VOLUME 4

Appendix L2
Surface water quality

Department of Infrastructure and Regional Development

Western Sydney Airport EIS
Surface Water Quality Assessment

August 2016

Limitations

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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 long term development. The assessment was undertaken on the basis of the revised draft Airport Plan and concept design available for the study.

Surface runoff water quality at the proposed airport was assessed with reference to the criteria specified in the Airports Act and Airports (Environment Protection) Regulations 1997 (AEPR) and the guidance provided in the Australian and New Zealand Environment and Conservation Council Guidelines (ANZECC 2000). In addition, the post-development pollutant loads were estimated and compared to those under existing conditions, and in terms of the proportion of pollutants retained on site, in line with current industry practice. The former is similar to the Neutral or Beneficial Effect Concept (NORBE) while the latter corresponds to Water Sensitive Urban Design Guidelines (WSUD).

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 either AEPR limits or ANZECC Guidelines default water quality trigger levels for total phosphorus and total nitrogen. However, total suspended solids loads are generally low and achieve ANZECC Guidelines default water quality objectives. These results can be attributed to the existing degradation of catchments on and around the airport site due to land clearing and other land uses.

To take into account existing water quality for receiving waters at the airport site, local standards for water quality will be developed under Part 5, Clause 5.02 (1) of the AEPR. However, as AEPR does not provide any specific guidance for the development of local standards, the site specific trigger level process under the ANZECC Guidelines will be used to guide the development of local standards. ANZECC Guidelines states that site specific trigger levels should be based on contiguous monthly data derived from a minimum of 2 years of monitoring. Accordingly, water quality monitoring for the airport site has commenced and will continue for at least 2 years. To date, 9 months of data have been collected and analysed, comprising of more than 80 samples for each water quality parameter collected at various locations around the airport site.

In this EIS, existing AEPR water limits and ANZECC Guidelines default water quality trigger levels have been included for the purposes of comparison and discussions. Interim site specific trigger levels have also been derived and presented to provide an early indication of the likely range of results expected when the full 24 months of water quality monitoring data becomes available. The water quality criteria used in this assessment and the interim trigger levels established for the airport site, for suspended solids, total phosphorus and total nitrogen, are presented in Table 1.

Table 1: Water Quality Criteria and Interim Trigger Levels

Criteria	Total Suspended Solids (TSS)	Total Phosphorus (TP)	Total Nitrogen (TN)
AEPR 1997 Limits (mg/L)	< 10% change from seasonal mean	0.01	0.1
ANZECC (2000) Guidelines Default Trigger Levels (mg/L)	40[2]	0.05	0.5
Interim Site Specific Trigger Levels[1] (mg/L)	23.2	0.92	6.2
Pollutant Load Retention Targets (WSUD)	80%	45%	45%
Pollutant Loads (NORBE) (kg/yr)	Post-development < Existing	Post-development < Existing	Post-development < Existing

1: Based on 9 months of water quality monitoring data and more than 80 samples for each parameter.
2: ANZECC Guidelines professional judgement (aquaculture); 50 mg/L for NSW Blue Book for Soils and Construction.

It is noted that the concept design has continued to be developed following display of the Draft EIS. This has included the addition of bio-retention Basin 9 in the Stage 1 design, and the deferment of bio-retention Basins 4 and 5 from Stage 1 to the long term development.

Available baseline water quality data for the airport site and surrounding areas have been reviewed. The results indicate that the nutrient loads in the existing waterways are generally high and exceed acceptable limits for water contamination in the AEPR and water quality default trigger levels for the protection of aquatic ecosystems in ANZECC Guidelines. However, total suspended solids loads are generally low and below ANZECC Guideline levels.

The monitoring results also indicate that the existing water quality does not satisfy the relevant criteria in the ANZECC guidelines for recreational use for both primary and secondary contact, and irrigation water use for food and non-food crops, most of the time. The existing water quality is, therefore, yet to satisfy the objectives of the Hawkesbury Nepean Catchment Action Plan and the National Water Quality Management Strategy (NWQMS).

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 the Stage 1 and the long term development phases of the project and used 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 nine 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 Basins 8 and 9 were positioned to manage flows discharging into Duncans Creek. All the basins are proposed for construction during Stage 1 of the project, except for Basin 4 and Basin 5, which would be constructed during the long term development phase. In addition to the nine bio-retention basins, drainage swales will also be constructed within the stormwater network as part of the treatment train.

The potential water quality impacts resulting from the proposed airport development, for both the Stage 1 and long term development, are summarised in Table 2.

Under the proposed Stage 1 development conditions, with the proposed bio-retention basins in place, the results indicate that the existing AEPR limits would not be satisfied at all the locations. Similarly, ANZECC Guidelines water quality default trigger levels would not be achieved, except for suspended solids. This is despite the results indicating that the proposed measures would generally improve the water quality concentrations relative to the existing environment.

However, using the interim site specific trigger levels established for the airport development site, the Stage 1 post-development concentrations are found to satisfy the water quality criteria at all the modelled outlet locations for total nitrogen, total phosphorus, and suspended solids. This is the case for the water quality within the local airport vicinity and the regional areas further downstream.

The results also indicate that the reduction of post-development loads to existing loads (NORBE) would not be achieved, except for suspended solids, where it is satisfied at four of nine locations at the airport vicinity, and four of five locations in the downstream regional areas. In terms of WSUD pollutant retention targets, it would be satisfied at five of the seven locations for total nitrogen, and six of seven locations for total suspended solids and total phosphorus.

Table 2: Post Development Water Quality Impacts

Criteria	Development Phase			
	Stage 1		Long Term	
	Local Water Quality	Regional Water Quality	Local Water Quality	Regional Water Quality
AEPR Limits	Does not satisfy	Does not satisfy	Does not satisfy	Does not satisfy
ANZECC Default Trigger Levels	Does not satisfy except for TSS	Does not satisfy except for TSS	Does not satisfy except for TSS	Does not satisfy except for TSS
Interim Site Specific Trigger Levels	Satisfy for TN, TP and TSS at all basin locations	Satisfy for TN, TP and TSS at all locations compared	Satisfy for TN, TP and TSS at all basin locations	Satisfy for TN, TP and TSS at all locations compared
Post-Development Loads compared to Existing Loads (NORBE)	Does not satisfy except for TSS at 4 out of 9 locations modelled	Does not satisfy except for TSS at 4 out of 5 locations compared	Does not satisfy except for TSS at 3 out of 9 locations modelled	Does not satisfy at 5 locations compared
Pollutant Load Retention Targets (WSUD)	Satisfy at 6 locations for TSS and TP, and 5 locations for TN out of 7 basin outlet locations	Not relevant	Satisfy for TSS and TN at 7 locations and TP at 8 locations, out of 9 basin outlet locations	Not relevant

TN: Total nitrogen; TP: Total phosphorus; TSS: Total suspended solids.
Local water quality refers to that discharged within the airport site and nearby vicinity.
Regional water quality refers to that at various locations downstream of the airport site.

Under the long term development, the existing AEPR limits would not be satisfied at all the locations. Similarly, ANZECC Guidelines default water quality trigger levels would not be satisfied, except for suspended solids. As for Stage 1, it is noted that this is despite the results indicating that the water quality concentrations would generally improve relative to that under existing conditions.

However, using the interim site trigger levels, the water quality is found to satisfy the criteria at all the locations, for suspended solids, total phosphorus, and total nitrogen. This is the case both locally and in the downstream catchment areas.

The results indicate that the reduction of the post-development loads to existing loads (NORBE) would not be achieved, except for suspended solids, where it is satisfied at three basin outlet locations within the airport vicinity, but none at the downstream regional areas. Using WSUD criteria, the targets are found to be satisfied at seven of the nine basin outlet locations for suspended solids and total nitrogen, and at eight locations for total phosphorus.

In summary, the results indicate that the Stage 1 bio-retention basins currently proposed in the revised draft Airport Plan and concept design would not satisfy existing AEPR water quality limits and ANZECC Guidelines default trigger levels. However, using the interim site specific trigger levels, the Stage 1 development measures would satisfy the criteria at all the local and downstream locations. Post-development water quality pollutant loads would not be reduced to existing load levels (NORBE), while WSUD criteria would be satisfied at up to six of seven locations.

Similarly, for the long term development, the bio-retention basins would not satisfy existing AEPR water quality limits and ANZECC Guidelines default trigger levels. However, using the interim site specific trigger levels, the criteria would be satisfied at all the locations. NORBE targets would not be achieved, while WSUD criteria would be satisfied at up to eight of nine locations.

Overall, it is considered that the use of site specific trigger levels is appropriate and would take precedence over existing AEPR limits and ANZECC Guidelines default trigger levels, as noted earlier. At this stage, only interim site trigger levels can be established, on the basis of the nine months of monitoring data available. However, this data indicates that if the same trends are exhibited in the field over the next fifteen months, the final site specific trigger levels would be similar to the interim levels. On this basis, the proposed bio-retention measures would satisfy AEPR under the provisions of a substitute local standard, for both Stage 1 and the long term development. In doing so, it would also satisfy ANZECC Guidelines site specific trigger levels.

It is understood that the basin footprints for the proposed concept design have sufficient buffers to enable the basins to be enlarged, where necessary. This would be investigated and incorporated during detailed design. Additional mitigation and management measures, as discussed in Section 6 of this report, would also be implemented during the construction and operational phases of the project. It is considered that these combined measures would further enhance the water quality treatment, with the potential that WSUD objectives would also be satisfied for both the Stage 1 and long term development.

During construction of the works, extensive disturbance to the existing soils is expected to occur. This has the potential to result in increased erosion and sedimentation and the discharge of pollutants into the downstream waterways, particularly during rainfall events. A Soil and Water Management Plan (SWMP) and a Construction Environmental Management Plan (CEMP) will be prepared and implemented prior to the commencement of any construction works. With these management plans in place, construction activity is not expected to have any significant impact on downstream water quality. Any potential impact is likely to be localised and short term. Upon completion of the construction works, water quality discharged from the airport site to the downstream waterways is expected to improve, compared to that under existing conditions, for total phosphorus, total nitrogen and suspended solids.

Terms and abbreviations

Term	Usage
AEPR	*Airport Environmental Protection Regulations (1997)*
Airport	See 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.

Term	Usage
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.
Long term development	A potential future stage in the development of the proposed airport, where the airport is assumed to comprise parallel runways and handling approximately 82 million passengers annually. The EIS assumes this occurs in 2063 for assessment purposes and provides a strategic level assessment of potential impacts. Development of the airport beyond the scope of Stage 1 would be subject to separate planning and environmental processes.
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 initial stage in the development of the proposed airport, including a single runway and facilities for 10 million annual passengers. The EIS assumes the airport could be operating at this level approximately five years after operations commence, which for assessment purposes has been assumed to be 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.

Term	Usage
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.
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 channel.
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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Appendices

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 1,780 hectares of land acquired by the Commonwealth in the 1980s and 1990s. Airport operations are expected to commence 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 (referred to as the Stage 1 development) 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 approximately 10 million passengers per year as well as freight operations. 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 subject to relevant approvals.

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 joint scoping study is being undertaken with the NSW Government to determine rail needs for Western Sydney and the airport. A potential final rail alignment will be determined through the joint scoping study with the New South Wales Government, with any significant enabling work required during Stage 1 expected to be subject to a separate approval and environmental assessment process.

As demand increases, additional aviation infrastructure and aviation support precincts are expected to be developed until the first runway reaches capacity at around 37 million passenger movements. At this time, expected to be around 2050, a second parallel runway is expected to be required. In the long term, approximately 40 years after operations commence, the airport development is expected to fully occupy the airport site, with additional passenger and transport facilities for around 82 million passenger movements per year.

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. A draft Airport Plan was exhibited for public comment with the draft EIS late in 2015.

Following receipt of public comments, a revised draft Airport Plan has been developed. The revised draft Airport Plan is the primary source of reference for, and companion document to, the EIS. The revised draft Airport Plan identifies a staged development of the proposed airport. It provides details of the initial development being authorised, as well as a long-term vision of the airport's development over a number of stages. This enables preliminary consideration of the implications of long term airport operations. Any airport development beyond Stage 1, including the construction of additional terminal areas or supporting infrastructure to expand the capacity of the airport using the first runway or construction of a second runway, would be managed in accordance with the existing process in the Airports Act. This includes a requirement that, for major airport developments (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 are 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

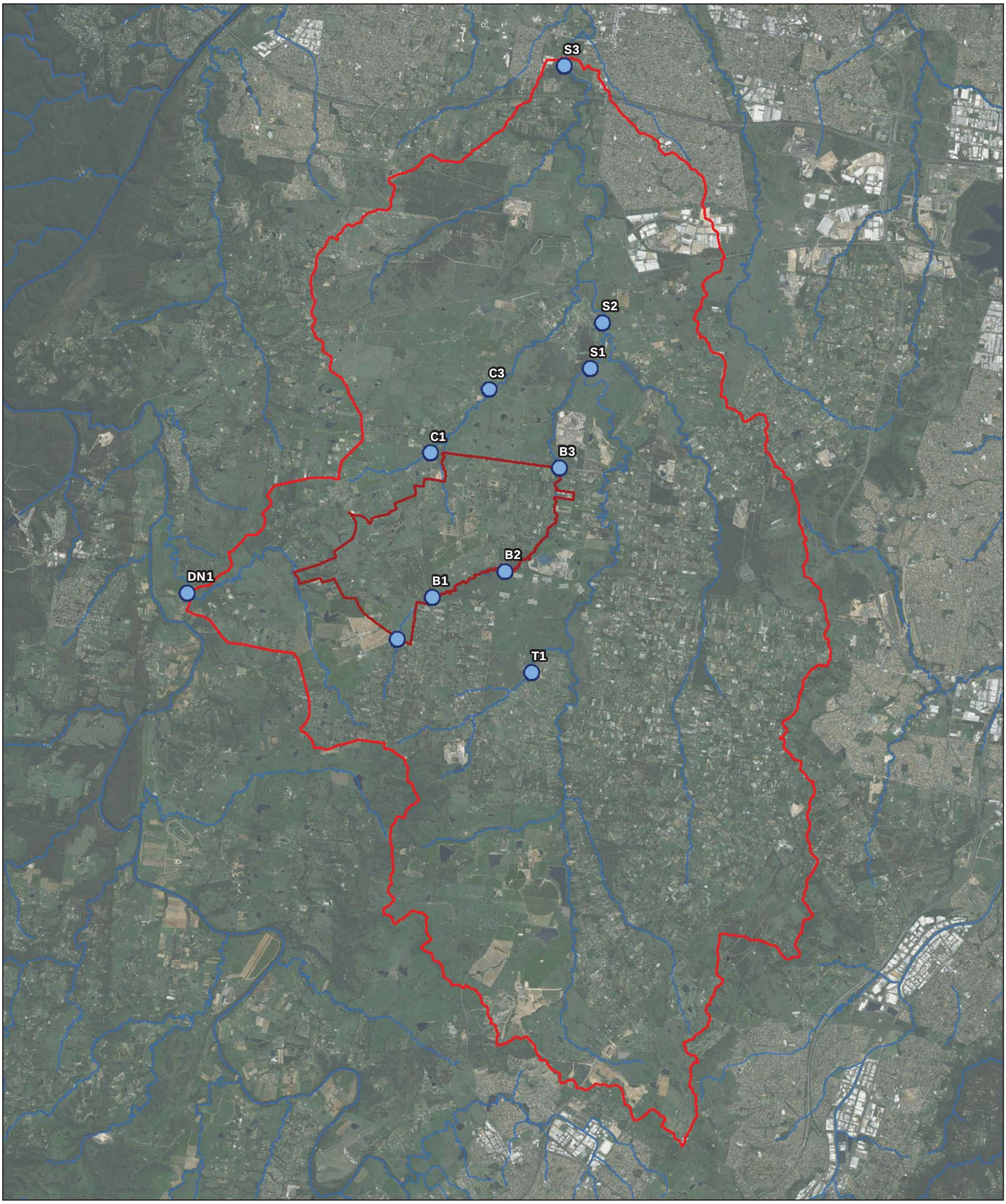
The study area for both Stage 1 and the long term development consists of the airport site as well as the hydrological catchments of Duncans Creek, Cosgroves Creek, Oaky Creek, and Badgerys Creek. Duncans Creek discharges to the Nepean River. Oaky Creek discharges to Cosgroves Creek, while Cosgroves 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 references legislations, guidelines, and policies;
- **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 during the operational phase 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.

Appendix A details the water quality data referred to and obtained during the preparation of this report. Appendix B and Appendix C summarise the water quality modelling results for Stage 1 and the long term development, respectively.



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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Job Number	21-24265
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Date	19 Aug 2016

Surface water quality study area and key features

Figure 1-1

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Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

2. Methodology

2.1 Legislation and guidelines

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

- *Guidelines for the Content of a Draft Environmental Impact Statement, Western Sydney Airport* (Australian Government Department of the Environment 2015)*;*
- *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act);
- *Airports Act 1996* (Cth) and *Airports (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;
- Liverpool Local Environmental Plan (Liverpool City Council 2008);
- 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 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 EIS 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 the *Airports (Environment Protection) Regulations 1997* (AEPR) sets out acceptable limits for water pollution which apply to the exclusion of various state laws. The limits in the AEPR for typical physical and chemical stressors are shown in Table 2-1. It is noted that the AEPR limits are about 5 times more stringent than the ANZECC Guidelines for total phosphorus and total nitrogen (see Table 2-2).

It is understood that the AEPR limits are currently under review. A recent discussion paper (Review of the Airports Building Control and Environment Protection Regulations, Department of Infrastructure and Transport, May 2013) recommended that limits in Schedule 2 of the AEPR be updated to align with the ANZECC Guidelines rather than the earlier ANZECC 1992 guidelines.

Table 2-1 Airport Environmental Protection Regulation (AEPR) Schedule 2 Water Pollution Accepted Limits

Parameter	AEPR Guideline	ANZECC Default Trigger Level
Total phosphorus (TP)	< 0.01 mg/L	< 0.05 mg/L
Total nitrogen (TN)	< 0.1 mg/L	< 0.5 mg/L
Dissolved oxygen (DO)	80% of average level for a normal 24 hr period or < 6 mg/L	85% to 110% saturation
Total suspended solids (TSS)	change not more than 10% from seasonal mean	< 40[1]
Turbidity	a reduction of 10% clarity in the euphotic zone from the seasonal mean	6 to 50 NTU
pH	6.5 – 9.0	6.5 – 8
Salinity	> 1000 mg/L or an increase of > 5%	125 – 2200 µS/cm

1: ANZECC Guidelines professional judgement (aquaculture)

To allow for climatic, topographic and other site-specific considerations such as these, Part 5 of the AEPR allows for the development of local water quality standards. Local standards may be proposed by an airport lessee company and approved by the Infrastructure Minister following a period of consultation with relevant authorities, stakeholders and the broader public. In particular, Clause 5.02 (1) states that a substitute standard (local standard) may be proposed where it is considered that a limit of contamination specified in the AEPR is inappropriate. AEPR does not, however, provide any technical guidance on how a substitute standard should be derived.

The approach for the development of site specific trigger levels in accordance with the ANZECC (2000) Guidelines has therefore been adopted to develop interim local standards as part of this assessment. In accordance with the ANZECC (2000) Guidelines, site specific trigger levels are required to be developed based upon a minimum of two years of contiguous monthly monitoring data. Nine months of contiguous water quality data is currently available so interim local standards for key water quality assessment parameters have therefore been developed for consideration in this report as described in Section 3.6. It anticipated that the interim local standards would be reassessed by the ALC following completion of the 24 months water sampling for approval in accordance with Part 5 of the AEPR.

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 WM Act will have limited direct applicability to the airport as a result of the Airports Act and the AEPR, however 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 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 water quality trigger levels are provided in ANZECC Guidelines for the protection of "slightly disturbed or modified ecosystems" for different regions of Australia and New Zealand. These default trigger levels are generally considered to be conservative but are useful as a guide where no data is available. It is noted that ANZECC Guidelines does not provide a different set of trigger levels for "highly disturbed ecosystems" but defaults to the same set of trigger levels for "slightly to moderately disturbed ecosystems", on the basis that it is a low risk guideline.

Default ANZECC Guidelines 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 emphasised that these default trigger values are guideline values or water quality objectives only, and are not compliance standards. In fact, ANZECC Guidelines states that site specific water quality values are preferred and should be established and adopted, and that the default trigger levels should only be used where site specific values are not available. This ensures that the trigger levels applied are not excessively and unnecessarily onerous. This is particularly the case for waterways that are already degraded, such as the airport and South Creek catchments.

According to ANZECC Guidelines, site specific trigger levels should be based on a minimum of two years of contiguous monthly data at the site, with the trigger levels computed as the 80th percentile values. Development of interim local standards based upon 9 months of available monitoring data is discussed in Section 3.6.

Table 2-2 ANZECC Guidelines Trigger Values for NSW Slightly Disturbed Ecosystems in 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
Total suspended solids (mg/L)	< 40[1]

Source: ANZECC Guidelines (2000)

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

2.1.6 NSW Water Quality Objectives

The NSW Water Quality Objectives (1999) are environmental values and long term goals endorsed by the NSW Government and the community for NSW's surface waters. They set out the following:

- The community's values and uses for our rivers, creeks, estuaries and lakes; and
- A range of water quality indicators to assist in establishing whether the current condition of the waterways supports those values and uses.

Uses and values protected by the NSW Water Quality Objectives include the following:

- Aquatic ecosystems;
- Aquatic foods;
- Drinking water at point of supply;
- Homestead water supply;
- Irrigation water supply;
- Livestock water supply;
- Primary contact recreation;
- Secondary contact recreation; and
- Visual amenity.

The NSW Water Quality Objectives are generally consistent with the national water quality framework set out in the ANZECC Guidelines (see Section 2.1.5). Essentially, the NSW Water Quality Objectives provide the environmental values for NSW waters, while the ANZECC Guidelines provides the technical guidance in assessing the water quality needed to protect those values.

Endorsed environmental values for the Hawkesbury Nepean include aquatic ecosystem protection, recreational water use, raw drinking water, irrigation and general use. Water drawn from the catchment is used for irrigation for lucerne, fodder, pasture, turf, vegetables, orchards, cereals, flowers and stock watering purposes. Recreational facilities such as golf courses and sporting fields also draw water for irrigation, and the downstream estuarine reaches of the Hawkesbury River support fishing, prawning and oyster industries and recreational boating.

It is noted that the airport site is not located within Sydney's drinking water catchment area. All of the airport sub-catchments drain to the Hawkesbury Nepean system downstream of Lake Burragorang.

2.1.7 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.

2.1.8 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.

2.1.9 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 80th percentile, depending on the ability of the weir to pass flows released upstream;
  - trading is permitted both within the management zone and 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.

2.1.10 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 recommends 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.

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

It is noted that the pollutant retention targets specified in Table 2-3 apply to urban or developed catchment areas. Thus, the targets are appropriate for the proposed airport development and proposed bio-retention basins, which are provided for the treatment of water quality, prior to release into the downstream areas. However, due to the rural nature and the absence of any proposed treatment measures along South Creek downstream of the airport, the application of these WSUD targets is less meaningful. On this basis, the use of WSUD targets in this report will focus on the performance of the bio-retention basins at their outlets and not in any of the catchment areas downstream of the airport.

Table 2-3 Retention Targets (WSUD Guidelines)

	Total Suspended Solids (TSS)	Total Phosphorus (TP)	Total Nitrogen (TN)
% Retention 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 the 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 this was 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 then 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 titled *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. A summary of these data is presented in Table 3-6 for some key parameters. Figure 3-1 shows the locations where this monitoring was conducted.

2.3 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 2-4.

Table 2-4 Key data sources for Western Sydney Airport

Document / dataset	Data source	Description	Date
Aerial imagery	NSW LPMA		2015
Revised draft Airport Plan – Concept Plan - Long Term	DIRD	Concept drawing of an indicative long term airport layout	2016
Revised draft Airport Plan – Concept Plan – Stage 1	DIRD	Concept drawing of the proposed Stage 1 airport layout	2016
Revised draft Airport Plan – Concept Plan – Stage 1 Land Use Zoning Plan	DIRD	Drawing of proposed land use zoning for Stage 1	2016
Revised draft Airport Plan – Concept Plan – Long Term Land Use Zoning Plan	DIRD	Drawing of indicative land use zoning for a long term development	2016
Stage 1 Surface Water Management Layout Plan	DIRD / GHD design team	Drawing of proposed surface water management strategy for Stage 1	2015
Long Term Surface Water Concept Drawings	DIRD / GHD design team	Drawing of indicative surface water management strategy for a long term development	2015
Revised draft Airport Plan – Western Sydney Airport	DIRD	Revised draft Airport Plan outlining the proposed Western Sydney Airport Stage 1 development at the time of conducting the surface water assessment	2016
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 long term development	2015
Hydraulic models	DIRD / GHD design team	MIKE 21 models of the existing airport site and long term development	2015

Document / dataset	Data source	Description	Date
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 long 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
Western Sydney Airport Concept Design	DIRD/ GHD design team	Final Stage 1 concept design	25 Jan 2016
Western Sydney Airport Concept Design	DIRD/ GHD design team	Stage 1 Construction Impact Zone	29 Feb 2016

2.4 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.

The model was calibrated to background monitoring data to facilitate a comparison between existing and future Stage 1 and long term development conditions. It is noted that additional water quality data obtained for the purposes of this EIS (Table 3-7 and Appendix A) were found to be generally consistent with the historical data.

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.

2.4.1 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.

2.4.2 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.

2.4.3 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 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 2-4). 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 uses 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 3-7) 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 2.4.2, and using an iterative process, until the modelled results were similar to the sampled data. The results of the calibration are presented in Table 2-5 and Figure 2-1.

In Table 2-5, the lower and upper range of results obtained from the MUSIC model are 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 2-5 and Table 2-6.

Table 2-5 Calibration of MUSIC model under existing conditions

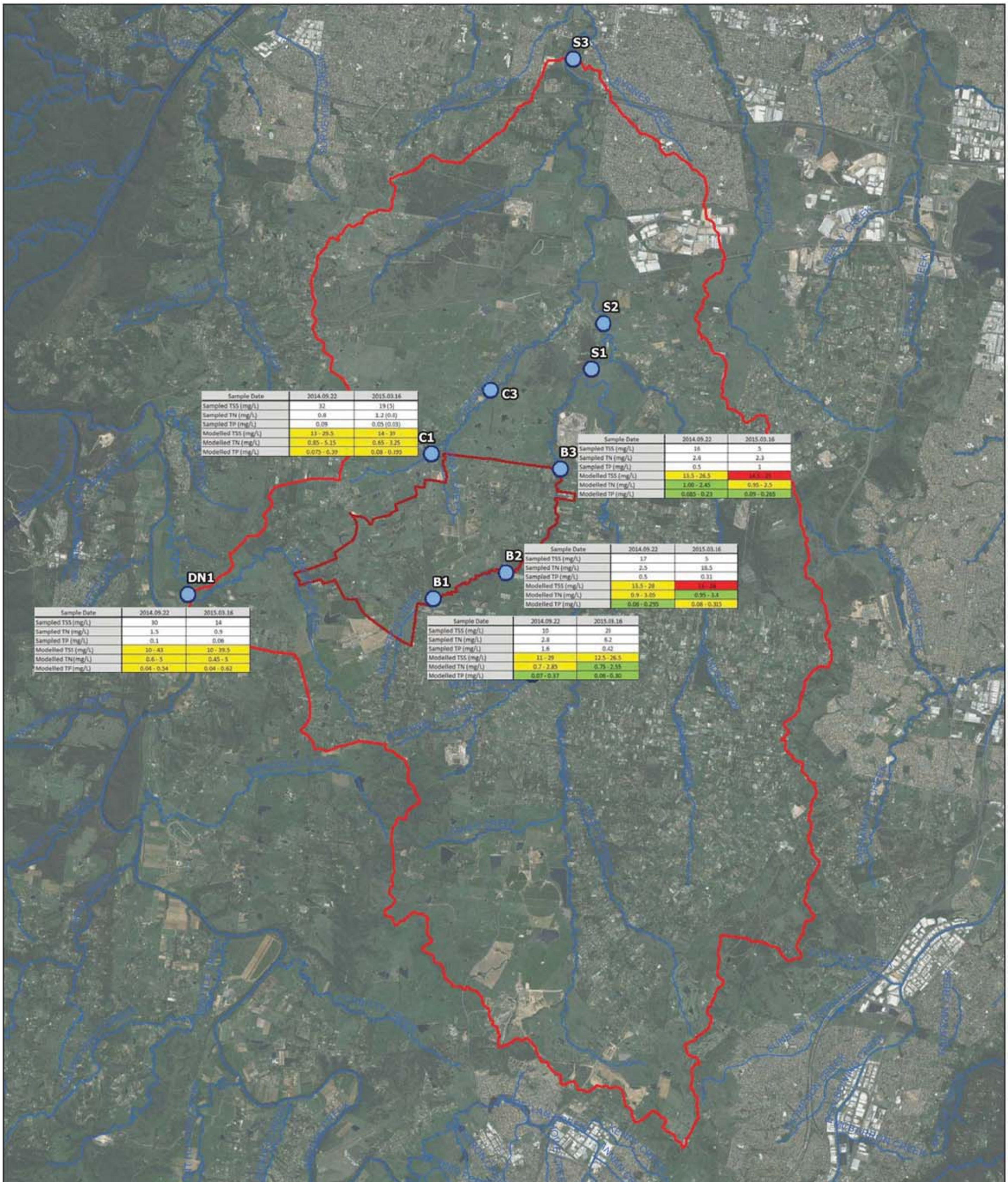
Location	Comparison of Sampled Data with Model Results (MUSIC)			
	Source	TSS (mg/L)	TN (mg/L)	TP (mg/L)
SMEC Data (22.9.2014)				
Badgerys Ck (B1)	Sampled Modelled	10 11-29	2.8 0.7-2.85	1.6 0.07-0.37
Badgerys Ck (B2)	Sampled Modelled	17 13.5-28	2.5 0.9-3.05	0.5 0.08-0.295
Badgerys Ck (B3)	Sampled Modelled	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 2-6 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)	2.8	2.3
Sampled TP (mg/L)	0.5	1
Modelled TSS (mg/L)	13.5 - 26.5	[illegible]
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	[illegible]
Modelled TN (mg/L)	0.9 - 3.05	0.95 - 3.4
Modelled TP (mg/L)	0.06 - 0.295	0.08 - 0.315

B1

Sample Date	2014.09.22	2015.03.16
Sampled TSS (mg/L)	10	20
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

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

LEGEND

- The airport site
- Water sampling site
- 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

Job Number	21-24265
Revision	A
Date	23 Jul 2015

Calibration of MUSIC model under Existing Conditions

Figure 2-1

N:\AU\Sydney\Projects\21\24265\GIS\Maps\Deliverables\KBM.mxd [KBM: 94]

Level 15, 133 Castlereagh Street Sydney NSW 2000 T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com.au W www.ghd.com.au

Data source: Created by: afoddy

Table 2-7 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	-0.52	0.30	0.36	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)

2.4.4 MUSIC modelling under Stage 1 and long term conditions

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

Water quality models for Stage 1 were developed as part of this study. 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 revised draft Airport Plan and the Stage 1 Concept Design (25 January 2016) (refer to Table 2-4).

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 2.4.3. 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 long 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 Stage 1 Concept Design (25 January 2016) and the revised 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 long 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 long term development.

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

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

In assessing the development phases of the project, it was considered that for the Stage 1 development, the Construction Impact Zone shown in the Stage 1 Concept Design would apply, and that for the long term development, the entire site would be urbanised, except for the Environmental Conservation Zones. Where catchment areas under existing conditions remain unchanged, existing rural model parameters (Table 2-6) were adopted. Similarly, areas proposed for development were classified as urban areas and urban parameters 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 2-8 and Table 2-9.

Table 2-8 Adopted Modelling Parameters for Stage 1 and long term urban 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 2-9 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

2.5 Bio-retention basins and swales design

2.5.1 Stormwater management strategy

The revised draft Airport Plan and Stage 1 Concept Design (2016) includes a stormwater management system consisting of a series of grassed swales to convey runoff from the developed areas within the airport site, and a series of bio-retention and flood detention basins to manage flow quality and quantity prior to discharge to the receiving waters. Low flows are diverted and treated in the bio-retention system, while the higher flows are designed to bypass the system and discharge directly into the flood detention basins. The flood detention basins then provide controlled release to the receiving waters in a way that mimics the natural flows as closely as possible over a range of storm durations and magnitudes.

2.5.2 Water quality assessment methodology

The modelling has considered the effectiveness of the proposed water management system to meet the objectives for the receiving waters with respect to:

- Average annual pollutant loads (kg/yr);
- Pollutant load retention targets for urban developments; and
- Average pollutant concentrations (mg/L).

In assessing the average annual loads, the post development levels are compared to those under existing conditions. This approach is similar to the NORBE (Neutral OR Beneficial Effect) approach to water quality management, which aims to manage the post development pollutant loads discharging from a site, 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) for the Sydney Drinking Water Catchment 2011 and relates to development within Sydney Water's drinking water catchments. This approach is typically 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 the SEPP for the Sydney Drinking Water Catchment. For example, it was one of the design criteria adopted in the 1997 Airport EIS for Badgerys Creek. Nevertheless, it is noted that the airport catchment is not located within the Sydney Water Drinking Water catchments, and on this basis, NORBE is applicable only as a tool for the consideration of loads, and is not a policy requirement.

