Roads and Maritime Services

Princes Highway Upgrade - Foxground to Berry Bypass Project

Water Quality Monitoring

Surface Water Monitoring Plan

July 2016

WATER | ENERGY & RESOURCES | ENVIRONMENT | PROPERTY & BUILDINGS | TRANSPORTATION

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1. Introduction

1.1 Background

The Foxground to Berry bypass (FBB) upgrade of the Princes Highway is the next section of upgrades between Gerringong and Bomaderry. The FBB comprises an 11.6 km upgrade of the Princes Highway between Toolijoola Road north of Foxground and Schofields Lane south of Berry.

The existing FBB section of the Princes Highway requires upgrading to the standard that is being applied over the broader Princes Highway Upgrade Program. The existing highway primarily comprises a two lane single carriageway.

The proposed upgrade of the Foxground to Berry section of the Princes Highway would have substantial benefits for improved road safety and traffic efficiency for local and regional movements including freight (RMS, 2013).

1.2 Project overview

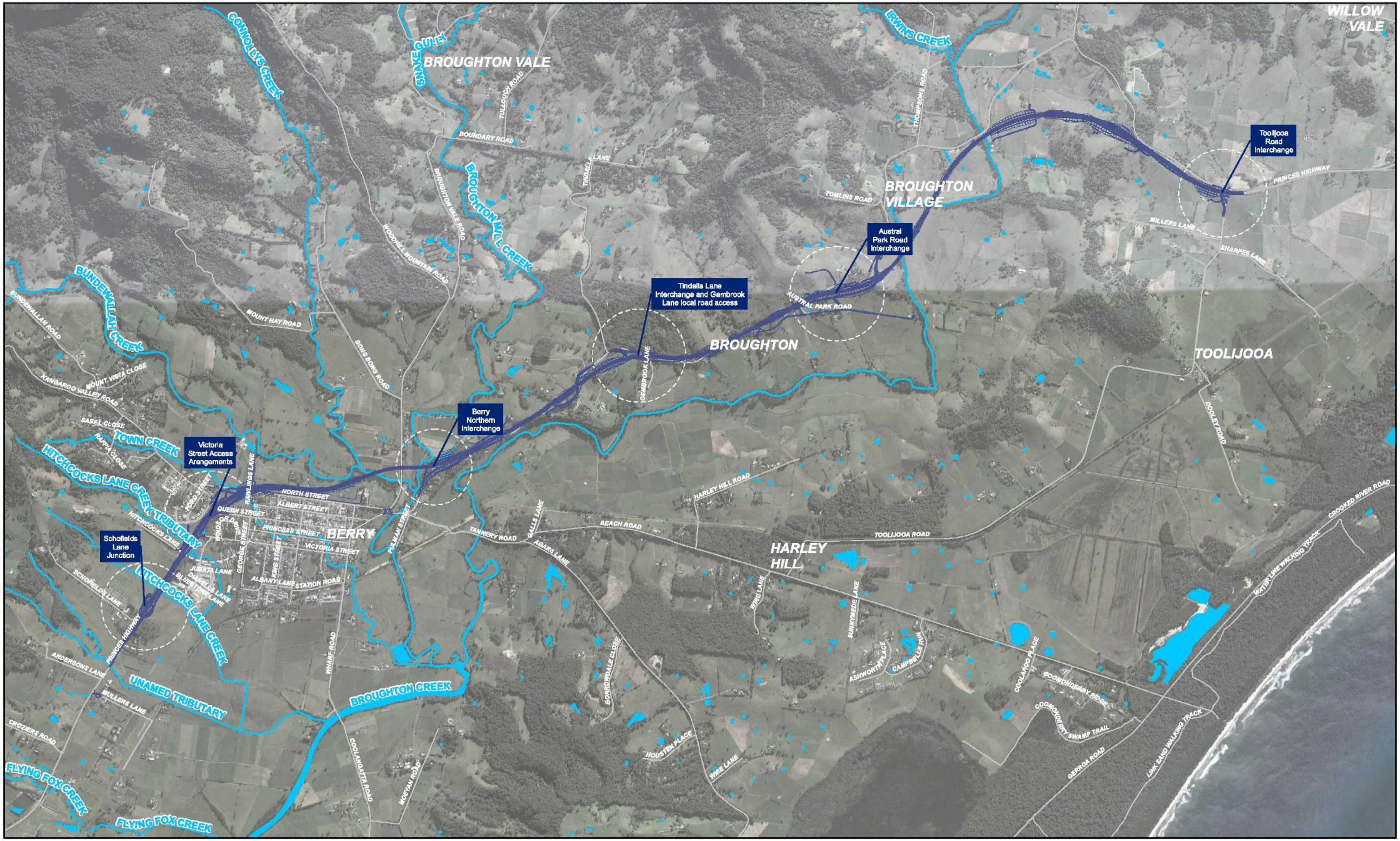
The proposed FBB Princes Highway upgrade will extend for 11.6 km from where Toolijoola Road intersects the current Princes Highway (north eastern end of the alignment) to where Schofields Lane intersects the current Princes Highway south west of Berry township. An overview of the FBB Princes Highway upgrade alignment is provided in Figure 1.

The general features of the proposed upgrade, as approved, are presented in the Director General's Environmental Assessment Report (AECOM, 2012) and are as follows:

- Construction of a four lane divided highway (two lanes in each direction) with median separation (wire rope barriers or concrete barriers where space is constrained, such as at bridge locations)
- Bypasses of the Foxground bends and Berry township
- Construction of around 6.6 kilometres of new highway where the project deviates from the existing highway alignment at Toolijooa Ridge, the Foxground bends and the Berry township
- Provision for the possible widening of the highway (if required in the future) to six lanes within the road corridor and, in some areas, construction of the road formation to accommodate future additional lanes where safety considerations, traffic disruption and sub-optimal construction practices are to be avoided
- Grade-separated interchanges at:
  - Toolijoola Road
  - Austral Park Road
  - Tindalls Lane
  - East of Berry at the existing Princes Highway, referred to as the northern interchange for Berry
  - West of Berry at Kangaroo Valley Road, referred to as the southern interchange for Berry
- A major cutting at Toolijooa Ridge (around 900 metres long and up to 26 metres deep)
- Six lanes (two lanes plus a climbing lane in each direction) through the cutting at Toolijooa Ridge for a distance of around 1.5 kilometres

- Four new highway bridges:
  - Broughton Creek bridge 1, a four span concrete structure around 170 metres in length and nine metres in height
  - Broughton Creek bridge 2, a three span concrete structure around 75 metres in length and eight metres in height
  - Broughton Creek bridge 3, a six span concrete structure around 190 metres long and 13 metres in height
  - A bridge at Berry, a 19 span concrete structure around 600 metres long and up to 12 metres in height
- Three highway overbridges:
  - Austral Park Road interchange, providing southbound access to the highway
  - Tindalls Lane interchange, providing southbound access to and from the highway
  - Southern interchange for Berry, providing connectivity over the highway for Kangaroo Valley Road along its existing alignment
- Eight underpasses including roads, drainage structures and fauna underpasses:
  - Toolijoola Road interchange, linking Toolijoola Road to the existing highway and providing northbound access to the upgrade
  - Property access underpass in the vicinity of Toolijooa Ridge at chainage 8400
  - Dedicated fauna underpass in the vicinity of Toolijooa Ridge at chainage 8450
  - Property access underpass between Toolijooa Ridge and Broughton Creek at chainage 9475
  - Combined drainage and fauna underpass in the vicinity of Austral Park Road at chainage 12800
  - Combined drainage and fauna underpass in the vicinity of Tindalls Lane at chainage 13320
  - Dedicated fauna underpass in the vicinity of Tindalls Lane at chainage 13675
  - Property access underpass between the Tindalls Lane interchange and the northern interchange for Berry in the vicinity of at chainage 15100
- Modifications to local roads, including Toolijoola Road, Austral Park Road, Gembrook Lane, Tindalls Lane, North Street, Queen Street, Kangaroo Valley Road, Hitchcocks Lane and Schofields Lane
- Diversion of Town Creek into Bundewallah Creek upstream of its confluence with Connollys Creek and to the north of the project at Berry
- Modification to about 47 existing property accesses
- Provision of a bus stop at Toolijoola Road and retention of the existing bus stop at Tindalls Lane
- Dedicated u-turn facilities at Mullers Lane, the existing highway at the Austral Park Road interchange, the extension to Austral Park Road and Rawlings Lane
- Roundabouts at the southern interchange for Berry and the Woodhill Mountain Road junction with the exiting Princes Highway
- Two culs-de-sac on North Street and the western end of Victoria Street in Berry
- Tie-in with the existing highway about 75 metres north of Toolijoola Road and about 440 metres south of Schofields Lane
- Left in/left out only provisions for direct property accesses to the upgraded highway

- Dedicated public space with shared pedestrian/cycle facilities along the southern side of the upgraded highway from the playing fields on North Street to Kangaroo Valley Road
- Ancillary operational facilities, including permanent detention basins, stormwater treatment facilities and a permanent ancillary facility site for general road maintenance



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LEGEND

- Berry to Foxground upgrade alignment
- Railways
- Alignment location of interest
- Waterways
- Roads
- Lakes and dams

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Overview of the Berry to Foxground upgrade

Figure 1

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2. Regulatory context

2.1 Environmental assessment

The FBB Princess Highway upgrade project has been assessed as a transitional project under Part 3A of the Environmental Planning and Assessment Act 1979 (EP&A Act). The Director-General's requirements (DGR's) for the FBB Princes Highway upgrade were issued on 11 February 2011.

The DGR's for surface water and groundwater required the assessment of:

- "*Water quality taking into account impacts from both accidents and runoff and considering relevant environmental water quality criteria specified in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000. The assessment must describe measures to control erosion and sedimentation during construction activities and measures to capture and treat runoff from the site during the operational phase*
- "*Identify potential risks of the project on groundwater resources including: characterising existing local and regional hydrology; potential risks of drawdown; impacts to groundwater quality; discharge requirements; and implications for groundwater-dependent surface flows (including springs and drinking water catchments), groundwater-dependent ecological communities and groundwater users*
- *Identifying potential impacts of the project on existing flood regimes, consistent with the Floodplain Development Manual (Department of Natural Resources, 2005), including impacts to existing receivers and infrastructure and the future development potential of affected land, demonstrating consideration of the changes to rainfall frequency and/or intensity as a results of climate change on the project. The assessment shall demonstrate due consideration of flood risk in the project design*
- *Waterways to be modified as a result of the project, including ecological, hydrological and geomorphic impacts (as relevant) and measures to rehabilitate the waterways to pre-construction conditions or better"*

The assessment of surface water impacts presented in the Environmental Assessment (EA) Report (AECOM, 2012) was prepared in accordance with the above DGR's. The EA was subsequently exhibited for consultation and a Submissions Report (RMS, 2013) prepared in response to the concerns raised.

Approval for the project was issued by the Minister for Planning and Infrastructure on 22 July 2013.

In terms of surface water monitoring, the EA (Appendix H, AECOM, 2012) provided an outline of the surface water monitoring that would be adopted for the project. The key components of the program recommended from construction and operation in the EA are summarised below:

- The program approach is based on the surface water monitoring program for the Tintenbar to Ewingsdale Pacific Highway upgrade (T2E upgrade) as this had extensive consultation with the Office of Environment and Heritage (OEH) and Department of Investment, Regional Infrastructure and Services (NOW and Fisheries) and has been approved by RMS and the Department of Planning and Infrastructure.
- In terms of performance standards, the water quality monitoring program should focus on site specific issues rather than on pre-determined guideline values.

- The water quality monitoring program should focus on impacts associated with the project rather than the wider catchment which may create background impacts. Subsequently monitoring should be localised to areas immediately up and down gradient of the project.
- Statistical methods for assessing impacts would be based on the development of control charts (up-stream sites) which would be compared against test sites (down-stream sites). During construction statistical methods for assessing impacts will be based on data collected from upstream sites compared to data collected from downstream sites in accordance with agency guidance. A trigger would be deemed to have occurred when the median concentration of independent samples taken at a test site exceeds the eightieth percentile of the same indicator at a suitably chosen reference site. The development of suitable median and
  80th percentile values would require the collection of suitable amount/period of baseline data. The statistical significance of the changes/trigger would be assessed further using a paired t-Test or Sign Test methods.
- Monitoring for the following key parameters:
  - In situ monitoring of dissolved oxygen (DO), Electrical Conductivity (EC), Oxygen Reduction Potential (ORP), pH, Temperature and Turbidity.
  - Total Suspended Solids (TSS).
  - Oils and Grease.
  - Total Petroleum Hydrocarbons (TPH).
  - Total Phosphorus (TP).
  - Total Nitrogen (TN).
  - Ammonia.
  - Metals (aluminium, cadmium, copper, lead, zinc).
- Construction sampling frequencies would focus on:
  - Wet weather events (i.e. greater than 15 mm of rainfall in 24 hours). One sample would be taken from upstream and downstream sites and compared immediately. If downstream is more than 10% greater than upstream, two more pairs of samples 15 min apart would be collected and compared.
  - Event based sampling of major wet weather events (i.e. greater than 50 mm in 24 hours)
- Operation sampling frequencies would focus on:
  - Sampling of minor wet weather events (as defined above) for one, or 12 sampling events per year, whichever is greater.

2.2 Conditions of Approval

The Project Approval was issued subject to a range of conditions, which included conditions for environmental monitoring and auditing. In relation to the monitoring of surface water, Condition of Approval number B16 (CoA No. B16) specifies that:

"*The Proponent shall prepare and implement a Water Quality Monitoring Program to monitor the impacts of the project on surface water and groundwater quality and resources and wetlands, during construction and operation*"

The Water Quality Monitoring Program (WQMP) is required to be developed in consultation with the Office of Environment and Heritage (OEH), Environmental Protection Authority (EPA), Department of Primary Industries (DPI) (Fishing and Aquaculture) and NSW Office of Water (NOW). Table 1 outlines the specific requirements of CoA B16 and provides section references where each criteria is addressed within this monitoring program.

