APPENDIX B4

Soil and Water Management Sub Plan

Warrell Creek to Nambucca Heads

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Glossary / Abbreviations

CEMP	Construction Environmental Management Plan
CoA	Condition of Approval
DPI	Department of Primary Industries
EA	Environmental Assessment
EEC	Endangered Ecological Community
EPA	Environment Protection Authority
EP&A Act	*Environmental Planning and Assessment Act 1979*
EPL	Environmental Protection Licence
EWMS	Environmental Work Method Statements
FM Act	*Fisheries Management Act 1994*
NOW	NSW Office of Water
OEH	Office of Environment and Heritage
PESCP	Progressive Erosion and Sediment Control Plan
POEO Act	*Protection of the Environmental Operations Act 1997*
RMS	Roads and Maritime Services
SEPP	State Environmental Planning Policy
SoC	Revised Statement of Commitments included in the Submissions Report
SWMP	Soil and Water Management Plan

1 Introduction

1.1 Context

This Soil and Water Management Sub Plan (SWMP or Plan) forms part of the Construction Environmental Management Plan (CEMP) for the upgrade of the Pacific Highway between Warrell Creek and Nambucca Heads (the Project). The WC2NH Project is Stage 2 of the Warrell Creek to Urunga (WC2U) Project, approved by the Minister for Planning and Infrastructure in 2011.

The WC2NH section of the WC2U Project involves the upgrade of approximately 19.6km of the Pacific Highway from the northern end of the Allgomera deviation south of Warrell Creek to Old Coast Road, west of Nambucca Heads. The WC2NH Project is being constructed by ACCIONA Ferrovial Joint Venture (AFJV).

This SWMP has been prepared to address the requirements of the Minister's Conditions of Approval (CoA), the RMS Statement of Commitments (SoC), the mitigation measures listed in the Warrell Creek to Urunga Environmental Assessment (EA) and all applicable legislation.

1.2 Background

The *Warrell Creek to Urunga – Upgrading the Pacific Highway - Environmental Assessment* (RTA 2010) assessed the impacts of construction and operation of the Project on soils and water, within chapters 16 and 18.

As part of EA development, a detailed flooding and water quality assessment was prepared to address the Environmental Assessment Requirements issued by the then Department of Planning. The flooding and water quality assessment was included in the EA as Working Paper 5 – Flooding and Water Quality.

The EA identified the potential for direct and indirect impacts on water quality but concluded that provided the proposed mitigation and management measures are implemented, no significant long-term impacts would be expected.

1.3 Environmental management systems overview

The overall Environmental Management System for the Project is described in the Construction Environmental Management Plan (CEMP).

The SWMP is part of the ACCIONA Ferrovial Joint Venture (AFJV) environmental management framework for the Project, as described in Section 4.1 of the CEMP. In accordance with CoA B31(d), this Plan has been developed in consultation with the NSW Environmental Protection Authority (EPA), Primary Industries – Fisheries and Aquaculture and NSW Office of Water.

Management measures identified in this Plan will be incorporated into site or activity specific Environmental Work Method Statements (EWMS) and Progressive Erosion and Sediment Control Plans (PESCP).

EWMS will be developed and signed off by environment and management representatives prior to associated works and construction personnel will be required to undertake works in accordance with the identified safeguards. For high risk activities, such as construction of working platforms in waterways, EWMS will be provided to EPA and DPI Fisheries Conservation and Aquaculture for input prior to sign off (refer to Section 4.1.3 of the CEMP).

PESCPs are designed for use as a practical guide and may be produced in conjunction with Environmental Work Method Statement (EWMS) to provide more detailed site-specific environmental mitigation measures. PESCP will be developed by the environment team in consultation with construction personnel and the Project Soil Conservationist, and modified as required when:

- Site conditions evolve.
- Flow paths change.
- Construction activities that affected the characteristics of ground conditions change.

An indicative schedule for the production of PESCP's is provided in Table 1.1. It is noted that this is indicative only and will change based on the construction program. Also, this list is not exhaustive and PESCP's will be produced when the Environmental Manager and/or the Project Soil Conservationist deem it necessary. Used together, the CEMP, strategies, procedures, EWMS and PESCP form management guides that clearly identify required environmental management actions for reference by AFJV personnel and contractors.

The review and document control processes for this Plan are described in Section 10 of the CEMP.

Table 1.1 – PESCP indicative staging

Construction Stage	**Indicative Timing**
Site Compound Establishment – Albert Drive	November 2014
Site Compound Establishment – Northern Compound	December 2014
Clearing and Grubbing/Topsoil Strip	December 2014
Initial Earthworks	March 2015
Culvert installation (major culverts that require diversions)	March 2015 – Late 2015
Installation and removal of working platforms and major structures	March 2015 – Late 2015
Advanced Earthworks	Late 2015 – Early 2016
Landscaping and rehabilitation	Mid – late 2016

2 Purpose and objectives

2.1 Purpose

The purpose of this Plan is to describe how the AFJV proposes to manage and protect water quality during construction of the Project.

2.2 Objectives

The key objective of the SWMP is to ensure that the potential impacts to water quality are minimised and within the scope permitted by the planning approval. To achieve this objective, AFJV will undertake the following:

- Ensure best management practice controls and procedures are implemented during construction activities to avoid or minimise erosion/sedimentation impacts and potential impacts to water quality in rivers, creeks and groundwater along the Project corridor.
- Ensure appropriate measures are implemented to address the relevant CoA and SoC outlined in Table 3.1 and Table 3.2, and the safeguards detailed in the EA.
- Ensure appropriate measures are implemented to comply with all relevant legislation and other requirements as described in Section 3.1 of this Plan.

2.3 Targets

The following targets have been established for the management of soil and water impacts during the Project:

- Ensure full compliance with the relevant legislative requirements, CoA and SoC.
- Meet environmental protection licence water quality discharge parameters for all planned basin discharges (ie those within design capacity).
- Manage downstream water quality impacts attributable to the Project (ie maintain water waterway health by avoiding the introduction of nutrients, sediment and chemicals outside of that permitted by the environmental protection licence and/or Australian and New Zealand guidelines for fresh and marine water quality (ANZECC guidelines).
- Ensure training on best practice soil and water management is provided to all construction personnel through site inductions.

3 Environmental requirements

3.1 Relevant legislation and guidelines

3.1.1 Legislation

Legislation relevant to soil and water management includes:

- *Environmental Planning and Assessment Act 1979* (EP&A Act).
- Environmental Planning and Assessment Regulation 2000.
- *Protection of the Environment Operations Act 1997*.
- *Water Management Act 2000.*
- *Fisheries Management Act 1994.*
- *Commonwealth Environment Protection and Biodiversity Conservation Act 1999.*
- *Water Act 1912*.

Relevant provisions of the above legislation are explained in the register of legal and other requirements included in Appendix A1 of the CEMP.

3.1.2 Guidelines and standards

The main guidelines, specifications and policy documents relevant to this Plan include:

- Acid Sulfate Soil Manual (ASSMAC 1998).
- Acid Sulfate Soil and Rock – Victorian EPA Publication 655.1 – July 2009.
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC and ARMCANZ 2000).
- Department of Environment and Conservation (DEC): Bunding & Spill Management. Insert to the Environment Protection Manual for Authorised Officers - Technical section "Bu" November 1997.
- Managing Urban Stormwater: Soils and Construction. Landcom, (4th Edition) March 2004 (reprinted 2006) (the “Blue Book”). Volume 1 and Volume 2.
- Volume 2A Installation of Services (DECCW 2008).
- Volume 2C Unsealed Roads (DECCW 2008).
- Volume 2D Main Roads Construction (DECCW 2008).
- DIPNR Roads and Salinity Guideline, 2003.
- DLWC, 1998. Constructed Wetlands Manual.
- Fairfull, S. and Witheridge, G. (2003) Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings. NSW Fisheries, Cronulla, 16 pp.
- *NSW Fisheries, November 2003. Fishnote – Policy and Guidelines for Fish Friendly* Waterway Crossings (Ref: NSWF – 1181).
- RMS Dewatering Guideline.
- RMS Pacific Highway Practice Note for Dewatering.
- RMS Specification G36 – Environmental Protection.
- RMS Specification G38 – Soil and Water Management.

- RTA's Code of Practice for Water Management – Road Development and Management (1999).
- Approved Methods for the Sampling and Analysis of Water Pollutants in NSW – March 2004.
- Guidelines for the Management of Acid Sulphate materials: Acid Sulphate Soils, Acid Sulphate Rock and Monosulphidic Black Ooze (RTA 2005).
- RMS Environment Direction Management of Tannins from Vegetation Mulch.
- Stockpile Site Management Guideline, RMS 2011.
- Environmental Best Management Practice Guideline for Concreting Contractors, DEC, 2004.

3.2 Minister's Conditions of Approval

The CoA relevant to this Plan are listed Table 3-1 below. A cross reference is also included to indicate where the condition is addressed in this Plan or other Project management documents.

Table 3-1 Conditions of Approval relevant to the SWMP

CoA No.	Condition Requirements	Document Reference
CoA B17	The Proponent shall prepare and implement a Water Quality Monitoring Program to monitor the impacts of the project on SEPP 14 wetlands, surface water quality and groundwater resources during construction and operation. The Program shall be developed in consultation with EPA and DPI and shall include but not necessarily be limited to: a) identification of surface water and groundwater quality monitoring locations which are representative of the potential extent of impacts from the project; b) 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 and risks to oyster farming in the Nambucca, Bellinger, and Kalang rivers; c) representative background monitoring of surface water and groundwater quality parameters for a minimum of six (6) months (considering seasonality) prior to the commencement of construction to establish baseline water conditions; d) development and presentation of indicators or standards against which any changes to surface water quality will be assessed, having regard to the Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000 (ANZECC, 2000); e) contingency and ameliorative measures in the event that adverse impacts to surface water quality are identified; f) a minimum monitoring period of three years following the completion of construction or until any disturbed waterways/ 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 basis and vegetation swales); and	Appendix A – Water Quality Monitoring Program

CoA No.	Condition Requirements	Document Reference
	g) reporting of the monitoring results to the Department, EPA and DPI. The Program shall 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 shall be submitted to EPA and DPI prior to its implementation.	
CoA B30 e) (iii)	…..measures to monitor and manage spoil and fill including details of how excavated material would be handled, stockpiled, reused and disposed and a stockpile management protocol detailing location criteria that would guide the placement of stockpiles and minimum management measures (including rehabilitation) that would be implemented to avoid/ minimise amenity impacts to surrounding residents and environmental risks (including to surrounding watercourses).	Appendix B, Appendix AI and the Waste and Energy Management Sub Plan
CoA B31 d)	a Construction Water Quality Management Plan to manage surface water quality and groundwater impacts during construction of the project. The Plan shall be developed in consultation with EPA, DPI (Fisheries and NOW) and include, but not necessarily be limited to:	This Plan
	i. a contingency plan, consistent with the Acid Sulfate Soils Manual, to deal with the unexpected discovery of actual or potential acid sulfate soils;	Appendix C - Acid Sulfate Soil Management Procedure
	ii. a tannin leachate management protocol to manage the stockpiling of mulch and use of cleared vegetation and mulch filters for erosion and sediment control;	Appendix D Management of Tannins from Vegetation Mulch
	iii. details of how construction activities would be managed and mitigated to minimise erosion and sedimentation consistent with condition C17;	Chapter 6
	iv. where construction activities have the potential to impact on waterways or wetlands (through direct disturbance such as construction of waterway crossings or works in close proximity to waterways or wetlands), site specific mitigation measures to be implemented to minimise water quality, riparian and steam hydrology impacts as far as practicable, including measures to stabilise bank structure and rehabilitate affected riparian vegetation to existing or better condition (including relevant performance indicators and monitoring requirements). The timing of rehabilitation of the waterways shall be as agreed to with DPI (Fisheries and NOW) shall be identified in the plan;	Chapter 6
	v. construction water quality monitoring requirements consistent with condition B17; and	Appendix A – Water Quality Monitoring Program
	vi. a groundwater management strategy, including (but not necessarily limited to): i. description and identification of groundwater resources (including depths of the water table and groundwater quality) potentially affected by the proposal based on baseline groundwater monitoring undertaken in accordance with condition B17(c); ii. identification of surrounding licensed bores,	Appendix E – Groundwater Management Strategy

CoA No.	Condition Requirements	Document Reference
	dams or other water supplies and groundwater dependent ecosystems and potential groundwater risks associated with the construction of the project on these groundwater users and ecosystems; iii. measures to manage identified impacts on water table, flow regimes and quality and to groundwater users and ecosystems; iv. groundwater inflow control, handling, treatment and disposal methods; and v. a detailed monitoring plan to identify monitoring methods, locations, frequency, duration and analysis requirements; and	
CoA C17	Soil and water management measures consistent with *Managing Urban Stormwater - Soils and Construction Vols 1 and 2, 4th Edition* (Landcom, 2004) and *Managing Urban Stormwater Soils And Construction Vols 2A and 2D Main Road Construction* (DECC 2008) shall be employed during the construction of the project for erosion and sediment control.	Chapter 6
CoA C18	Where available, and of appropriate chemical and biological quality, the Proponent shall use stormwater, recycled water or other water sources in preference to potable water for construction activities, including concrete mixing and dust control.	Chapter 6

3.3 Statement of commitments

Relevant SoC are listed Table 3-2 below. This includes reference to required outcomes, the timing of when the commitment applies, relevant documents or sections of the environmental assessment influencing the outcome and implementation.

Table 3-2 Statements of commitment relevant to this SWMP

Outcome	Ref #	Commitment	Timing	SWMP Reference
Erosion and sediment controls are effective	W1	Minimisation of the area of soil exposure during construction.	Construction	Chapter 6
	W2	Detailed design will further investigate any additional feasible and reasonable mitigation and management measures to minimise construction erosion and sedimentation.	Pre-construction	Chapter 6 and appendices
	W3	Monitoring of groundwater impacts and surface water quality upstream and downstream of the site during construction will determine the effectiveness of mitigation strategies. Implementation of additional feasible and reasonable management measures will occur if necessary.	Pre-construction and construction	Chapter 6, Appendix A
	W4	Development and implementation of specific construction measures for in-stream works to limit water quality impacts will occur in consultation with relevant government agencies.	Pre-construction Construction	Chapter 6
	W5	Managing operational water quality will occur by applying RTA's Code of Practice for Water	Operation	Chapter 6

Outcome	Ref #	Commitment	Timing	SWMP Reference
		Management – Road Development and Management (1999).		
Minimise groundwater related impacts	W6	Investigation of the potential for changes in the groundwater table will take place before starting any major earthworks. Where a potential for change is identified, the significance of the change and any resultant impacts will be determined and measures to manage the changes will be designed and implemented as necessary.	Pre-construction and construction	Chapter 6 Table 6.1 Appendix E
	W7	Baseline monitoring of groundwater levels and chemical levels at cutting sites near springs, creeks or endangered ecological communities prior to construction commencing.	Pre-construction and construction	Chapter 6 Table 6.1
Minimise impact of exposing acid sulfate soil.	S1	Identification and management of Acid Sulfate Soils will be in accordance with the Guidelines for the Management of Acid Sulfate materials: Acid Sulfate Soils, Acid Sulfate Rock and Monosulphidic Black Ooze (RTA 2005)	Pre-construction and construction	Appendix C
Protection of the environment, workers and the public.	S2	There will be identification, investigation and appropriate management of areas of potential soil contamination (including works in the vicinity of the old municipal tip site in Nambucca State Forest).	Pre-construction and construction	Appendix K

4 Existing environment

The following sections summarise what is known about factors influencing soils and water within and adjacent to the Project corridor.

The key reference documents are Chapter 16, Chapter 18 and Working Paper 5 of the EA.

4.1 Topography and soil characteristics

Two major geological terrain types are found across the project: the alluvial floodplains at major waterway crossings, and the foothills of the coastal ranges. The characteristics of these terrain types are summarised in Table 4-1. The topography of the foothills is characterised by spurs and ridgelines positioned predominantly in a west to east direction. The ridges and valleys are typically between 10 metres and 30 metres Australian Height Datum (AHD).

The topography adjacent to the major river crossings typically consists of extensive areas of alluvial floodplains less than five metres AHD. Swamp areas are sometimes present on the larger extensive alluvial floodplains of the Nambucca River.. These swamp areas are typically the product of billabongs (river meanders cut off from the main waterway) or scouring during flood events. These low topographic areas contain alluvial soils and are located away from the major waterways.

Geology and soils along the project are also outlined in Table 4-1.

Table 4-1 Topography, geology and soils

Terrain unit	Topography	Geology	Soils
Floodplains	Flat to gently sloping coastal plains and river terraces, with estuarine mud flats.	Quaternary alluvial and estuarine soils up to about 15 to 35 metres thick.	Alluvial/ estuarine: sands, silts, clays, organic clays, possible gravels, expected to be potential acid sulfate soils.
Foothills	Gently to moderately undulating hills, with wide river valleys and creeks.	Nambucca Beds (schists and phyllites), with some granite intrusions and local granodiorite dykes.	Residual clay of high plasticity to less than 5m depth. Small creeks: Alluvial sediments.

Potential acid sulfate soils contain iron sulfides (pyrites), which may oxidise when exposed to air, resulting in the soil acidification and dissolved acid and metal discharge into nearby surface water bodies via surface water runoff and groundwater flows. Soil acidification and dissolved acid runoff can result in detrimental impacts on the health of land and aquatic plants and animals. The acid sulfate soil analyses in the EA indicated that both actual and potential acid sulfate soils are present, including broad areas of high risk acid sulfate soils and some areas of low risk acid sulfate soils (see Appendix A6 of the CEMP). Since the acid neutralising capacity of the soils is insufficient to neutralise the total potential acidity present in the soils, appropriate acid sulfate soil management practices will be required. This is addressed further in Chapter 6 and Appendix C – Acid Sulfate Soil Management Procedure.

Naturally mineralised soil and rock deposits, in particular arsenic, were found to be present within the WC2NH upgrade alignment. There is potential for mineralised areas within the upgrade alignment to be exposed during excavations of cuttings during highway construction activities.

The presence of elevated levels (ie above background levels) of naturally occurring arsenic in rock has been identified in the following chainages for cutting:

- Cut 11 (48400-48950)
- Cut 12 (49200-49650)
- Cut 25 (57800-58000)

As such appropriate arsenic rock management practices will be required. This is addressed further in Appendix J – Arsenic Rock Management Strategy.

4.2 Surface water

The project crosses 11 waterways along its length. These include freshwater systems, estuarine systems, intermittently closed and open lakes and lagoons (in which salinity levels vary between freshwater and saline conditions) and wetlands. The larger wetlands in the locality are often within or associated with wetlands listed under SEPP 14. Major waterways are outlined in Table 4-2 and are shown on the sensitive area maps attached at Appendix A6 of the CEMP.

A water sampling regime was undertaken as part of the EA that concluded that overall the water quality of waterways in the Warrell Creek to Urunga study area was slightly better under dry weather conditions than following wet weather, although the smaller tributaries (predominately those classified as lowland rivers) had poor water quality during dry weather due to very low flow and/or stagnant water conditions at the time of sampling. Poor water quality during dry weather was generally due to high turbidity and low dissolved oxygen and pH concentrations that failed to meet the ANZECC/ARMCANZ (2000) trigger values for slightly disturbed estuarine and lowland river ecosystems. Following wet weather, the water quality at all sites deteriorated due to increased turbidity and lower dissolved oxygen levels. The extent to which the waterways were affected by wet weather appears dependent on the surrounding catchment and the amount of riparian vegetation. Sites with well vegetated banks and permeable catchment surfaces are less affected by rainfall and runoff as the sediment can become trapped by the vegetation thereby reducing the amount of runoff entering the waterways.

A pre-construction water quality monitoring program is underway. The pre-construction water quality monitoring program is being undertaken by Roads and Maritime with AFJV delivering the construction phase water quality monitoring program. This preconstruction water quality monitoring data will be used to evaluate broader water quality trends throughout and following construction of the project. The water quality monitoring program to be implemented during and following construction is provided as Appendix A.

A broad qualitative evaluation of water quality from the EA is provided in Table 4-2.

Table 4-2 Watercourses, wetlands and water quality

Location	Waterways	Summary of water quality
Allgomera deviation to Nambucca River extends from the northern end of the existing Allgomera deviation to the northern bank of the Nambucca River at Macksville.	Freshwater systems - Upper Warrell Creek, Butchers Creek, Stony Creek, Rosewood Creek and Williamson Creek. Estuarine systems - Warrell Creek and	• Water quality in the freshwater creeks (Upper Warrell, Butchers, Rosewood, Stony and Williamson Creeks) was generally good, with the exception of dissolved oxygen levels. The dissolved oxygen levels were below the minimum saturation requirement for aquatic ecosystems. This is potentially due to the very low flow conditions at the time of sampling and volume of macrophyte growth. Acid sulfate soils are likely to be present at Butchers Creek.

	Nambucca River. Passes approximately 180 metres from SEPP 14 Wetland No 388 (Gumma Creek).	• Low dissolved oxygen concentrations were found in Williamson Creek (a freshwater tributary of Warrell Creek) on all sampling occasions. This creek has the poorest water quality in this section. • All of the freshwater creeks sampled are currently impacted by runoff from the existing Pacific Highway and/or other roads, as well as runoff from farmland. The freshwater creeks have degraded banks and limited riparian vegetation. • The estuarine waterways (Warrell Creek and Nambucca River) were found to have high turbidity and low dissolved oxygen concentrations. Water quality appeared to deteriorate in wet weather as a result of stormwater runoff. • Sampling conducted in Nambucca River by Nambucca Shire Council 1991-2007 (upstream and downstream of the Proposal) indicated that ANZECC and ARMCANZ guideline values for aquatic ecosystems were exceeded on 80% of occasions for oxidised nitrogen and 50% for total phosphorous. Wastewater effluent from wastewater treatment plant at Gumma Road, Macksville is likely to have contributed to high nutrient concentrations. • Wetland No 388 was found to have elevated turbidity and low dissolved oxygen. Water quality appeared to deteriorate in wet weather as a result of increased sediment in the runoff from Gumma Road.
Nambucca River to Nambucca Heads extends from the northern bank of the Nambucca River at Macksville to the North Coast Railway crossing at Nambucca Heads.	No waterways, however passes approximately 40 metres from SEPP 14 Wetland No 383 and approximately 900 metres from Wetland No 386.	• Wetland No 383 and No 386 did not contain any water at the time sampling. • Wetland No 386 is impacted by runoff from the existing Pacific Highway. The water quality at Wetland No 383 may potentially be impacted by local roads and Newee Creek that flows through the wetland. • Both wetlands are surrounded by disturbed and high-risk acid sulfate soils.

4.3 Groundwater

Two main types of groundwater regimes are likely to be found along the Project based on geological types and groundwater levels observed in standpipe piezometers installed during the EA. These include:

- Undulating hills (underlain by typically weathered phyllite).
- Alluvial floodplains.

The phyllite in the hilly areas exhibits low permeability with the main transport route for groundwater being defects in the rock, particularly along veins and foliation partings. Groundwater level measurements indicated that water levels were generally greater than 10 metres depth in these areas.

The second groundwater regime was beneath the alluvial floodplains either side of the major waterways. Groundwater levels were high (less than five metres depth) and typically reflected their proximity to the major watercourses. Groundwater levels across the floodplains are likely to fluctuate due to tidal influences by up to 0.5 metres. There are a number of groundwater dependent vegetation communities along the project. These include swamp forests and communities generally associated with low-lying land, wetlands and watercourses.

The most likely locations where groundwater is close to the ground surface and therefore more at risk of contamination, is in streams, as base flow, around the rivers and in the wetlands. Agricultural practices also represent the greatest risk in terms of groundwater contamination where fertilisers or pesticides are or have historically been applied to the land. As part of the EA, soil samples were taken in areas of both potential point source and diffuse pollution sources and tested for a range of contaminants including heavy metals and organic herbicides and pesticides. The soil samples returned results below laboratory reporting limits indicating very low to negligible levels of contaminants when compared to the adopted assessment criteria or laboratory reporting limits. Therefore the risk to groundwater in these locations is considered to be low.
Water quality basins for the project, both during construction and operational phases will be designed in accordance with *Soils and Construction Vol 1 2004 and Volumes 2C & 2D* (known as "*the Blue Book*"). To mitigate the potential for impact on groundwater dependent ecosystems, minimum design standard drainage structures would be used in areas adjacent to wetlands and saturated soils, to maintain the current hydrological regime.

The EA identified 7 licensed bores within the study area. The bores located around Macksville intersected shale and slates and the bores north of Nambucca Heads generally intersected clay, shales and slate. The depths of the bores varied between four metres and 58 metres. However, depths generally ranged between 30 and 40 metres. The groundwater levels of these bores at the time of sampling (where available) range from five to 30 metres. Salinity was found to be good and bore yields up to 8.84 litres per second. The majority of bores are used for domestic supply with or without stock. Other bore uses include waste disposal, industrial and recreational purposes.

4.4 Rainfall

The rainfall records from Macksville and South West Rocks have been selected to reflect the potential rainfall conditions across the project site due to its proximity to the overall site, and extent of available data (from 1888 to present). The mean rainfall data has been sourced from the Macksville Country Club Weather Station (059018) which is located 2.5km from the Nambucca River Bridge on the WC2NH Project Alignment. The mean rain days data has been sourced from Smokey Cape Lighthouse, South West Rocks (059030) which is located 24.7km to the South East of the southern extent of the alignment. A summary of the rainfall records from the Bureau of Meteorology is provided in Table 4-3 below.

Table 4-3 Summary of rainfall records,

Summary of rainfall record from 1888 to present													
	Summer / Autumn						Winter / Spring						
	Dec	Jan	Feb	Mar	Apr	Ma	Jun	July	Aug	Sep	Oct	Nov	Year
Mean rainfall[Note 1] (mm)	117.7	147.4	169.2	175.6	126.3	108.4	105.7	65.2	65	58.7	84.6	99.9	1323.7
Mean rain days[Note 2]	10.2	10.8	11.8	12.9	10.7	9.4	8.6	6.3	6.3	6.2	8.6	9.5	76

Note 1 – Data from Macksville Country Club (059018)

Note 2 – Data from South West Rocks (Smoky Cape Lighthouse 059030)

Rainfall is typically higher during summer and autumn. Winter and spring are typically drier periods during the year.

4.5 Rainfall erosivity factor

The rainfall erosivity factor is a measure of the ability of rainfall to cause erosion (referred as “R” in the Revised Universal Soil Loss Equitation RUSLE). The rainfall erosivity factor is used to determine the soil loss in tonnes per hectare over one year, and is used in calculations when sizing construction sediment basins.

The Project has a Rainfall Erosivity Factor of 4220 SI.

4.6 Flooding

Two hydrologic models were used to model the flows within the three key waterways located along the project based on rainfall data and catchment characteristics:

- Upper Warrell Creek.
- Warrell Creek.
- Nambucca River.

The existing flooding regime predicted by the model for Nambucca River was widespread flooding in the low-lying areas of Macksville and the surrounds, particularly in Gumma Swamp.

The existing flooding regime for the Nambucca River is characterised by widespread flooding in the low-lying areas of Macksville and surrounds, particularly in Gumma Swamp. Flooding of these areas occurs as a result of a lack of conveyance of the river, and floodwater backing up into the low-lying Gumma Swamp.

The lower reaches of Warrell Creek are tidally influenced. However, flooding around the Project is primarily influenced by the conveyance of the waterway.

The Warrell Creek and Upper Warrell Creek existing flooding regime is characterised by a well defined channel and confined floodplain in the study area.

5 Environmental aspects and impacts

5.1 Construction activities

Key aspects of the Project that could result in adverse impacts to soils and water include:

- Vegetation clearing and topsoil stripping.
- Bulk earthworks.
- Site access including temporary waterway crossings.
- Culvert and drainage works.
- Bridge construction.
- Material stockpiles including the treatment of acid sulfate soil and rock.
- Batch plant operation.
- Paving activities.
- Water use / extraction.
- Compounds operation including fuel and chemical storage, refuelling and chemical handling.
- Noxious weed treatment including herbicide spraying.

5.2 Impacts

The potential for impacts on soil and water will depend on a number of factors. Primarily impacts will be dependent on the nature, extent and magnitude of construction activities and their interaction with the natural environment. Potential impacts attributable to construction might include:

- Exposure of soils during vegetation clearing and earthworks, creating the potential for off-site transport of eroded sediments and pollutants.
- Release of earthern or fine material to downstream environments from waterway platform construction/deconstruction and from bridging/drainage layers in fill areas.
- Production of tannins from mulch during clearing.
- Disturbance of acid sulfate soils, creating the potential for oxidation of these soils and subsequent generation of acidic run-off.
- Alteration of surface and subsurface flows that could cause disturbances to hydrology and hydraulics.
- Intercepting with cuts perched water tables or layers of relatively low permeability soil/rock that support surrounding ecosystems and groundwater sensitive areas.
- A reduction in groundwater levels and flows, and off-site discharge of water containing sediment from dewatering activities.
- Interception and interference with an aquifer that could obstruct groundwater flow and limit groundwater availability.
- Contamination of soils, and surface and groundwater from accidental spills or oil leaks. This might include grease or fuel from machinery and vehicles, construction sites or compounds, or spills of other chemicals that may be used during the course of construction.

- Disturbance of unidentified contaminated land eg former tick dip sites, or other pesticide/chemical concentrations in soil from historical land use practices, and subsequent generation of contaminated runoff.

Some impacts on soil and water attributable to the Project are anticipated. Relevant aspects and the potential for related impacts have been considered in a risk assessment at Section 3.4/Appendix A2 of the CEMP. Chapter 6 provides a suite of mitigation measures that will be implemented to avoid or minimise those impacts.

6 Environmental control measures

A range of environmental requirements and control measures are identified in the various environmental documents, including the EA, Statement of Commitments, supplementary assessments, Conditions of Approval and RMS documents, and from recent experience on similar road projects. Specific measures and requirements to address impacts on soil and water are outlined in Table 6-1.