Water quality management using the approach of pollutant load retention targets is a practical way of treating stormwater quality from urban developments. This is similar to the WSUD approach discussed in Section 2.1.11. 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 retention 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 NORBE in situations where the existing catchments are of a rural nature, as in the case of the airport site.

Pollutant concentrations are readily monitored and have a direct correlation with the relative health of waterways and ecosystems. Both AEPR and ANZECC Guidelines refer to concentrations in the setting of trigger levels and pollutant limits. The recommendations of 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 concentrations 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.

It is noted that where ANZECC Guidelines default water quality objectives are not achieved for nutrient concentrations they are also not achieved under the limits set out in the AEPR, which are five times more stringent. However, as discussed in Section 2.1.2, the limits in the AEPR were based on ANZECC (1992) and it is understood that AEPR is proposed to be updated to align with the ANZECC Guidelines.

For the purposes of this EIS, interim site specific trigger levels have also been calculated and assessed using the water quality monitoring data undertaken as part of this EIS. Water quality monitoring for this EIS commenced in November 2015, and so, the period of monitoring is still currently well short of 24 months at this stage. However, the interim results are considered to be useful in providing an early indication of the likely range of results expected when the full 24 months of data becomes available. Estimation of the interim site specific trigger levels for the proposed airport site is discussed further in Section 3.6.

2.5.3 Adopted bio-retention and swale sizes

The bio-retention basin sizes included in the revised draft Airport Plan and Stage 1 Concept Design were defined and assessed in the MUSIC model. The minimum bio-retention basin areas specified in the concept design are shown in Table 2-10 for Stage 1 and Table 2-11 for the long term. The surface areas of these basins correspond to about 0.2% to 0.7% of the catchment areas discharging to them.

It is understood that the bio-retention sizes adopted in Table 2-10 and Table 2-11 in the revised draft Airport Plan and Stage 1 Concept Design have been provided with the aim of satisfying WSUD Guidelines, rather than NORBE or the ANZECC Guidelines default water quality trigger levels. However, for the purposes of this EIS, site specific water quality trigger levels will also be referred to, as intended in the ANZECC Guidelines.

It is also noted that the civil design for each of the bio-retention basins has additional buffer areas set aside, to enable a greater treatment area to be provided, in the event that the basins have to be enlarged beyond the minimum bio-retention areas specified. In Table 2-10, the maximum available areas are shown in the first row, while the minimum bio- retention basin sizes are shown in the second row. This approach provides flexibility to increase the level of treatment as required following the adoption of site specific water quality trigger levels developed following the completion of long term baseline monitoring in accordance with the ANZECC Guidelines.

Table 2-10 shows that the majority of the bio-retention basins are proposed for construction as part of the Stage 1 development, with only Basin 4 and Basin 5 to be proposed to be built in the long term (see Table 2-11). The construction of Basins 4 and 5 will not compromise the overall level of treatment required. The locations of the proposed basins for Stage 1 and long term are shown in Figure 2-2 and Figure 2-3 respectively.

In addition to bio-retention basins, grassed swales have been included into the revised draft Airport Plan to assist in formalising the drainage network of the airport site. Swales will, in conjunction with bio-retention basins help improve water quality across the site, with the aim of satisfying the WSUD Guidelines. Table 2-12 and Table 2-13 show the adopted swale dimensions for Stage 1 and the long term respectively. It can be seen from these tables that in Stage 1, no swales are provided in the catchments for Basin 4, Basin 5 and Basin 9. However, in the long term, swales will be in place in all areas across the site, except for the catchments reporting to Basin 9. All swales modelled are assumed to have a bed slope of 0.5%, a base width of 4 m, top width of 16 m and a depth of 1 m.

Table 2-10 Stage 1 Bio-retention Basin Sizes Adopted

Parameter	Basin 1	Basin 2	Basin 3	Basin 4	Basin 5	Basin 6	Basin 7	Basin 8	Basin 9
Surface Area Available (Ha)	1.40	0.90	1.33	N/A	N/A	1.74	1.96	1.13	0.16
Minimum Bio-retention Area (Ha)	0.6	0.22	0.6	N/A	N/A	1.0	0.5	0.2	0.15
Extended Detention Depth (m)	0.3	0.3	0.3	N/A	N/A	0.3	0.3	0.3	0.3
Surface Area as % of Catchment Area	0.3	0.3	0.5	N/A	N/A	0.5	0.2	0.3	0.3
Extended Detention Volume (m^3)	1800	660	1800	N/A	N/A	3000	1500	600	450
Filter Media Volume (m^3)	2400	880	2400	N/A	N/A	4000	2000	800	600
Proposed Construction Stage	Stage 1	Stage 1	Stage 1	Long term	Long term	Stage 1	Stage 1	Stage 1	Stage 1

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

Table 2-11 Long Term Bio-retention Basin Sizes Adopted

Parameter	Basin 1	Basin 2	Basin 3	Basin 4	Basin 5	Basin 6	Basin 7	Basin 8	Basin 9
Minimum Bio-retention area (Ha)	1.8	0.55	0.6	1.1	0.5	1.1	1.0	0.4	0.15
Extended Detention Depth (m)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Surface Area as % of Catchment Area	0.7	0.6	0.5	0.5	0.5	0.5	0.4	0.6	0.3
Extended Detention Volume (m^3)	5400	1650	1800	3300	1500	3300	3000	1200	450
Filter Media Volume (m^3)	7200	2200	2400	4400	2000	4400	4000	1600	600
Proposed Construction Stage	Stage 1 + Long term	Stage 1 + Long term	Stage 1	Long term	Long term	Stage 1	Stage 1	Stage 1	Stage 1

Notes: 1) Minimum surface area = minimum filter area; 2) % catchment area = bio-retention area as percentage of catchment area 2) The concept design for the long term has yet to be undertaken and is subject to potential changes.

Table 2-12 Stage 1 Swale Dimensions Adopted

Parameter	Basin 1	Basin 2	Basin 3	Basin 4	Basin 5	Basin 6	Basin 7	Basin 8	Basin 9
Total Length (m)	1780	450	1650	0	0	4110	4866	200	500
Bed Slope (%)	0.5	0.5	0.5	-	-	0.5	0.5	0.5	0.5
Base Width (m)	4	4	4	-	-	4	4	4	4
Top Width (m)	16	16	16	-	-	16	16	16	16
Depth (m)	1	1	1	-	-	1	1	1	1

Notes: 1) Total length = total length of swales upstream of each associated basin

Table 2-13 Long Term Swale Dimensions Adopted

Parameter	Basin 1	Basin 2	Basin 3	Basin 4	Basin 5	Basin 6	Basin 7	Basin 8	Basin 9
Total Length (m)	3290	600	900	1200	350	4110	4866	200	500
Bed Slope (%)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Base Width (m)	4	4	4	4	4	4	4	4	4
Top Width (m)	16	16	16	16	16	16	16	16	16
Depth (m)	1	1	1	1	1	1	1	1	1

Notes: 1) Total length = total length of swales upstream of each associated basin; 2) The concept design for the long term has yet to be undertaken and may be subject to changes.

LEGEND

- Airport site
- Watercourses
- Detention Basin
- Bioretention Basin
- Stage 1 development area

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	01 Sep 2016

Locations of Bio-Retention Basins (Stage 1)

Figure 2-2

G:\21\24265\GIS\Maps\Deliverables\KBM.mxd [KBM: 200]

Level 15, 133 Castlereagh Street Sydney NSW 2000 T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com.au W www.ghd.com.au

Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

LEGEND

- Airport site
- Watercourses
- Detention Basin
- Bioretention Basin
- Long term development area

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	01 Sep 2016

Locations of Bio-Retention Basins
(Long Term)

Figure 2-3

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Level 15, 133 Castlereagh Street Sydney NSW 2000 **T** 61 2 9239 7100 **F** 61 2 9239 7199 **E** sydmail@ghd.com.au **W** www.ghd.com.au

Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

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. 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 of 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.

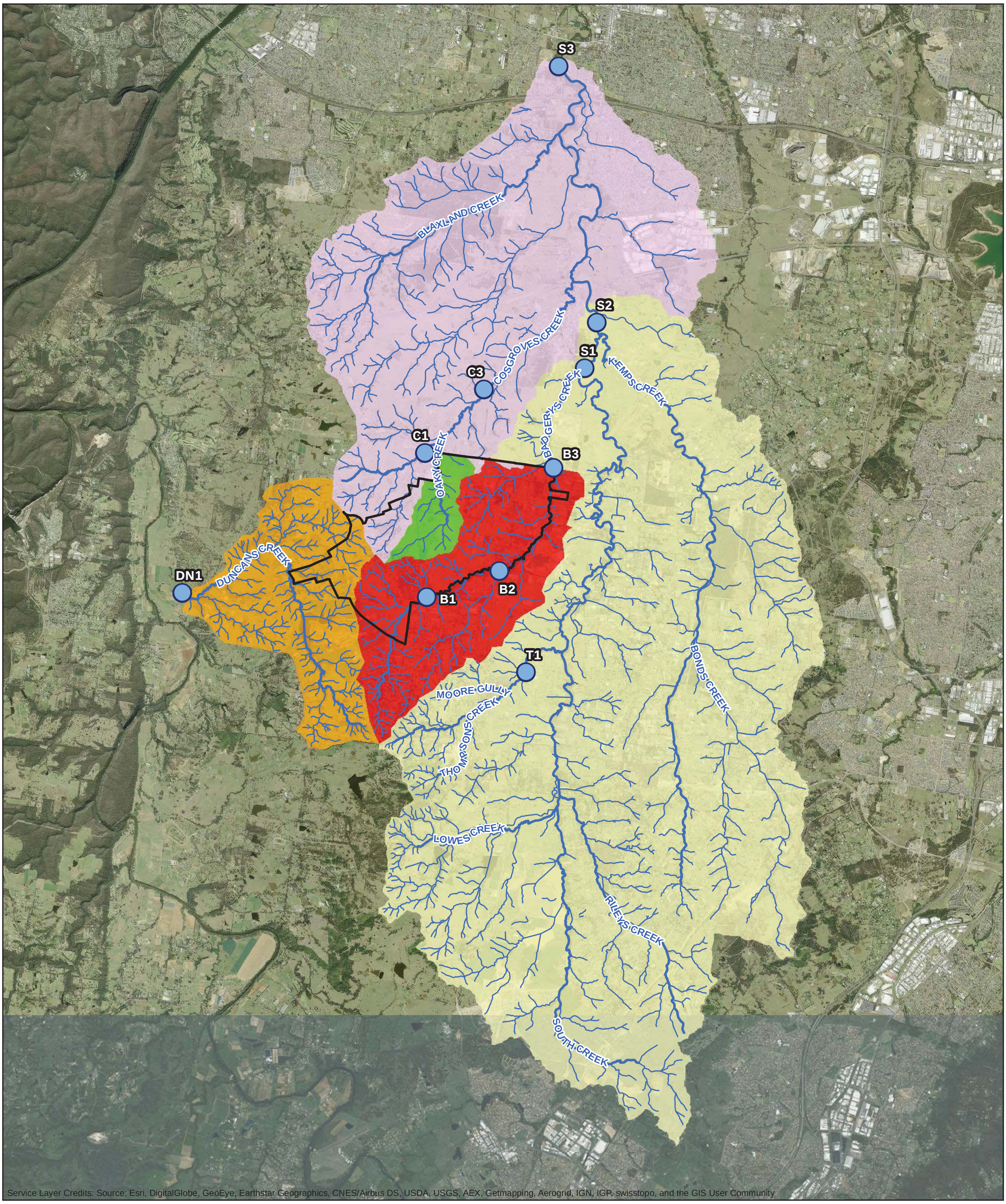
3.2 Major waterways

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 sub-catchment areas of Cosgroves Creek, Oaky Creek, Badgerys Creek, Duncans Creek and South Creek are shown in Figure 3-1 in various colours. 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 1780 hectares.

Table 3-1 Waterway Catchment Areas

Waterway	Airport Catchment Area (Ha)	External Catchment Area (Ha)	Total Catchment Area (Ha)
Badgerys Creek (B3)	1051	1300	2351
Cosgroves Creek (C1)	532	407	939
Duncans Creek (DN1)	192	1852	2044
Badgerys Creek-Elizabeth Drive to South Creek confluence (S1)	0	16524	16524
South Creek confluence with Kemps Creek (S2)	0	6889	6889
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

Existing catchments

- Cosgroves Creek
- Badgerys Creek
- South Creek
- Duncans Creek
- Oaky Creek

Paper Size A3

0 1 2 4

Kilometres

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

N

GHD

Job Number	21-24265
Revision	A
Date	29 Aug 2016

Catchments in vicinity of the airport site

Figure 3-1

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Level 15, 133 Castlereagh Street Sydney NSW 2000 T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com.au W www.ghd.com.au

Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

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 returning 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 Environnement (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 Creek and Cosgroves Creek

Oaky Creek has its headwaters located within 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 located 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 passes close to the southern tip of the airport site before turning sharply towards the south-west and later meandering north again. Duncans Creek discharges 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).

3.2.4 South Creek

South Creek has a catchment area of 414 square kilometres. It has its headwaters approximately 4 km north east of Narellan and 7 km west of Minto. From there it generally flows north and is joined by seventeen tributaries, including Badgerys Creek, Cosgroves Creek, Kemps Creek, Blaxland Creek, Werrington Creek, Byrnes Creek, Ropes Creek, Little Creek and

Eastern Creek. As noted earlier, Badgerys Creek and Cosgroves Creek both discharge through the airport site. Overall, South Creek has a river course length of about 70 kilometres and falls about 94 m in elevation prior to discharging into the Hawkesbury River near Windsor.

Most of the airport site drains to the South Creek catchment. It is noted that the airport site, which has a catchment area of 17.75 square kilometres, is relatively small, and equates to only about 4% of the South Creek catchment. This suggests that total runoff from the airport site will be relatively small as a proportion of the total inflows for South Creek. On this basis, any increase in runoff from the proposed airport is not anticipated to have a significant contribution to water quality within the overall South Creek catchment.

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

	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

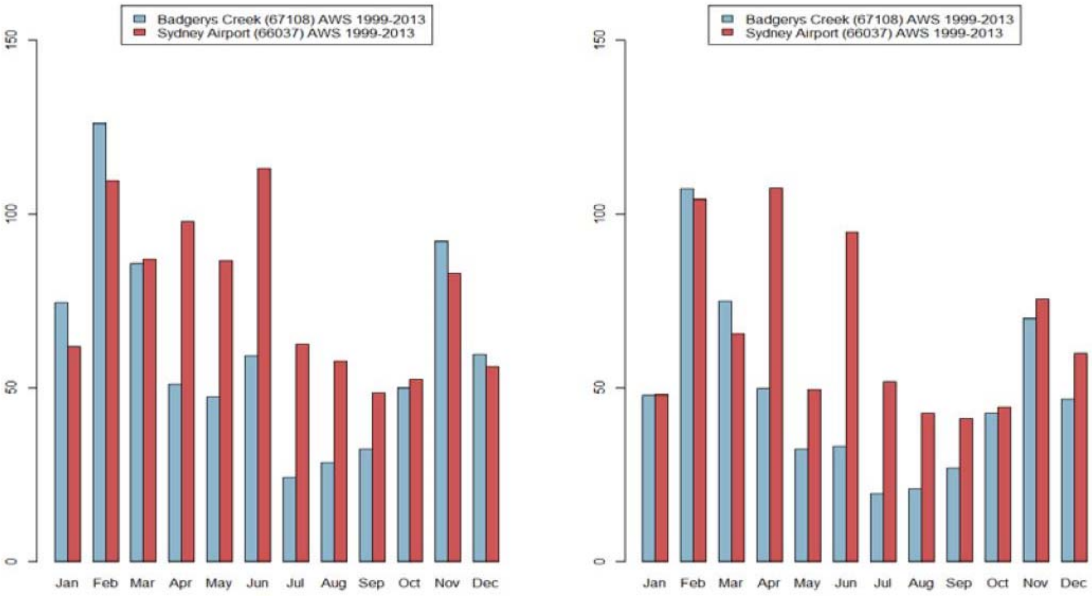


Figure 3-3 Comparison of rainfall at Badgerys Creek and Sydney (Kingsford Smith) Airport

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

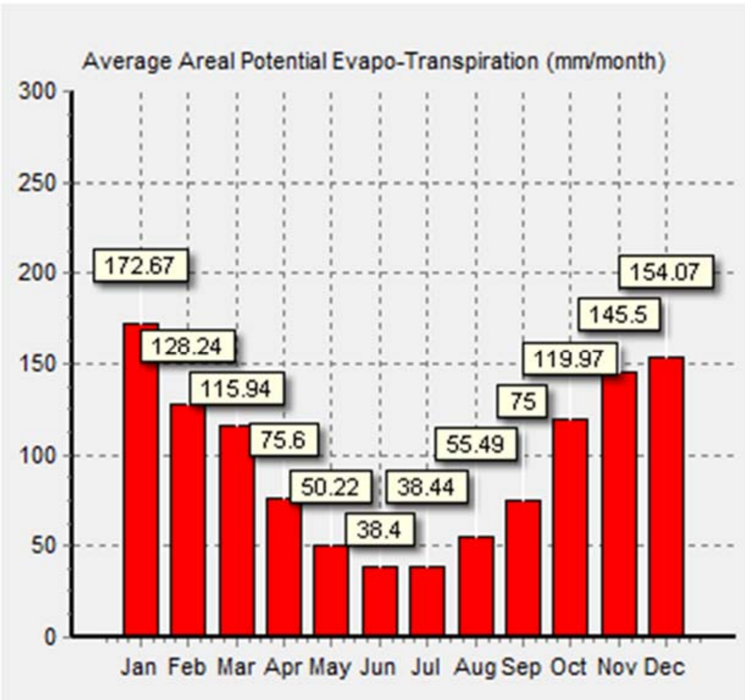


Figure 3-4 Evaporation data from Parramatta gauge

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% naturalised 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 Creek, 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*

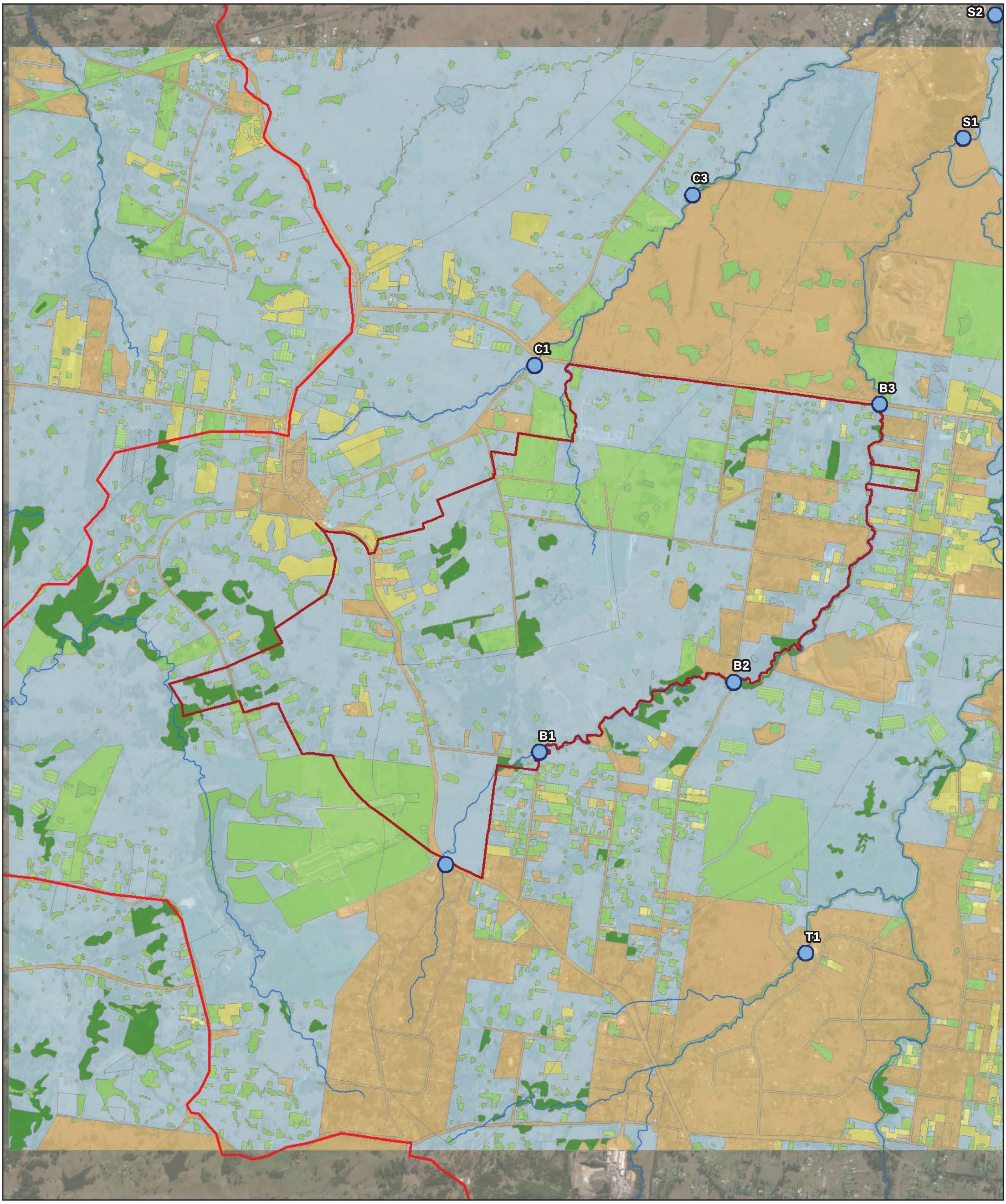
Note: Refer to Figure 3-1 for locations S1 and S2

External Site: South Creek catchment at location S1 excluding airport site. This is the land use in the catchment area between the airport site boundary and point S1.

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 Agriculture
- Naturalised pastures
- Horticulture
- Forest

Paper Size A3

0 300 600 1,200

Metres

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

N

Job Number	21-24265
Revision	A
Date	19 Aug 2016

Map of Existing Land Use Plan

Figure 3-5

G:\21\24265\GIS\Maps\Deliverables\KBM.mxd [KBM: 71]

Level 15, 133 Castlereagh Street Sydney NSW 2000 **T** 61 2 9239 7100 **F** 61 2 9239 7199 **E** sydmail@ghd.com.au **W** www.ghd.com.au

Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

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

Waterway	ID	Existing Land Use Types					
		Rural Residential	Forest	Horticu lture	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	Horticu lture	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. This is the land use in the catchment area between the airport site boundary and point S1.

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

3.5 Existing Water Quality Data

3.5.1 Water quality data from previous studies

Water quality data obtained for the Second Sydney Airport EIS (PPK, 1997-1999) and *Environmental Field Survey of Commonwealth land at Badgerys Creek* (SMEC 2014) are presented in Table 3-6.

Both sets of data show that the nutrient loads (i.e. total nitrogen (TN) and total phosphorus (TP)) were elevated or significantly elevated above AEPR Limits and ANZECC Guidelines 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 3-6 Water quality data from previous studies

Location	DO %S	pH	Turbidity NTU	TSS mg/L	TN mg/L	TP mg/L
AEPR limits	**80%[a]**	**6.5-9**	**<10%[b]**	**<10%[c]**	**0.1**	**0.01**
ANZECC default trigger	**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

Location	DO %S	pH	Turbidity NTU	TSS mg/L	TN mg/L	TP mg/L
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
[a] Denotes 80% of average
[b] Denotes <10% change in clarity
[c] Denotes <10% change in mean
* ANZECC Guidelines Professional judgement (aquaculture); 50 mg/L NSW Blue Book for Soils and Construction; AEPR limits – please refer to Table 2-1
Source: Collated from reports shown above. Additional sampling data obtained for this EIS are presented in Table 3-7 and Appendix A.

3.5.2 Water quality data from present study

A limited scope of water quality sampling was undertaken by GHD during the aquatic ecology surveys on 16 March 2015. Sampling results for some key parameters at locations immediately surrounding the airport site are presented in Table 3-7 with the full results presented in Appendix A. The locations of the March 2015 sampling points are shown in Figure 3-6

Field visits to the airport site and surrounding areas were 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.

As access to some properties was restricted, 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. The water quality data sampled to date indicate typically high nutrient loads and low dissolved oxygen levels consistent with the existing land use in the catchment.

Further water sampling commenced in November 2015 and is currently ongoing. The results obtained to date, for the adopted sampling locations, are presented in Table 3-7

Table 3-7 indicates that the nutrient loads within the locality of the airport site, including total nitrogen and total phosphorus, are generally high and elevated well above default ANZECC Guidelines water quality trigger values. Turbidity and total suspended solids are generally within acceptable levels, while dissolved oxygen levels are found to be relatively low. Both the GHD March 2015 and present EIS results are fairly consistent with those obtained by PPK (1997) and SMEC (2014). The present ongoing monitoring data also indicates that the conductivity levels fluctuate above and below the threshold trigger level but are generally at the upper end of the scale.

Heavy metals, hydrocarbons and pesticides were also sampled as part of the water quality monitoring programme (Appendix A). The results for TPH, OP/OC, PAH, BTEX and phenols were found to be negative for all the samples tested. Arsenic, cadmium, lead, nickel and mercury were found to be below detectable limits or below ANZECC Guideline levels. However, some exceedances were observed for chromium, copper, and zinc.

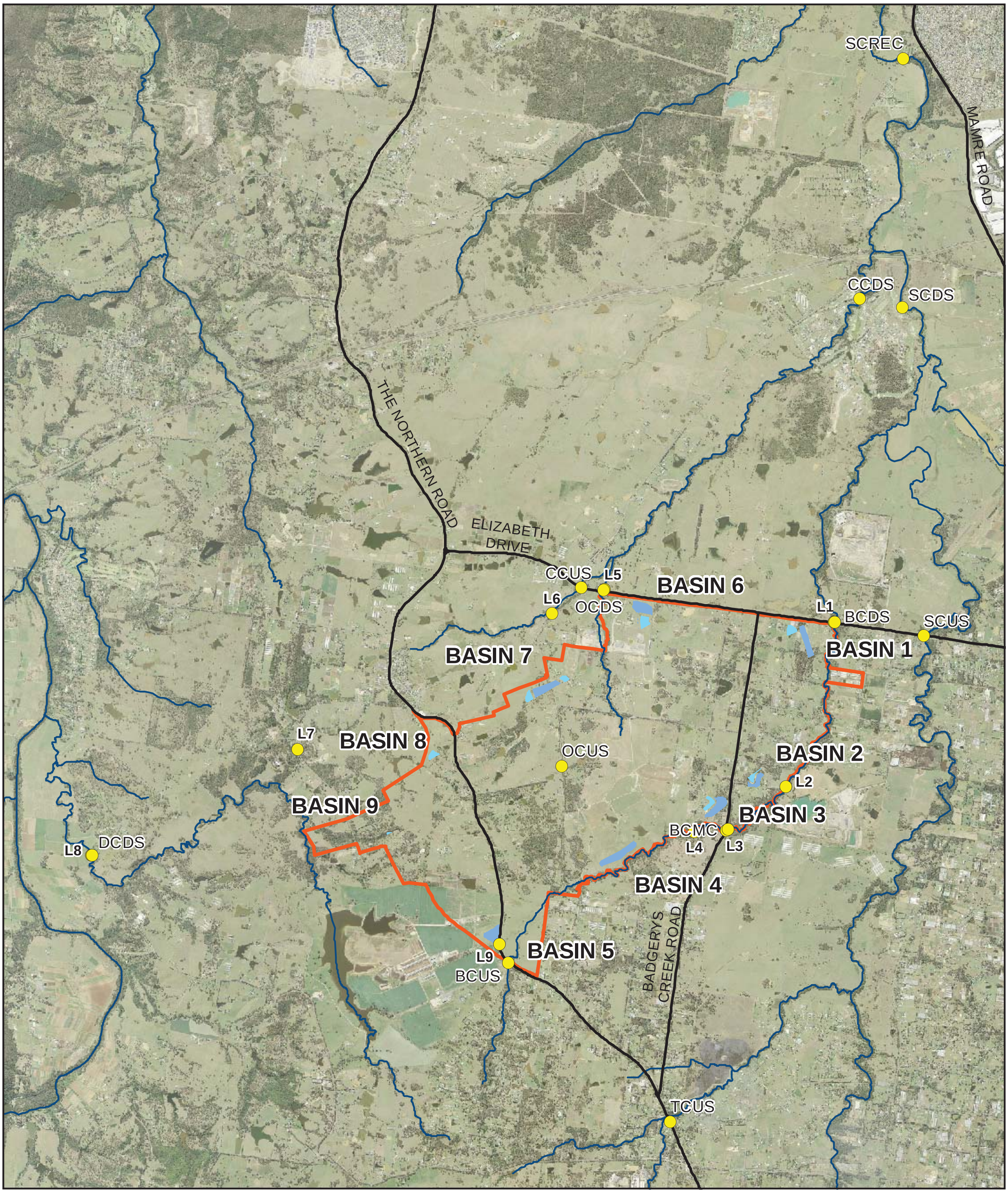
Of particular note is location L9 at Badgerys Creek off the Northern Road at the upstream end of the airport site. Water flow was observed to be blocked during the early stages of monitoring, with resulting high local levels of faecal coliforms, turbidity, nutrients, and heavy metals. However, the blockage appears to have cleared recently, and the high levels of pollution appear to have reduced. The full set of water quality sampling results available at the time of this report is included in Appendix A.

Overall, the results indicate that the existing water quality is yet to satisfy the objectives of the Hawkesbury Nepean Catchment Plan.

Table 3-7 Recent Surface Water Quality Data (GHD 2015, 2016)

Location	DO % sat	Conductivity uS/cm	Turbidity NTU	TSS mg/L	TN mg/L	TP mg/L
AEPR limits	**80%[a]**	**6.5-9**	**<10%[b]**	**<10%[c]**	**0.1**	**0.01**
ANZECC Guidelines	**85-110%**	**125-2200**	**6-50**	**40**	**0.5**	**0.05**
GHD (Mar 2015)						
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
GHD (Nov 2015 to July 2016, averaged monthly data)						
L1 (DS Basin 1)	44.4	1486	39.9	14.2	3.7	0.4
L2 (DS Basin 2)	45.7	1646	19.1	15.6	3.2	0.4
L3 (DS Basin 3)	57.1	6933	55.1	20.7	5.6	0.8
L4 (DS Basin 4)	45.8	1825	70.2	26.3	9.3	1.6
L5 (DS Basin 6)	54.5	2370	28.2	8.4	2.4	0.1
L6 (DS Basin 7)	41.2	*770*	31.9	8.8	1.1	0.1
L7 (DS Basin 8)	58.8	1502	20.3	11.7	1.1	0.1
L8 (Greendale Rd)	48.1	1534	33.6	10.5	1.1	0.1
L9 (Northern Rd)	17.8	2736	251.2	80.1	36.3	5.9

DO: Dissolved Oxygen; TN: Total nitrogen TP; Total phosphorus; TSS guideline level based on NSW Blue Book
a Denotes 80% of average
b Denotes <10% change in clarity
c Denotes <10% change in mean
Additional details are provided in Appendix A. ANZECC Guidelines values shown are default trigger values. AEPR limits – please refer to Table 2-1; <10%* = less than 10% change



LEGEND

- Airport site
- Monitoring Site
- Detention Basin
- Bio Retention Basin
- Road
- Waterway

1:70,000 @ A4

0 0.25 0.5 1 1.5 2

Kilometres

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

N

GHD

Recent surface water quality sampling locations

Job Number	21-2426508
Revision	C
Date	27 Apr 2016

Figure 3-6

Level 15, 133 Castlereagh Street Sydney NSW 2000 **T** 61 2 9239 7100 **F** 61 2 9239 7199 **E** sydmail@ghd.com.au **W** www.ghd.com.au

G:\21\24265\GIS\Maps\Deliverables\21_24265_Z126_Water Quality Monitoring Locations.mxd

Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

3.6 Interim Local Standards

Both AEPR and ANZECC Guidelines refer to water quality concentrations, as noted earlier. The water quality concentration limits specified in AEPR are more stringent, and for total nitrogen and total phosphorus, 5 times lower than those in ANZECC Guidelines. However, AEPR was developed in reference to ANZECC (1992) Guidelines, which has been updated to ANZECC (2000). Based on recent reviews and recommendations, it is understood that the limits in AEPR are likely to be updated to those of ANZECC Guidelines.

Part 5 of AEPR also provides flexibility in the administration of water quality standards. As noted earlier, Clause 5.02 (1) states that a substitute standard (local standard) may be proposed where it is considered that a limit of contamination specified in the AEPR is inappropriate. AEPR does not, however, provide any technical guidance on how a substitute standard should be derived, and the guidance provided in ANZECC Guidelines is therefore considered to be appropriate.

