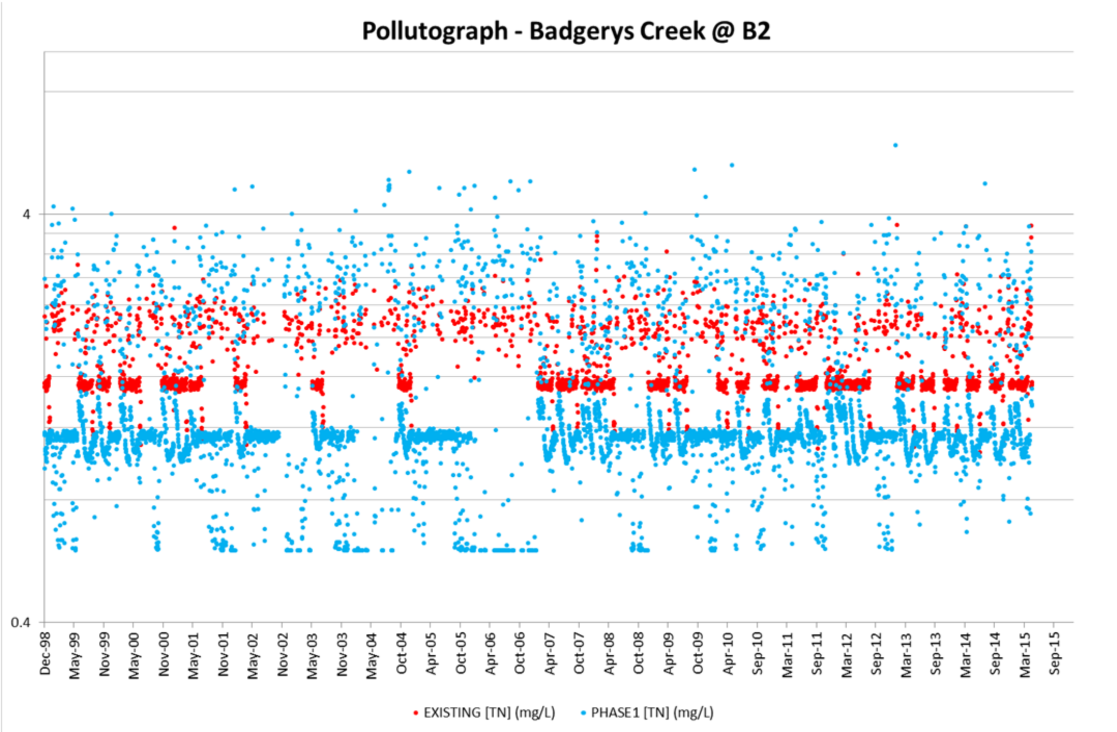

Figure B 6 Stage 1Total Nitrogen at Badgerys Creek B2

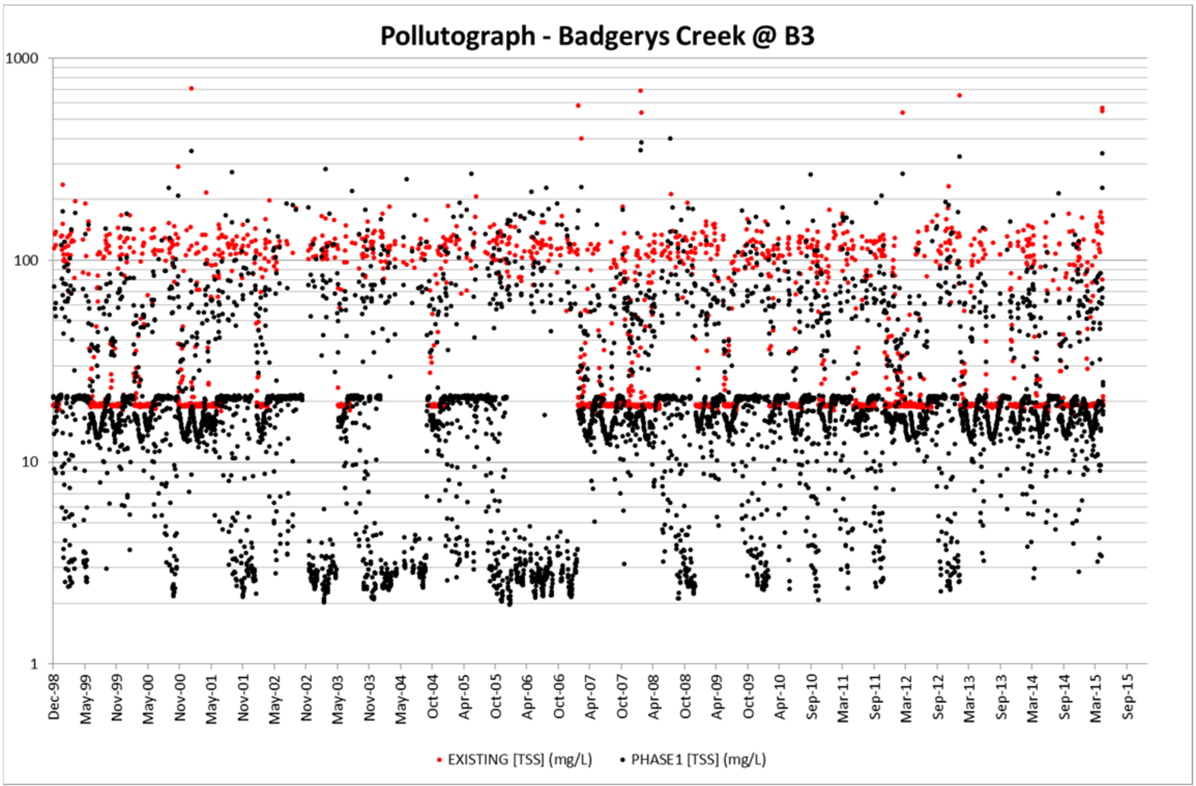

Figure B 7 Stage 1Total Suspended Solids at Badgerys Creek B3

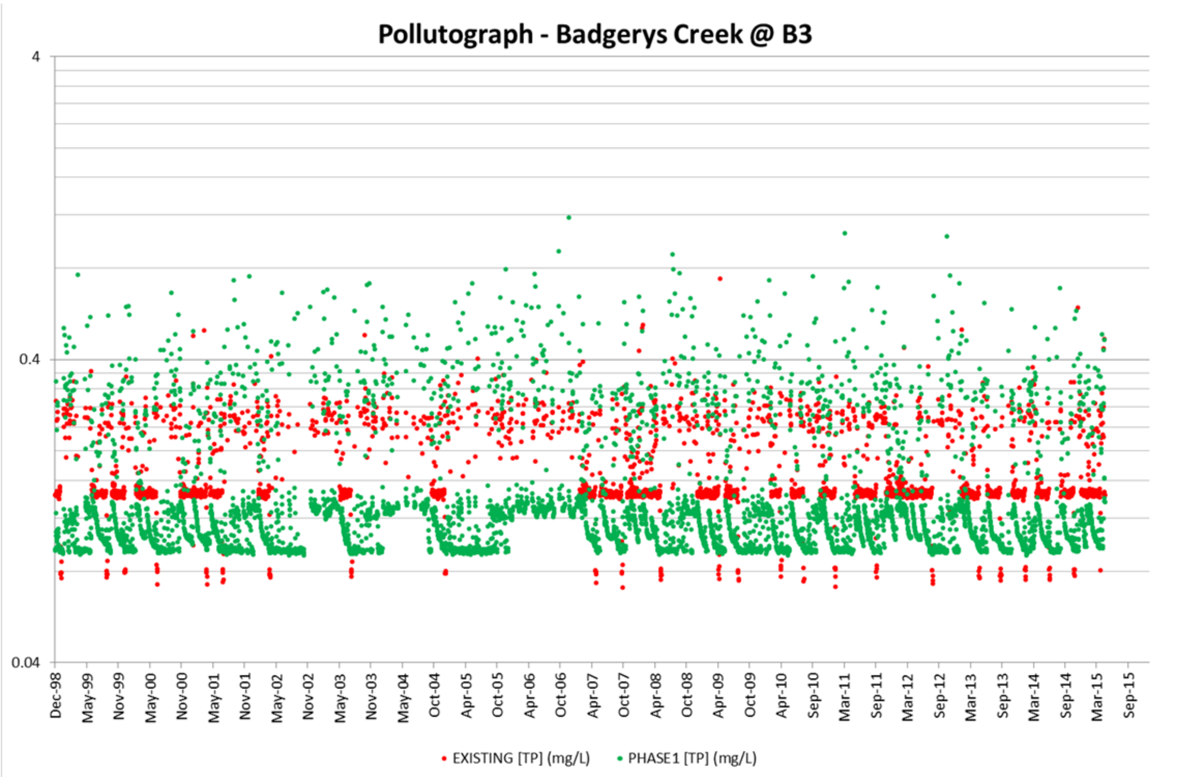

Figure B 8 Stage 1Total Phosphorus at Badgerys Creek B3

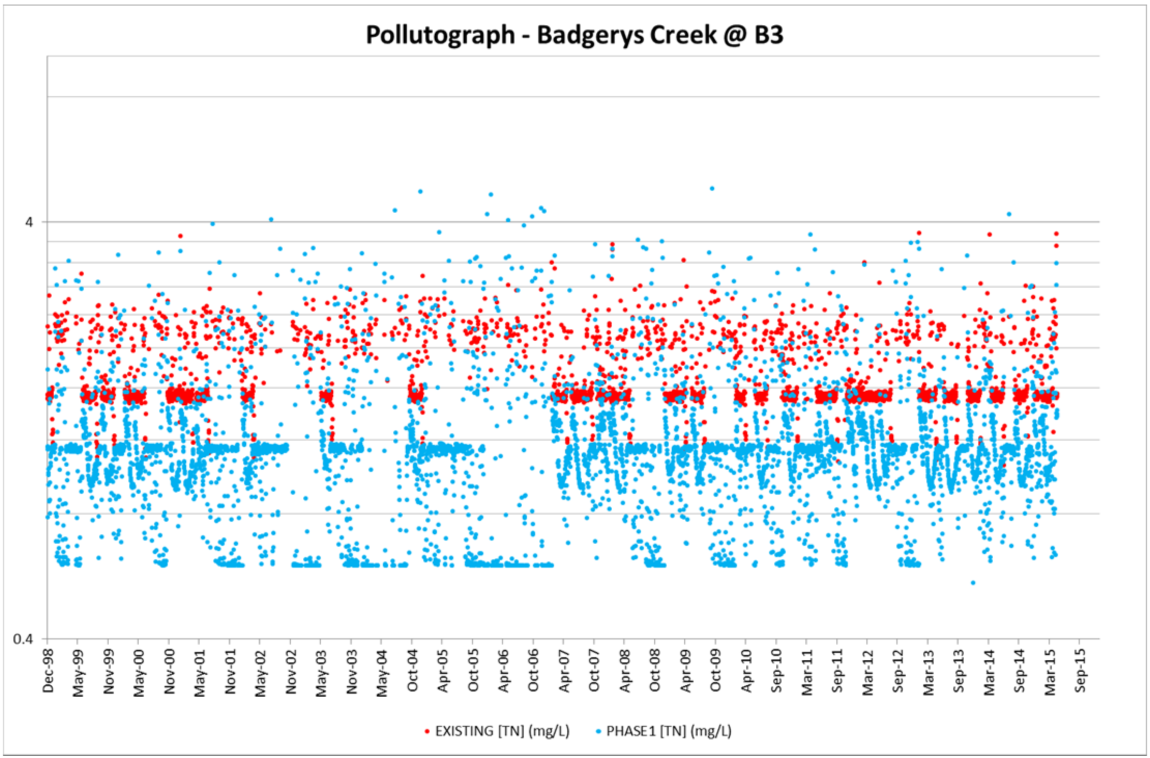

Figure B 9 Stage 1Total Nitrogen at Badgerys Creek B3

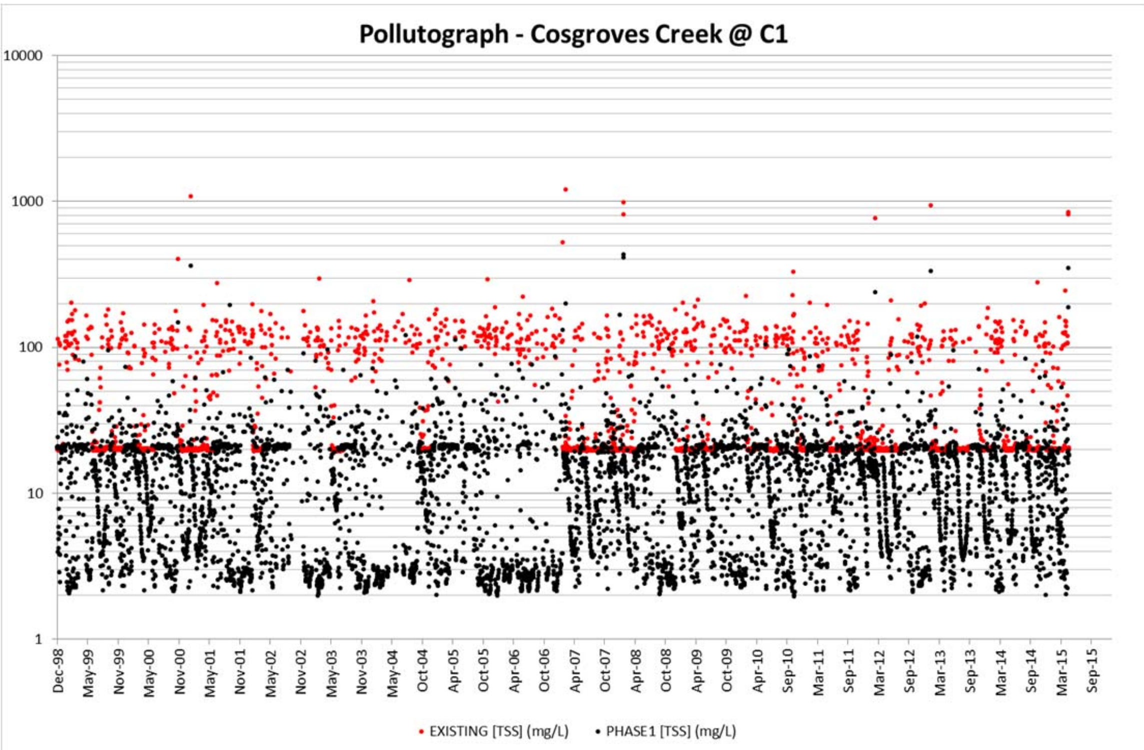

Figure B 10 Stage 1 Total Suspended Solids at Cosgroves Creek C1

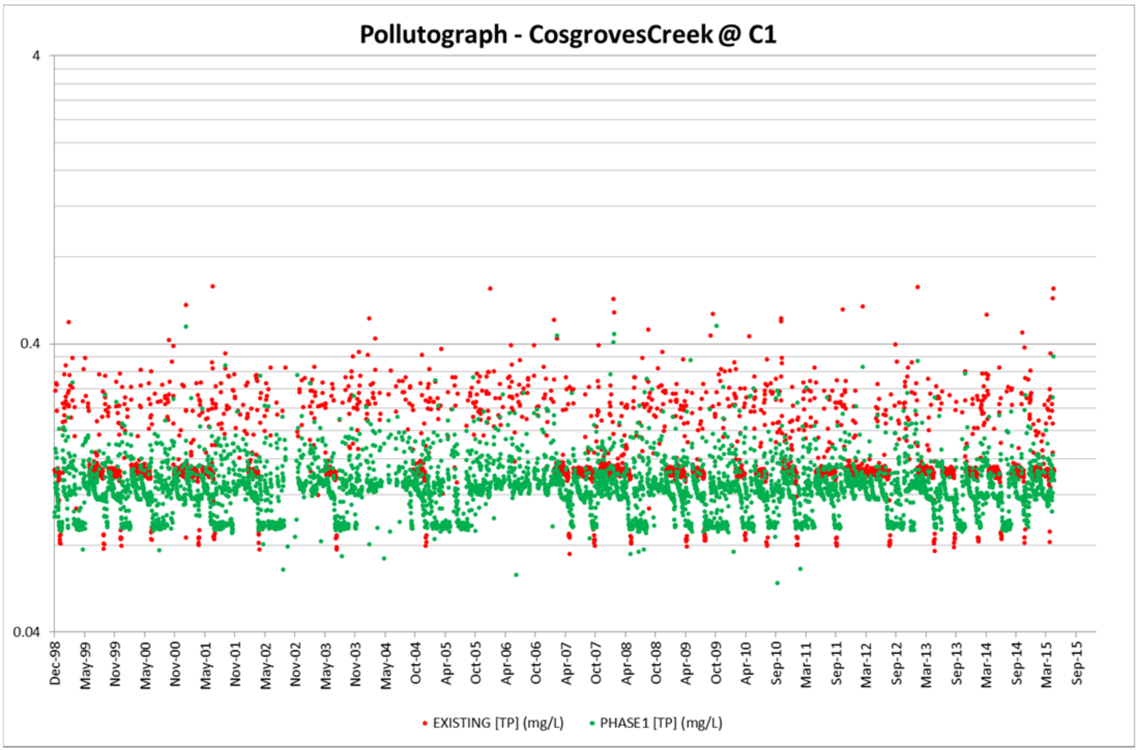