Table 1: Condition of approval B16 (NSW DPI, 2013)

Condition of approval B16	WQMP section reference where addressed
(a) identification of surface and groundwater quality monitoring locations (including watercourse, water bodies and SEPP 14 wetlands), which are representative of the potential extent of impacts from the project	Surface water – Section 3, 4 and 9 Groundwater is in the groundwater quality monitoring document
(b) the results of the groundwater modelling undertaken under condition B15	Within the groundwater quality monitoring plan document
(c) identification of works and activities during construction and operation of the project, including emergencies and spill events, that have the potential to impact on surface water quality of potentially affected waterways	Section 3
(d) development and presentation of parameters and standards against which any changes to water quality will be assessed, having regard to Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000 (ANZECC, 2000)	Sections 7 and 8
e) representative background monitoring of surface and groundwater quality parameters for a minimum of twelve months (considering seasonality) prior to the commencement of construction to establish baseline water conditions, unless otherwise agreed by the Director General	Section 4 and Section 9. Initial monitoring data to be provided to RMS as ongoing monitoring data updates separate to this report
(f) a minimum monitoring period of three years following the completion of construction or until the affected waterways and/or groundwater resources are certified by an independent expert as being rehabilitated to an acceptable condition. The monitoring shall also confirm the establishment of operational water control measures (such as sedimentation basins and vegetation swales)	Operation criteria discussed in Sections 9 to 13
(g) contingency and ameliorative measures in the event that adverse impacts to water quality are identified	Section 9 and 10
(h) reporting of the monitoring results to the Department, OEH, EPA and NOW	To be supplied as monitoring reports to RMS and subsequently to OEH, EPA and NOW

The Program must also be submitted to the Director General for approval six (6) months prior to the commencement of construction of the project, or as otherwise agreed by the Director General. A copy of the Program must also be submitted to OEH, EPA, DPI (Fishing and Aquaculture) and NOW prior to its implementation.

The conditions of approval outlined above form the objectives for the Water Quality Monitoring Plan (WQMP). This document provides the Surface Water Monitoring Plan (SWMP) component of the WQMP. A Groundwater Monitoring Program (GWMP) (GHD, 2014a) and a groundwater sampling protocol (GHD, 2014b) have also been prepared to meet other aspects of CoA No. B16 and should be read in conjunction with this document.

2.3 Statement of commitments

RMS has committed to a range of surface water quality protection measures as part of the environmental assessment under Part 3A of the EP&A Act. The primary objective of the measures proposed is to minimise the impacts to downstream surface water quality. The statement of commitments for surface water quality, as outlined in the Submission report (AECOM, 2013), is provided in Table 2. These commitments have been considered in the preparation of this SWMP and would also be taken into account in the development of the detailed design and project environmental management plans.

Table 2: Statement of commitments – surface water and groundwater quality

Ref No	Commitment	Key Action	Timing	Reference Document
SG1	Minimise impacts to water quality during construction and operation	Water quality measures such as water quality basins, swales or bioretention systems at sensitive receiving environments will be designed and installed to respond to the project water quality design criteria.	Pre-construction and construction	Managing Urban Stormwater: Council Handbook (EPA, 1997) Section 7.4 of the environmental assessment
SG2	Minimise water quality impacts and impacts to the flow regimes of Town Creek and Bundewallah Creek	A design and re-vegetation strategy for the Town Creek diversion will be developed during detailed design and will include measures to: Maintain flushing efficiency. Mitigate erosion risk at the connection with Bundewallah Creek. The design of the diversion will be finalised in consultation with directly affected landowners. The Town Creek diversion will be stabilised to mitigate erosion risk prior to operation.	Pre-construction and construction	Managing Urban Stormwater – Volume 1 (Soils and Construction) (Landcom (2004) Managing Urban Stormwater – Soils and Construction, Volume 2D – Main Road Construction (known as the Blue Book) (DECCW 2008) Guidelines for In stream Works on Waterfront Land (NSW Office of Water, 2012) Section 7.4 of the environmental assessment Section 2.11 of the response to submissions
SG3	Minimise impacts on farm dams	Permanent losses to farm dam catchments and inflows will be identified during detailed design. Mitigation strategies will be developed in consultation with affected landowners and implemented where reasonable and feasible.	Pre-construction	Section 7.4 of the environmental assessment
SG4 and SG5	Minimise impacts on drinking water supply	Drinking water drawn from Broughton Creek will be maintained through measures identified in commitment AQ1. In the event that water drawn from Broughton Creek does not meet existing drinking water quality standards, an appropriate source of potable water will be made available to affected residents, following consultation.	SG4 – Construction SG5 - Pre-construction	Section 2.11 of the response to submissions

Ref No	Commitment	Key Action	Timing	Reference Document
		RMS will consult with landholders along the existing Town Creek alignment, below the proposed diversion, to confirm that there are no Basic Landholder Rights (under the Water Management Act 2000) to access water for domestic or stock purposes.		
SG6	Minimise changes in current flow regimes	Waterway structures will be designed to maintain existing flow regimes, where practicable.	Pre-construction	Section 7.5 of the environmental assessment
SG7 and SG8	Manage the impacts associated with changes to flooding and drainage	Detailed design will seek to minimise increases in peak flood levels in the 1 in 100 year flood event. Changes to flood impacts on property will be identified as part of detailed design. Where increased flood impacts to structures, such as residences, are identified, mitigation measures will be proposed and implemented where reasonable and feasible.	Pre-construction (SG7) Pre-construction and construction.(SG8)	Section 7.5 of the environmental assessment
SG9	Minimise impacts on channel structure	Impacts on stream channel structure diversion will be minimised during detailed design. Measures to be considered may include culvert sizing, energy dissipation measures, scour protection and other design features to control flow intensity and direction.	Preconstruction	Section 7.5 of the environmental assessment
SG10	Minimise the impact on groundwater levels	Groundwater monitoring of water levels and water quality will be undertaken. Where levels and/or quality indicate that the project is potentially having an adverse impact, mitigation measures will be considered and implemented where reasonable and feasible.	Construction	Section 7.4 of the environmental assessment
SG11	Conservation of water	Water efficient work practices, such as water reuse and recycling for road construction and re-vegetation irrigation will be implemented, where feasible. In the event that surface water from watercourses or groundwater is required to supply water to the project, a site specific impact assessment will be carried out in consultation	Construction	Section 7.4 of the environmental assessment Section 2.11 of the response to submissions

Ref No	Commitment	Key Action	Timing	Reference Document
		with the NSW Office of Water and potentially affected stakeholders.		
SW4	Avoid contamination of waterways	Monitoring of water quality upstream and downstream of the project site will be undertaken before and during construction. Also refer to SG4.	Preconstruction and construction	Section 7.4 and 8.1 of the environmental assessment Erosion and Sedimentation Management Procedure (RTA, 2008) Managing Urban Stormwater – Soils and Construction Volume 1 (Landcom, 2004) Managing Urban Stormwater – Soils and Construction, Volume 2D – Main Road Construction (DECCW, 2008) RMS QA Specification G38 Soil and Water Management RMS QA Specification G39 Soil and Water Management (Erosion and Sediment Control Plan)

The statement of commitments presented in the above table that are relevant to the SWMP and hence this document includes SG4 and SW4. Other commitments are either not associated specifically with water quality monitoring or will be dealt with in the groundwater monitoring plan document accompanying this report.

Further to the above it is noted that this water quality monitoring document is primarily focused on developing a monitoring program for pre-construction monitoring when there is a general absence of construction and operational water quality infrastructure such as sediment dams. The monitoring locations and frequency may have to be expanded to include monitoring at these locations once this infrastructure has been developed.

3. Overview of environmental risks

Potential impacts of the FBB Princes Highway upgrade on water quality were investigated as part of the project approval assessments under Part 3A of the EP&A Act and are discussed in detail in Chapter 7.4.3 of the EA Report (AECOM, 2012). An understanding of the risks to surface water quality associated with the construction and operational phases of the project is critical in developing an adequate monitoring program.

The following sections provide an overview of the key sources of risk and associated impacts to guide the development and assessment of performance objectives, standards and measurement criteria.

3.1 Sources of risk

The key sources of risk can be divided into two distinct areas - chronic water quality risks and acute water quality risks. Chronic risks refer to those which may cause detrimental effects after a prolonged period, while acute risks relate to those which cause immediate effect. These risks can be further refined to those associated with either the construction phase or operational phase of the project. The risks associated with these sources, and subsequent impacts, differ significantly between construction and operation and as such have been reviewed independently in the following sections. The review of construction and operational risks below is provided to identify the potential sources of risk and does not discuss management of these risks or represent the residual risk to water quality following implementation of mitigation measures (Aurecon, 2010).

A review of the potential sources of risk rather than the significance of the impact on water quality is made at this stage of the project. This approach has been adopted to ensure that the surface water monitoring program considers all potential sources of risk not just those with the highest risk (Aurecon, 2010).

3.1.1 Construction phase

Construction works and activities

There are a range of works and activities with the potential to impact on surface water quality if not managed correctly that must be recognised in order to understand the likely sources of risk during the construction phase of the project, including:

- Clearing, cut and fill operations (earthmoving activities)
- Sediment release from stockpiles
- Chemical and fuel spills
- Exposure of acid sulphate soils
- General waste generated during construction
- Increase in surface runoff due to use of site compounds, stockpiles and ancillary sites
- Clearing and grubbing including riparian vegetation
- Construction of Town Creek diversion

Each of these construction phase works and activities may result in chronic and acute risks to surface water quality. A summary of the potential sources of risk associated with these activities is provided in the following sections.

Chronic risks

The EA Report (AECOM, 2012) identified that 'clearing, cut and fill operations along the project alignment, including the construction of permanent and temporary creek crossings, represent the primary risk to surface water quality during and following construction'. The project site requires areas of cut and fill to be undertaken during construction of the FBB Princes Highway upgrade. Consequently there would be large areas of exposed soils, resulting in the potential for sediment laden runoff to enter the catchment if not managed correctly. An increase in sedimentation of watercourses could smother and kill aquatic habitats and organism. There is also a potential to increase the concentration of nutrients, metals and other potential toxicants that attach to sediment particles in surrounding waterways. Also, litter and gross pollutants resulting from general construction activities may enter the catchment.

Acute risks

In addition to an increase in sediment loads, the EA Report (AECOM, 2012) also identified the potential for chemical or fuel spills to enter the catchment. These risks are primarily associated with spills and leakages from plant or storage facilities on the construction site. If spills are not contained and managed correctly, these contaminants have the potential to impact on the catchment.

3.1.2 Operational phase

Operational works and activities

There are a range of works and activities with the potential to impact on surface water quality if not managed correctly that must be recognised in order to understand the likely sources of risk during the operational phase of the project, including:

- General operation of the highway (i.e. oil and grease)
- Traffic accidents (i.e. fuel and chemical spills)
- Motorist associated pollutants (i.e. non-biodegradable litter)
- Atmospheric deposition of nutrients
- Drainage of road surface and surrounds
- Erosion of the roadway and road shoulders

Chronic risks

The key sources of risk during operation of the FBB Princes Highway upgrade are associated with the increase surface runoff generated from the paved surface of the road. The EA Report (AECOM, 2012) concluded that 'road runoff is likely to be contaminated with nutrients, heavy metals, hydrocarbons, gross pollutants and suspended solids from the highway operations'.

Acute risks

Whilst the likelihood is expected to be low there is a risk of a chemical or fuel spill associated with a traffic accident entering waterways. Spills may be from vehicles carrying hazardous or dangerous goods or from general motor vehicle accidents.

3.1.3 Summary of environmental risks sources

A summary of the chronic and acute environmental risks associated with the construction and operation of the FBB Princes Highway upgrade is provided in Table 3

Table 3: Summary of environmental risks (adapted from Aurecon, 2010)

Project phase	Chronic/acute	Source of risk	Potential Environmental Impact
Construction	Chronic	Sediment laden runoff	• Increase in turbidity resulting in potential smothering of aquatic flora and fauna and disruption of ecological processes • Increased pollutant loads from contaminants and nutrients bound to sediment • Potential impact on drinking water and water treatment works
	Acute	Spills/leakages from plant and storages	• Potential for fuels and other chemicals to enter the catchment
Operation	Chronic	Runoff from paved surfaces	• Potential for contaminants (nutrients, heavy metals, hydrocarbons, suspended soils and pathogens) to enter the catchment • Increase in turbidity from batter slope runoff resulting in potential smothering of aquatic flora and fauna and disruption of ecological processes and habitat
	Acute	Spills from vehicles	• Potential for pollutants to enter the catchment from a dangerous goods spill • Potential for pollutants (hydrocarbons etc) to enter the catchment from a motor vehicle accident

3.2 Catchment overview

3.2.1 Catchment overview

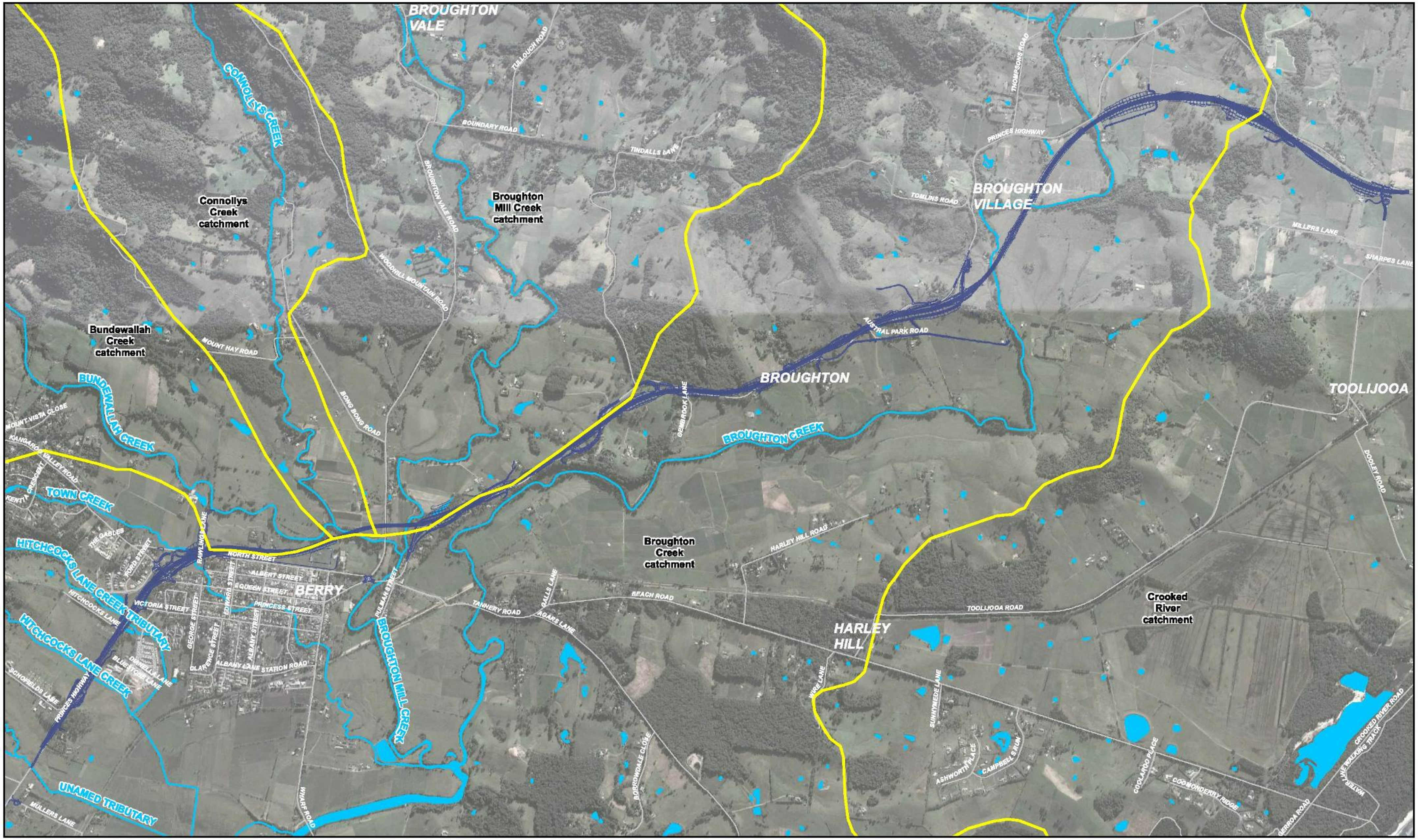
The alignment of the FBB Princes Highway upgrade would pass through the six major and three minor catchments identified in this section. The location of the upgrade alignment in relation to the catchments is shown in Figure 2, with catchment overview photographs provided in Figure 3 to Figure 7.