Based on ANZECC Guidelines, the site specific trigger levels may be established by computing the 80th percentile values from a minimum of two years of contiguous monthly data. The use of site specific trigger levels is preferred in ANZECC Guidelines, unless no monitoring data is available, as noted earlier.

Based on the above considerations, it is evident that for the proposed airport site, the use of site specific trigger levels is preferred and is more appropriate than the use of either the default trigger levels in ANZECC Guidelines or the current AEPR limits. This is particularly the case as the existing water quality is relatively poor, and a majority of the catchments surrounding the airport have relatively high pollutant loads from residential or intensive agricultural land activities.

For the Western Sydney Airport, monthly water quality monitoring commenced in November 2015 and 9 months of monitoring data have been collected and analysed at the time of this report. This comprises more than 80 samples collected at various locations around the airport site for each water quality parameter.

The interim site specific trigger levels derived from the 9 months of data, for total phosphorus, total nitrogen and suspended solids, are summarised in Table 3-8 and compared with AEPR limits and ANZECC default trigger levels. It is recognised that, despite the size of the present samples, the period of sampling still falls short of the 24 months stipulated in ANZECC Guidelines. Nevertheless, these interim results are considered to be useful in providing an early indication of the likely range of results expected when the full 24 months of data becomes available.

In Table 3-8, it is noted that the interim site trigger levels for total phosphorus and total nitrogen concentrations are significantly elevated above both the ANZECC Guidelines default trigger levels and AEPR limits. For suspended solids, however, the interim site trigger level is less than that in ANZECC Guidelines and the NSW Blue Book for Soils and Construction.

Table 3-8 Interim Site Trigger Levels

	TSS (mg/L)	TP (mg/L)	TN (mg/L)
Interim Site Trigger Levels[1]	23.2	0.92	6.2
ANZECC Guidelines Default Trigger Levels	40	0.05	0.5
AEPR Limits	Change not more than 10% from seasonal mean	0.01	0.1

1) Based on monthly water quality monitoring data obtained at various locations around the airport site, consisting of more than 80 samples for each parameter.

3.7 MUSIC modelling results under existing conditions

The results obtained from the MUSIC modelling for the existing environment are presented in Table 3-9 and Table 3-10 for key locations at and around the airport site. In Table 3-9, the results are presented for total phosphorus, total nitrogen, suspended solids and gross pollutants, in terms of annual loads, while the results in Table 3-10 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 9) as part of the airport concept design (Table 2-4), 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 3-9, it is estimated that on average, the airport site (Basin Outlets 1 to 9) would contribute approximately 230,440 kg of suspended solids, 376 kg of phosphorus, and 3,404 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 320,000 kg for suspended solids, 567 kg for phosphorus and 5,260 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 158,000 kg for suspended solids, 220 kg for phosphorus and 2,180 kg for nitrogen.

At the downstream locations of Duncan Creek (DN1), South Creek confluence with Kemps Creek (S2), and South Creek confluence with Blaxland Creek (S3), 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 3-10, the estimated pollutant concentrations are compared against ANZECC Guidelines default trigger values for moderately disturbed lowland rivers. It can be seen from these results that the phosphorus and nitrogen concentrations modelled at all the locations do not achieve ANZECC Guidelines default water quality objectives.

For total phosphorus, the mean concentrations are estimated to range from 0.09 to 0.38 mg/L, compared to an ANZECC default guideline of 0.05 mg/L. Similarly, the mean concentrations for total nitrogen are estimated to range from 1.45 to 2.91 mg/L, compared to an ANZECC default guideline level of 0.5 mg/L. The range of nutrient concentrations in these areas is largely consistent with the existing land uses and pollutant export rates in the catchment.

For total suspended solids, however, the estimated concentrations are expected to meet ANZECC Guidelines default water quality objectives at all the locations. The modelled concentrations are found to range from 20.4 to 23.2 mg/L, which are well below the ANZECC Guidelines level of 40 mg/L.

In Table 3-10, the interim trigger levels established in Table 3-8 for the airport site are also shown. It can be seen from these results that the modelled concentrations, under existing conditions, are generally below the interim trigger levels. In this regard, it is noted that the modelled results are based on 17 years of continuous rainfall data, while the interim trigger levels have been based on 9 months of data.

The above results are generally consistent with field measurements obtained by SMEC and GHD, as noted in Table 3-6 and Table 3-7. In terms of concentrations, there was little variation in the pollutant levels for both the airport site and downstream environment.

Overall, the results indicate that the existing airport development site and downstream South Creek catchments are of a fairly degraded nature and have poor water quality, particularly in terms of nutrients. The poor water quality does not satisfy ANZECC Guidelines default trigger levels for the protection of aquatic ecosystems, primary and secondary contact recreation, as well as irrigation water use for food and non-food crops most of the time.

Table 3-9 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	57400	103	915	1050
Basin 2 Outlet	56.4	6640	8.71	83.3	178
Basin 3 Outlet	149	20100	22.7	217	361
Basin 4 Outlet	77.9	4450	33.2	292	0
Basin 5 Outlet	260	35700	60.3	529	126
Basin 6 Outlet	372	52400	76.1	684	75.9
Basin 7 Outlet	171	30300	39.8	396	68.7
Basin 8 Outlet	120	16300	23.4	212	75.1
Basin 9 Outlet	53.9	7150	8.64	75.9	8.7
Total Basins 1 to 8 Outlets	**1765**	**230440**	**376**	**3404**	**1943**
Badgerys Creek B1	940	101000	183	1720	3010
Badgerys Creek B2 – BCMC	1600	180000	328	3060	3950
Badgerys Creek B3 – BCDS	2740	320000	567	5260	6330
Cosgroves Creek C1	999	158000	220	2180	532
Cosgroves Creek C3	1700	254000	368	3640	2450
Duncans Creek DN1	2300	317000	477	4230	1820
Kemps Creek Confluence S2	22500	2910000	4520	46000	76000
Blaxland Creek Confluence S3	32000	3880000	6110	61600	115000

Note: Refer to Figure 1-1, Figure 2-2, Figure 2-3 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 3-10 Average Pollutant Load Concentrations under Existing Conditions

Location	Average Pollutant Load Concentrations (mg/L)		
	TSS	TP	TN
AEPR Limits	**Change not more than 10% from seasonal mean**	**0.01**	**0.1**
ANZECC Default Guidelines	**< 40**	**0.05**	**0.5**
Interim Site Trigger Levels	**23.2**	**0.92**	**6.2**
Basin 1 Outlet	22.1	0.14	1.54
Basin 2 Outlet	22.1	0.09	1.25
Basin 3 Outlet	21.9	0.09	1.26
Basin 4 Outlet	20.7	0.38	2.91
Basin 5 Outlet	23.0	0.17	1.74
Basin 6 Outlet	22.5	0.15	1.60
Basin 7 Outlet	22.2	0.15	1.59
Basin 8 Outlet	23.2	0.13	1.52
Basin 9 Outlet	20.4	0.10	1.26
Badgerys Creek B1	21.5	0.14	1.48
Badgerys Creek B2 – BCMC	21.8	0.15	1.55
Badgerys Creek B3 – BCDS	21.9	0.15	1.55
Cosgroves Creek C1	22.7	0.15	1.61
Cosgroves Creek C3	22.5	0.15	1.58
DN1	22.1	0.14	1.54
Kemps Creek Confluence S2	21.0	0.13	1.45
Blaxland Creek Confluence S3	20.9	0.13	1.39

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

Time steps of zero flow have been excluded

4. Assessment of operational impacts of proposal

4.1 Changes in land use types and areas

The proposed land use plans for the Stage 1 development and the long term development are shown in Chapter 4 in Volume 1 of the EIS. The waterway catchment areas within the airport site corresponding with the initial and long term 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.

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

Waterway	Airport Site Catchment Areas (Ha)		
	Existing Conditions	Stage 1	Long Term
Badgerys Creek	1056	1038	1051
Cosgroves Creek	515	526	532
Duncans Creek	204	211	192
Total	**1775**	**1775**	**1775**

For the purposes of this study, the land use types for the proposed Stage 1 development and long 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 Long Term Development

Waterway	Grassed (%)	Paved (%)	Roofed (%)	TOTAL (%)
Stage 1 Development				
Badgerys Creek	89.4	7.6	3.0	100
Cosgroves Creek	68.3	29.6	2.1	100
Duncans Creek	88.2	11.5	0.3	100
Long Term Development				
Badgerys Creek	44.6	45.8	9.6	100
Cosgroves Creek	42.5	48.9	8.6	100
Duncans Creek	56.8	33.9	9.2	100

4.2 Treatment basins and residual catchment areas

As part of the revised draft Airport Plan and Concept Design, a number of bio-retention basins have been proposed for water quality treatment purposes. The proposed locations of these basins are shown in Figure 2-2 for Stage 1 and Figure 2-3 for the long term.

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 long term development. The residual areas are those areas that cannot physically discharge into the basins due to the proposed landform constraints. 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. However, it is noted that for the purposes of estimating the percentage retention of the pollutant loads under the WSUD Guidelines for Western Sydney, only the developed areas are included in the assessment.

Overall, it is estimated that 83%, 15%, and 2% of the airport site will be grassed, paved and roofed, respectively, during the Stage 1 development (Table 4-3). This will be modified to 45%, 45% and 10%, respectively, for the long term development (Table 4-4). In other words, the pervious areas (grassed) will reduce from 83% to 45%, while the impervious areas (paved and roofed) will increase from 17% to 55%.

Table 4-3 Basin Catchment Areas for Stage 1 Development

Basin Name	Basin and Residual Catchment Areas (Ha)			
	Grassed	Paved	Roofed	Total
Basin 1	116.4	43.9	17.8	178.1
Basin 1 Residual	14.1	0.6	-	14.6
Basin 2	56.6	12.9	8.7	78.2
Basin 2 Residual	151.3	4.0	-	155.3
Basin 3	122.1	10.4	4.6	137.1
Basin 3 Residual	101.6	1.1	-	102.7
Basin 4	-	-	-	-
Basin 4 Residual	76.2	-	-	76.2
Basin 5	-	-	-	-
Basin 5 Residual	289.9	5.8	-	295.6
Basin 6	103.1	101.6	7.0	211.7
Basin 6 Residual	55.1	8.9	-	64.0
Basin 7	181.0	42.7	3.9	227.7
Basin 7 Residual	20.1	2.6	0.1	22.8
Basin 8	55.2	15.1	0.7	71.0
Basin 8 Residual	36.5	2.9	-	39.6
Basin 9	48.0	6.3	-	54.3
Basin 9 Residual	46.8	-	-	46.8
Total	**1474 (83%)**	**259 (15%)**	**42 (2%)**	**1775 (100%)**

Notes: 1) Residual areas that cannot physically discharge into the basins due to landform constraints are assumed to discharge downstream of the basins for modelling purposes; however for the WSUD Guidelines for Western Sydney, only developed catchments are included in the assessment. 2) Basin 4 and Basin 5 are not constructed in the Stage 1 development but are constructed in the long term development.

Table 4-4 Basin Catchment Areas for Long Term Development

Basin Name	Basin and Residual Catchment Areas (Ha)			
	Grassed	Paved	Roofed	Total
Basin 1	75.0	125.9	44.3	245.2
Basin 1 Residual	73.8	18.6	-	92.40
Basin 2	44.9	44.4	4.5	93.7
Basin 2 Residual	42.0	0.8	-	42.8
Basin 3	45.1	61.3	20.9	127.2
Basin 3 Residual	18.7	1.4	0.08	20.2
Basin 4	78.4	149.1	19.1	244.6
Basin 4 Residual	18.3	0.8	-	19.1
Basin 5	45.2	52.8	11.7	109.7
Basin 5 Residual	28.1	28.2	-	56.3

Basin Name	Basin and Residual Catchment Areas (Ha)			
	Grassed	Paved	Roofed	Total
Basin 6	79.8	110.3	24.6	214.7
Basin 6 Residual	53.6	11.2	-	64.9
Basin 7	73.6	135.8	21.1	230.5
Basin 7 Residual	19.8	3.2	0.08	23.1
Basin 8	20.6	46.0	4.2	70.8
Basin 8 Residual	0.1	10.4	12.5	23.0
Basin 9	41.2	8.9	1.0	51.1
Basin 9 Residual	45.7	-	-	45.7
Total	**805 (45%)**	**807 (45%)**	**163 (10%)**	**1775**

Note: Residual areas that cannot physically discharge into the basins due to landform constraints are assumed to discharge downstream of those basins for modelling purposes; however for the WSUD Guidelines for Western Sydney, only developed catchments are included in the assessment.

4.3 Operational Runoff Water Quality

Surface water runoff generated during the operational phase of the airport may include a range of pollutants such as suspended and dissolved solids, nutrients, gross pollutants, heavy metals, and total petroleum hydrocarbons (TPH).

Suspended solids and nutrients are generated, in differing quantities, under all types of rural and urban catchments, and may be the result of soil erosion, decaying vegetation and matter, and the use of fertilisers. Gross pollutants include anything larger than sediment, and may be organic or non-organic. They include rubbish, plastic, bottles, tyres, or larger items such as shopping trolleys. Heavy metals such as zinc, lead, chromium and copper are generally associated with aircraft and vehicle movement, as well as repair workshops and maintenance areas. The corrosion of galvanised materials, pipes, metal work, wear and tear of tyres, brakes, and the combustion of lubricating oils all have the potential to generate heavy metals. Total petroleum hydrocarbons in fuels stored, transferred or burnt, may also find their way into the drainage system and impact on the downstream waterways.

It is noted that heavy metal elements may also originate from natural soils in the area or from existing land uses. Indeed, recent water quality data (Section 3.5 and Appendix A) obtained at the airport watercourses indicate that under existing conditions, there have been exceedances above ANZECC Guideline levels for zinc, copper and chromium. Similarly, elevated levels of suspended solids and nutrients have been recorded under existing conditions, as discussed in Section 3.5.

Water quality monitoring data for Brisbane Airport during its operational phase, as well as other international literature, indicate that heavy metal elements, especially those in particulate form, are generally strongly bound to suspended solids in surface runoff. The available data also suggests that the heavy metal elements are effectively filtered and captured through grass swales and sediment retention basins provided as part of a water quality management and treatment strategy.

For the proposed airport, ongoing monitoring of the watercourses during the development and operational phases of the project will be used to inform the project of the level of pollution and effectiveness of the proposed measures. However, additional measures will be implemented where required. TPHs will also be handled under strict management and containment policies to ensure that there are no breaches. This is discussed further in Sections 5 and 6.

In the following sections, surface water runoff pollutants assessed for both the Stage 1 development and long term development of the airport are limited to suspended solids, nutrients (phosphorus and nitrogen), and gross pollutants. This is the current industry standard in Australia. This is partly attributed to the limitations of existing industry modelling software, as well as the inherent uncertainties and margins of error in the modelling of other pollutants. The results of the modelling are discussed below.

4.4 Stage 1 development

4.4.1 Average annual pollutant loads

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 airport 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. The increase in nutrient loads is predicted to increase with the incorporation of all the proposed bio-retention basins in place. It is noted that Basin 4 and Basin 5 will not be constructed in the Stage 1 development but would be constructed in the long term.

Based on these results, the total phosphorus loads at the basin outlets are estimated to increase by between 0% to +1530% compared to existing loads. Similarly, the total nitrogen loads are estimated to change by between -23% to +890% relative to existing conditions. For total suspended solids, five (5) of the nine (9) outlet locations are estimated to have load increases of between +1% to +418%, while the remaining outlets are estimated to have reductions of between -15% to -68%. In other words, the proposed bio-retention basins would generally be unable to attenuate the pollutant loads to pre-development levels. However, a reduction in suspended solids is expected at some of the locations.

Due to the change in catchment areas associated with the proposed topography, not all flows can be directed to the proposed basin locations. This may result in the expected increases in total phosphorus and total nitrogen loads in the Stage 1 development. However, the flow paths are expected to improve in the long term development.

The bio-retention basins proposed for the Stage 1 development for water quality management are not likely to satisfy the pre-development load targets. This is not surprising, considering that the targets are particularly difficult to comply with for rural sites, as noted earlier, meaning that they may not be achievable without sterilising large sections of the airport site. Further improvements in water quality relative to pre-development load targets are, however, expected 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), 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 +32% (annual flows), +5% (suspended solids), +72% (total phosphorus), and +30% (total nitrogen) compared to pollutant loads under existing conditions. The impacts are then estimated to reduce to +4% (annual flows), -5% (reduction in suspended solids), +8% (total phosphorus), and +3% (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 much the same with +6% (annual flows), -4% (reduction in suspended solids), +9% (total phosphorus), and +4% (total nitrogen).

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 +93% (annual flows), -8% (reduction in suspended solids), +84% (total phosphorus), and +39% (total nitrogen) are observed to dissipate to +54% (annual flows), -6% (reduction in suspended solids), +49% (total phosphorus), and +23% (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 +8%, a +5% increase for suspended solids, a +6% increase for total phosphorus, and a +7% increase for total nitrogen.

Overall, the above results indicate that the development of bio-retention basins will not fully achieve the pre-development load targets at the downstream regional locations. Due to the increased loads derived from catchments outside of the airport site, these regional impacts are expected to progressively decrease at locations further downstream.

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 (to Badgerys Creek)	555 (+10%)	18400 (-68%)	103 (+5%)	702 (-23%)	257
Basin 2 Outlet (to Badgerys Creek)	456 (+709%)	34400 (+418%)	142 (+1530%)	825 (+890%)	2430
Basin 3 Outlet (to Badgerys Creek)	410 (+175%)	20400 (+1%)	106 (+367%)	626 (+188%)	1360
Basin 4 Outlet (to Badgerys Creek)	130 (+67%)	15600 (+251%)	60.9 (+83%)	336 (+15%)	2310
Basin 5 Outlet (to Badgerys Creek)	529 (+103%)	67500 (+89%)	254 (+321%)	1340 (+153%)	9750
Basin 6 Outlet (to Oaky/ Cosgroves Creek)	899 (+142%)	44300 (-15%)	188 (+147%)	1200 (+75%)	2160
Basin 7 Outlet (to Cosgroves Creek)	573 (+235%)	20100 (-34%)	109 (+174%)	745 (+88%)	696
Basin 8 Outlet (to Duncans Creek)	169 (+41%)	6400 (-61%)	34.4 (+47%)	220 (+4%)	0
Basin 9 Outlet (to Duncans Creek)	172 (+219%)	8400 (+17%)	44.2 (+412%)	272 +258%)	539

Location	Annual Flow (ML/yr)	Average Annual Loads (kg/yr)			
		TSS	TP	TN	Gross Pollutants
B1	1080 (+15%)	110000 (+9%)	355 (+94%)	2330 (+35%)	12600
B2 – BCMC	1700 (+11%)	199000 (+11%)	523 (+59%)	3680 (+20%)	15800
B3 – BCDS	3620 (+32%)	337000 (+5%)	976 (+72%)	6830 (+30%)	20700
Regional Impacts					
Cosgroves Creek C1	1930 (+93%)	146000 (-8%)	404 (+84%)	3030 (+39%)	3250
Cosgroves Creek C3	2610 (+54%)	240000 (-6%)	549 (+49%)	4480 (+23%)	5130
Duncans Creek DN1	2480 (+8%)	332000 (+5%)	507 (+6%)	4540 (+7%)	3190
Kemps Creek Confluence - S2	23400 (+4%)	2770000 (-5%)	4900 (+8%)	47200 (+3%)	90400
Blaxland Creek Confluence – S3	33800 (+6%)	3710000 (-4%)	6670 (+9%)	63800 (+4%)	132000

Notes: 1) Values in brackets show percentage increase (+) or decrease (-) in loads compared to existing conditions 2) The results at the location of Basin 4 and Basin 5 are those without the basins being constructed, as Basin 4 and Basin 5 are developed only in the long term.

4.4.2 Pollutant Load Retentions

The potential impacts of the proposed Stage 1 Development, measured against the requirements of pollutant retention guidelines, specifically the WSUD Guidelines (see Table 2-3), 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 in the use of the WSUD Guidelines for Western Sydney, the basin outlet flows are derived only from the proposed development areas. In addition, Basin 4 and Basin 5 will not be constructed in the Stage 1 development but would be constructed in the long term.

It is noted that the above WSUD Guidelines specify only the retention targets that should be achieved on-site at the basin outlets. Consequently, 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, or where large rural catchments remain in those downstream areas. For this reason, the pollutant retention targets shown in Table 4-6 are limited to only the airport basin outlets, and do not include any of the downstream catchments.

In Table 4-6, the nine (9) 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, total phosphorus and total nitrogen Basins 1, 3, 6, 7 and 8 satisfy the retention target. The remaining Basins 2 and 9 do not satisfy the retention targets. However, Basin 9 also satisfies the retention target for total phosphorus.

Overall, the results indicate that the percentage retention targets are met for flows discharging from the site into Oaky Creek and Cosgroves Creek. For Badgerys Creek (Basin 2) and Duncans Creek (Basin 9) where the percentage retention targets are not met, it is considered that additional management measures may be required. This includes the possibility of enlarging the treatment areas provided. Other potential measures are discussed in Section 6.

Table 4-6 Stage 1 Percentage Pollutant Load Retentions

Location	% Retention of Pollutant Loads		
	TSS (%)	TP (%)	TN (%)
Western Sydney Guidelines	**80%**	**45%**	**45%**
Basin 1 Outlet (to Badgerys Creek)	85.0	60.6	48.4
Basin 2 Outlet (to Badgerys Creek)	62.9	40.4	34.7
Basin 3 Outlet (to Badgerys Creek)	83.0	59.6	53.7
Basin 4 Outlet (to Badgerys Creek)	0.0	0.0	0.0
Basin 5 Outlet (to Badgerys Creek)	0.0	0.0	0.0
Basin 6 Outlet (to Oaky/ Cosgroves Creek)	82.6	61.3	45.1
Basin 7 Outlet (to Cosgroves Creek)	83.4	61.0	45.3
Basin 8 Outlet (to Duncans Creek)	83.4	60.1	45.4
Basin 9 Outlet (to Duncans Creek)	76.1	50.8	37.4

Notes: 1) Basin 4 and Basin 5 are not constructed in Stage 1 but as part of the long term development.

4.4.3 Pollutant concentrations

The results of the MUSIC modelling for the Stage 1 development are summarised in Table 4-7 for suspended solids, total phosphorus and total nitrogen, together with ANZECC Guidelines default trigger levels for slightly disturbed ecosystems in lowland rivers, AEPR limits, and interim site trigger levels established for the airport catchment (see Section 3.6). Detailed results showing the pollutant concentrations obtained under Stage 1 development 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 2, Basin 3, and Basin 9 where total phosphorus increases marginally from 0.09 - 0.10 mg/L to 0.11 mg/L and at Basins 4 and 5 (without the basin), where suspended solids are estimated to increase slightly.

Overall, the results indicate that ANZECC Guidelines default objectives and AEPR limits would not be achieved in the Stage 1 development, with the exception of total suspended solids. This is notwithstanding the general improvements in water quality relative to the existing environment. However, using the interim site trigger levels established for the airport catchment, the Stage 1 post-development water quality is found to satisfy the site specific water quality objectives for suspended solids, total phosphorus, and total nitrogen at all the locations.

(b) Regional Impacts

The regional downstream impacts are not as great as the local impacts. All 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.

However, as in the case of local impacts, the regional results indicate that ANZECC Guidelines default water quality objectives and AEPR limits would not be achieved, despite the general improvements in water quality, with the exception of the level of suspended solids.

Compared against the interim site trigger levels, however, the Stage 1 regional post-development water quality is found to satisfy the site specific water quality objectives for suspended solids, total phosphorus, and total nitrogen at all the locations.

The above outcomes are due to the degraded nature of the existing catchments, as discussed in Section 2.1.5. Nevertheless, it is noted that the proposed airport does not preclude the opportunity to make further improvements in downstream water quality in South Creek in the future, in order to satisfy the NSW Water Quality Objectives. However, it is expected that, in order to achieve this, significant improvements in land use practices and water management for the entire South Creek catchment would be required. Further, it is expected that such improvements can only be achieved progressively over an extended period of time and coordinated by state or regional organisation.

Table 4-7 Stage 1 Pollutant Load Concentrations

Location	Pollutant Load Concentrations (mg/L)					
	Existing			Stage 1		
	TSS	TP	TN	TSS	TP	TN
AEPR Limits	**<10%***	**0.01**	**0.1**	**<10%***	**0.01**	**0.1**
ANZECC Guidelines	**40**	**0.05**	**0.5**	**40**	**0.05**	**0.5**
Interim Site Trigger Levels[3]	**24.4**	**0.95**	**6.2**	**24.4**	**0.95**	**6.2**
Local Impacts						
Basin 1 Outlet (to Badgerys Creek)	22.1	0.14	1.54	7.09	0.12	0.75
Basin 2 Outlet (to Badgerys Creek)	22.1	0.09	1.25	15.7	**0.11**	0.97
Basin 3 Outlet (to Badgerys Creek)	21.9	0.09	1.26	13.2	**0.11**	0.91
Basin 4 Outlet (to Badgerys Creek)	20.7	0.38	2.91	**23.5**	0.10	1.19
Basin 5 Outlet (to Badgerys Creek)	23.0	0.17	1.74	**23.9**	0.10	1.18
Basin 6 Outlet (to Oaky/ Cosgroves Creek)	22.5	0.15	1.60	12.3	0.11	0.87
Basin 7 Outlet (to Cosgroves Creek)	22.2	0.15	1.59	7.56	0.12	0.75
Basin 8 Outlet (to Duncans Creek)	23.2	0.13	1.52	2.45	0.12	0.62
Basin 9 Outlet (to Duncans Creek)	20.4	0.10	1.26	13.3	**0.11**	0.94
Badgerys Creek B1	21.5	0.14	1.48	**23**	0.11	1.20
Badgerys Creek B2	21.8	0.15	1.55	22.9	0.11	1.22
Badgerys Creek B3	21.9	0.15	1.55	15.1	0.12	1.00
Regional Impacts						
Cosgroves Creek at C1	22.7	0.15	1.61	11.0	0.12	0.88
Cosgroves Creek at C3	22.5	0.15	1.58	11.4	0.12	0.91
Duncans Creek at DN1	22.1	0.14	1.54	14.9	0.12	1.03
South Creek Kemps Creek Confluence S2	21	0.13	1.45	15.2	0.12	1.04
South Creek Blaxland Creek Confluence S3	20.9	0.13	1.39	14.4	0.11	1.01

Note: 1) Locations where the mean concentrations have increased are shown in bold. 2) Additional details for AEPR limits are shown in Table 2-1; <10%* = less than 10% change. 3) 80th percentile site data based on water quality monitoring undertaken for this EIS.

4.5 Long term development

4.5.1 Average annual pollutant loads

The average annual pollutant loads obtained for the long 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 existing conditions is shown in brackets for comparison. Both local and regional impacts are summarised in this table. The local impacts relate to those up to 16 km 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 long term development conditions, the annual loads for total phosphorus and total nitrogen will increase, compared to existing conditions. The average annual loads for total phosphorus are estimated to increase by 161% to 821% at the various basin outlet locations assessed. Similarly, the average annual total nitrogen loads are estimated to increase by 91% to 549%. For total suspended solids, the results indicate that some locations will be impacted by an increase of up to 756%. However, at the Basin 3, Basin 6 and Basin 8 outlets, a reduction in total suspended solids is expected. Overall, 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 long 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 due to additional areas being urbanised as part of the development of the proposed airport.

(b) Regional Impacts

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

Badgerys Creek, on leaving the airport site at Elizabeth Drive (B3) is estimated to have increases of +102% (annual flows), +22% (suspended solids), +105% (total phosphorus), and +63% (total nitrogen) compared to pollutant loads under existing conditions. These impacts are estimated to reduce to +12% (annual flows), +2% (suspended solids), +13% (total phosphorus), and +8% (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 much the same with +13% (annual flows), +3% (suspended solids), +14% (total phosphorus), and +8% (total nitrogen).

Similarly, at the Elizabeth Drive crossing of Cosgroves Creek (C1), the increases of +154% (annual flows), +12% (suspended solids), +130% (total phosphorus), and +75% (total nitrogen) are observed to reduce to +89% (annual flows), +7% (suspended solids), +77% (total phosphorus), and +45% (total nitrogen) by the time the flows arrive at Cosgroves Creek 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 +18%, an increase of +11% for suspended solids, a +21% increase for total phosphorus and a +17% 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 Long Term Average Annual Pollutant Loads

Location	Annual Flow (ML/yr)	Average Annual Pollutant Loads (kg/yr)			
		TSS	TP	TN	Gross Pollutants
Local Impacts					
Basin 1 Outlet (to Badgerys Creek)	1300 (+157%)	69600 (+21%)	269 (+161%)	1750 (+91%)	3990
Basin 2 Outlet (to Badgerys Creek)	402 (+613%)	15200 (+129%)	80.2 (+821%)	541 (+549%	617
Basin 3 Outlet (to Badgerys Creek)	577 (+287%)	19300 (-4%)	104 (+358%)	764 (+252%)	467
Basin 4 Outlet (to Badgerys Creek)	1090 (+1299%)	38100 (+756%)	199 (+499%)	1440 (+393%)	345

Location	Annual Flow (ML/yr)	Average Annual Pollutant Loads (kg/yr)			
		TSS	TP	TN	Gross Pollutants
Basin 5 Outlet (to Badgerys Creek)	638 (+145%)	77200 (+116%)	193 (+220%)	1050 (+98%)	5090
Basin 6 Outlet (to Oaky/ Cosgroves Ck)	1030 (+177%)	50700 (-3%)	209 (+175%)	1370 (+100%)	2520
Basin 7 Outlet (to Cosgroves Creek)	1050 (+514%)	40800 (+35%)	191 (+380%)	1400 (+254%)	789
Basin 8 Outlet (to Duncans Creek)	313 (+161%)	16000 (-2%)	63.2 (+170%)	419 (+98%)	0
Basin 9 Outlet (to Duncans Creek)	182 (+238%)	8970 (+25%)	46.1 (+434%)	289 (+281%)	539
B1	1190 (+27%)	117000 (+16%)	294 (+61%)	2030 (+18%)	7970
B2 – BCMC	2840 (+78%)	224000 (+24%)	605 (+84%)	4480 (+46%)	9210
B3 – BCDS	5540 (+102%)	391000 (+22%)	1160 (+105%)	8550 (+63%)	15100
Regional Impacts					
Cosgroves Creek C1	2540 (+154%)	177000 (+12%)	506 (+130%)	3810 (+75%)	3690
Cosgroves Creek C3	3210 (+89%)	273000 (+7%)	653 (+77%)	5280 (+45%)	5580
Duncans Creek DN1	2710 (+18%)	352000 (+11%)	578 (+21%)	4930 (+17%)	6580
South Creek Kemps Creek Confluence - S2	25300 (+12%)	2970000 (+2%)	5090 (+13%)	49600 (+8%)	84800
South Creek Blaxland Creek – S3	36300 (+13%)	3980000 (+3%)	6940 (+14%)	66800 (+8%)	127000

4.5.2 Pollutant Load Retentions

The potential impacts of the long term airport development, measured against the requirements of pollutant load retentions or 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, in the use of the WSUD Guidelines for Western Sydney, the basin outlet flows are those derived from the developed portions of the airport site.

The WSUD Guidelines specify only the retention targets that should be achieved on site at the proposed basin outlets. As such, these 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. Catchment areas downstream of the airport site have therefore been excluded from this assessment.

In Table 4-9, the nine (9) 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, the discharges from all basins except Basin 5 satisfy the 80% retention target. The 79.3% achieved at Basin 1 is considered to be acceptable and within the limits of modelling error. For total phosphorus, all basins except Basins 5 satisfy the 45% retention target, while for total nitrogen, all basins except Basin 5 and Basin 9 satisfy the 45% retention target.

Overall, the results indicate that the retention targets, in terms of WSUD Guidelines, are generally satisfied for flows discharging from the airport site into Badgerys Creek and

Cosgroves Creek (except Basin 5). At the basin outlet locations where the targets are not satisfied (Basins 5 and 9), it is suggested that consideration be given to enlarging the basin treatment areas provided. This may occur during the detailed design phase. Other potential management measures are discussed in Section 6.

Table 4-9 Long Term Percentage Load Retentions

Location	% Retention in Pollutant Loads		
	TSS (%)	TP (%)	TN (%)
Western Sydney Technical Guidelines	**80**	**45**	**45**
Basin 1 Outlet (to Badgerys Creek)	79.3	58.2	45.4
Basin 2 Outlet (to Badgerys Creek)	86.9	63.7	46.9
Basin 3 Outlet (to Badgerys Creek)	87.1	63.4	46.4
Basin 4 Outlet (to Badgerys Creek)	88.5	67.2	46.3
Basin 5 Outlet (to Badgerys Creek)	56.3	42.4	31.9
Basin 6 Outlet (to Oaky/ Cosgroves Creek)	81.6	59.6	45.1
Basin 7 Outlet (to Cosgroves Creek)	86.5	65.2	45.2
Basin 8 Outlet (to Duncans Creek)	83.5	63.7	45.4
Basin 9 Outlet (to Duncans Creek)	81.8	55.1	41.0

4.5.3 Pollutant concentrations

The results for the long term development are summarised in Table 4-10 for suspended solids, total phosphorus and total nitrogen, together with ANZECC Guidelines default trigger levels for slightly disturbed ecosystems in lowland rivers, AEPR limits, and interim site trigger levels established for the airport catchment. Detailed results showing the pollutant concentrations obtained under long 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 4-10. The exceptions are those at Basins 2, 3 and 9, where total phosphorus increases marginally from 0.09 – 0.10 mg/L to 0.11 mg/L.