Figure B 11 Stage 1Total Phosphorus at Cosgroves Creek C1

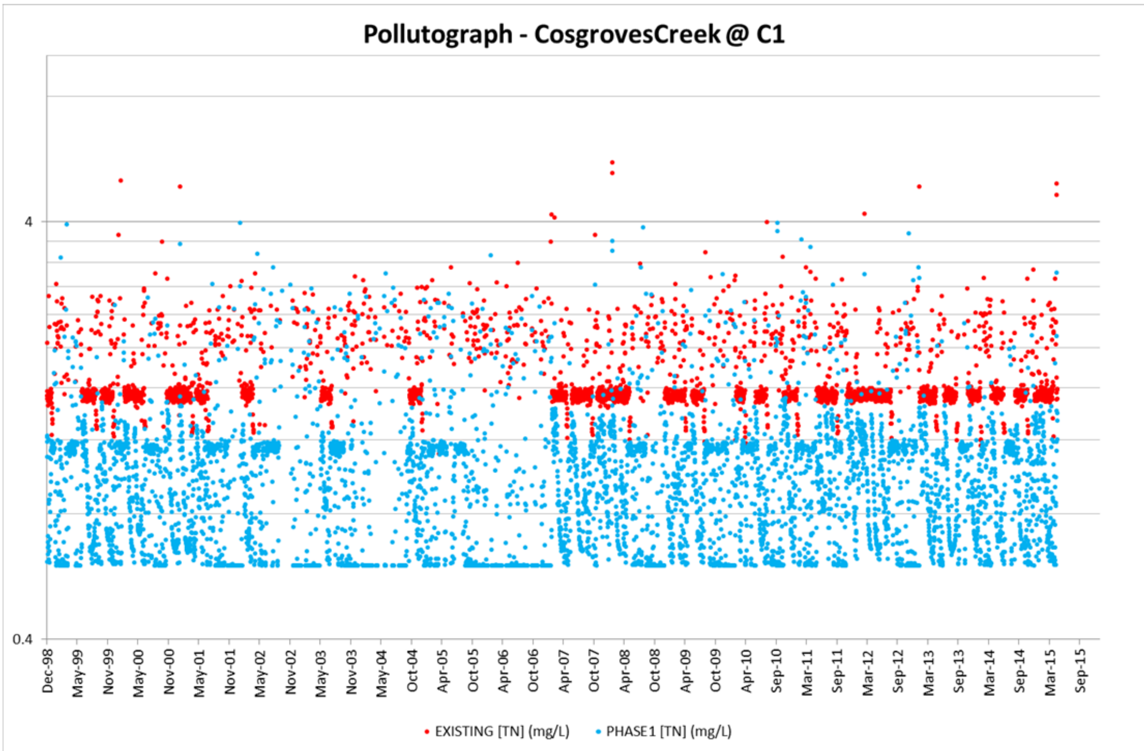

Figure B 12 Stage 1Total Nitrogen at Cosgroves Creek C1

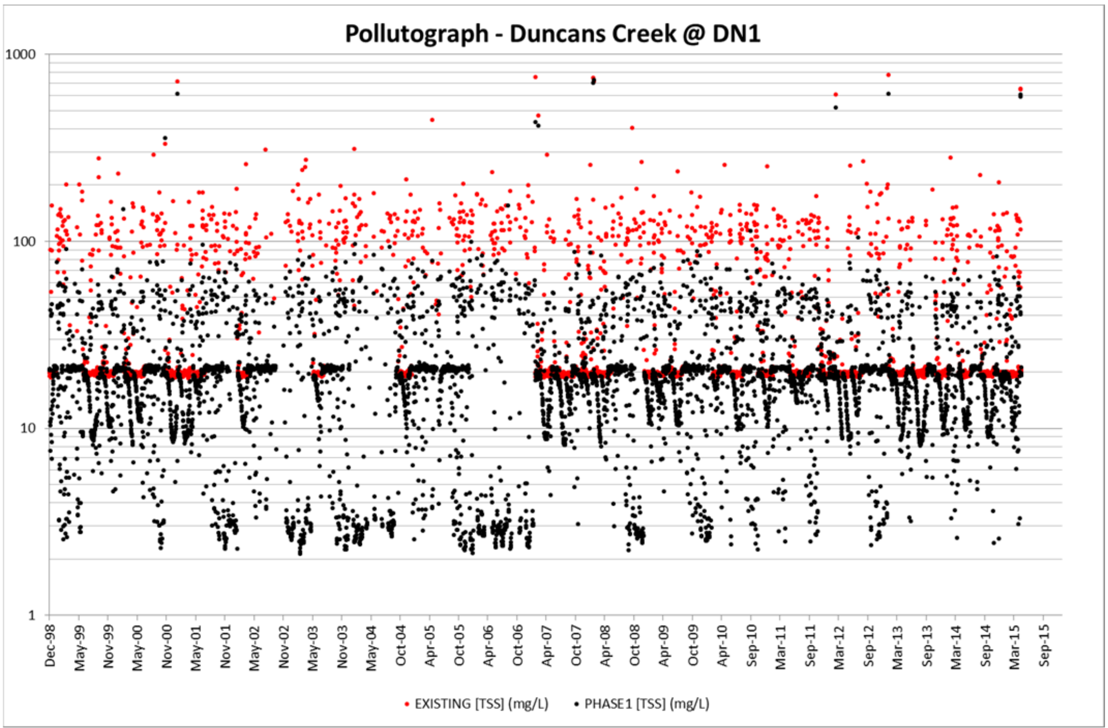

Figure B 13 Stage 1Total Suspended Solids at Duncans Creek DN1

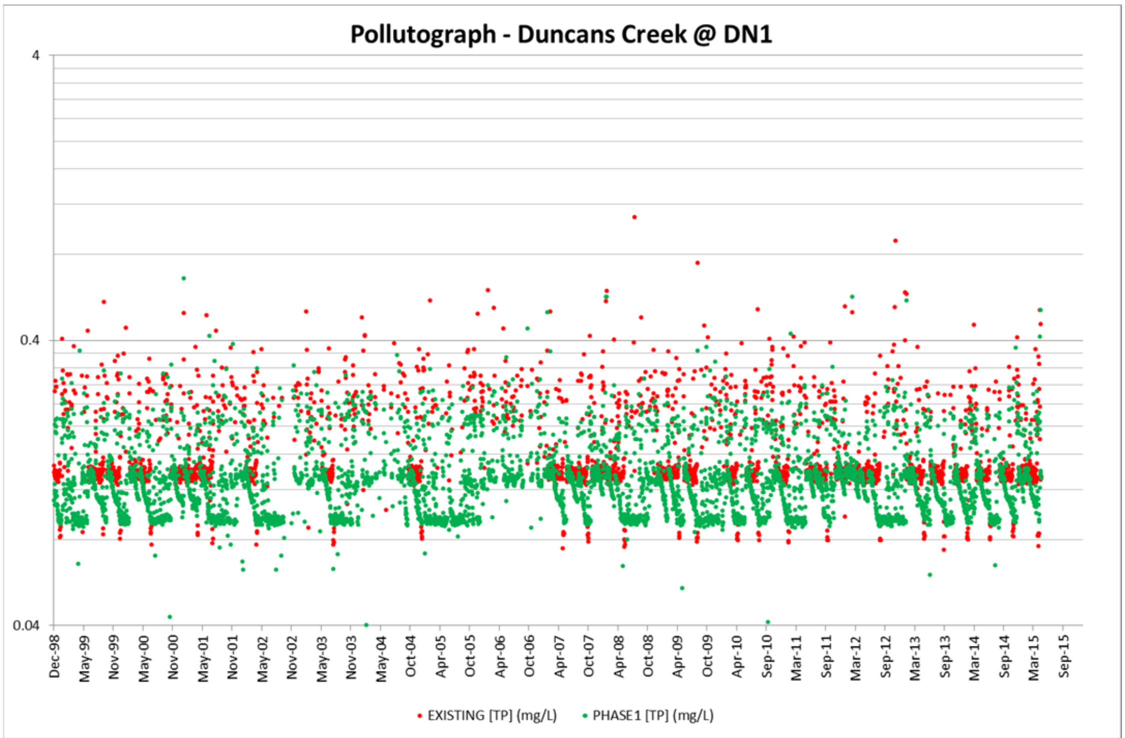

Figure B 14 Stage 1Total Phosphorus at Duncans Creek DN1

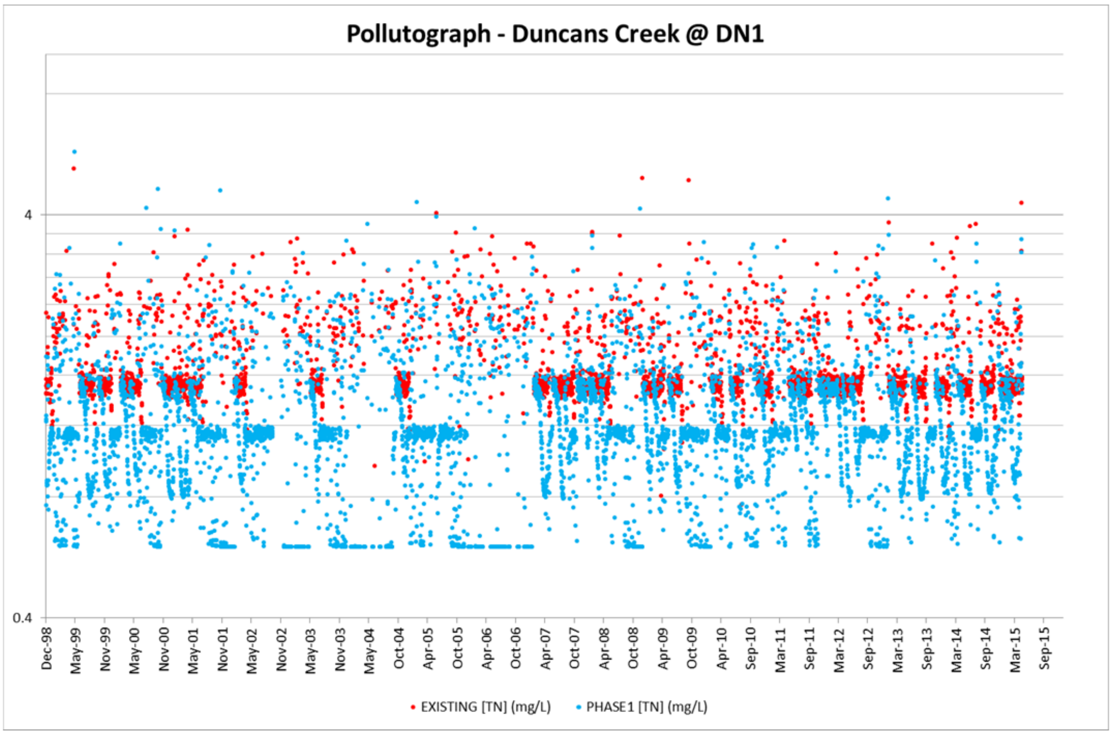

Figure B 15 Stage 1Total Nitrogen at Duncans Creek DN1

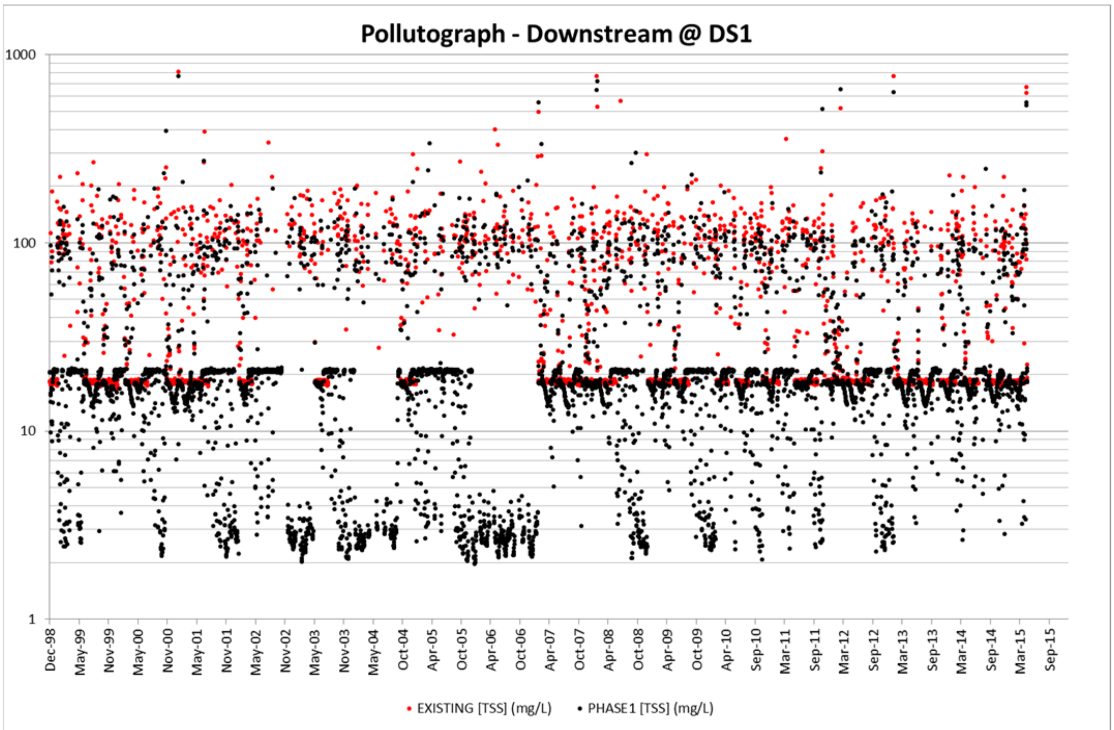