Crooked River catchment

A small section of the project area is located within the upper Crooked River catchment, near Toolijooa Ridge. The creeks and streams that form part of the Crooked River catchment start at Currys Mountain and flow in a south-easterly direction into a coastal floodplain before discharging into the ocean via the estuarine Crooked River Lagoon. No significant or ephemeral waterways within the Crooked River catchment are located within the project footprint.

Broughton Creek catchment

Broughton Creek is the main watercourse in the project area and starts just below the Illawarra plateau at around 500 metres AHD (Australian height datum).The Broughton Creek catchment lies next to and south of the Crooked River catchment, and is separated by the ridge that extends from Currys Mountain to Toolijooa Hill, Moeyan Hill and eventually Coolangatta Mountain. After crossing the existing Princes Highway corridor, Broughton Creek flows in a south west direction. At Berry, Broughton Creek is joined by Broughton Mill Creek at the entrance of a coastal floodplain and eventually discharges into the lower Shoalhaven River. The Broughton Creek catchment upstream of Berry is around 30 square kilometres in area.



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Grid: Map Grid of Australia 1994, Zone 56

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LEGEND

- Catchment Boundaries
- Berry to Foxground upgrade alignment
- Roads
- Railways
- Waterways
- Lakes and dams

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Surface Water Catchments

Figure 2

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Figure 3: Overview of Typical Catchment Conditions

Figure 4: Overview of Typical Catchment Conditions – North Road, Berry

Figure 5: Overview of Typical Catchment Conditions

Figure 6: Overview of Typical Catchment Conditions – Broughton Creek

Figure 7: Overview of Typical Catchment Conditions – Berry Township

Broughton Mill Creek, Bundewallah and Connollys Creek catchment

To the north and north-west of Berry are the Broughton Mill Creek, Connollys Creek and Bundewallah Creek catchments, respectively. Broughton Mill Creek originates underneath the Illawarra plateau as a number of secondary streams. It flows south through Broughton Vale and crosses the existing Princes Highway near the Woodhill Mountain Road intersection on the eastern edge of Berry, around two kilometres upstream of its confluence with Broughton Creek.

Town Creek catchment

Town Creek is a small ephemeral watercourse that passes directly through Berry township. It has a catchment area of 70 hectares upstream of Berry. Town Creek crosses the undeveloped section of North Street, on the north west edge of Berry, before crossing the town between Princess Street and Queen Street and exiting via Prince Alfred Street. Town Creek flows south east before joining Broughton Mill Creek near its confluence with Broughton Creek. The reach of Town Creek through Berry is in poor condition.

Minor catchments

Hitchcocks Lane Creek, its tributary and an unnamed tributary of Broughton Creek flow across the existing highway, south of Berry. These watercourses join southwest of the existing highway and eventually discharge into the estuarine reach of Broughton Creek. Hitchcocks Lane Creek and its tributary have a catchment area of 68 hectares and 75 hectares respectively. The unnamed tributary of Broughton Creek has a catchment area of 6.2 hectares.

3.2.2 Land-use and Vegetation

The following excerpt from Appendix H of the EA (AECOM, 2012) summarises the land use and riparian vegetation within the primary project catchments.

"*The reach of Broughton Creek upstream of Berry is surrounded by cleared agricultural land although there are significant sections with relatively intact native riparian vegetation dominated by river oak (Casuarina cunninghamiana subsp. Cunninghamiana and Eucalyptus spp.) (Cardno Ecology Lab, 2011).*

The land surrounding Broughton Mill Creek has largely been cleared for agricultural use, with existing riparian vegetation containing a mixture of native and exotic trees and shrubs. Similarly, the land surrounding Bundewallah Creek had been cleared for agricultural use and recreation. Riparian vegetation is relatively continuous and composed of native trees (river oak) and exotic shrubs, climbers and annuals (Cardno Ecology Lab, 2011).

Broughton Creek, Broughton Mill Creek and Bundewallah Creek were all classed as Category 1 Riparian Habitats (Environmental Corridor), this classification representing the objective to provide biodiversity linkages by maintaining connectivity for the movement of aquatic species along the riparian corridor and between key destinations (for example, the bottom and the top of the catchment) (Cardno Ecology Lab, 2011)."

3.2.3 Catchment water quality

The following extract for water quality in waterways from the conclusions of the EA report (AECOM, 2012) is provided below:

"The long term agricultural land use in the region has resulted in significant pollution that is greater than the water quality levels that are considered to be sustainable for maintaining ecosystem integrity. The values of total phosphorus within the Crooked River and Broughton Creek catchments are regularly above the ANZECC guidelines. The applications of fertilisers and manure from stock are the likely sources of the high nutrient levels (The Ecology Lab, 1999, 2007). Broughton Creek, Broughton Mill Creek, Connollys Creek and Bundewallah Creek are considered to be sensitive receiving environments owing to the ecological values of these waterways.

Previous studies within the Crooked River and Broughton Creek catchments have also found that water quality was generally within the ANZECC threshold limits for pH and conductivity, and to a lesser extent, turbidity (The Ecology Lab, 1999; 2007). Sampling carried out in 2007 during a period of low rainfall found that sites within Crooked River and Broughton Creek catchments were frequently below ANZECC lower limits for dissolved oxygen (The Ecology Lab, 2007). Low dissolved oxygen values can be caused by low flow conditions and/or high in-stream organic loads.

Crooked River, Broughton Creek and Broughton Mill Creek have previously been found to be within ANZECC aquatic ecosystem threshold limits for a range of organochlorine pesticides, oxides of nitrogen and trace elements, although all were above the ANZECC guidelines for chloride. Crooked River was also above the ANZECC guidelines for copper and recorded concentrations of oil and grease, and suspended solids, that were much higher than samples taken from sites within the Broughton Creek catchment (The Ecology Lab, 2007).

The existing highway, which has no water quality controls, is also likely to be contributing pollutant loads to nearby waterbodies particularly at or near creek crossings. This would include oil, grease and other hydrocarbon products, generated by general vehicular use of the highway.

The water quality within Town Creek is expected to be characteristic of a watercourse with a developed residential and agricultural catchment. The long-term urban and agricultural land use in the area has likely lead to elevated nutrient levels (for example from fertilisers and livestock manure), low dissolved oxygen and raised suspended solids resulting from the erosion of soils."

3.2.4 Existing aquatic habitats

The appendix H of the environmental assessment (AECOM, 2012) provides an overview of the studies undertaken by Cardno Ecology Lab (2012) which state that:

"*Broughton Creek is a Class 1 waterway providing major fish habitat, Broughton Mill Creek and Bundewallah Creek are Class 2 waterways providing moderate fish habitat and Connollys Creek is a Class 3 waterway with minimal fish habitat. These creeks are considered sensitive receiving environments with respect to this project. Town Creek is a Class 4 waterway unlikely to provide fish* *habitat. The waterway is ephemeral at the proposed route crossing and much of the watercourse channel is undefined and has been colonised by pasture grasses and annual weeds (Cardno Ecology Lab, 2012)."*

Appendix H of the EA (AECOM, 2012) also noted that:

"*Downstream of the project at the confluence of Broughton Creek and the Shoalhaven River there are a variety of important estuarine wetland habitats such as seagrass beds, tidal flats, saltmarsh and mangroves which are important for seabirds and migratory waders. There are a number of State Environmental Planning Policy No.14 Coastal Wetlands (SEPP 14 wetlands) in this locality, including the Comerong Island Nature Reserve, which are sensitive receiving environments.*

Coomonderry Swamp, to the southeast of the study area near the coast, is a freshwater coastal wetland and sensitive receiving environment that is also protected under SEPP14 and represents one third of all semi-permanent coastal freshwater wetland habitat in NSW (NPWS, 1998)."

3.2.5 Existing surface water use

Communications with the NSW Office of water suggest that there is likely to be water supplies abstracted from all surface water features located with the catchment as part to of basic landholder rights. This water may be used for stock water and domestic used including potable water supply.

Other uses in the area are anticipated to be for irrigation and dairy wash down supplies. These supplies are required to be registered with NOW.

3.3 Management of environmental risks

RMS recognise the importance of, and is committed to, ensuring that water quality within the multiple catchments is not significantly impacted by the construction and operational activities of the FBB Princes Highway.

3.3.1 Construction phase management

As per the requirement of CoA B16, implementation of appropriate mitigation and management measures to prevent soil erosion and the discharge of sediments and pollutants from the project during construction phases of the project would be undertaken to be compliant with Section 120 of the Protection of the Environment Operations (POEO) Act 1997 and the EPL for the project.

Section 7.44 of the EA Report (AECOM, 2012) outlines the proposed mitigation and management measures that would be undertaken during the construction phase of the project in order to meet the conditions of approval and to minimise the impact on the environment. A Construction Environmental Management Plan (CEMP) has been developed and was issued by RMS in February 2014. Appendix B4 of this document details the soil and water quality management procedures for the construction of the highway upgrade with Table 7.1 of this appendix detailing the soil and water management mitigation measures that will be adopted for the highway upgrade.

The CEMP includes mitigation measures similar to those outlined within the EA (AECOM, 2012) which included:

- Construct temporary drainage structures in accordance with the 'Technical Guideline – Temporary stormwater drainage for road construction' (RMS, 2011). Locate sedimentation basins during construction in areas as determined during detailed design. These would be in addition to the permanent operational water quality basins that may be used during construction for temporary sedimentation control.
- Include 'at source' management measures in areas of residual high risk erosion and sedimentation areas. These areas are where basins are not feasible due to topographical

constraints or small catchment areas. Measures would include small scale sedimentation capture devices, designed in consultation with a specialist soil conservationist

- Carry out construction in sequence to minimise the extent of disturbed areas and rehabilitate as soon as practicable
- Install permanent clean water diversions and top of cut drains at the start of construction to limit the volume of water on site
- Construct sediment and water quality basins prior to clearing activities in each area
- Establish water quality swales before or concurrently with clearing activities to enable their use during construction
- Stabilise fill batters progressively as they are constructed
- Manage vegetation stockpiles to minimise the impact of tannins leaching into the surrounding environment. Manage stockpiles in accordance with *Environmental Guidance – Management of Tannins from Vegetation Mulch* (RMS, 2012)
- Use dust management techniques, such as water spraying, to suppress dust
- Manage and use treated effluent in accordance with RMS' Environmental Direction No: 19 - Use of Reclaimed Water (RTA 2006) and RMS' Tip Sheet – Use of Reclaimed Water (RTA 2006)
- Minimise the depth of excavations in areas of alluvium
- Limit the need to dewater during construction
- Implement a communications procedure to educate construction personnel on groundwater issues
- Minimise disturbance and control runoff from construction areas
- Provide bunding and spill kits around fuel depots and stockpile areas. Develop response plans to address fuel leaks and spills at machinery compounds or during refuelling, including a hazardous materials plan and spill emergency procedure
- Establish a groundwater monitoring network along the project to monitor groundwater quality within each lithology and to establish background groundwater quality
- Detail the establishment of a groundwater monitoring network along the route to adequately characterise groundwater quality and establish background water quality within the alluvial/colluvial aquifers and Shoalhaven Group Sediments, including the Broughton Sandstone and latite
- Install monitoring wells adjacent to major cuts to confirm existing groundwater levels and to monitor the effect on groundwater levels by construction activity, where groundwater is encountered
- Implement a groundwater monitoring plan that would assess the performance of groundwater mitigation measures during and after construction. This plan would provide an assessment of groundwater level and quality trends and identification of exceedances (if any)
- During the initial works onsite, undertake further testing for ASS across the Broughton Creek floodplains
- Should the presence of ASS be confirmed, avoid or minimise disturbance, and/or activities that may lower the watertable in these areas

- Prepare an ASSMP if required, to identify strategies to remove or reduce the risks associated with ASS. This has been completed and is provided as a sub-plan within Appendix B4 of the CEMP
- Undertake staged construction of the Town Creek diversion to reduce the exposure of soils
- Stabilise banks of the constructed channel prior to diversion of flows from the upper catchment of Town Creek
- Maintain flushing efficiency and mitigate erosive forces at the discharge location into Bundewallah Creek through the design of the diversion. This could be achieved by increasing the channel roughness to reduce flow velocities. Revegetate the banks of the diversion channel to stabilise and reduce the risk of erosion

The control measures outlined above are based on the conceptual design developed as part of the environmental assessment. Further development of environmental controls would be undertaken during the detailed design stage of the project with the aim of improving the treatment performance. In addition to meeting the requirements of the conditions of approval, further development of control measures would also be guided by the RTA's *Erosion and Sedimentation Control Procedure* (RTA Procedure PN 143P). This procedure provides the administrative framework to guide the development of erosion and sediment controls through each of the key design phases from concept through to full detailed design.

State of Commitment SW2 states that:

"*A specialist soil conservation consultant will be engaged to provide advice on erosion and sedimentation control during pre-construction and construction*".

It would also help to deliver a range of best management practice techniques as well as continued onsite innovation.

3.3.2 Operational phase management

The risk to water quality during the operational phase of the project would come primarily from the increase of road surface runoff through impervious surfaces and drainage infrastructure or from traffic accident spills. Management of these sources of impact are discussed separately below.