Despite the above improvements, the results indicate that ANZECC Guidelines default water quality objectives and AEPR limits would not be achieved, except for suspended solids. However, the interim site specific trigger levels would be satisfied for suspended solids, total phosphorus and total nitrogen at all the locations.

(b) Regional Impacts

The regional downstream impacts are smaller than the local impacts. All 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.

As in the case of local impacts, the regional results for the downstream areas indicate that ANZECC Guidelines default water quality objectives would not be achieved, except for suspended solids, despite the general improvements in water quality. By comparison, the interim site specific trigger levels would be satisfied for suspended solids, total phosphorus, and total nitrogen at all the locations modelled.

The above results reflect the degraded nature of the existing catchments. As noted earlier, there would be opportunities to make further improvements in downstream water quality in South Creek in the future, in order to work towards satisfying the NSW Water Quality Objectives. However, significant improvements in land use practices and management of water quality, for the entire South Creek catchment, are expected to be required in order to achieve this.

As discussed in Section 2.1.5 and Section 3.6, site specific water quality trigger levels (rather than default trigger levels) will be adopted when a minimum of two years of water quality monitoring data becomes available. With the implementation of the mitigation and management measures outlined in this report, it is expected that the discharge water quality from the airport development will comply with the site specific criteria.

Table 4-10 Long Term Development Pollutant Concentrations

Location	Existing Conditions (mg/L)			Long Term Development (mg/L)		
	TSS	TP	TN	TSS	TP	TN
AEPR Limits	**<10%***	**0.01**	**0.1**	**< 10%***	**0.01**	**0.1**
ANZECC Guidelines	**40**	**0.05**	**0.5**	**40**	**0.05**	**0.5**
Interim Site Trigger Levels[2]	**24.4**	**0.95**	**6.20**	**24.4**	**0.95**	**6.2**
Basin 1 Outlet (to Badgerys Creek)	22.1	0.14	1.54	13.0	0.11	0.88
Basin 2 Outlet (to Badgerys Creek)	22.1	0.09	1.25	13.3	**0.11**	0.91
Basin 3 Outlet (to Badgerys Creek)	21.9	0.09	1.26	10.6	**0.11**	0.84
Basin 4 Outlet (to Badgerys Creek)	20.7	0.38	2.91	9.70	0.12	0.82
Basin 5 Outlet (to Badgerys Creek)	23.0	0.17	1.74	14.2	0.11	0.89
Basin 6 Outlet (to Oaky/ Cosgroves Creek)	22.5	0.15	1.60	12.5	0.11	0.87
Basin 7 Outlet (to Cosgroves Creek)	22.2	0.15	1.59	9.5	0.12	0.81
Basin 8 Outlet (to Duncans Creek)	23.2	0.13	1.52	2.9	0.13	0.63
Basin 9 Outlet (to Duncans Creek)	20.4	0.10	1.26	13.4	0.11	0.92
Badgerys Creek B1	21.5	0.14	1.48	15.0	0.12	0.98
Badgerys Creek B2	21.8	0.15	1.55	13.3	0.12	0.95
Badgerys Creek B3	21.9	0.15	1.55	13.3	0.12	0.95
Cosgroves Creek at C1	22.7	0.15	1.61	12.5	0.12	0.94
Cosgroves Creek C3	22.5	0.15	1.58	12.8	0.12	0.96
Duncans Creek DN1	22.1	0.14	1.54	14.8	0.12	1.04
South Creek Kemps Creek Confluence S2	21.0	0.13	1.45	13.9	0.12	1.01
South Creek Blaxland Creek Confluence S3	20.9	0.13	1.39	13.7	0.12	0.99

Note: 1) Additional details for AEPR limits are shown in Table 2-1, <10%* = less than 10% change. 2) 80^{th} percentile site data based on water quality monitoring undertaken for this EIS.

4.6 Fuel jettisoning

The issue of potential adverse effects from fuel jettisoning (fuel dumping) 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 in the 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, 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 the maximum landing weight. Data for annual frequency and amounts of fuel jettisoned near Australian airports is unavailable, however in total, it is estimated that up to 6,800 tonnes of fuel was released over oceans in the 1990s (Aerospaceweb, 2005). The significant cost of fuel means that fuel jettisoning only occurs when necessary. It is in the airlines' best interest to conserve fuel and consider alternate options prior to jettisoning fuel.

Fuel jettisoning events are extremely rare worldwide. For example, All Nippon Airways (Japan's largest airline by revenues and passenger numbers in 2012) had only three cases of fuel jettisoning 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 jettisoning fuel.

Civil aircraft generally use Jet-A1 grade fuel which contains up to approximately 20% aromatic hydrocarbons (including benzene) by volume and approximately 2% of naphthalenes (including Polycyclic Aromatic Hydrocarbons) by volume (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 during long-term exposure (Harrison et al, 2010). However, since fuel jettisoning is a rare event and protocols are in place to ensure the safety of persons and property on the ground, fuel jettisoning 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 surface water quality during the construction phases for both the proposed Stage 1 development and the long term development. 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 may result in the release of pollutants into 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 and 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 Guidelines 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 is noted below.

5.2 Duration of construction works

Large rainfall events occurring during the construction phase of the proposed airport may result in increased mobilisation of soils, flooding of equipment and increased risks due to construction 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, these 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.

Frequently disturbed areas, including vehicle access tracks and areas with surface grades greater than 2.5 per cent 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. Other disturbed areas with exposed soils, including stockpiled soils, are susceptible to erosion during rainfall events or high winds and will require careful on-site management.

Construction of the long term airport development involves the disturbance of additional land surfaces and 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 airport site during construction may still enter the downstream waterways if not managed carefully. In the event that runoff from the airport site is uncontrolled and discharges into downstream waterways, localised scour could occur at the points of discharge.

Erosion and sediment controls implemented during the construction phase are likely to prevent significant increases in nutrient loads. However particulate phosphorous is likely to increase where erosion and scour is allowed to propagate.

5.4 Potential for spills

Potentially harmful chemicals and other substances may be released during construction. This would have the potential to impact on water quality in receiving waters downstream of the airport site. Potentially contaminating substances 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 may pollute surface water runoff and be transported downstream from the proposed construction areas. Contaminants in waterways may cause water quality and associated ecological impacts 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. However, 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 long 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 include:

- 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.

Mobilised dust, litter and other building materials that are deposited and picked up by surface water runoff, waterways or stormwater management infrastructure may degrade 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. Building materials associated with demolition waste, 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 Stage 1 development and the long term development, key water quality management measures proposed as part of the management strategy include the following:

(a) Design based measures

- During detailed design, consideration would be given to enhancing the infiltration properties of the swales in order to increase their effectiveness in polishing the stormwater quality prior to discharging to the bio-retention basins.
- During detailed design, diversion drains would be designed to convey flows from developed “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.

(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 surface water in gross pollutant traps and bio retention 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*.
- To take into account existing water quality levels at the airport site, local standards for water quality will be developed under Part 5 of the AEPR. However, as AEPR does not provide any specific guidance for the development of local standards, the site specific trigger level process under the ANZECC Guidelines will be used to guide the development of local standards. ANZECC Guidelines states that site specific trigger levels should be based on contiguous monthly data derived from a minimum of 2 years of monitoring. Accordingly, water quality monitoring for the airport site has commenced and will continue for at least 2 years. To date, 9 months of data have been collected and analysed, comprising of more than 80 samples for each water quality parameter collected at various locations around the airport site.
- Interim site specific trigger levels have been derived and included in this report.
- 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.
- 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 Stage 1 and long 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 proposed airport development. 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 Stage 1 development and long term development. 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 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;
- direction of all runoff leaving the construction site to a detention or water quality facility before downstream release;
- stabilisation of the banks of temporary stream diversion channels 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 the 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 chemical 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 long term development stages of the proposed airport development.

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 either AEPR limits or ANZECC Guidelines default water quality levels and objectives for total phosphorus and total nitrogen. However, total suspended solids loads are generally low and achieve ANZECC Guidelines default water quality objectives.

To take into account existing water quality levels at the airport site, local standards for water quality will be developed under Part 5 of the AEPR. However, as AEPR does not provide any specific guidance for the development of local standards, the site specific trigger level process under the ANZECC Guidelines will be used to guide the development of local standards. ANZECC Guidelines states that site specific trigger levels should be based on contiguous monthly data derived from a minimum of 2 years of monitoring. Accordingly, water quality monitoring for the airport site has commenced and will continue for at least 2 years. To date, 9 months of data have been collected and analysed, comprising of more than 80 samples for each water quality parameter collected at various locations around the airport site.

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 development and the long term development phases for the proposed airport and identify the potential impacts of the proposed airport development.

Bio-retention basins proposed as part of the Draft Airport Plan and Concept Plan were incorporated into the modelling. Nine 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 Basins 8 and 9 were provided to manage flows discharging into Duncans Creek. The majority of the basins are proposed for construction during Stage 1 of the project, except for Basin 4 and Basin 5, which would be constructed during the long 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 proposed airport development. In evaluating the effectiveness of the proposed measures, five sets of water quality criteria were used. These were (i) AEPR water quality limits, (ii) ANZECC Guidelines default trigger levels, (iii) interim site specific trigger levels, (iv) comparison of post development pollutant loads with existing loads (NORBE), and (v) pollutant retention targets (WSUD).

Under the Stage 1 development, the results indicate that the existing AEPR limits and ANZECC Guidelines default water quality trigger levels would not be achieved, except for suspended solids. This is despite the general improvements in water quality concentrations relative to the existing environment, particularly in Badgerys Creek and South Creek. However, use of the interim site trigger indicate that the criteria would be achieved for suspended solids, total phosphorus and total nitrogen at all the locations.

The Stage 1 results indicate that the post-development loads would not be reduced to existing loads (NORBE), except for suspended solids in four out of the nine basin outlet locations.

The Stage 1 results indicate that the pollutant retention targets (WSUD) would be satisfied at five out of the seven basin outlet locations. Where the pollutant retention targets are not met in Basin 2 and Basin 9, consideration will be given to increasing the size of the basin treatment areas during detailed design. The buffer areas set aside within the basin footprints would facilitate this increase. Other supplementary design measures would also be considered during the detailed design phase.

Under the long term development, the results indicate that that AEPR limits and ANZECC Guidelines default water quality objectives would not be achieved, except for suspended solids. This is despite the general improvements in water quality, in terms of concentrations, relative to the existing environment. However, as for Stage 1, use of the interim site specific water quality trigger levels indicate that the interim criteria would be achieved for suspended solids, total phosphorus and total nitrogen at all the locations.

The long term results indicate that the post-development loads would not be reduced to existing loads (NORBE), except for suspended solids, where it is achieved at three of the nine basin outlet locations.

The long term results indicate that the pollutant retention targets (WSUD) for total suspended solids, total phosphorus, and total nitrogen are satisfied for flows discharging from all the basins, with the exception of Basin 5. At this basin outlet location where the target is not satisfied, consideration will be given to increasing the size of the basin treatment areas at these locations during detailed design. Other supplementary design measures may also be considered where necessary.

Overall, it is considered that the use of site specific trigger levels is appropriate and would take precedence over existing AEPR limits and ANZECC Guidelines default trigger levels. At this stage, only interim site trigger levels can be established, on the basis of the nine months of monitoring data available. However, the indications are that if the same trends are exhibited in the field when a total of 24 months of data becomes available, the final site specific trigger levels would be similar to the interim levels. On this basis, the proposed airport would satisfy the AEPR water quality limits under the provisions of a substitute local standard, for both Stage 1 and the long term development. It would also satisfy ANZECC Guidelines in the use of the site specific trigger levels.

During detailed design, additional measures would be assessed for implementation with the aim of optimising the level of water quality treatment provided prior to downstream discharge. In particular, it is noted that the concept design has been designed with sufficient buffers to enable the bio-retention treatment areas to be enlarged. Increasing the size of the bio-retention treatment areas would improve the level of treatment achieved, and is expected to lead to the pollutant retention targets being satisfied at all the basin outlet locations.

Other potential improvement measures include the use of enhanced infiltration swales along all the drainage lines for additional water quality polishing and the implementation of diversion drains to convey additional flows from the urbanised residual areas to the proposed basin locations. It is considered that these combined measures would further enhance the water quality treatment, with the potential that the WSUD pollutant retention objectives would be satisfied for both the Stage 1 and long term development.

During construction of the works, extensive disturbance to the existing soils is expected to occur. This has the potential to result in increased erosion and sedimentation and the discharge of pollutants into the downstream waterways, particularly during rainfall events. A Soil and Water Management Plan (SWMP) and a Construction Environmental Management Plan (CEMP) will be prepared and implemented prior to the commencement of any construction works. With these management plans in place, construction activity is not expected to have any significant impact on downstream water quality. Any potential impact is likely to be localised and short term. Upon completion of the construction works, water quality discharged from the airport site to the downstream waterways is expected to improve, compared to that under existing conditions, for total phosphorus, total nitrogen and suspended solids,

8. References

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Appendices

Appendix A – Water Quality Sampling Data

1. Water quality monitoring results

1.1 Water quality monitoring November 2015

This section presents a summary of the sampling event conducted **2nd November 2015**.

The highlighted results in Table 1 are those which exceeded the ANZECC (2000) Freshwater Guidelines (Lowland Rivers) and field observations for the sampling event are provided in Table 2.

Table 1 November 2015 water quality analysis

Analyte	ANZECC Guideline	DS Basin 1	DS Basin 2	DS Basin 3	DS Basin 4	DS Basin 6	DS Basin 7	DS Basin 8	DS Residual	U/S Airport New
pH (in situ)	6.5-8.0	6.9	7.31	6.9	7.17	7.04	6.85	8.04	7.42	7.44
Conductivity (µS/cm)	2200	865.9	2132	540.2	2963	6088	228.4	2168	2764	1841
DO (mg/L)	N/A	4.82	4.42	3.91	3.61	3.3	4.37	4.32	3.37	3.5
DO (%sat)	85-110	51	46.9	44.1	39.5	37.1	49.7	51.2	37.2	39.5
Turbidity (NTU)	6-50	94.4	7.7	88.3	9.6	5.5	39	32.4	66.6	511
Faecal Coliforms (CFU/100mL)		6800	220	9600	52	4600	1200	18000	1800	15000
SS (mg/L)	40	16	10	30	<5	19	6	24	12	52
NOx (mg/L)	0.04	2.08	0.02	0.45	0.1	0.1	0.03	0.03	0.04	3.94
TKN (mg/L)	N/A	1.5	1.4	1.1	2.2	0.9	1.1	2.6	0.5	5.9
TN (mg/L)	0.5	3.6	1.4	4.6	2.3	1.0	1.1	2.6	0.5	9.8
TP (mg/L)	0.05	0.32	0.19	0.36	0.82	0.08	0.09	0.17	0.04	2.02
Chlorophyll-a (mg/m³)	3	1	30	1	15	7	2	<1	5	46
Arsenic (mg/L)	0.024	0.002	0.003	0.002	0.002	<0.001	<0.001	0.002	0.002	0.006
Cadmium (mg/L)	0.002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium (mg/L)	0.001	0.002	<0.001	0.002	<0.001	0.001	0.002	0.001	<0.001	0.002
Copper (mg/L)	0.0014	0.014	0.003	0.01	0.001	0.004	0.012	0.003	<0.001	0.018
Lead (mg/L)	0.0034	0.003	<0.001	0.002	<0.001	0.002	0.001	<0.001	<0.001	0.002
Nickel (mg/L)	0.011	0.003	0.002	0.003	0.001	0.002	0.002	0.002	0.002	0.006
Zinc (mg/L)	0.008	0.02	<0.005	0.014	<0.005	0.011	0.014	0.009	<0.005	0.032
Mercury (mg/L)		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

Total Petroleum Hydrocarbon, OP/OC, PAH/BTEX/Phenol testing was performed for all samples. The results for these analyses were negative. The ANZECC (2000) guidelines do not cite specific trigger values for these, noting the insufficiency of data, and the large range of hydrocarbons, etc and their varying toxicities.

Table 2 November 2015 Field Observations

Site	Temp (˚C)	Conductivity (µS/m)	pH	DO (mg/L)	DO (%)	Turbidity (NTU)	Sample Appearance	Conditions	Nuisance Organisms / Other
DS Basin 1	18.61	865.9	6.9	4.82	51	94.4	Light brown, cloudy	Duck weed, GP	NA
DS Basin 2	18.47	2132	7.31	4.42	46.9	7.7	Brown, slightly turbid, reeds	Some duck weed, woody debris, GP US	NA
DS Basin 3	21.87	540.2	6.9	3.91	44.1	88.3	Brown, turbid, reeds and macrophytes	NA	NA
DS Basin 4	19.93	2963	7.17	3.61	39.5	9.6	Brown, slightly turbid	Duck Weed	NA
DS Basin 6	20.88	6088	7.04	3.3	37.1	5.5	Light brown, cloudy	GP on banks, woody debris	NA
DS Basin 7	22.43	228.4	6.85	4.37	49.7	39	Brown, slightly turbid	GP, tyres	NA
DS Basin 8	24.23	2168	8.04	4.32	51.2	32.4	Light brown, cloudy	NA	Algae
DS Residual	20.42	2764	7.42	3.37	37.2	66.6	Brown, slightly turbid/ cloudy, macrophytes	Few GP on banks	NA
U/S Airport	22.23	1841	7.44	3.5	39.5	511	Light Brown, cloudy, reeds	GP on banks	NA

There was no rainfall in the five days leading up to the sampling. The day was hot, sunny with little to no wind.

1.2 Monitoring Sites (December 2015)

This section presents a summary of the sampling event conducted **8th December 2015**. The highlighted results in Table 3 are those which exceeded the ANZECC (2000) Freshwater Guidelines (Lowland Rivers) and field observations for the sampling event are provided in Table 4.

Table 3 December 2015 water quality analysis

Analyte	ANZECC Guideline	DS Basin 1	DS Basin 2	DS Basin 3	DS Basin 4	DS Basin 6	DS Basin 7	DS Basin 8	DS Residual	U/S Airport New
pH (in situ)	6.5-8.0	7.58	7.46	7.12	7.60	7.22	7.98	8.00	7.83	7.95
Conductivity (µS/cm)	2200	2167	1695	8620	2148	4516	2273	2019	1847	3744
DO (mg/L)	N/A	4.85	2.71	1.90	1.70	3.25	2.18	3.86	2.94	1.23
DO (%sat)	85-110	54.3	31	21.9	18.2	34.9	23.7	43.6	31.5	11.7
Turbidity (NTU)	6-50	4.87	23.5	12	7.49	3.62	2.42	9.39	4.2	450
Faecal Coliforms (CFU/100mL)		43	15	64	100	28	90	1000	88	87000
SS (mg/L)	40	5	14	21	12	14	6	26	5	180
NOx (mg/L)	0.04	0.04	0.01	<0.01	<0.01	0.01	0.04	0.04	0.05	0.21
TKN (mg/L)	N/A	1.6	2.0	2.0	2.3	0.9	1.3	1.7	0.7	100
TN (mg/L)	0.5	1.6	2.0	2.0	2.3	0.9	1.3	1.7	0.8	100
TP (mg/L)	0.05	0.44	0.5	0.9	1.73	0.02	0.04	0.11	0.05	13.8
Chlorophyll-a (mg/m^3)	3	4	22	14	22	9	7	145	6	3
Arsenic (mg/L)	0.024	0.01	0.005	0.004	0.003	<0.001	<0.001	0.001	<0.001	0.01
Cadmium (mg/L)	0.002	0.0006	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001
Chromium (mg/L)	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.003
Copper (mg/L)	0.0014	0.003	0.001	0.001	<0.001	<0.001	0.01	<0.001	<0.001	0.076
Lead (mg/L)	0.0034	0.005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004
Nickel (mg/L)	0.011	0.003	0.003	0.003	0.002	0.001	0.003	0.001	0.001	0.021
Zinc (mg/L)	0.008	0.092	0.012	<0.005	0.006	<0.005	<0.005	<0.005	<0.005	0.293
Mercury (mg/L)		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

Total Petroleum Hydrocarbon, OP/OC, PAH/BTEX/Phenol testing was performed for all samples. The results for these analyses were negative with the exception of Site US Airport New which recorded values for the C15 – C40 fractions. The ANZECC (2000) guidelines do not cite specific trigger values for these, noting the insufficiency of data, and the large range of hydrocarbons, etc and their varying toxicities.

Table 4 December 2015 field observations

Site	Temp (˚C)	Conductivity (µS/m)	pH	DO (mg/L)	DO (%)	Turbidity (NTU)	Sample Appearance	Conditions	Nuisance Organisms / Other
DS Basin 1	20.79	2167	7.58	4.85	54.3	4.87	CLEAR	SCUM/SHEEN, DUCK WEED, GP	ALGAE
DS Basin 2	22.03	1695	7.46	2.71	31	23.50	BROWN, TURBID	WOODY DEBRIS, ALGAL SCUM, OILY SHEEN	ALGAE
DS Basin 3	22.20	8620	7.12	1.90	21.9	12	INDIVIDUAL POOLS, MOSTLY CLEAR	NA, GP	FILAMENTOUS ALGAE
DS Basin 4	19.24	2148	7.60	1.70	18.2	7.49	CLEAR AT EDGES, BLACK	DUCK WEED	NA
DS Basin 6	20.59	4516	7.22	3.25	34.9	3.62	SLIGHTLY TURBID	GP, WOODY DEBRIS	GAMBUSIA
DS Basin 7	20.01	2273	7.98	2.18	23.7	2.42	CLEAR	NA	NA
DS Basin 8	21.72	2019	8.00	3.86	43.6	9.39	CLEAR	SCUM/SHEEN	GAMBUSIA
DS Residual	19.85	1847	7.83	2.94	31.5	4.20	SLIGHTLY TURBID	SCUM/SHEEN	GAMBUSIA
U/S Airport	20.26	3744	7.95	1.23	11.7	450	BROWN, TURBID	GP	NA

There was no rainfall in the five days leading up to the sampling. The day was overcast with some drizzle in the afternoon.

1.3 Monitoring Sites (January 2016)

This presents a summary of the sampling event conducted **5th January 2016**. The highlighted results in Table 5 are those which exceeded the ANZECC (2000) Freshwater Guidelines (Lowland Rivers) and field observations for the sampling event are provided in Table 6.

Table 5 January 2016 Water quality analysis

Analyte	ANZECC Guideline	DS Basin 1	DS Basin 2	DS Basin 3	DS Basin 4	DS Basin 6	DS Basin 7	DS Basin 8	DS Residual	U/S Airport New
pH (in situ)	6.5-8.0	7.08	7.28	7.45	7.47	6.97	7.90	7.80	7.76	7.75
Conductivity (µS/cm)	2200	1336	3119	1529	1293	896	172	1045	1720	1638
DO (mg/L)	N/A	4.61	4.40	5.35	5.27	7.32	6.26	5.76	4.53	1.23
DO (%sat)	85-110	50.4	48.3	58.6	57.6	79.7	69.1	63.3	49.9	13.6
Turbidity (NTU)	6-50	57.40	45.40	216	246	47.40	20.70	32.80	62.40	296
Faecal Coliforms (CFU/100mL)		61,000	18,000	54,000	71,000	4300	580	12,000	510,000	3,600, 000
SS (mg/L)	40	17	23	76	83	8	<5	11	26	159
NOx (mg/L)	0.04	12.6	8.55	17.3	17.5	0.1	0.02	0.05	1.04	22.2
TKN (mg/L)	N/A	3.3	5.5	12.0	13.0	1.0	0.7	0.8	2.2	24.4
TN (mg/L)	0.5	15.9	14.0	29.3	30.5	1.1	0.7	0.8	3.2	46.6
TP (mg/L)	0.05	0.94	1.06	2.7	2.96	0.99	0.04	0.07	0.44	6.33
Chlorophyll-a (mg/m³)	3	9	13	1	1	2	1	3	9	4
Arsenic (mg/L)	0.024	0.002	0.004	0.004	0.004	<0.001	<0.001	<0.001	0.001	0.009
Cadmium (mg/L)	0.002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium (mg/L)	0.001	0.001	0.001	0.003	0.004	0.001	<0.001	<0.001	<0.001	0.004
Copper (mg/L)	0.0014	0.006	0.012	0.024	0.026	0.007	0.006	0.005	0.004	0.069
Lead (mg/L)	0.0034	0.001	<0.001	0.003	0.003	0.002	<0.001	<0.001	<0.001	0.003
Nickel (mg/L)	0.011	0.003	0.005	0.009	0.007	0.002	<0.001	0.003	0.004	0.014
Zinc (mg/L)	0.008	0.025	0.019	0.036	0.041	0.007	<0.005	0.01	0.012	0.082
Mercury (mg/L)		<0.0001	<0.0001	<0.000 1	<0.000 1	<0.000 1	<0.000 1	<0.000 1	<0.0001	<0.0001

Total Petroleum Hydrocarbon, OP/OC, PAH/BTEX/Phenol testing was performed for all samples. The results for these analyses were negative with the exception of Site US Airport New which recorded values for the C10 – C40 fractions. The ANZECC (2000) guidelines do not cite specific trigger values for these, noting the insufficiency of data, and the large range of hydrocarbons, etc and their varying toxicities.

Table 6 January 2016 field observations

Site	Temp (˚C)	Conductivity (µS/m)	pH	DO (mg/L)	DO (%)	Turbidity (NTU)	Sample Appearance	Conditions	Nuisance Organisms / Other
DS Basin 1	19.54	1336	7.08	4.61	50.4	57.40	HIGH, LIGHT BROWN, TURBID	NA	NA
DS Basin 2	19.45	3119	7.28	4.40	48.3	45.40	HIGH, LIGHT BROWN, TURBID	NA	NA
DS Basin 3	19.59	1529	7.45	5.35	58.6	216	HIGH FLOW, LIGHT BROWN, TURBID	NA	NA
DS Basin 4	19.50	1293	7.47	5.27	57.6	246	LIGHT BROWN, TURBID	SOME DUCK WEED	NA
DS Basin 6	19.37	896	6.97	7.32	79.7	47.40	LIGHT BROWN, TURBID	PLANT MATTER	NA
DS Basin 7	20.15	172	7.90	6.26	69.1	20.70	BROWN	SOME PLANT MATTER	NA
DS Basin 8	19.87	1045	7.80	5.76	63.3	32.80	BROWN, SLIGHTLY TURBID	PLANT MATTER	NA
DS Residual	19.78	1720	7.76	4.53	49.9	62.40	HIGH, BROWN, TURBID	NA	NA
U/S Airport	19.86	1638	7.75	1.23	13.6	296	TURBID	PLANT MATTER, GP	NA

Around 70 mm of rain fell between the 4th and 5th January. The day was overcast and raining.

1.4 Monitoring Sites (February 2016)

This presents a summary of the sampling event conducted **4th February 2016**. The highlighted results in Table 7 are those which exceeded the ANZECC (2000) Freshwater Guidelines (Lowland Rivers) and field observations for the sampling event are provided in Table 8.

Table 7 February 2016 Water quality analysis

Analyte	ANZECC Guideline	DS Basin 1	DS Basin 2	DS Basin 3	DS Basin 4	DS Basin 6	DS Basin 7	DS Basin 8	DS Residual	U/S Airport New
pH (in situ)	6.5-8.0	7.35	7.31	7.43	7.53	7.51	7.62	7.78	7.70	7.28
Conductivity (µS/cm)	2200	890	803	832	894	938	527	432	851	1839
DO (mg/L)	N/A	5.12	5.76	5.72	5.88	7.30	4.13	5.52	4.91	2.46
DO (%sat)	85-110	59.8	66.5	65.8	67.8	86	49.5	65.7	58.6	28
Turbidity (NTU)	6-50	24.30	24.70	15.50	17.70	56.40	11.10	19.70	26.60	70.60
Faecal Coliforms (CFU/100mL)		~260	~400	~150	~260	~560	~250	~900	~220	~40000
SS (mg/L)	40	6	14	<5	<5	<5	<5	9	<5	40
NOx (mg/L)	0.04	0.34	0.18	0.16	0.13	0.04	<0.01	0.03	0.15	0.01
TKN (mg/L)	N/A	1.8	1.8	1.7	1.8	1.2	1.0	0.8	1.0	19.3
TN (mg/L)	0.5	2.1	2.0	1.9	1.9	1.2	1.0	0.8	1.2	19.3
TP (mg/L)	0.05	0.69	0.80	0.88	0.92	0.05	0.05	0.07	0.11	8.45
Chlorophyll-a (mg/m³)	3	5	3	3	9	1	2	4	9	<1
Arsenic (mg/L)	0.024	0.002	0.003	0.002	0.002	0.001	0.001	<0.001	0.001	0.007
Cadmium (mg/L)	0.002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium (mg/L)	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002
Copper (mg/L)	0.0014	0.004	0.005	0.003	0.003	0.002	0.002	0.002	0.002	0.024
Lead (mg/L)	0.0034	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002
Nickel (mg/L)	0.011	0.003	0.003	0.002	0.002	0.002	0.001	0.001	0.002	0.011
Zinc (mg/L)	0.008	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.058
Mercury (mg/L)		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

Total Petroleum Hydrocarbon, OP/OC, PAH/BTEX/Phenol testing was performed for all samples. The results for these analyses were negative with the exception of Site US Airport New which recorded values for Phenol and 3- & 4-Methylphenol. The ANZECC (2000) guidelines do not cite specific trigger values for these, noting the insufficiency of data.

Table 8 February 2016 field observations

Site	Temp (˚C)	Conductivity (µS/m)	pH	DO (mg/L)	DO (%)	Turbidity (NTU)	Sample Appearance	Conditions	Nuisance Organisms / Other
DS Basin 1	22.99	890	7.35	5.12	59.8	24.30	Brown, turbid	Few GP	NA
DS Basin 2	22.40	803	7.31	5.76	66.5	24.70	Dark Brown, Turbid	NA	NA
DS Basin 3	22.25	832	7.43	5.72	65.8	15.50	Mostly Clear, Brown	NA	NA
DS Basin 4	22.34	894	7.53	5.88	67.8	17.70	Dark Brown, turbid	NA	NA
DS Basin 6	23.40	938	7.51	7.30	86	56.40	Brown, slightly turbid	Few GP, plant matter	Algae
DS Basin 7	24.34	527	7.62	4.13	49.5	11.10	Opaque	GP	NA
DS Basin 8	24.07	432	7.78	5.52	65.7	19.70	Mostly clear	NA	NA
DS Residual	24.19	851	7.70	4.91	58.6	26.60	Brown, turbid	GP on banks	NA
U/S Airport	21.46	1839	7.28	2.46	28	70.60	Black, smelly	Oily sheen, GP on bank, reeds cut back	NA

The day was overcast with some drizzle. There was 25 mm rain in the last two days of January.

1.5 Monitoring Sites (March 2016)

This presents a summary of the sampling event conducted **2nd March 2016**. The highlighted results in Table 9 are those which exceeded the ANZECC (2000) Freshwater Guidelines (Lowland Rivers) and field observations for the sampling event are provided in Table 10.

Table 9 March 2016 Water quality analysis

Analyte	ANZECC Guideline	DS Basin 1	DS Basin 2	DS Basin 3	DS Basin 6	DS Basin 7	DS Basin 8	DS Residual	U/S Airport New
pH (in situ)	6.5-8.0	7.72	7.52	7.58	7.47	8.16	8.33	7.64	7.73
Conductivity (µS/cm)	2200	2017	1308	1474	2294	2322	2253	19.73	1877
DO (mg/L)	N/A	3.81	1.97	3.67	1.50	0.51	2.22	1.96	0.99
DO (%sat)	85-110	44.2	23	42.5	17.1	5.9	26.4	19.1	11
Turbidity (NTU)	6-50	42.8	15.7	17.0	2.7	24.8	16.0	9.0	127.5
Faecal Coliforms (CFU/100mL)		~280	~240	~630	~120	~10	~660	~110	~910
SS (mg/L)	6	14	39	10	<5	16	10	6	23
NOx (mg/L)	0.04	0.02	<0.01	<0.01	<0.01	<0.01	0.03	<0.01	<0.01
TKN (mg/L)	N/A	1.2	1.3	1.4	1.2	1.8	1.0	0.5	7.8
TN (mg/L)	0.5	1.2	1.3	1.4	1.2	1.8	1.0	0.5	7.8
TP (mg/L)	0.05	0.23	0.34	0.52	0.06	0.13	0.05	0.04	3.67
Chlorophyll-a (mg/m^3)	3	33	39	16	36	9	16	4	28
Arsenic (mg/L)	0.024	0.002	0.003	0.005	<0.001	0.005	0.001	0.001	0.008
Cadmium (mg/L)	0.002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium (mg/L)	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002
Copper (mg/L)	0.0014	0.002	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	0.005
Lead (mg/L)	0.0034	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001
Nickel (mg/L)	0.011	0.003	0.003	0.002	0.002	0.004	0.001	0.002	0.007
Zinc (mg/L)	0.008	0.008	0.006	0.010	0.030	<0.005	<0.005	<0.005	0.011
Mercury (mg/L)		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

Total Petroleum Hydrocarbon, OP/OC, PAH/BTEX/Phenol testing was performed for all samples. The results for these analyses were negative with the exception of Site DS Basin 7 which recorded values for the C10 - C28 hydrocarbon fractions. The ANZECC (2000) guidelines do not cite specific trigger values for these, noting the insufficiency of data.