Figure B 16 Stage 1Total Suspended Solids Downstream at DS1

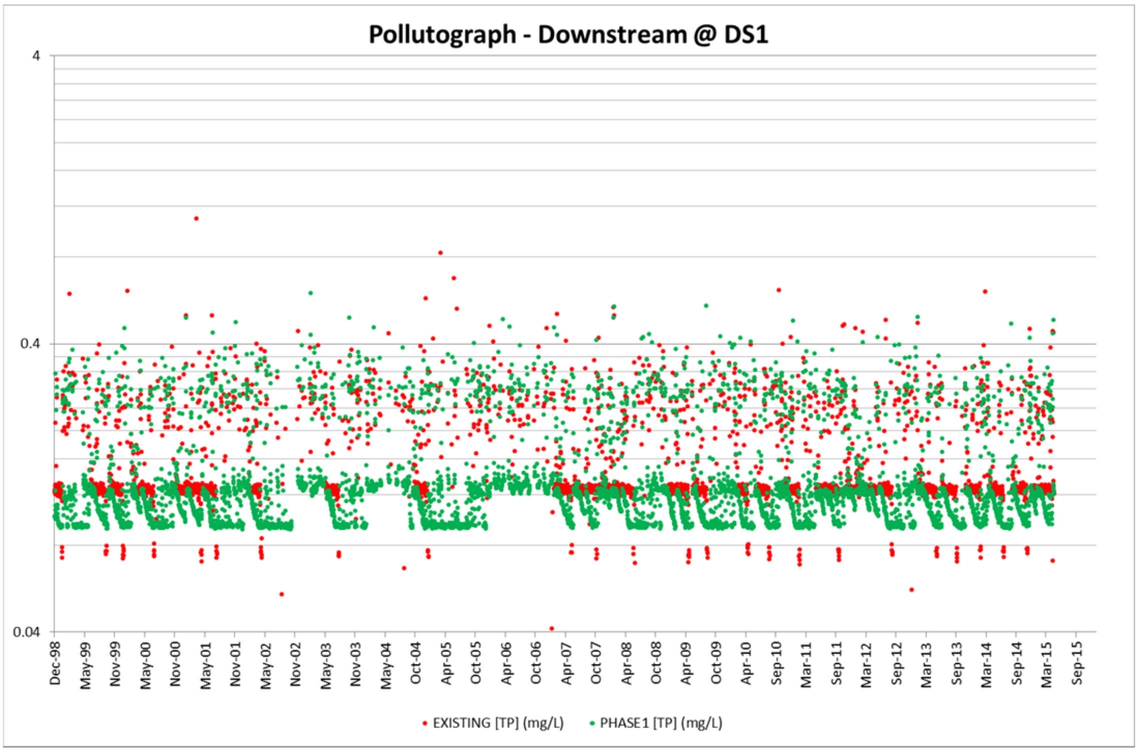

Figure B 17 Stage 1Total Phosphorus Downstream at DS1

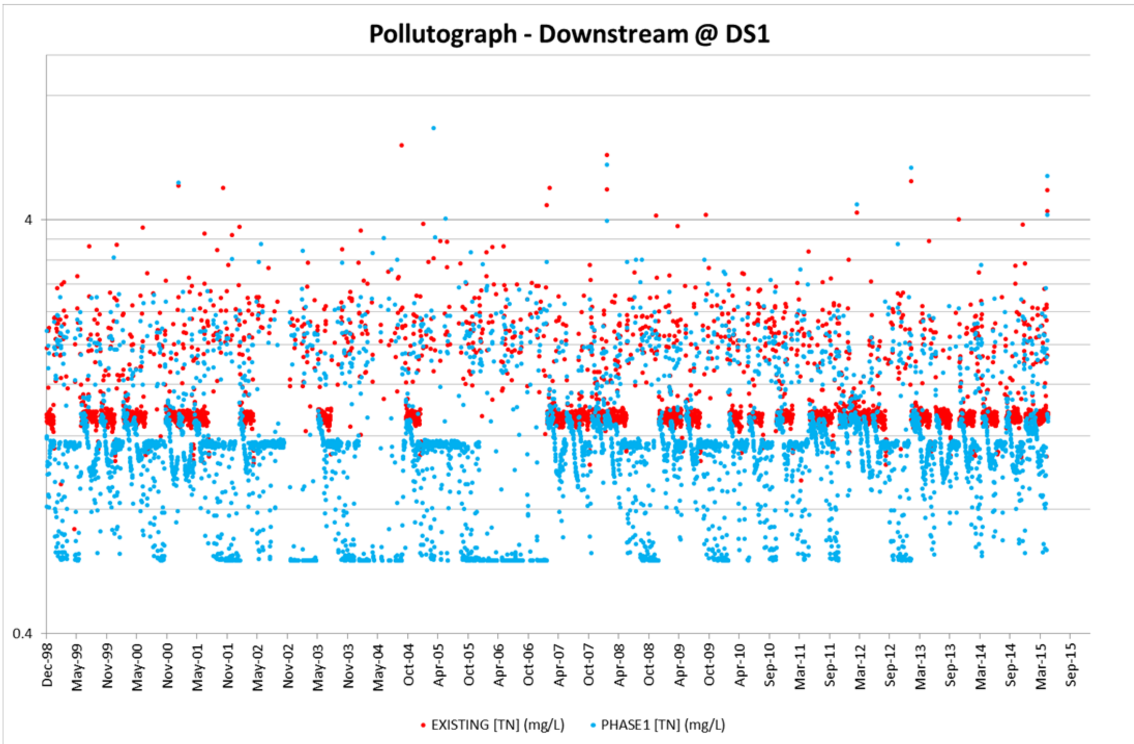

Figure B 18 Stage 1Total Nitrogen Downstream at DS1

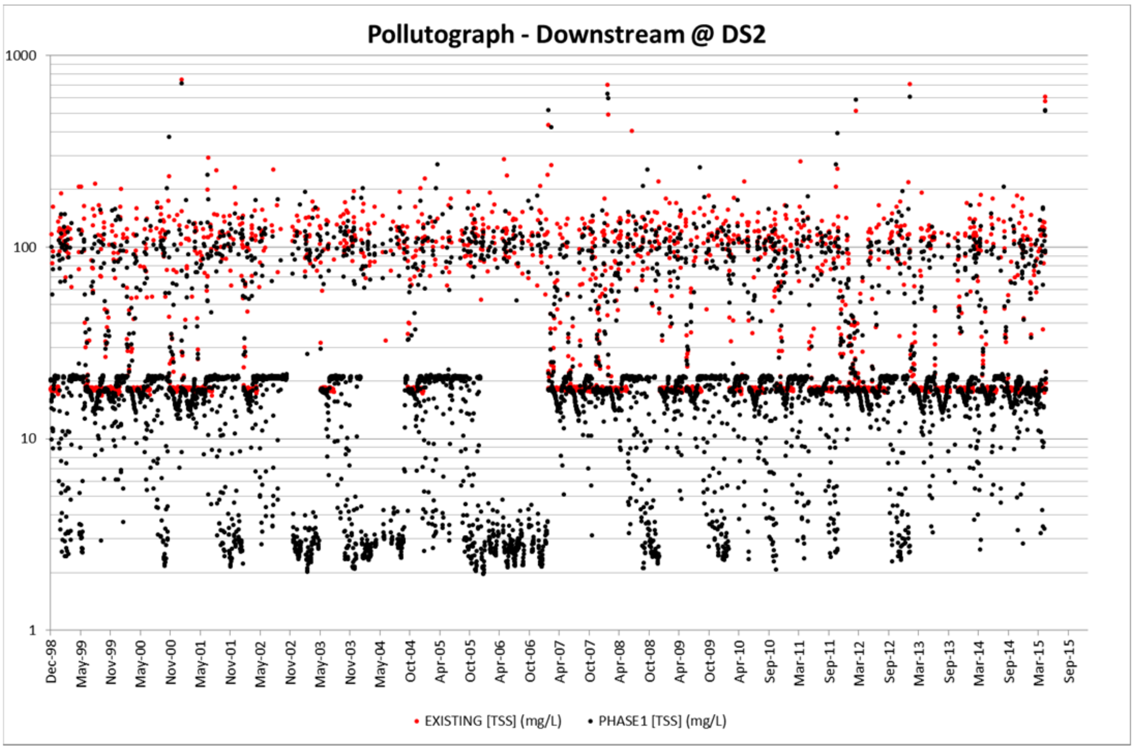

Figure B 19 Stage 1Total Suspended Solids Downstream at DS2

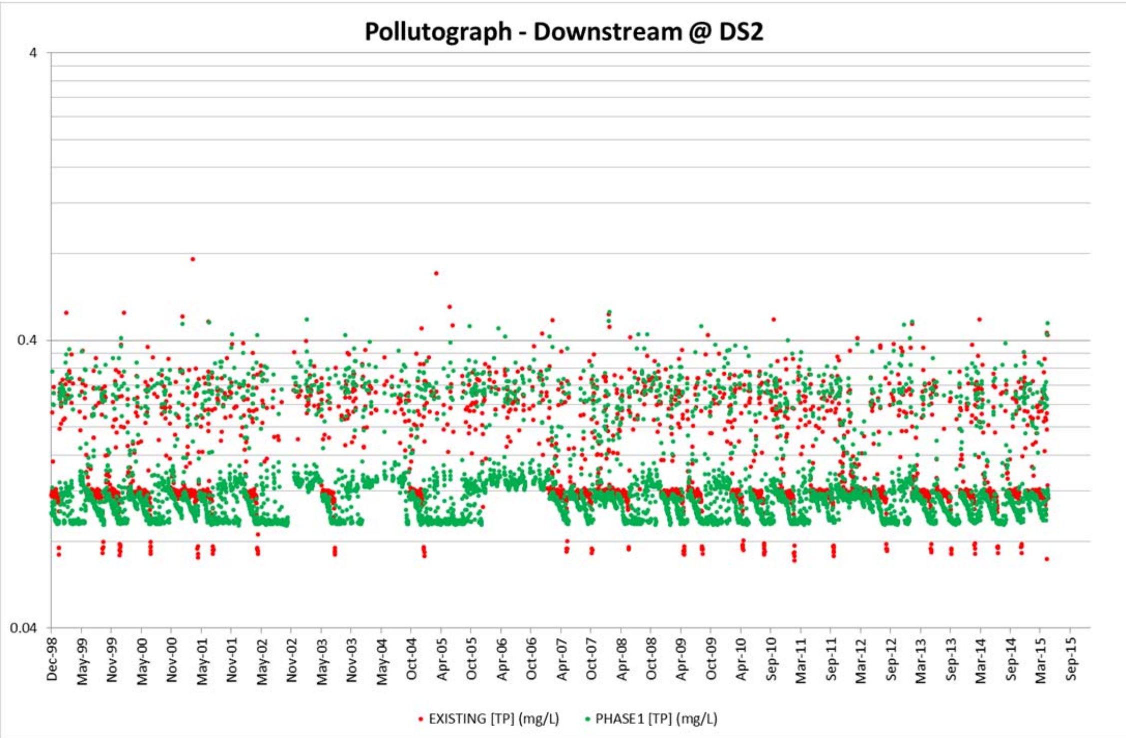

Figure B 20 Stage 1Total Phosphorus Downstream at DS2

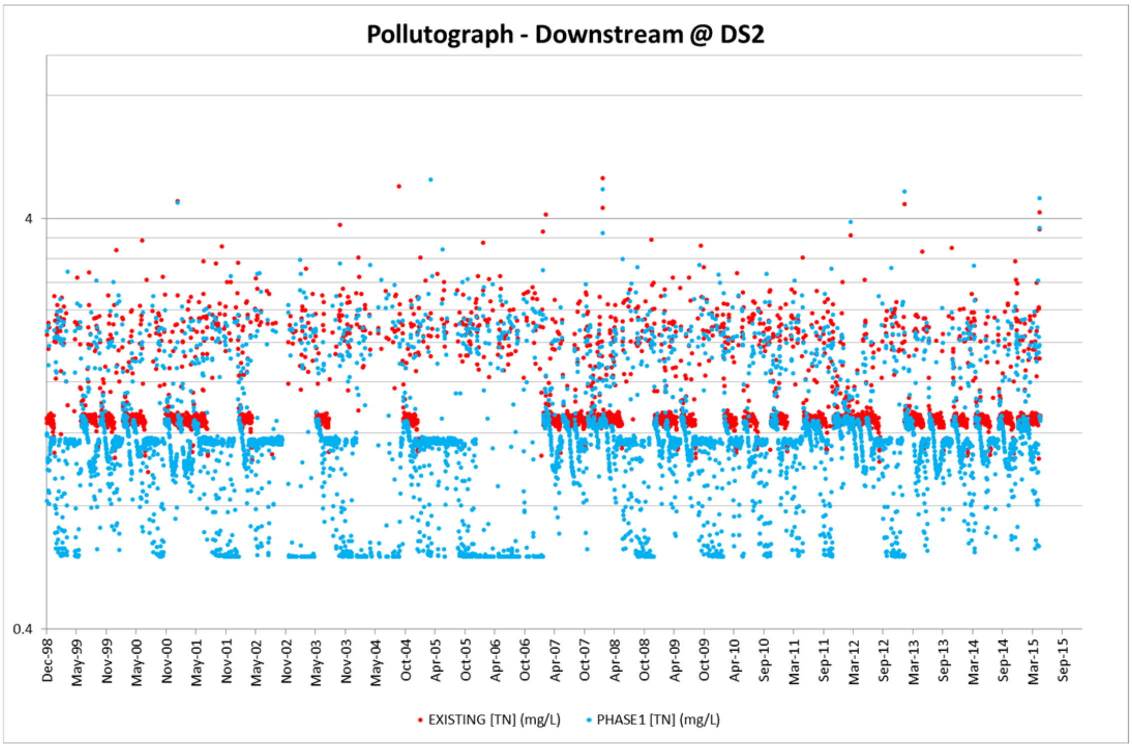

Figure B 21 Stage 1Total Nitrogen Downstream at DS2