Road surface run-off

Surface water quality modelling undertaken for previous assessments (AECOM, 2012) suggested incorporating treatment measures such as swales and permanent operational water quality basins would reduce pollutant loads to receiving environments and improve existing water quality. As such it was recommended that the water quality strategy includes a combination of swales and water quality basins to treat road runoff and protect downstream receiving environments, in accordance with the following:

- Swales: As a minimum these swale sizes would meet the total area requirements of 140 metres long by two metres wide, per hectare of upstream catchment
- Basins: Providing 300 cubic metres of working volume per hectare of road Catchment are recommended. Based on the current concept design, up to 18 operational water quality basins will treat run-off prior to discharge to the environment. The proposed locations of operational sediment quality basins are presented in Figure 8. It is expected that water quality basins will be designed to capture a rainfall event equal to or less than 42 mm over a 24 hour period.

Additionally, the cut batters could be managed as separate catchments with multiple small sediment capture devices to reduce reliance on the end of line water quality basin. It should be noted that the actual operational water quality requirements, including number and location of basins, would be refined and finalised during detailed design (AECOM, 2012).

Capture and spills

The upgraded highway alignment would likely provide for safer transportation of vehicles compared with the existing alignment. This would reduce the total number of accidents along the upgraded section and therefore the potential of a spill of hazardous substances would also reduce.

Any spills that do occur would be directed to the permanent water quality basins and swales, all of which would have the capacity to receive a spill with a volume corresponding to that of a typical transport truck.

Both water quality basins and swales have potential for spillage control or containment. These water quality treatment measures provide capacity to treat first flush from the pavement surface and reduce the risk of spills discharging onto adjacent land or watercourses. The potential for spillage control or containment would be based on the hydrologic conditions prevailing at the time of the spill.

Additional treatment measures for sensitive receiving environments

Basins capturing runoff from pavements that drain to sensitive receiving environments would be designed with special outlet configurations to reduce the likelihood of overflow into the sensitive environment. For example:

- Water quality basins would have a permanent pool which a volume of spill would have to displace before passing through the entire basin
- Bioretention systems would have extended detention depths that would have to be breached before overflowing into the downstream environment

These simple yet effective arrangements would be incorporated into the design of water treatment systems as mentioned above with capacity to accommodate a typical transport truck.

In addition to swales and water quality basins, other treatment measures would be considered to further reduce nutrient loads from road runoff (primarily targeting nitrogen).

With the implementation of the management measures discussed above it is anticipated that the risk of surface water impact will generally be reduced relative to the existing highway and are anticipated to result in improved overall catchment water quality.

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LEGEND

O Water quality basins
-Berry to Foxground upgrade alignment
Roads
-Railways
Waterways
Lakes and dams

Roads and Maritime Services
Water Quality Monitoring

Job Number 121-23174
Revision 0
Date 09 Jul2014

Proposed water quality basins

Figure 8

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4. Consideration of groundwater interaction

Condition of Approval B16 requires that 'The Proponent shall prepare and implement a Water Quality Monitoring Program to monitor the impacts of the project on surface and groundwater quality and resources and wetlands, during construction and operation. The surface water and groundwater monitoring programs have been divided into two separate reports.

A monitoring program has subsequently been developed for groundwater quality and is presented in the *Groundwater Monitoring Program – Berry to Foxground Princes Highway Upgrade* (GHD, 2014b). The groundwater monitoring plan details the results of groundwater modelling works that have been completed which characterise the relationships between surface water and groundwater, in particular the contribution of groundwater to surface water baseflow and the potential changes to these flows associated with dewatering of groundwater systems around cuttings along the alignment.

5. Monitoring objectives

5.1 Performance objectives

When developing a monitoring program, performance objectives must be clearly stated to identify the goals of the monitoring program – i.e. what does the monitoring program aim to achieve.

The performance objectives for the FBB Princes Highway upgrade SWMP are based on the findings of the Environmental Assessment investigations, which reflect the intent of the Director Generals Conditions of Approval, which require that:

"*The Proponent shall prepare and implement a Water Quality Monitoring Program to monitor the impacts of the project on surface water and groundwater quality and resources and wetlands, during construction and operation*"

The performance objectives are outlined in Table 4, which reflect the performance criteria adopted for the T2E Upgrade.

Table 4: Performance objectives for the monitoring program (adapted from Aurecon 2012).

Performance Objective
1. To monitor for the potential impact of the Upgrade on surface water and groundwater quality to protect the existing and ongoing human, horticultural and agricultural uses of that water
2. To monitor for potential impact of the Upgrade on water quality to protect existing and future status of aquatic ecology and ecosystem characteristics in all catchments intersected by, and downstream of, the Upgrade

5.2 RMS water policy

The above performance objectives also support the RMS water policy (RTA, 1999):

'*The Roads and Traffic Authority*[1] *will use the most appropriate water management practices in the planning, design, construction, operation and maintenance of the roads and traffic system in order to:*

- *conserve water*
- *protect the quality of water resources*
- *preserve ecosystems*

[1] Now referred to as Roads and Maritime Services (RMS)

6. Performance standards

In accordance with recommendations provided in the EA this section mimics that presented in the water quality monitoring documents for the T2E project developed by Aurecon in 2010.

6.1 Protection of surface water quality

6.1.1 Water quality guidelines

There are several water quality standards of relevance to a project of this nature and each have been reviewed in determining an appropriate performance standard for the FBB Princes Highway upgrade.

The standards include:

- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC, 2000).
- Managing Urban Stormwater: Council Handbook (EPA, 1997).

A brief summary of these documents and discussion of their relevance to the project is provided below.

6.1.2 ANZECC guidelines

The Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC guidelines) provide a management framework, guideline water quality triggers, protocols and strategies to assist water resource managers in assessing and maintaining aquatic ecosystems. The guidelines are intended to provide government, industry, consultants and community groups with a sound set of tools that would enable the assessment and management of ambient water quality in a wide range of water resource types, and according to designated environmental values.

The primary objective of the ANZECC guidelines is:

'To provide an authoritative guide for setting water quality objectives required to sustain current or likely future environmental values for natural and semi-natural water resources in Australia and New Zealand'.

The ANZECC guidelines provide the following water quality management framework:

1. Identify the environmental values that are to be protected in a particular water body and the spatial designation of the environmental values (i.e. decide what values will apply where).
2. Identify management goals and then select the relevant water quality guidelines for measuring performance. Based on these guidelines, set water quality objectives that must be met to maintain the environmental values.
3. Develop statistical performance criteria to evaluate the results of the monitoring programs (e.g. statistical decision criteria for determining whether the water quality objectives have been exceeded or not).
4. Develop tactical monitoring programs focusing on the water quality objectives.
5. Initiate appropriate management responses to attain (or maintain if already achieved) the water quality objectives.

The guidelines recommend numerical and descriptive water quality guidelines to help managers establish water quality objectives that would maintain the environmental values of water resources.

They are not standards, and should not be regarded as such (ANZECC, 2000). It should also be noted that they are not suitable for direct application to stormwater quality. Rather, the guidelines have been derived to apply to the ambient waters that receive stormwater discharges, and to protect the environmental values that they support.

Of particular importance is the philosophical approach for using the ANZECC guidelines of:

'*protect environmental values by meeting management goals that focus on concerns or potential problems'* (ANZECC, 2000).

That is, development of a monitoring program, including the performance objectives, standards and measurement criteria, should focus on specific issues not on pre-determined guideline values.

The philosophy, management framework and guiding principles outlined in the ANZECC guidelines have formed the basis for development of project specific performance standards for the FBB Princes Highway upgrade Surface Water Monitoring Program.

The framework and management approach outlined above have been taken from the Australian Guidelines for Water Quality Monitoring and Reporting (ANZECC, 2000a), which are also referenced in Section 9 of the Australian Drinking Water Guidelines (NHMRC, 2011) in regard to development of monitoring programs. As such this framework is considered to be applicable for assessing drinking water catchments.

6.1.3 NSW DECCW Stormwater Quality Guidelines

The NSW Department of Environment, Climate Change and Water (DECCW)[2] introduced stormwater quality guidelines as part of the 'Draft - *Managing Urban Stormwater: Council Handbook*'. The handbook was developed to assist councils in preparing catchment wide stormwater management plans and is aimed at reducing the pollutant loads from stormwater that enter rivers and estuaries.

The guidelines outlined in the Council Handbook are presented as proposed treatment objectives and are formulated on a retention based approach. That is, they aim to retain a percentage of the annual average load for a range of parameters during operation of a stormwater system. They also provide specific concentration targets for suspended solids during construction works. These guidelines are a useful tool for assessing a development in isolation from the catchment by determining the removal efficiency of treatment measures for parameters such as Total Phosphorus, Total Nitrogen and Total Suspended Solids. They do not, however allow for an assessment of the potential impacts on the environmental water quality as the standard relates to removal efficiency only.

These guidelines have been developed for urban catchments and not strictly applicable to rural catchments. The recommended treatments objectives have been used as a basis for developing appropriate design criteria for the project.

6.2 Environmental Protection Licence

The FBB Princes Highway upgrade, as a freeway or tollway greater than 5 kilometres outside a metropolitan area, is classified as a scheduled activity (Schedule 1 – 35 Road Construction) under the *Protection of the Environment Operations Act 1997* (POEO Act). As such, an Environmental Protection Licence (EPL) will be required for construction under Part 3 of the POEO Act.

Under section 75(V) of the EP&A Act, such a licence cannot be refused, however a range of licence conditions may be imposed. Typically an EPL for a similar project would include licence conditions for parameters such as Oil and Grease, pH and Total Suspended Solids. Allowances for exceedance of these criteria are based on the requirement to capture rainfall events up to a set

[2] Currently known as the NSW Office of Environment and Heritage

recurrence as defined in the licence conditions – i.e. the concentrations of these parameters may only be exceeded where discharges from a sediment basin are a result of a rainfall event in excess of a prescribed magnitude.

The licence conditions of the EPL for this project will be determined by the EPA, and issued to the construction contractor. These conditions would form part of the water quality performance standards for the project during the construction phase.

6.3 Development of project specific performance standards

While the performance objectives identify the goals of the monitoring program, the performance standards define the benchmark and measures against which the performance is assessed. It is critical that the performance standards adopted provide a meaningful and quantifiable measure of 'performance'.

The FBB Princes Highway upgrade passes through the six main and three minor catchments (as identified in Section 3.2). It is important to protect the quality of water within these catchments. Protection of water quality in these areas is important in the development of performance standards for the monitoring program.

The nature of the land use within the catchment has potential to impact the water quality of the creeks and rivers. This should be recognised in the development of performance standards. The performance standard and monitoring approach must be capable of quantifying the impact that is directly attributable to the FBB Princes Highway upgrade – i.e. the assessment should be based on the impacts associated with the upgrade, not on the overall health of the catchment upstream.

6.4 Proposed performance standards

The potential impacts on water quality during the construction and operational phases of the FBB Princes Highway upgrade are outlined in Section 3. Whilst the key sources of risk associated with each phase of the project differ, the performance standards developed would follow the same approach, as outlined in the following sections.

6.4.1 Construction phase

For most road upgrades the approach to monitoring during construction involves sampling water quality upstream and downstream of the construction activity. This approach would be utilised for the FBB Princes Highway upgrade as it allows for an assessment of impacts that are directly attributable to the construction activities rather than the impacts related to the overall catchment.

During the construction phase of the project, the greatest risk to water quality is from the mobilisation of exposed sediments. A range of erosion and sediment control procedures would be implemented to reduce the risk of mobilised sediments entering the waterway, however appropriate monitoring standards are required to determine the performance of the control measures.

During large storm events, discharge will occur from on-site treatment/capture systems. However, with appropriate control measures in place the impact to water quality would be low. Impacts are most likely to be detected during wet weather as a result of exceedance of the control measure or from the failure of the control measures installed to adequately capture/remove pollutants.

The results of wet weather sampling undertaken during construction would be compared against upstream samples taken during the same sampling events in accordance with agency guidance.. Control charts present a 'baseline' data set (refer Section 7.4) and are developed based on data from a reference site, in this case upstream of the construction works. The control chart for each site provides the performance standard for that site. In addition to the comparison of data against the control chart, construction phase data will also be assessed against the EPL criteria for the project. The EPL for the project, which forms part of the construction phase performance standards, will be included in an Appendix once it has been issued by EPA.

6.4.2 Operational standards

During the operational phase, the greatest risk to water quality is increased pollutant loads resulting from road surface runoff. The runoff from the road surface may potentially contain a range of contaminants, including heavy metals and hydrocarbons.

A range of containment measures, including gross pollutant traps and water quality basins would be included to reduce the pollutant load entering the downstream creeks. The proposed treatment measures will be designed to capture the 'first flush' of pollutants, which has the potential to result in a significant reduction in pollutant loads.

Sampling would be undertaken upstream and downstream of the highway, with the downstream sampling site below the water quality basins. Sampling would also be undertaken within the outlet pipe of the water quality basins. Sampling would be undertaken during wet weather, as during dry weather there should be no measurable difference between the upstream and downstream sampling sites, with pollutants mobilised during wet weather only.

The wet weather sampling undertaken upstream and downstream of the highway during the operational phase would be compared against site specific control charts. Where any significant difference is identified (refer Section 8), additional investigation will be undertaken to ascertain whether the difference in the upstream and downstream data can be attributable to the FBB Princes Highway upgrade.

6.5 Control charts

Controls charts will not be used to assess construction impacts. Feedback from regulators on the first year of monitoring included a request to remove the use of control charts during construction water quality monitoring.

The Australian Guidelines for Water Quality Monitoring and Reporting (Water Quality Monitoring Guidelines) (ANZECC, 2000b), provide guidance for the development of monitoring programs and assessment of water quality. They form Volume 7 of the National Water Quality Management Strategy (ANZECC, 2000a) of which the ANZECC guidelines are also part.

The Water Quality Monitoring guidelines provide the following discussion of control charts:

'Control charting techniques used for the last 70 years in industry have an important role to play in an environmental context. They are particularly relevant to water quality monitoring and assessment. Regulatory agencies are moving away from the 'command and control' mode of water quality monitoring, and recognising that, in monitoring, the data generated from environmental sampling are inherently 'noisy'. The data's occasional excursion beyond a notional guideline value may be a chance occurrence or may indicate a potential problem. This is precisely the situation that control charts target. They not only provide a visual display of an evolving process, but also offer 'early warning' of a shift in the process level (mean) or dispersion (variability)'.

The advantages of the use of control charts are identified as:

- minimal processing of data is required
- they are graphical: trends, periodicities and other features are easily detected
- they have early warning capability: the need for remedial action can be seen at an early stage

This ability to recognise 'noise' in the water quality data and the early detection of changing trends makes the use of control charts a powerful tool for assessing the impact of the FBB Princes Highway upgrade within a sensitive catchment where other land use factors may be contributing to a change in water quality.