Table 10 March 2016 field observations

Site	Temp (˚C)	Conductivity (µS/m)	pH	DO (mg/L)	DO (%)	Turbidity (NTU)	Sample Appearance	Conditions	Nuisance Organisms / Other
DS Basin 1	22.53	2017	7.72	3.81	44.2	42.80	BROWN, TURBID	ALGAL SCUM, FEW GP	GAMBUSIA, ALGAE
DS Basin 2	22.54	1308	7.52	1.97	23	15.70	BROWN, TURBID	SCUM	GAMBUSIA
DS Basin 3	22.17	1474	7.58	3.67	42.5	17.00	BROWN, MOSTLY CLEAR, DISJOINTED POOLS	FEW GP, SCUM	GAMBUSIA
DS Basin 6	22.38	2294	7.47	1.50	17.1	2.70	MOSTLY CLEAR, BROWN	FEW GP, PLANT MATTER	ALGAE, GAMBUSIA
DS Basin 7	21.83	2322	8.16	0.51	5.9	24.80	BLACK, NO FLOW THROUGH, POOLS	LEAF LITTER	GAMBUSIA
DS Basin 8	23.92	2253	8.33	2.22	26.4	16.00	MOSTLY CLEAR	PLANT MATTER, SHEEN	GAMBUSIA
DS Residual	21.90	19.73	7.64	1.96	19.1	9.00	MOSTLY CLEAR, BLACK/BROWN, LITTLE/NO FLOW	SLIGHT SHEEN/SCUM, DUCK WEED, FEW GP	GAMBUSIA, ALGAE
U/S Airport	22.99	1877	7.73	0.99	11	127.50	BROWN, TURBID	FEW GP, PLANT MATTER	ALGAE

The day was partly cloudy and hot. There was no rain in the week preceding sampling resulting in low water levels.

1.6 Monitoring Sites (April 2016)

This presents a summary of the sampling event conducted **7th April 2016**. The highlighted results in Table 11 are those which exceeded the ANZECC (2000) Freshwater Guidelines (Lowland Rivers) and field observations for the sampling event are provided in Table 12.

Table 11 April 2016 Water quality analysis

Analyte	ANZECC Guideline	DS Basin 1	DS Basin 2	DS Basin 3	DS Basin 6	DS Basin 7	DS Basin 8	DS Residual	U/S Airport New
pH (in situ)	6.5-8.0	7.39	7.46	6.88	7.38	7.81	8.26	7.89	7.88
Conductivity (µS/cm)	2200	1890	1460	23134	2562	709	2346	1516	2360
DO (mg/L)	N/A	2.37	2.92	7.68	3.79	1.85	5.42	4.36	3.19
DO (%sat)	85-110	25.4	31.9	93	40.9	19.5	59.8	47	35
Turbidity (NTU)	6-50	19.50	9.86	11.90	2.09	23.20	4.73	3.67	15.70
Faecal Coliforms (CFU/100mL)		~7	~26	~5	~60	~360	660	280	1900
SS (mg/L)	6	27	10	29	8	20	10	7	15
NOx (mg/L)	0.04	<0.01	<0.01	<0.01	0.04	<0.01	0.09	0.02	0.33
TKN (mg/L)	N/A	1.5	1.4	0.8	0.7	1.4	1.0	0.4	6.8
TN (mg/L)	0.5	1.5	1.4	0.8	0.7	1.4	1.1	0.4	7.1
TP (mg/L)	0.05	0.44	0.20	0.31	0.02	0.13	0.05	0.03	2.54
Chlorophyll-a (mg/m³)	3	39	5	33	16	4	39	5	44
Arsenic (mg/L)	0.024	0.002	0.002	0.002	<0.001	0.002	0.002	<0.001	0.006
Cadmium (mg/L)	0.002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium (mg/L)	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper (mg/L)	0.0014	<0.001	<0.001	0.001	<0.001	0.005	0.003	<0.001	0.003
Lead (mg/L)	0.0034	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel (mg/L)	0.011	0.001	0.002	<0.001	0.002	0.004	0.002	0.001	0.005
Zinc (mg/L)	0.008	<0.005	0.007	<0.005	0.006	0.005	<0.005	<0.005	<0.005
Mercury (mg/L)		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

Total Petroleum Hydrocarbon, OP/OC, PAH/BTEX/Phenol testing was performed for all samples. The results for these analyses were negative with the exception of Site DS Basin 7 which recorded values for the C10 – C40 hydrocarbon fractions. The ANZECC (2000) guidelines do not cite specific trigger values for these, noting the insufficiency of data.

Table 12 April 2016 field observations

Site	Temp (˚C)	Conductivity (µS/m)	pH	DO (mg/L)	DO (%)	Turbidity (NTU)	Sample Appearance	Conditions	Nuisance Organisms / Other
DS Basin 1	18.47	1890	7.39	2.37	25.4	19.50	VERY LOW, NO FLOW	ALGAL SCUM, DUCK WEED	ALGAE
DS Basin 2	19.84	1460	7.46	2.92	31.9	9.86	VERY LOW, NO FLOW, MOSTLY CLEAR	SCUM, SMALL AMOUNT OF DUCK WEED	NA
DS Basin 3	20.69	23134	6.88	7.68	93	11.90	VERY LOW, DISJOINTED POOLS, MOSTLY CLEAR	SCUM/SHEEN	NA
DS Basin 6	18.64	2562	7.38	3.79	40.9	2.09	VERY LOW, DARK BROWN/BLACK, MOSTLY CLEAR	GP	GAMBUSIA
DS Basin 7	18.19	709	7.81	1.85	19.5	23.20	VERY LOW, DISJOINTED POOLS, BLACK	SCUM	NA
DS Basin 8	19.90	2346	8.26	5.42	59.8	4.73	VERY LOW, MOSTLY CLEAR	NA	GAMBUSIA
DS Residual	18.66	1516	7.89	4.36	47	3.67	VERY LOW, MOSTLY CLEAR	DUCK WEED, SCUM/SHEEN	NA
U/S Airport	19.69	2360	7.88	3.19	35	15.70	DARK BROWN	NA	NA

The day was mild and overcast. There was no rain in the week preceding sampling resulting in low water levels.

1.7 Monitoring Sites (May 2016)

This presents a summary of the sampling event conducted **5th May 2016**. The highlighted results in Table 13 are those which exceeded the ANZECC (2000) Freshwater Guidelines (Lowland Rivers) and field observations for the sampling event are provided in Table 14.

Table 13 May 2016 Water quality analysis

Analyte	ANZECC Guideline	DS Basin 1	DS Basin 2	DS Basin 3	DS Basin 6	DS Basin 7	DS Basin 8	DS Residual	U/S Airport New
pH (in situ)	6.5-8.0	7.36	7.80	7.41	7.81		8.37	7.72	8.58
Conductivity (µS/cm)	2200	2064	1355	30315	3540		2675	1797	4656
DO (mg/L)	N/A	0.23	5.78	6.09	2.78		4.82	1.86	0.20
DO (%sat)	85-110	2.3	55.8	57.5	22		48.1	18.2	2.7
Turbidity (NTU)	6-50	11.40	7.50	6.40	0		8.50	0.30	669
Faecal Coliforms (CFU/100mL)		~2	~10	~4	~2		950	60	11000
SS (mg/L)	6	8	<5	<5	<5		5	<5	164
NOx (mg/L)	0.04	0.05	<0.01	<0.01	0.12		0.07	0.05	0.02
TKN (mg/L)	N/A	1.0	0.8	0.7	0.7		0.6	0.2	95.9
TN (mg/L)	0.5	1.0	0.8	0.7	0.8		0.7	0.2	95.9
TP (mg/L)	0.05	0.12	0.08	0.20	0.01		0.04	0.01	10.9
Chlorophyll-a (mg/m^3)	3	12	8	23	3		41	3	<1
Arsenic (mg/L)	0.024	<0.001	0.004	0.003	0.001		0.001	<0.001	0.010
Cadmium (mg/L)	0.002	<0.0001	0.0001	0.0002	0.0001		0.0001	<0.0001	<0.0001
Chromium (mg/L)	0.001	<0.001	<0.001	<0.001	<0.001		<0.001	<0.001	0.004
Copper (mg/L)	0.0014	<0.001	0.041	0.002	0.001		0.002	<0.001	0.086
Lead (mg/L)	0.0034	<0.001	0.002	<0.001	<0.001		<0.001	<0.001	0.005
Nickel (mg/L)	0.011	0.001	0.002	<0.001	0.002		<0.001	0.001	0.019
Zinc (mg/L)	0.008	<0.005	0.034	0.007	<0.005		<0.005	<0.005	0.262
Mercury (mg/L)		<0.0001	<0.0001	<0.0001	<0.0001		<0.0001	<0.0001	<0.0001

Total Petroleum Hydrocarbon, OP/OC, PAH/BTEX/Phenol testing was performed for all samples. The results for these analyses were negative with the exception of Site DS Basin 2 and U/S Airport NEW which recorded values for the C10 – C40 hydrocarbon fractions. The ANZECC (2000) guidelines do not cite specific trigger values for these, noting the insufficiency of data.

Table 14 May 2016 field observations

Site	Temp (˚C)	Conductivity (µS/m)	pH	DO (mg/L)	DO (%)	Turbidity (NTU)	Sample Appearance	Conditions	Nuisance Organisms / Other
DS Basin 1	14.02	2064.00	7.36	0.23	2.3	11.40	SLIGHTLY TURBID	DUCK WEED	ALGAE
DS Basin 2	13.91	1355.00	7.80	5.78	55.8	7.50	SLIGHTLY TURBID	SCUM LAYER	GAMBUSIA
DS Basin 3	7.89	30315.00	7.41	6.09	57.5	6.40	MOSTLY CLEAR, VERY LOW, UNCONNECTED POOLS	SCUM LAYER	GAMBUSIA
DS Basin 6	9.82	3540.00	7.81	2.78	22	0.00	CLEAR, LOW	GP, PLANT MATTER	GAMBUSIA
DS Basin 7							DRY, TWO SMALL PUDDLES, DRY 100M US	DRY	DRY
DS Basin 8	15.17	2675.00	8.37	4.82	48.1	8.50	MOSTLY CLEAR, VERY LOW	PLANT MATTER	GAMBUSIA
DS Residual	14.77	1797.00	7.72	1.86	18.2	0.30	MOSTLY CLEAR	SHEEN/SCUM, DUCK WEED	GAMBUSIA
U/S Airport	15.35	4656.00	8.58	0.20	2.7	669.00	DARK BROWN, TURBID	GP ON BANKS	NA

The day was mild and overcast. There was no rain in the week preceding sampling resulting in low water levels.

1.8 Monitoring Sites (June 2016)

This presents a summary of the sampling event conducted **17th June 2016**. The highlighted results in Table 15 are those which exceeded the ANZECC (2000) Freshwater Guidelines (Lowland Rivers) and field observations for the sampling event are provided in Table 16.

Table 15 June 2016 Water quality analysis

Analyte	ANZECC Guideline	DS Basin 1	DS Basin 2	DS Basin 3	DS Basin 6	DS Basin 7	DS Basin 8	DS Residual	U/S Airport New	U/S Airport 2
pH (in situ)	6.5-8.0	6.92		7.08	6.91	7.16	7.72	7.45	7.44	7.37
Conductivity (µS/cm)	2200	1190		923	1161	195	864	1033	2620	890
DO (mg/L)	N/A	4.23		6.02	7.63	5.15	6.76	7.47	0.23	3.83
DO (%sat)	85-110	37.2		53	68.8	45.5	60.3	66.3	2.1	34.5
Turbidity (NTU)	6-50	33.4		29.7	40.0	68.0	33.5	53.0	101.5	26.9
Faecal Coliforms (CFU/100mL)		46		78	26	100	~11000	150	36000	80
SS (mg/L)	6	19		5	5	8	8	6	78	<5
NOx (mg/L)	0.04	1.56		2.17	5.11	0.05	0.09	0.45	<0.01	3.78
TKN (mg/L)	N/A	1.1		1.4	0.9	0.4	0.5	0.8	18.6	1.0
TN (mg/L)	0.5	2.7		3.6	6.0	0.4	0.6	1.2	18.6	4.8
TP (mg/L)	0.05	0.17		0.22	0.04	0.06	0.04	0.12	4.81	0.10
Chlorophyll-a (mg/m^3)	3	1		<1	<1	2	<1	3	3	2
Arsenic (mg/L)	0.024	0.001		<0.001	<0.001	<0.001	<0.001	<0.001	0.005	<0.001
Cadmium (mg/L)	0.002	<0.0001		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium (mg/L)	0.001	<0.001		<0.001	<0.001	0.002	<0.001	<0.001	0.003	<0.001
Copper (mg/L)	0.0014	0.005		0.005	0.006	0.015	0.001	0.006	0.025	0.003
Lead (mg/L)	0.0034	<0.001		<0.001	<0.001	0.003	<0.001	<0.001	0.002	<0.001
Nickel (mg/L)	0.011	0.002		0.003	0.002	0.002	0.001	0.002	0.011	0.002
Zinc (mg/L)	0.008	0.009		0.013	0.010	0.020	<0.005	0.008	0.064	0.009
Mercury (mg/L)		<0.0001		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

Total Petroleum Hydrocarbon, OP/OC, PAH/BTEX/Phenol testing was performed for all samples. The results for these analyses were negative with the exception of Site U/S Airport NEW which recorded values for the C10 – C40 hydrocarbon fractions. The phenolic compounds Phenol and 3- & 4-Methylphenol also recorded values. The ANZECC (2000) guidelines do not cite specific trigger values for these, noting the insufficiency of data.

Table 16 June 2016 field observations

Site	Temp (˚C)	Conductivity (µS/m)	pH	DO (mg/L)	DO (%)	Turbidity (NTU)	Sample Appearance	Conditions	Nuisance Organisms / Other
DS Basin 1	10.08	1190	6.92	4.23	37.2	33.4	MOSTLY CLEAR, OPAQUE	GP	NA
DS Basin 3	10.08	923	7.08	6.02	53	29.7	MOSTLY CLEAR	SCUM, GP	FILAMENTOUS ALGAE
DS Basin 6	10.98	1161	6.91	7.63	68.8	40.0	LIGHT BROWN, OPAQUE	PLANT MATTER, GP	NA
DS Basin 7	10.12	195	7.16	5.15	45.5	68.0	LIGHT BROWN, OPAQUE	FEW GP	NA
DS Basin 8	10.35	864	7.72	6.76	60.3	33.5	LIGHT BROWN, TURBID	SLIGHT SHEEN	NA
DS Residual	10.09	1033	7.45	7.47	66.3	53.0	LIGHT BROWN, TURBID	GP	NA
U/S Airport	11.37	2620	7.44	0.23	2.1	101.5	BLACK, TURBID	PLANT MATTER, GP	NA
U/S Airport 2	10.90	890	7.37	3.83	34.5	26.9	BROWN, TURBID	SHEEN	TYPHA BLOCKING FLOW

The day was cool and overcast with light drizzle at times. There was no rain in the week preceding sampling though very high falls early in the month resulted in higher water levels.

1.9 Monitoring Sites (July 2016)

This presents a summary of the sampling event conducted **8th July 2016**. The highlighted results in Table 17 are those which exceeded the ANZECC (2000) Freshwater Guidelines (Lowland Rivers) and field observations for the sampling event are provided in Table 18.

Table 17 July 2016 Water quality analysis

Analyte	ANZECC Guideline	DS Basin 1	DS Basin 2	DS Basin 3	DS Basin 6	DS Basin 7	DS Basin 8	DS Basin 9	DS Residual	U/S Airport New	U/S Airport 2
pH (in situ)	6.5-8.0	6.95	7.08	7.04	6.92	7.23	7.78	7.03	7.48	7.76	7.33
Conductivity (µS/cm)	2200	1499	1296	1087	1239	293	995	4628	1136	3487	3172
DO (mg/L)	N/A	4.65	7.58	6.37	7.55	3.27	8.57	1.54	8.1	2.6	2.34
DO (%sat)	85-110	41.8	62.5	57.9	70.4	30.3	80.1	14.8	74.8	24.5	22.1
Turbidity (NTU)	6-50	23.8	18.7	52	15.1	17.7	11.1	0	38.2	48	11.2
Faecal Coliforms (CFU/100mL)	1000	180	11	28	11	28	~1100	~5	40	3700	47
SS (mg/L)	6	10	10	7	7	<5	9	11	17	24	10
NOx (mg/L)	0.04	1.18	0.87	0.87	1.40	0.04	0.06	0.02	0.16	8.19	14.7
TKN (mg/L)	N/A	1.5	1.4	1.5	1.0	0.7	0.4	0.2	0.7	15.4	2.2
TN (mg/L)	0.5	2.7	2.3	2.4	2.4	0.7	0.5	0.2	0.9	23.6	16.9
TP (mg/L)	0.05	0.20	0.21	0.26	0.02	0.04	0.02	<0.01	0.07	2.89	0.10
Chlorophyll-a (mg/m³)	3	6	8	2	<1	2	1	<1	8	2	6

Analyte	ANZECC Guideline	DS Basin 1	DS Basin 2	DS Basin 3	DS Basin 6	DS Basin 7	DS Basin 8	DS Basin 9	DS Residual	U/S Airport New	U/S Airport 2
Arsenic (mg/L)	0.024	0.001	0.002	0.002	<0.001	<0.001	<0.001	<0.001	0.001	0.007	0.001
Cadmium (mg/L)	0.002	<0.0001	<0.0001	0.0002	<0.0001	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	0.0002
Chromium (mg/L)	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper (mg/L)	0.0014	0.004	0.005	0.005	0.003	0.016	<0.001	<0.001	0.003	0.014	0.002
Lead (mg/L)	0.0034	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel (mg/L)	0.011	0.003	0.002	0.002	0.002	0.002	0.001	0.002	0.002	0.006	0.001
Zinc (mg/L)	0.008	0.008	0.007	0.007	0.010	0.016	<0.005	<0.005	<0.005	0.020	0.007
Mercury (mg/L)		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

Total Petroleum Hydrocarbon, OP/OC, PAH/BTEX/Phenol testing was performed for all samples. The results for these analyses were negative. The ANZECC (2000) guidelines do not cite specific trigger values for these, noting the insufficiency of data.

Table 18 July 2016 field observations

Site	Temp (˚C)	Conductivity (µS/m)	pH	DO (mg/L)	DO (%)	Turbidity (NTU)	Sample Appearance	Conditions	Nuisance Organisms / Other
DS Basin 1	10.09	1499	6.95	4.65	41.8	23.8	NORMAL LEVEL, MOSTLY CLEAR	GP	ALGAE
DS Basin 2	6.31	1296	7.08	7.58	62.5	18.7	NORMAL LEVEL, BROWN, MOSTLY CLEAR	NA	NA
DS Basin 3	10.52	1087	7.04	6.37	57.9	52	NORMAL, VERY LITTLE FLOW. FROGS PRESENT	ALGAL SCUM UNDER BRIDGE, GP	ALGAE
DS Basin 6	11.69	1239	6.92	7.55	70.4	15.1	NORMAL LEVEL, OPAQUE	GP	ALGAE
DS Basin 7	12.02	293	7.23	3.27	30.3	17.7	NORMAL LEVEL, OPAQUE	FEW GP	NA
DS Basin 8	11.9	995	7.78	8.57	80.1	11.1	NORMAL LEVEL, MOSTLY CLEAR	OILY SHEEN	NA
DS Basin 9	12.37	4628	7.03	1.54	14.8	0	LOW, CLEAR	NA	NA
DS Residual	11.14	1136	7.48	8.1	74.8	38.2	NORMAL LEVEL, LOW FLOW	SCUM/SHEEN, GP	TYPHA/MACROPHYTES BLOCKING FLOW
U/S Airport	11.85	3487	7.76	2.6	24.5	48	NORMAL LEVEL, DARK BROWN	FEW GP, SLIGHT SCUM	NA
U/S Airport 2	12.4	3172	7.33	2.34	22.1	11.2	NORMAL LEVEL, BROWN	SLIGHT SHEEN/SCUM	TYPHA BLOCKING WATER FLOW

The day was cool and overcast. There was 5 mm over the week preceding sampling.

GHD (March 2015) Surface Water Quality Data

Matrix:	WATER	Sample Type:		REG	REG	REG	REG	REG	REG	REG	REG	REG	REG	REG
Workgroup:	ES1506236	ALS Sample number		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 (2nd												
		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

GHD Water Quality Sampling Data (November, December 2015, January, February, March 2016)