Appendix C - MUSIC Water Quality Results for Longer Term Development

Plots of pollutant concentrations at various locations

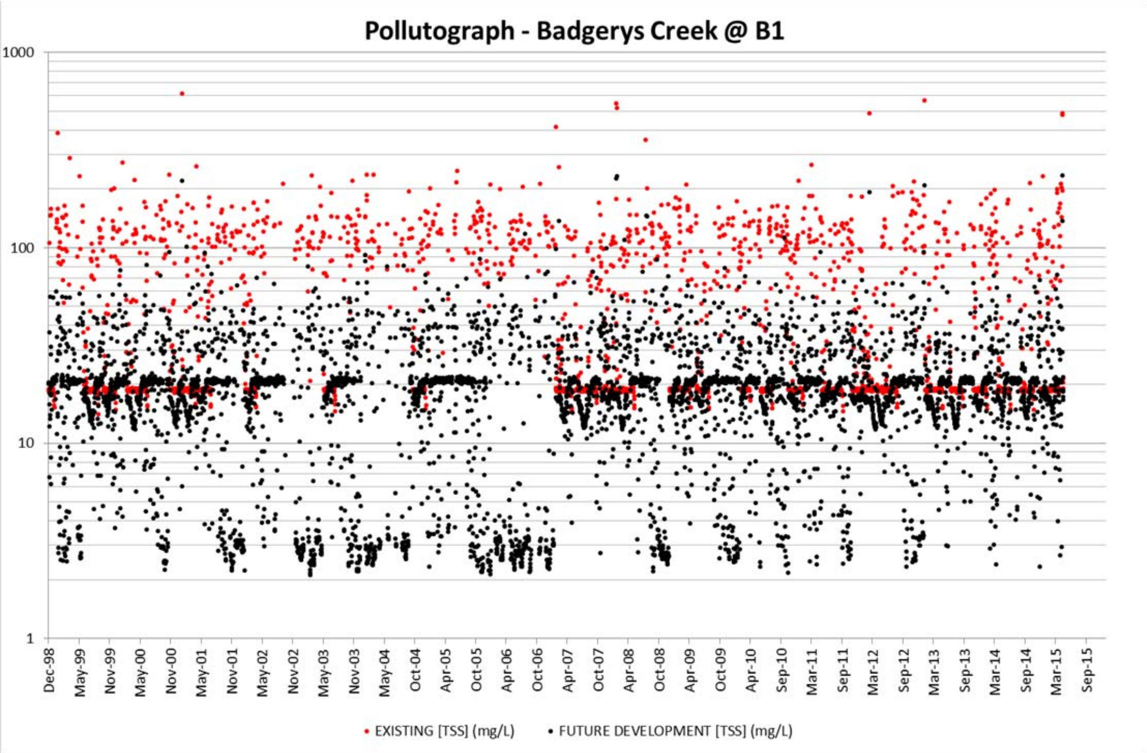

Figure C 1 Longer Term Development Total Suspended Solids at Badgerys Creek B1

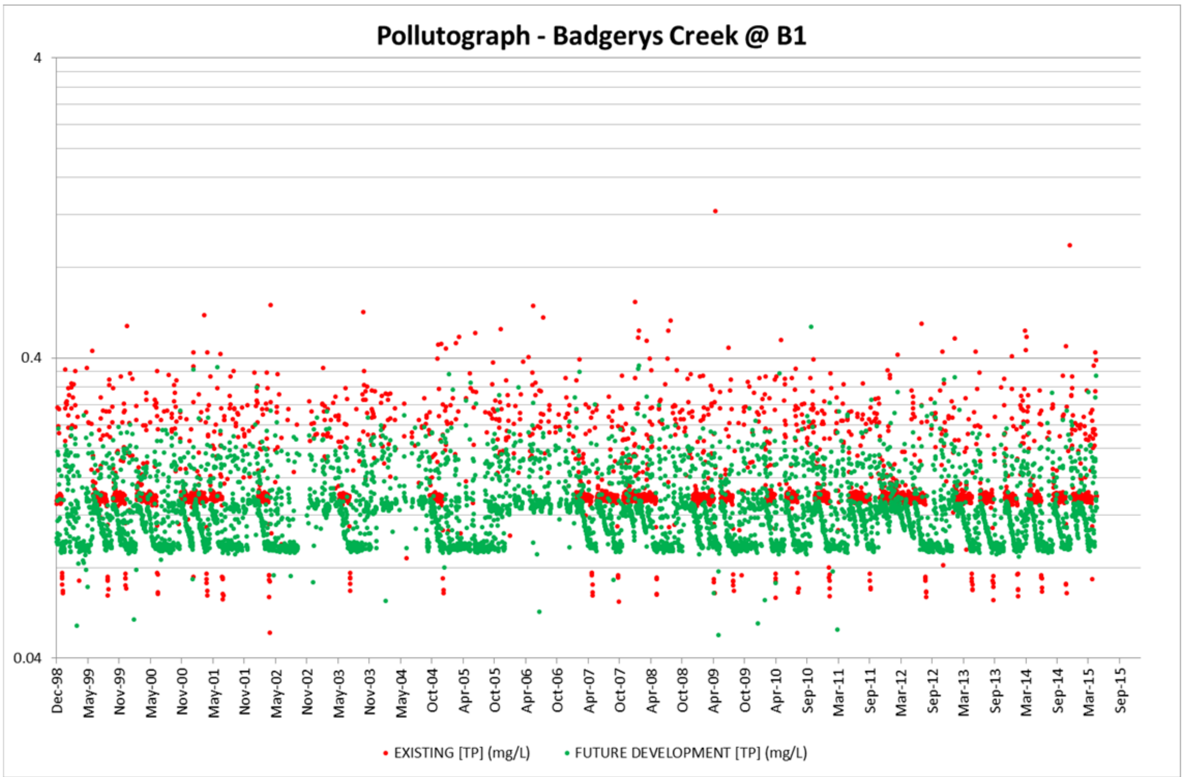

Figure C 2 Longer Term Development Total Phosphorus at Badgerys Creek B1

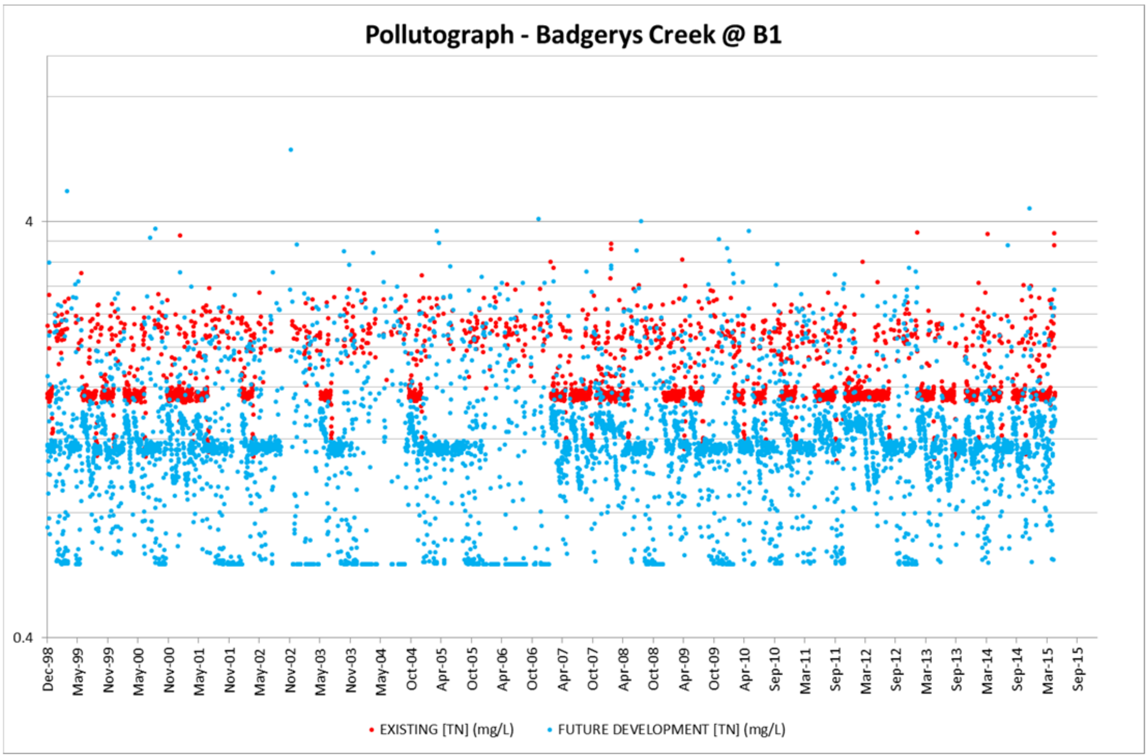

Figure C 3 Longer Term Development Total Nitrogen at Badgerys Creek B1

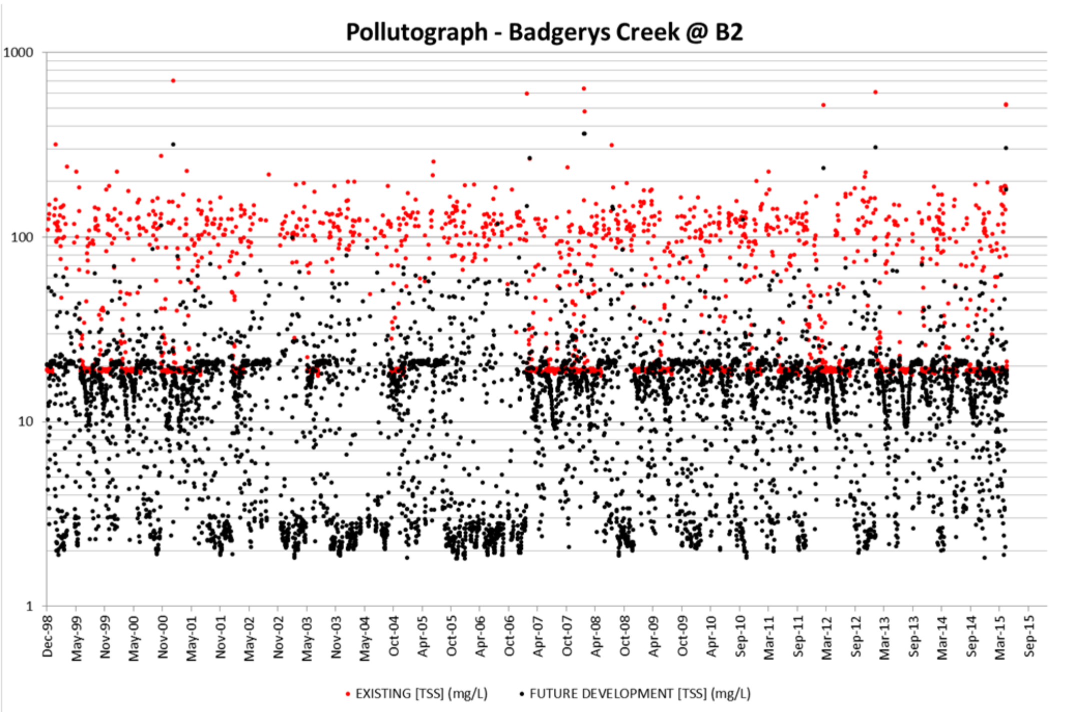