6.5.1 Development of site specific control charts

For each of the proposed monitoring sites, a site specific control chart would be developed to provide a suitable reference criteria and performance standard. The control chart is produced by plotting the median concentration from the assessment site (i.e. downstream of the highway alignment) against the 80th percentile of the reference site (i.e. upstream of the highway alignment). Ideally, the 80th percentile at the reference site would be based on the most recent 24 monthly observations.

The Water Quality Monitoring Guidelines (ANZECC, 2000b) recommends the following procedure for calculating the 80th percentile of the data set:

- arrange the 24 data values in ascending order (i.e. lowest to highest)
- take the simple average (mean) of the 19th and 20th observation in the ordered set

The reference criteria may be kept up-to-date by recalculating the 80th percentile each month with the most recent 24 monthly observations. This would be of particular importance during the operational phase of the project, where gradual upstream catchment changes may influence the analysis of the water quality data.

An example control chart is provided in Figure 9.

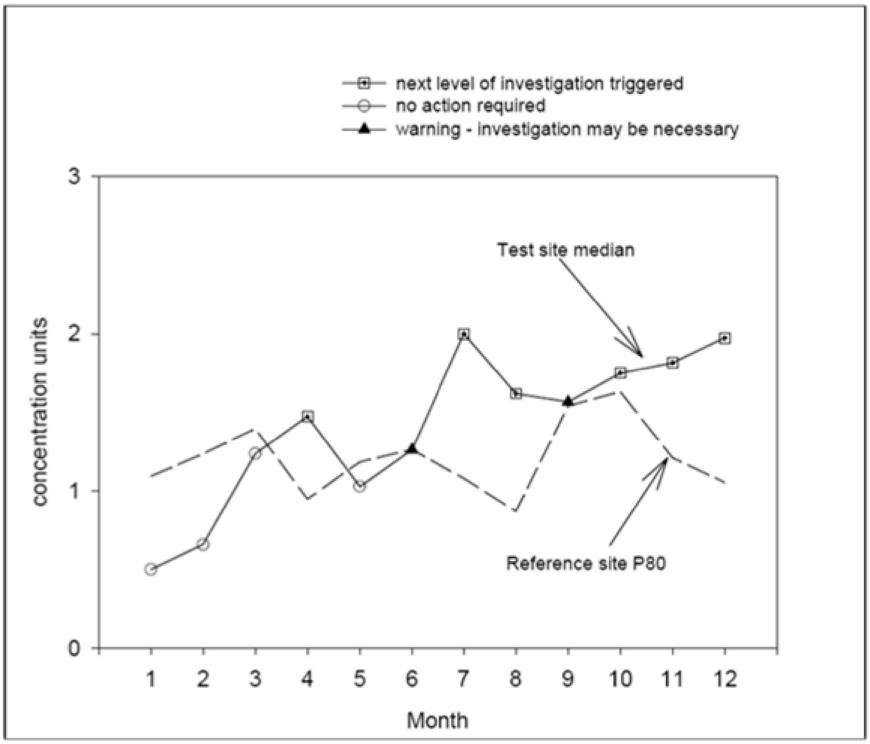

Figure 9: Example control chart (Aurecon 2010a)

Availability of data for development of control charts would be dependent on the project program and on reaching an agreement with stakeholders on the proposed approach early in the planning process.

This would allow the current background monitoring program to focus on collecting wet weather samples at the locations required to develop control charts for each site. Data collected during the construction phase of the project would also be used for reference data during the operational phase.

In accordance with agency guidance, control charts will be used during the operational monitoring but will not be used during the construction phase.

7. Measurement and assessment criteria

The following measurement and assessment criteria have been adapted from those agreed and approved with key stakeholders for similar projects in NSW and are considered to be applicable to the FBB project. They mimic those adopted for the T2E Upgrade (Aurecon, 2010).

Measurement criteria provide the 'trigger' for a management response, are related to the risks associated with the FBB Princes Highway upgrade and allow for assessment against the performance standards. The following sections provide an overview of the measurement criteria, while the processes for assessment that would result in the triggering of a management action are presented in Section 10.

7.1 Trigger criteria

The ANZECC guidelines (ANZECC, 2000a) provide a framework for setting trigger criteria. In the development of this framework the following criteria were considered:

- explicit recognition of the inherent (and usually large) variability of natural systems
- robustness under a wide range of operating conditions and environments
- no, or only weak, distributional assumptions about the population of values from which the assessment and reference data are obtained
- known statistical properties, consistent with and supporting the monitoring objectives [of the ANZECC guidelines]
- ease of implementation and interpretation
- suitability for visual display and analysis
- intuitive appeal

The trigger criteria recommended by the ANZECC guidelines for physio-chemical stressors, and subsequently adopted for the assessment of water quality impacts of the FBB Princes Highway upgrade is stated as:

"A trigger for further investigation will be deemed to have occurred when the median concentration of n independent samples taken at a test site [i.e. downstream of the highway] exceeds the eightieth percentile of the same indicator at a suitably chosen reference site [i.e. upstream of the highway]".

The above trigger criterion does not define or represent a point where an ecologically significant impact would occur. This approach is intended as an early warning mechanism to alert the catchment manager of a potential or emerging change that would require further investigation (ANZECC, 2000a).

The ANZECC guidelines also note that 'the statistical significance associated with a change in condition equal to or greater than a measurable perturbation [i.e. median of downstream sample exceeding 80th percentile of upstream sample] would require a separate analysis (ANZECC, 2000a).This analysis is discussed in the following sections.

7.2 Statistical analysis

In addition to the assessment against the above trigger criteria, a statistical analysis would also be used to test the significance of any observed difference between the upstream and downstream samples. Both a Paired t-Test and a Sign Test would be used in determining statistical significance. These are discussed further in the following sections.

7.2.1 Paired t-Test

A paired t-Test would be used to test the null hypothesis that there is no difference in the pairs (i.e. upstream and downstream samples at each time step) of data. The paired t-Test assumes that the paired differences (i.e. the difference between the upstream and downstream samples) are normally distributed around their mean. The two groups of data are assumed to have the same variance and shape. As such, if they differ, it is only in their mean. The null hypothesis can be stated as:

$$H_0 : \mu = \mu$$

i.e. the means for group *x* (upstream) and *y* (downstream) are identical

If the differences are not normal and especially when they are not symmetric, the probability (i.e. pvalues) from the t-Test would not be accurate. The primary consequence of overlooking the normality assumption underlying the t-Test is a loss of power to detect differences which may truly be present. The second consequence is an unfounded assumption that the mean difference is a meaningful description of the differences between the two groups (Helsel and Hirsch, 2002). Consequently, when assessing results of a t-Test, any large variance of significant outliers in either the upstream or downstream data set may influence the results.

7.2.2 Sign Test

A Sign Test would also be used to test for significant difference between the upstream and downstream samples. The Sign Test is used for pairs of data to determine whether one data set (upstream) is generally larger, smaller or different than the other (downstream).

$$H_0 : PROB[x > y] = 0.5$$

Two paired groups of data are compared, to determine if one group tends to produce larger (or different) values than the other group. No assumptions about the distribution of the differences are required. This means that no assumption is made that all pairs are expected to differ by about the same amount. Numerical values for the data are also not necessary, as long as their relative magnitudes may be determined (Helsel and Hirsch, 2002). As such, the Sign Test is non-parametric and can be used regardless of distribution. The hypothesis, however, is more general than the t-Test.

The t-Test and Sign Test have both been proposed as each has strengths and weaknesses. The t-Test is a more powerful parametric test that uses all the information available while the Sign Test makes no assumption of distribution and is less affected by outlying data or significant variance.

7.3 Pollutant loads

During the operational phase of the FBB Princes Highway upgrade, monitoring would be undertaken on the outlet of some water quality basins between the upstream and downstream sample points (refer Section 9). This would allow for an assessment of the magnitude of pollutants entering the waterway by calculating pollutant loads. Pollutant loads can be calculated using the following formula:

$$Li = \frac{\Sigma\,(C_1Q_1 + C_2Q_2 + \cdots CnQn)}{n}$$

Where:

- L_i is the average pollutant load for event *i* (mg/s)
- C_n is the pollutant concentration at time *n* (mg/L)
- Q_n is the discharge at the same time *n* (L/s)

The pollutant load reductions will be compared against design criteria and the Managing Urban Stormwater Council handbook (NSW EPA, 1997) treatment objectives to test the efficiency of management systems.

8. Monitoring program

8.1 Monitoring Program Criteria

The monitoring regime is focused on collectively addressing the conditions of approval and statement of commitments and the surface water monitoring regime recommended in the EA, which are outlined in Section 2.

Further to this the monitoring program has been developed to:

- Monitor for the key environmental risks outlined in Section 3. Which can be separated in into:
  - Construction related impacts primarily associated with spills of chemicals and release of sediment laden water from active site areas and site sediment dams.
  - Operation related impacts primarily associated with chemicals from spills and generally impacted surface water run-off discharging from water quality basins.
- Meet the monitoring objectives outlined in Section 5, the performance standards outlined in Section 6 and the measurement and assessment criteria presented in Section 7, which are In particular this includes:
  - Adopting the interpretation of the ANZECC (2000) water quality guidance used for the T2E upgrade.
  - Isolating impacts of the site from broader catchment conditions/impacts.
  - Developing reference sites (upstream) and assessment sites (down-stream sites) on which standard statistical techniques (recommended in the ANZECC 2000 guidance) can be used to establish the presence of any impacts and the significance of the impacts identified.

The remainder of this section details the program developed to meet these criteria.

8.2 Water quality monitoring sites

8.2.1 Pre-construction

The RMS commenced pre-construction background monitoring of surface water quality in December 2013 at sites along the existing Princes Highway.

The Conditions of Approval for the FBB Princes Highway upgrade require 'background monitoring of surface water quality parameters for twelve months prior to the commencement of relevant works or activities'. RMS will continue to monitor background conditions to provide a greater understanding of the catchment conditions and to provide a suitable baseline dataset for the assessment of performance of the environmental control measures during construction and operation of the FBB Princes Highway upgrade (refer Section 7).

Seventeen locations have been identified for baseline monitoring of water quality along the alignment. The sites characterise the baseline water quality in all surface water features identified in the EA that cross the alignment (at locations immediately up and down gradient).

Locating sampling sites directly up-gradient and down-gradient of where the alignment crosses water ways generally only accounts for impacts associated with the development of the alignment in those particular locations and has inherent limitations, which are outlined below.

- Sediment dams and water quality basins (the locations of which are currently unknown for construction) may discharge to locations down gradient of where the alignment crosses creeks and these need to be captured by the baseline and ongoing sampling. This approach is unlikely to result in significant potential for influence from activities not associated with the alignment.

- Broughton Creek flanks and essentially lies down gradient of approximately 5 km of the alignment making it particularly difficult to isolate specific site activities from broader catchment activities. For example there is 5 km of catchment that lies between the immediately upgradient point and the immediately downgradient point.

In light of the above limitations, the sites have been located:

- where required further down gradient than the alignment to account for potential discharge from sediment and water quality basins; and
- to provide broad characterisation of the conditions along Broughton Creek with recognition that isolating specific site activities is not feasible in this area.

The sampling locations are presented in Figure 10 and are summarised below.

- **SW01** to **SW03** and **SW05** are located along Broughton Creek: Monitoring site SW01 is located immediately upgradient of the alignment. SW02 is located immediately down gradient of a number of creek crossings and of the cuts at Toolijooa Ridge. SW03 and SW05 are further downstream on Broughton Creek. SW03 is located toward central areas of the alignment, while SW05 represents the only true downgradient location for Broughton Creek.
- **SW04** is located on Broughton Mill Creek upstream of the alignment.
- **SW06** is located at the confluence of Bundewallah and Connollys Creeks upstream of the alignment.
- **SW07** is located on Broughton Mill Creek downstream of the alignment and of SW04, SW06, SW08
- **SW08** is located on Bundewallah Creek upstream of the alignment and just upstream of the proposed location of the Town Creek diversion to Bundewallah Creek.
- **SW09** is located downstream the alignment and of SW06 and SW08 on Bundewallah Creek.
- **SW10** and **SW11** are located upstream and downstream of the alignment along Town Creek. Town Creek downgradient of the diversions and hence SW11 is likely to have significantly different characteristics after the diversion.
- **SW12** and **SW13** are located upstream and downstream of the alignment along Hitchcocks Lane Creek Tributary
- **SW14** and **SW15** are located upstream and downstream of the alignment along Hitchcocks Lane Creek.
- **SW16** and **SW17** are located upstream and downstream of the alignment along an unnamed tributary of Broughton Creek.

8.2.2 Construction phase

During the construction phase of the project, water quality would be monitored at the same location as for background conditions. Additional sampling would be required to the background monitoring undertaken to characterise the water quality of discharge from the proposed sediment basins. The locations of these dams are currently unknown. This monitoring would only be conducted if the trigger criteria were exceeded in the existing monitoring network or as part of assessing the efficiency of treatment systems implemented under the CEMP.

Additional sampling will also be required at construction phase in areas of dewatering at major cuts and bridges along the Upgrade alignment before this water can be discharged into receiving waters.

Additional sampling may be required at sites down gradient of other construction activities such as stockpile areas, however, it is recommended that this only occurs when the existing system identifies exceedance of the trigger criteria within the existing sampling regime.

8.2.3 Operational phase

During the operational phase of the project, water quality would be monitored at the same locations as the pre-construction phase, but with subsequent additional monitoring of water quality basins discharge similar to the construction phase if exceedances of the trigger criteria are identified in the existing monitoring network. Appendix H of the EA (AECOM. 2012) suggests that construction sediment quality basins could be converted to water quality basins for the operational phase of the project.

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Map Projection: Transverse Mercator
Horizontal Datum: Geocentric DabJm of Australia (GOA)
Grid: Map Grid of Australia 1994, Zone 56

N

LEGEND

O Surface Water Sampling Locations	-Railways
-Berry to Foxground upgrade alignment	Waterways
Roads	Lakes and dams

Roads and Maritime Services
Water Quality Monitoring

Job Number 121-23174
Revision 0
Date 09 Jul2014

Surface water sampling locations

Figure 10

Level15, 133 Castlereagh street Sydney NSW2000 T61 2 9239 7100 F61 2 9239 7199 E sydmail@ghd.com.au Wwww.ghd.com.au

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8.3 Monitoring parameters

The monitoring parameters proposed, as outlined in Table 5, are based on the review of potential pollutant sources and reflect those selected for background monitoring by RMS (Project Brief, 2013) and those in the EA.