Table 6-1 Soil and water management and mitigation measures

ID	Measure / Requirement	Resources needed	When to implement	Responsibility	Reference
GENERAL					
SW1	Training will be provided to all project personnel, including relevant sub-contractors on sound erosion and sediment control practices and the requirements from this plan through inductions, toolboxes and targeted training.		Pre-construction Construction	Construction Manager / Environment Manager	G38/G36, Good practice
SW2	A Project Soil Conservationist will be engaged and regularly consulted throughout construction to provide advice on erosion and sediment control design, installation and maintenance		Pre-construction / Construction	Environment Manager	G38, Good practice
SW3	An environmental protection scheduled activity licence will be obtained for the Project. All relevant conditions relating to soil and water management will be implemented as required by the licence.		Construction / Post construction	Construction Manager	*POEO Act 1997*
SW4	Ancillary facilities and stockpiles will be located in accordance with the criteria outlined in Appendix A4 of the CEMP and Appendix I of this sub plan, respectively.		Pre-construction / Construction	Construction Manager / Environment Manager	CoA C27
SW5	Where available, and of appropriate chemical and biological quality, the Proponent shall use stormwater, recycled water or other water sources in preference to potable water for construction activities, including concrete mixing and dust control.		Construction	Construction Manager / Environment Manager	CoA C18
PROCEDURES AND PLANS					
SW6	Progressive erosion and sediment control plans (ESCPs) will be prepared and implemented in advance of construction, including earthworks and stockpiling. ESCPs and will be updated as required.		Pre-construction / Construction	Environment Officer / Foreman	Managing Urban Stormwater: Soils and Construction Volume 1 (Landcom 2006). Managing Urban Stormwater: Soils and Construction, Volume 2D, Main Road Construction (DECC 2008).

ID	Measure / Requirement	Resources needed	When to implement	Responsibility	Reference
SW7	EWMS will be prepared for construction actvities and implemented to manage soil and water impacts. EWMS for activities identified as having high environmental risk will undergo a period of consultation with EPA and DPI (Fisheries Conservation and Aquaculture).		Construction	Superintendent / Environment Manager	G38 CEMP Section 4.1
SW8	All ASS or PASS disturbed during the construction process will be managed in accordance with RMS Acid Sulfate Soil Management Procedure attached at Appendix C. The requirements will be incorporated into the EWMS for management of Acid Sulfate Materials.		Pre-construction / Construction	Superintendent / Environment Manager	
SW9	The requirements of the spoil and fill management procedure attached at Appendix B will be implemented throughout construction. The plan includes, among other detail, the types of material expected to be encountered during construction, and how excavated material will be handled, transported, stockpiled, reused and disposed.		Construction	Superintendent / Foreman	CoA B30 e) (iii)
SW10	Dewatering will be undertaken and managed in accordance with the Pacific Highway Projects Dewatering Guidelines attached at Appendix G. A specific EWMS for dewatering, will be prepared and will consider and/or incorporate the following detail: • Areas of the site that will require dewatering. • Dewatering methods that will minimise potential environmental impacts. • Opportunities for reuse. • The limitations for any proposed reuse methods. • Discharge locations and adequate energy dissipation. • Water quality criteria for discharge and/or reuse. • Treatment techniques required to meet the water quality criteria. • Water sampling and testing requirements.		Construction	Superintendent / Environment Manager	G36
SOIL EROSION CONTROL					

ID	Measure / Requirement	Resources needed	When to implement	Responsibility	Reference
SW11	Works will be programmed to minimise the extent and duration of disturbance to vegetation. This will include leaving clearing (unless undertaken by manual means) and initial earthworks in intermittent and permanent watercourses until subsequent works are about to commence.		Pre-construction Construction	Superintendent / Foreman	G38
SW12	Wastewater or "dirty" water generated during the construction process will, wherever possible, be collected, treated and disposed of by appropriate means, including the installation of sediment barriers downslope of all disturbed areas. In areas where it is not possible to direct dirty water to sediment basins, other sediment controls will be implemented in accordance with "Blue book" best practice.		Construction	Superintendent / Foreman	G38
SW13	Clean and dirty water runoff will be adequately separated to avoid mixing where possible through the use of diversions, clean water drains, and the early installation of permanent drainage infrastructure.		Construction	Superintendent / Foreman	EA, G38
SW14	The velocity of water flow over the construction site will be minimised by implementation/construction of level spreaders, check dams, bank and channel linings and other similar techniques.		Construction	Superintendent / Foreman	EA
SW15	The land will be shaped, where possible, to minimise slope lengths and gradients and to improve drainage.		Construction	Superintendent / Foreman	EA
SW16	All disturbed areas would be progressively stabilised and/or rehabilitated as they are completed in accordance with the Blue Book. Rehabilitation would aim to achieve at least 70% cover (i.e. C-factor of 0.05 or less) within 60 days on cut and fill batters or other disturbed areas, or 10 days in concentrated flow paths.		Construction	Superintendent / Foreman	EA Good practice
SW17	In accordance with the Blue Book, temporary ground covers would be used for any temporary cessation in works in an area exceeding 20 days, to achieve at least 50% cover (i.e. a C-factor of 0.15 or less). This would apply to stockpile sites and other exposed areas and		Construction	Superintendent / Foreman	G38, EA Good practice

ID	Measure / Requirement	Resources needed	When to implement	Responsibility	Reference
	measures would include (but are not limited to): • Biodegradable polymer soil binders; • Geotextile fabrics; • Erosion control blankets; • Temporary seeding; and • Mulching.				
SW18	In accordance with the requirements of the Blue Book, active work areas will be stabilised at the end of each day's work and/or just prior to inclement weather, by means such as: • Graded drains are to be cut to basins and to slow flows down slopes; • Fills and stockpiles are to be compacted and sealed off; • Any required temporary 'clean' water drains are to be reinstalled and lined appropriately; • Any final surface protections with geofabric, hardstand materials or mulch will be implemented; • Temporary bunds, traps and batter chutes will be reinstated; and • Gypsum placed in basin inlets prior to rain to allow for self-flocculation. The timing of the implementation of stabilisation measures will be determined by the Superintendent and Environmental Manager by the monitoring online weather services and when there is a 90% of more than 10mm of rain forecast.		Construction	Superintendent / Foreman Environmental Manager	G38
SW19	Catch drains, contour and diversion drains across exposed areas will be installed immediately following clearing, and re-established and maintained during topsoil removal and earthwork operations.		Construction	Superintendent / Foreman	G38
SW20	Sediment controls, such as traps (sediment fence) and check dams, will be installed where required, especially in smaller catchments where sediment basins have not		Pre-construction / Construction	Superintendent / Foreman	EA

ID	Measure / Requirement	Resources needed	When to implement	Responsibility	Reference
	been proposed.				
SW21	Barrier fences or flagging will be installed to delineate the extent of site disturbance.		Pre-construction / Construction	Superintendent / Foreman	EA
SW22	Erosion and sediment control structures will remain installed and maintained until sufficient vegetative cover is achieved.		Construction	Superintendent / Foreman	
SW23	Swale drains, where appropriate, instead of sediment basins will be used on floodplains where ASS may be encountered. Topsoil stripping is to be avoided in these areas to minimise soil disturbance. Stabilise exposed areas as soon as practical after earthworks is complete.		Construction	Superintendent / Foreman	Submissions Report
SW24	Site compounds, access tracks, stockpile sites and temporary work areas will be located to minimise erosion.		Pre-construction / Construction	Superintendent / Foreman	G38
SW25	Hardstand material, rumble grids or similar will be provided at exit points from construction areas onto public roads to minimise the tracking of soil and particulates onto public roads.		Pre-construction / Construction	Superintendent / Foreman	G38
SW26	Vehicle movements from site will be minimised during wet weather if the tracking of mud may become an issue.		Pre-construction / Construction	Superintendent / Foreman	Good practice
SW27	Loose rock, soil, debris etc will be removed from local road surfaces (including sweeping of the road) immediately or as soon as reasonably practical after being identified.		Pre-construction / Construction	Superintendent / Foreman	G38
DRAINAGE AND WATERWAY					
SW28	The EWMS for working platforms in or adjacent to waterways will detail how the works are to be undertaken to reduce erosion and minimise impacts on water quality and riparian fauna and flora. Considerations will include: • Ensuring that where possible earth and/or rock		Pre-construction / construction	Environment Manager / Superintendent	G36 / Good practice

ID	Measure / Requirement	Resources needed	When to implement	Responsibility	Reference
	platforms for driving piles are constructed to minimise impacts on the direct water channel. • Keeping vegetation clearing to a minimum. • Constructing rock platforms for driving piles / girder erection only where necessary. • Selecting the optimum rock size for platforms/ haul roads to account for all issues including safety and environment. • Using larger rock size and grades on the lower side of the works to assist in reducing failure risks. • Addressing stormwater overflow design and pipe capacity. • Enclosing platforms in geotextile fabric and appropriate erosion and sediment controls before clearance commences. The EWMS will be prepared in consultation with EPA and DPI (Fisheries Conservation and Aquaculture).				
SW29	Where temporary crossings are required, these will be designed, constructed and maintained in accordance with Managing Urban Stormwater Soils and Construction Volumes 2A and 2D Main Road Construction (DECC 2008) and section 5.3.4 of the guideline Managing Urban Stormwater 4th edition March 2004, Volume 1 Soils and Construction and subject to the preparation of an EWMS identified in SW2 and SW31. Temporary crossings will: • Be ‘fish friendly’ with a lower section of the temporary crossing provided to act as an emergency spillway. • Be used for the shortest time required to complete their designed operational function. • Clean, rigid, non-polluting aggregate rock (100-150mm approximately or larger) that will not result in fine sediment material entering the waterway. • Where rock crossings are used, the rock will be of		Construction	Environment Manager / Superintendent / Engineers	G36

ID	Measure / Requirement	Resources needed	When to implement	Responsibility	Reference
	suitable size to prevent / reduce the likelihood of the material being washed away in a storm or flood event, with large sized rock on the lower side of crossings where water velocity increases. • Be designed to minimise turbulence down stream of the crossing. • Be designed to extend past the crossing along the haul road to minimise mud tracking over the crossing.				
SW30	Scour protection will be installed at the base of permanent and temporary drainage outlets, and will be integrated where feasible into current banks to minimise impacts.		Construction	Engineers	G36, G38
SW31	Drainage works will be stabilised against erosion by appropriate selection of channel dimensions, slope and lining, and the inclusion, if necessary, of drop structures and energy dissipaters.		Construction	Engineers	
SW32	Culverts and permanent stream protection measures will be installed as early as possible in the construction program to facilitate transverse drainage during the early stages of construction.		Construction	Superintendent / Foreman	
GROUNDWATER					
SW33	Groundwater intercepted in cuttings will be directed down slope and returned to the groundwater system through absorption trenches where possible. Alternatively, the water will be directed to surface erosion and sediment control structures such as sediment basins. Where groundwater is directed to sediment basins, the Project Soil Conservationist is to reassess the capacity of the basin to ensure adequate capacity for stormwater run-off.		Construction	Superintendent / Foreman	Submissions Report
SW34	Implement mitigation measures contained in the Groundwater Management Strategy attached at Appendix E.		Pre-construction / Construction	Superintendent / Environment Manager	

ID	Measure / Requirement	Resources needed	When to implement	Responsibility	Reference
WATER QUALITY AND USE					
SW35	Temporary construction water quality basins will be designed in accordance with Soils and Construction, Volume 1, 2004, and Volumes 2C and 2D, 2008 manuals ('the Blue Book'). Basins will typically incorporate: • Inlet flow control structures (i.e. baffles, bypass weirs, forebays) to control the velocity water entering the basin and allow settling of some material at the inlet. This can extend the maintenance cycle of construction basins. • Internal baffles where the length-to-width ratio of the basin is less than 3:1. • An emergency outlet or spillway. • Outlet protection to reduce erosion downstream. • Compacted earth embankments or a rock filled wire basked wall with geofabric lining. Basins will also be subject to conditions required by the EPL.		Pre-construction / Construction	Engineers	EA
SW36	All required sediment basins and associated drainage will be installed and commissioned prior to the commencement of clearing and grubbing works in that catchment that could cause sediment to leave site. (Except where clearing is required for basin installation).		Construction	Superintendent / Foreman	Good practice EPL
SW37	Water captured in sediment basins and other areas will be reused for dust suppression, compaction, or other construction activities in preference to potable water. Reuse of water from sediment basins will be permitted following approval by environment staff.		Construction	Superintendent / Foreman	
SW38	All sediment basin discharge points will be clearly identified and access made available at all times for inspections or management.		Construction	Foreman	
SW39	Sediment basins will be retained for a minimum of six months or until a 70% vegetative cover is achieved in its		Construction / post construction	Environment Manager / Construction	

ID	Measure / Requirement	Resources needed	When to implement	Responsibility	Reference
	catchment, or other satisfactory controls are in place, or the basin is otherwise redundant.			Manager	
SW40	Sediment basins will be operated and maintained in accordance with the Sediment Basin Management and Discharge Procedure and Water Quality Monitoring Program contained in Appendix H and Appendix A, respectively. Basins will not be discharged until all monitoring and water quality criteria has been verified and documented.		Construction	Superintendent / Foreman	
SW41	Water will be used during construction for a number of purposes, including, but not limited to: • Concrete and asphalt batching. • Dust control. • Washing of plant and equipment. • Drinking water. • Amenities. • Landscaping and re-vegetation. Prior to and during construction, water needs will be identified and water sources assessed to determine the most appropriate water source(s). When determining the most appropriate water source(s), the use of non-potable water sources will be considered in preference to potable water where appropriate. The water sources likely to be considered for construction include: • Creeks. • Groundwater. • Farm dams. • Sediment basins. • Rainwater collection. • Potable water. • Effluent reuse where available and meeting suitable standards.		Construction	Environment Manager / Superintendent / Foreman	CoA B30 e) (ii) / CoA 18 / Good practice

ID	Measure / Requirement	Resources needed	When to implement	Responsibility	Reference
	Appropriate licences and/or permits will be sought for each water source as required.				
SW42	Permanent water quality basins at sensitive water crossings will incorporate sufficient design capacity to retain a minimum 40,000 litres of oil or chemical polluted run-off.		Operation	Engineers	EA
SW43	Managing operational water quality will occur by applying RTA's Code of Practice for Water Management – Road Development and Management (1999).		Operation	RMS	SoC W5
MATERIAL STORAGE AND MANAGEMENT					
SW44	Concrete pumping or concreting activities will be undertaken in accordance with Environmental Best Management Practice Guideline for Concreting Contractors 2002 to prevent and/or minimise spillages. Weather forecasts will be regularly reviewed to check for adverse (wet) weather conditions for pre start planning and paving activities to prevent washing off/runoff from bitumen spray seals curing compounds high pH water etc.		Construction	Superintendent / Foreman	G38
SW45	Designated impervious bunded facilities will be provided for washout of concrete trucks and cleaning and/or maintenance of other vehicles, plant or equipment. These facilities will be located at least 40 metres away from natural and built drainage lines.		Construction	Superintendent / Foreman	G38
SW46	An EWMS for managing tannin leachate will be prepared in accordance with the RMS Environmental Direction for the Management of Tannins from Vegetation Mulch attached at Appendix D. The requirements include detail on: • Planning and staging vegetation processing activities. • Stockpile location and management to minimise the production and release of tannins. • Monitoring the stockpiles for the production of		Construction	Environment Manager / Foreman	RMS Environmental Direction for the Management of Tannins from Vegetation Mulch

ID	Measure / Requirement	Resources needed	When to implement	Responsibility	Reference
	tannins. • Response to tannin production.				
SW47	All chemicals and fuels associated with construction will be stored in roofed and bunded areas. Spill kits will be provided at all chemical storage facilities/compound sites. All chemicals to be stored, handled and used in accordance with relevant NSW WorkCover codes of practice, eg. *Managing risks of hazardous chemicals in the workplace: Code of practice - July 2014*		Pre-construction / Construction	Superintendent / Foreman	EA
SW48	Vegetation and mulch erosion and sediment control filters will only be used where it can be demonstrated that tannin leachate will not be discharged from the site either overland or into groundwater.		Construction	Environment Manager / Foreman	
SW49	Where refuelling on site is required, the following management practices will be implemented: • Refuelling for construction plant will be undertaken on level ground and at least 20 metres from drainage lines, waterways and/or environmentally sensitive areas. • Refuelling for highly mobile vehicles will be undertaken within the designated refuelling areas with appropriate bunding and/or absorbent material. • Will not be undertaken on or in the vicinity vegetated areas (even roadside grasses). • Will be attended at all times. • Spill kits will be readily available and personnel trained in their use. A spill kit will be kept on the refuelling truck at all times. • Hand tools will be refuelled within lined trays of site vehicles wherever possible.		Construction	Foreman	Good practice
CONTAMINATION					
SW62	Set up a no-go zone for the itinerant saw mill on Cockburns Lane, avoid impact to this area through the design of the Project alignment. If impact to this area is		Design/Construction	Superintendent/ Design Manager /Environment	Good Practice

ID	Measure / Requirement	Resources needed	When to implement	Responsibility	Reference
	required, the TRH impacted soils will require stripping and stockpiling for testing to obtain a Waste Classification (See WEMP for Waste Classification Guidelines)			Manager	
SW63	Set up a no-go zone for the isolated contaminated areas at the Former Oyster/Boat Shed. Avoid impact to this area by designing the Project bridge and temporary works away from this area. If contamination is encountered during the geotechnical investigations, the material is to be removed and stockpiled for waste classification (see WEMP for Waste Classification Guidelines).		Construction	Superintendent/ Environment Manager	Good Practice
SW64	Set up a no-go zone around the former Newee Creek Landfill site and design the Project alignment to avoid this area.		Design	Design Manager/Environment Manager	Good Practice
SW65	The presence of arsenic in naturally mineralised areas will be managed in accordance with the Arsenic Rock Management Strategy included as Appendix J of this Plan.		Construction	Construction Manager/Environment Manager	SWTC Appendix 4
SW50	Unexpected Discovery of Contaminated Land Procedure contained in Appendix F will be followed if potentially contaminated land, spoil or fill is encountered. Works in the vicinity will be stopped or modified and will not recommence until the material has been analysed and management measures developed. The procedure incorporates relevant requirements of the Contaminated Land Management Guideline (RTA 2005e) and Contaminated Lands Management Act (year).		Construction	Foreman / Superintendent / Environment Manager	
REHABILITATION AND LANDSCAPING					
SW51	Disturbed areas will be progressively stabilised during the construction phase eg with a cover crop, hydromulch, hydroseeding, topsoil and/or mulch. Wherever possible, permanent landscaping and revegetation works will take place progressively in accordance with the Urban Design and Landscape		Construction	Superintendent / Foreman	G38

ID	Measure / Requirement	Resources needed	When to implement	Responsibility	Reference
	Plan.				
SW52	Topsoil and mulched vegetation will be stockpiled and reused within the general areas from which it is removed.		Construction	Superintendent / Foreman	EA
FLOOD PLAINS					
SW53	A number of management strategies shall be considered to deal with erosion and sediment control across floodplains. These strategies include: • Undertake works during the dryer periods of the year, especially to clear vegetation and install the bridging/drainage rock layer; • Minimise the time and extent of exposure, and limit access to only those areas absolutely necessary to ensure safe and efficient construction; • Preferably select erosion control measures to minimise the reliance on sediment controls across floodplain areas; • Any sediment control devices need to be able to tolerate inundation. As such, rock checks and rock filter berms will be used in preference to earth structures or other materials that might be damaged by inundation; • Wherever possible, vegetative (grass or similar) buffers will be maintained along the edge of the works corridor; • Infiltration of water will be promoted to help maintain the natural runoff/infiltration balance inherently found on floodplain areas; • Develop a flood action plan to stabilise key areas and remove materials that might get washed away; and • Restrict access during and after wet weather to minimise the risk of soil damage.		Construction	Environmental Manager / Superintendent / Foreman	Good practice
SW54	For fill areas on floodplains, the following will be		Construction	Superintendent /	Good practice

ID	Measure / Requirement	Resources needed	When to implement	Responsibility	Reference
	undertaken: • Use drainage blankets to promote trafficability along • access roads; • Divert upstream/ dirty runoff around bridging/ drainage • layers; • Minimise fine material within bridging/drainage rock layers; • Use geofabric where possible to filter colloidal material; and • Consider use of gypsum in setting up bridging/drainage layer controls.			Foreman / Environmental Manager / Design Manager	
MONITORING					
SW55	Rainfall forecasts will be monitored daily to plan for daily work activities and prevent creating/increasing environmental risks.		Construction	Superintendent / Foreman / Environmental Manager / Environment Officer	G38
SW56	Erosion and sediment controls will be inspected at least daily (with maintenance and/or modifications made as necessary). Inspections and/or maintenance during rainfall that causes runoff from the premises maybe increased where necessary.		Construction	Foreman	Good practice
SW57	A project soil conservation specialist will inspect the work areas, assess drainage and riparian conditions, prepare erosion and sediment control plans and provide advice to the project team to maintain a high standard of erosion and sediment practices on site. Inspections will be undertaken typically on a fortnightly basis, or as required where high-risk activities are proposed, or where sensitive areas have the potential to be affected eg SEPP 14 wetland, heritage sites.		Pre-construction / Construction	Soil Conservation Specialist Environment Manager	Good practice
SW58	All surface water quality monitoring will be undertaken in		Construction	Environment Officer	B31 d)

ID	Measure / Requirement	Resources needed	When to implement	Responsibility	Reference
	accordance with the Water Quality Monitoring Program attached at Appendix A.				
SW59	All groundwater monitoring will be undertaken in accordance with the Ground Water Monitoring Strategy attached at Appendix E.		Construction	Environment Officer	B31 d) (vi)
SW60	Monitoring of sediment basin water quality will be undertaken in accordance with EPL requirements. See Sediment Basin Management and Discharge Procedure in Appendix H.		Construction	Environment Officer	EA
RECORDS					
SW61	Records of dewatering activities will be maintained. Details will include: i. A copy of the work method statement(s). ii. Date, time and estimated volume released at each discharge location. iii. Water quality test results for each discharge. iv. The personnel approving the dewatering activities. v. Evidence of discharge monitoring, or risk assessment and mitigation measures used to eliminate the risks of pollution.		Construction	Environmental Manager	G36

7 Compliance management

7.1 Roles and responsibilities

The AFJV Project Team's organisational structure and overall roles and responsibilities are outlined in Section 4.2 of the CEMP. Specific responsibilities for the implementation of environmental controls are detailed in Section 6 of this Plan.

7.2 Training

All employees, contractors and utility staff working on site will undergo site induction training relating to soil and water management issues. The induction training will address elements related to soil and water management including:

- Existence and requirements of this sub-plan.
- Relevant legislation.
- Roles and responsibilities for soil and water management.
- The location of ASS or PASS.
- Water quality management and protection measures.
- Procedure to be implemented in the event of an unexpected discovery of contaminated land.

Targeted training in the form of toolbox talks or specific training will also be provided to personnel with a key role in soil and water management. Examples of training topics include:

- ERSED control installation methodology.
- Sediment basin construction.
- Sediment basin operation.
- Sediment basin maintenance.
- Working near or in drainage lines and creeks.
- Emergency response measures in high rainfall events.
- Preparedness for high rainfall events.
- Lessons learnt from incidents and other event eg high rainfall/flooding.
- Mulch and tannin management.
- Spill response.
- Stockpile location criteria.
- Identification of potentially contaminated spoil and fill material.

Further details regarding staff induction and training are outlined in Section 5 of the CEMP.

7.3 Monitoring and inspection

Regular monitoring and inspections will be undertaken in the lead up to, during and following construction. Monitoring and inspections will include, but not be limited to:

- Up and downstream of the project alignment water quality monitoring at nominated locations.

- Groundwater monitoring, both level and quality at nominated locations.
- Monitoring of groundwater dependent endangered ecological communities to evaluate health and vitality.
- Construction sediment basin water quality prior to discharge.
- Weekly and post rainfall inspections to evaluate the effectiveness of erosion and sediment controls measures in accordance with Section 8.1.1 of the CEMP.

The type, timing, frequency, assessment criteria and associated reporting requirements are detailed in the Water Quality Monitoring Program attached at Appendix A.

Additional requirements and responsibilities in relation to inspections are documented in Section 8.2 of the CEMP.

7.4 Licenses and permits

An EPL will be obtained for the scheduled activity “road construction”, “extractive activities” and “crushing, grinding or separating”. The EPL typically prescribes water quality parameters to be measured and associated discharge criteria from licensed discharge points. They also detail the monitoring and analytical requirements by reference to authority publications eg Approved Methods for Sampling and Analysis of Water Pollutants in NSW, 2004. The water quality discharge criteria for licensed discharge points on the Project are listed in Table 7-1.

Table 7-1 Discharge water quality criteria

Parameter	Criteria	Sampling method	Analytical method
pH*	6.5 –8.5	Probe or Grab Sample	Field analysis and confirmed as required with laboratory assessment
Turbidity	TBA following correlation with TSS results	Grab Sample	Field analysis and confirmed as required with laboratory assessment, regularly updating correlations and having a factor of conservatism.
Total Suspended Solids*	50 mg/L	Grab Sample	Laboratory analysis
Oil and Grease*	No visible	Grab Sample	Field analysis and confirmed as required with laboratory assessment

Note: that as optional condition of the EPL, a correlation will be established between turbidity and suspended solids, which, will allow turbidity to replace suspended solids as the water quality criteria. This will allow all required water quality results (pH, turbidity and visible oil and grease) to be measured on site, thus decreasing waiting times for results from laboratories and assisting in basin management

Any other relevant licenses or permits will be obtained in the lead up to and during construction as required.

7.5 Weather monitoring

Rainfall at the premises will be measured and recorded in millimetres per 24-hour period at the same time each day from the time that the site office associated with the activities is established. Automatic rainfall intensity/ weather devices will be installed in at one location on the project, likely to be at the major compound.

Weather stations will be specifically located, operated and maintained in accordance with the Roads and Maritime Specification R272 – Automatic Weather Stations. The Roads and Maritime specification covers details such as:

- Equipment requirements;
- Installation including siting;
- Commissioning;

- Data supply;
- Performance requirements;
- Operation and maintenance; and
- Decommissioning

7.6 Auditing

Audits (both internal and external) will be undertaken to assess the effectiveness of environmental controls, compliance with this sub plan, CoA and other relevant approvals, licenses and guidelines.

Audit requirements are detailed in Section 8.4 of the CEMP.

7.7 Reporting

Reporting requirements and responsibilities are documented in the Water Quality Monitoring Program, and Chapter 7 and Section 8.4 of the CEMP.

8 Review and improvement

8.1 Continuous improvement

Continuous improvement of this Plan will be achieved by the ongoing evaluation of environmental management performance against environmental policies, objectives and targets for the purpose of identifying opportunities for improvement.

The continuous improvement process will be designed to:

- Identify areas of opportunity for improvement of environmental management and performance.
- Determine the cause or causes of non-conformances and deficiencies.
- Develop and implement a plan of corrective and preventative action to address any non-conformances and deficiencies.
- Verify the effectiveness of the corrective and preventative actions.
- Document any changes in procedures resulting from process improvement.
- Make comparisons with objectives and targets.

8.2 SWMP update and amendment

The processes described in Section 8 and Section 9 of the CEMP may result in the need to update or revise this Plan. This will occur as needed.

Any revisions to this Plan will be in accordance with the process outlined in Section 1.6 of the CEMP and as required, be provided to relevant stakeholders for review and comment and forwarded to the Director General of DP&I for approval.

A copy of the updated plan and changes will be distributed to all relevant stakeholders in accordance with the approved document control procedure – refer to Section 10.2 of the CEMP.

Surface Water Monitoring Program

Warrell Creek to Nambucca Heads Pacific Highway Upgrade

quality solutions sustainable future

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Surface Water Monitoring Program

Warrell Creek to Nambucca Heads Pacific Highway Upgrade

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Introduction

This document presents the Surface Water Monitoring Program for the southern section of the Warrell Creek to Urunga (WC2U) Pacific Highway Upgrade. The southern section of the highway upgrade covers a distance of approximately 19.5 kilometres from Warrell Creek to Nambucca Heads (termed 'WC2NH' in this report), which runs from design chainage 0 to 19,500 m.

The purpose of this document is to detail a monitoring program for surface water quality for pre-construction, construction and post-construction stages of the WC2NH section of the Pacific Highway Upgrade. This document forms part of an overall Water Quality Monitoring Program for the Warrell Creek to Urunga Pacific Highway Upgrade which includes the following accompanying documents:

- Groundwater Monitoring Program – Warrell Creek to Nambucca Heads Pacific Highway Upgrade;
- Groundwater Monitoring Program - Nambucca Heads to Urunga Pacific Highway Upgrade; and
- Surface Water Quality Monitoring Program – Nambucca Heads to Warrell Creek Pacific Highway Upgrade.

1.1 Project overview

The Warrell Creek to Urunga Pacific Highway Upgrade involves an upgrade of the existing highway to four lane divided highway from the existing Allgomera deviation, south of Warrell Creek, to Waterfall Way at Raleigh north of Urunga. The proposed upgrade extends over approximately 42 kilometres.

The Warrell Creek to Urunga (WC2U) project was identified as a critical infrastructure project by the NSW Government, designed to improve safety, traffic efficiency and increase capacity along the Pacific Highway. It forms part of the overall program for upgrading the Pacific Highway. Planning commenced on the WC2U project in 2003 and project approval was granted on 19 July 2011, under Part 3A of the *Environmental Planning and Assessment Act 1979*.

The 22 kilometre section of the highway upgrade from Nambucca Heads to Urunga has been agreed between the Australian and NSW Governments with major construction likely to commence in 2013. Therefore the Water Quality Monitoring Program for the Warrell Creek to Urunga Pacific Highway Upgrade has been divided into the two highway upgrade sections: Warrell Creek to Nambucca Heads (WC2NH) and Nambucca Heads to Urunga (NH2U).

As part of the Proposal's approval, preparation and implementation of a Water Quality Monitoring Program is required to address the Minister for Planning and Infrastructure's Condition of Approval (CoA) B17, and Sections 2.15.4, and Commitments W3, W6, W7 of the "Warrell Creek to Urunga Submissions and preferred project report" (hereafter referred to as the 'Submissions Report'). Requirements outlined in each of the Conditions and relevant section of the Submissions Report is provided in Section 1.2.

1.2 Regulatory Context

1.2.1 Environmental Assessment

The Minister for Planning declared on 5 December 2006 that the Warrell Creek to Urunga upgrade is a project to which Part 3A of the *Environmental Planning and Assessment Act 1979* applies. In accordance with the requirements of the *Environmental Planning and Assessment Act 1979*, an environmental assessment (EA) was prepared (SKM, 2010) to assess the potential impacts of the Proposal.

The environmental assessment for the WC2U project outlined a Draft Statement of Commitments that identified a range of environmental outcomes and management measures required to avoid, minimise, manage, mitigate or offset and/or monitor impacts identified in the environmental assessment. After consideration of the issues raised in the public submissions, the draft statement of commitments for the WC2U project were revised as detailed below.

1.2.2 Statements of Commitments

The revised Statement of Commitments relevant to this Surface Water Quality Monitoring Program are reproduced in **Table 1.1** overleaf.

1.2.3 Conditions of Approval

The project approval documents for the WC2U project (RTA, 2011) include conditions of approval from the NSW Minister for Planning. The condition of approval relevant to this Surface Water Quality Monitoring Program is detailed below.