Figure C 4 Longer Term Development Total Suspended Solids at Badgerys Creek B2

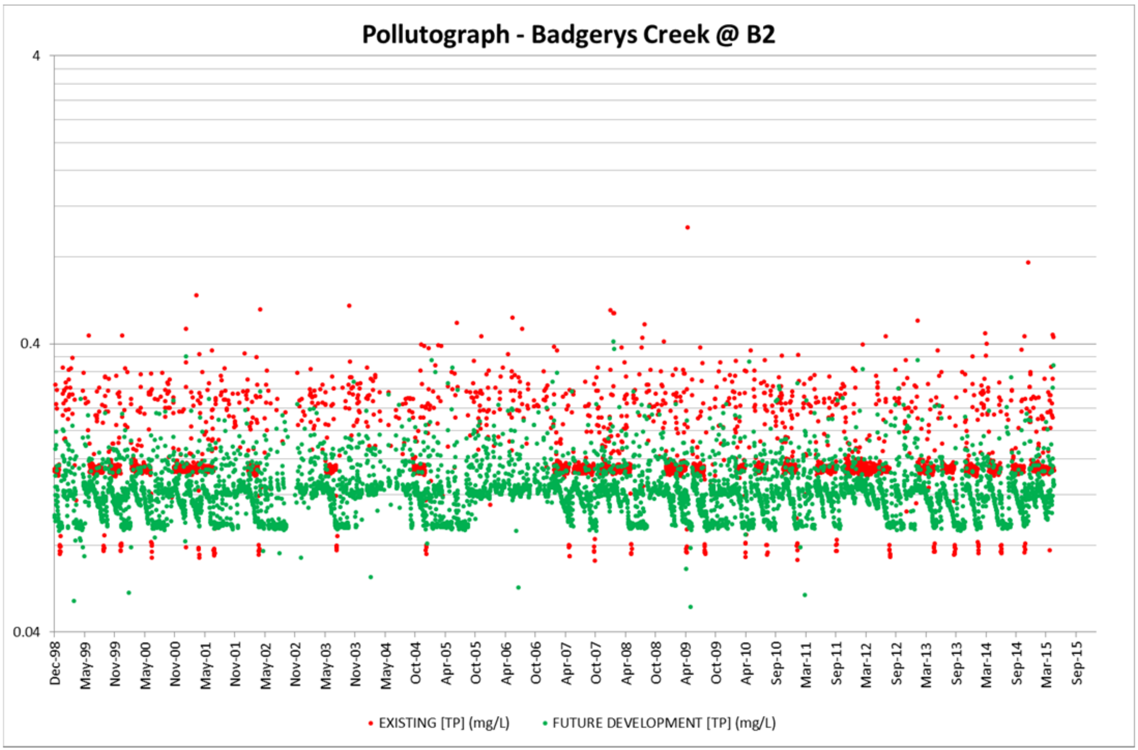

Figure C 5 Longer Term Development Total Phosphorus at Badgerys Creek B2

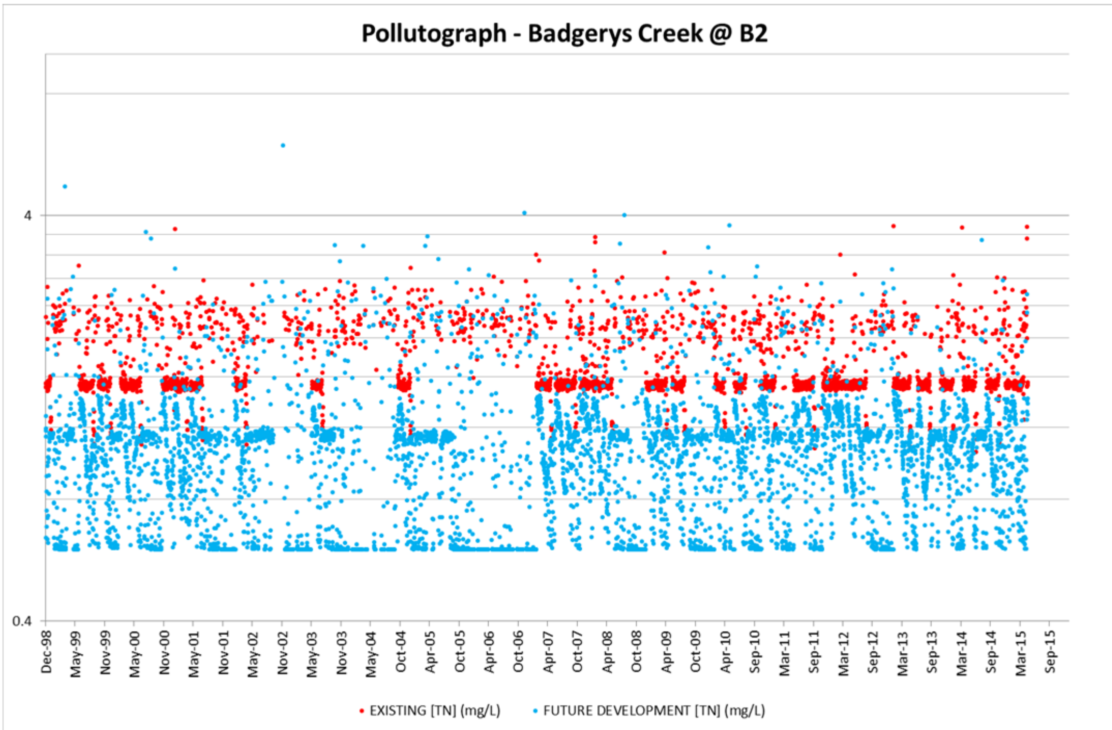

Figure C 6 Longer Term Development Total Nitrogen at Badgerys Creek B2

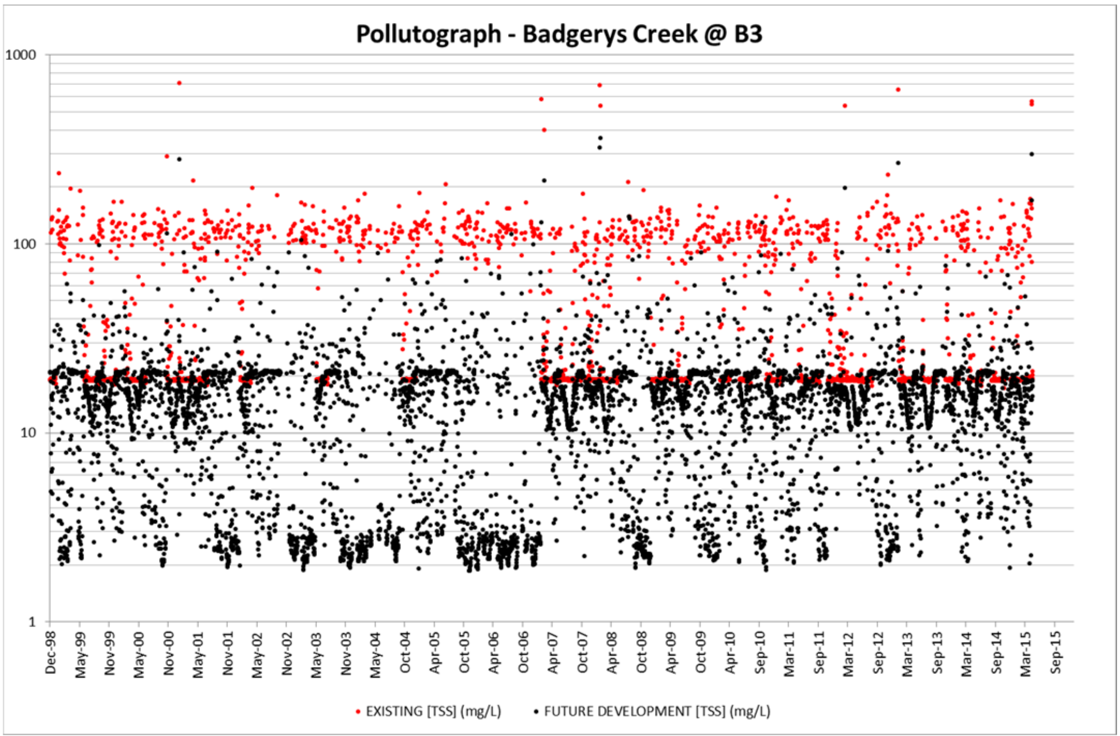

Figure C 7 Longer Term Development Total Suspended Solids at Badgerys Creek B3

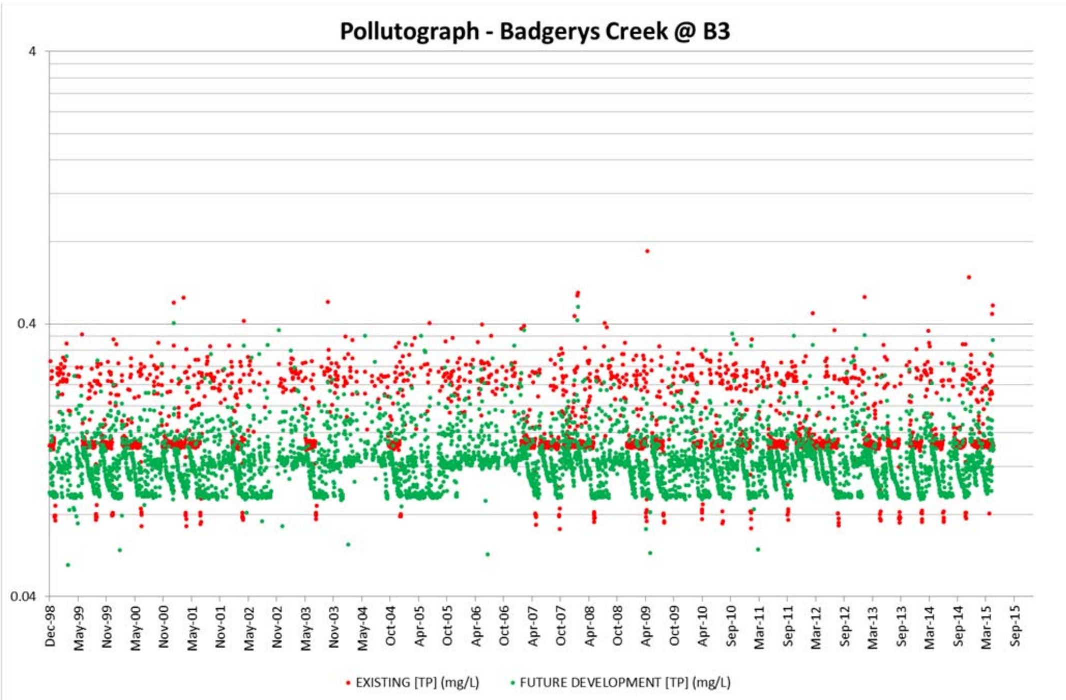

Figure C 8 Longer Term Development Total Phosphorus at Badgerys Creek B3