Table 5: Construction and operational phase monitoring parameters

Parameter	Unit	Analysis
Dissolved oxygen	mg/L	Insitu
Electrical conductivity	µS/cm	Insitu
Oxygen Reduction Potential	mV	Insitu
pH		Insitu
Temperature	°C	Insitu
Turbidity	NTU	Laboratory
Total suspended solids	mg/L	Laboratory
Oils and Grease	mg/L	Laboratory (visual)
Total Petroleum Hydrocarbons	mg/L	Laboratory
Total Phosphorus	mg/L	Laboratory
Total Nitrogen	mg/L	Laboratory
Heavy Metals (As, Cd, Cr, Cu, Pb, Hg, Ni, Zn)	mg/L	Laboratory

8.4 Sample collection

The collection approach proposed differs between the pre-construction and other phases of the project. During the pre-construction phase samples would be collected at upstream and downstream sites in accordance with the sampling protocol outlined in the sampling protocol document (GHD, 2014a).

8.5 Sampling regime (time and frequency)

As discussed in the preceding sections, the primary impact to water quality during both the construction phase and the operational phase is during wet weather where sediments and pollutants may be mobilised and enter the receiving water. They are most likely to enter surface water via treatment trains that include sediment basins/water quality basin and swales or as diffuse incidental run-off from uncaptured areas or inappropriately designed construction areas.

Diffuse run-off from impacted areas may occur under low level rainfall events when general run-off is initiated from the catchment, but when water quality basins are not discharging. The EA suggested a rainfall event of 15 mm in a 24 hour period would be suitable to characterise these conditions. A review of Broughton Creek flow data against rainfall data suggests that a 15 mm, 24 hour event generally results in increased flows in Broughton Creek (and hence catchment run-off) and would therefore be suitable for catching diffusely impacted run-off from the alignment.

Sediment and water quality basin discharge would generally only occur when their storage capacity is reached which would generally be under extreme rainfall events. Extreme rainfall events were estimated to be 50 mm in a 24 hour period in the EA, which is understood to be greater than the storage capacity of operation water quality basins for the project and hence discharge would be occurring from the basins under these conditions.

Based on the above, the following sampling will be implemented for pre-construction, construction and operational phases:

Pre-construction Phase

- Monthly sampling of minor wet weather events (ie, where greater than 15 millimetres of rainfall is recorded in a 24 hour period).
- Event based sampling of major wet weather events (ie where greater than 50 millimetres of rainfall is recorded in a 24 hour period).

Construction Phase

- Monthly sampling of minor wet weather events (ie where greater than 15 millimetres of rainfall is recorded in a 24 hour period). One sample would be taken from upstream and downstream sites and compared immediately. If downstream is more than 10% greater than upstream, two more pairs of samples 15 min apart would be collected and compared
- Event based sampling of major wet weather events (ie where greater than 50 millimetres of rainfall is recorded in a 24 hour period). One sample would be taken from upstream and downstream sites and compared immediately. If downstream is more than 10% greater than upstream, two more pairs of samples 15 min apart would be collected and compared A maximum of three major events would be sampled per year for the duration of the construction phase.
- During construction the primary impacts would be associated with sediment laden water discharging from the site. Other parameters would not expect to be as prevalent as they would generally be associated with incidental spills and would be stringently managed under the CEMP. As such, during construction turbidity and total suspended solids would be the primary constituents analysed at the laboratory. Other laboratory analytes would be sampled on a quarterly basis as opposed to the event based sampling outlined above for the appearance of broad scale impacts.
- Increases in monitoring associated with construction dewatering activities will be dealt with as part of the specific construction management practices.

Operation Phase

- Monthly sampling of minor wet weather events (ie where greater than 15 millimetres of rainfall is recorded in a 24 hour period). One sample would be taken from upstream and downstream sites and compared immediately. If downstream is more than 10% greater than upstream, two more pairs of samples 15 min apart would be collected and compared.
- Event based sampling of major wet weather events (ie where greater than 50 millimetres of rainfall is recorded in a 24 hour period). One sample would be taken from upstream and downstream sites and compared immediately. If downstream is more than 10% greater than upstream, two more pairs of samples 15 min apart would be collected and compared. A maximum of three major events would be sampled per year.

This sampling regime will allow repeatability between each phase and hence provide the best potential for characterisation of impacts.

It should be recognised that this is an adaptive monitoring program and this sampling regime may be modified based on the findings of early monitoring results. Further discussion on the review and adaptation of this monitoring plan is provided in Section 11.

8.6 Sampling protocol

To reduce the risk of sampling error, all sampling would be undertaken in accordance with the following standards:

- Australian Standard AS/NZS 5667.1 1998 Water quality – Sampling Part 1: Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples
- Approved Methods for the Sampling and Analysis of Water Pollutants in NSW (EPA, 2004)

A Chain of Custody (CoC) form would also be used to ensure chronological documentation of data collection, transfer and analysis. A sampling procedure manual; Surface Water and Groundwater Sampling Protocol (GHD, 2014) has been developed to ensure consistency in the sampling technique and methodology adopted during each sampling event and should be referred for additional detail on this topic.

8.7 Sample analysis

The following key points should be noted for the analysis of water quality data:

- To reduce the potential for error resulting from sample analysis, a laboratory NATA accredited for the analysis undertaken would be used to ensure a high standard of analysis
- Where an in-situ measurement is taken, the water quality sonde should be calibrated prior to each sampling event. A copy of the calibration certificate should be included with the copy of all sample results

Further detail on this is provided within the sampling protocol document (GHD, 2014a).

9. Data analysis and interpretation

9.1 Analysis of Pre-construction phase data

Analysis for preconstruction data will be limited and as the focus of this data collection is provide baseline information on which any changes during construction and operation can be compared. The data collected will be compared against relevant water quality guidelines to establish the overall conditions of water quality. The data will also be compared against the relevant surface flow data and rainfall data to provide and understanding of the flow and rainfall events that have been characterised by the sampling event undertaken. The data will also be used to develop the baseline control charts on which the operational water quality can be compared.

9.2 Analysis of construction phase data

During the construction phase, the water quality monitoring program would focus on assessing whether the erosion and sediment control procedures are effectively managing the impact from the construction works. An overview of the process for assessing the performance against the agreed objectives and standards is provided in the following sections and summarised in the flowchart in Figure 11. The management response to any observed impacts are outlined in Section 11.

9.2.1 Step 1: Data collection and collation

All water quality samples would be collected in accordance with the procedures outlined in sampling protocol document (GHD, 2014a). This includes the use of a hand-held water quality probe for in-situ assessment of a range of parameters, while other parameters would be assessed by collecting samples for analysis at a NATA certified laboratory.

9.2.2 Step 2: Analysis and interpretation

The second stage of the assessment process includes review of upstream variability, review of the data against upstream water quality and an assessment of the statistical significance of any observed change. Whilst the majority of steps in this methodology allow for a clear process to be followed, the objectivity and understanding of the user in reviewing the findings would be important.

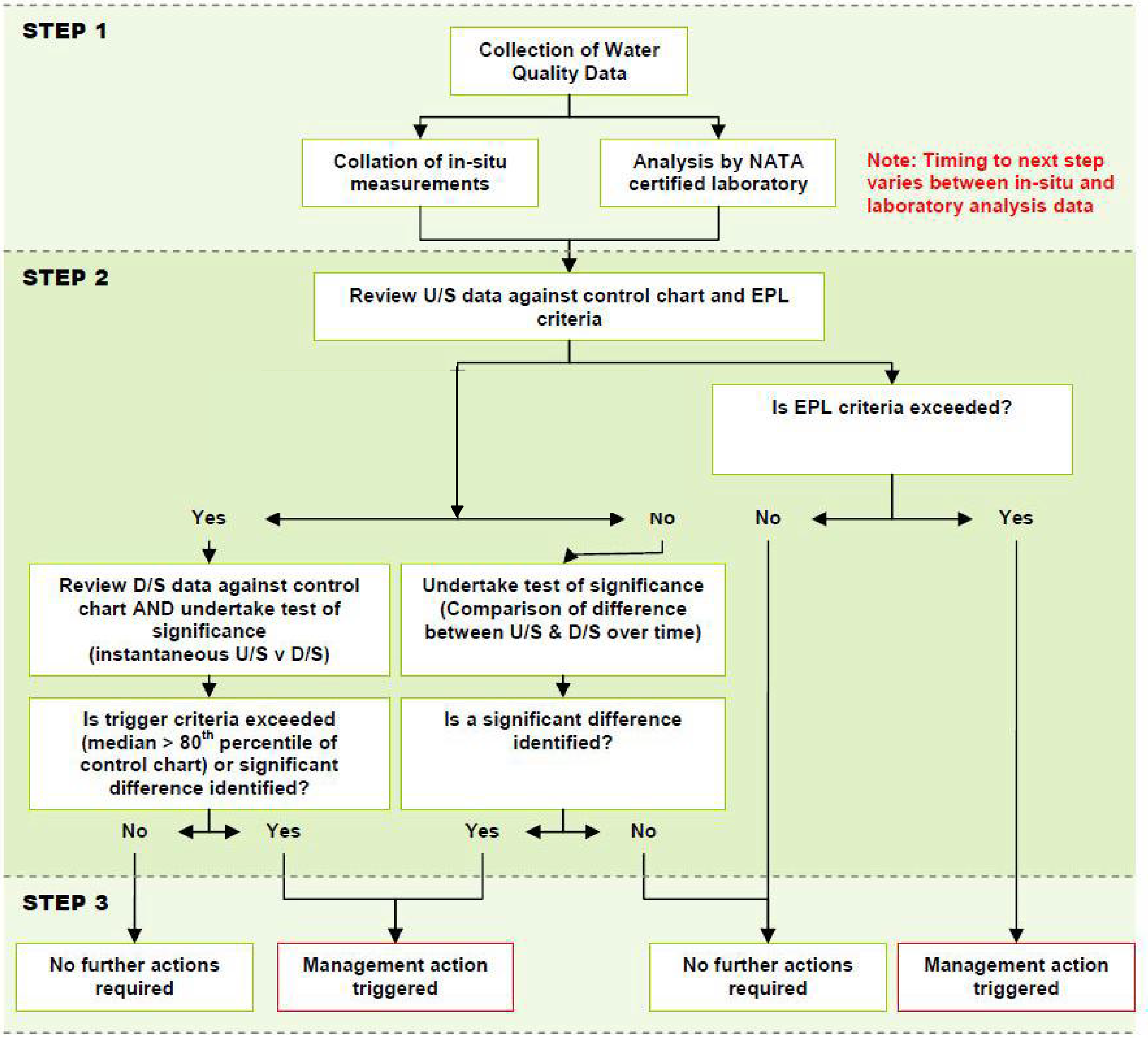

Figure 11: Construction phase water quality impact assessment procedure (Aurecon, 2010)

Notes:

CL = Confidence limit

U/S = Upstream

D/S – Downstream

Assessment against Environment Protection Licence (ELP)

An EPL will be required for construction under Part 3 of the POEO Act. The results of the monitoring program will be reviewed against the licence conditions of the EPL. Should the licence conditions be exceeded a management action would be triggered.

Assessment of significance

To ensure a robust assessment of the water quality data is completed, a test of significance would be undertaken to compare the samples upstream and downstream of the highway collected during each sampling event. The significance would be tested using both a t-Test and Sign Test as described in Section 7.2. The methodology would allow an assessment of the pollutants that are directly attributable to the highway during each event and is independent of the variable influences such as the volume of rainfall or time since last rain event. This process provides a direct comparison and assessment of impacts.

Comparison of long term differences

Where the assessment of upstream variability has identified that a particular sample event falls outside the expected range (i.e. where a significant change to upstream catchment influences has occurred), an assessment of the differences (i.e. U/S to D/S paired data) over time should be undertaken. When undertaking the above tests of significance, the paired data (i.e. upstream and downstream) from each event is used. For this analysis, however, the median value for each event should be used. By assessing the relative difference between each sample event, any trends or unexpected variance can be identified.

9.3 Analysis of operational phase data

During the operational phase of the project, the water quality monitoring program would focus on assessing whether the treatment processes (e.g. gross pollutant traps and water quality basins) are effectively mitigating the impact of the highway operation. An overview of the process for assessing the performance against the agreed objectives and standards is provided in the following sections and summarised in the flowchart in Figure 12. The management response to any observed impacts is outlined in Section 11.

9.3.1 Step 1 and Step 2 methodology

The majority of processes for the analysis and interpretation of the operational phase data are the same as for the construction phase of the FBB Princes Highway upgrade and as such the description of these steps has not been repeated.

The difference in methodologies relates to the process where the trigger criterion is exceeded or an impact of statistical significance is identified. An overview of this process is described below.

Assessment of basin outflow

During the operational phase, there will be monitoring of an estimated 18 representative water quality basins outflow (refer Section 3). Measuring the concentrations of pollutants that are leaving the basins allows for a more comprehensive assessment of any differences between upstream and downstream data.

The first stage of this process is to calculate the pollutant loads associated with the basin outflow. This requires details of the pollutant concentrations and discharge volumes and would be calculated using the formula presented in Section 8.3. By calculating the pollutant loads of the discharge leaving the basins, an assessment can be made to determine whether the observed difference between upstream and downstream samples can be attributed to the highway runoff.

The results of the MUSIC modelling presented in Chapter 7 of the EA Report (AECOM, 2012), indicate that the likely loads of pollutants entering the waterway will increase without any water quality treatment. By measuring the pollutants leaving the basins, the assumption of this modelling and the detailed design investigation can be confirmed and the actual performance of the treatment process assessed.