Appendix B – MUSIC Water Quality Results for Stage 1 Development

Plots of pollutant concentrations at various locations

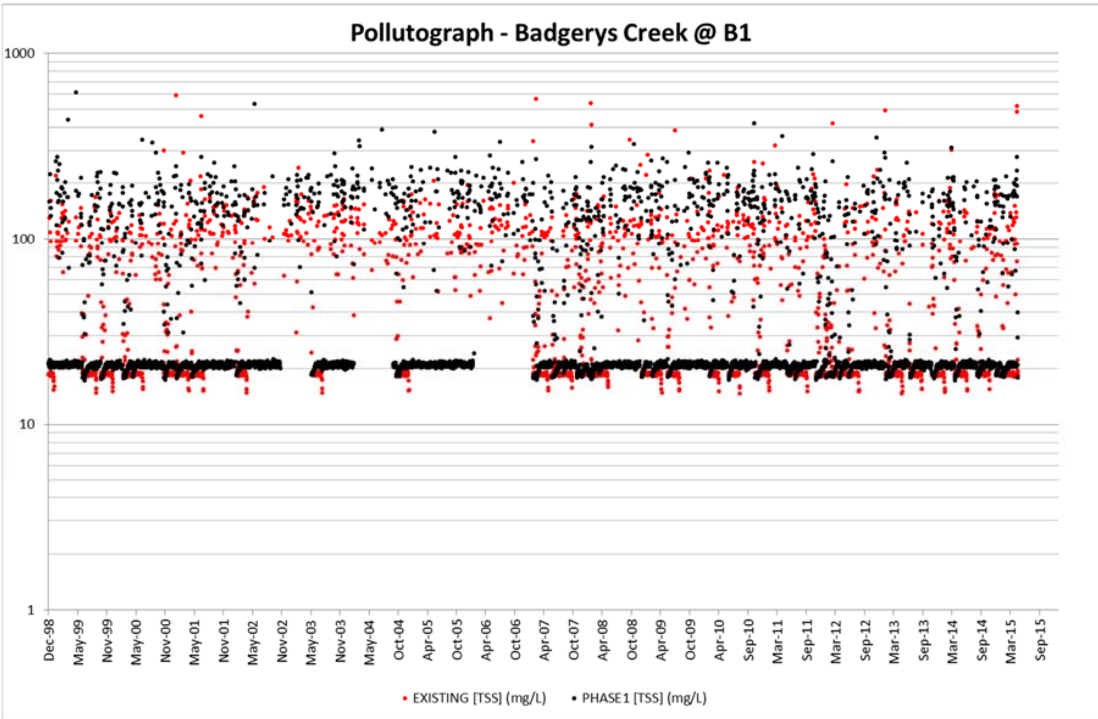

Figure B 1 Stage 1 Total Suspended Solids at Badgerys Creek B1

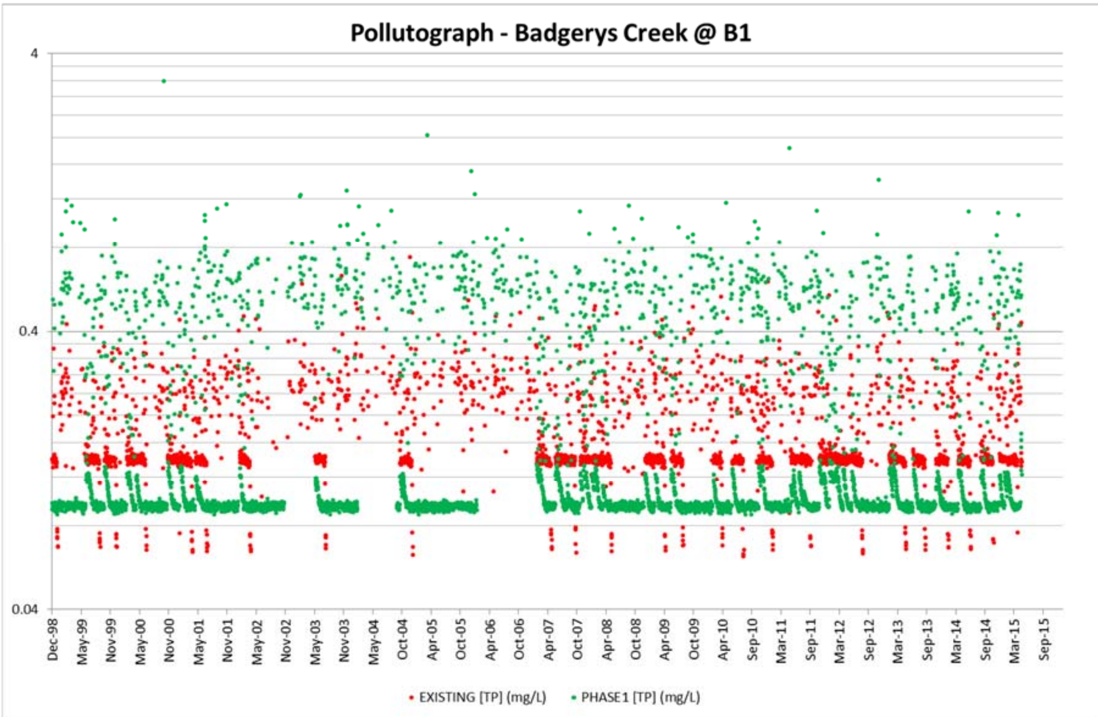

Figure B 2 Stage 1 Total Phosphorus at Badgerys Creek B1

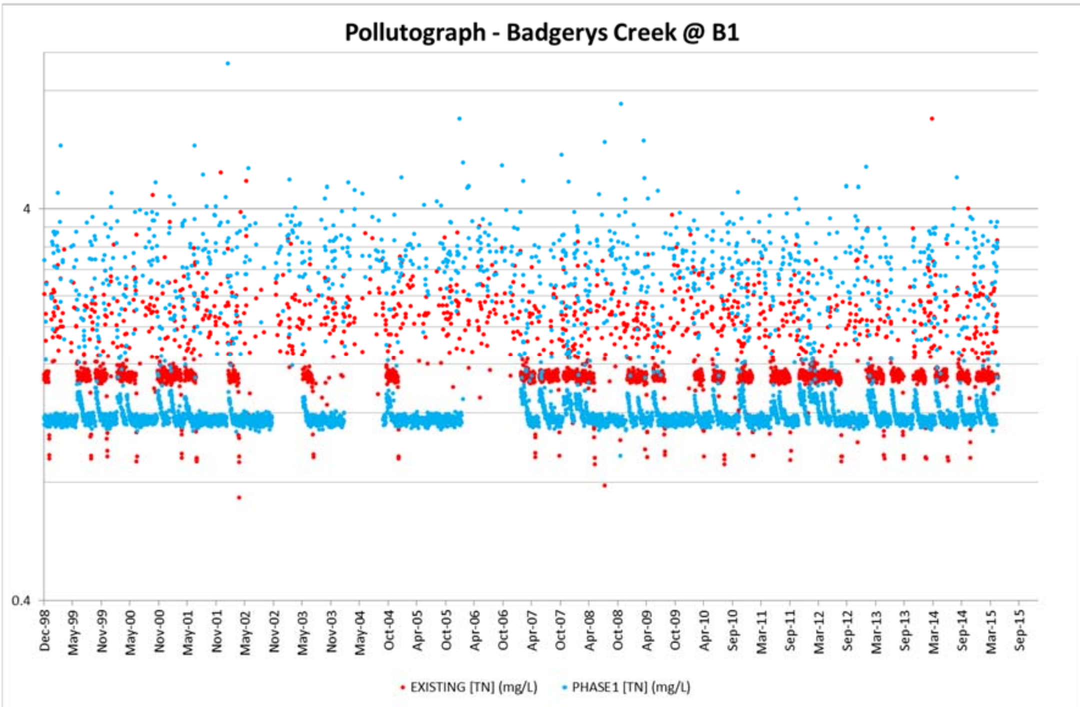

Figure B 3 Stage 1 Total Nitrogen at Badgerys Creek B1

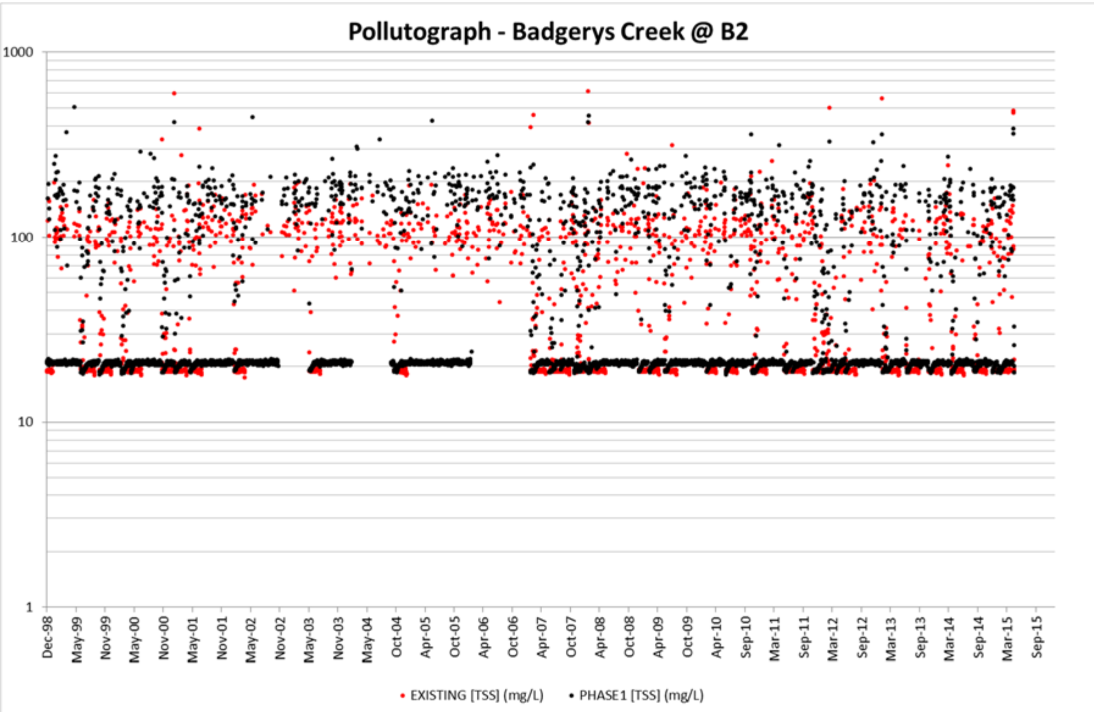

Figure B 4 Stage 1 Total Suspended Solids at Badgerys Creek B2

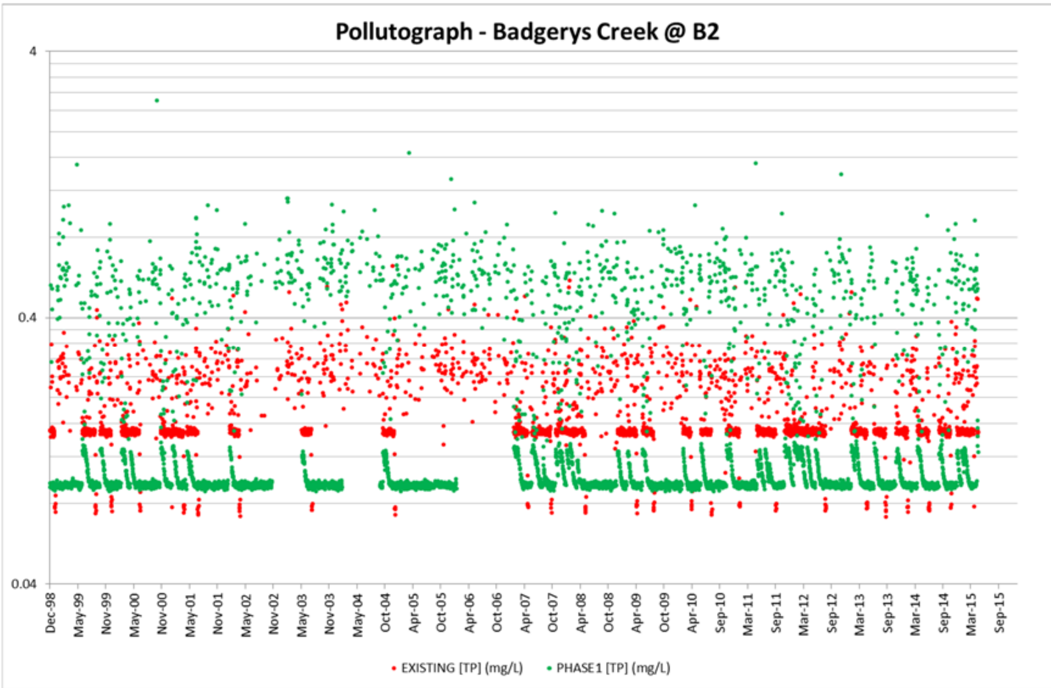

Figure B 5 Stage 1 Total Phosphorus at Badgerys Creek B2

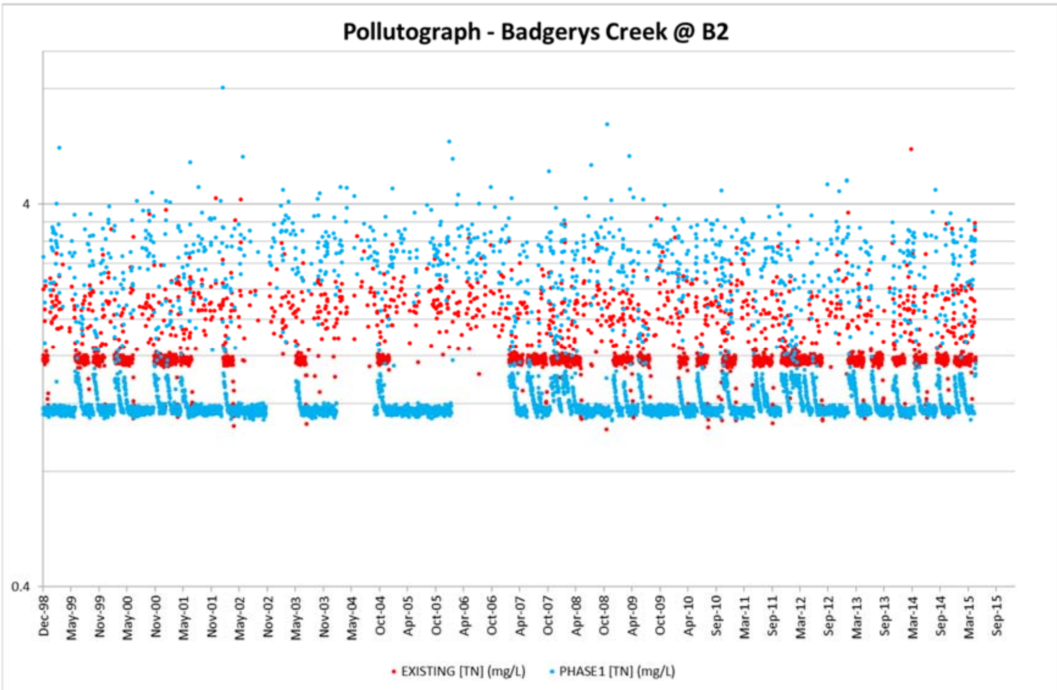

Figure B 6 Stage 1 Total Nitrogen at Badgerys Creek B2

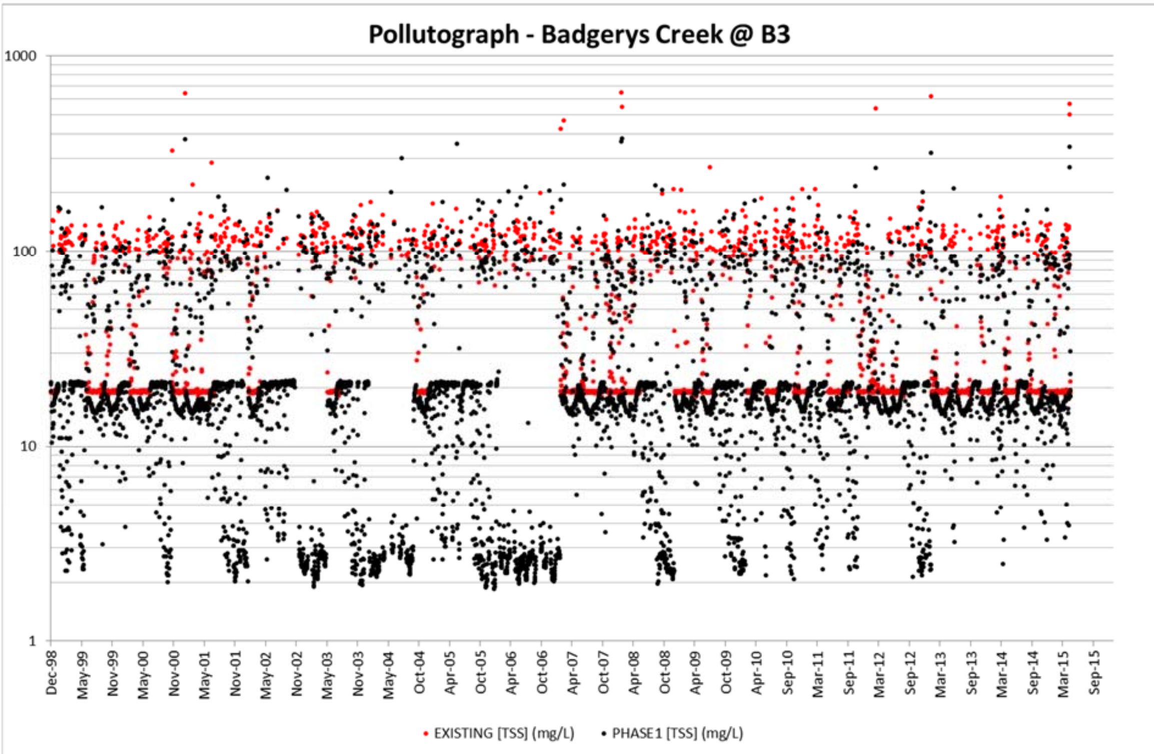

Figure B 7 Stage 1 Total Suspended Solids at Badgerys Creek B3

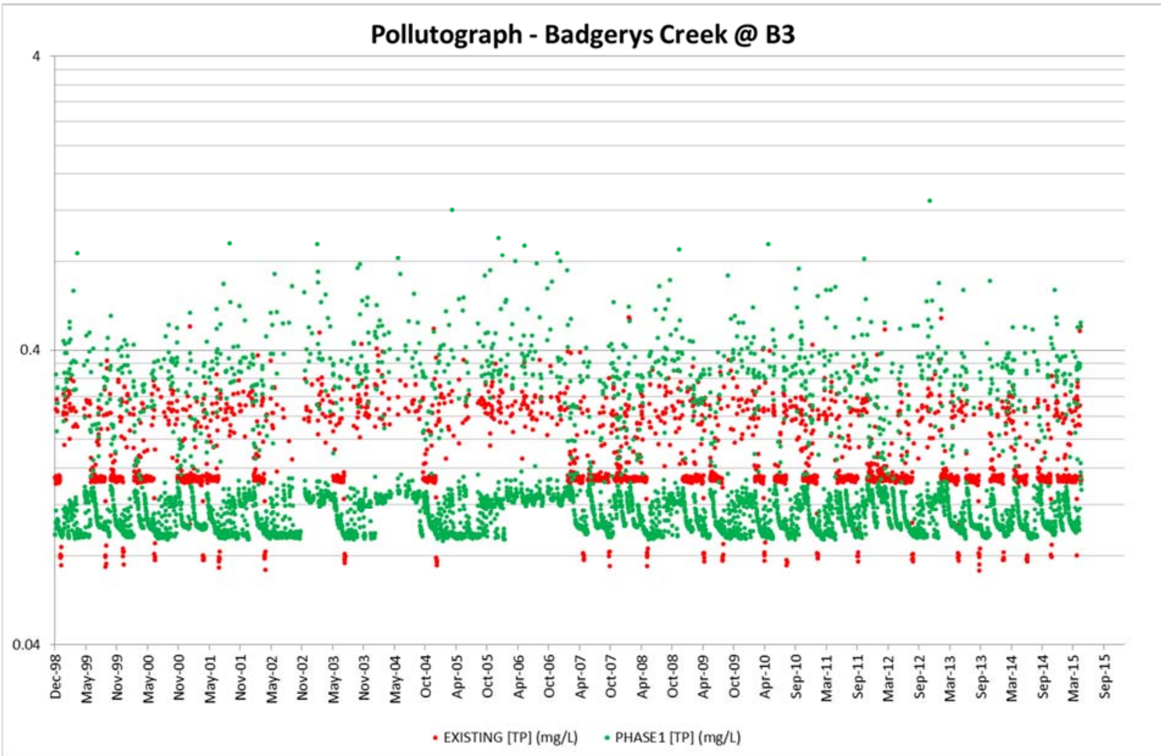

Figure B 8 Stage 1 Total Phosphorus at Badgerys Creek B3

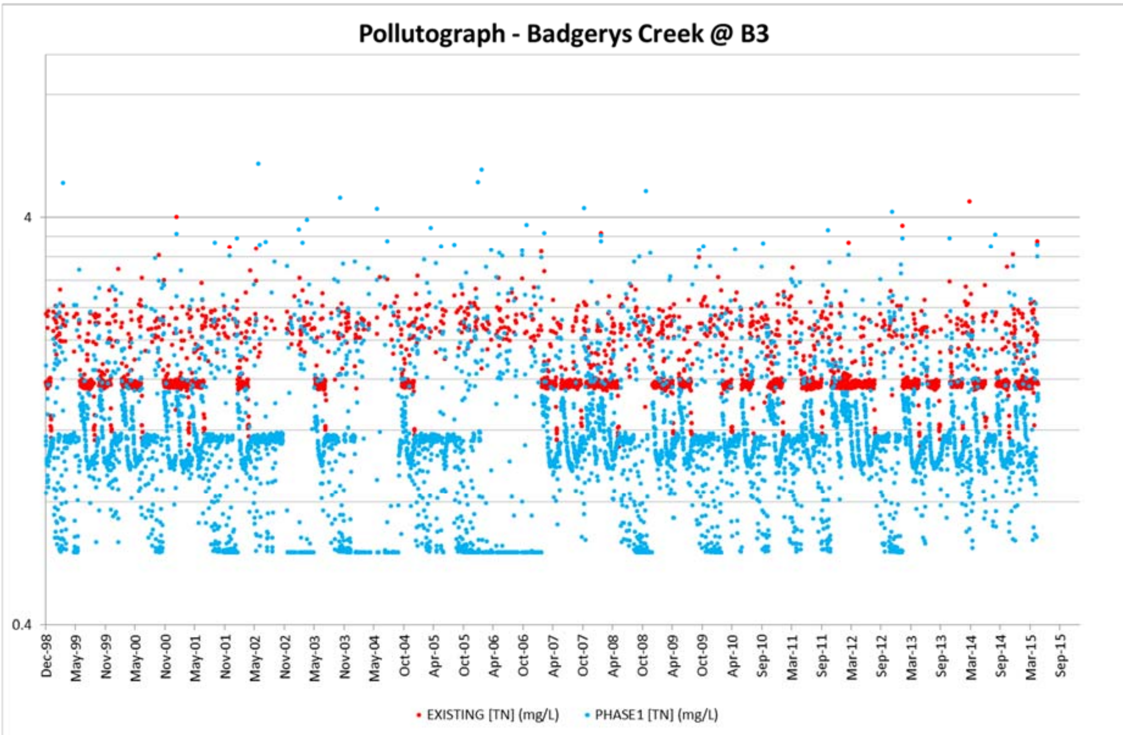

Figure B 9 Stage 1Total Nitrogen at Badgerys Creek B3

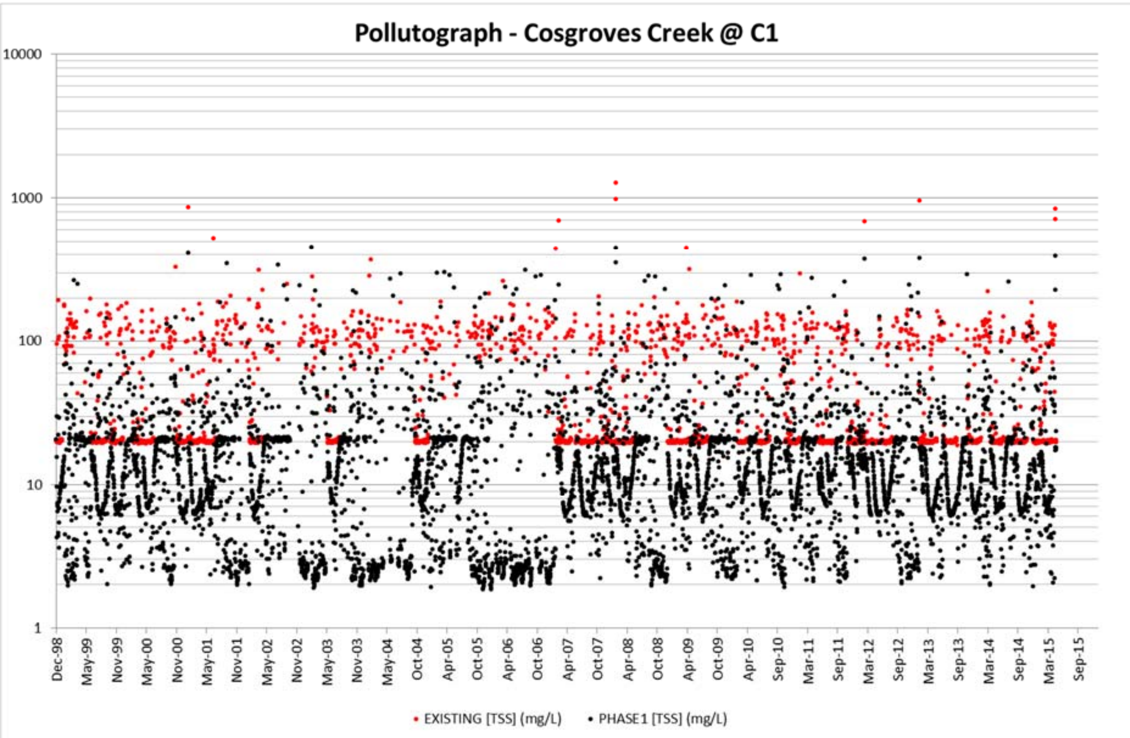

Figure B 10 Stage 1 Total Suspended Solids at Cosgroves Creek C1

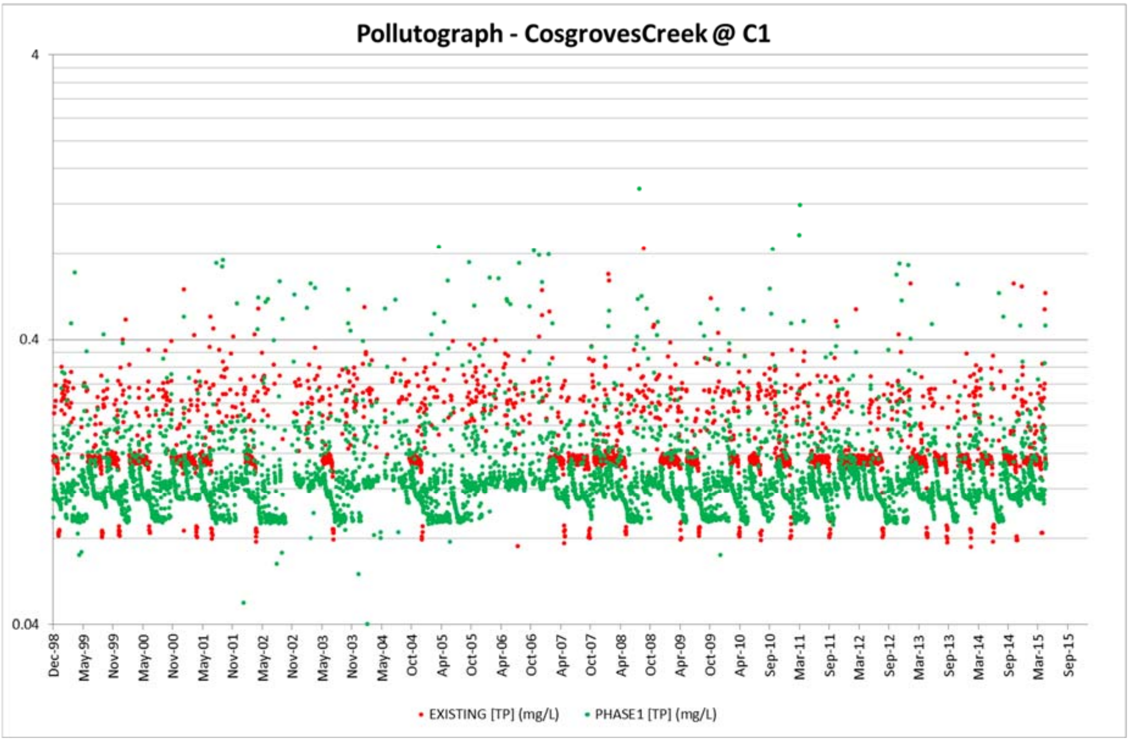

Figure B 11 Stage 1 Total Phosphorus at Cosgroves Creek C1

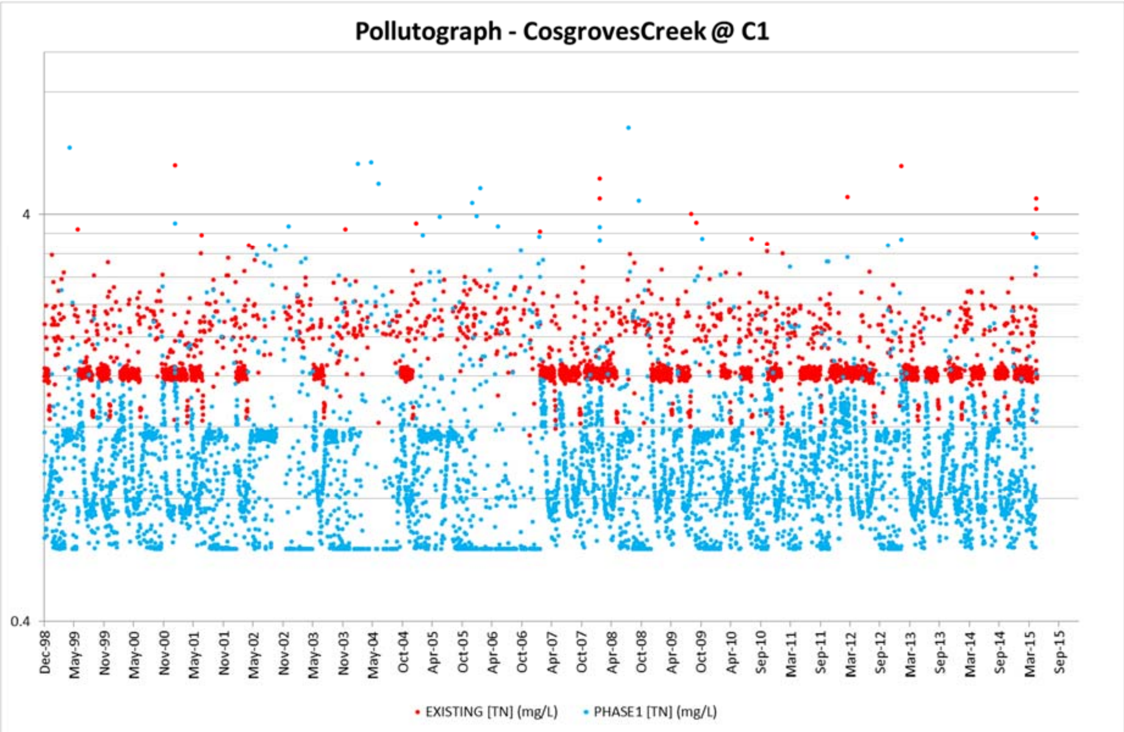

Figure B 12 Stage 1 Total Nitrogen at Cosgroves Creek C1

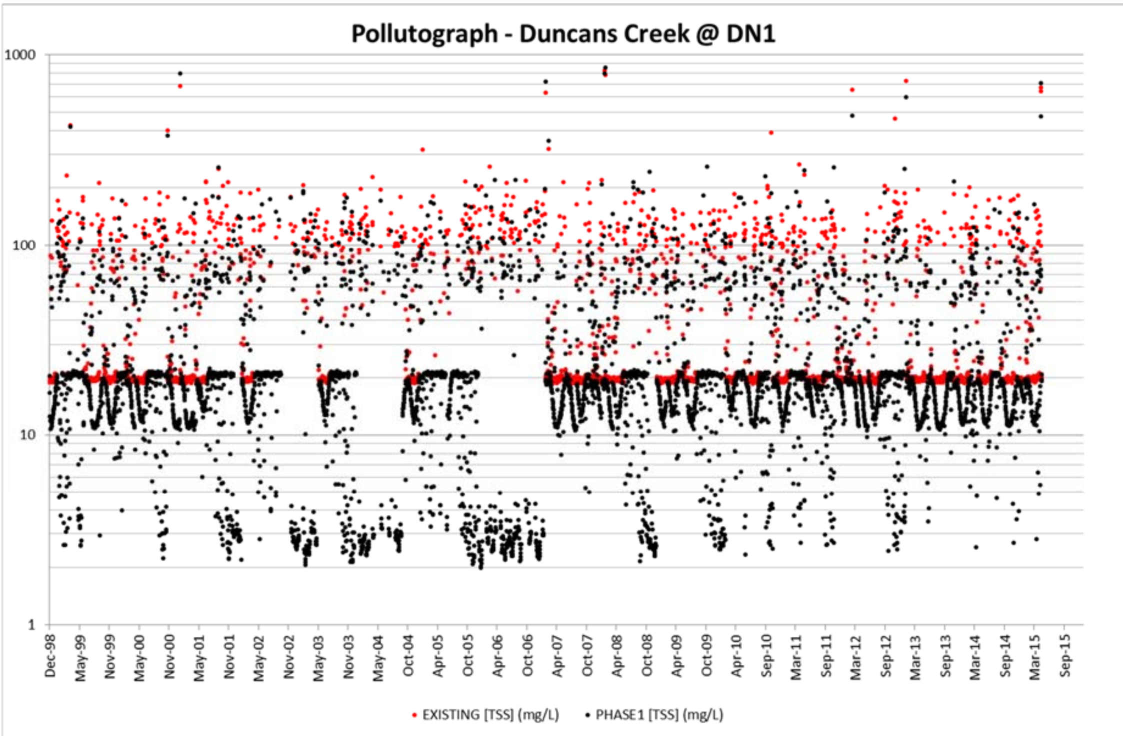

Figure B 13 Stage 1Total Suspended Solids at Duncans Creek DN1

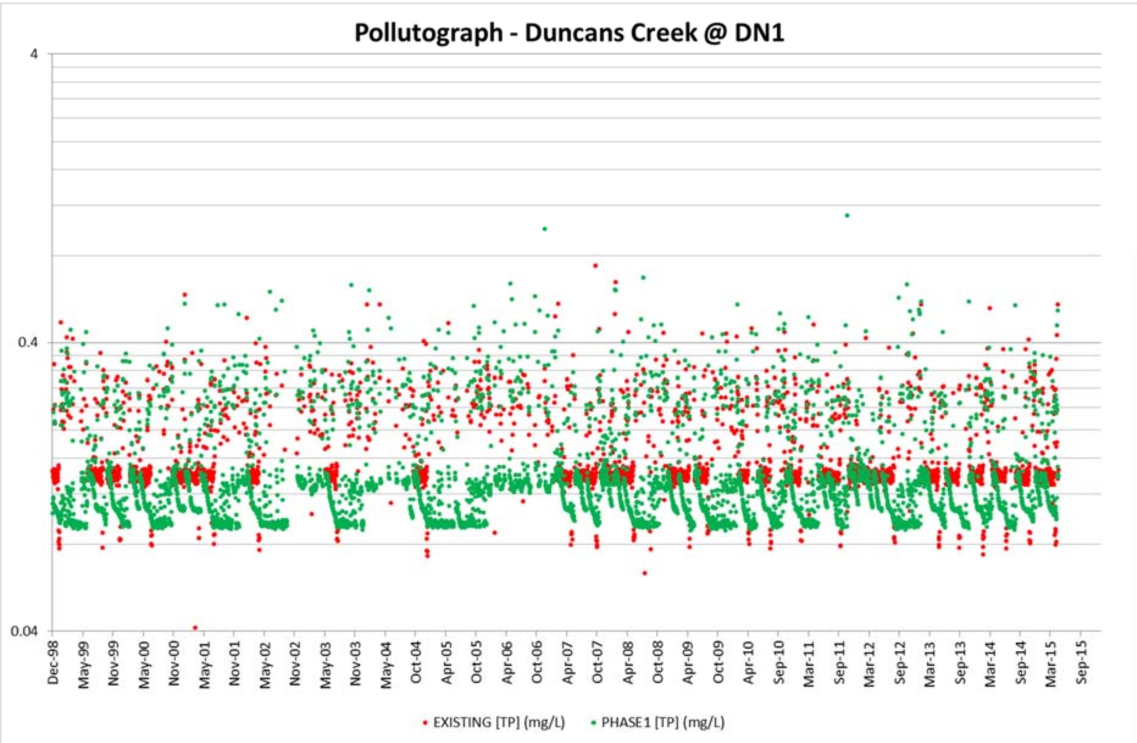

Figure B 14 Stage 1 Total Phosphorus at Duncans Creek DN1

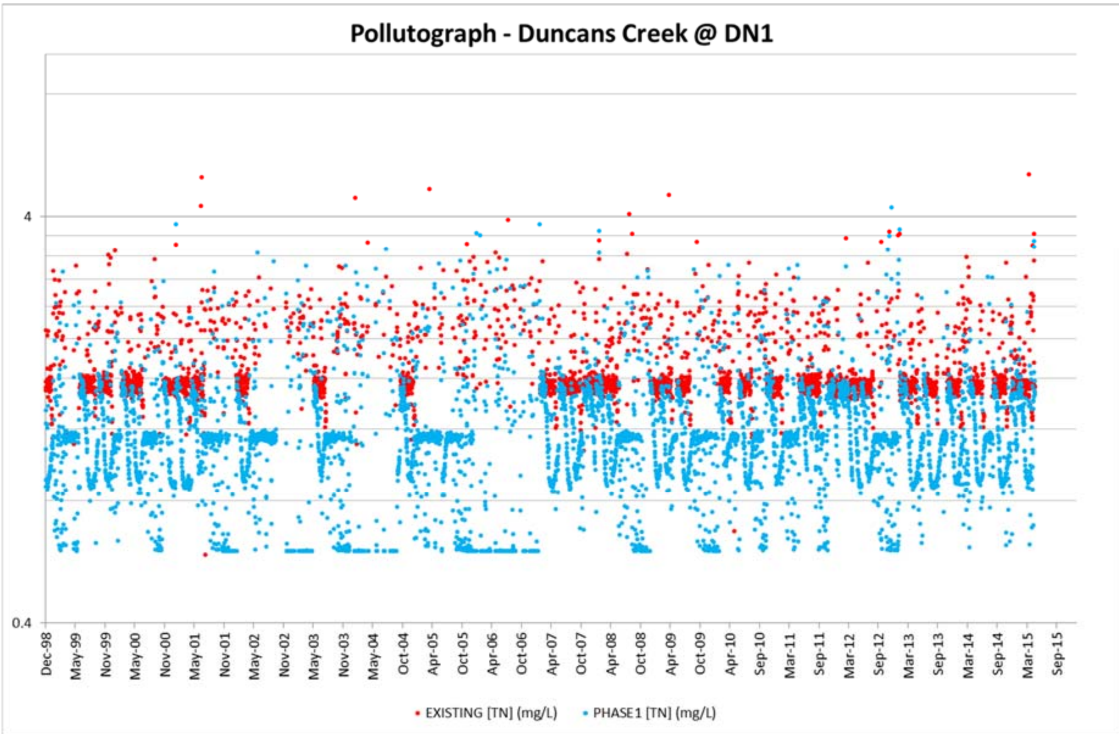

Figure B 15 Stage 1 Total Nitrogen at Duncans Creek DN1

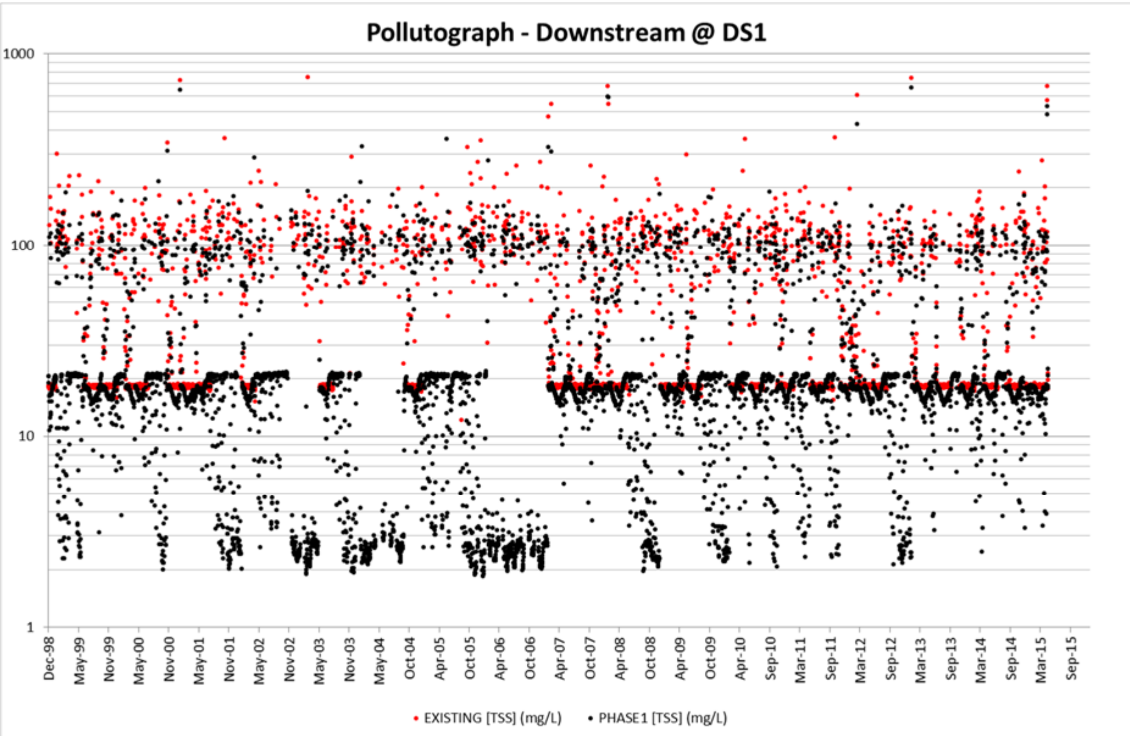