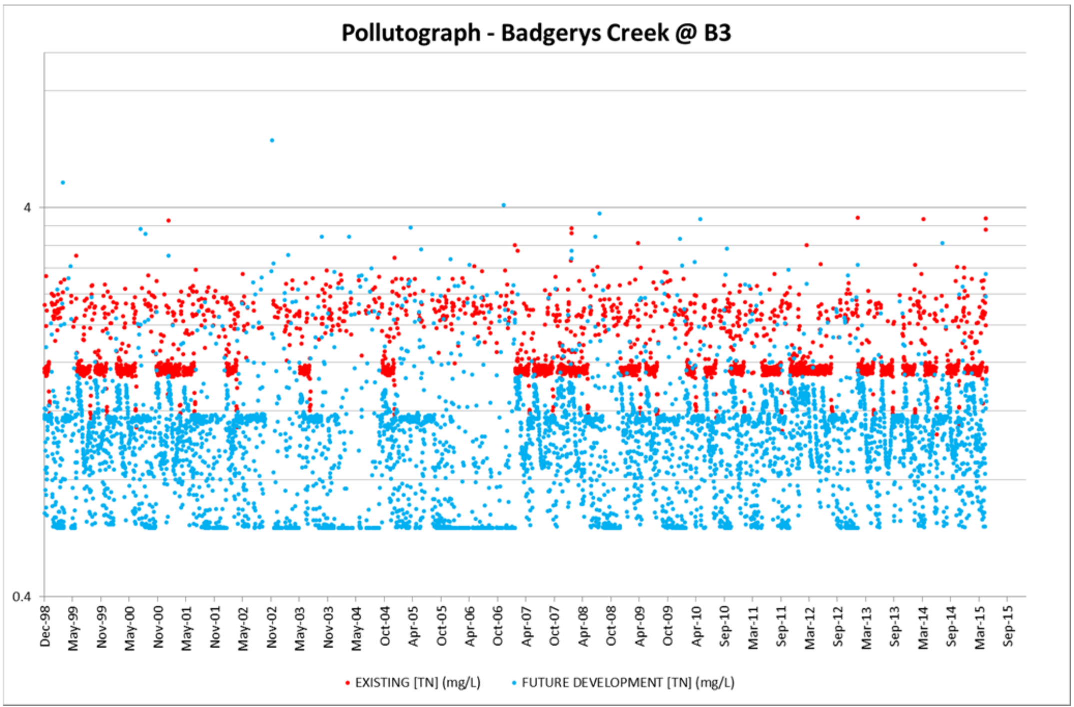

Figure C 9 Longer Term Development Total Nitrogen at Badgerys Creek B3

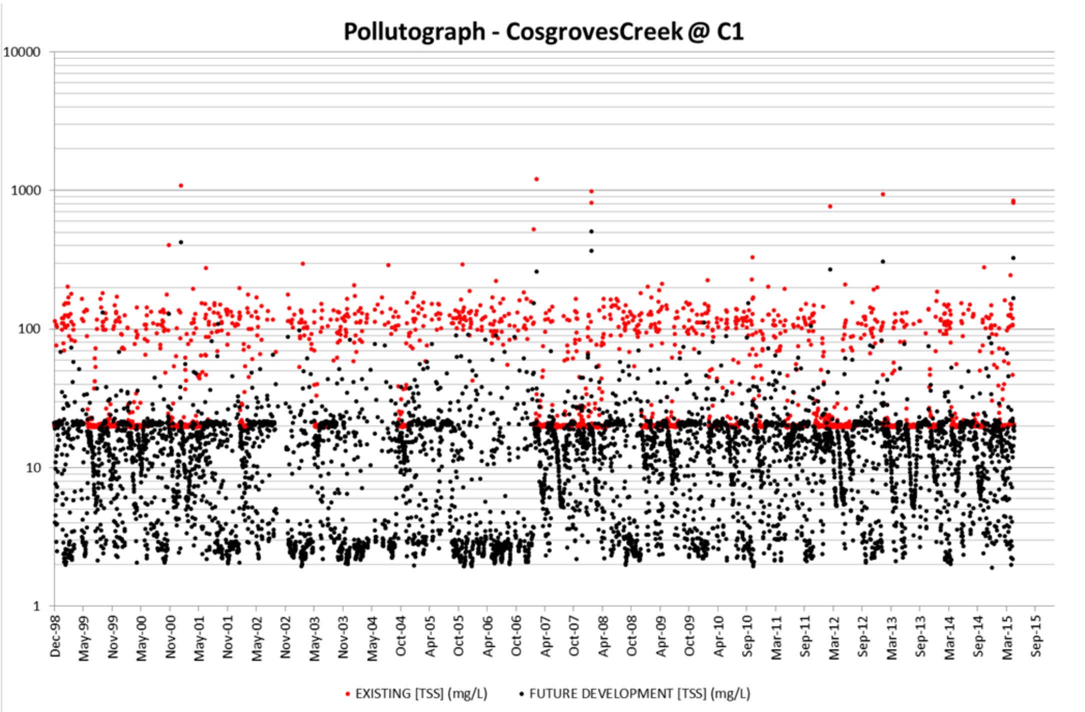

Figure C 10 Longer Term Development Total Suspended Solids at Cosgroves Creek C1

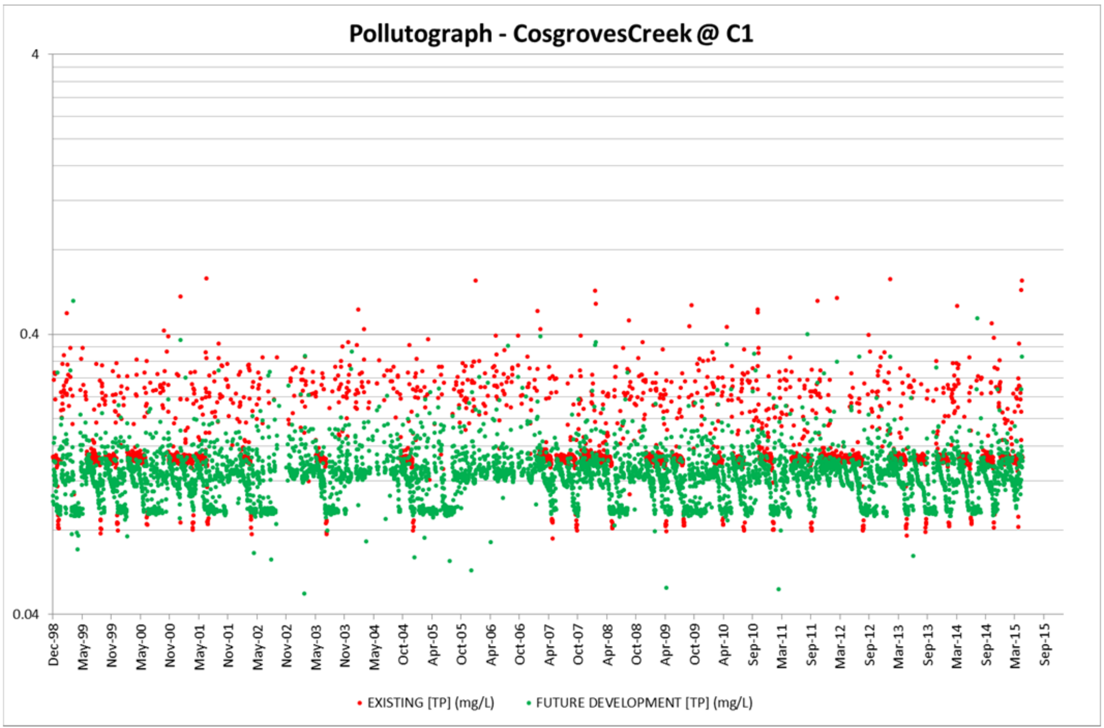

Figure C 11 Longer Term Development - Total Phosphorus at Cosgroves Creek C1

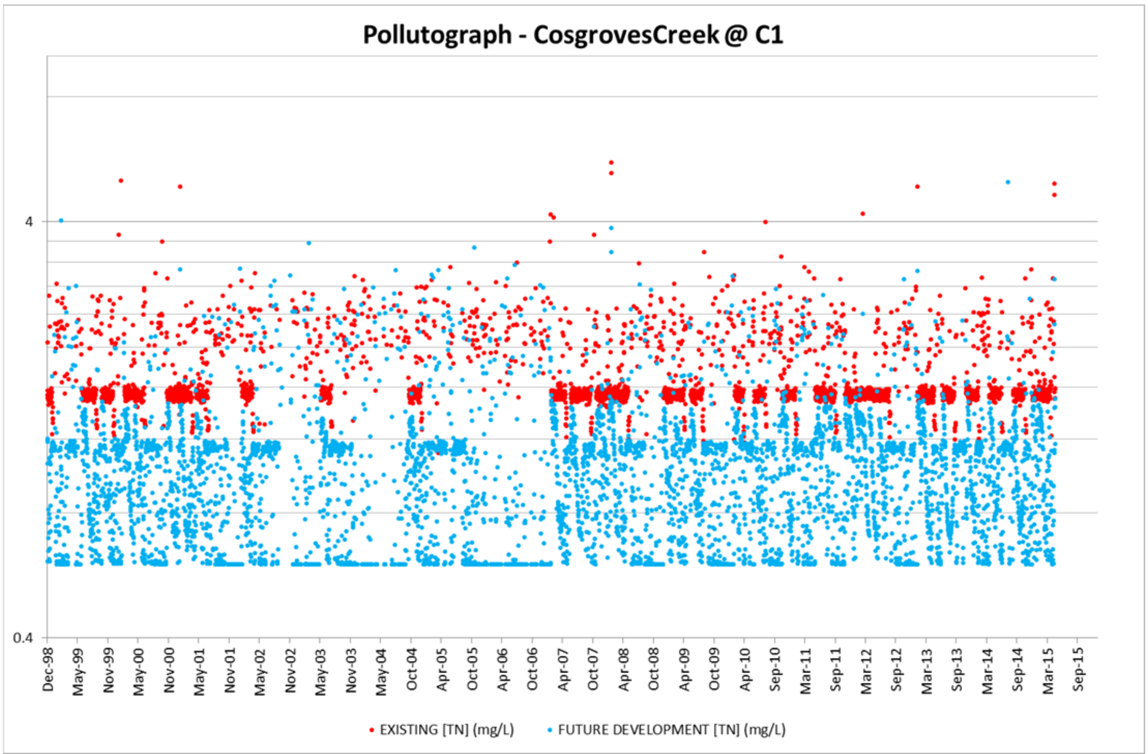

Figure C 12: Longer Term Development Total Nitrogen at Cosgroves Creek C1

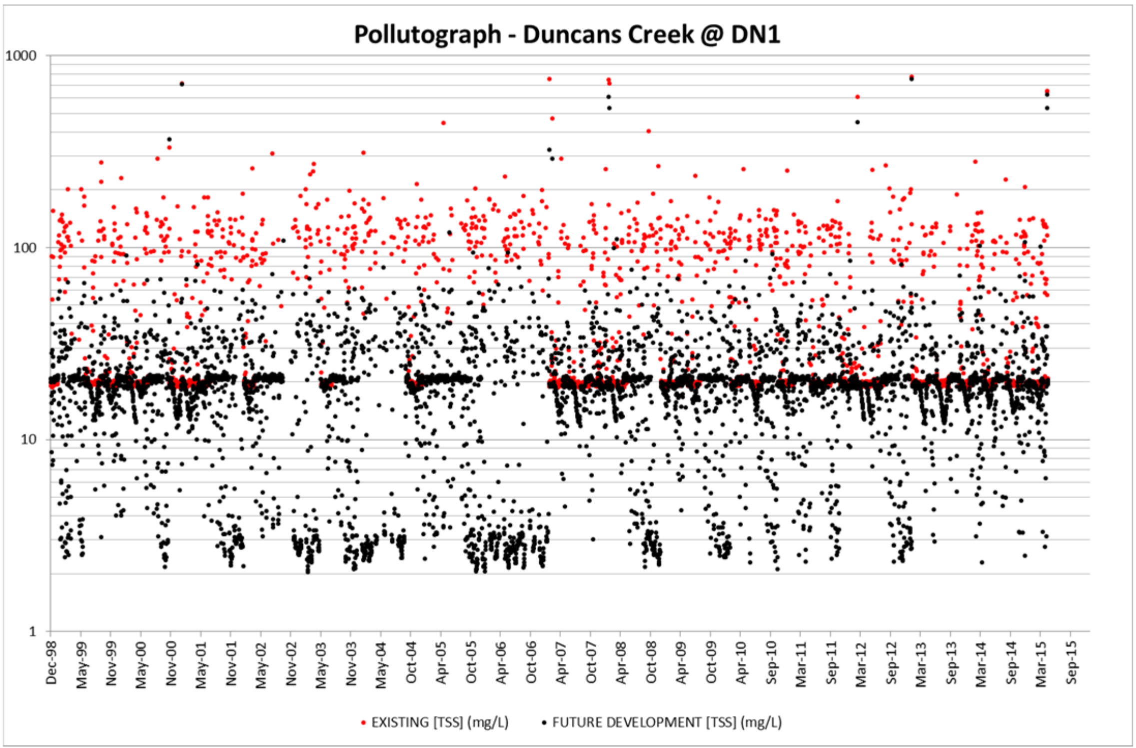