Condition of Approval B17- Water Quality
The Proponent shall prepare and implement a **Water Quality Monitoring Program** to monitor the impacts of the project on SEPP 14 wetlands, surface water quality and groundwater resources during construction and operation. The Program shall be developed in consultation with OEH [now EPA] and DPI and shall include but not necessarily be limited to:

a) identification of surface water and groundwater quality monitoring locations which are representative of the potential extent of impacts from the project;
b) 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 and risks to oyster farming in the Nambucca, Bellinger, and Kalang rivers;
c) representative background monitoring of surface water and groundwater quality parameters for a minimum of six (6) months (considering seasonality) prior to the commencement of construction to establish baseline water conditions;
d) development and presentation of indicators or standards against which any changes to surface water quality will be assessed, having regard to the Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000 (ANZECC, 2000);
e) contingency and ameliorative measures in the event that adverse impacts to surface water quality are identified;
f) a minimum monitoring period of three years following the completion of construction or until any disturbed waterways/ 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); and
g) reporting of the monitoring results to the Department, OEH and DPI.

The Program shall 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 shall be submitted to OEH [now EPA] and DPI prior to its implementation.

Table 1.1 Statements of Commitments

Outcome	*Ref No.*	*Key Action*	*Timing*	*Reference document*
Water quality and hydrology				
	W3	Monitoring of groundwater impacts and surface water quality upstream and downstream of the site during construction will determine the effectiveness of mitigation strategies Implementation of additional feasible and reasonable management measures will occur if necessary.	Pre-construction and construction	Draft *DECC "Managing Urban Stormwater: Soils and Construction, Volume 2, Book 4, Main Road Construction (2006)".* Volume 2A Installation of Services (DECCW 2008). Volume 2C Unsealed Roads (DECCW 2008). Volume 2D Main Roads Construction (DECCW 2008). Managing Urban *Stormwater: soils and construction* (Landcom 2004). The RTA's *Code of Practice for Water Management – Road Development and Management.* RTA *QA Specification G38 Soil and Water Management.*
Minimise groundwater related impacts	W6	Investigation of the potential for changes in the groundwater table will take place before starting any major earthworks. Where a potential for change is identified, the significance of the change and any resultant impacts will be determined and measures to manage the changes will be designed and implemented as necessary.	Pre-construction and construction	Section 16.4 and table 16-4 of the EA. *RTA's Code of Practice for Water Management – Road Development and Management (1999).* RTA *QA Specification G38 Soil and Water Management.* *Water Act 1912*
	W7	Base line monitoring of groundwater levels and chemical levels at cutting sites near springs, creeks or endangered ecological communities prior to construction commenting.	Pre-construction and construction	Section 16.4.1.3 and table 16-4 of the EA. *RTA's Code of Practice for Water Management – Road Development and Management (1999).* RTA *QA Specification G38 Soil and Water Management.* *Water Act 1912*

2

Surface Water Environment and Risks

This section provides background information regarding the surface water environment and the general risks to surface waters posed by the highway upgrade. The information in this section is largely based on the environmental assessment by SKM (2010) for the highway upgrade. The purpose of this section is to provide the context to the surface water management monitoring program which is detailed in **Section 4** of this report.

2.1 Catchment Overview

The study area encompasses portions of the following catchments:

- the Nambucca River catchment; and
- the Warrell Creek catchment (which includes Warrell Creek).

Warrell Creek flows into Nambucca River approximately 900 m upstream of the ocean entrance. These two catchments comprise a total catchment area of approximately 1,300 km^2, (1000km^2 for the Nambucca River and 300km^2 for Warrell Creek). The Nambucca Heads township is located at the entrance of the Nambucca River (SKM, 2010c:8).

2.2 Waterways

The WC2NH highway upgrade crosses a number of freshwater and estuarine systems along its length. There are also a number of wetlands including SEPP 14 wetlands located to the east of the highway upgrade. The main waterways and wetlands relevant to the study area are summarised in **Table 2.1**. The waterways/ wetlands are shown in **Illustrations 2.1** to **2.2**.

Table 2.1 Watercourses and Wetlands in the Study Area of the WC2NH Highway Upgrade

Chainage	*Waterway Name*	*Freshwater / Estuarine*	*Fisheries Classification*[1]
730	Upper Warrell Creek	Freshwater	Class 1 - major fish habitat
1,640	Butchers Creek	Freshwater	Class 2 - moderate fish habitat
2,700	Rosewood Creek	Freshwater	Class 2 - moderate fish habitat
3,800	Stony Creek	Freshwater	Class 2 - moderate fish habitat
5,300	Williamsons Creek	Freshwater	Class 2 - moderate fish habitat
6,400	Lower Warrell Creek	Estuarine	Class 1 - major fish habitat
9,300	SEPP 14 Wetland No 388	Estuarine	n/a
10,350	Nambucca River	Estuarine	Class 1 - major fish habitat
11,200	SEPP 14 Wetland No 383	Estuarine	n/a

Source: SKM (2010c)
Notes: 1. classification with respect to the *Policy and Guidelines for Bridges, Roads, Causeways and Similar Structures* (NSW Fisheries, 1999).

Butchers Creek, Rosewood Creek, Stony Creek and Williamsons Creek are highly degraded creeks with excessive vegetation growth and poor water quality during both dry and wet weather. Warrell Creek and the Nambucca River have better water quality, however quality deteriorates during warmer weather (SKM, 2010c:51).

2.2.1 Surface Water and Groundwater Interactions

There are two main types of groundwater regimes likely to be found along the area of the highway upgrade based on geological types and groundwater levels observed in standpipe piezometers. These include foothills and alluvial floodplains. The main interactions between surface water and groundwater are:

- in close vicinity to waterways where base flows are provided largely by relatively shallow local and intermediate groundwater flow systems;
- in wetlands; and
- on alluvial floodplains.

Elsewhere in the study area groundwater levels were generally at a significant depth (greater than 10 m depth) which would limit interaction between surface waters and groundwater.

2.2.1.1 Groundwater in Foothills

The phyllite in the hilly areas exhibits low permeability with the main groundwater transport route being defects in the rock, particularly along veins and foliation partings. Groundwater level measurements in these areas indicated that groundwater levels were generally greater than 10 m depth (SKM, 2010a:370).

2.2.1.2 Groundwater in Alluvial Floodplains

The groundwater found in the alluvial floodplains was high (less than five meters in depth) and typically reflected their proximity to the major water courses. Groundwater levels across the floodplains are likely to fluctuate due to tidal influences by up to 0.5 m (SKM, 2010a:370).

2.2.1.3 Groundwater Dependent Ecosystems

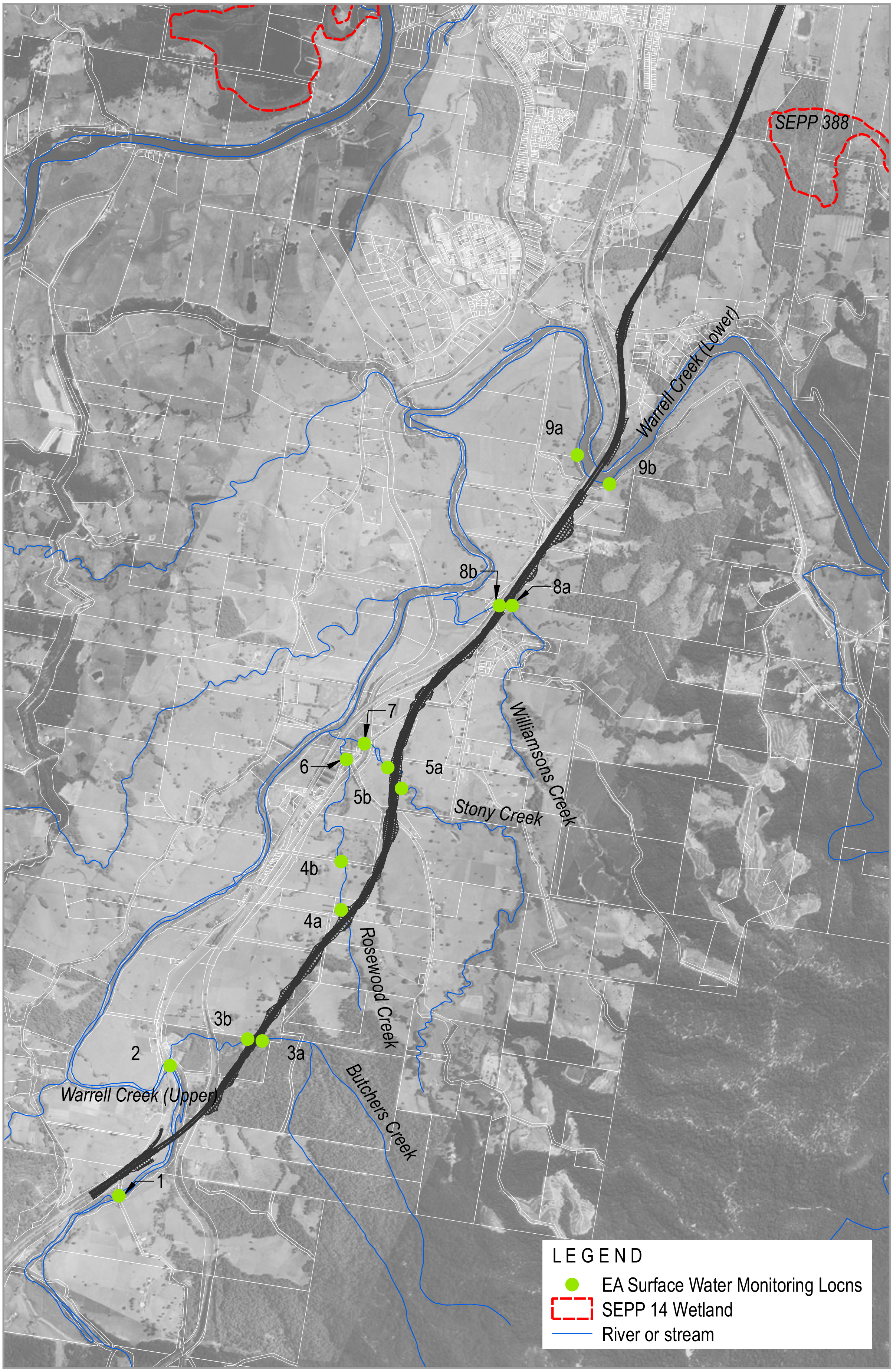
Groundwater dependent ecosystems (GDEs) in the area of the highway upgrade include terrestrial vegetation, base flows in streams, aquifers, or wetlands. Those vegetation communities and habitats with the greatest potential to be affected by changing groundwater levels consist of terrestrial vegetation and wetlands located in the low-lying floodplain areas intersected by the proposed highway upgrade, including:

- Swamp oak floodplain forest;
- Swamp sclerophyll forest;
- Subtropical coastal floodplain forest;
- Lowland rainforest; and
- Freshwater wetlands.

Other vegetation communities within riparian areas may have some level of ground-water dependence, including wet sclerophyll forests in proximity to creek flats (SKM, 2010a:190-191).

Information shown is for illustrative purposes only

Drawn by: PPT Checked by: RE Reviewed by: TIM Date: October 2013
Source of base data: NSW RMS



Waterways and EA Sampling Locations - Ch 0 to 9600

GeoLINK environmental management and design

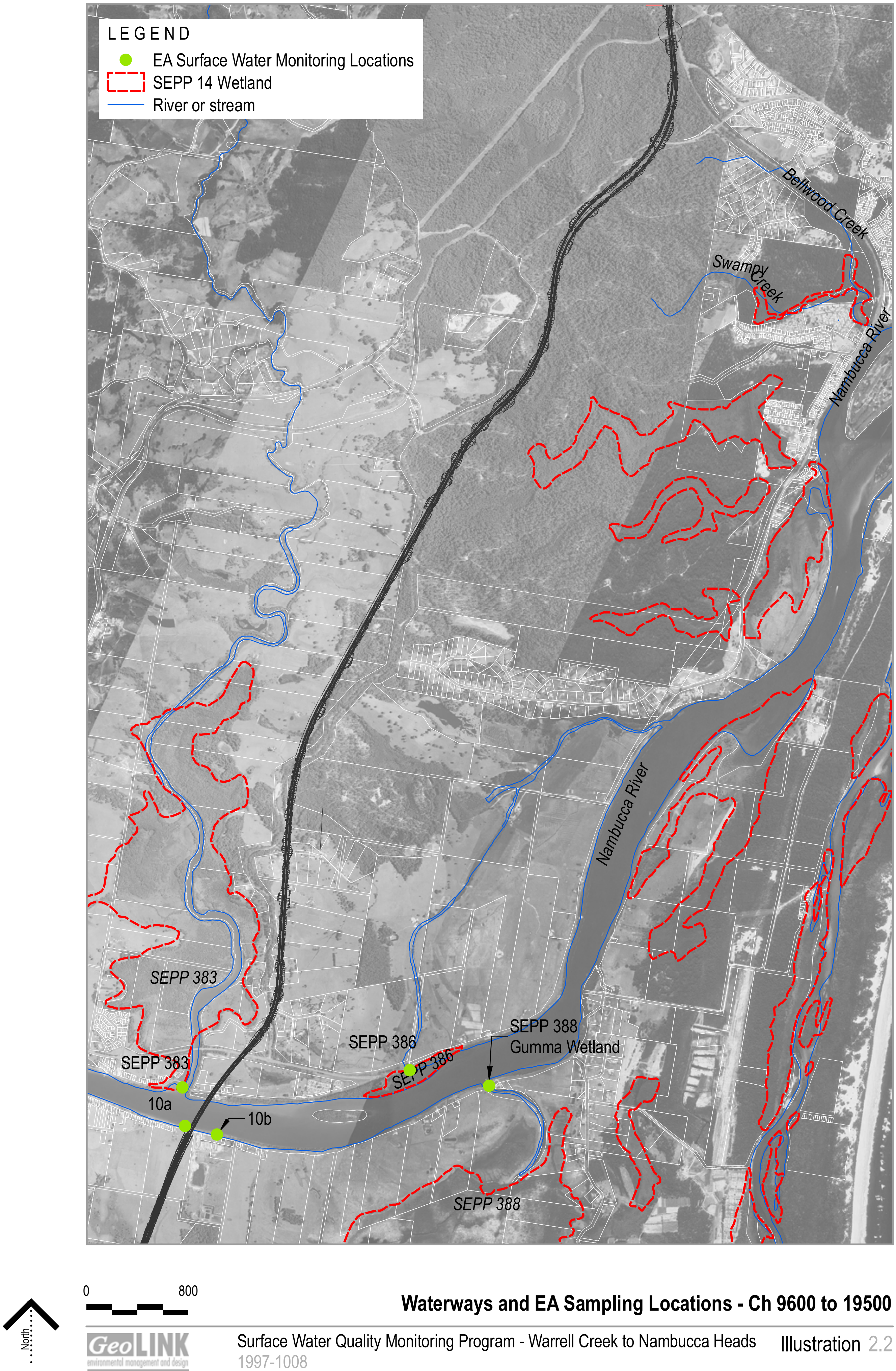
Surface Water Quality Monitoring Program - Nambucca Heads to Urunga

1997-1007

Illustration 2.1

Information shown is for illustrative purposes only

Drawn by: PPT Checked by: RE Reviewed by: TIM Date: October 2013
Source of base data: NSW RMS



Waterways and EA Sampling Locations - Ch 9600 to 19500

GeoLINK environmental management and design

Surface Water Quality Monitoring Program - Warrell Creek to Nambucca Heads
1997-1008

Illustration 2.2

2.3 Risks to Surface Water

2.3.1 Construction Stage

The main risks to surface water (and consequent risks to oyster farming in the Nambucca River) as a result of the construction of the proposal are as follows:

- exposure of soils during earthworks, which creates the potential for off-site transport of eroded sediments and pollutants;
- disturbance of acid sulfate soils, which creates the potential for oxidation of these soils and subsequent generation of acidic run-off. The waterways with the highest probability of acid sulfate soils are Warrell Creek, Nambucca River, all SEPP wetlands (No. 383, 386 and 388) and other low-lying areas, creeks and wetlands;
- alteration of surface and subsurface flows which could cause disturbances to hydrology and hydraulics;
- off-site discharges of sediment-laden water; and
- accidental spills or leaks of oil, grease or fuel from work machinery and vehicles or from construction sites or compounds, and accidental spills of other chemicals that may be used during the course of construction (SKM, 2010a:374).

The main risks to creeks and rivers crossed by the highway upgrade are associated with an increase in sedimentation and the corresponding reduction in dissolved oxygen. The risk of water quality impacts within the creeks is exacerbated by existing poor water quality and the shallow degraded creek banks (SKM, 2010a:374).

The waterways with the potential to be affected due to a high probability of acid sulfate soils include Warrell Creek, Nambucca River and SEPP 14 wetlands No. 383. Exposure of these soils would result in a decrease in pH levels (SKM, 2010a:374).

2.3.2 Operational Stage

The main risk to water quality (and consequent risks to oyster farming) is road runoff from the impervious surfaces and the associated pollutants including suspended sediment; heavy metals attached to particles washed off the paved surface; oil and grease and other hydrocarbon products; nutrients; and anthropogenic litter.

Additional potential risks to water quality that may result from operation of the highway upgrade include:

- accidental spills of fuels or chemicals; and
- impacts associated with the maintenance of the roadway, which may include herbicide use, mowing, road surface cleaning and repair (SKM, 2010a:376-377).

The above risks have the potential to impact on the waterways in a variety of ways such as increase turbidity of the water column, decrease dissolved oxygen levels, increase silting of the waterways, stimulate the growth of algae and some aquatic plants through increased nutrients, toxicity to aquatic biota and fish and other adverse impacts on aquatic and terrestrial ecosystems associated with the waterways.

2.4 Management of Risks to Surface Water

2.4.1 Construction Stage

The key mitigation measures for the construction stage will be construction of sediment basins and additional erosion and sediment controls to intercept run-off and retain the associated sediments and pollutants. These measures will be formulated at the detailed design stage as part of a comprehensive soil and water management plan required to be prepared in accordance conditions B30, B31(d) and C17 of the conditions of approval. The construction water quality management plan is required to be prepared in consultation with the EPA, DPI (Fisheries and NOW) and be approved by the Director General of Department of Planning and Infrastructure prior to construction commencing. The plan will include water quality monitoring at the outlet of the sediment basins (SKM, 2010a:394). Following completion of the construction, a number of the sediment basins would be converted to permanent sediment basins depending on their suitability for operation (SKM, 2010a:389).

Management of acid sulfate soils (ASS) will include:

- avoidance or minimising the disturbance of ASS by minimising excavation or lowering the water table in ASS areas;
- monitoring of water quality downstream of ASS risk areas to allow early identification of ASS leachate to ensure that mitigation measures are implemented in a timely manner; and
- treatment of acid generation where ASS is disturbed (SKM, 2010c:68).

An acid sulfate soils management procedure has been developed as part of the construction soil and water management plan and implemented prior to the commencement of construction works. The sub-plan will include a contingency plan to deal with the unexpected discovery of actual or potential acid sulfate soils as required by condition B31(d) and measures to manage acid sulfate soil impacts (SKM, 2010a:440).

2.4.2 Operational Stage

The water quality measures that will be incorporated into the drainage design of the highway upgrade include permanent water quality basins, vegetated swales and permanent spill containment basins.

Permanent water quality basins would be used to trap the finer sediments and associated contaminants before stormwater is discharged into the receiving waterways. The basins would treat road pavement and batter runoff collected by the pavement drainage network (SKM, 2010a:396).

Permanent spill containment basins will be used and designed for the retention of a minimum 20,000 litres of oil or chemical polluted run-off for the more sensitive water crossings (SKM, 2010a:395). Permanent operational basins providing spill protection are proposed for the following locations (SKM, 2010c:66) (it is noted that these locations may change during the detailed design phase):

- upper Warrell Creek – north and south (Ch 750);
- Butchers Creek – north and south (Ch 1,560);
- Rosewood Creek – north and south (Ch 2,710);
- Stony Creek – north and south (Ch 3,820);
- Williamsons Creek – north and south (Ch 5,290);
- lower Warrell Creek – north and south (Ch 6,430); and
- Nambucca River – north and south (Ch 10,480).

A practical water quality monitoring program that includes mitigation and management measures to manage potential impacts on downstream water quality will also be implemented, until revegetation becomes established. These mitigation and management measures, along with the proposed water quality design features are considered appropriate to manage the potential water quality risks. With the implementation of the proposed impact mitigation and management measures there would be little, if any, residual impacts on water quality. The occurrence of any residual impacts of the highway upgrade would be identified through the water quality monitoring program, with action taken to address any residual impacts as required (SKM, 2010a:396).

2.5 Previous Monitoring of Surface Water

Monitoring of existing surface water quality has been undertaken at thirty-one monitoring locations for the entire WC2U upgrade as part of the environmental assessment process. The results of this monitoring are summarised below to provide some context to the current condition of the watercourses in the study area.

2.5.1 Previous Sampling Locations and Dates

For most waterways, previous monitoring was generally undertaken immediately upstream or downstream of the proposed alignment crossing. SEPP14 wetland water quality was also monitored including No's 383, 386 and 388, however results are available for only No. 388 as the other wetlands were dry on each sampling occasion (SKM, 2010c:20). Sites upstream of the crossing are labelled 'a' while sites downstream are labelled 'b'. The monitoring locations are shown in **Illustrations 2.1** to **2.2**.

The monitoring dates for each environmental assessment (EA) sampling site are shown in **Table 2.2**. Two dry weather sampling events were conducted between 24 and 25 September 2007, and 22 and 24 October 2007 for the WC2NH sites. Dry weather is classified as less than 20 mm of rainfall in the study area 48 hours prior to sampling. Wet weather sampling was undertaken on 30 October and 8-9 November 2007. Wet weather is classified as >20 mm of rainfall within the study area 48 hours prior to sampling. An average of approximately 26.6 mm, 23.3 mm and 12.7 mm of rain fell in the Nambucca River catchment in the 48 hrs prior to 30 October 2007. Most of the rain fell on 29 October 2007. An average of approximately 38.9 mm, 29.9 mm and 50.3 mm of rain fell in the Nambucca River catchment respectively in the 48 hrs prior to 9 November 2007. Most of the rain fell on 8 November 2007 (SKM, 2010c:20).

Table 2.2 Sampling Dates for Previous EA Water Quality Sampling

Site [1]	*24-25 Sep 2007 (Dry)*	*22-24 Oct 2007 (Dry)*	*30 Oct 2007 (Wet)*	*8-9 Nov 2007 (Wet)*	*14-16 July 2008 (Dry)*
1 - Warrell Creek (upper)	✓	✓	✓	✓	
2 - Convergence of Warrell Creek and Butchers Creek	✓	✓	✓	✓	
3a - Butchers Creek					✓
3b - Butchers Creek					✓
4a - Rosewood Creek					✓
4b - Rosewood Creek					✓
5a - Stony Creek					✓
5b - Stony Creek					✓
6 - Rosewood Creek	✓	✓	✓	✓	
7 - Stony Creek	✓	✓	✓	✓	
8a - Williamsons Creek	✓	✓		✓	
8b - Williamsons Creek	✓	✓		✓	
9a - Warrell Creek	✓	✓	✓	✓	
9b - Warrell Creek	✓	✓	✓	✓	
10a - Nambucca River	✓	✓	✓	✓	
10b - Nambucca River	✓	✓	✓	✓	
SEPP 388 - Gumma wetland		✓	✓	✓	

Source: Table 3-1 in SKM, 2010c:20

Notes: 1. Numbering system used in Water Quality Working Paper (SKM 2010c). Sites labelled 'a' were located upstream of the proposed crossing, whereas sites labelled 'b' were located downstream of the proposed crossing.

2.5.2 Previous Sampling Parameters

Parameters measured included:

- turbidity (NTU);
- conductivity (mS.cm^{-1});
- salinity (ppt);
- temperature (°C);
- pH; and
- dissolved oxygen (per cent saturation and mg.L-1).

Measurements were generally collected between 15 and 30cm below the surface depending on the depth of water with the sampling depth recorded in the field. For each parameter, three replicate measurements were recorded approximately 10m apart from the access point to the site. Each parameter was then reported as the average (arithmetic mean) of the three measurements. The individual replicates are also reported to provide an understanding of the variation between individual readings (SKM, 2010c:22).

2.5.3 Monitoring Results from Previous Sampling

The water quality results from the background monitoring are shown in Table 2.3. The results are compared with default trigger values for chemical and physical stressors for the protection of aquatic ecosystems for south-east Australia for slightly disturbed estuarine and lowland river ecosystems (ANZECC/ARMCANZ2000). There are no default trigger values recommended for wetlands in south-eastern Australia. Highlighted results in Table 2.3 indicate exceedances of these default trigger values. The results for each waterway are summarised below.

2.5.3.1 Upper Warrell Creek, Butchers Creek, Stony Creek and Rosewood Creek

Sites 1 (Upper Warrell Creek), 2 (Warrell/Butchers Creek), 6 (Rosewood Creek) and 7 (Stony Creek) currently receive run-off from the existing Pacific Highway or minor roads. The water quality at these sites did not meet the ANZECC/ARMCANZ (2000) guidelines for dissolved oxygen during both dry and wet weather. Sites in Butchers Creek (3a & b), Stony Creek (5a & b) and Rosewood Creek (4a & b) also had low dissolved oxygen concentrations upstream and downstream of the proposed highway and failed to meet the lower guideline limit (SKM, 2010c:31).

All sites are heavily impacted by macrophyte growth such as water lilies and ribbon weed. On the first sampling occasion the pH at sites 1, 2, 6 and 7 also failed to meet the lower limit of 6.5, although mean levels increased on subsequent sampling occasions. During dry weather sampling undertaken in July 2008, pH at all sites failed to comply with the lower guideline limit. In particular, Butchers Creek (3a & b) had a very low, acidic pH. The water at this site was also unusually clear which may be an indication that acid sulfate soils are present in the area and impacting on the water quality of Butchers Creek. (SKM, 2010c:32).

All sites sampled are non-tidal and therefore had conductivities consistent with lowland river systems. Whilst increased flow following wet weather generally appeared to improve the water quality by re-oxygenating the waterway, this is probably due to the antecedent drought conditions and subsequently reduced flow in the creeks. Despite this minor improvement in water quality following wet weather, it is anticipated that these sites could be further impacted during the construction and operation of the highway upgrade without appropriate mitigation measures particularly as the sites generally have degraded banks with little vegetation to act as a buffer (SKM, 2010c:33).

2.5.3.2 Williamsons Creek

The pH of Williamson Creek (sites 8a and 8b) generally met the ANZECC/ARMCANZ (2000) guideline apart from site 8b which had slightly lower pH levels. Dissolved Oxygen did not comply with the guidelines and was as low as 8 per cent upstream and 15 per cent downstream of the existing crossing on the second (dry) sampling occasion due to very little flow and stagnant water conditions (SKM, 2010c:36).

The turbidity of Williamson Creek varied between sampling occasions. Turbidity levels varied between very low and exceeding the upper limit on dry sampling occasions. Following wet weather, turbidity decreased slightly to comply with the guidelines, possibly due to increased flow through the creek. Conductivity of Williamson Creek remained within the limits for lowland river ecosystems (0.125 – 2.0 mS/cm), but decreased slightly following wet weather due to increased runoff entering the creek (SKM, 2010c:36).

Williamson Creek is already impacted by the existing highway and farming land uses, which may be responsible for the poor water quality with respect to low dissolved oxygen and high turbidity. However there is potential for this site to be further impacted with the construction and operation of the highway upgrade, particularly with further increases in turbidity and decreases in dissolved oxygen resulting from increased sedimentation from disturbed soils and subsequent rainfall wash (SKM, 2010c:37).

2.5.3.3 Warrell Creek

Warrell Creek is already impacted by the existing highway which crosses the creek. The highway upgrade would result in a new crossing of Warrell Creek alongside the existing bridge. The section of Warrell Creek discussed in this sub-section is tidally influenced and has consequently been classified as estuarine. The water quality was similar between the upstream and downstream sites, possibly due to the influence of tides (SKM, 2010c:38).

Mean pH levels fluctuated on differing dry sampling dates falling marginally below and complying with the ANZECC/ARMCANZ (2000) guidelines. Following wet weather, pH levels decreased slightly but remained within the 7 – 8.5 guideline range. A potential impact of the construction of the Proposal could be a decrease in pH levels if the 'high risk' ASS, which are present in the area, were to become exposed (SKM, 2010c:38).

Warrell Creek is tidal at the sampling locations and conductivities are indicative of high/ incoming tides on three of the sampling occasions (22-24 October, 30 October and 8-9 November 2007). The higher conductivity coincided with higher pH levels which are expected in estuarine systems. Mean dissolved oxygen concentrations in Warrell Creek failed to meet the lower guideline limit of 80 per cent saturation for the protection of aquatic ecosystems on all sampling occasions (SKM, 2010c:39).

Turbidity levels on 3 of the 4 sampling occasions (one dry and two wet) were elevated both upstream and downstream of the proposed crossing of Warrell Creek subsequently exceeding the ANZECC/ARMCANZ guideline of 10NTU for estuarine ecosystems (SKM, 2010c:39).

Warrell Creek at the sampling location has highly degraded banks due to cattle access and egress with the opposite (northern) bank containing a limited amount of casuarina riparian vegetation, both of which provide little buffer to poor water quality. Due to the tidal nature of the creek, water quality of the creek may also be impacted further upstream and downstream of the crossing than non-tidal creeks (SKM, 2010c:39).

2.5.3.4 Nambucca River

The Proposal crosses the Nambucca River at Macksville, approximately 200 m downstream of its confluence with Newee Creek and approximately 1.3 km downstream of the existing Pacific Highway crossing of the Nambucca River. Water quality at sites 10a and 10b comply with the recommended ANZECC/ ARMCANZ (2000) guidelines for protection of aquatic ecosystems for pH and dissolved oxygen during dry weather. (SKM, 2010c:40).

Turbidity at both sites complied with the ANZECC/ARMCANZ (2000) guideline of less than 10 NTU for estuarine systems on only one sampling occasion. Turbidity following wet weather slightly exceeded the guidelines with mean turbidity of ~14-15 NTU at both sites (SKM, 2010c:40).

Whilst the Nambucca River generally has good water quality under dry weather conditions, it worsens slightly following wet weather, possibly due to an increase in runoff and sediment entering the waterway from River Street which runs adjacent to the Nambucca River. Water quality would be directly impacted due to the proximity to the road, although some vegetation is present which may provide a buffer by reducing sediment transport to the river (SKM, 2010c:40).

2.5.3.5 SEPP 14 No.388

The water quality of SEPP 14 Wetland No 388 was sampled during dry and wet weather. During dry weather pH levels were recorded at approximately 7.78, dissolved oxygen at 77 per cent saturation and turbidity was around 17 NTU. Following wet weather, pH levels and dissolved oxygen decreased to as low as 7.6 and 50 per cent saturation and turbidity increased to 20.7 NTU. This is possibly a result of increased sediment in runoff from the adjacent Gumma Road (SKM, 2010c:41).