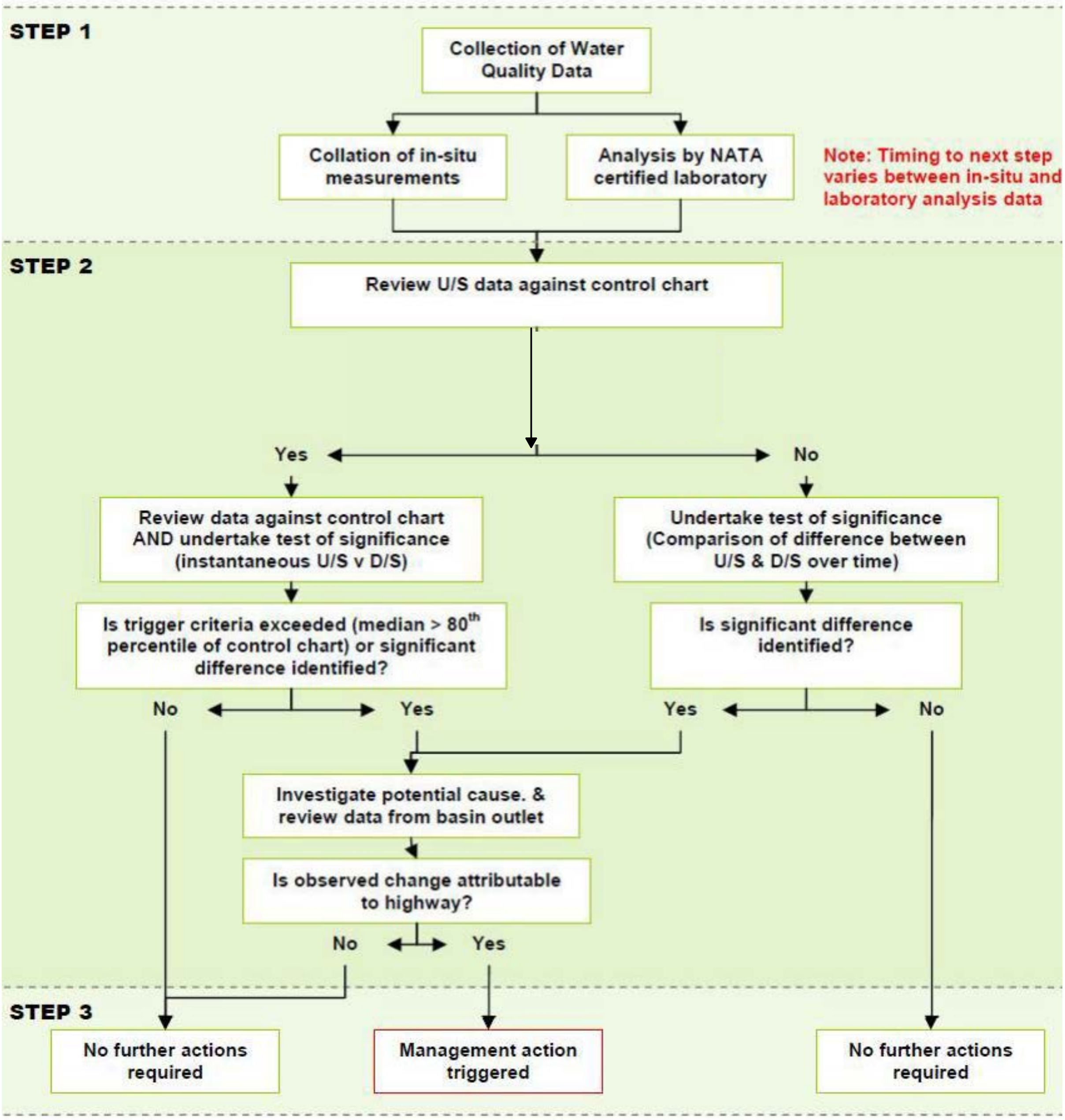

Figure 12: Operational phase water quality assessment (Aurecon, 2010)

10. Management actions

The management actions have adapted from the Surface Water monitoring programs from similar NSW projects (Aurecon, 2010a) which have been approved by all relevant stakeholders and is applicable to this project.

For a monitoring program to be effective, the performance objectives, performance standards and measurement criteria trigger must be linked to management actions. The management actions outlined in this section relate specifically to where the monitoring program has identified a potential impact. Management actions and responses for all other environmental impacts would be covered under the Construction and Operational Environmental Management Plans.

Section 6 outlines the criteria for triggering a management action, and Section 7 provides an overview of the process for assessment against these criteria. The following sections describe the management actions to be undertaken during the construction and operational phases of the project, should a trigger criteria be exceeded.

10.1 Construction phase

Best practice environmental management and control procedures would be used for the management of impacts during the construction phase of the project. The greatest risk to water quality during construction would arise in the event that these environmental control measures will not be sufficient or are inadequately installed/maintained to prevent sediment laden runoff from entering the receiving water.

The flow chart presented in Figure 13 provides an overview of the key steps in the assessment of construction phase environmental controls in the event of a management action being triggered. This is a guide only and should not be considered the only path for a management response. All management actions should include an investigation of the reasons for exceedance of the trigger and ensure that all practicable actions have been undertaken to prevent further incident.

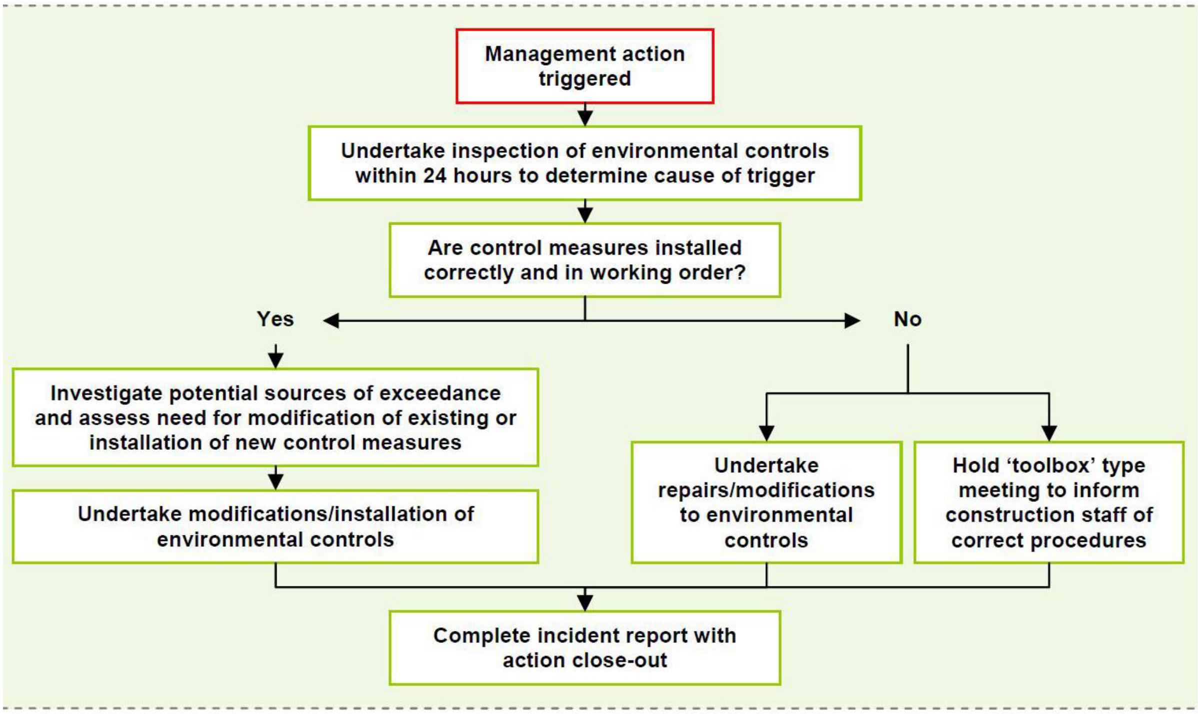

Figure 13: Construction phase management framework (adapted from Aurecon, 2010)

During the construction phase, the timing of the management actions is critical. Any trigger as a result of exceedance of a performance standard would most likely be a result of increased sediment loads following rainfall. The investigation should commence within 6 hours of the management action trigger and subsequent response should be undertake within 24 hours to ensure that any repairs, modification or additional measures are incorporated into the environmental controls before subsequent rainfall events.

A key aspect of the management response is to ensure that the findings of any investigation are communicated to the project team. This communication process would ensure that the team are aware of the correct procedures for installation and maintenance of environmental controls and would be included in the Construction Environmental Management Plan.

Reporting following the triggering of a management action would be undertaken in accordance with the processes outlined in Section 11.

10.2 Operational phase

The operational phase environmental controls proposed for the FBB Princes Highway Upgrade are outlined in the EA Report (AECOM, 2012). Should the environmental controls perform as predicted there should be no measurable effect as a result of the operation of the FBB Princes Highway upgrade and consequently no management actions would be triggered.

Management actions are only likely to be triggered where the treatment process fails to perform as expected (i.e. a lower removal efficiency than modelled is observed), or where additional pollutants beyond those normally associated with an operational highway are recorded. As a result of the complexity of these issues, the management actions following exceedance of a performance standard during the operational phase of the project would require considerable investigation and may require further monitoring before the action can be closed out.

The flow chart presented in Figure 14 provides an overview of the key steps in the assessment of operational phase impacts in the event of a management action being triggered. As for the construction phase actions, the flow chart is provided as a guide only and should not be considered the only path for the investigation of management responses. All management triggers during the operational phase would include an investigation of the reasons for exceedance of the trigger and ensure that all practicable actions have been undertaken to prevent further incident.

Reporting following the triggering of a management action would be undertaken in accordance with the processes outlined in Section 11.

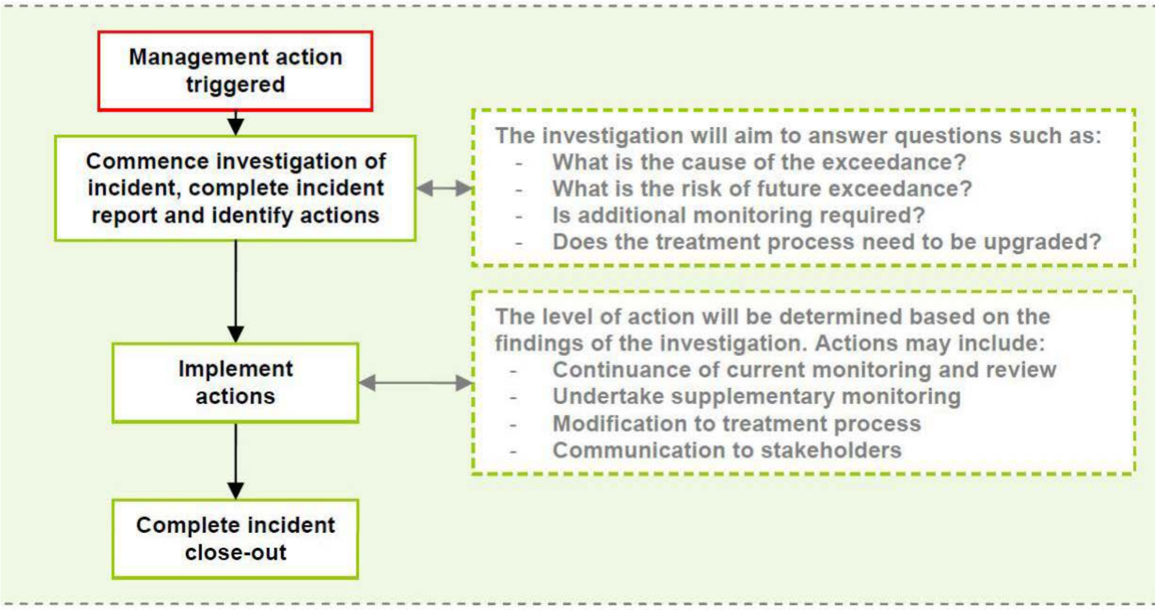

Figure 14: Operational phase management framework (adapted from Aurecon, 2010)

11. Management framework

The implementation of the proposed environmental controls, in combination with effective monitoring and management, would ensure that the risk from the FBB Princes Highway upgrade on the water quality of the local catchments would be significantly reduced. The following sections provide the framework for implementation, adaptation, review and management of the FBB SWMP. These mimic those adopted for the T2E upgrade developed by Aurecon, 2010.

11.1 Adaptive management approach

RMS recognises the importance of undertaking environmental management using an adaptive management approach and as such the SWMP would be a working document. The nature of water quality monitoring is such that there is no simple solution that provides a monitoring and management response to all scenarios.

Whilst this monitoring program has been developed based on the best available information at the time, it must be recognised that an adaptive approach is required to deliver an effective monitoring program into the future. Where the review and audit process identify opportunities for improvement, or areas where the monitoring approach may be refined, the FBB SWMP would be reviewed and updated. This would ensure that the monitoring program outlined within this surface water monitoring plan is capable and would continue to be capable of assessing the performance of the construction and operational phase environmental controls against the defined performance objectives and standards.

11.2 Roles and responsibilities

For the FBB Surface Water Monitoring Program to be implemented effectively, the roles and responsibilities for the implementation, management, review and auditing, must be clearly defined. Separate responsibilities are defined for the construction (refer Table 6) and operational (refer Table 7) phases of the project.

Table 6: Construction Phase Roles and Responsibilities

Organisation	Responsibility	Personnel and Contact Details
RMS	Implementation of the SWMP Assessment against performance objectives and standards Ensuring a CEMP is developed and implemented effectively Ensuring appropriate measures are implemented for management of acute impacts Investigation of any potential or observed impacts Identification and implementation of management actions as required Review and updating of SWMP Reporting	Ron De Rooy Senior Project Manager Ph: 02 4221 2585 Email: Ron.DE.ROOY@rms.nsw.gov.au

Organisation	Responsibility	Personnel and Contact Details
NOW	Review of Annual Progress Report and Incident Reports. Provide feedback as necessary.	Bob Britten Water Regulation Officer Ph: 6491 8209 Email: Bob.Britten@water.nsw.gov.au
NSW DP&I - Fisheries	Review of Annual Progress Report and Incident Reports. Provide feedback as necessary.	Dr Trevor Daly Fisheries Conservation Manager – South Coast. Ph: 02 4478 9103 Email: trevor.daly@dpi.nsw.gov.au
NSW EPA	Review of Annual Progress Report and Incident Reports. Provide feedback as necessary.	Julian Thompson Unit Head - South East Region Ph: (02) 6229 7002 Email: julian.thompson@epa.nsw.gov.au
OEH	Review of Annual Progress Report and Incident Reports. Provide feedback as necessary.	Peter Marczan A/manager noise policy Ph: (02) 9995 6059 Email: peter.marczan@epa.nsw.gov.au

Table 7: Operation Phase Roles and Responsibilities

Organisation	Responsibility	Personnel and Contact Details
RMS	Implementation of the SWMP Assessment against performance objectives and standards Ensuring appropriate measures are implemented for management of acute impacts Regular inspection of treatment measures (water quality basins) Maintenance of treatment measures Investigation of any potential or observed impacts Identification and implementation of management actions as required Review and updating of SWMP Reporting Consultation	Ron De Rooy Senior Project Manager Ph: 02 4221 2585 Email: Ron.DE.ROOY@rms.nsw.gov.au

Organisation	Responsibility	Personnel and Contact Details
NOW	Review of Annual Progress Report and Incident Reports. Provide feedback as necessary.	Bob Britten Water Regulation Officer Ph: 6491 8209 Email: Bob.Britten@water.nsw.gov.au
NSW DP&I - Fisheries	Review of Annual Progress Report and Incident Reports. Provide feedback as necessary.	Dr Trevor Daly Fisheries Conservation Manager – South Coast. Ph: 02 4478 9103 Email: trevor.daly@dpi.nsw.gov.au
NSW EPA	Review of Annual Progress Report and Incident Reports. Provide feedback as necessary.	Julian Thompson Unit Head - South East Region Ph: (02) 6229 7002 Email: julian.thompson@epa.nsw.gov.au
OEH	Review of Annual Progress Report and Incident Reports. Provide feedback as necessary.	Peter Marczan A/manager noise policy Ph: (02) 9995 6059 Email: peter.marczan@epa.nsw.gov.au

11.3 Reporting and auditing

Condition of Approval B16(g) requires ‘reporting of the monitoring results to the Department, OEH, EPA and NOW’. The following sections outline the reporting process to be implemented during the construction and operational phases of the project to meet this requirement and to ensure the delivery of an effective monitoring program.