Figure B 16 Stage 1 Total Suspended Solids Downstream at DS1

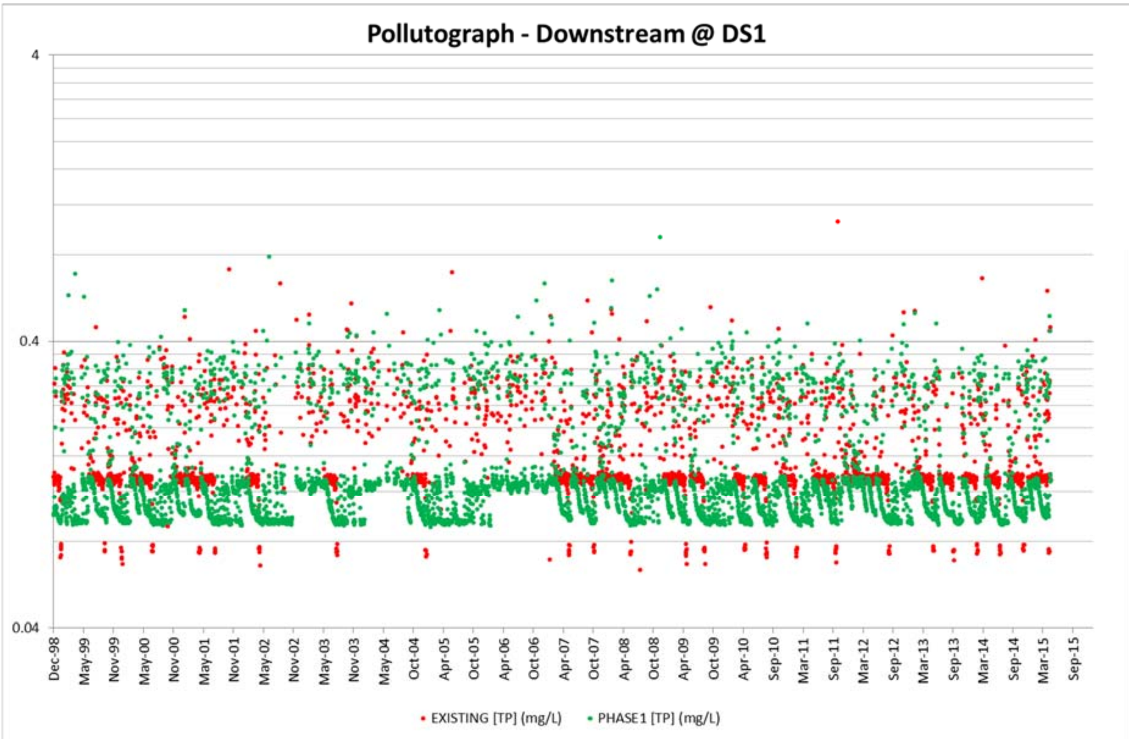

Figure B 17 Stage 1 Total Phosphorus Downstream at DS1

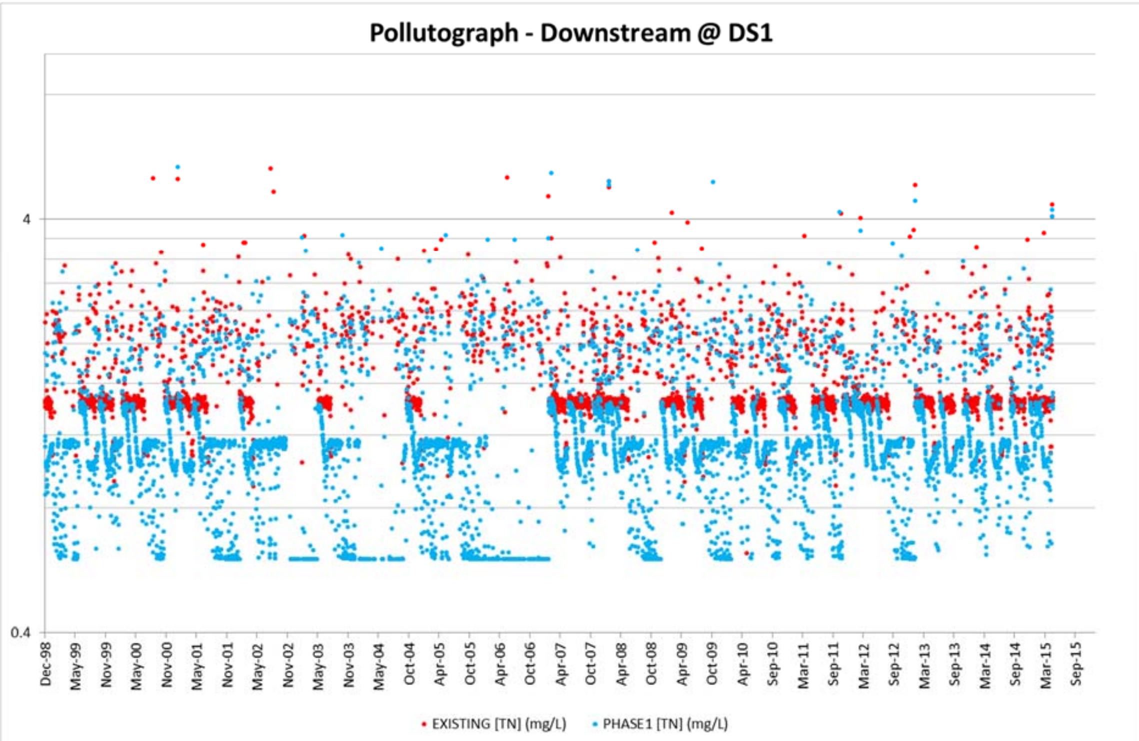

Figure B 18 Stage 1 Total Nitrogen Downstream at DS1

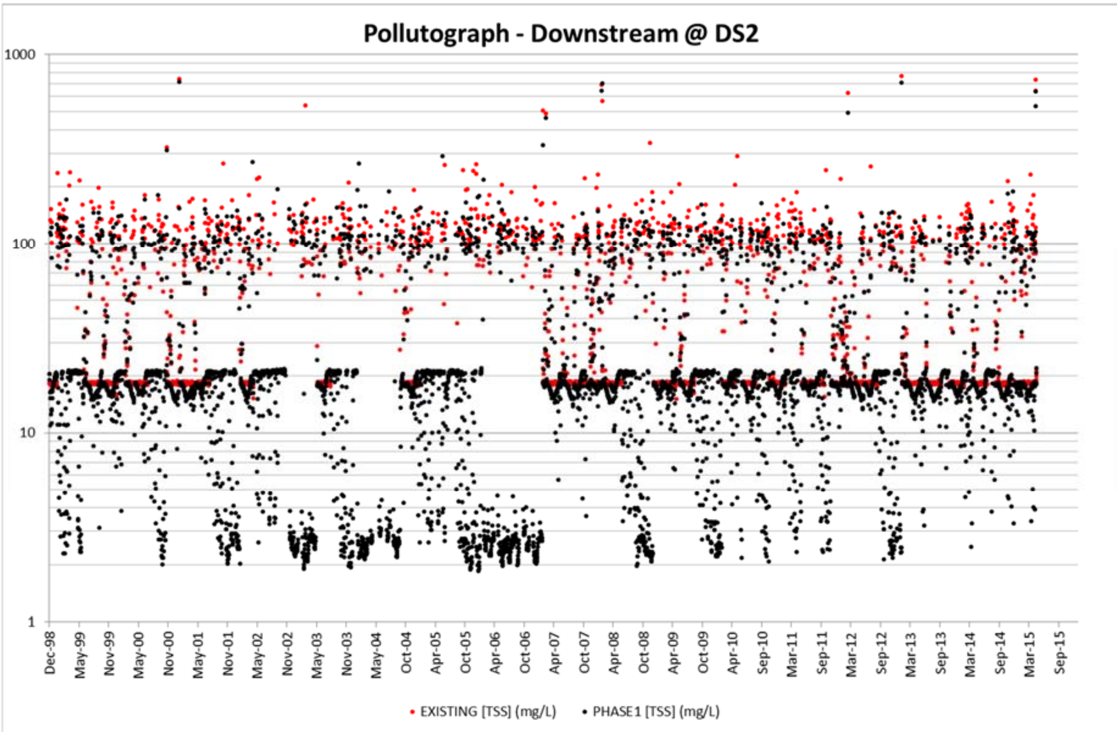

Figure B 19 Stage 1 Total Suspended Solids Downstream at DS2

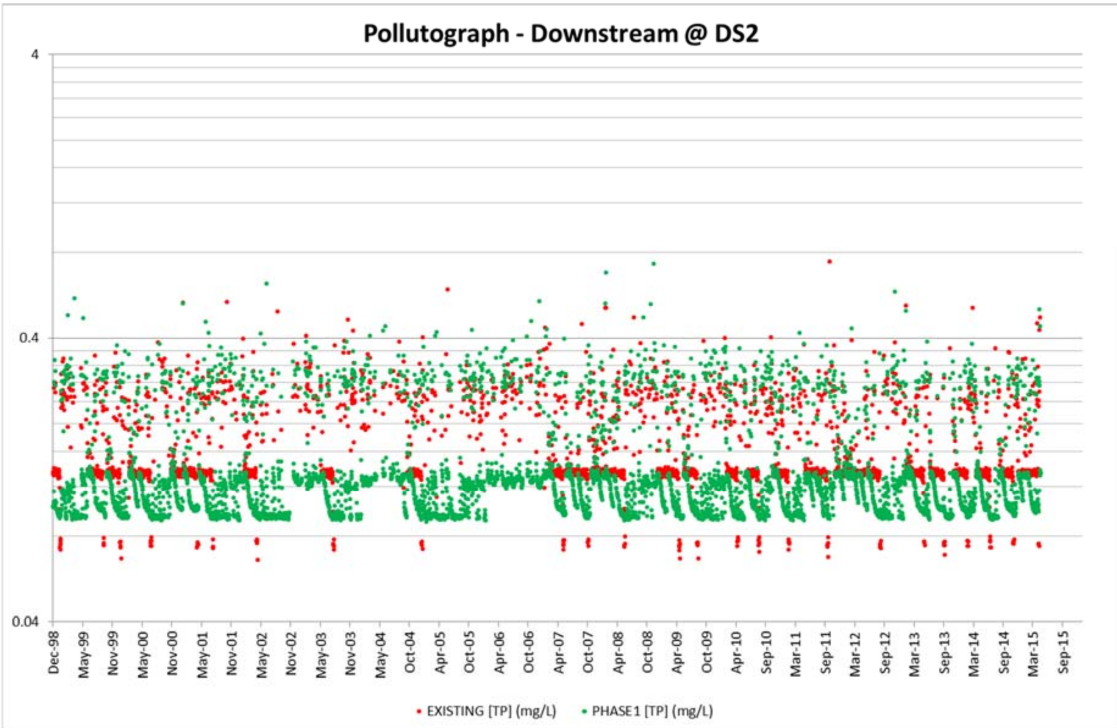

Figure B 20 Stage 1 Total Phosphorus Downstream at DS2

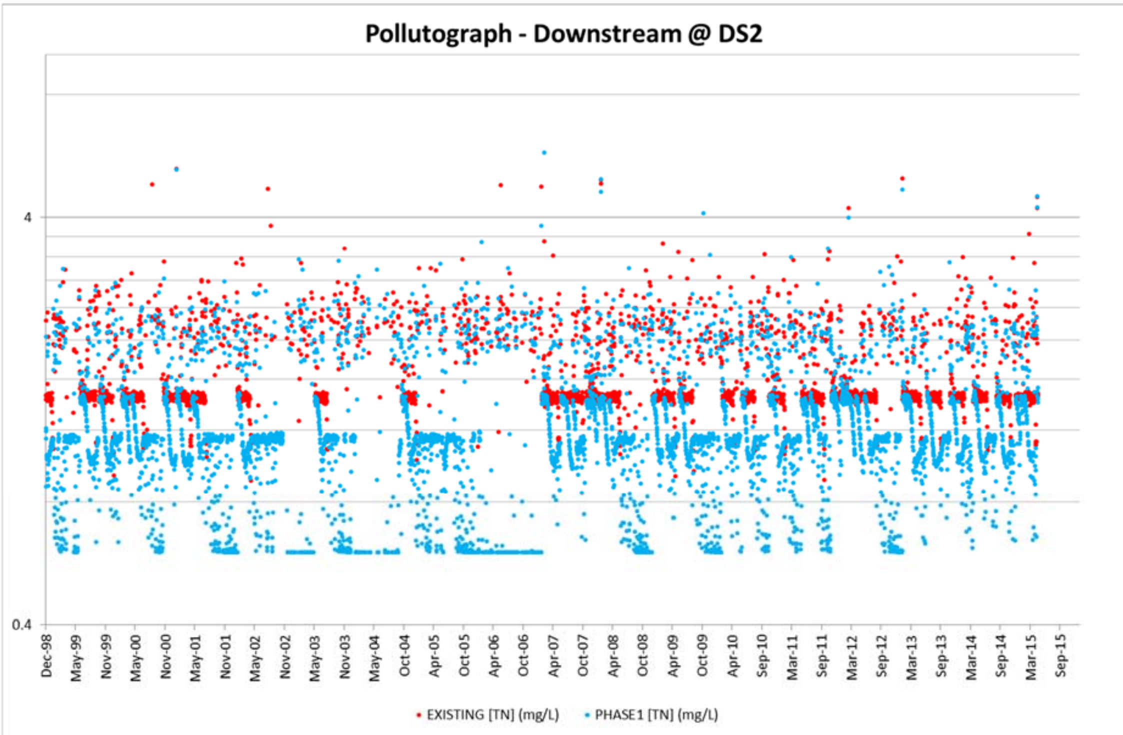

Figure B 21 Stage 1 Total Nitrogen Downstream at DS2

Appendix C - MUSIC Water Quality Results for Long Term Development

Plots of pollutant concentrations at various locations

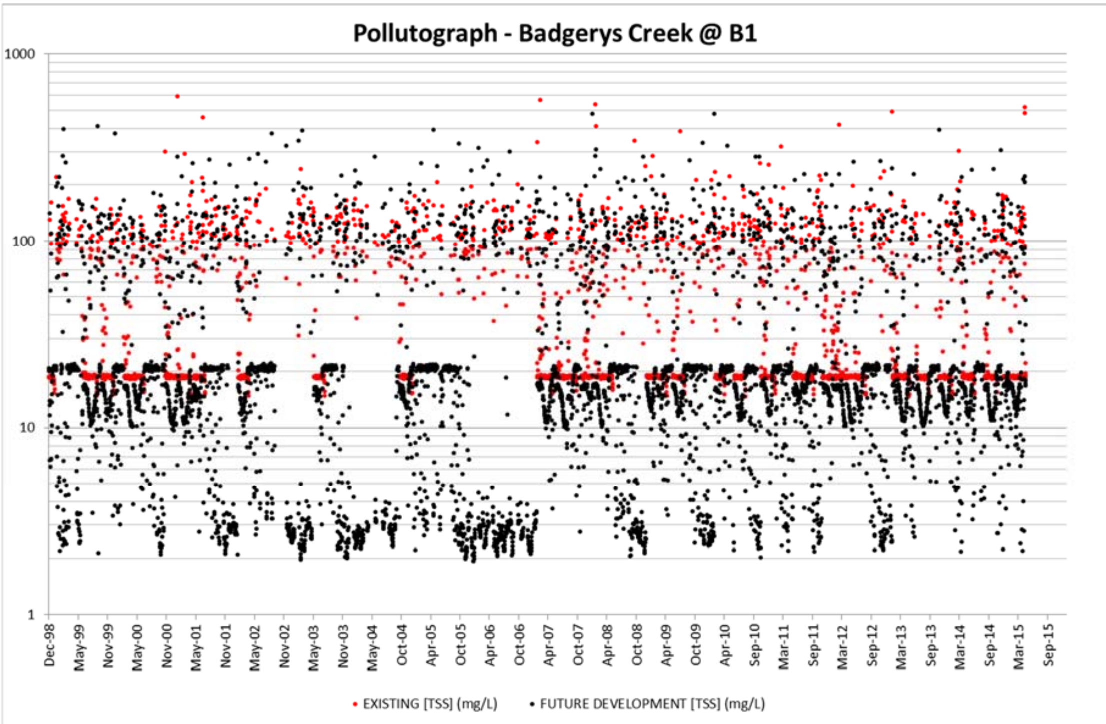

Figure C 1 Long Term Development Total Suspended Solids at Badgerys Creek B1

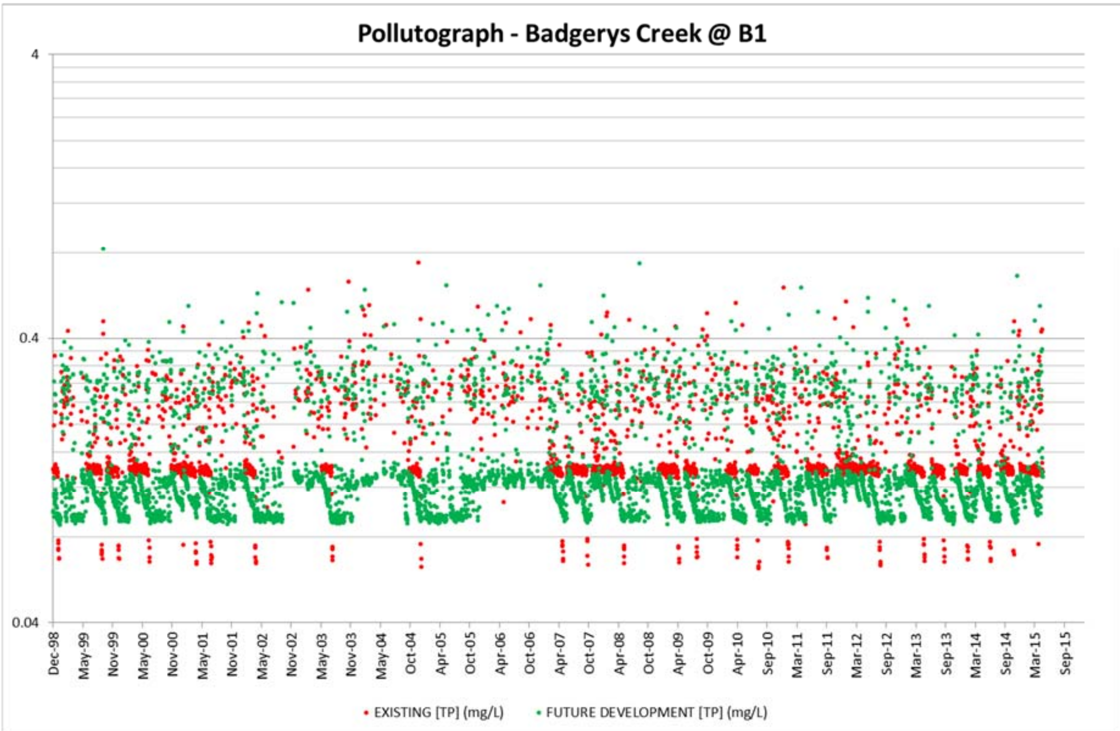

Figure C 2 Long Term Development Total Phosphorus at Badgerys Creek B1

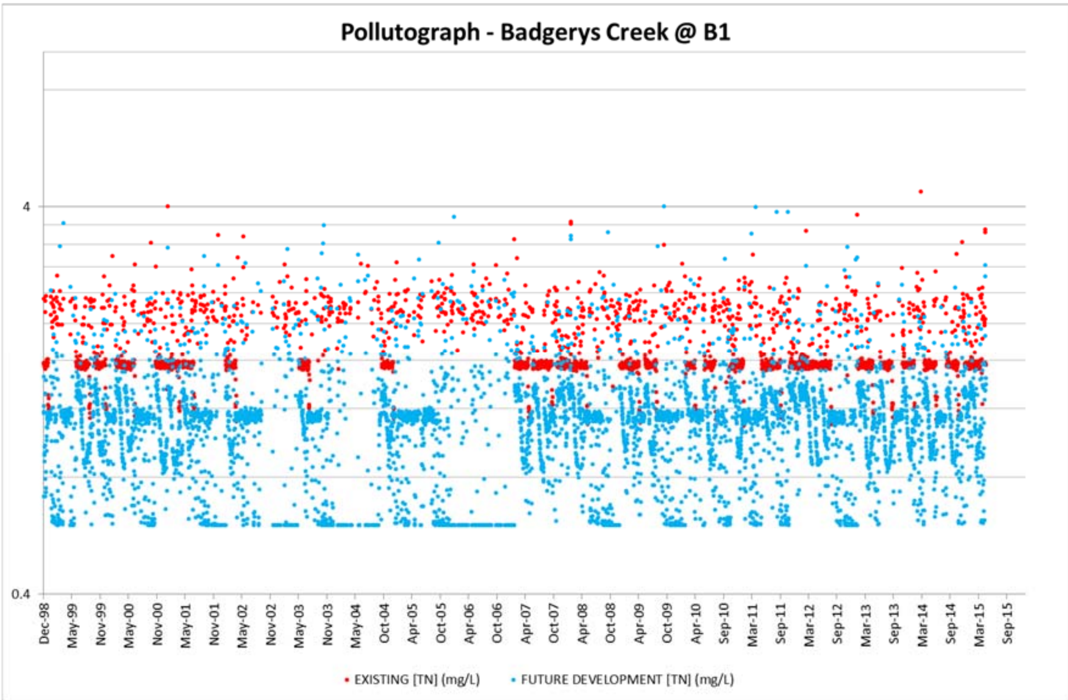

Figure C 3 Long Term Development Total Nitrogen at Badgerys Creek B1

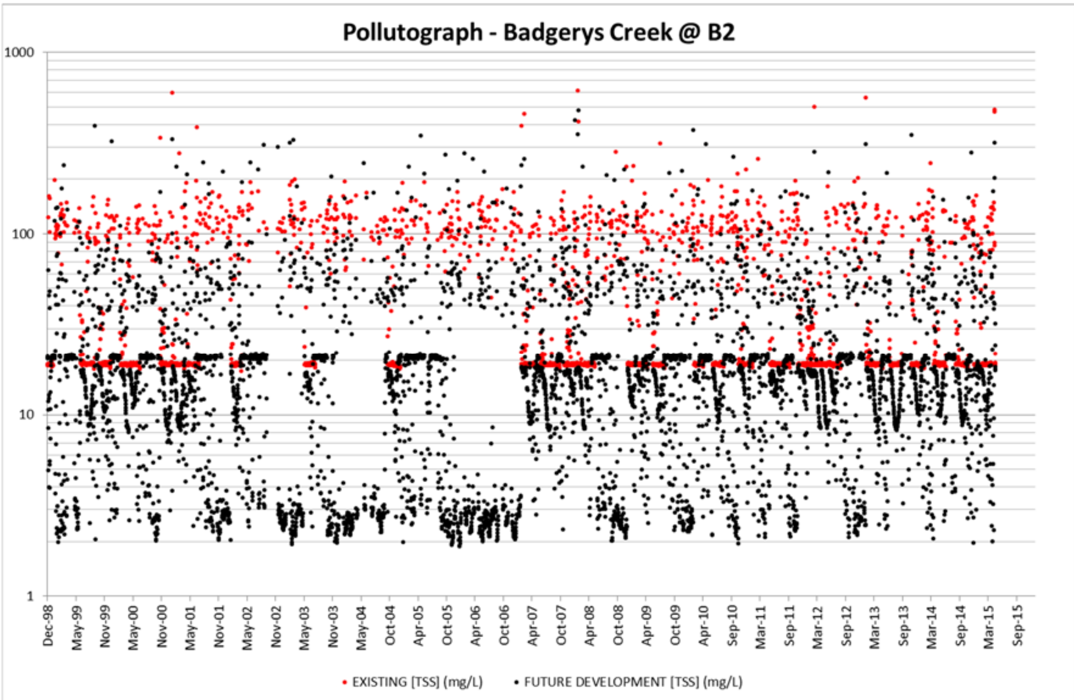

Figure C 4 Long Term Development Total Suspended Solids at Badgerys Creek B2

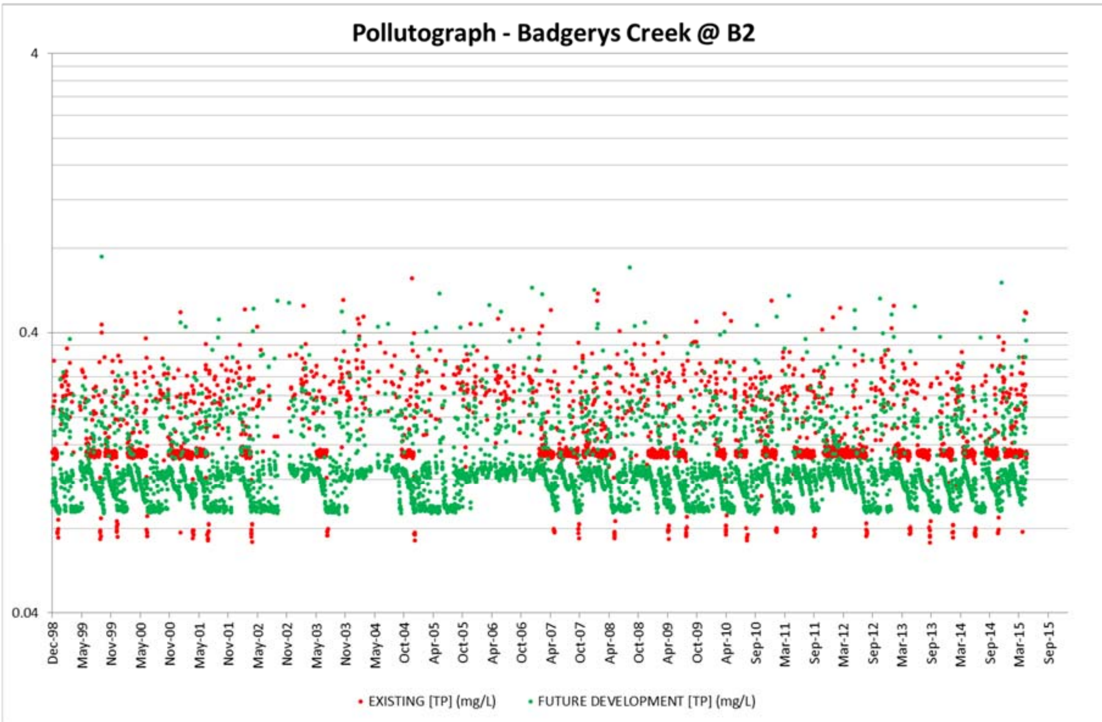

Figure C 5 Long Term Development Total Phosphorus at Badgerys Creek B2

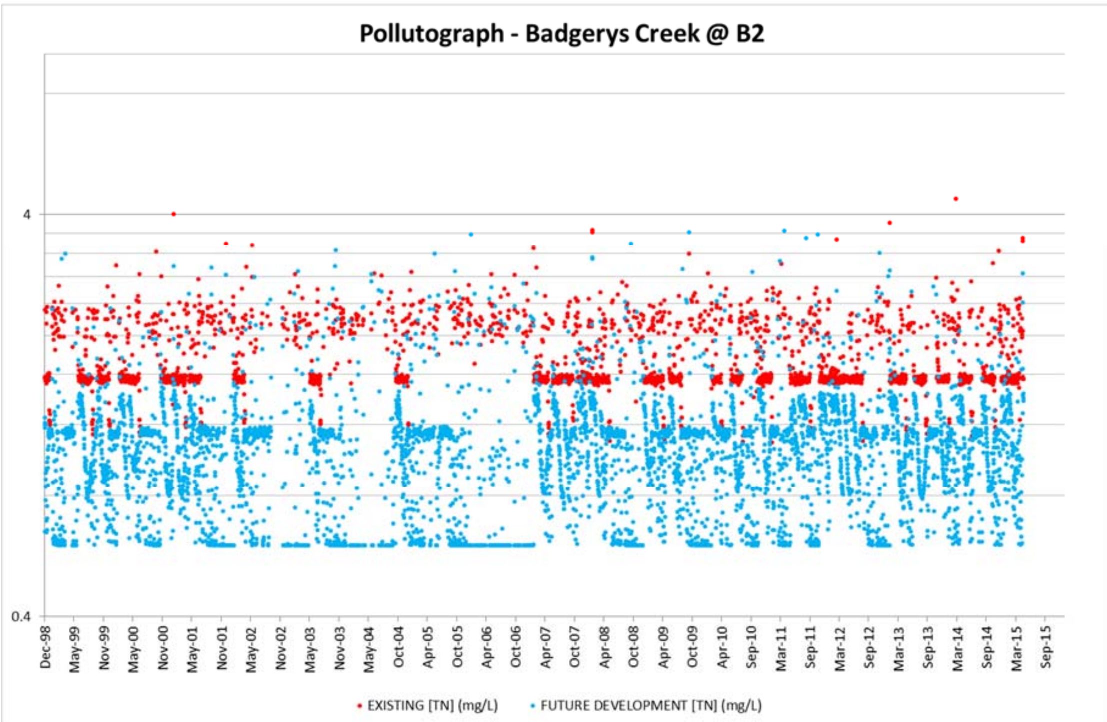

Figure C 6 Long Term Development Total Nitrogen at Badgerys Creek B2

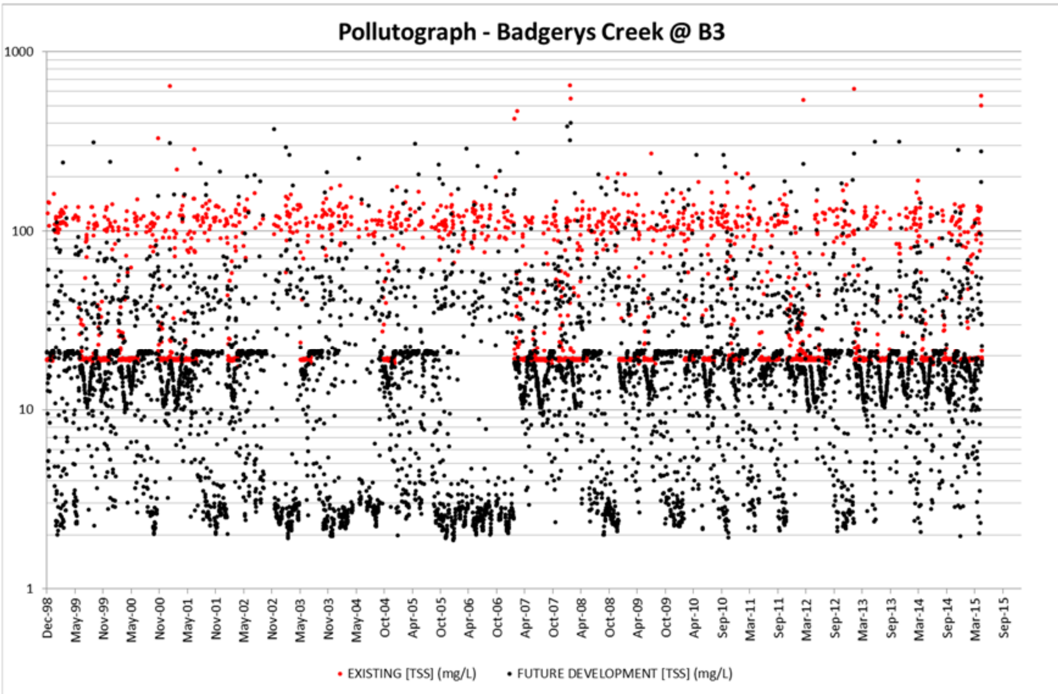

Figure C 7 Long Term Development Total Suspended Solids at Badgerys Creek B3

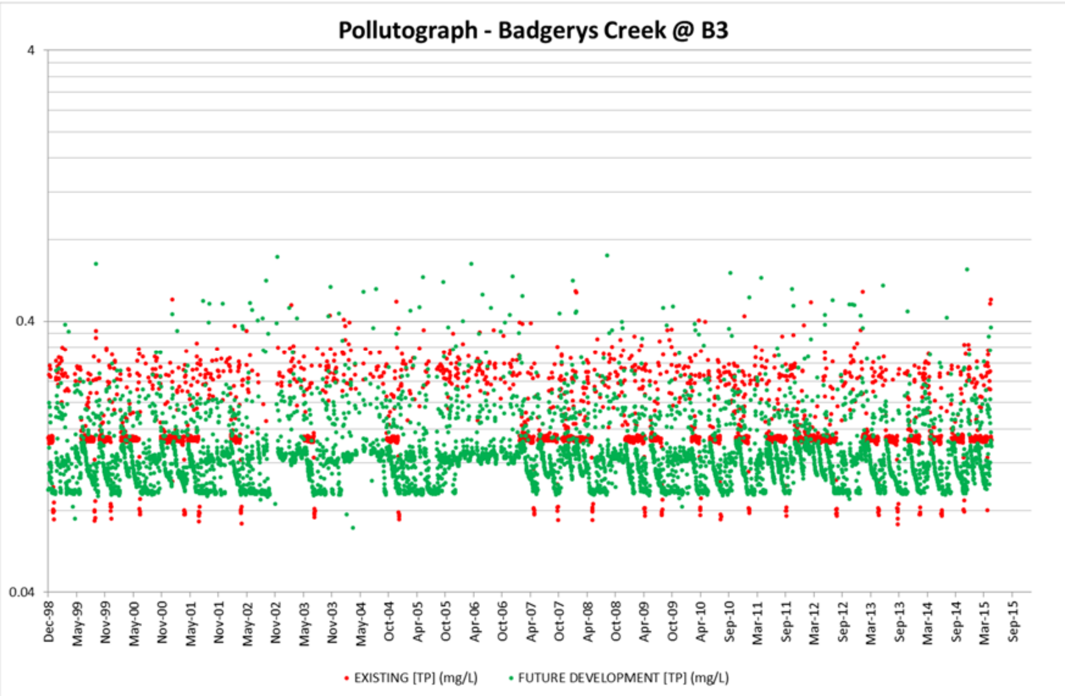

Figure C 8 Long Term Development Total Phosphorus at Badgerys Creek B3

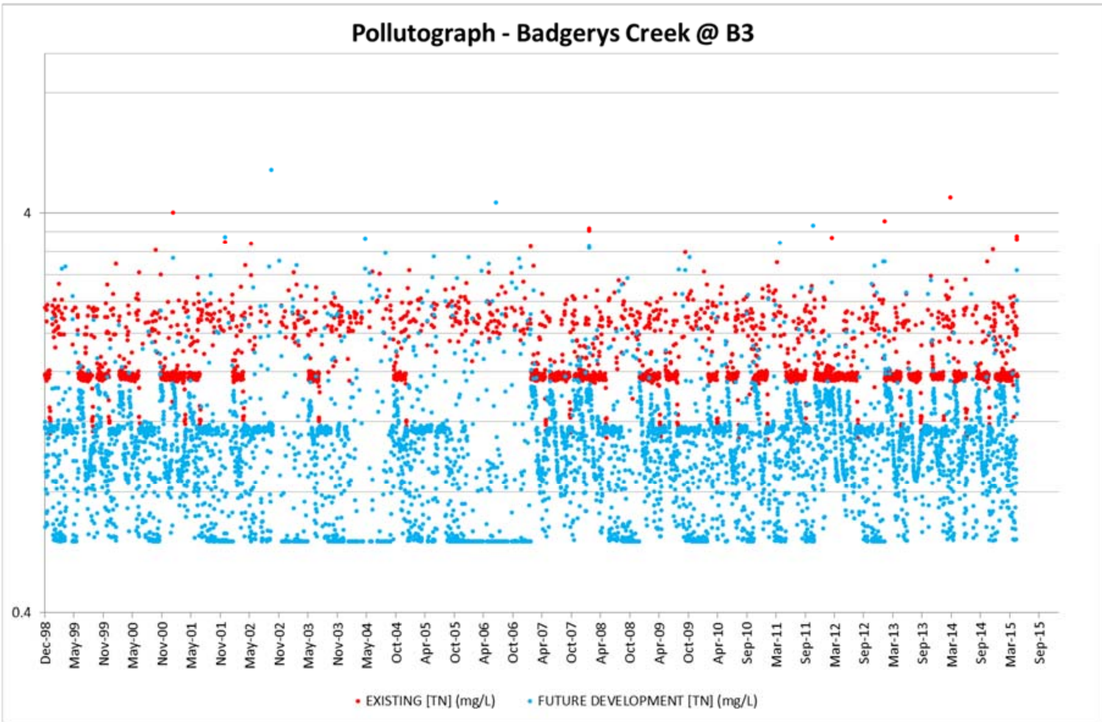

Figure C 9 Long Term Development Total Nitrogen at Badgerys Creek B3