2.5.3.6 SEPP 14 No.383 and 386

The highway upgrade runs adjacent to SEPP14 wetland No 383. SEPP No 383 is located approximately 20 m to the west of the highway upgrade and on the right bank of Newee Creek. SEPP No. 386 is located alongside the Nambucca River approximately 800 m to the east of the highway upgrade (SKM, 2010c:41).

Both wetlands did not have enough water present to ascertain water quality conditions at the time of sampling. SEPP No. 386 would currently be impacted by runoff from the existing highway. SEPP No. 383 has the potential to be impacted by local roads in close proximity to the wetland and the water quality of Newee Creek which flows through the wetland. Both wetlands are surrounded by disturbed and high risk ASS which would need to be managed appropriately during construction so that there is minimal impact on the wetlands (SKM, 2010c:41).

Table 2.3 Mean Water Quality Results for Previous EA Sampling

Date	*Water Quality Parameter*	*1*	*2*	*3a*	*3b*	*4a*	*4b*	*5a*	*5b*	*6*	*7*	*8a*	*8b*	*ANZECC/ARMCANZ (2000) default trigger values for protection of aquatic ecosystems* *(11b – 14b)*	*9a*	*9b*	*10a*	*10b*	*SEPP 351*	*ANZECC/ARMCANZ (2000) default trigger values for protection of aquatic ecosystems* *(15a-16)*
24-25 September 2007 DRY	pH	5.75	5.84	No Data- Not sampled	No Data - Not sampled	No Data - Not sampled	No Data - Not sampled	No Data - Not sampled	No Data - Not sampled	6.26	6.45	6.66	6.19	6.5-8 (lowland river) 7.0-8.5 (estuarine)	6.95	6.94	8.13	7.43	No Data - Not sampled	7.0-8.5
	Conductivity (mS/cm)	330.7	367.3							503.5	441.5	0.28	0.28	0.125-2.2*	1.5	1.99	34.8	35.7		N/A
	Turbidity (NTU)	2.20	20.30							5	3.60	6.2	4.7	<50 (lowland river) <10 (estuarine)	3.4	2.83	1.9	1.7		<10
	Dissolved Oxygen (% saturation)	5701 3	24							77.27	64.10	59.1	60.2	85-110 (lowland river) 80-110 (estuarine)	58.9	67.5	87.4	89.3		80-110
	Temperature (°C)	17.17	18.5							19.2	19.15	17	17.3	N/A	20.4	22.9	18.9	13.8		N/A
22-24 October 2007 DRY	pH	7.46	7.175	No Data- Not sampled	No Data - Not sampled	No Data - Not sampled	No Data - Not sampled	No Data - Not sampled	No Data - Not sampled	7.245	7.09	7.3 4	7.4 1	6.5-8 (lowland river) 7.0-8.5 (estuarine)	7.59	7.55	8.14	8.15	No Data - Not sampled	7.0-8.5
	Conductivity (mS/cm)	330.3	315							503.5	258	0.29	0.3	0.125-2.2*	4.68	4.7	38.3	38.5		N/A
	Salinity (ppt)	0.15	0.28							0.24	0.1	0.12	0.13	N/A	4.85	2.61	24.3	24.4		N/A
	Turbidity (NTU)	50.70	21.1							49.45	28.50	51.8	47.9	<50 (lowland river) <10 (estuarine)	21.6	14.4	37.0	20.1		<10
	Dissolved Oxygen (% saturation)	43.53	40.35							39.15	54.03	7.9	14.8	85-110 (lowland river) 80-110 (estuarine)	65.9	61.1	85.9	84.3		80-110
	Temperature (°C)	20.67	23.75							20.88	19.11	16.6	16.8	N/A	23.7	22.8	25.1	25.2		N/A
30 October 2007 WET	pH	7.30	7.47	No data - Not sampled	No Data - Not sampled	No Data - Not sampled	No Data - Not sampled	No Data - Not sampled	No Data - Not sampled	7.123	7.21	No Data - Not sampled	No Data - Not sampled	6.5-8 (lowland river) 7.0-8.5 (estuarine)	7.51	7.39	7.94	8.01	7.64	7.0-8.5
	Conductivity (mS/cm)	312.7	320							261.3	525			0.125-2.2*	5.96	5.93	39.5	39.5	40.34	N/A
	Salinity (ppt)	0.13	0.14							0.11	0.235			N/A	3.24	2.61	25.1	25.2	25.86	N/A
	Turbidity (NTU)	13.77	12.77							18.83	23.35			<50 (lowland river)	17.1	15.4	14.6	13.3	20.7	<10

Date	*Water Quality Parameter*	*1*	*2*	*3a*	*3b*	*4a*	*4b*	*5a*	*5b*	*6*	*7*	*8a*	*8b*	*ANZECC/ARMCANZ (2000) default trigger values for protection of aquatic ecosystems (11b – 14b)*	*9a*	*9b*	*10a*	*10b*	*SEPP 351*	*ANZECC/ARMCANZ (2000) default trigger values for protection of aquatic ecosystems (15a-16)*
														<10 (estuarine)						
	Dissolved Oxygen (% saturation)	13.93	24.73							39.97	4.00			85-110 (lowland river) 80-110 (estuarine)	70.6	44.0	62.4	62.9	49.87	80-110
	Temperature (°C)	21.02	22.15							22	20.75			N/A	27.0	25	23.9	24	23.09	N/A
8-9 November 2007 WET	pH	7.52	7.656	No Data- Not sampled	No Data - Not sampled	No Data - Not sampled	No Data - Not sampled	No Data - Not sampled	No Data - Not sampled	7.59	7.61	7.84	7.80	6.5-8 (lowland river) 7.0-8.5 (estuarine)	7.64	7.54	8.13	8.28	8.29	7.0-8.5
	Conductivity (mS/cm)	323	321.7							249.7	408	0.2	0.2	0.125-2.2*	7.85	6.19	42.2	42.1	42.79	N/A
	Salinity (ppt)	0.14	0.133							0.10	0.17	0.10	0.10	N/A	5.90	3.36	26.4	27.0	27.49	N/A
	Turbidity (NTU)	17.30	20							16.40	21.20	26.2	29.9	<50 (lowland river) <10 (estuarine)	14.4	12.8	15.1	14.6	14.7	<10
	Dissolved Oxygen (% saturation)	6.87	15.43							47.23	24.45	42.2	44.0	85-110 (lowland river) 80-110 (estuarine)	35.4	46.3	75.3	75.1	72.3	80-110
	Temperature (°C)	18.27	19.15							17.83	18.18	16.9	16.9	N/A	22.2	20.8	22.4	22.4	21.55	N/A
17-16 July 2008 DRY	pH	No Data- Not sampled	No Data - Not sampled	4.80	4.65	6.12	5.64	6.44	5.06	No Data - Not sampled	No Data - Not sampled	No Data - Not sampled	No Data - Not sampled	6.5-8 (lowland river) 7.0-8.5 (estuarine)	No Data - Not sampled	No Data - Not sampled	No Data - Not sampled	No Data - Not sampled	No Data - Not sampled	7.0-8.5
	Conductivity (mS/cm)			148	148	425	438	250	239					0.125-2.2*						N/A
	Turbidity (NTU)			3.57	2.07	24	17.7	6.5	8.40					<50 (lowland river) <10 (estuarine)						<10
	Dissolved Oxygen (% saturation)			49.4	34.2	62.4	79.1	72.2	64.5					85-110 (lowland river) 80-110 (estuarine)						80-110
	Temperature (°C)			14.6	14.5	14.2	14.7	15.1	15.5					N/A						N/A

*Range of default trigger values for conductivity is only relevant for lowland rivers
u/s = upstream; d/s = downstream

3

Monitoring Objectives

3.1 RMS Water Policy and Objectives

The NSW Roads and Maritime Services' commitment to water management as outlined in the RTA Water Policy states:

> *"The RTA 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; and*
> - *preserve ecosystems."*

The general water quality objectives described in the RMS Code of Practice for Water Management (RTA, 1999) essentially aim at minimising potential impacts on the environment as indicated in the following general principles:

- Pre-Construction – designs will incorporate appropriate techniques to contain and treat road run-off to avoid or minimise potential impacts to aquatic and riparian environments (RTA,1999:8);
- Construction – Effective water management practices and procedures will be implemented, in accordance with the Construction Environment Management Plan / SWMP, as an integral part of on-site construction management to ensure that water quality and quantity impacts to the environment are minimised (RTA, 1999:10); and
- Operational – The RTA will investigate and incorporate appropriate pollution control technologies on existing major roads and bridges to contain and treat road run-off, wherever practical and cost-effective, in order to minimise potential impacts on the environment (RTA, 1999:13).

This Surface Water Quality Monitoring Program links with the above objectives by providing water quality information to assess the impacts of the highway upgrade on the waterways in the study area. This is the general objective of the Statement of Commitment No. W3:- *Monitoring of groundwater impacts and surface water quality upstream and downstream of the site during construction will determine the effectiveness of mitigation strategies. Implementation of additional feasible and reasonable management measures will occur if necessary*.

3.2 Monitoring Objectives

The primary objective of this Surface Water Quality Monitoring Program is to evaluate the impact of the highway upgrade on water quality in the relevant waterways from Nambucca Heads to Urunga.

To achieve the above monitoring objective, this report provides the following information:

- parameters for monitoring during pre-construction, construction and operational stages;
- monitoring locations for surface water quality;
- a monitoring program to establish baseline surface water quality data;
- a monitoring program to identify impacts of the highway upgrade on surface water quality; and
- a monitoring program to help assess and refine surface water management measures.

3.3 Monitoring Approach

The type of monitoring study to be employed is one that measures change (i.e. any change in water quality as a result of the highway upgrade). The general category of design for this monitoring program is the before–after, control–impact (BACI) type design as described in ANZECC ARMCANZ (2000b:3-3). This essentially involves monitoring two sites before and after the disturbance occurs (pre-construction and construction/ operation). The two sites comprise one that will be subjected to the disturbance (an 'impact' site) and one that will not (a 'control' site). The same parameters are monitored at both 'control' and 'impact' sites before and after the highway upgrade to determine whether or not the pattern of behaviour over time at the impact site(s) change relative to the control sites.

3.3.1 Defining the Control and Impact Site

The Surface Water Quality Monitoring Program has selected sampling sites on the upstream and downstream side of each waterway crossing with:

- the upstream site representing the 'control' site ; and
- the downstream site representing the 'impact' site.

It should be noted there is likely to be some 'natural' variation in water quality between the upstream and downstream sampling sites at the pre-construction stage (pre-disturbance). A measure or sense of this 'natural' variation will be established from the pre-construction monitoring. This 'natural' variation will then be incorporated into the analysis of the construction/ operational stage monitoring to ensure it is not misinterpreted as an impact of the highway upgrade.

3.4 Statistical Analysis

The technique for comparing sampling results and baseline data or trigger values will be either by the use of tabulated results or control charts (or a combination of both) as described in ANZECC ARMCANZ (2000b:6-17). This is discussed further in Section 5 of this document.

4

Monitoring Program

4.1 Monitoring Site Locations

The following monitoring locations have been selected for the WC2NH section of the highway upgrade:

- upper Warrell Creek (Site 1 in EA): Chainage 200 and 700;
- Stony Creek (Site 5a and 5b in EA): Chainage 3,700 and 3,900;
- lower Warrell River (Site 9a and 9b in EA): Chainage 6,400;
- unnamed drainage line : Chainage 8,450; and
- Nambucca River (Site 10a and 10b in EA): Chainage 10,300.

The locations are shown in **Illustrations 4.1** and **4.2**. Monitoring of the unnamed drainage line at chainage 8,450 includes three monitoring locations as shown in **Plate 4.1** due to the presence of two tributaries that join at the location of the proposed highway.

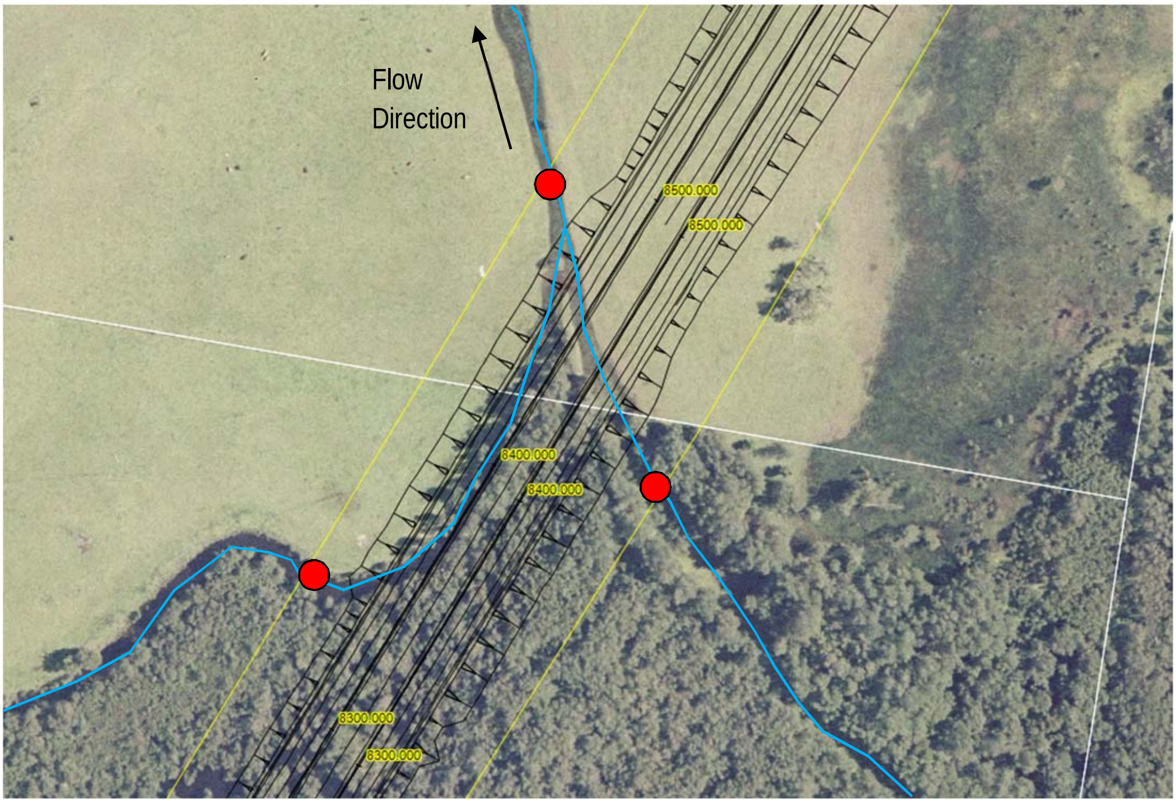
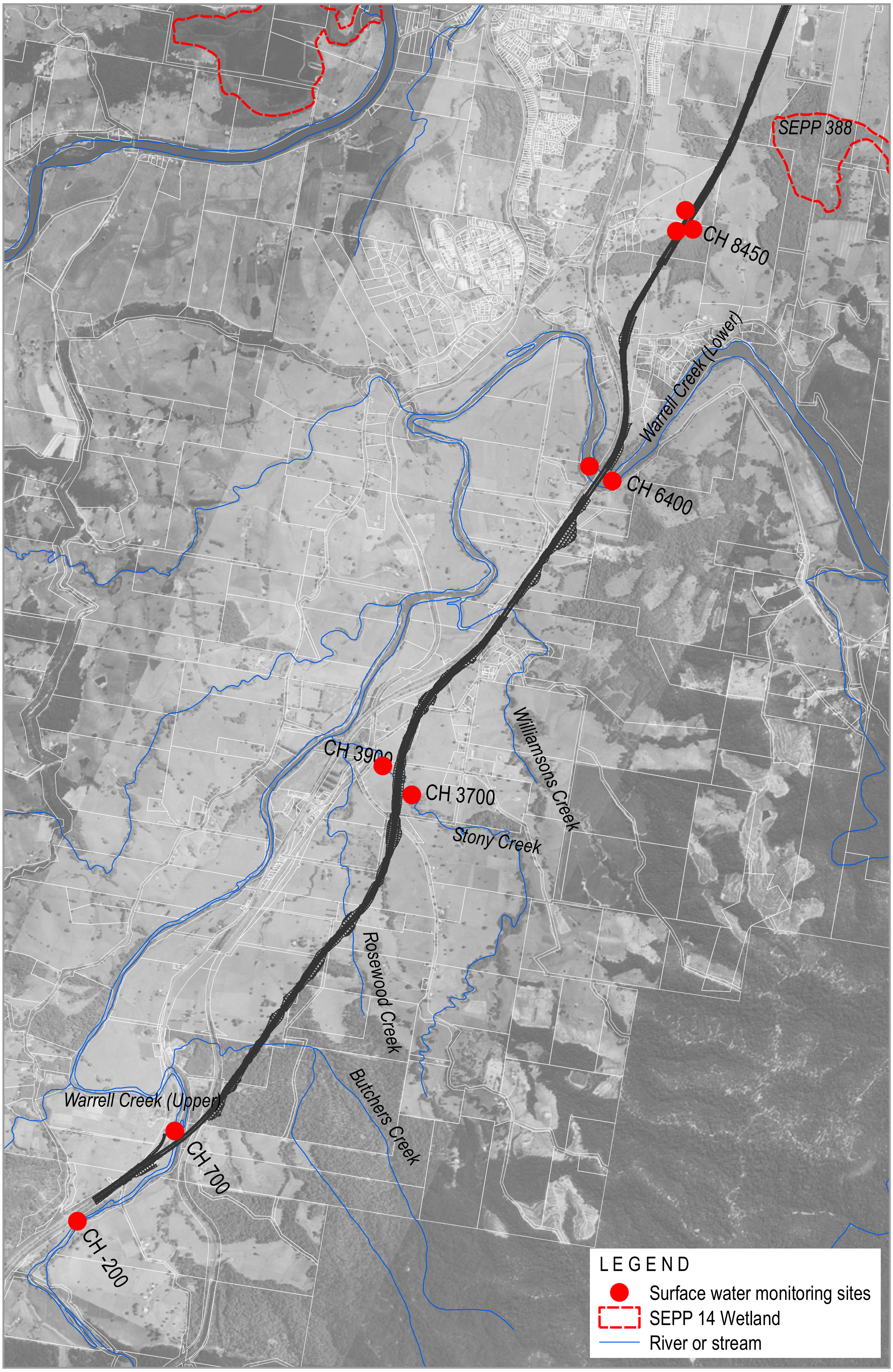


Plate 4.1 Monitoring Sites for Unnamed Drainage Line – Chainage 8,450

The upstream and downstream sampling points at each waterway crossing will be located just inside the project boundary of the highway upgrade. The exact locations will be determined on-site with consideration of safety, access, and the impact of the construction process on access over the duration of the monitoring program. Any proposed changes to sampling points during the construction phase for safety, access or other reasons will be discussed and agreed by the Environmental Review Group at the Environmental Review Group meetings.

Information shown is for illustrative purposes only

Drawn by: PPT Checked by: RE Reviewed by: TIM Date: October 2013
Source of base data: NSW RMS

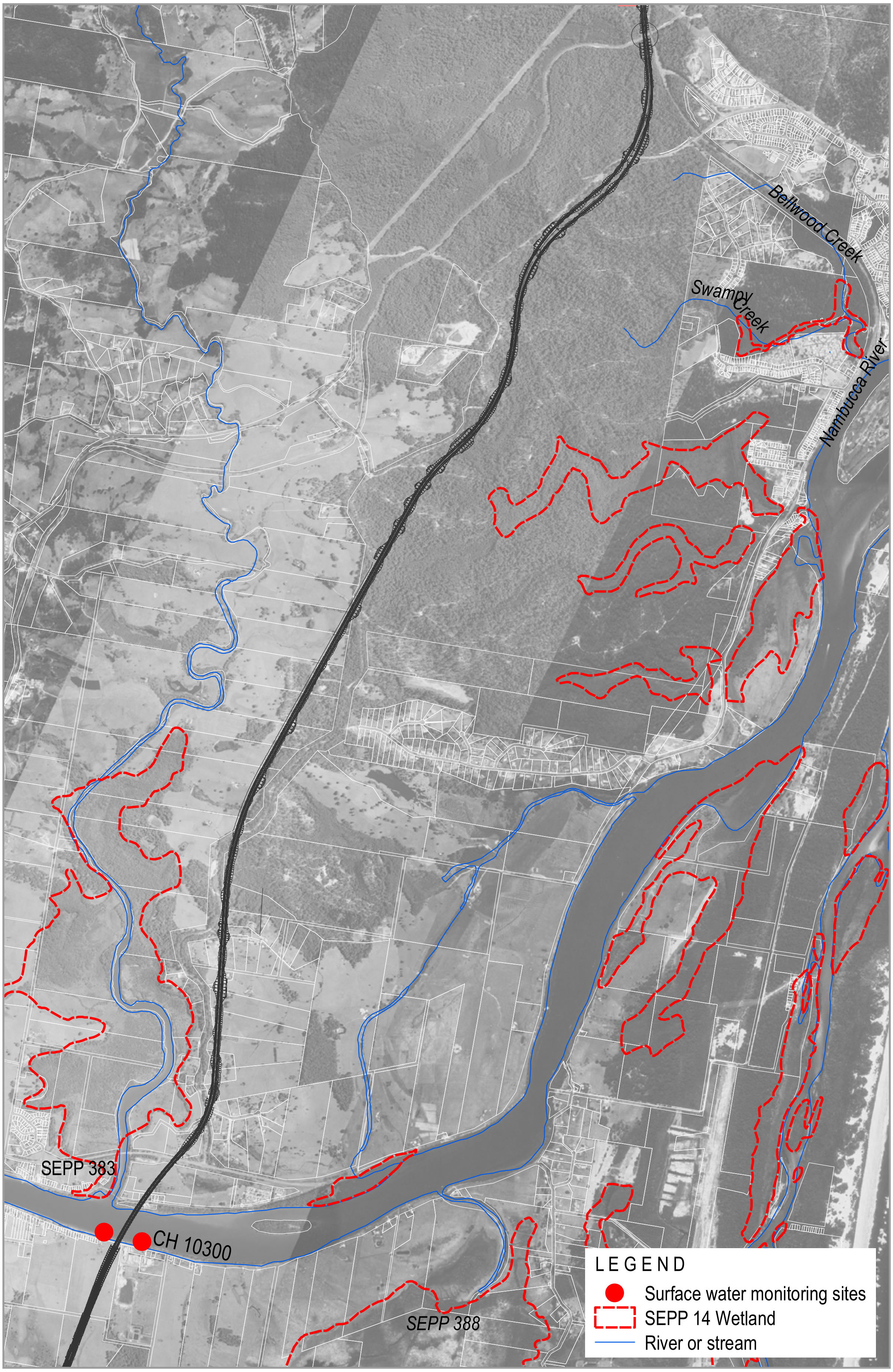


Surface Water Monitoring Sites - Ch 0 to 9600

GeoLINK environmental management and design

Surface Water Quality Monitoring Program - Nambucca Heads to Urunga
1997-1009

Illustration 4.1



Waterways and EA Sampling Sites - Ch 9600 to 19500

4.1.1 Reasons for Selection of Monitoring Locations

The monitoring locations were selected with consideration of:

- coverage of the various geographical terrains and waterway types along the project length;
- selection of generally permanent watercourses as opposed to intermittent or low-flow watercourses;
- representation of waterways in different catchments; and
- monitoring of waterways associated with wetlands (the unnamed drainage line at chainage 8,450).

SEPP No. 388 is not selected for monitoring due to the absence of any permanent watercourse crossing the highway alignment. Therefore, the nearby unnamed drainage line at chainage 8,450 was selected as indicative of potential impacts from construction on the floodplain.

Similarly, SEPP No. 383 is not selected due to the absence of any drainage line crossing the highway alignment.

4.2 Monitoring Parameters

Selection of water quality parameters has been based on those previously monitored (refer to Section 2.5), RMS *Guideline for Construction Water Quality Monitoring* (RTA, undated) and *Australian guidelines for water quality monitoring and reporting* (ANZECC ARMCANZ, 2000b). The range of parameters to be monitored at each site is listed below. It is noted that some parameters will be monitored more frequently than others – refer to Section 4.4.

Parameters to be monitored at each site:

- physical properties: Electrical Conductivity, Turbidity, Total suspended solids (TSS), Temperature;
- chemical properties: pH, Dissolved Oxygen;
- hydrocarbons: visual assessments for oils and grease. If oils and greases are visible, a sample will be taken for TPH analysis;
- nutrients: Total Nitrogen and Total Phosphorus; and
- heavy metals sweeps.

4.2.1 Other Monitoring Parameters

Daily rainfall figures from the construction site / nearest Bureau of Meteorology sites will be recorded as part of the monitoring program for practical correlation with surface water monitoring results.

4.3 Monitoring Duration

The durations of the various phases of the monitoring program are:

- Pre-construction phase (prior to the commencement of any Construction as defined in the project approval): a minimum of six months;
- Construction phase (following commencement of Construction as defined in the project approval): for the duration of the construction period;
- Operational phase: a minimum of three years following completion of Construction as defined in the project approval or until any disturbed waterways/ groundwater resources are certified by an independent expert as being rehabilitated to an acceptable condition (refer to Condition of Approval B17 in Section 1.2.3 of this report).

4.4 Sampling Frequency

The sampling frequencies are outlined in the following sub-sections and summarised in Table 4.1 to 4.5. Potential water quality impacts from the highway upgrade, particularly the construction activities will most likely result from erosion and sediment loss during rainfall events in the construction stage and from runoff in the operational stage. Therefore, monitoring will include water quality samples during rainfall events (RTA, undated: 6).

4.4.1 Pre-Construction Stage

To ensure a comprehensive set of baseline data the following monitoring frequency is required for pre-construction stage:

- for physical properties, chemical properties, and hydrocarbons (monitoring for hydrocarbons involves visual assessments for oils and grease and sampling for TPH if oil and grease is visible):
  - two wet events per month (a wet event is defined as a rainfall event of 10 mm or greater in a 24 hour period); and
  - one dry event per month;
- for nutrients and heavy metals sweeps:
  - one wet event per month; and
  - one dry event every second month.

Total suspended solids (TSS) will be analysed at the same frequency as turbidity in the pre-construction stage to assist with developing a correlation between these two parameters in the construction stage. This will enable a reduction in the frequency of TSS testing in the construction stage by using turbidity as an indicator of TSS levels. This is proposed due to the relative ease and less expense associated with testing turbidity.

4.4.2 Construction Stage

The following monitoring frequency will be implemented for the construction stage (note: the following frequency is consistent with the RMS *Guideline for Construction Water Quality Monitoring* (RTA, undated) :

- for physical properties (excluding TSS), chemical properties, and hydrocarbons (monitoring for hydrocarbons involves visual assessments for oils and grease and sampling for TPH if oil and grease is visible):
  - two wet events per month (a wet event is defined as a rainfall event of 10mm or greater in a 24 hour period); and
  - one dry event per month;
- for TSS, nutrients and heavy metals sweeps:
  - one wet event per month; and
  - one dry event every second month.

In addition to the above monitoring frequency requirements, surface water discharges from sediment basins will also be monitored when they occur, as per the EPL conditions.

4.4.3 Operational Stage

RMS *Guideline for Construction Water Quality Monitoring* recommends monthly monitoring for the operational stage, however if sampling results demonstrate that the site or parts of the site have stabilised, the sampling frequency may be reviewed and reduced or discontinued (RTA, undated: 9). Therefore, in general terms monthly monitoring will be undertaken for the first year of operation after which time it is assumed that revegetation will have generally established and stabilised. Following the first year the frequency will be reduced to once every second month for the second year of operation and then once every six months for the third year of operation.

In detail, the following sampling frequency will apply for physical properties (excluding TSS), chemical properties, and hydrocarbons (monitoring for hydrocarbons involve visual assessments for oils and grease and sampling for TPH if oil and grease is visible):

- First year of operation:
  - once per month during a wet episode defined as a rainfall event of 10 mm or greater in a 24 hour period; and
  - once every 6 months during a dry episode.
- Second year of operation:
  - once every second month during a wet episode; and
  - once every 6 months during a dry episode.
- Third year of operation:
  - once every 6 months during a wet episode; and
  - once every 6 months during a dry episode.

For TSS, nutrients and heavy metals sweeps, the following sampling frequency will apply:

- First year of operation:
  - once every second month during a wet episode; and
  - once every 6 months during a dry episode.
- Second to third year of operation:
  - once every 6 months during a wet episode; and
  - once every 6 months during a dry episode.

Table 4.1 Surface Water Quality Parameters – Pre-Construction Stage

Frequency	*Analytical Group*	*Analytes*	*Analysis Method*
Monthly (two wet episode sampling events and one dry episode sampling event)[1]	Physical properties	Electrical Conductivity (EC) Turbidity (NTU) Total suspended solids (TSS) Temperature	Field measurement Field measurement Laboratory analysis Field measurement
	Chemical properties	pH Dissolved oxygen (DO)	Field measurement Field measurement
	Hydrocarbons	Visual inspection of oil / grease. Sampling of TPH if oil / grease is visible	Field measurement Laboratory analysis
Monthly to Bi-Monthly (one wet episode sampling event every month one dry episode sampling event every second month)[1]	Hydrocarbons	TPH	Laboratory analysis
	Heavy metals	Copper (Cu) Lead (Pb) Cadmium (Cd) Zinc (Zn) Arsenic (As) Selenium (Se) Iron (Fe) Manganese (Mn) Silver (Ag) Chromium (Cr) Nickel (Ni) Aluminium (Al) Mercury (Hg)	Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis
	Nutrients	Total Nitrogen Nitrate Nitrite Ammonia Total Phosphorus Phosphate	Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis

Notes: 1. A wet episode is defined as a rainfall event of 10mm in a 24hour period. Sampling of a wet episode must occur within 24 hours following a wet episode.

Table 4.2 Surface Water Quality Parameters – Construction Stage

Frequency	*Analytical Group*	*Analytes*	*Analysis Method*
Monthly (one dry episode sampling event and two wet episode sampling events)[1]	Physical properties	Electrical Conductivity (EC) Turbidity (NTU) Temperature	Field measurement Field measurement Field measurement
	Chemical properties	pH Dissolved oxygen (DO)	Field measurement Field measurement
	Hydrocarbons	Visual inspection of oil / grease. Sampling of TPH if oil / grease is visible	Field measurement Laboratory analysis
Monthly to Bi-Monthly (one wet episode sampling event every month one dry episode sampling event every second month)[1]	Hydrocarbons	TPH	Laboratory analysis
	Heavy metals	Copper (Cu) Lead (Pb) Cadmium (Cd) Zinc (Zn) Arsenic (As) Selenium (Se) Iron (Fe) Manganese (Mn) Silver (Ag) Chromium (Cr) Nickel (Ni) Aluminium (Al) Mercury (Hg)	Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis
	Physical properties	Total suspended solids (TSS)	Laboratory analysis
	Nutrients	Total Nitrogen Nitrate Nitrite Ammonia Total Phosphorus Phosphate	Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis

Notes: 1. A wet episode is defined as a rainfall event of 10mm in a 24hour period. Sampling of a wet episode must occur within 24 hours following a wet episode.