11.3.1 Reporting

Regular reporting would be undertaken to allow assessment against the surface water objectives and performance standards. A brief factual monitoring report would be prepared after each sampling event, to present the data collected and ensure the environmental controls are effective.

A more comprehensive progress report would be prepared annually. The review and preparation of the progress report would not only report on the data collected during the year, but would also allow for an assessment of gradual trends and changes within the system – i.e. this review would provide early detection of any potential impacts and allow management actions to be triggered to address them before an impact occurs.

Incident reporting would also be undertaken where a performance standard has not been met. Exceedance of a performance standard does not necessarily mean that an impact has occurred, but provides a trigger for further review. The preparation of an incident report would be the first step in this process and would identify the management approach to be adopted to resolve any potential concerns.

Following all audits (internal and external), a close-out report would be prepared. Where non-conformances are noted, the report would include a summary of the actions undertaken to address the non-conformance and the steps that have been put in place to prevent further occurrence.

A summary of the reporting for the FBB Surface Water Monitoring Program is presented in Table 8.

Table 8: Summary of reporting requirements (adapted from Aurecon, 2010a)

Report	Condition of Approval Reference	Content	Timing	Circulation
Monitoring Report	B16 (h)	Following each sampling event a brief report would be prepared that describes water quality performance against the agreed objectives and standards for that particular event.	All phases until monitoring no longer required.	EPA, NOW, OEH DPI.
Annual Progress Report	B16 (h) B29 (c), (g)	As a minimum the progress report would include: • A summary of the monitoring results recorded during the previous 12 months; • An assessment of performance against defined objectives, standards and measurement criteria; • An overview of any environmental incidents recorded and the corresponding action taken; • Details and rationale for any modification to the surface water sampling program; • An outline of any changes to the environmental controls; • Findings of all audits and details of any corrective actions required; • Recommendations for any changes to the monitoring program or control measures; and • Review of any complaints and actions from the ERG.	Annual – No long operational period specified in COA	EPA, NOW, OEH DPI.
Incident Report	A5, B29 (e), (f), (g)	In the event of an exceedance in water quality performance standards, a brief report would be prepared to examine all relevant data and to determine a likely source and appropriate management action. An action plan would be developed and would include a timeframe for implementation.	Initial notification to DG in 24 hours with report provided within 7 days	EPA, NOW, OEH DPI.

12. Management of acute impacts

12.1 Acute risks to surface water quality

An assessment of acute impacts during the construction is summarised in Section 3.

During the construction phase the primary source of risk is from spills and leakages from plant or storage facilities on the construction site. If these spills are not contained and managed correctly, the contaminants have the potential to enter the catchment. The CEMP developed for the Project includes a range of control measures to significantly reduce this risk (Aurecon, 2012).

Risks during the operational phase of the project relate primarily to spills from road accidents.

The risk of pollutants entering the waterway as a result of a spill during the construction or operational phase of the project is low, however it is pertinent that this risk is acknowledged and managed accordingly. The nature of a risk such as a spill is that the location of the spill cannot be predicted. Also, while an assessment of potential pollutants can be made, the exact contaminant would not be known until after the spill has occurred.

12.2 Consideration of acute impacts

As discussed, for monitoring to be effective and meaningful, the program must produce quantifiable results that can be attributed to a source. That is, if contaminants are detected they must be attributable to the highway construction or operation before a management response can be implemented. Monitoring to assess the potential impacts of such spills it is not considered practical.

Acute impacts are best managed through the implementation of effective Construction and Operational Environmental Management Plans (CEMP and OEMP), as required by Condition of Approval B35 and D1. Good environmental management as a preventative measure would be far more effective in preventing impacts on catchment water quality than implementing a monitoring program.

In the event that an accident does occur and a spill results from that accident, the management response would be directed by the emergency response plan. Development of emergency response plans for both the construction and operational phase of the project would significantly reduce the risk of an impact on water quality and is a requirement of the project Conditions of Approval. An emergency response plan is required within condition of approval B35 for the CEMP.

In addition to these management solutions and emergency response procedures, a range of environmental controls would be in place to prevent spills from entering the waterway. This would include factors such as sizing water quality basin to capture the occurrence of acute impacts.

With the implementation of the management measures discussed above it is anticipated that the risk of surface water impact will generally be reduced relative to the existing highway and are anticipated to result in improved overall catchment water quality.

13. Consultation

13.1 Consultation undertaken during development of the SWMP

The Conditions of Approval for the project require that the SWMP is ‘developed in consultation with the OEH, EPA, DPI (Fishing and Aquaculture) and NOW.

Contacts from these organisations have been contacted and have been supplied with the brief for the project as a means of providing familiarity with the project prior.

A copy of this document, the sampling protocol document and groundwater management plan have also been provided to the key stakeholders for comment prior to finalisation of the documents.

A summary of the comments submitted on this document and how these have been dealt with are presented in the Table 9. Additional correspondence is provided in Appendix A.

Table 9: Stakeholder Comments and Response

Organisation	Date submitted to stakeholder	Contact	Document section and document page number	Comments	Comment date	GHD response	Response Date
Fisheries NSW - DPI	14/04/2014, Rev 2 submitted 23/04/14	Trevor Daly	General comment	Think it could be better focussed to address the key risk – which is sediment coming from the site during rainfall events during the construction phase	4/03/2014	The sampling requirements during construction have now been changed to focus sampling during wet events as recommended by DPI and the EA and focusing on Turbidity and TSS (i.e. sediment in discharge)	13/06/2014
			General comment	More wet weather sampling at the expense of dry weather sampling (especially during large rainfall events eg >25mm/day in addition to the >10mm/day events currently proposed)	4/03/2014	Dry weather sampling has been removed and ongoing sampling will focus on wet weather events. The wet weather event sampling is now based on that recommended in the EA and focuses on first flush run-off capture and then high events when discharge from sediment and water quality basins will be occurring.	13/06/2014
			General comment	Analysis focus should be TSS or turbidity during construction phase. EC, temperature, pH, DO and heavy metals could be sampled less as I doubt they will show much response. Sampling of TN and TP could be minimised as well as they are likely to be closely correlated with TSS anyway. Minimising the low risk items could allow more funding to be used for more wet weather sampling (eg after hours and weekends)	4/03/2014	Construction based sampling has been revised accordingly to reduce laboratory parameters other than TSS and Turbidity to quarterly events. Inset parameters will be collected as part of adopting standard sampling protocols.	13/06/2014
			General comment	More emphasis put on the need to have paired sampling sites – ie 1 in the waterway upstream of construction activities and a 2nd in the waterway downstream of construction activities	4/03/2014	This has been undertaken where possible; however, there are limitations to adopting this approach due to catchment conditions. These limitations relate to capturing impacts from sediment dam discharges and general run off from the site, particularly into Broughton Creek. Section 8.2.1 discusses these limitations and how they have been managed.	13/06/2014
			General comment	Due to the possible presence of Australian Grayling (threatened fish species) in Broughton Creek, the construction sediment basins need to be designed for the 90th% rain event for the Gerringong-Berry section. This is consistent with what RMS have done elsewhere in NSW for threatened fish habitat waterways.	4/03/2014	Acknowledged. This will be dealt with in the CEMP and is not discussed further in this document.	13/06/2014

Organisation	Date submitted to stakeholder	Contact					
		Trevor Daly (and Allan Lugg)	Figure 2, pg 20	Broughton Mill Creek catchment boundary is incorrect. Should be further west	24/04/2014	This has been corrected.	13/06/2014
			Section 6.4.1 (construction phase), pg 34	What will the design standards be for the control measure (retention basins)	24/04/2014	Details of the design will be provided in the CEMP and design documents.	13/06/2014
			Section 6.4.1 (construction phase), pg 34	Statement about impact on water quality doesn't make sense. If the controls are being exceeded because the storm is larger than the Design Standard, then the control measures will not be having much effect. The impacts could be very significant if large quantities of sediment are deposited into streams.	24/04/2014	Wording has been revised to clarify this further and now states that "During large storm events, discharge will occur from on-site treatment/capture systems. However, with appropriate control measures in place the impact to water quality would be low".	13/06/2014
			Section 6.4.1 (construction phase), pg 34	Why not just sample upstream and downstream of the works and compare the 2 results? Any discrepancies would most likely be attributable to the works. A Control Chart sounds like an unnecessary distraction.	24/04/2014	This section essentially describes up and down gradient comparison. Reference sites are essentially upgradient sites, while assessment sites are essentially down gradient sites. The control charts allow reasonable boundaries to be established for some variability between up and down gradient sites before triggering a response. For example, there might be a slight increase in a parameter between up and down gradient, which could trigger an exceedance without the control charts, but which would be rationalised as acceptable using the control chart approach.	13/06/2014
			Section 6.5.2, pg 36	This section is an exact duplicate (highlighted yellow) of 6.5.1	24/04/2014	This section has been removed.	13/06/2014

Organisation	Date submitted to stakeholder	Contact					
			Section 7.1 (trigger criteria), pg 38	ANZECC guidelines for physio-chemical stressors over complicating the issue. It will require collection of lots of samples and statistical analysis of those samples. The reality is that most of the samples will come from dry weather periods when impacts are unlikely - ie they will tell us nothing. In fact they will give the impression that everything is good. It would be much better to concentrate on comparing paired samples (upstream and downstream) taken during or shortly after rainfall events.	24/04/2014	Sampling has been revised to include wet weather sampling only.	13/06/2014
			Section 8.1.1	grammatical error	24/04/2014	This section has been revised.	13/06/2014
			Figure 10, pg 42	SW01 site location too far upstream	24/04/2014	This site has now been moved to just upgradient of the alignment.	13/06/2014
			Figure 10, pg 42	Five points where crossing of Broughton Creek and Princes Highway should have paired upstream and downstream sites	24/04/2014	This is not considered necessary for the reasons outlined in section 8.2.1. It is based on the fact that SW01 is the only real upgradient site and SW05 is really the only down gradient site. Additional sites are just places in between. Further immediately up and down gradient of the alignment would really only account for construction works crossing Broughton Creek rather than all other sources of impact that will be present along the Creek from the alignment.	13/06/2014
			Figure 10, pg 42	Should be several paired upstream and downstream sites in the minor creeks that cross the alignment.	24/04/2014	Please see the comments above. Where the sites are genuinely up and down gradient of the alignment this method has been adopted.	13/06/2014
			Section 8.2 Table 5, pg 43	Temperature is irrelevant. The works will not affect temperature.	24/04/2014	Agreed. Temperature will be taken as a part of standard sampling protocol with insitu readings.	13/06/2014
			Section 8.2 Table 5, pg 43	Drop all the dry episodes to save money. 99% of the risk is during wet weather.	24/04/2014	This has been undertaken.	13/06/2014
			Section 8.2 Table 5, pg 43	Highly unlikely that there will be any impact upon Electrical Conductivity.	24/04/2014	Acknowledged. This will be dealt with in the CEMP and is not discussed further in this document.	13/06/2014

Organisation	Date submitted to stakeholder	Contact					
			Section 9.2.2 (Analysis of construction phase data), pg 48	Don't agree that should data fall outside the 95% confidence interval a significant change is likely to have occurred upstream. The pre commencement monitoring is limited in terms of frequency and duration so it is reasonable to expect that extreme values will not be detected.	24/04/2014	Acknowledged. The text is confusing and the methods proposed are potentially inappropriate. The text has been revised to make this section more relevant and clearer. It now focuses on a subjective assessment for the impacts of upgradient changes in the wider catchment on the comparison between up and down gradient sites using control charts.	13/06/2014
			Section 12.1, pg 58	"Risks during the operational phase of the project relate primarily to spills from road accidents" But arguably these risks are less than under the current situation. The new road will be safer.	24/04/2014	Acknowledged. Text has been added to sections 3 and 12 to make this point clearer.	13/06/2014
NSW office Water	14/04/2014, Rev 2 submitted 23/04/14	Bob Britten		The report has been provided and no comments have been provided.		Bob Britten has been communicated with on a number of occasions via telephone. We understand that NOW is focused on groundwater issues associated with the Project. Bob has provided feedback on the groundwater modelling and GWMP documents which is included within the GWMP report.	13/06/2014
OEH	Not submitted.	James Dawson		The report has not been provided to OEH.		An informal face to face meeting was held with James Dawson on the 3 April 2014. During that meeting James stated that he was currently dealing with Toby Lambert from Parsons Brinkerhoff who were developing the monitoring plan for instream ecology. He noted that this was more relevant to biodiversity and threatened species. As such, it was considered that the surface water monitoring plan was of lower importance. James noted that Peter Marczan and Tim Pritchard of the OEH Water and Coastal team may have some interest in the project. At this time contact has not been made with Tim or Peter.	13/06/2014

Organisation	Date submitted to stakeholder	Contact					
		Peter Marczan		The report has not been provided to OEH.	19/06/2014	Email received from Peter Marczan detailing that he is currently in a different position and forwarded the email to Penny Vella of OEH who is currently acting team leader for Water Quality.	30/06/2014
		Penny Villa		The report has not been provided to OEH.	20/06/2014	Email received from Penny Villa of OEH stating the "she can confirm that OEH does not need to review the surface water and groundwater monitoring plan document, or the sampling protocol." She acknowledged that the EPA are already engaged on this issue.	30/06/2014
EPA	14/04/2014	Julian Thompson	Table 9, pg 53-54	Details the roles and responsibilities for management in the operational phase of the Foxground Berry Bypass. The NSW EPA is listed in this table as having part responsibility for the review of the Annual Progress Reports and Incident Reports, and to provide feedback as necessary. It should be noted that while the project will be licensed by the EPA during the construction phase, the Environment Protection Licence will not be required during the operational phase of the project. The EPA will therefore not have a formal management role post-construction, except for its general Appropriate Regulatory Authority Role for RMS under section 6 of the Protection of the Environment Operations Act 1997.	20/05/2014	The reference to EPL for operational phases of the project has been removed from the document text.	13/06/2014

14. References

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Appendices

Appendix A – Stakeholder Comments