Figure C 13 Longer Term Development Total Suspended Solids at Duncans Creek DN1

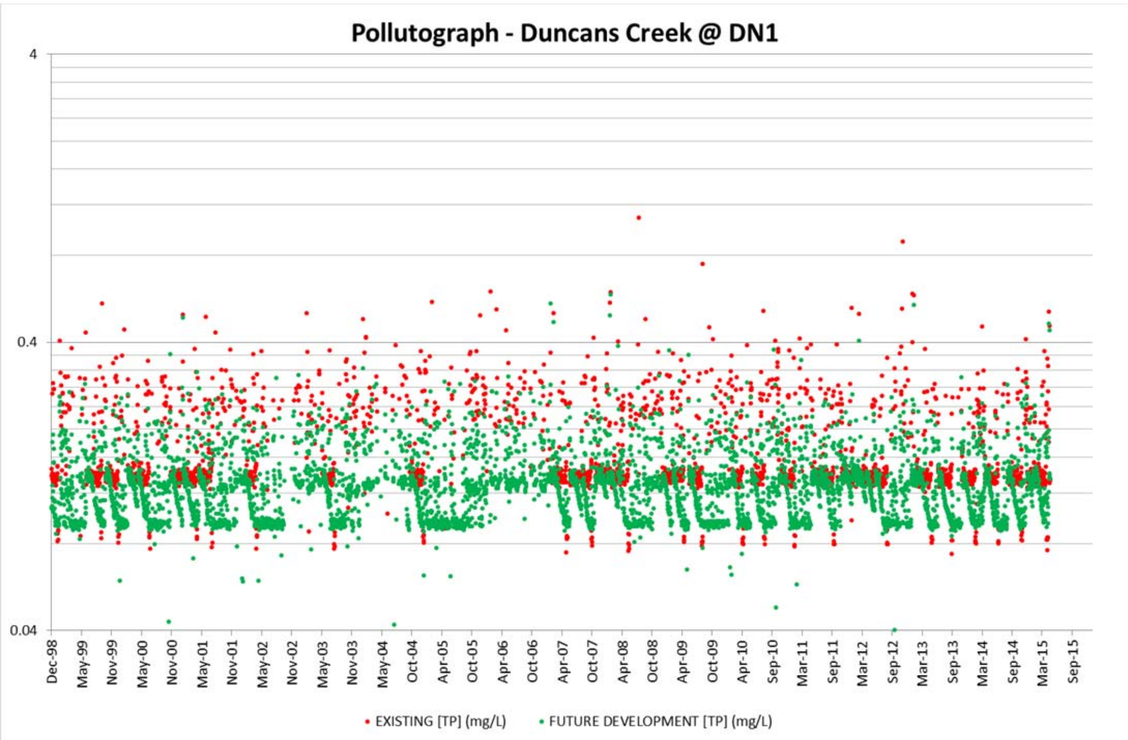

Figure C 14 Longer Term Development Total Phosphorus at Duncans Creek DN1

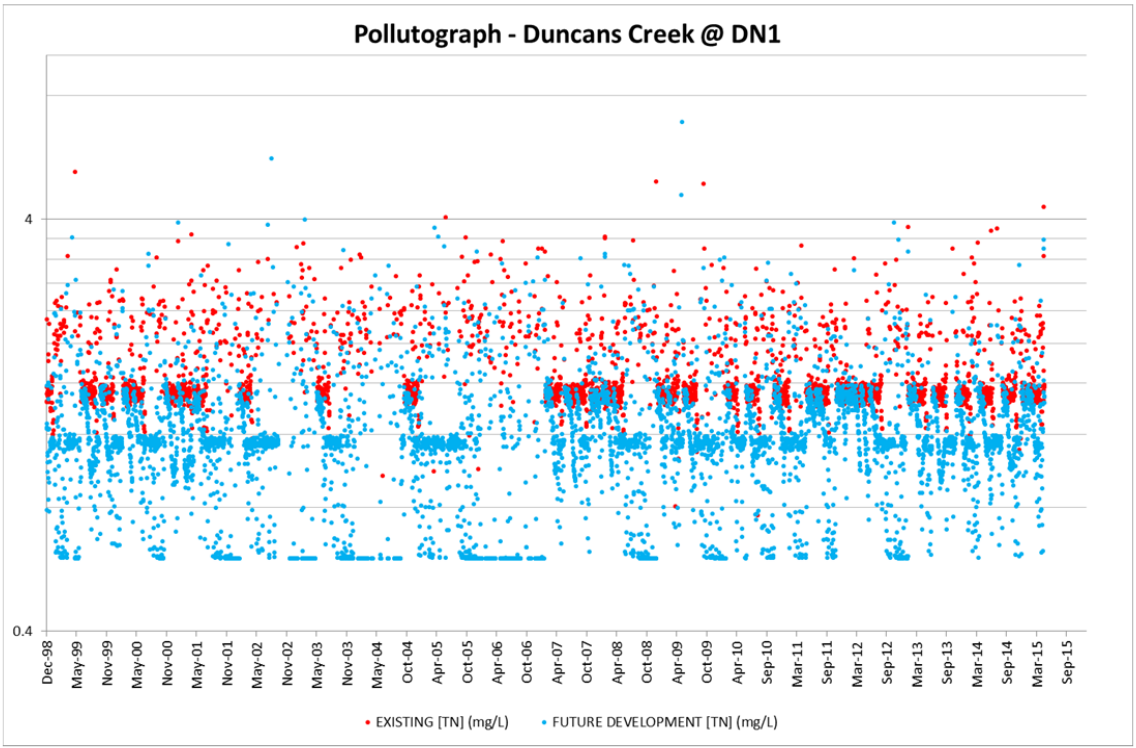

Figure C 15 Longer Term Development Total Nitrogen at Duncans Creek DN1

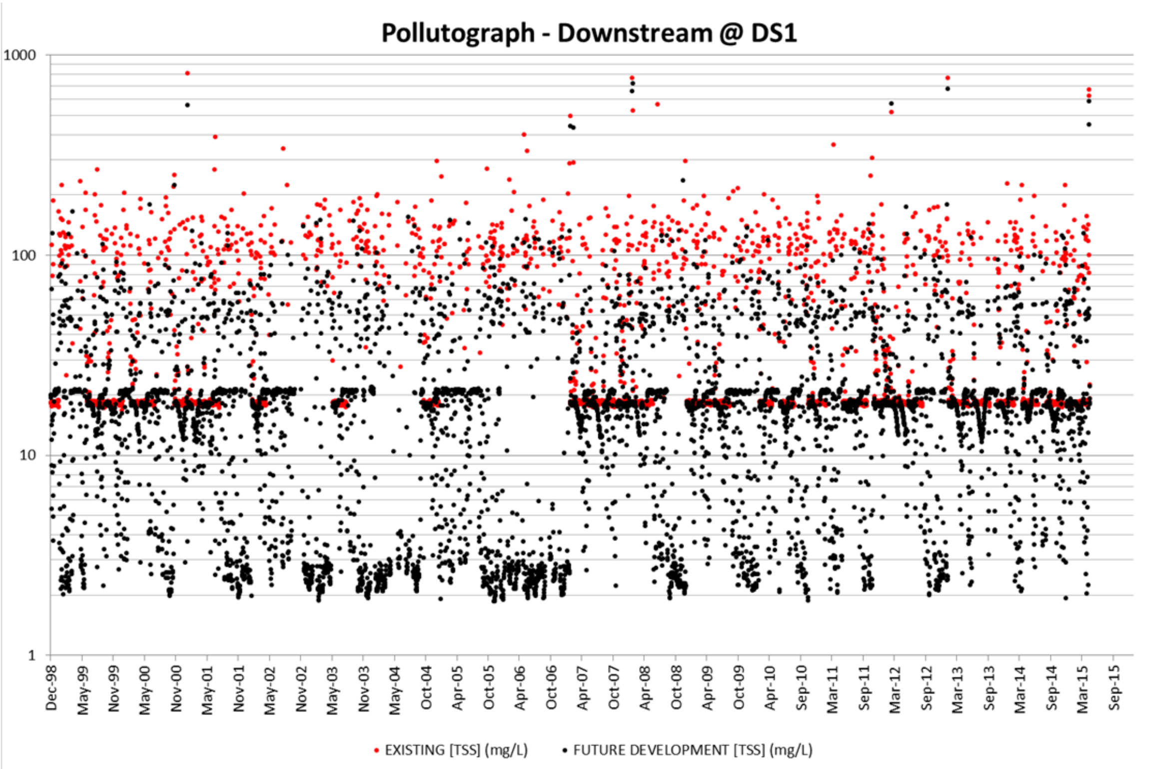

Figure C 16 Longer Term Development Total Suspended Solids Downstream at DS1

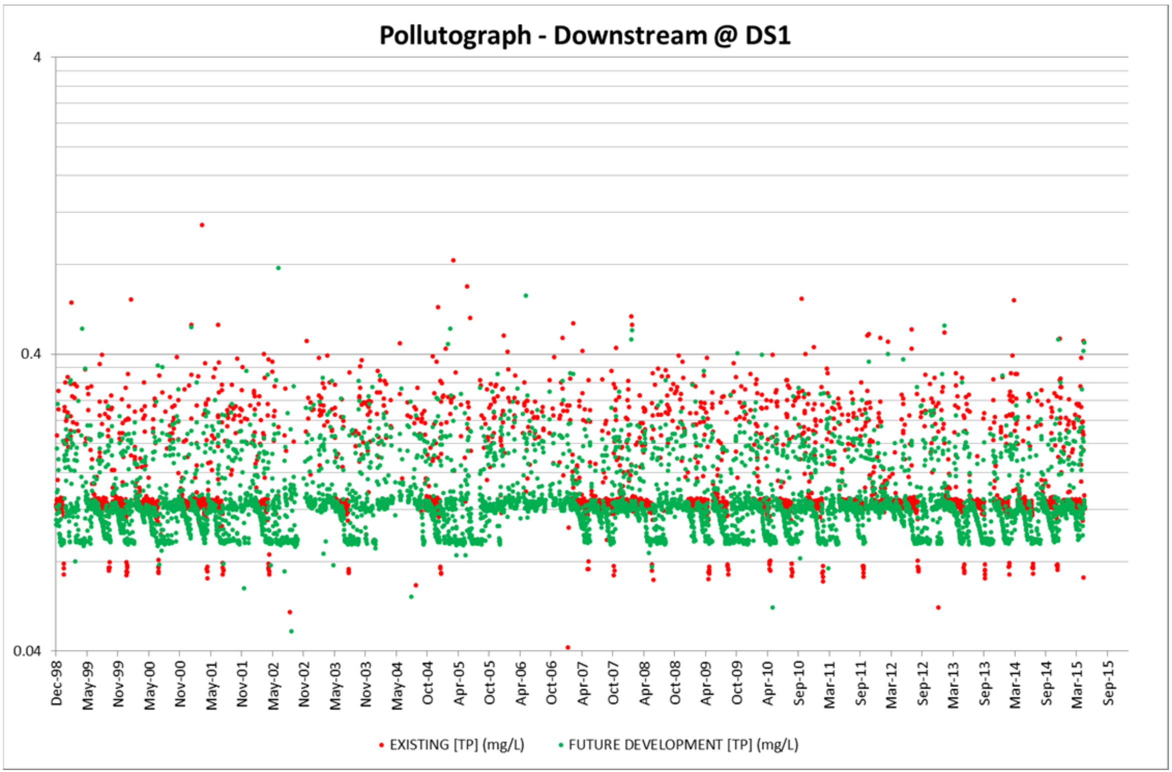

Figure C 17 Longer Term Development Total Phosphorus Downstream at DS1