Table 4.3 Surface Water Quality Parameters – Operational Stage - First Year of Operation

Frequency	*Analytical Group*	*Analytes*	*Analysis Method*
Monthly (one wet episode sampling event)[1]	Physical properties	Electrical Conductivity (EC) Turbidity (NTU) Temperature	Field measurement Field measurement Field measurement
	Chemical properties	pH Dissolved oxygen (DO)	Field measurement Field measurement
	Hydrocarbons	Visual inspection of oil / grease. Sampling of TPH if oil / grease is visible	Field measurement Laboratory analysis
Bi-Monthly (one wet episode sampling event)[1]	Hydrocarbons	TPH	Laboratory analysis
	Heavy metals	Copper (Cu) Lead (Pb) Cadmium (Cd) Zinc (Zn) Arsenic (As) Selenium (Se) Iron (Fe) Manganese (Mn) Silver (Ag) Chromium (Cr) Nickel (Ni) Aluminium (Al) Mercury (Hg)	Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis
	Physical properties	Total suspended solids	Laboratory analysis
	Nutrients	Total Nitrogen Nitrate Nitrite Ammonia Total Phosphorus Phosphate	Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis
Six-Monthly (one dry episode sampling event)	Physical properties	Same analytes as above	Field measurement
	Chemical properties	Same analytes as above	Field measurement
	Hydrocarbons	TPH	Field measurement / Laboratory analysis
	Heavy metals	Same analytes as above	Laboratory analysis
	Physical properties	Total suspended solids	Laboratory analysis
	Nutrients	Same analytes as above	Laboratory analysis

Notes: 1. A wet episode is defined as a rainfall event of 10mm in a 24hour period. Sampling of a wet episode must occur within 24 hours following a wet episode.

Table 4.4 Surface Water Quality Parameters – Operational Stage - Second Year of Operation

Frequency	*Analytical Group*	*Analytes*	*Analysis Method*
Bi-Monthly (one wet episode sampling event)[1]	Physical properties	Electrical Conductivity (EC) Turbidity (NTU) Temperature	Field measurement Field measurement Field measurement
	Chemical properties	pH Dissolved oxygen (DO)	Field measurement Field measurement
	Hydrocarbons	Visual inspection of oil / grease. Sampling of TPH if oil / grease is visible	Field measurement Laboratory analysis
Six-Monthly (one dry episode sampling event)	Physical properties	Same analytes as above	Field measurement
	Chemical properties	Same analytes as above	Field measurement
	Hydrocarbons	TPH	Field measurement / Laboratory analysis
	Heavy metals	Copper (Cu) Lead (Pb) Cadmium (Cd) Zinc (Zn) Arsenic (As) Selenium (Se) Iron (Fe) Manganese (Mn) Silver (Ag) Chromium (Cr) Nickel (Ni) Aluminium (Al) Mercury (Hg)	Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis
	Physical properties	Total suspended solids	Laboratory analysis
	Nutrients	Total Nitrogen Nitrate Nitrite Ammonia Total Phosphorus Phosphate	Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis
Six-Monthly (one wet episode sampling event)	Hydrocarbons	TPH	Laboratory analysis
	Heavy metals	Same analytes as above	Laboratory analysis
	Physical properties	Total suspended solids	Laboratory analysis
	Nutrients	Same analytes as above	Laboratory analysis

Notes: 1. A wet episode is defined as a rainfall event of 10mm in a 24hour period. Sampling of a wet episode must occur within 24 hours following a wet episode.

Table 4.5 Surface Water Quality Parameters – Operational Stage - Third Year of Operation

Frequency	*Analytical Group*	*Analytes*	*Analysis Method*
Six-Monthly (one dry episode sampling event and one wet episode sampling event) [1]	Physical properties	Electrical Conductivity (EC) Turbidity (NTU) Temperature	Field measurement Field measurement Field measurement
	Chemical properties	pH Dissolved oxygen (DO)	Field measurement Field measurement
	Hydrocarbons	Visual inspection of oil / grease. Sampling of TPH if oil / grease is visible	Field measurement Laboratory analysis
	Heavy metals	Copper (Cu) Lead (Pb) Cadmium (Cd) Zinc (Zn) Arsenic (As) Selenium (Se) Iron (Fe) Manganese (Mn) Silver (Ag) Chromium (Cr) Nickel (Ni) Aluminium (Al) Mercury (Hg)	Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis
	Physical properties	Total suspended solids	Laboratory analysis
	Nutrients	Total Nitrogen Nitrate Nitrite Ammonia Total Phosphorus Phosphate	Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis Laboratory analysis

Notes: 1. A wet episode is defined as a rainfall event of 10mm in a 24hour period. Sampling of a wet episode must occur within 24 hours following a wet episode.

4.5 Timing of Sampling

Due to the tidal nature of a number of the waterways, water quality and flow direction may vary according to the tidal cycle. Therefore, to provide comparable data between sampling events sampling must be:

- consistently taken during the same tidal phase for each sampling event (or as close as practical) at the sites listed below; and
- conducted on an ebb (falling) tide and as close to low tide (at the monitoring location) as possible to ensure the flow direction is from the 'control' point (upstream monitoring location) to the 'impact ' site (downstream monitoring location).

The monitoring sites that are potentially influenced by tidal flows are:

- Warrell Creek (lower): Chainage 6,400; and
- Nambucca River: Chainage 10,300.

It is noted the above timing preferences will not always be practical due to shifting tidal cycles not always aligning with normal work hours. However the above timing preferences must be adhered to wherever practical or reasonable.

4.6 Field Measurements and Observations

4.6.1 Field Measurements

Some parameters (e.g. temperature) can only be measured in the field. For other parameters (e.g. dissolved oxygen), field measurements are necessary because the value of the parameter might change in the sample after collection ANZECC ARMCANZ (2000b:4-1). The following parameters will be measured in the field:

- electrical conductivity (EC);
- turbidity (NTU);
- temperature;
- pH; and
- dissolved oxygen (DO).

Field measurements will be made on separate sub-samples of water to avoid contamination.

4.6.2 Field Observations

At each visit, the following information will be recorded on a field-record sheet (based on information in ANZECC ARMCANZ, 2000b):

- the exact locations of sampling sites (if sites need to be refined during the construction phase due to safety, access or other reasons, these proposed changes will be discussed with the Environmental Review Group at the Environmental Review Group meetings);
- accurate description of where samples were collected;
- weather conditions and general observations on the condition of the waterbody because these factors may influence the variables being measured;
- the date and time when samples are taken (standard or daylight-saving time);
- tidal cycle (ebb or flood tide and time of nearest low tide at the sampling site) for the monitoring sites at: Warrell Creek (lower): Chainage 6,400; and Nambucca River: Chainage 10,300;
- visual observations of oil/ grease on the water surface;
- any other observations or information on the conditions at the time of sampling that may assist in interpretation of the data; and
- photographic records are also highly desirable for future reference.

4.7 Field Sampling

Due to the relatively shallow depth of the waterways, bottle sampling is considered an appropriate sampling technique. For this purpose, immersion of a sample bottle by hand to just below the surface (typically 0.25–0.5 m depth) is satisfactory, provided any contribution from surface films is avoided, the sampler is downstream of where the sample is to be collected and other standard sampling techniques are adopted to avoid contamination of the sample (ANZECC ARMCANZ, 2000b:4-5 – 4-6).

4.8 Replicate Samples

One blind replicate water sample will be collected for each monitoring event. This is based on the general requirement of one blind sample for every 20 samples.

4.9 Sampling Protocol

Sampling protocol will follow standard procedures as outlined in documents such as Australian Standard AS/NZS 5667 and *Australian guidelines for water quality monitoring and reporting* (ANZECC ARMCANZ, 2000b).

4.9.1 Sample Collection

Protocols to include the following basic precautions for avoiding contamination during sample collection:

- field measurements to be made on separate sub-samples of water;
- new or reused sample containers must be appropriately cleaned (use of containers supplied by the analytical laboratory is recommended);
- all field equipment is pre-cleaned to the same standard as the containers;
- sample bottles suitable for each parameter to be used;
- containers are uncapped or removed from their transport bags for minimum amounts of time;
- containers that were filled with water as part of the preparation protocol are emptied well away from and downstream of the sampling location before being rinsed with sample and refilled; and
- sampling staff must use standard techniques to avoid contamination when handling sample containers (e.g. avoid touching the sample and the insides of caps or containers) (ANZECC ARMCANZ, 2000b:4-11,4-14).

4.9.2 Tracking Samples and Field Data

During sampling or field measurements, field data sheets or similar records that describes the samples taken, their labels and other relevant details will be completed (see Section 4.4.2 - Field Observations). All field data and instrument calibration data are recorded on this sheet. All field records must be completed before leaving a sampling station. Any observations or information on the conditions at the time of sampling that may assist in interpretation of the data will be noted on a field-record sheet. Chain of custody documentation that will be recorded as part of the sampling program is listed in Table 4.6.

Table 4.6 Chain of Custody Documentation

Process Step	*Quality Assurance Procedure*
Field sampling	Field register of sample number, site, type/technique, time, date, technician, field data sheet
Sample storage and transport	Field register of transport container number and sample numbers, time, date
Laboratory receipt of samples	Laboratory register of transport container number and sample numbers, time, date
Laboratory storage of samples	Laboratory register of storage location, type, temperature, time, date
Sample preparation	Analysis register of sample (laboratory) number, pre-treatment, date, technician
Sample analysis	Analysis register of instrument, calibration, technician, standard method, date, result

Source: Table 4.6 in ANZECC ARMCANZ (2000b:4-14)

4.9.3 Sample Identification

Sample containers will be marked in a clear and durable manner in order to permit clear identification of all samples in the laboratory. Blind replicate samples will be submitted to the laboratory as individual samples without any indication to the laboratory that they are replicates.

4.9.4 Sample Preservation

Water samples are susceptible to change as a result of physical, chemical or biological reactions which may take place between the time of sampling and the analysis. These changes are often sufficiently rapid to modify the sample considerably in the space of several hours.

All samples will be stored in a refrigerated state immediately following sampling (e.g. stored on ice in an esky or in a vehicle refrigerator).

The preservation of samples to be analysed for heavy metals may require acidification in the field (which would necessitate the use of separate sample containers for the heavy metals sample) or acidification in the laboratory within 6 hours of sampling. Liaison with the analytical laboratory will be undertaken to confirm the most appropriate method of preservation of the heavy metals samples.

4.9.5 Sample Transport

Samples will be transported according to the relevant parts of Australian Standard AS/NZS 5667.1:1998. The time between sampling and analysis will be reported.

4.10 Sample Analysis

Standard laboratory analytical procedures will be employed throughout and all analyses will be undertaken by laboratories with NATA-accredited methods.

Parameters that require laboratory analysis are:

- physical properties: total suspended solids (TSS);
- hydrocarbons;
- nutrients; and
- heavy metals.

5

Data Analysis and Interpretation

5.1 Data Analysis

5.1.1 Pre-Construction Monitoring Data

Data analysis of the pre-construction monitoring results will aim to establish baseline data and an indication of the degree of variation for each water quality parameter for existing conditions.

Analysis of the pre-construction data will assess the existing variation in water quality between the upstream and downstream sampling sites at each monitoring location. This existing variation will be incorporated into the analysis of the construction/ operational stage monitoring to ensure it is not misinterpreted as an impact of the highway upgrade.

The pre-construction data will also be used to establish a correlation between total suspended solids and turbidity to assist in using turbidity as an indicator of total suspended solids during the construction and operational phases.

5.1.2 Trigger Values

It is difficult to specify meaningful trigger values due to the significant variation in some water quality parameters between monitoring events in each of the waterways as shown in Table 2.3 in this report. The pre-construction data will provide an indication of baseline conditions and the degree of variation for each water quality parameter for existing conditions which can be used for comparison with construction and operational sampling results, noting there will likely be different climatic factors such as rainfall and drought and land use across the project stages.

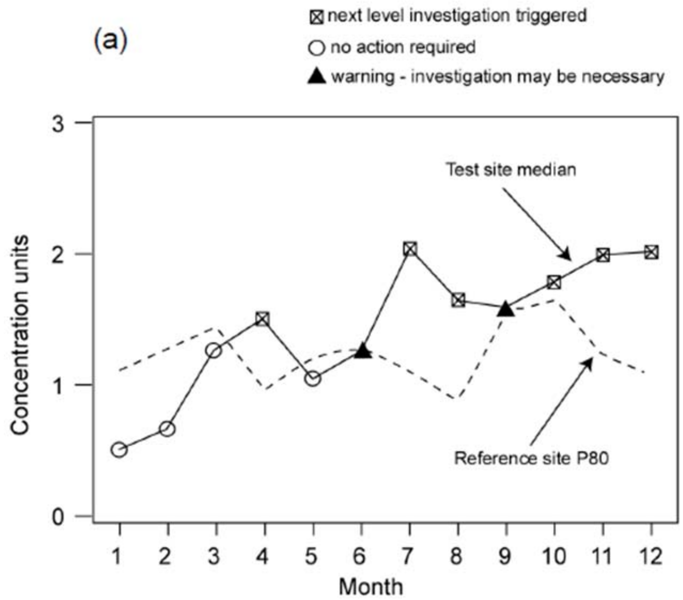
To assist the comparison of construction / operational sampling results with the pre-construction data, a comparison of median data versus 80th and 20th percentile data will be employed. This will involve comparing the median values of the downstream data with the 80th and 20th percentile of values of the upstream data at each monitoring site location. This comparison is aimed at ensuring the downstream median values for each parameter are lower than the upstream 80th percentile of values or greater than the upstream 20th percentile for parameters such as dissolved oxygen where low values are the problem. Thus the 80th and 20th percentiles will be used as trigger values (ANZECC ARMCANZ, 2000b:6-17).

It is noted that the use of the downstream median value comparison with the upstream 80th/ 20th percentiles will include consideration of the pre-construction variation (or 'natural' difference) in water quality between the upstream and downstream sampling sites at each monitoring location as discussed in Section 5.1.1.

5.1.3 Comparison of Sampling Data and Baseline Data

The technique for comparing sampling results and baseline data or trigger values will use either tabulated results or control charts (or a combination of both).

An example of the use of control charts for the comparison of downstream median value with the upstream 80th/ 20th percentiles is shown in Plate 5.1. Here, the monthly results for a test parameter for a monitoring location are graphed in a control chart whereby the test site results (at the downstream or 'impact' site) are compared to the trigger value using the 80th/ 20th percentile from the adjusted reference site data (upstream monitoring location).



Source: Figure 6.7 in ANZECC ARMCANZ, 2000b:6-19

Plate 5.1 Example Control Chart

5.2 Data Interpretation

After the data analysis, the results will be collated into a concise statistical summary and assessed in the context of the monitoring objectives below.

5.2.1 Pre-Construction Stage

Data interpretation for the pre-construction stage monitoring will address:

- consideration of the difference in the pre-construction monitoring results between the upstream and downstream sites at each waterway crossing (refer to **Section 5.1.1**); and
- establishment of baseline surface water quality data for the project including the degree of variation for each water quality parameter for existing conditions.

5.2.2 Construction Stage

Data interpretation for the construction stage monitoring will address:

- identification of impacts of the highway upgrade construction on surface water quality; and
- determination of any required refinement of construction surface water management measures.

5.2.3 Operational Stage

Data interpretation for the operational stage monitoring will address:

- identification of impacts of the highway upgrade operation on surface water quality;
- determination of any required adjustment of operational surface water management strategies and stabilisation works.

5.3 Reporting

5.3.1 Pre-Construction Stage

At the completion of the pre-construction stage monitoring a report will be produced containing full and complete details of all aspects of the monitoring. The report will include:

- introduction and background: description of the program and objectives and delineating the study boundary;
- experimental detail, describing the study location and study design, including detail of the sampling locations so they can be unambiguously identified, e.g. GPS directions and descriptions of methods of sampling and analysis;
- presentation, interpretation and discussion of the results including addressing the items outlined in Section 5.2.1 and the Statement of Commitments identified in Table 1.1;
- review and recommendations for the monitoring program for the construction and operational stages; and
- appendices, providing laboratory reports, data tables or other relevant information.

5.3.2 Construction Stage

Reporting during the construction stage will include interim reports, annual reports and a final report at the completion of the construction stage.

Interim reports will be produced on a monthly basis to provide the results of the monitoring during the past month. This will comprise a simple but clear tabulation of the monitoring results to be tabled at the Environmental Review Group meetings. The report will include any relevant discussion of the results to inform the ongoing management of the surface water management measures and the results will be discussed and minuted at the monthly Environmental Review Group meetings.

Annual reports will be of a similar format to that outlined in Section 5.3.1.

Similarly, the final report at the completion of the construction stage will be of a similar format to that outlined in Section 5.3.1 and will include recommendations for the operational monitoring program.

5.3.3 Operational Stage

Reporting during the operation stage will also include interim reports, annual reports and a final report at the completion of the first three years of operation.

Interim reports will be produced on a six-monthly basis to provide the results of the monitoring during the past six months and any relevant discussion of the results to inform the ongoing management of the permanent surface water management strategies and stabilisations works.

Annual reports will be of a similar format to that outlined in Section 5.3.1 for the pre-construction stage but excluding recommendations for the operational monitoring program.

Similarly, the final report at the completion of the first three years of operation will be of a similar format to that outlined in Section 5.3.1 but including recommendations for a continued operational monitoring program if deemed appropriate.

6

Management Actions

The Surface Water Quality Monitoring Program will form part of the Construction Environmental Management Plan (CEMP) and the Operational Environment Management System and will be reviewed annually.

6.1 Management Actions

During the construction stage the monthly interim, annual and final reports outlined in the previous section will be discussed and minuted at monthly Environmental Review Group meetings.

Similarly, during the operational stage the six-monthly interim, annual and final reports outlined in the previous section will be assessed in relation to refinement of surface water management measures or other relevant measures / procedures identified in the Operational Environment Management System.

6.1.1 Surface Water Management Measures for Construction Phase

The surface water management measures detailed in Section 2.4.1 will be implemented.

6.1.2 Surface Water Management Measures for Operational Phase

The surface water management measures detailed in Section 2.4.2 will be implemented.

7 Consultation

7.1 Regulatory Agencies

The NSW Environment Protection Authority (EPA) and Department of Primary Industries (DPI) have been consulted during preparation of this monitoring program. DPI had no comments on the monitoring program. EPA comments and the response to the comments are contained in Appendix A.

EPA, DPI and NoW will be consulted during the implementation of the Surface Water Quality Monitoring Program. As a minimum, this consultation is to include forwarding of all reports (interim, annual and stage completion reports) outlined in Section 5.3 to NSW EPA.

7.2 Landholders

Landholders relevant to monitoring sites will be consulted as required throughout implementation of the Surface Water Quality Monitoring Program in regard to establishment of monitoring sites and ensuring ongoing access to monitoring sites and related matters.

References

ANZECC ARMCANZ (2000a). *Australian and New Zealand guidelines for fresh and marine water quality. Volume 1, The Guidelines*. Australian and New Zealand Environment and Conservation Council (ANZECC), Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ).

ANZECC ARMCANZ (2000b). *Australian guidelines for water quality monitoring and reporting*. Australian and New Zealand Environment and Conservation Council (ANZECC), Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ).

AS/NZS 5667.1:1998. Australian / New Zealand Standard™. *Water Quality – Sampling. Part 1: Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples*.

AS/NZS 5667.12:1999. Australian / New Zealand Standard™. *Water Quality – Sampling. Part 12: Guidance on sampling of bottom sediments*.

DLWC (1998) *Stressed Rivers Assessment Report . NSW State Summary*. NSW Department of Land and Water Conservation. April 1998.

NSW Fisheries 1999, *Policy and Guidelines: Aquatic Habitat Management and Fish Conservation*: (1999 update). Smith, A. and Pollard, D.A. (eds) NSW Fisheries, Port Stephens Research Centre.

RMS (2012). *Pacific Highway upgrade – Warrell Creek to Urunga. Brief – Preparation of Water Quality Monitoring Program.* March 2012. Contract No. 12.2544.0085

RTA (1999). *Code of Practice for Water Management. Road Development and Management.* [Online]. Available: http://www.rta.nsw.gov.au/environment/downloads/enviro_wcop_dl1.html [Accessed 14th March 2012].

RTA (2011). *Upgrading the Pacific Highway, Warrell Creek to Urunga. Project Approval Documents*. RTA/Pub.11.282. October, 2011.

RTA (undated). *Guideline for Construction Water Quality Monitoring.* [Online]. Available: http://www.rta.nsw.gov.au/environment/downloads/constrwaterqualmonit_dl1.html [Accessed 14th March 2012].

SKM (2010a). *Warrell Creek to Urunga, Upgrading the Pacific Highway. Environmental Assessment.* Volume 1 Environmental Assessment. January 2010.

SKM (2010b). *Warrell Creek to Urunga, Upgrading the Pacific Highway. Environmental Assessment.* Volume 2 – Working Paper No.1 – Flora and Fauna. January 2010.

SKM (2010c). *Warrell Creek to Urunga, Upgrading the Pacific Highway. Environmental Assessment.* Volume 2 – Working Paper No.5 – Water Quality Impact Assessment. January 2010.

Copyright and Usage

Appendix A

Agency Consultation

ENVIRONMENT PROTECTION AUTHORITY - COMMENT SHEET

Project:	Warrell Creek to Nambucca Heads Pacific Highway Upgrade Project		
Document title:	Surface Water Monitoring Program		
Revision No.:	Initial draft		
Reviewer name:	Craig Dunk	Review date:	10 April 2013
Responses by:	Environment Protection Authority (EPA)	Response due:	N/A

Thankyou for the opportunity to comment on the Project's **Surface Water Monitoring Program**. The EPA has reviewed the proposed Surface Water Monitoring Program submitted to the Department on the 15 January 2013 and has provided comments on key areas of concern in the table below.

Report Reference	EPA Comments	Response
Section 2.1 Waterways – Illustration 2.1	The EPA notes that monitoring point 4a shown on illustration 2.1 is downstream of the highway upgrade and does not reflect the background.	The monitoring sites in Illustrations 2.1 and 2.2 are the sampling locations used during the environmental assessment (EA) phase and are not the proposed monitoring locations for the monitoring program. The proposed monitoring locations for the monitoring program are shown in Illustrations 4.1 and 4.2 and have been selected to provide background (upstream) monitoring as well as impact (downstream) monitoring.
Section 2.1 Waterways – Illustration 2.1	The EPA notes that monitoring points 1 may be in a location were it is impacted by run 0ff or releases from the project and therefore not represent background conditions.	Refer comment above., It is noted that this monitoring point in Illustration 4.1 may be potentially impacted by the works. Therefore the pre construction monitoring site will be moved south-west (upstream) along Warrell Creek away from the threat of potential run off from works. The exact location will be determined following review of the most recent design

Report Reference	EPA Comments	Response
		files with consideration of basin discharges and taking into account access.
Section 2.1 Waterways – Illustration 2.2	The EPA notes that the monitoring point for SEPP 383 is a downstream (potentially impacted) site and there is no upstream sampling point. It is important to ensure that any up steam point is not impacted by the project including stockpiles or compound sites or waters released from sediment basins.	As noted previously, the monitoring sites in Illustrations 2.1 and 2.2 are the sampling locations used during the environmental assessment (EA) phase and are not the proposed monitoring locations for the monitoring program. Notwithstanding the above, it is not proposed that SEPP 383 is monitored (as stated in Section 4.1.1 of the report) due to the absence of any feed drainage line crossing the highway alignment. Refer also to Section 4.1.1 of the report for other reasons for selection of the monitoring locations.
Section 2.5.1 Previous Sampling locations and dates	The EPA understands that a very limited amount of monitoring (as little as one grab sample per site) has been conducted to date. The very limited amount of sampling undertaken is not sufficient to draw any conclusions about the current pre project environmental health of any of the sites monitored and should be supported by more rigorous monitoring before construction activities commence.	There is a proposed monitoring program for a minimum of six months prior to construction in additional to other data as outlined in the report.
Section 4.1 Monitoring site locations	The EPA notes that upstream (background) monitoring sites should be chosen so that waters being sampled are not impacted by project activities such as basin discharges, compound sites, stockpiles or concrete batch plants as has been the case on other projects.	Noted. This is detailed design issue available after the construction contractor selects their preferred sites. This matter would be discussed athe ERG meetings if there was a need to refine a site location.
Section 4.4.1 Preconstruction stage	The EPA notes that the document proposes that total suspended solids (TSS) is analysed at the same frequency as turbidity in the pre construction stage to develop a correlation between these two parameters, and that this will enable a reduction in the frequency of TSS testing in the construction stage by using turbidity as an indicator of TSS levels. The EPA notes that there are likely to be conditions of the EPL which relate to the development of a correlation between NTU and TSS for use on the project. Any use of a correlation will be subject to sufficient samples being	Noted. This is acceptable to RMS, noting correlations will be developed in the construction stage.

Report Reference	EPA Comments	Response
	collected and the strength of the correlation which is developed. The EPA suggests that as a guide RMS consider advice previously provided to projects which is as follows: 1. Where less than 100 samples have been collected then 1 in 3 of the samples will be required to be sent to a lab for analysis; and 2. Where more than 100 samples have been collected then 1 in 10 of the samples will be required to be sent to a lab for analysis to confirm the ongoing accuracy/validity of the correlation developed. It is also important to understand the how the correlation will be used i.e. one correlation to cover the entire site or several correlations to cover different soils types (the proposed movement of soils across the site may influence this decision). It will also be important to include a safety factor (projects often use a figure of 30%) to minimise the risk of non-compliance with EPL discharge conditions.	
Section 4.4.2 Construction stage	The EPA notes that there is no reference to the requirement to monitor surface water discharges from basins in compliance with the EPL conditions during construction stage.	The proposed monitoring program is in addition to the requirement to monitor surface water discharges from basins in compliance with the EPL conditions during construction stage. This is noted in the amended report.
General Comment	I noted that there were also a number of typing/spelling errors in the document.	Typing/spelling errors has been corrected.

Groundwater Monitoring Program

Warrell Creek to Nambucca Heads Pacific Highway Upgrade

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Version History			
Version	*Date issued*	*Issued By*	*Description*
Initial Draft	08/08/2012	Tim Ruge	Draft
Final Rev 1	23/10/2013	Tim Ruge	Amended Appendix A – EPA comments Emailed to RMS – Tammie Tribe
Final Rev 2	10/04/2014	Tim Ruge	input additional comments from RMS – J O'Donnell
Final Rev 3	17/08/2017	Sean Hardiman	In accordance with s4.4: • Amendment of monitoring locations to cease monitoring at locations that have been dry throughout pre-construction and construction • Inclusion of reference to Project chainages and cutting numbers. It should be noted that since EA development, the reference to project chainages (i.e. the measurement of a point of the project from a defined starting point) has been revised. During construction chainages will be based on a distance north of Kempsey, the correction factor for this is +41,765m.

Illustrations

Tables

Plates

Appendices

Introduction

This document presents the Groundwater Monitoring Program for the southern section of the Warrell Creek to Urunga (WC2U) Pacific Highway Upgrade. The southern section of the highway upgrade covers a distance of approximately 20 kilometres from Warrell Creek to Nambucca Heads (termed ‘WC2NH’ in this report), which runs from design chainage 0 to 19,500 m (project chainage 41,765 to 61,265).

The purpose of this document is to detail a monitoring program for groundwater levels and groundwater quality for pre-construction, construction and post-construction stages of the WC2NH section of the Pacific Highway Upgrade. This document forms part of an overall Water Quality Monitoring Program for the Warrell Creek to Urunga Pacific Highway Upgrade which includes the following accompanying documents:

- Surface Water Quality Monitoring Program - Nambucca Heads to Urunga Pacific Highway Upgrade;
- Groundwater Monitoring Program –Nambucca Heads to Urunga Pacific Highway Upgrade; and
- Surface Water Quality Monitoring Program – Warrell Creek to Nambucca Heads Pacific Highway Upgrade.

1.1 Project Overview

The Warrell Creek to Urunga Pacific Highway Upgrade involves an upgrade of the existing highway to four lane divided highway from the existing Allgomera deviation, south of Warrell Creek, to Waterfall Way at Raleigh north of Urunga. The proposed upgrade extends over approximately 42 kilometres.

The Warrell Creek to Urunga (WC2U) project was identified as a critical infrastructure project by the NSW Government, designed to improve safety, traffic efficiency and increase capacity along the Pacific Highway. It forms part of the overall program for upgrading the Pacific Highway. Planning commenced on the WC2U project in 2003 and project approval was granted on 19 July 2011, under Part 3A of the *Environmental Planning and Assessment Act 1979*.

The 42 kilometre long project is being delivered in two sections:

- the 20 kilometre section from Warrell Creek to Nambucca Heads; and
- the 22 kilometre section from Nambucca Heads to Urunga.

The northern section of the highway upgrade from Nambucca Heads to Urunga has been agreed between the Australian and NSW Governments with major construction likely to commence in 2013. Therefore the Water Quality Monitoring Program for the Warrell Creek to Urunga Pacific Highway Upgrade has been divided into the two highway upgrade sections: Warrell Creek to Nambucca Heads (WC2NH) and Nambucca Heads to Urunga (NH2U).

As part of the Proposal’s approval, preparation and implementation of a Water Quality Monitoring Program is required to address the Minister for Planning and Infrastructure’s Condition of Approval (CoA) B17, and Sections 2.15.4, and Commitments W3, W6, W7 of the “Warrell Creek to Urunga Submissions and preferred project report” (hereafter referred to as the ‘Submissions Report’). Requirements outlined in each of the Conditions and relevant section of the Submissions Report is provided below.

1.2 Regulatory Context

1.2.1 Environmental Assessment

The Minister for Planning declared on 5 December 2006 that the Warrell Creek to Urunga upgrade is a project to which Part 3A of the *Environmental Planning and Assessment Act 1979* applies. In accordance with the requirements of the *Environmental Planning and Assessment Act 1979*, an environmental assessment was prepared (SKM, 2010) to assess the potential impacts of the Proposal.

The environmental assessment for the WC2U project outlined a Draft Statement of Commitments that identified a range of environmental outcomes and management measures required to avoid, minimise, manage, mitigate or offset and/or monitor impacts identified in the environmental assessment. After consideration of the issues raised in the public submissions, the draft statement of commitments for the WC2U project were revised as detailed below.

1.2.2 Statements of Commitments

The revised Statement of Commitments relevant to this Groundwater Monitoring Program is reproduced in Table 1.1 overleaf.