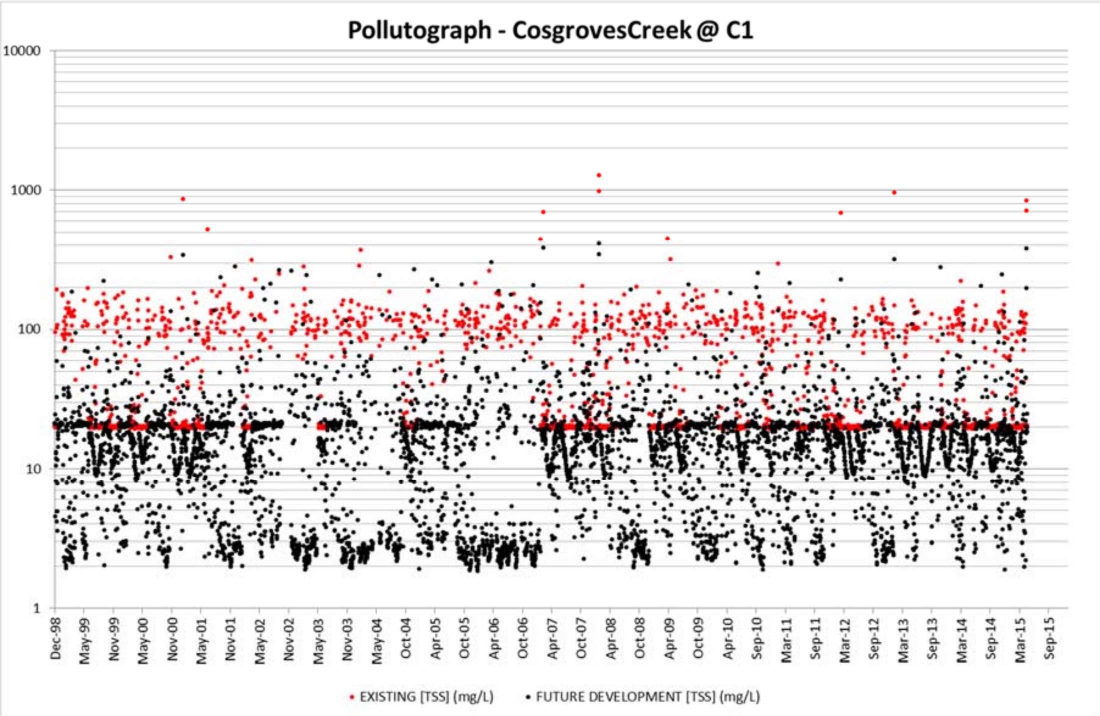

Figure C 10 Long Term Development Total Suspended Solids at Cosgroves Creek C1

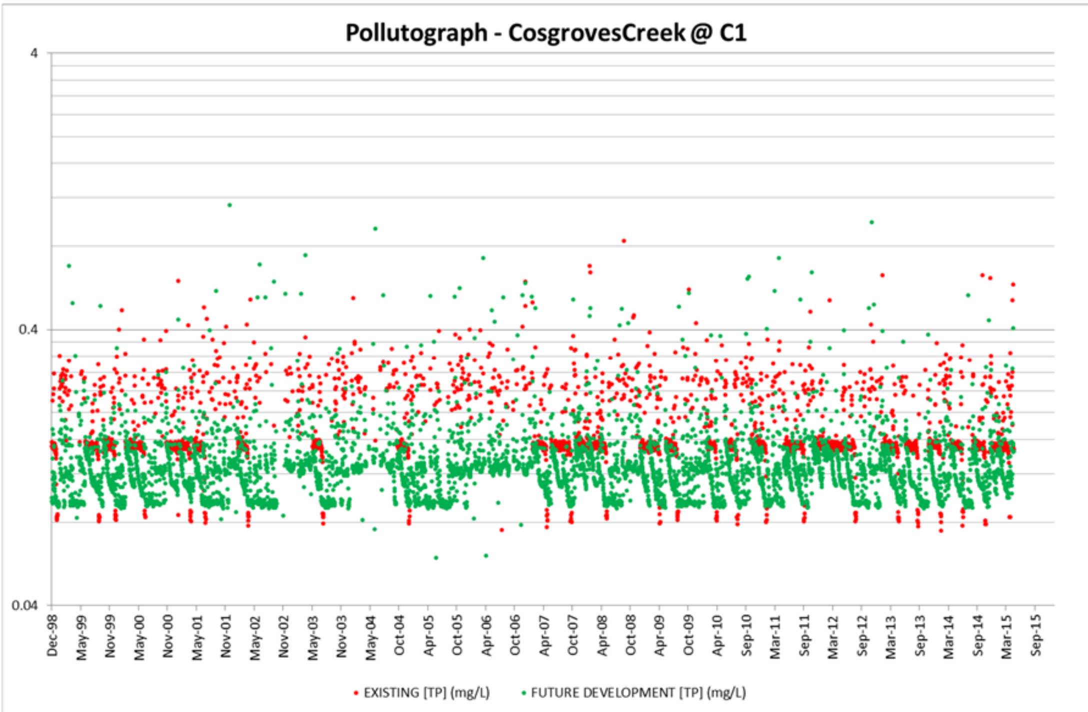

Figure C 11 Long Term Development - Total Phosphorus at Cosgroves Creek C1

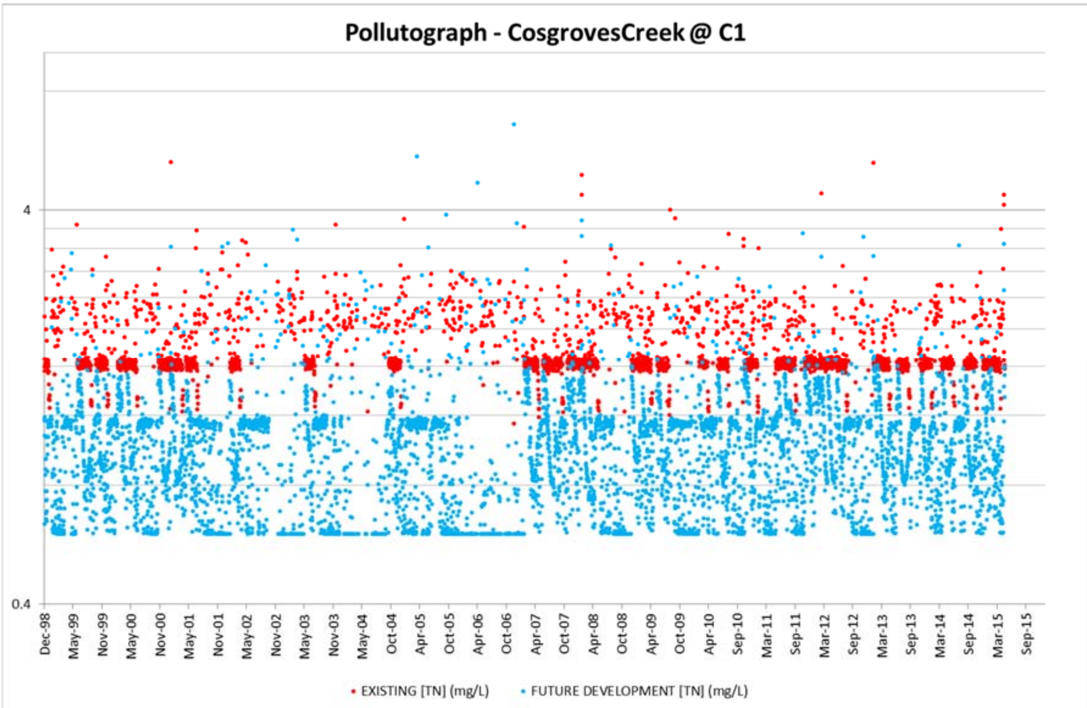

Figure C 12: Long Term Development Total Nitrogen at Cosgroves Creek C1

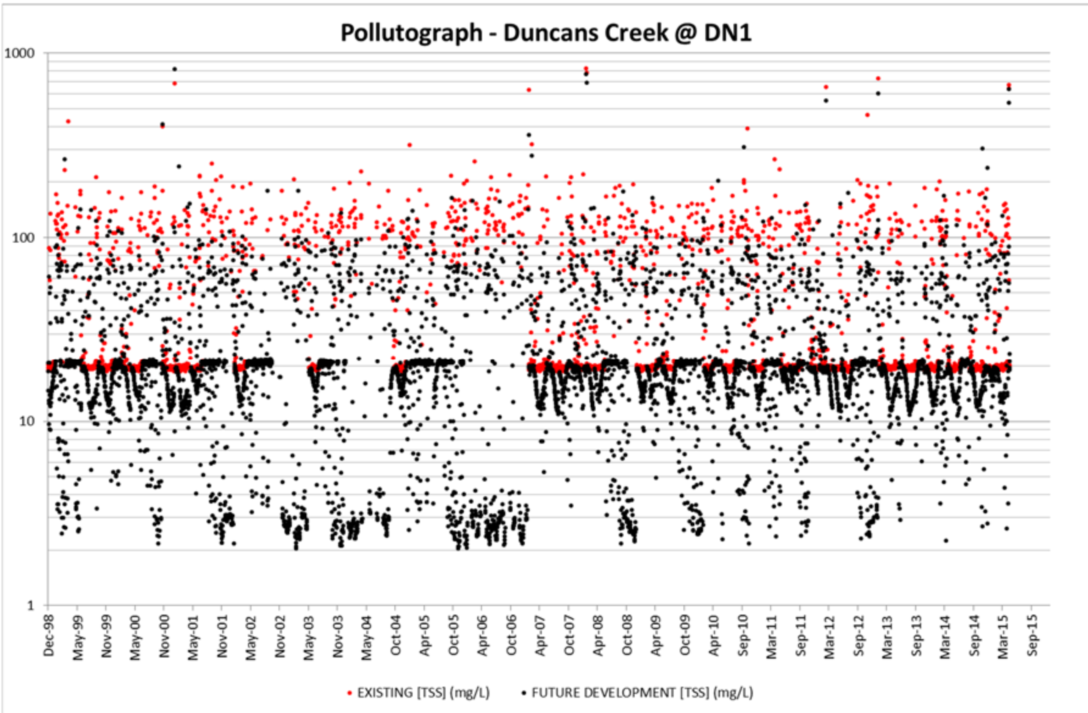

Figure C 13 Long Term Development Total Suspended Solids at Duncans Creek DN1

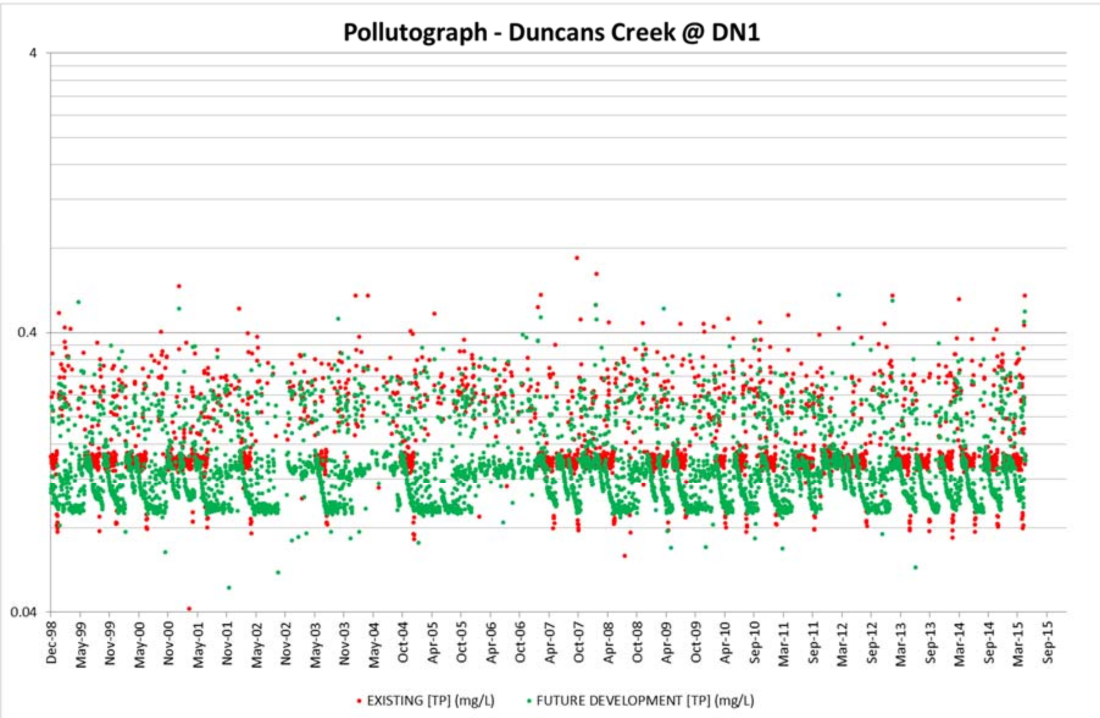

Figure C 14 Long Term Development Total Phosphorus at Duncans Creek DN1

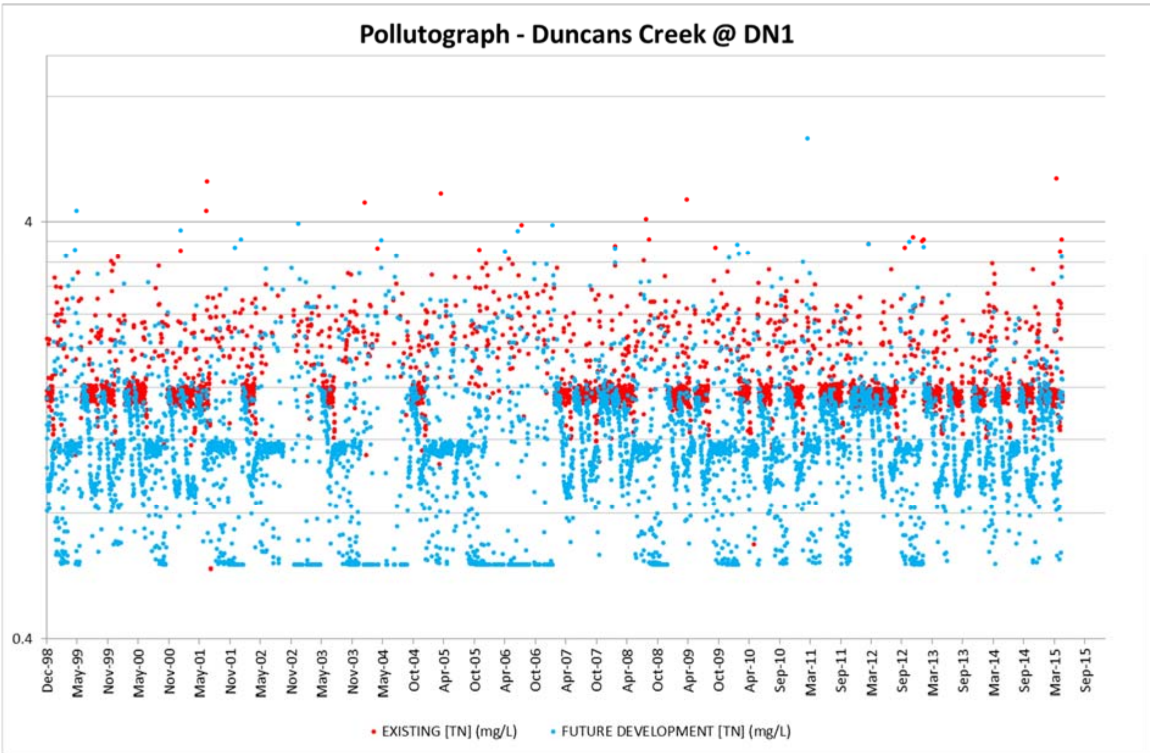

Figure C 15 Long Term Development Total Nitrogen at Duncans Creek DN1

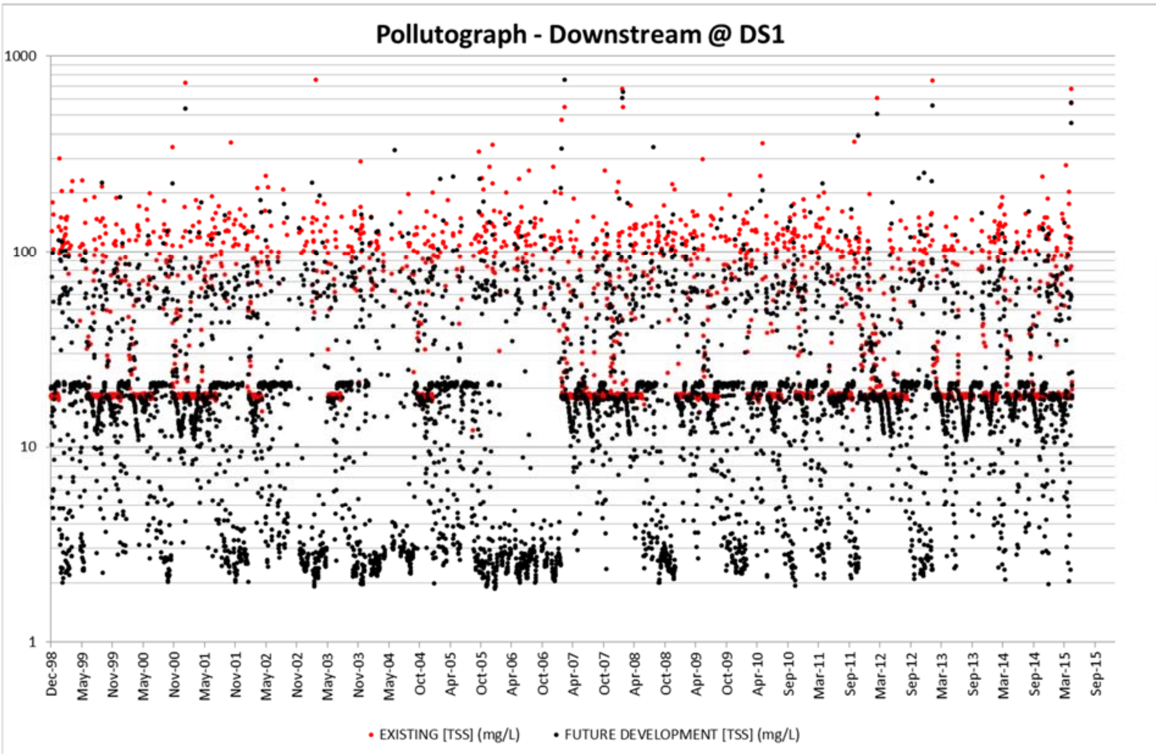

Figure C 16 Long Term Development Total Suspended Solids Downstream at DS1

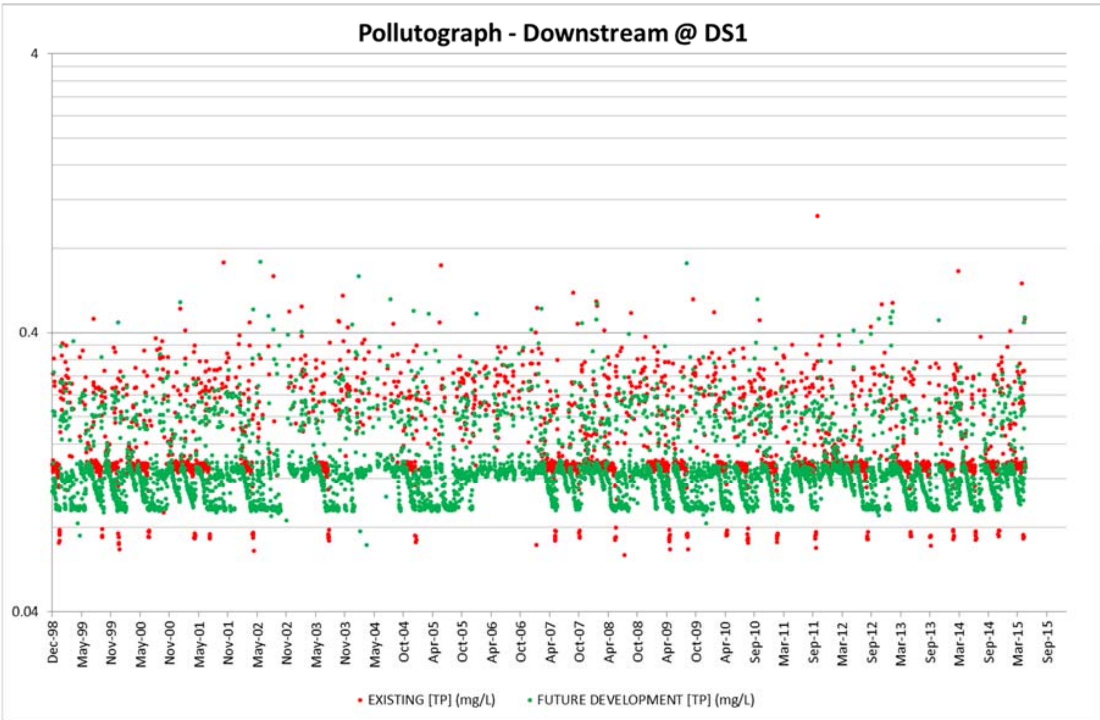

Figure C 17 Long Term Development Total Phosphorus Downstream at DS1

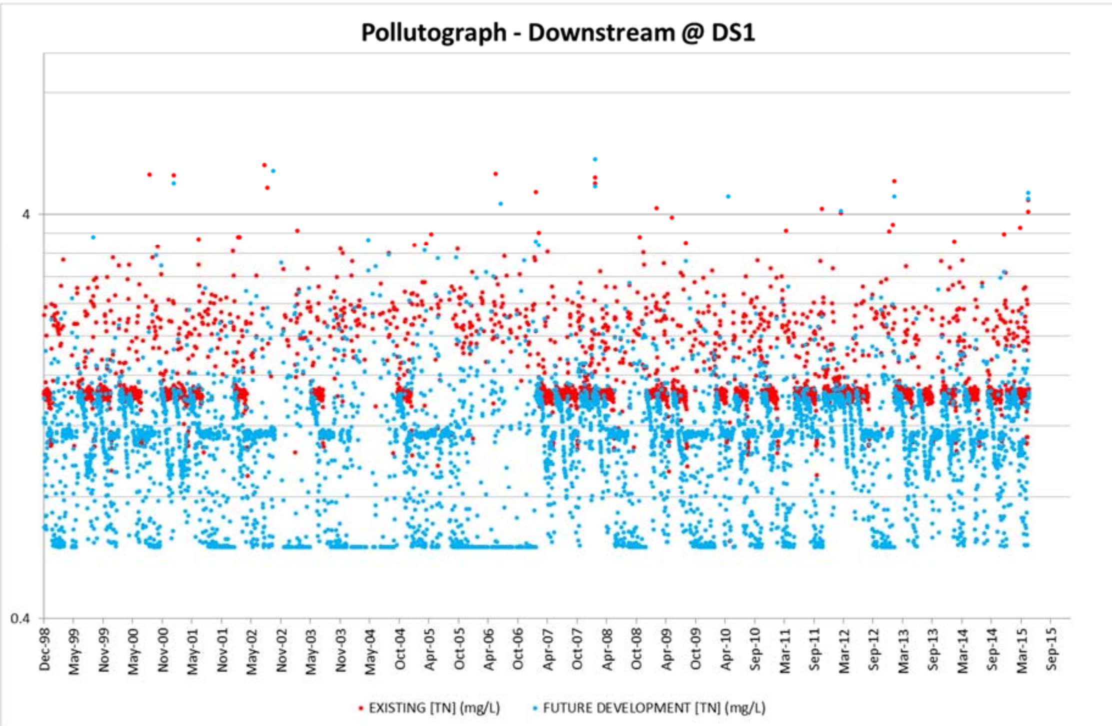

Figure C 18 Long Term Development Total Nitrogen Downstream at DS1

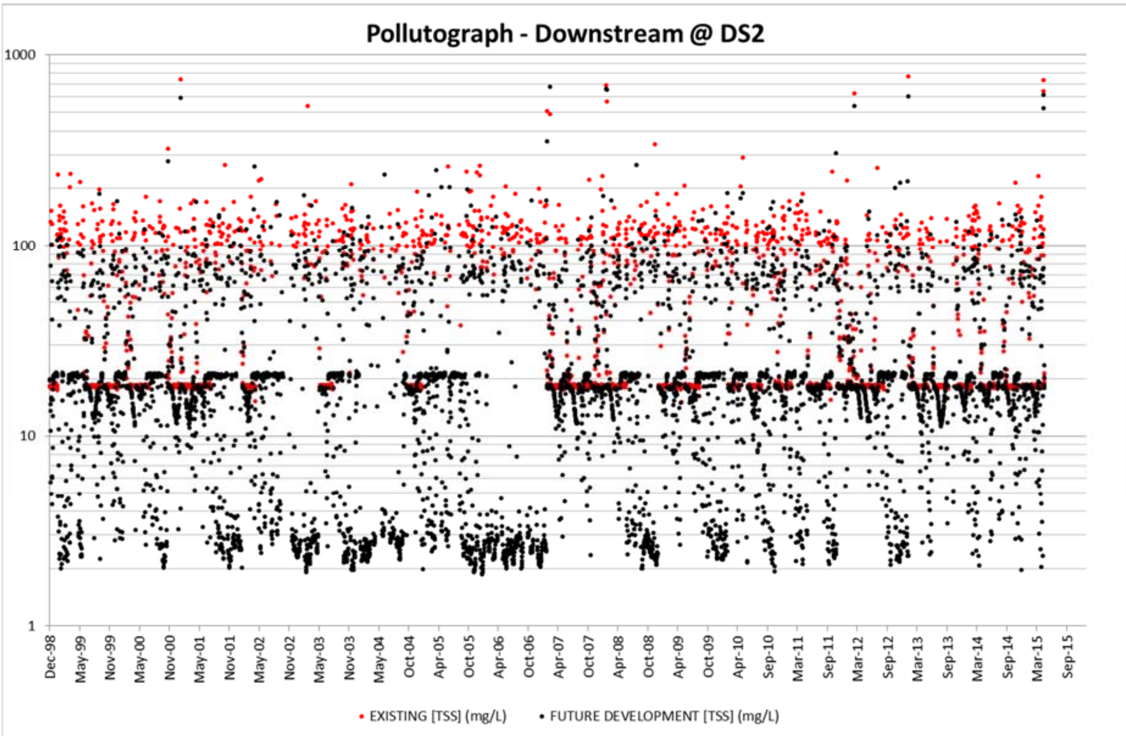

Figure C 19 Long Term Development Total Suspended Solids Downstream at DS2

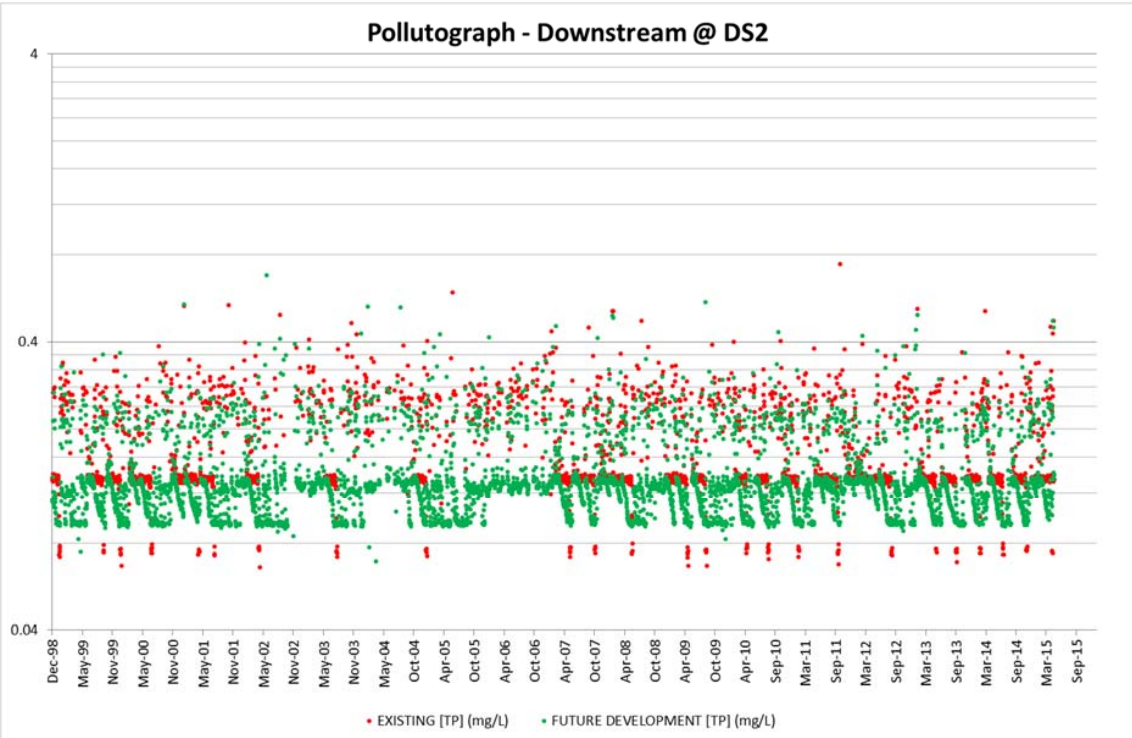

Figure C 20 Long Term Development Total Phosphorus Downstream at DS2

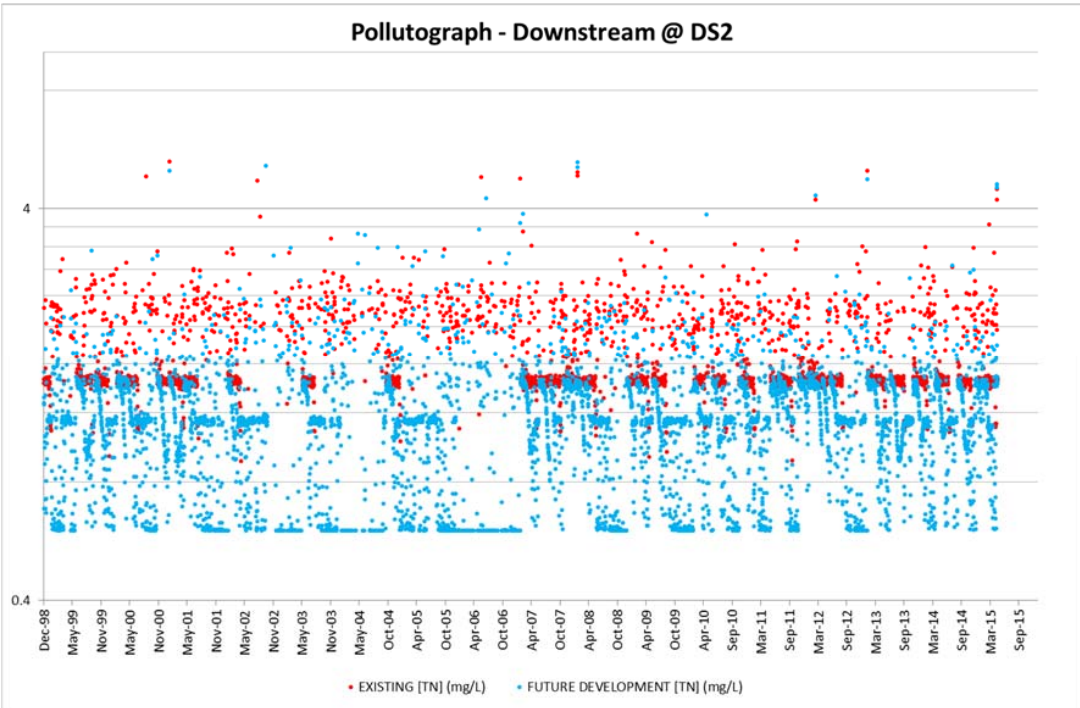

Figure C 21 Long Term Development Total Nitrogen Downstream at DS2

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Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
A	Ricky Kwan	G Marshall		N Bailey		27.07.15
B	Ricky Kwan	N Bailey		R Kwan		14.08.15
C	Ricky Kwan	Ricky Kwan		G Marshall		26.08.15

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