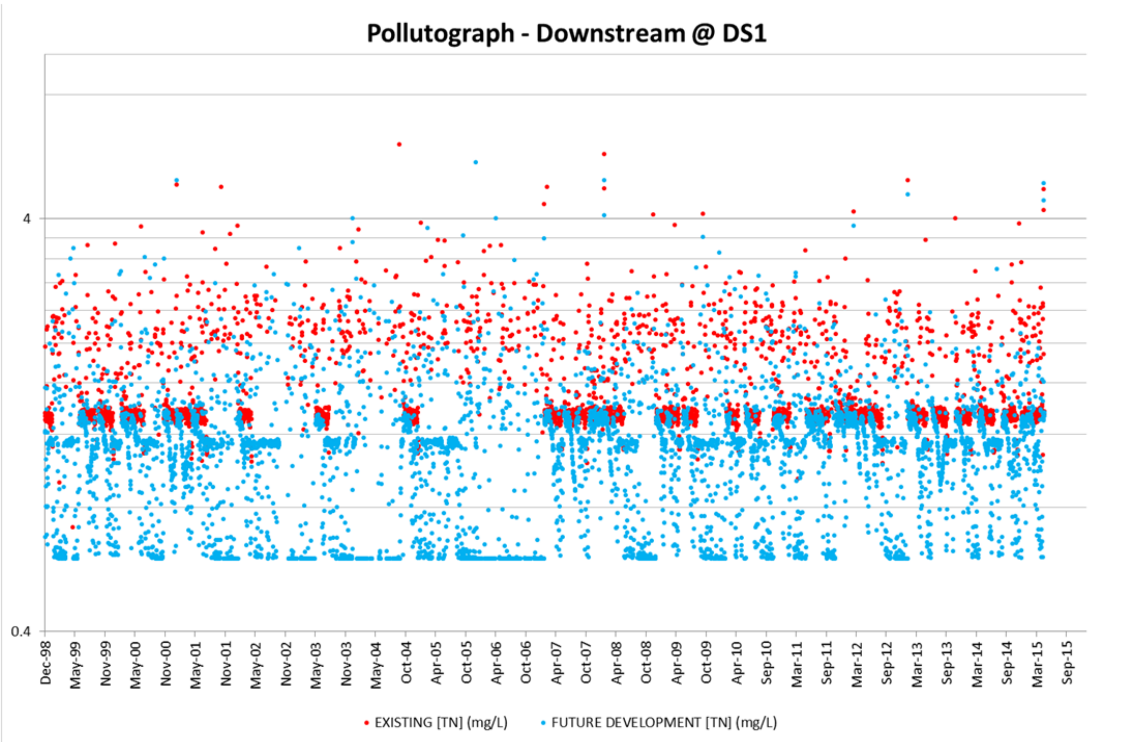

Figure C 18 Longer Term Development Total Nitrogen Downstream at DS1

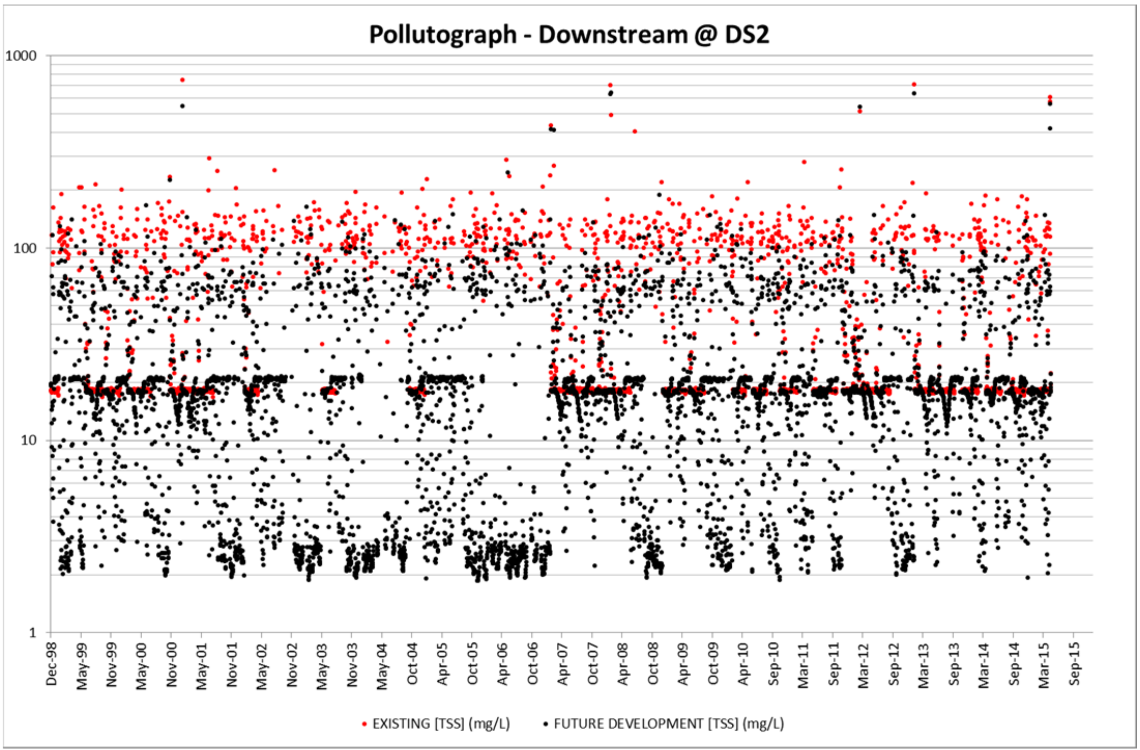

Figure C 19 Longer Term Development Total Suspended Solids Downstream at DS2

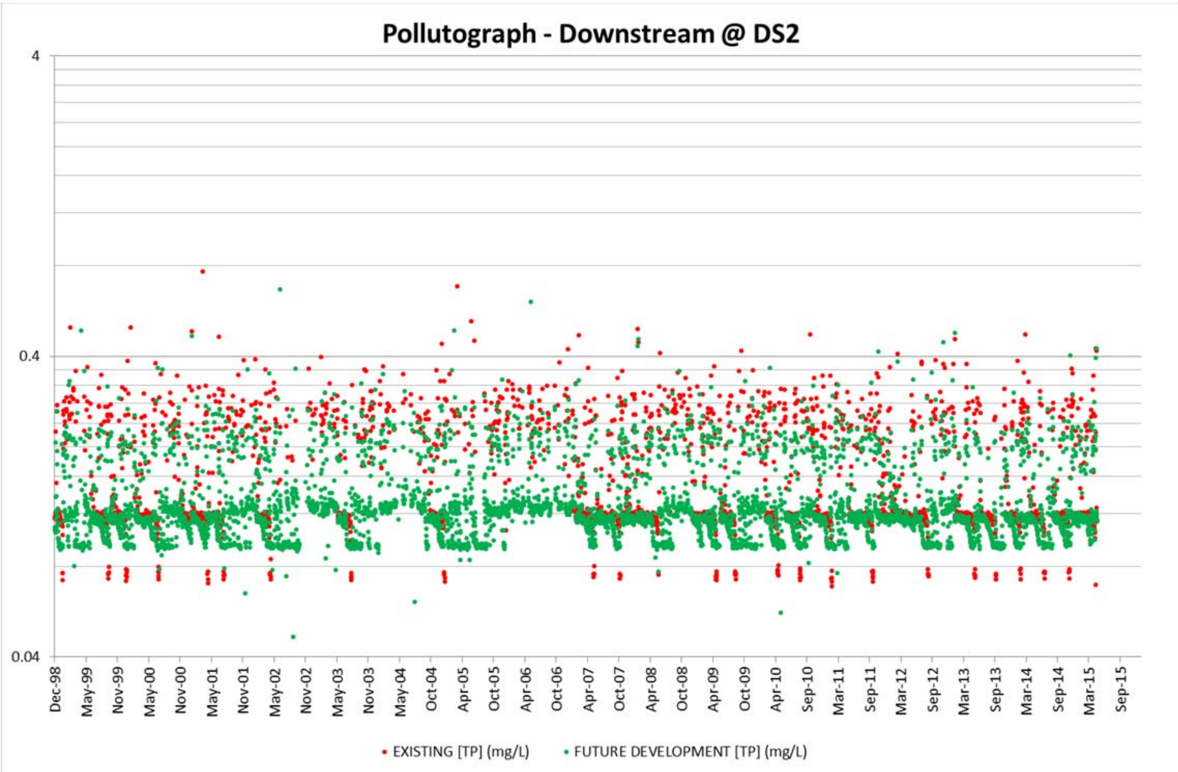

Figure C 20 Longer Term Development Total Phosphorus Downstream at DS2

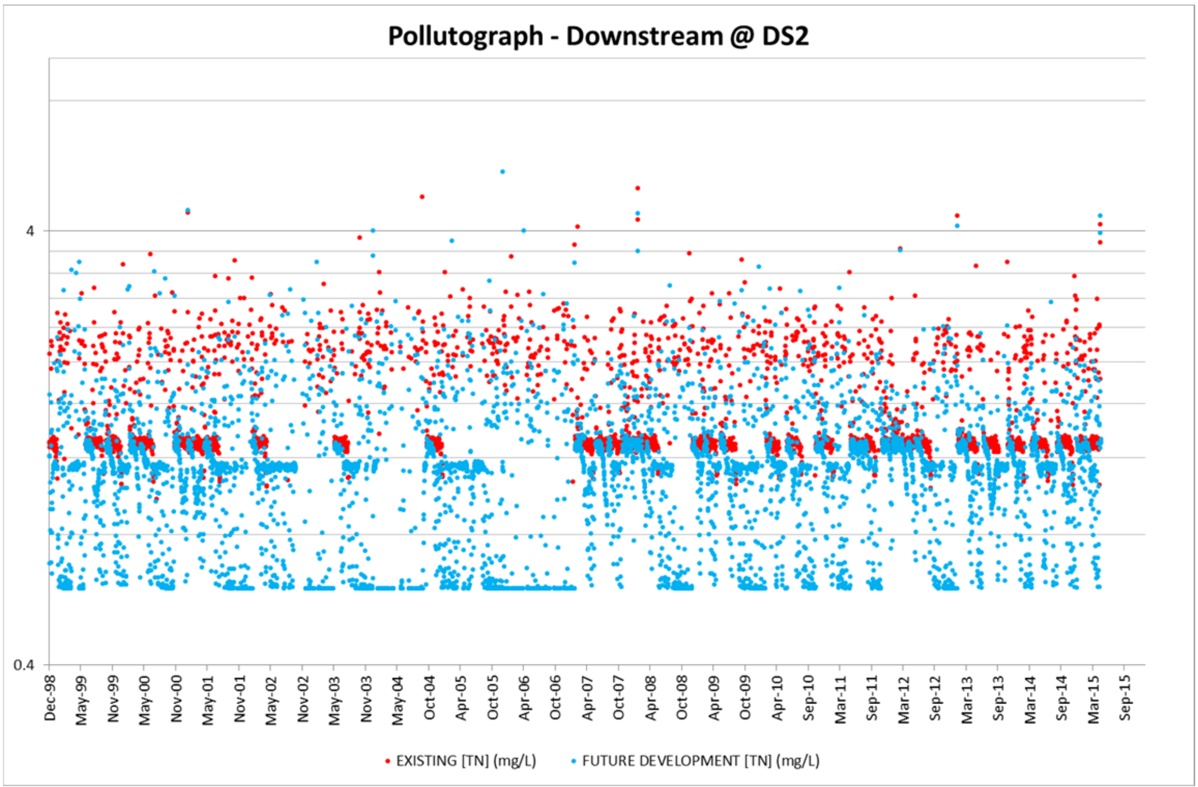

Figure C 21 Longer Term Development Total Nitrogen Downstream at DS2

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