1.2.3 Conditions of Approval

The project approval documents for the WC2U project (includes conditions of approval from the NSW Minister for Planning. The condition of approval relevant to this Groundwater Monitoring Program is detailed below.

Condition of Approval B17- Water Quality
The Proponent shall prepare and implement a Water Quality Monitoring Program to monitor the impacts of the project on SEPP 14 wetlands, surface water quality and groundwater resources during construction and operation. The Program shall be developed in consultation with OEH [now EPA] and DPI and shall include but not necessarily be limited to:

a) identification of surface water and groundwater quality monitoring locations which are representative of the potential extent of impacts from the project;
b) 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 and risks to oyster farming in the Nambucca, Bellinger, and Kalang rivers;
c) representative background monitoring of surface water and groundwater quality parameters for a minimum of six (6) months (considering seasonality) prior to the commencement of construction to establish baseline water conditions;
d) development and presentation of indicators or standards against which any changes to surface water quality will be assessed, having regard to the Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000 (ANZECC, 2000);
e) contingency and ameliorative measures in the event that adverse impacts to surface water quality are identified;
f) a minimum monitoring period of three years following the completion of construction or until any disturbed waterways/ 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); and
g) reporting of the monitoring results to the Department, OEH and DPI.

The Program shall 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 shall be submitted to OEH [now EPA] and DPI prior to its implementation.

Table 1.1 Statements of Commitments

Outcome	*Ref No.*	*Key Action*	*Timing*	*Reference document*
Water quality and hydrology	W3	Monitoring of groundwater impacts and surface water quality upstream and downstream of the site during construction will determine the effectiveness of mitigation strategies Implementation of additional feasible and reasonable management measures will occur if necessary.	Pre-construction and construction	Draft *DECC "Managing Urban Stormwater: Soils and Construction, Volume 2, Book 4, Main Road Construction (2006)".* Volume 2A Installation of Services (DECCW 2008). Volume 2C Unsealed Roads (DECCW 2008). Volume 2D Main Roads Construction (DECCW 2008). Managing Urban *Stormwater: soils and construction* (Landcom 2004). The RTA's *Code of Practice for Water Management – Road Development and Management.* RTA *QA Specification G38 Soil and Water Management.*
Minimise groundwater related impacts	W6	Investigation of the potential for changes in the groundwater table will take place before starting any major earthworks. Where a potential for change is identified, the significance of the change and any resultant impacts will be determined and measures to manage the changes will be designed and implemented as necessary.	Pre-construction and construction	Section 16.4 and table 16-4 of the EA. *RTA's Code of Practice for Water Management – Road Development and Management (1999).* RTA *QA Specification G38 Soil and Water Management.* *Water Act 1912*
	W7	Base line monitoring of groundwater levels and chemical levels at cutting sites near springs, creeks or endangered ecological communities prior to construction commenting.	Pre-construction and construction	Section 16.4.1.3 and Table 16-4 of the EA. *RTA's Code of Practice for Water Management – Road Development and Management (1999).* RTA *QA Specification G38 Soil and Water Management.* *Water Act 1912*

1.3 Groundwater Policy Framework

There are a set of NSW policies which aim to protect groundwater from unsustainable degradation. These policies are organised into three component policies which come under the overall NSW Groundwater Policy Framework Document. The *NSW State Groundwater Policy Framework Document 1997* sets the overall direction for groundwater management in NSW, with broad objectives and principles to guide decisions. The *NSW State Groundwater Quality Protection Policy 1998* provides more detail and guidance on how to protect groundwater quality. The *NSW State Groundwater Quantity Management Policy (unpublished)* was aimed at managing extraction of groundwater within sustainable yields. This policy has been superseded by the ongoing implementation of water sharing plans. *NSW State Groundwater Dependent Ecosystems Policy 2002* guides the management of groundwater to ensure the maintenance and protection of groundwater dependent ecosystems. These policies and their relationship are shown below in Plate 1.1.

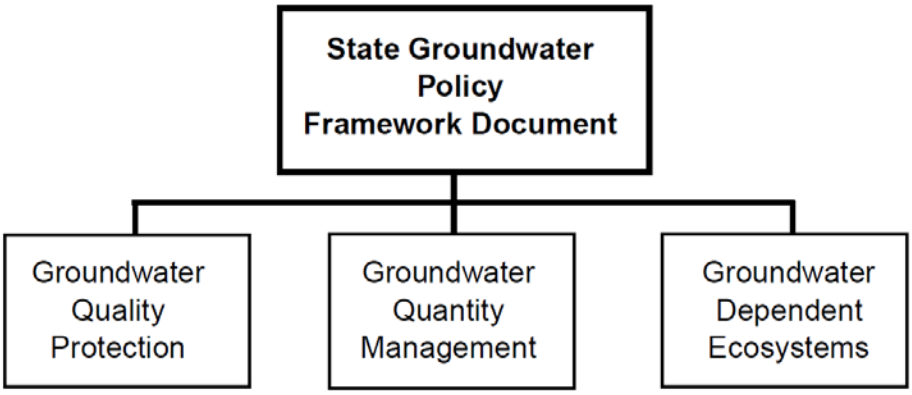


Plate 1.1 Relationship of NSW State Groundwater Policies

The principles outlined in these policies require the protection of groundwater quantity and quality for the towns and ecosystems that depend on it.

1.3.1 The NSW State Groundwater Policy Framework Document

The Goal for the management of groundwater in New South Wales is:

> *To manage the State's groundwater resources so that they can sustain environmental, social and economic uses for the people of NSW.*

1.3.1.1 Policy Objectives

It is the policy of the NSW Government to encourage the ecologically sustainable management of the State's groundwater resources, so as to:

- *slow and halt, or reverse any degradation of groundwater resources;*
- *ensure long term sustainability of the systems ecological support characteristics;*
- *maintain the full range of beneficial uses of these resources; and*
- *maximise economic benefit to the Region, State and Nation.*

1.3.1.2 Policy Principles

The State Groundwater Policy objectives will be achieved through application of the following resource management principles:

- *An ethos for the ecologically sustainable management of groundwater resources should be encouraged in all agencies, communities and individuals, who own, manage or use these resources, and its practical application facilitated.*
- *Non-sustainable resource uses should be phased out.*
- *Significant environmental and/or social values dependent on groundwater should be accorded special protection.*

- *Environmentally degrading processes and practices should be replaced with more efficient and ecologically sustainable alternatives.*
- *Where possible, environmentally degraded areas should be rehabilitated and their ecosystem support functions restored.*
- *Where appropriate, the management of surface and groundwater resources should be integrated.*
- *Groundwater management should be adaptive, to account for both increasing understanding of resource dynamics and changing community attitudes and needs.*
- *Groundwater management should be integrated with the wider environmental and resource management framework, and also with other policies dealing with human activities and land use, such as urban development, agriculture, industry, mining, energy, transport and tourism* (Department of Land and Water Conservation 1997).

As mentioned, the State Groundwater Policy encompasses three component policies. Clearly, and necessarily, these policies overlap and interrelate in many regards. They include the:

- Quality Protection Policy;
- Quantity Management Policy; and
- Dependent Ecosystems Policy.

In association with the Framework Document these policy documents make up the State Groundwater Policy. The Framework document sets out the overall direction of groundwater management in NSW and provides broad objectives and principles to guide management (as above). The component policies build on this approach and provide more detail and guidance on how to manage and protect groundwater quality, groundwater quantity and groundwater dependent ecosystems respectively (Department of Land and Water Conservation 1998).

1.3.2 The NSW Groundwater Quality Protection Policy

The Groundwater Quality Protection Policy is specifically designed to protect our valuable groundwater resources against pollution. Adoption of this Policy means that the sustainability of groundwater resources and their ecosystem support functions will be given explicit consideration in resource management decision making.

1.3.2.1 Policy Objectives

For groundwater quality protection, it is the policy of the NSW Government to encourage the ecologically sustainable management of the State's groundwater resources so as to:

- *slow and halt, or reverse any degradation in groundwater resources;*
- *direct potentially polluting activities to the most appropriate local geological setting so as to minimise the risk to groundwater;*
- *establish a methodology for reviewing new developments (industrial/mining/urban and rural) with respect to their potential impact on water resources that will provide protection to the resource commensurate with both the threat that the development poses and the value of the resource; and*
- *establish triggers for the use of more advanced groundwater protection tools such as groundwater vulnerability maps, or groundwater protection zones* (Department of Land and Water Conservation 1998).

1.3.2.2 Policy Principles

The Groundwater Quality Protection Policy adopts the principles outlined in the NSW State Groundwater Policy Framework Document. In relation to Groundwater Quality Protection, the following principles specifically apply:

- *All groundwater systems should be managed such that their most sensitive identified beneficial use (or environmental value) is maintained.*
- *Town water supplies should be afforded special protection against contamination.*
- *Groundwater pollution should be prevented so that future remediation is not required.*

- *For new developments, the scale and scope of work required to demonstrate adequate groundwater protection shall be commensurate with the risk the development poses to a groundwater system and the value of the groundwater resource.*
- *A groundwater pumper shall bear the responsibility for environmental damage or degradation caused by using groundwaters that are incompatible with soil, vegetation or receiving waters.*
- *Groundwater dependent ecosystems will be afforded protection.*
- *Groundwater quality protection should be integrated with the management of groundwater quantity.*
- *The cumulative impacts of developments on groundwater quality should be recognised by all those who manage, use, or impact on the resource.*
- *Where possible and practical, environmentally degraded areas should be rehabilitated and their ecosystem support functions restored* (Department of Land and Water Conservation 1998).

1.3.3 The NSW Groundwater Quantity Management Policy

The *NSW State Groundwater Quantity Management Policy (unpublished)* was aimed at managing extraction of groundwater within sustainable yields to ensure continuing availability of groundwater into the future and ensure the viability of groundwater dependant ecosystems. The quantity policy has been in draft form for approximately seven years and is not publicly available. The draft policy has essentially been superseded by the ongoing implementation of water sharing plans which detail quantity management for specific groundwater aquifers. The only current water sharing plan relevant to the highway upgrade is for the Bellinger River Area Unregulated and Alluvial Water Sources (2008). Review of the water sharing plan indicates no significant restrictions or implications for the highway upgrade.

1.3.4 The NSW Groundwater Dependent Ecosystems Policy

The State Groundwater Dependant Ecosystems Policy is specifically designed to protect our valuable ecosystems which rely on groundwater for survival so that, wherever possible, the ecological processes and biodiversity of these dependent ecosystems area maintained or restored, for the benefit of the present and future generations.

This Policy provides guidance on how to protect and manage these valuable natural systems in a practical sense. The range of tools that can be used to manage these ecosystems should be adapted to suit local conditions.

The following principles apply to the management of groundwater-dependent ecosystems in NSW:

1. *The scientific, ecological, aesthetic and economic values of groundwater-dependent ecosystems, and how threats to them may be avoided, should be identified and action taken to ensure that the most vulnerable and the most valuable ecosystems are protected.*
2. *Groundwater extraction should be managed within sustainable yield of aquifer systems, so that the ecological processes and biodiversity of their dependent ecosystems area maintained and/or restored. Management may involve establishment of threshold levels that are critical for ecosystem health, and controls on extraction in the proximity of groundwater dependent ecosystems.*
3. *Priority should be given to ensuring that sufficient groundwater of suitable quality is available at the time when it is need:*
   - *For protecting ecosystems which are known to be, or are most likely to be, groundwater dependent; and*
   - *For the groundwater dependent ecosystems which are under an immediate or high degree of threat from groundwater-related activities.*
4. *Where scientific knowledge is lacking, the Precautionary Principle should be applied to protect groundwater dependent ecosystems. The development of adaptive management systems and research to improve understanding of these ecosystems is essential to their management.*
5. *Planning, approval and management of development and land use activities should aim to minimise adverse impacts on groundwater dependent ecosystems by:*

- *Maintaining, where possible, natural patterns of groundwater flow and not disruption groundwater levels that are critical for ecosystems;*
- *Not polluting or causing adverse changes in groundwater quality; and*
- *Rehabilitating degraded groundwater systems where practical* (Department of Land and Water Conservation 2002)*.*

Groundwater Environment and Risks

This section provides background information regarding the groundwater environment and the general risks to groundwater posed by the highway upgrade. The information in this section is largely based on the environmental assessment by SKM (2010) for the highway upgrade. The purpose of this section is to provide the context to the groundwater monitoring program which is detailed in Section 4 of this report.

2.1 Topography and Geology

The study area comprises two major terrain units: the alluvial floodplains and the foothills of the coastal ranges. The floodplains comprise flat to gently sloping coastal plains and river terraces, with estuarine mud flats. The foothills are gently to moderately undulating hills, with wide river valleys and creeks. The characteristics of the geology and soils associated with the two units are:

- Floodplains: Quaternary alluvial and estuarine soils up to about 15 to 35 m thick. Alluvial estuarine soils: sands, silts, clays, organic clays, possible gravels, and potential acid sulfate soils.
- Foothills: Nambucca Beds (mainly phyllites with some slate and schists), with some granite intrusions and local granodiorite dykes. Soils: residual clay of high plasticity to less than 5m depth and alluvial/ colluvial sandy clay sediments in the small creeks (SKM, 2010a:422-423).

2.1.1 Floodplains

The soils on the floodplains and surrounding the waterways are fine-grained alluvial soils such as silty clays and sandy clays. Archaeological investigations also uncovered quartz gravel in some areas which would have a greater permeability. Compaction by livestock which was evident on much of the agricultural land along the highway upgrade, would act to reduce groundwater permeability (SKM, 2010c:27).

2.1.2 Foothills

Phyllite is a fine-grained rock formed from low grade metamorphism of claystones. Boreholes, up to 26 m in depth, encountered moderately to highly weathered phyllite. There is a gradual transition from weathered rock to residual clay soil. Rock below alluvial flats exhibited less weathered rock than those located in the ridgelines.

Boreholes encountered extensive quartz veining in the phyllite. The phyllite predominantly displays signs of increased weathering in the vicinity of the quartz veining, which is likely due to groundwater flow through the veining (SKM, 2010a:424).

2.2 Existing Groundwater Conditions

The EA indicates there are two main types of groundwater regimes likely to be found along the area of the highway upgrade based on geological types and groundwater levels observed in standpipe piezometers. These include:

- foothills; and
- alluvial floodplains.

2.2.1 Groundwater in Foothills

The phyllite in the hilly areas exhibits low permeability with the main groundwater transport route being defects in the rock, particularly along veins and foliation partings. Groundwater level measurements in these areas indicated that groundwater levels were generally greater than 10 m depth (SKM, 2010a:370).

2.2.2 Groundwater in Alluvial Floodplains

The groundwater tables found in the alluvial floodplains were high (less than five metres in depth) and typically reflected their proximity to the major water courses. Groundwater levels across the floodplains are likely to fluctuate due to tidal influences by up to 0.5 m (SKM, 2010a:370).

2.2.3 Groundwater Quality

There is limited data with respect to existing groundwater quality. Previous risk assessments of groundwater bores and monitoring programs indicate low risk of contamination of groundwater in the vicinity of the highway upgrade.

A desktop assessment including a site visit undertaken as part of the EA to identify potentially contaminating land uses indicated the risk to groundwater of contamination from heavy metals, pesticides and herbicides is considered to be low (SKM, 2010c:29).

2.3 Groundwater Dependent Ecosystems

Groundwater dependent ecosystems (GDEs) in the area of the highway upgrade include terrestrial vegetation, base flows in streams, aquifers, or wetlands. Those vegetation communities and habitats with the greatest potential to be affected by changing groundwater levels consist of terrestrial vegetation and wetlands located in the low-lying floodplain areas intersected by the proposed highway upgrade, including:

- Swamp oak floodplain forest;
- Swamp sclerophyll forest;
- Subtropical coastal floodplain forest;
- Lowland rainforest; and
- Freshwater wetlands.

Other vegetation communities within riparian areas may have some level of ground-water dependence, including wet sclerophyll forests in proximity to creek flats (SKM, 2010a:190-191).

2.4 Groundwater Users

A search of the NSW groundwater database in 2004 indicated the majority of groundwater bores in the vicinity of the highway upgrade are used for domestic supply with or without stock (SKM, 2010c:28).

2.5 Risks to Groundwater

The three main risks to groundwater posed by the highway upgrade include leaching of acid sulfate soils (ASS), contamination from accidental spills, and cuttings of the proposal intersecting or diverting groundwater from the existing groundwater regime and limiting base flow to waterways, wetlands and groundwater dependent ecosystems (GDEs).

2.5.1 Risks to Groundwater Quality - Leaching of Acid Sulfate Soils

Disturbance of ASS can occur during the construction process or through activities which lower the water table such as excavation and dewatering operations. These activities create the potential for oxidation of ASS and subsequent generation of acidic runoff to surface waters and acidic leachate to groundwater. This is generally a risk within the floodplain areas.

2.5.2 Risks to Groundwater Quality - Accidental Spills

Groundwater bores may be exposed to risk of impact from accidental spillages of fuels, oils and chemical agents associated with construction of the highway upgrade. Such pollutants may infiltrate to the groundwater and adversely affect groundwater quality. The EA concluded that the likelihood of significant impacts to groundwater quality from accidental spills is low (SKM, 2010c:52).

2.5.3 Risks to Groundwater Quantity – In-Stream Structures and Embankments

Groundwater barriers can form from construction of in-stream structures such as bridges, or embankments on soft soil which compresses and forms a less permeable layer of soil. The bridges that would be built would only impact groundwater movement in very localised areas and are therefore not considered to be a risk to groundwater flow. Construction of embankments should pose little risk to the formation of groundwater barriers (SKM, 2010c:53).

The Flora and Fauna Working Paper (SKM, 2010b) addressed the impact of in-stream structures or embankments on groundwater flow. There would be a greater impact on areas with naturally high water tables and saturated soils such as freshwater wetlands and swamps. However, in general, the Working Paper concluded that provision of minimum design standard drainage structures adjacent to wetlands and saturated soils is expected to mitigate the potential impacts from altered ground-water recharge rates and that a detectable change in groundwater levels is not expected (SKM, 2010b:169).

2.5.4 Risks to Groundwater Quantity - Cuttings

Geotechnical investigations have found that base flows to local creeks are provided largely by relatively shallow local and intermediate groundwater flow systems. This infers that any cutting that significantly diverts potential rainfall recharge away from the local shallow groundwater system, or intersects the water table significantly, is likely to diminish water discharges to the creeks and water bodies, therefore having secondary impacts on groundwater dependent ecosystems (GDEs) reliant on this recharge (SKM, 2010a:377-378).

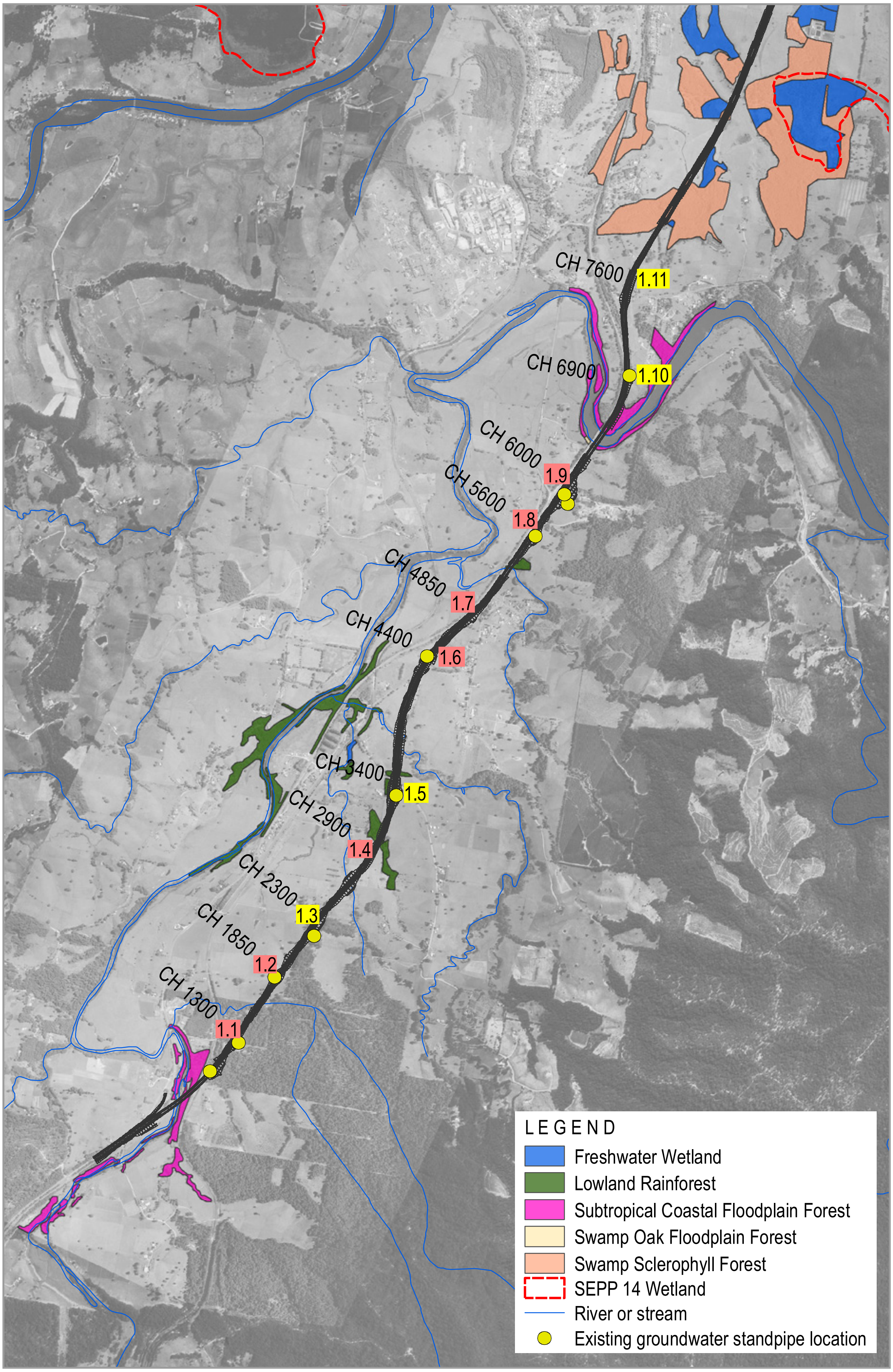
There are six cuttings considered to have a high risk and 15 cuttings considered to have a moderate risk of impacting surrounding ecosystems and groundwater sensitive areas – refer to Table 2.1 and Illustrations 2.1 to 2.4. Groundwater depths measured in close proximity to Warrell Creek and Nambucca River were in the range of 0.7 m depth to 3.0 m depth below ground level (SKM, 2010c:29). Elsewhere, groundwater depths were in the range of 10 m depth to 18 m depth below ground level (SKM, 2010c:29). The proposed depth of cut at cutting sites along the Warrell Creek to Nambucca Heads highway upgrade ranges from approximately 8 m to 17 m based on cutting depths reported in Table 6.2 in the EA (SKM, 2010a:111). A comparison of typical cutting depths and groundwater depths is shown in Table 2.2 of this report.

Table 2.1 Cuttings with a Moderate to High Risk of Groundwater Impact

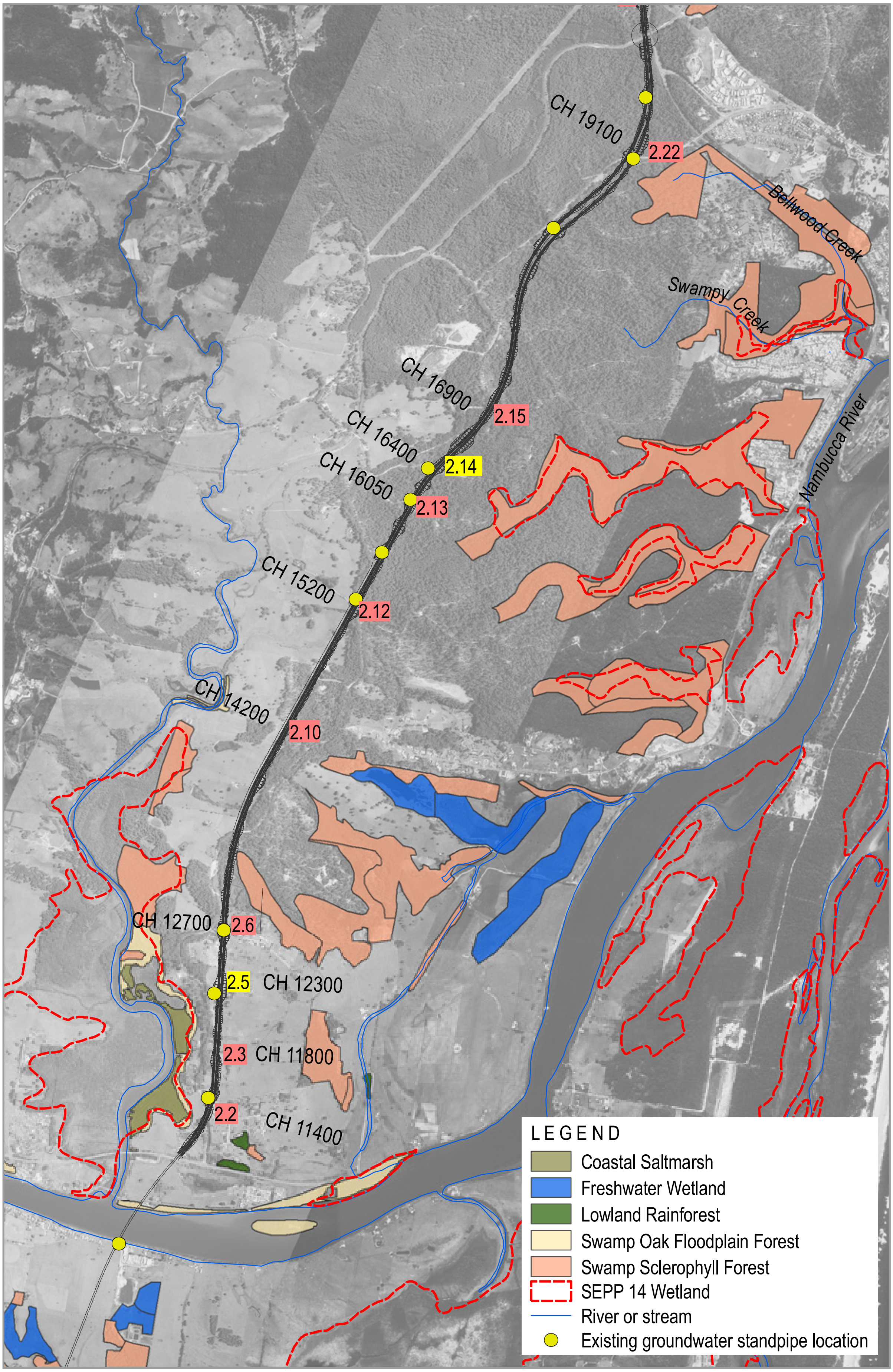
Classification	*Numbers of Cuttings within Category*[1]	*Cutting Identifiers*[1]
High Risk – cuttings with a significant depth of excavation into the topography (> 12 m depth), a large length and area of extent, and/or with known EECs, creeks, bores or structures in the immediate vicinity of the cutting (within approx. 250 m).	Section 1: four Section 2: two Total: six	Section 1: 1.3, 1.5, 1.10, 1.11 Section 2: 2.5 and 2.14
Moderate Risk – cuttings with a moderate depth of excavation into the topography (5 - 12 m depth), a small to moderate length and area of extent, and/or with known EECs, creeks, bores or structures in the vicinity of the cut (within approx. 500 m).	Section 1: seven Section 2: eight Total: 15	Section 1: 1.1, 1.2, 1.4, 1.6, 1.7, 1.8, 1.9 Section 2: 2.2, 2.3, 2.6, 2.10, 2.12, 2.13, 2.15, 2.22

Source: Table 16-4 in SKM, 2010a:379

Notes: 1. Section 1 and 2 refer to sections of the WC2U highway upgrade as described in the EA documents (SKM, 2010a). Section 1 is from approximate design chainage 0 to 10,700 [project chainage 0 to 52, 465] (Allgomera Deviation to the northern bank of the Nambucca River) and Section 2 from 10,700 to 19,500 [project chainage 52, 465 to 61,265] (the northern bank of the Nambucca River to the railway crossing west of Nambucca Heads).



Cuttings with a Moderate to High Groundwater Risk - Ch 0 to 9600 (Project Chainage 41,870 to 51,365)



Cuttings with a Moderate to High Groundwater Risk - Ch 9600 to 19500 (Project Chainage 51,365 to 61,265))

Table 2.2 Typical Cutting Depths and Groundwater Depths

Section of Proposed Highway[1]	*Approximate Cutting Depth*[2]		*Groundwater Depth (m below ground level)*[3]	
	Max. Cut	*Typical Cut*	*Depth*	*Dates of Sampling*
Section 1 - design chainage 0 to 10,700 (project chainage 0 to 52, 465)	17 m	12 m	12.78 0.70 9.90 – 10.65 2.95	1/03/08 1/03/08 1/03/08 & 25/07/08 25/07/08
Section 2 - design chainage 10,700 to 19,500 (project chainage 52, 465 to 61,265)	16 m	8 m	12.34 12.35 – 13.03 17.89 – 18.22	10/02/08 2/10/07 & 6/10/07 2/10/07, 10/02/08 & 1/03/08

Notes:
1. Section 1 and 2 refer to sections of the WC2U highway upgrade as described in the EA documents (SKM, 2010a). Section 1 is from approximate design chainage 0 to 10,700 [project chainage 0 to 52, 265] (Allgomera Deviation to the northern bank of the Nambucca River) and Section 2 from 10,700 to 19,500 [project chainage 52, 465 to 61,265] (the northern bank of Nambucca River to the railway crossing west of Nambucca Heads).
2. Source: Table 6-2 in SKM, 2010a:111
3. Source: Table 4-1 in SKM, 2010c:29

The Flora and Fauna Working Paper (SKM, 2010b) also highlights the potential for altered hydrology regimes to impact on SEPP 14 wetlands including Gumma Swamp south of Nambucca River and Newee Creek (SKM, 2010b:170).

2.6 Management of Risks to Groundwater

The Water Quality Working Paper (SKM, 2010c) states that the main safeguards to protect groundwater quantity and quality involve mitigation of impacts from accidents and spills, mitigation of impacts from cuttings, groundwater monitoring, and minimising excavation and lowering the water table in acid sulfate soil areas. In respect to the management of groundwater impacts to GDEs and SEPP 14 wetlands, the Flora and Fauna Working Paper (SKM, 2010b:196) states that the highway will be designed to minimise impacts to hydrological regimes.

2.6.1 Groundwater Monitoring

2.6.1.1 Pre-construction and Construction Stage

To quantitatively assess possible groundwater impacts, management requirements, or mitigation measures, the EA recommended that baseline monitoring of both groundwater levels and chemical quality be completed at selected cutting sites at the detail design stage. Establishing these monitoring systems will help to resolve the uncertainty of groundwater behaviour, which will be especially important at cutting sites which may potentially impact upon features such as springs, creeks, and endangered ecological communities. The EA (SKM, 2010a) recommends monitoring of selected cutting sites should commence in advance of construction and comprise the following:

- installation and monitoring of groundwater wells (potentially nested or multi-level) prior to road construction;
- hydraulic tests (falling head) to estimate hydraulic conductivities of the shallow and possible deep aquifer systems that the cuts may intersect (prior to road construction);
- groundwater sampling and analysis for at least total dissolved solids, pH, and heavy metals and hydrocarbon compounds prior to, during, and following road construction to identify whether base flow to creeks is provided by the groundwater systems;
- monitoring of cuttings to determine whether these are having an adverse impact on water quality;

- visual observations and quantitative measurements of surface water flows at creeks;
- an assessment of the condition of endangered ecological communities; and
- where there is the potential for adverse impacts on groundwater, measures including the use of groundwater diversion systems would be included in the detailed design.

2.6.1.2 Operational Stage

Groundwater monitoring will continue throughout the early years of operation at a frequency to be determined (potentially quarterly). The objective of monitoring would be to verify the validity of groundwater levels, and to flag adverse trends.

At cuttings where mitigation measures are implemented, monitoring may permit an early assessment of groundwater behaviour in response to the mitigation measures and verify the effective functioning of those measures.

The transfer of seepage or extracted water downstream to maintain local groundwater levels may be required. Transfer could include the collection of seepage from the cut face in the drainage system which would be diverted to absorption trenches or to water quality ponds to be tested and possibly treated before being released back to the creek or natural drainage system at some point downstream.

During construction, storage of potentially harmful materials would be undertaken away from watercourses and within impermeable, bunded facilities to protect water quality from accidents and spills. Spill contingency equipment would also be stored in close proximity (SKM, 2010c:69).

During operation the concept design includes scope for inclusion of spill contingency measures, which capture accidental spillages to ensure that they are not released directly to the environment (SKM, 2010c:69).

2.6.2 Management of Impacts from Cuttings

The Water Quality Working Paper (SKM, 2010c) outlines the following measures. If seepages in the batter face of road cuttings develop due to interception of a permeable layer of soil/ rock, sub-horizon drains should be installed to relieve the water pressure in the batter. If seepages develop from interception of a perched water table, engineering mitigation measures need to be installed to transfer the seepage water into the groundwater ecosystem immediately downslope of the cut. These measures should involve collecting the seepage water from the cut face just above the level of the road and piping it under the cut/fill platform to the downslope side of the highway. The water could either be returned to the ground through absorption trenches, or held in water quality ponds to be tested and possibly treated before being discharged back into the surface water system (SKM, 2010c:69).

2.6.3 Management of Acid Sulfate Soils

Management of acid sulfate soils (ASS) will be adequately addressed with the implementation of an acid sulfate soil management plan as part of the construction soil and water management plan. This will include:

- avoidance or minimising the disturbance of ASS by minimising excavation or lowering the water table in ASS areas; and
- treatment of acid generation where ASS is disturbed (SKM, 2010c:68).

2.6.4 Management of Accidental Spills

In terms of protecting water quality from accidents and spills during construction, storage of potentially harmful materials would be undertaken away from watercourses and within impermeable, bunded facilities. Spill contingency equipment would also be stored in close proximity. During operation the concept design includes scope for inclusion of spill contingency measures, which capture accidental spillages to ensure that they are not released directly to the environment (SKM, 2010c:68).

Monitoring Objectives

3.1 RMS and NSW Government Policy and Objectives

3.1.1 RMS Water Policy

The NSW Roads and Maritime Services' commitment to water management as outlined in the RTA Water Policy states:

> *"The RTA 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; and*
> - *preserve ecosystems."*

The general water quality objectives described in the RMS Code of Practice for Water Management (RTA, 1999) essentially aim at minimising potential impacts on the environment as indicated in the following general principles:

- Pre-Construction – the project design is to target the minimisation of impacts on the groundwater regimes in and around road corridors and designs will incorporate appropriate techniques to contain and treat road run-off to avoid or minimise potential impacts to aquatic and riparian environments (RTA,1999:8);
- Construction – Effective water management practices and procedures will be implemented, in accordance with the Construction Environment Management Plan/ SWMP, as an integral part of on-site construction management to ensure that water quality and quantity impacts to the environment are minimised (RTA, 1999:10); and
- Operational – The RTA will investigate and incorporate appropriate pollution control technologies on existing major roads and bridges to contain and treat road run-off, wherever practical and cost-effective, in order to minimise potential impacts on the environment (RTA, 1999:13).

3.1.2 NSW Government Policy

As described in Section 1, the NSW State Groundwater Policy Framework Document has a range of broad objectives and principles including:

- managing groundwater systems such that their most sensitive identified beneficial use (or environmental value) is maintained;
- ensuring the viability of groundwater dependant ecosystems by:
  - maintaining, where possible, natural patterns of groundwater flow and not disruption groundwater levels that are critical for ecosystems; and
  - not polluting or causing adverse changes in groundwater quality.

3.1.3 Link with this Groundwater Monitoring Program

This Groundwater Monitoring Program links with the above objectives by providing groundwater levels and quality information to assess the impacts of the highway upgrade on the groundwater in the study area. This is the general objective of the Statement of Commitment No. W3:- *Monitoring of groundwater impacts and surface water quality upstream and downstream of the site during construction will determine the effectiveness of mitigation strategies. Implementation of additional feasible and reasonable management measures will occur if necessary*.

3.2 Monitoring Objectives

The primary objective of this Groundwater Monitoring Program is to evaluate the impact of the highway upgrade on groundwater levels and quality in the study area from Warrell Creek to Nambucca Heads.

To achieve the above monitoring objective, this report provides the following information:

- parameters for monitoring during pre-construction, construction and operational stages;
- monitoring locations for groundwater levels and groundwater quality;
- a monitoring program to establish baseline groundwater levels and quality data in areas where the highway upgrade is most likely to impact on groundwater;
- a monitoring program to identify impacts of the highway upgrade on groundwater levels and quality; and
- a monitoring program to help assess and refine groundwater management measures.

3.3 Monitoring Approach

The type of monitoring study to be employed is one that measures change (i.e. any change in groundwater levels and quality as a result of the highway upgrade). The general category of design for this monitoring program is the before–after, control–impact (BACI) type design as described in ANZECC ARMCANZ (2000b:3-3). This essentially involves monitoring two sites before and after the disturbance occurs (pre-construction and construction/ operation). The two sites comprise one that will be subjected to the disturbance (an 'impact' site) and one that will not (a 'control' site). The same parameters are monitored at both 'control' and 'impact' sites before and after the highway upgrade to determine whether or not the pattern of behaviour over time at the impact site(s) change relative to the control sites.

3.3.1 Defining the Control and Impact Site

The Groundwater Monitoring Program nominates sites on opposite sides at selected cuttings which are most likely to impact environmental features such as springs, creeks and endangered ecological communities (typically Type A cuttings in Table 16-4 of the EA (SKM, 2010a:394)):

- the monitoring site that is hydraulically downslope of the cutting will represent the 'impact' site; and
- the monitoring site that is hydraulically upslope of the cutting will represent the 'control' site.

It should be noted there is likely to be some 'natural' variation or difference in groundwater levels and quality between the upslope and downslope sampling sites at the pre-construction stage (pre-disturbance). A measure or sense of this 'natural' variation or difference will be established from the pre-construction monitoring. This 'natural' variation will then be incorporated into the analysis of the construction/ operational stage monitoring to ensure it is not misinterpreted as an impact of the highway upgrade.

3.4 Statistical Analysis

The technique for comparing sampling results and baseline data or trigger values will be either by the use of tabulated results or control charts (or a combination of both) as described in ANZECC ARMCANZ (2000b:6-17). This is discussed further in **Section 5** of this document.

Monitoring Program

4.1 Monitoring Site Locations

Selection of the groundwater monitoring sites is largely based on the cutting sites that were classified as high-risk in the EA (SKM, 2010a) – refer to Table 2.1. Cuttings classified as high-risk in the EA have a significant depth of excavation (> 12 m depth); a large length and area; and/or there are known EECs, creeks, bores or structures in the immediate vicinity of the cutting (within approx. 250 m).

In addition to the cutting sites, a monitoring site is required in an area of embankment fill on the Nambucca River floodplain adjacent to a freshwater wetland and within 200 m to SEPP 14 wetland No. 388 ('Gumma Swamp') at Chainage 9,200 (Project Chainage 50,965):. This monitoring site will be used to assess if the embankment is creating a groundwater barrier due to soil compression resulting in a less permeable layer of soil (refer to risks in Section 2.5.3).

The selected groundwater monitoring sites are shown in Illustrations 4.1 to 4.2 and comprise:

- Chainage 3,400 (Project Chainage 45,165): Cutting No. 1.5 (Cut 6) on the west of the alignment (Type A high-risk cutting);
- Chainage 6,900 (Project Chainage 48,665): Cutting No. 1.10 (Cut 11) on the east and west of the alignment (Type A high-risk cutting);
- Chainage 7,600 (Project Chainage 49,365): Cutting No. 1.11 (Cut 12) on the west of the alignment (Type A high-risk cutting);
- Chainage 9,200 (Project Chainage 50,965): embankment fill adjacent to freshwater wetland EEC and upslope of SEPP 14 wetland No. 388 ('Gumma Swamp') on the east and west of the alignment;
- Chainage 12,300 (Project Chainage 54,065): Cutting No. 2.5 (Cut 15) on the east and west of the alignment (Type A high-risk cutting).

Monitoring bores will be located within the project boundary of the highway upgrade. The monitoring bores will be located near the project boundary to avoid impacting on construction works and to safeguard against an induced gradient from the cut impacting on groundwater levels at the monitoring location. Based on preliminary information it is estimated that there will not be an impact from induced gradients, however the suitability of the locations will be reassessed following review of the pre-construction phase monitoring results (refer to Section 5.1.1). The monitoring bores will be located approximately at the mid-point of the length of the cut for the cutting sites.

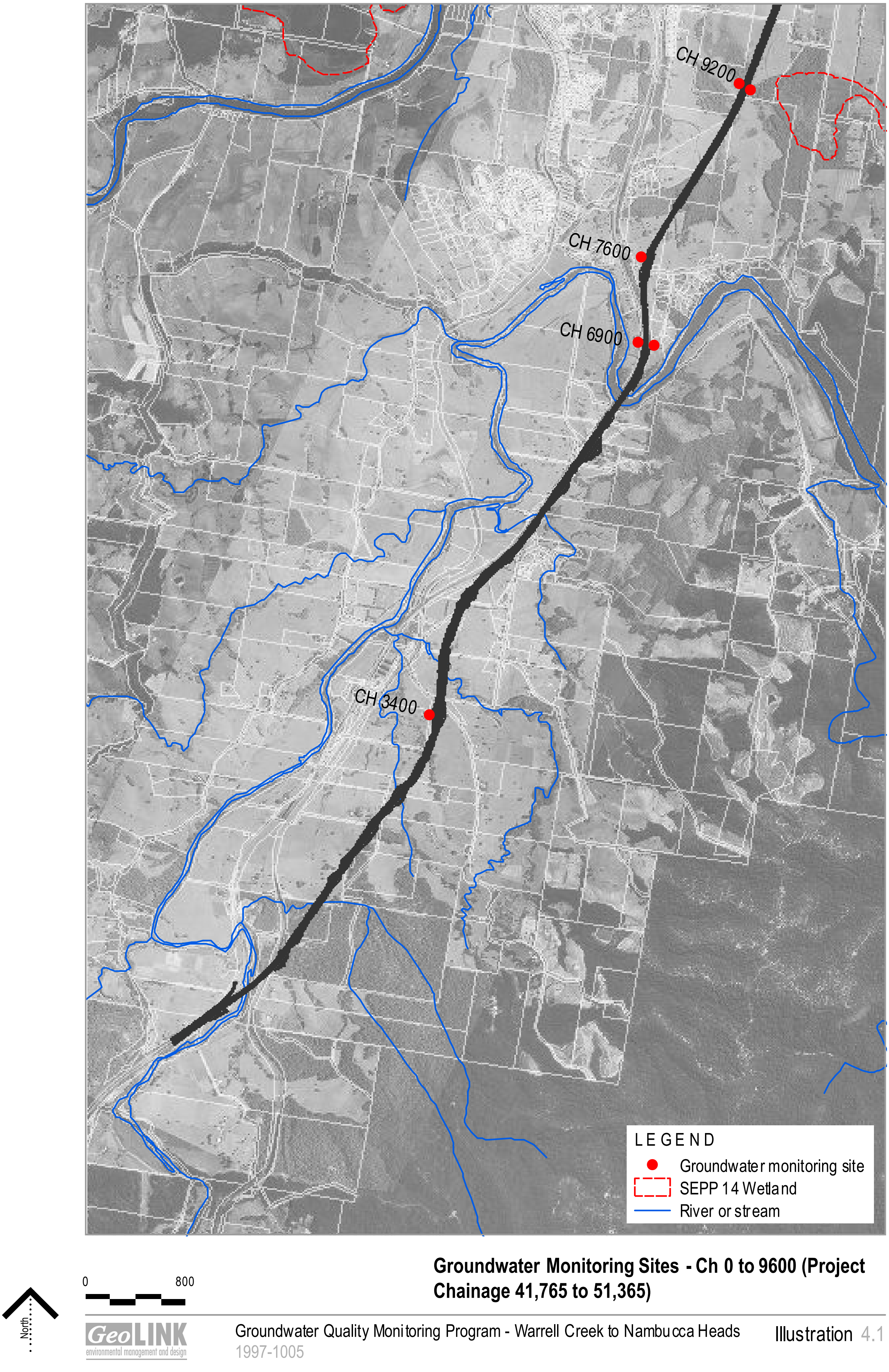
If any monitoring sites need to be adjusted at any stage of the project, the adjustments will need to be approved by RMS in consultation with the Environmental Review Group for the project.

It is noted that areas of ASS are not specifically nominated for monitoring as this is not considered a significant risk to groundwater for the WC2NH highway upgrade. The main ASS risks to groundwater are associated with lowering the water table during excavation and dewatering operations in the construction stage. The acid sulfate soil management plan for the construction stage will adequately address these risks and avoid any significant lowering of the water table in ASS areas. The acid sulfate soil management plan will also monitor water quality downstream of ASS risk areas to allow early identification of ASS leachate. Therefore, it is not considered necessary to monitor ASS areas as part of the groundwater monitoring program.

Drawn by: AB Checked by: RE Reviewed by: DMT Date: 19/01/2017

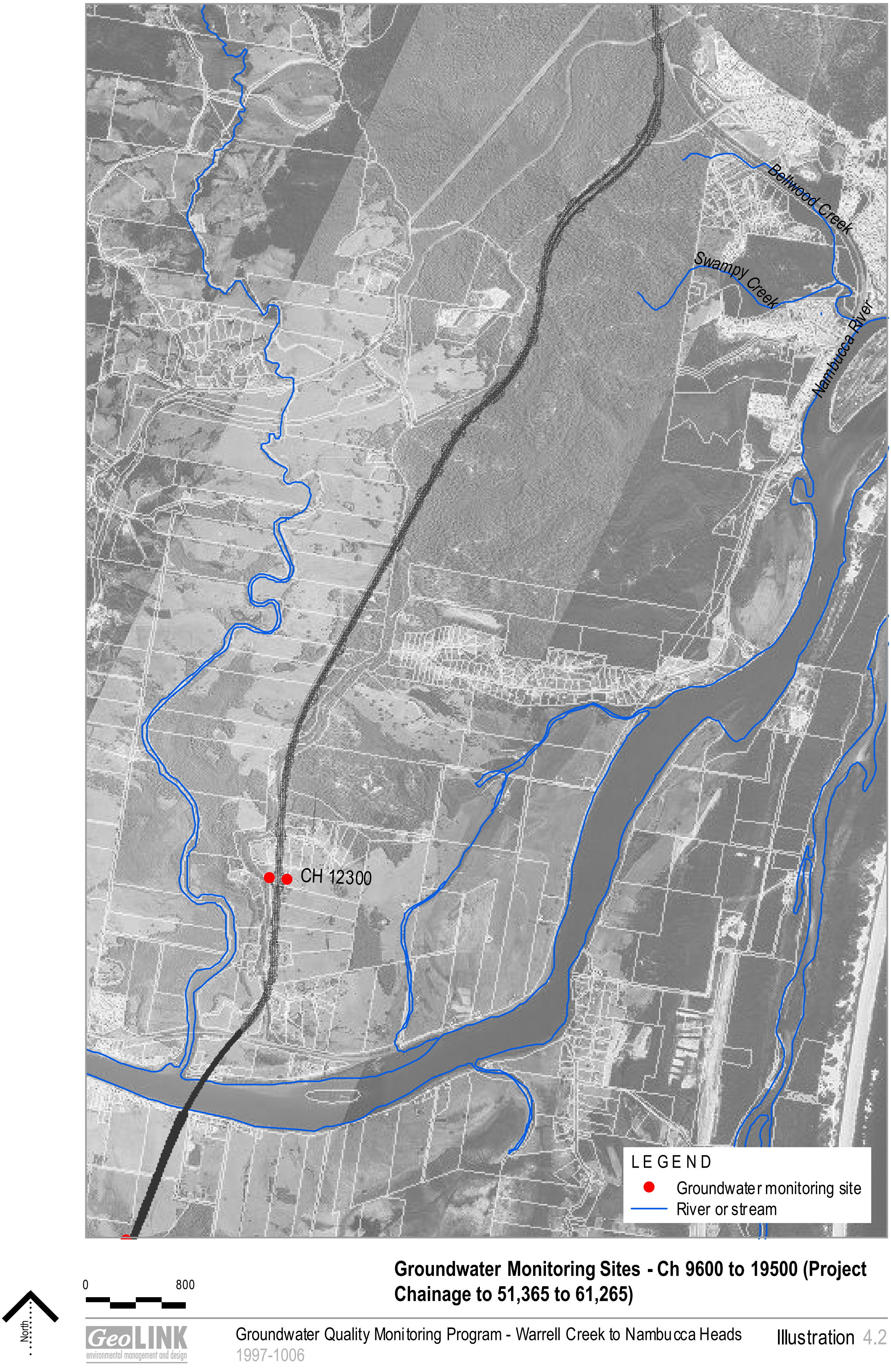
Source of base data: NSW RMS

Information shown is for illustrative purposes only



Groundwater Monitoring Sites - Ch 0 to 9600 (Project Chainage 41,765 to 51,365)

GeoLINK environmental management and design



Groundwater Monitoring Sites - Ch 9600 to 19500 (Project Chainage to 51,365 to 61,265)

Plate 4.1 Monitoring Sites for Project Chainage 45,165: Cut 6 (Type A high-risk cutting)

Plate 4.2 Monitoring Sites for Project Chainage 48,665 : Cut 11 (Type A high-risk cutting)

Plate 4.3 Monitoring Sites for Project Chainage 49,365 : Cut 12 (Type A high-risk cutting)

Plate 4.4 Monitoring Sites for Project Chainage 50,965: embankment fill adjacent to freshwater wetland EEC and upslope of SEPP 14 wetland No. 388 ('Gumma Swamp')

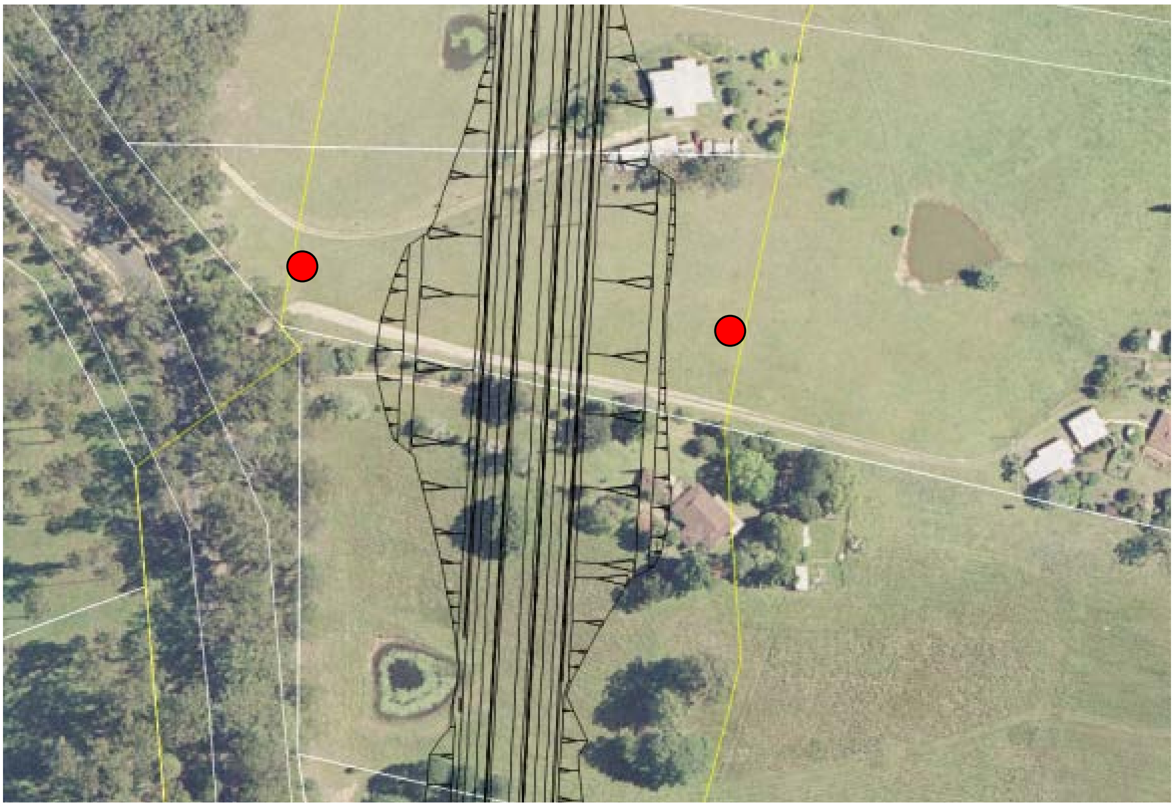


Plate 4.5 Monitoring Sites for Project Chainage 54,065 : Cut 15 (Type A high-risk cutting)

4.2 Monitoring Parameters

4.2.1 Groundwater Levels

Groundwater level monitoring will be undertaken at each of the monitoring sites using automatic water level recorders and will involve potentially nested or multi-level monitoring.

4.2.2 Groundwater Quality

The groundwater quality parameters to be monitored at each of the monitoring sites are outlined below in **Table 4.1**. These parameters are based on RMS *Guideline for Construction Water Quality Monitoring* (RTA, undated) and other literature.

Table 4.1 Groundwater Quality Monitoring Parameters

Indicators / Parameters	*Analytical Group*	*Analytes*	*Analysis Method*
Groundwater Quality Indicators	Physical and chemical properties	pH, Electrical Conductivity (EC), Temperature	Field measurement
Groundwater Quality Parameters	Physical properties	Total dissolved solids (TDS)	Laboratory analysis
	Hydrocarbons	Total petroleum hydrocarbons	Laboratory analysis
	Heavy Metals	Aluminium (Al), Arsenic (As), Cadmium (Cd), Chromium (Cr), Copper (Cu), Iron (Fe), Lead (Pb), Manganese (Mn), Mercury (Hg), Nickel (Ni), Selenium (Se), Silver (Ag), Zinc (Zn)	Laboratory analysis
	Nutrients	Total Nitrogen (TN), Nitrate (NO_3), Ammonia (NH_3), Total Phosphorus (TP), Phosphate (PO_4)	Laboratory analysis
	Major Anions[1]	chloride (Cl^-), sulfate (SO_4^{2-}), bicarbonate (HCO^{3-}), nitrate (NO^{3-})	Laboratory analysis
	Major Cations[1]	sodium (Na^+), potassium (K^+), calcium (Ca^{2+}) and magnesium (Mg^{2+})	Laboratory analysis

Notes: 1. Based on Sundaram *et. al.,* (2009) – these listed species represent the majority of ions in groundwater

4.2.3 Daily Rainfall

Daily rainfall figures from the construction site/ nearest Bureau of Meteorology sites will be recorded as part of the monitoring program for correlation with groundwater level monitoring.

4.3 Monitoring Duration

The durations of the various phases of the monitoring program are:

- Pre-construction phase (prior to the commencement of any Construction as defined in the project approval): a minimum of six months;
- Construction phase (following commencement of any Construction as defined in the project approval): for the duration of the construction period; and
- Operational phase: a minimum of three years following completion of Construction as defined in the project approval or until any disturbed waterways/ groundwater resources are certified by an

independent expert as being rehabilitated to an acceptable condition (refer to Condition of Approval B17 in Section 1.2.3 of this report).

4.4 Sampling Frequency

The sampling frequencies are outlined in Table 4.2. The nominated sampling frequencies for groundwater levels and groundwater quality indicators for the construction period may be reduced following construction of the cuttings/ embankments if the results indicate no significant variation between sampling events. Any reduction in the proposed frequency below must be discussed and agreed by the Environmental Review Group at the Environmental Review Group meetings.

Should monitoring observations at particular sites confirm that no significant water quality impacts are occurring (eg. water quality is consistently good or below the trigger values outlined in this plan for a minimum period of 3 months), then some parameters may be removed from the monitoring program at those locations (or they may be sampled less frequently) following approval by RMS. If individual parameters or sites are to be withdrawn from the program it should be demonstrated that there is no longer an impact over a minimum period of 3 months and that the corresponding construction site catchment is adequately stabilised and permanent works effectively completed. Consultation with RMS, EPA and DPI (Fishing and Aquaculture) will be undertaken for any proposed alterations to the monitoring program with respect to parameters, sites, and sampling frequency.

Table 4.2 Monitoring Frequency at Each Site

Parameter	*Pre-Construction*	*Construction*	*Operation*
Groundwater Levels	Automatic water level recorders set to take readings at a maximum of 1 hour intervals with a maximum 3 monthly period between downloads and calibration[1]		
Groundwater Quality Indicators[2]	Twice-monthly	Monthly[1]	Quarterly
Groundwater Quality Parameters[2]	Monthly	Quarterly	Six monthly

Notes: 1. refer to discussion in paragraph above the table;
2. refer to Table 4.1 for associated parameters.

4.5 Sampling Protocol

Monitoring of the quality of groundwater involves techniques different from those used for surface water quality investigations because groundwater, by its very nature, cannot be sampled without some disturbance from the construction of a bore or other access hole and the effects of sampling devices and procedures. These may also cause chemical and biological contamination unless stringent precautions are taken. Hence sampling staff must make extreme effort to ensure that the samples are representative of the water in the aquifer. Groundwater sampling will be carried out by experienced field staff or in close consultation with experts to ensure sample integrity (ANZECC ARMCANZ, 2000b:4-7).

4.5.1 Groundwater Level Measurements

The total depth of the bore and depth to the water level will be measured within the bore before any purging and sampling. All depth measurements will be related back to Australian Height Datum (AHD).

The total depth of the bore is required as the base of the monitoring bores can silt up, and this can occur to the top of the slotted/ screened interval. Comparing the measured total depth reading with the depth documented at the time of construction can be useful to determine the status of the bore (Sundaram *et. al.,* 2009:24).

The depth to the water level in the bore will be measured and recorded before every sampling event.

4.5.2 Groundwater Quality Sampling Collection

There are three main methods of sampling that can be employed to obtain a representative groundwater sample. These are: bore purging method; low flow sampling method; and passive groundwater sampling (i.e. 'no-flow' or 'no-purge' sampling). Sample collection will comply with the NSW EPA's *Approved Methods for the Sampling and Interpretation of Results of Water Pollutants in NSW* (Department of Environment and Conservation, 2004), Geoscience Australia's *Groundwater Sampling and Analysis – A Field Guide* (Sundaram *et. al.*, 2009) and contemporary industry standards.

Protocols to include the following basic precautions for avoiding contamination during sample collection:

- field measurements to be made on separate sub-samples of water;
- new or reused sample containers must be appropriately cleaned (use of containers supplied by the analytical laboratory is recommended);
- all field equipment is pre-cleaned to the same standard as the containers;
- sample bottles suitable for each parameter to be used;
- containers are uncapped or removed from their transport bags for minimum amounts of time;
- containers that were filled with water as part of the preparation protocol are emptied well away from and downstream of the sampling location before being rinsed with sample and refilled; and
- sampling staff must use plastic disposable gloves when handling sample containers at every stage during sampling (to avoid touching the sample, and the insides of caps or containers) ANZECC ARMCANZ (2000b:4-11,4-14).

4.5.3 Field Measurements

Some parameters (e.g. temperature) can only be measured in the field. For other parameters, field measurements are necessary because the value of the parameter might change in the sample after collection ANZECC ARMCANZ (2000b:4-1). The following parameters will be measured in the field:

- Electrical Conductivity (EC);
- Temperature; and
- pH.

4.5.4 Sampling for Groundwater Quality Parameters

Sampling protocol will follow standard procedures as outlined in documents such as Australian Standard AS/NZS 5667 and *Australian guidelines for water quality monitoring and reporting* (ANZECC ARMCANZ, 2000b).

4.5.5 Field Observations

At each visit, the following information will be recorded on a field-record sheet (based on information in ANZECC ARMCANZ, 2000b):

- The exact locations of sampling sites;
- Weather conditions;
- The date and time when samples are taken (standard or daylight-saving time);
- Any other observations or information on the conditions at the time of sampling that may assist in interpretation of the data;
- Photographic records are also highly desirable for future reference.

4.5.6 Replicate Water Samples

One blind replicate water sample will be collected for each monitoring event. This is based on the general requirement of one blind sample for every 20 samples.

4.5.7 Tracking Samples and Field Data

During sampling or field measurements, field data sheets or similar records that describes the samples taken, their labels and other relevant details will be completed (see Section 4.4.5 - Field Observations). All field data and instrument calibration data are recorded on this sheet. All field records must be completed before leaving a sampling station. Any observations or information on the conditions at the time of sampling that may assist in interpretation of the data will be noted on a field-record sheet. Chain of custody documentation that will be recorded as part of the sampling program is listed in Table 4.3.

Table 4.3 Chain of Custody Documentation

Process Step	*Quality Assurance Procedure*
Field sampling	Field register of sample number, site, type/technique, time, date, technician, field data sheet
Sample storage and transport	Field register of transport container number and sample numbers, time, date
Laboratory receipt of samples	Laboratory register of transport container number and sample numbers, time, date
Laboratory storage of samples	Laboratory register of storage location, type, temperature, time, date
Sample preparation	Analysis register of sample (laboratory) number, pre-treatment, date, technician
Sample analysis	Analysis register of instrument, calibration, technician, standard method, date, result

Source: Table 4.6 in ANZECC ARMCANZ (2000b:4-14)

4.5.8 Sample Identification

Sample containers will be marked in a clear and durable manner in order to permit clear identification of all samples in the laboratory. Blind replicate samples will be submitted to the laboratory as individual samples without any indication to the laboratory that they are replicates.

4.5.9 Sample Preservation

Water samples are susceptible to change as a result of physical, chemical or biological reactions which may take place between the time of sampling and the analysis. These changes are often sufficiently rapid to modify the sample considerably in the space of several hours.

All samples will be stored in a refrigerated state immediately following sampling.

The preservation of samples to be analysed for heavy metals may require acidification in the field (which would necessitate the use of separate sample containers for the heavy metals sample) or acidification in the laboratory within 6 hours of sampling. Liaison with the analytical laboratory will be undertaken to confirm the most appropriate method of preservation of the heavy metals samples.

4.5.10 Sample Transport

Samples will be transported according to the relevant parts of Australian Standard AS/NZS 5667.1:1998. The time between sampling and analysis will be reported.

4.6 Sample Analysis

Any laboratory used for sample analysis must be National Association of Testing Authorities (NATA) registered for each analysis required.

Parameters that require laboratory analysis are:

- physical properties: Total dissolved solids (TDS);
- hydrocarbons;
- nutrients;
- heavy metals;
- major anions; and
- major cations.

Data Analysis and Interpretation

5.1 Data Analysis

5.1.1 Pre-Construction Monitoring Data

Data analysis of the pre-construction monitoring results will aim to establish baseline data and an indication of the degree of variation for groundwater levels and each water quality parameter for existing conditions.

Analysis of the pre-construction data will assess the existing variation in groundwater levels and water quality between the upslope and downslope sampling sites (in respect to groundwater gradient) at each monitoring location. This existing variation will be incorporated into the analysis of the construction/ operational stage monitoring to ensure it is not misinterpreted as an impact of the highway upgrade.

The location of the monitoring bores at the cutting sites will also need to be reviewed in consideration of the depths to groundwater and proposed depth of cutting, to assess whether the cutting will result in an induced groundwater gradient that will impact on groundwater levels at the monitoring location. If it is considered the monitoring location will be impacted by an induced gradient then the monitoring bore location will be re-established outside the zone of induced gradient.

5.1.2 Trigger Values

The pre-construction data will provide an indication of baseline conditions and the degree of variation for groundwater levels and each water quality parameter for existing conditions which will be used for comparison with construction and operational sampling results.

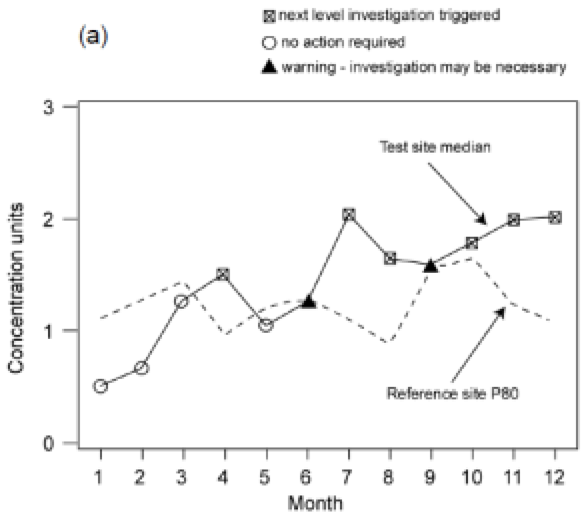
To assist the comparison of construction/ operational sampling results with the pre-construction data, a comparison of median data versus 80th and 20th percentile data will be employed. This will involve comparing the median values of the hydraulically down-gradient data with the 80th and 20th percentile of values of the hydraulically up-gradient data at each monitoring site location. This comparison is aimed at ensuring the down-gradient median values for each parameter are lower than the up-gradient 80th percentile of values or greater than the up-gradient 20th percentile for parameters where low values are the problem. Thus the 80th and 20th percentiles will be used as trigger values (ANZECC ARMCANZ, 2000b:6-17).

It is noted that the use of the down-gradient median value comparison with the up-gradient 80th/ 20th percentiles will include consideration of the pre-construction variation (or 'natural' difference) in groundwater levels and water quality between the up-gradient and down-gradient sampling sites at each monitoring location as discussed in **Section 5.1.1**.

5.1.3 Comparison of Sampling Data and Trigger Values

The technique for comparing sampling results and baseline data or trigger values will the use either tabulated results or control charts (or a combination of both).

An example of the use of control charts for the comparison of down-gradient median value with the up-gradient 80th/ 20th percentiles is shown in **Plate 5.1**. Here, the monthly results for a test parameter for a monitoring location are graphed in a control chart whereby the test site results (at the down-gradient or 'impact' site) are compared to the trigger value using the 80th/ 20th percentile from the adjusted reference site data (up-gradient monitoring location).



Source: Figure 6.7 in ANZECC ARMCANZ, 2000b:6-19

Plate 5.1 Example Control Chart

5.2 Data Interpretation

After the data analysis, the results will be collated into a concise statistical summary and assessed in the context of the monitoring objectives below.

5.2.1 Pre-Construction Stage

Data interpretation for the pre-construction stage monitoring will:

- Establish the relative difference in groundwater levels between the up-gradient and down-gradient side at the monitoring sites (refer to Section 5.1.1);
- Establish if there is any significant difference in groundwater quality between the up-gradient and down-gradient side at the monitoring sites (refer to Section 5.1.1);
- Adjust control site data to accurately account for the difference in the pre-construction monitoring results between the upslope and downslope side at the selected cutting sites (refer to Section 5.1.1);
- Establish baseline groundwater levels and quality data for the project.

5.2.2 Construction Stage

Data interpretation for the construction stage monitoring will address:

- identification of impacts of the highway upgrade construction on groundwater levels and quality; and
- determination of any required refinement of construction groundwater management measures.

5.2.3 Operational Stage

Data interpretation for the operational stage monitoring will address:

- identification of impacts of the highway upgrade operation on groundwater levels and quality; and
- determination of any required adjustment of operational groundwater management measures and stabilisation works.

5.3 Reporting

5.3.1 Pre-Construction Stage

At the completion of the pre-construction stage monitoring a report will be produced containing full and complete details of all aspects of the study. The report will include:

- introduction and background: description of the program and objectives and delineating the study boundary;
- experimental detail, describing the study location and study design, including detail of the sampling locations so they can be unambiguously identified, e.g. GPS directions and descriptions of methods of sampling and analysis;
- presentation, interpretation and discussion of the results including addressing the items outlined in Section 5.2.1 and the Statement of Commitments identified in Table 1.1;
- review and recommendations for the monitoring program for the construction and operational stages, including recommendations as to whether ongoing monitoring at the moderate-risk cutting sites is required; and
- appendices, providing laboratory reports, data tables or other relevant information.

5.3.2 Construction Stage

Reporting during the construction stage will include interim reports, annual reports and a final report at the completion of the construction stage.

Interim reports will be produced on a monthly basis to provide the results of the monitoring during the past month. This will comprise a simple but clear tabulation of the monitoring results to be tabled at the Environmental Review Group meetings. The report will include assessment of the results to inform the ongoing management of the groundwater management measures and the results will be discussed and minuted at the Environmental Review Group meetings. Potential refinements/ improvement of the water quality monitoring program will also be discussed at the meetings.

Annual reports will be of a similar format to that outlined in Section 5.3.1 for the pre-construction stage but excluding recommendations for the operational monitoring program.

Similarly, the final report at the completion of the construction stage will be of a similar format to that outlined in Section 5.3.1 but including recommendations for the operational monitoring program.

5.3.3 Operational Stage

Reporting during the operation stage will also include interim reports, annual reports and a final report at the completion of the first three years of operation.

Interim reports will be produced on a six-monthly basis to provide the results of the monitoring during the past six months and any relevant discussion of the results to inform the ongoing management of the permanent groundwater management strategies and stabilisations works.

Annual reports will be of a similar format to that outlined in Section 5.3.1 for the pre-construction stage but excluding recommendations for the operational monitoring program. Review of monitoring would be considered annually as part of that report.

Similarly, the final report at the completion of the first three years of operation will be of a similar format to that outlined in Section 5.3.1 but including recommendations for a continued operational monitoring program if deemed appropriate.

Management Actions

The Groundwater Monitoring Program will form part of the Construction Environmental Management Plan (CEMP) and the Operational Environment Management System and will be reviewed annually.

6.1 Management Actions

During the construction stage the monthly interim, annual and final reports outlined in the previous section will be will be discussed and minuted at the Environmental Review Group meetings.

Similarly, during the operational stage the six-monthly interim, annual and final reports outlined in the previous section will be assessed to determine any required update of the Groundwater Monitoring Program or refinement of groundwater management measures or other relevant measures/ procedures identified in the Operational Environment Management System.

6.1.1 Groundwater Management Measures for Cuttings

The groundwater management measures detailed in Section 2.6.2 or other measures approved by RMS will be implemented.

6.1.2 Groundwater Management Measures for Embankments

If there is a detectable change in groundwater levels from up-gradient to down-gradient levels as a result of the highway construction then engineering mitigation measures will be installed to enable down-gradient groundwater transfer to re-establish down-gradient groundwater levels. These measures may involve installing ‘conduits’ of higher permeable materials beneath the highway embankment/ through the compressed soils.

6.1.3 Groundwater Management Measures for Accidents and Spills

The groundwater management measures detailed in Section 2.6.4 or other measures approved by RMS will be implemented.

6.1.4 Groundwater Management Measures for Leaching of Acid Sulfate Soils

The groundwater management measures detailed in Section 2.6.3 or other measures approved by RMS will be implemented.

Consultation

7.1 Regulatory Agencies

The NSW Environment Protection Authority (EPA) and Department of Primary Industries (DPI) have been consulted during preparation of this monitoring program (refer to **Appendix A**).

EPA, DPI, and NoW will be consulted during the implementation of the Groundwater Monitoring Program. As a minimum, this consultation is to include forwarding of all reports (interim, annual and stage completion reports) outlined in **Section 5.3** to NSW EPA.

7.2 Landholders

Landholders relevant to monitoring sites will be consulted as required throughout implementation of the Groundwater Monitoring Program in regard to establishment of monitoring sites and ensuring ongoing access to monitoring sites and related matters.

References

ANZECC ARMCANZ (1995). *Guidelines for groundwater protection in Australia*. Australian and New Zealand Environment and Conservation Council (ANZECC), Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ).

ANZECC ARMCANZ (2000a). *Australian and New Zealand guidelines for fresh and marine water quality. Volume 1, The Guidelines*. Australian and New Zealand Environment and Conservation Council (ANZECC), Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ).

ANZECC ARMCANZ (2000b). *Australian guidelines for water quality monitoring and reporting*. Australian and New Zealand Environment and Conservation Council (ANZECC), Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ).

AS/NZS 5667.1:1998. Australian / New Zealand Standard™. *Water Quality – Sampling. Part 1: Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples*.

AS/NZS 5667.12:1999. Australian / New Zealand Standard™. *Water Quality – Sampling. Part 12: Guidance on sampling of bottom sediments*.

DLWC (1998) *Stressed Rivers Assessment Report*. *NSW State Summary*. NSW Department of Land and Water Conservation. April 1998.

NSW EPA (2004). *Approved Methods for the Sampling and Interpretation of Results of Water Pollutants in NSW* (Department of Environment and Conservation, March 2004. [Online]. Available: http://www.environment.nsw.gov.au/water/wateranalysis_methods.htm [Accessed 14th March 2012].

NSW Fisheries 1999, *Policy and Guidelines: Aquatic Habitat Management and Fish Conservation*: (1999 update). Smith, A. and Pollard, D.A. (eds) NSW Fisheries, Port Stephens Research Centre.

RTA (1999). *Code of Practice for Water Management. Road Development and Management.* [Online]. Available: http://www.rta.nsw.gov.au/environment/downloads/enviro_wcop_dl1.html [Accessed 14th March 2012].

RTA (2011). *Upgrading the Pacific Highway, Warrell Creek to Urunga. Project Approval Documents*. RTA/Pub.11.282. October, 2011.

RTA (undated). *Guideline for Construction Water Quality Monitoring.* [Online]. Available: http://www.rta.nsw.gov.au/environment/downloads/constrwaterqualmonit_dl1.html [Accessed 14th March 2012].

SKM (2010a). *Warrell Creek to Urunga, Upgrading the Pacific Highway. Environmental Assessment.* Volume 1 Environmental Assessment. January 2010.

SKM (2010b). *Warrell Creek to Urunga, Upgrading the Pacific Highway. Environmental Assessment.* Volume 2 – Working Paper No.1 – Flora and Fauna. January 2010.

SKM (2010c). *Warrell Creek to Urunga, Upgrading the Pacific Highway. Environmental Assessment.* Volume 2 – Working Paper No.5 – Water Quality Impact Assessment. January 2010.

Sundaram, B., Feitz, A., Caritat, P. de, Plazinska, A., Brodie, R., Coram, J. and Ransley, T. (2009). *Groundwater Sampling and Analysis – A Field Guide*. Geoscience Australia, Record 2009/27 95 pp.

The information provided on illustrations is for illustrative and communication purposes only. Illustrations are typically a compilation of data supplied by others and created by GeoLINK. Illustrations have been prepared in good faith, but their accuracy and completeness are not guaranteed. There may be errors or omissions in the information presented. In particular, illustrations cannot be relied upon to determine the locations of infrastructure, property boundaries, zone boundaries, etc. To locate these items accurately, advice needs to be obtained from a surveyor or other suitably-qualified professional.

Agency Consultation

ENVIRONMENT PROTECTION AUTHORITY - COMMENT SHEET

Project:	Warrell Creek to Nambucca Heads Pacific Highway Upgrade Project		
Document title:	Ground Water Monitoring Program		
Revision No.:	Initial draft		
Reviewer name:	Craig Dunk	Review date:	10 April 2013
Responses by:	Environment Protection Authority (EPA)	Response due:	N/A

Thankyou for the opportunity to comment on the Project's **Ground Water Monitoring Program**. The EPA has reviewed the proposed Ground Water Monitoring Program submitted to the Department on the 15 January 2013 and has provided comments on key areas of concern in the table below.

Report Reference	EPA Comments	Response
Section 2.6.1 Groundwater monitoring	The EPA notes that there is a reference to the assessment of endangered ecological communities recommended in the EA along with a number of other actions – there is however no commitment that RMS or Abigroup will undertake any or all of these activities.	Section 2.6.1 provides an overview of the range of management measures to address risks to groundwater. However the scope of the Ground Water Monitoring Program is to just address monitoring of groundwater levels and quality. Any queries regarding commitments to undertake other measures listed in Section 2.6.1 should be directed to RMS.
Section 4.1 Monitoring site locations	The EPA notes that there is a reference to construction techniques in the EA that would minimise the degree to which soft soils would compress, and therefore construction of embankments should pose little risk to the formation of groundwater barriers. It is noted that there is no discussion or confirmation as to what techniques are being proposed.	Section 18.4.1.1 of the Environmental Assessment (EA) identifies a range of construction techniques that could be used to treat soft soils. This section of the EA also identifies the likelihood of staged construction of embankments due to the presence of soft soils. The section of the EA also advises that Management strategies for the construction of the project on soft soils would be further developed during the detailed design. This detailed design will be prepared by the contractor and the

Report Reference	EPA Comments	Response
		adopted management strategies will be identified in the groundwater management strategy required under MCoA B31.(d)(vi). Section 6.3 of the Water Quality Working Paper for the EA addresses risks to groundwater quality and indicates that the issue of soft soils is discussed in Chapter 18 of the EA. It should be noted that the compressible soft soils are the finer grained low permeable silts and clays which provide very little conveyance of groundwater. As construction of embankments using the techniques identified in Section 18.4.1.1 would result in minimal compression of the more permeable coarse grained sands and gravels, construction of the embankments would pose little risk to the formation of groundwater barriers. Section 6.3 of the Working Paper also states that 'Since mitigation measures would be put in place to minimise the degree to which soft soils would compress, the construction of embankments should pose little risk to the formation of groundwater. It is acknowledged that this comment was poorly worded and that, instead of referring to minimising the degree to which soft soils would compress, it should have referred to the management of soft soils using the techniques identified in Section 18.4.1.1 of the EA and discussed the relative permeability of the more compressible fine grained silts and clays compared to the less compressible coarse grained sands and gravels. Nevertheless, the conclusion that the construction of embankments should pose little risk to the formation of groundwater barriers remains valid. barriers.
Section 4.1 Monitoring site locations	The EPA notes that a number of groundwater monitoring sites are shown in illustrations 4.1 to 4.2. The EPA stresses the importance of ensuring that these are located so that they are not "lost" or located in a location within the alignment that will be subject to earthworks during the construction phase of the project as has been the case on other projects.	The proposed groundwater monitoring sites have been located adjacent to the project boundaries in an attempt to maximise the distance from the construction footprint and thereby avoid being "lost" or located in an area within the alignment that will be subject to earthworks during the construction phase

Report Reference	EPA Comments	Response
Section 7.1 Regulatory Agencies	The EPA notes that a commitment has been made to involve agencies (including the EPA) during the implementation of the groundwater monitoring program, through (at a minimum) the provision of all reports including interim, annual and stage completion reports.	Noted
General Comment	The EPA notes that there were also a number of typing/spelling errors in the document.	Noted - typing/spelling errors to be rectified

Appendix B
Spoil and Fill Management Procedure

Pacific Highway Upgrade:
Warrell Creek to Nambucca Heads

APPENDIX B: Spoil and Fill Management Procedure
WC2NH-EN-PRO-0001 Spoil and Fill Management Procedure Rev 0

Rev	Description	Originator	Reviewed	Approved	Date
A	Appendix B to the Soil and Water Management Sub Plan: Initial WC2NH Spoil and Fill Management Procedure	Claudio Senese	Noelene Rutherford		
B	Incorporating internal AFJV Comments	Noelene Rutherford			
C	Comments from ER/Roads and Maritime included	Noelene Rutherford			
D	Further comments from Roads and Maritime incorporated	Noelene Rutherford			27/11/14
E	Comments from the EPA incorporated	Noelene Rutherford			08/12/14
0	Finalised and Approved	Noelene Rutherford	Roads and Maritime	DPE	10/12/14

Details of Revision Amendments

Procedure Control

The latest approved version of this Procedure will be available for all Project personnel on the Electronic Document Management System - TeamBinder. The functional manager will maintain, review and update this Procedure in accordance with the Revision requirements of the Construction Environmental Management Plan (Refer to section 1.6 of the CEMP).

Amendments

Each new revision to the Procedure will be distributed to all required personnel for review and approval. The revision number is included at the end of the document number, which is noted in the footer of each page. The document will be allocated a new revision number each time a change is made to the document.

When a new revision to the document is available, a notification email will be distributed to all project personnel by the Document Control Team advising of the update.

The functional Manager is responsible for the implementation and review of the Procedure. The Project Director will approve new revisions of the Procedure via the review and approval process as detailed in the Document Control Procedure.

Functional Manager Authorisation	Distribution List	
Name: Noelene Rutherford	Project Director	
Date: 10 December 2014	Design Manager	
Position: Environment Manager	Quality Manager	
Signature:	Procurement Manager	
Comments: —	Construction Manager	
	Safety Manager	
	Commercial Manager	
	Environmental Manager	
Project Director Authorisation	Finance Manager	
Name: L. Guillermo Ripado	Engineer Manager	
Date: 10/12/14	Area Manager	
Signature:	Human Resources Manager	
Comments: —	Site Superintendents	
	Roads and Maritime Services	
	IMS Manager	
	Other:	

Contents

Terms and Abbreviations

AADJV	Arup and Aurecon Design Joint Venture
ACCIONA	ACCIONA Infrastructure Australia Pty Ltd
AFJV	ACCIONA and Ferrovial Joint Venture
AS/NZS	Australian and New Zealand Standard
ASM	Acid Sulfate Materials
ASMMP	Acid Sulfate Materials Management Plan
CEMP	Construction Environmental Management Plan
D&C	Design and Construction
DJV	Design Joint Venture
DoE	Department of Environment (Commonwealth)
EEC	Endangered Ecological Communities
EDMS	Electronic Document Management System (TeamBinder)
ENM	Excavated Natural Materials
EPBC	Environmental Protection and Biodiversity Conservation
EPRM	Excavated public road material
EWMS	Environmental Works Method Statement
Ferrovial	Ferrovial Agroman (Australia) Pty Ltd
IMS	Integrated Management System
ISO	International Standards Organisations
KPI	Key Performance Indicator
MCoA	Minister's Conditions of Approval
MNES	Matters of National Environmental Significance
NSW	New South Wales
O&M	Operations and Maintenance
PCBU	Person Conducting a Business or Undertaking
PMT	Project Management Team
PV	Project Verifier
RMS	Roads and Maritime Services
SWMP	Soil and Water Management Plan (CEMP Appendix B4 Soil and Water Management Sub Plan)
VENM	Virgin Excavated Natural Materials
WC2NH	Warrell Creek to Nambucca Heads (the Project)
WEMP	Waste and Energy Management Plan (CEMP Sub plan)

Definitions

Client	An organisation inviting and receiving tenders and letting contracts. For the purposes of this project - Roads and Maritime Services
Contractor	An organisation that contracts with a client to carry out construction and related services. For the purposes of this Project - ACCIONA Ferrovial Joint Venture.
Davis Langdon	Davis Langdon Australia Pty Ltd
Deed	D&C Project Deed, IC-DC-C91-1, Pacific Highway Warrell Creek to Nambucca Heads
Design Joint Venture	Joint Venture consisting of Arup and Aurecon
Government Agency	NSW government department, authority, corporation or entity established by an Act of the NSW Parliament
Persons Conducting a Business or Undertaking	Is an employer, corporation, partnership, unincorporated association that has the primary duty of care for workplace health and safety - (AFJV and Contractors are a PCBU)
Principal Contractor	A person conducting a business or undertaking that commissions a construction project. For the purposes of this project - AFJV
Project	The design and construction of the upgrade to the Pacific Highway between Warrell Creek and Nambucca Heads
Project Verifier	For the purpose of the Project, this is Davis Langdon Australia Pty Ltd
Proof Engineer	For the purpose of the Project, Cardno Pty Ltd
Subcontractor	Organisation that contracts with a principal contractor as the client to carry out construction and related services
Supplier	Organisation that contracts with a client to provide a product and / or service.
TeamBinder	The project Electronic Document Management System software
Worker	Is anyone who carries out work for a PCBU and includes: an employee, contractor or sub-contractor or an employee of, labour hire personnel, apprentice or trainee, work experience student

1. Introduction

The Warrell Creek to Nambucca Heads Pacific Highway Upgrade project (the WC2NH Project) is being designed and constructed in a joint venture consisting of ACCIONA Infrastructures Pty Ltd (ACCIONA) and Ferrovial Agroman (Australia) Pty Ltd (Ferrovial), in liaison with various other pre-qualified construction contractors, with overall project management and site supervision of the project by Roads and Maritime Services (RMS).

1.1. Project Background

The WC2NH project consists of the detailed design and construction of 19.6 km of new dual carriageway road on the Pacific Highway between the northern end of the existing Allgomera Deviation south of Warrell Creek and the southern end of the Nambucca Heads to Urunga Pacific Highway upgrade project west of Nambucca Heads. The project includes:

- 19.6 km of new divided dual carriageway;
- two grade separated interchanges at Warrell Creek and Bald Hill Road south of Macksville. Roads and Maritime is also investigating the provision of north facing ramps at North Macksville;
- longitudinal bridges across Upper Warrell Creek (including North Coast Railway Line), Williamson Creek, Warrell Creek, Nambucca River floodplain (2 of) and Nambucca River;
- overbridges on Rosewood Road, Albert Drive, Scotts Heads Quarry access road, Bald Hill Road, Old Coast Road South, Mattick Road and Old Coast Road North;
- an underpass at Cockburns Lane;
- local roads and drainage and fauna crossing structures; and
- associated infrastructure.

1.2. Purpose

This Spoil and Fill Management Procedure (the Procedure) forms Appendix B to the WC2NH Soil and Water Management Sub Plan (SWMP), as part of the Construction Environmental Management Plan (CEMP).

The Procedure details the actions that will be taken by ACCIONA Ferrovial Joint Venture (AFJV) to identify the types of materials expected to be encountered and ensure effective controls are established and maintained to manage potential environmental impacts during the construction of the WC2NH project. In particular, the Procedure prescribes the measures to monitor and manage spoil and fill including details of how excavated material will be handled, transported, stockpiled, reused and disposed.

For specific requirements on the location of stockpiles and minimum management measures that would be implemented to avoid/minimise amenity impacts to surrounding residents and environmental risks (including surrounding watercourses), refer to the Stockpile Management Protocol and the Stockpile Register (available from AFJV) in Appendix I to the SWMP.

1.3. Scope

This Procedure is applicable to all activities conducted by personnel on the Project that involve spoil and fill management.

Relevant management measures identified in this Procedure will be incorporated into site or activity specific Environmental Work Method Statements (EWMS), progressive Erosion and Sediment Control Plans (ESCPs) and the Earthworks Management Plan.

1.4. Objectives

The objectives of this Procedure are to:

- Identify spoil and fill issues potentially arising from the Project;
- Identify and describe measures to be implemented relating to spoil and fill activities that may impact on the environment and local amenity; and
- Ensure all Project personnel are aware of the requirements for spoil and fill material handling, transportation and movement, stockpiling, reuse and disposal to protect the environment and maximise the reuse of earthen materials generated on site.

2. References

The following documents are referenced in conjunction with this Procedure:

- Project Approval (Minister's Conditions of Approval up to Modification 6)
- Construction Environmental Management Plan (CEMP)
- Soil and Water Management Sub-Plan (SWMP)
- SWMP Appendix C - Acid Sulfate Material Management Procedure
- SWMP Appendix F - Unexpected Discovery of Contaminated Land Procedure
- SWMP Appendix I – Stockpile Management Protocol
- Waste and Energy Management Sub Plan
- Earthworks Management Plan
- Traffic Management Plan

These documents are available in Teambinder. Enquiries in relation to the CEMP and all Sub plans should be notified to the Environmental Manager.

3. Legislative and other Requirements

3.1. Legislation

The key legislation relevant to materials management includes:

- Environmental Planning and Assessment Act, 1979 (EP&A Act)
- Protection of the Environment Operations Act, 1997 (PoEO Act)
- Contaminated Land Management Act, 1997
- Waste Avoidance and Resource Recovery Act 2001
- Resource Recovery Exemptions of the PoEO (Waste) Regulation 2005
- Fisheries Management Act, 1994.

3.1. Minister's Conditions of Approval

The CoA relevant to this Sub Plan is listed Table 1 below.

Table 1: CoA relevant to this Procedure

CoA	Condition requirements	Details of Compliance
B.30 (e) (iii) In part	Prior to the commencement of construction, the Proponent shall prepare and (following approval) implement a Construction Environmental Management Plan for the Project. The plan shall outline the environmental management practices and procedures that are to be followed during construction and shall be prepared in consultation with the EPA, DPI and relevant council and shall include but not necessarily be limited to............. (e)(iii) measures to monitor and manage spoil and fill including details of how excavated material would be handled, stockpiled, reused and disposed and a stockpile management protocol detailing location criteria that would guide the placement of stockpiles and minimum management measures including rehabilitation) that would be implemented to avoid / minimise amenity impacts to surrounding residents and environmental risks (including to surrounding watercourses)	This Procedure in regards to the measures to monitor and manage spoil and fill including details of how excavated material will be handled, transported, stockpiled, reused and disposed. Refer to the Stockpile Management Protocol detailing location criteria that would guide the placement of stockpiles and minimum management measures including rehabilitation) that would be implemented to avoid / minimise amenity impacts to surrounding residents and environmental risks.

3.2. Relevant Standards

Guidelines and Standards relevant to this Procedure include:

- Waste Classification Guidelines, Part 1: Classifying Waste (NSW DECCW 2009)
- Australian and New Zealand Guidelines for Assessment and Management of Contaminated Sites, ANZECC/NHMRC, 1992
- Assessment Classification and Management of Liquid and Non-Liquid Waste (EPA), 1999.
- Guidelines for the Management of Acid Sulfate Material Acid Sulfate soils, Acid Sulfate Rock and Monosulfidic Black Ooze, RTA 2005
- RMS Specification D&C R44
- Stockpile Site Management Guideline, RMS 2011.
- Managing Urban Stormwater, 4th Edition, Landcom 2004.

4. Key Responsibilities and Accountabilities

4.1. Organisational Chart

An updated version of the organisational chart shall be maintained and available on the Project site, displayed in clear accessible locations and available upon request. The organisational chart is available on the Electronic Document Management System (EDMS) – TeamBinder.

4.2. Key Staff

The overall roles and responsibilities for environmental management are outlined in Section 4.2 of the CEMP. The responsibilities and accountabilities for key Project staff in the implementation of this Procedure include:

4.2.1. Project Director

- Approve this Procedure for implementation and all subsequent revisions;
- Instruct all Project personnel on adherence to this Procedure.

4.2.2. Construction Manager

- Ensure the requirements of this procedure are referenced within earthworks requirements for all construction packages;
- Liaise with the Environmental Manager for each package of work involving spoil and fill generation and handling.

4.2.3. Environmental Manager

- Ensure the Procedure remains current and is reviewed and consulted with RMS and the Environmental Representative (ER);
- Assist the Construction team.

4.2.4. All Other Managers, Superintendents and Workers

- Be familiar with this Procedure and comply with the requirements incorporated within construction management plans and procedures, including Environmental Works Method Statements (EWMS) that are imposed in relation to spoil and fill where applicable.

5. Procedure

5.1. Classification of Spoil

Construction of the project will involve significant clearing and excavation of materials along the alignment. Approximately 3 million cubic metres of earthen material is estimated to be excavated from cutting along the vertical alignment for the roadway. This volume of excavated material includes approximately 200,000 cubic metres of potential residual surplus spoil. It is noted that this is a preliminary volume and further detailed design is still being undertaken to reduce the overall volumes of surplus material.

For the purposes of this Procedure the excavated material is broadly categorised into the following classifications.

5.1.1. Topsoil and Mulch

Topsoil and vegetation mulch are important resources for the final rehabilitation and landscaping of the project. To achieve a successful landscape and revegetated outcome relies upon the proper management of topsoil and mulch during the construction phase.

Given the particular sensitivity of topsoil and mulch, the composition and handling of topsoils and mulch requires:

- Planning of topsoil stripping operations to ensure the material is not mixed with sub-soil layers;
- Identifying areas where a topsoil/mulch mix may be used in permanent landscaping to add organic matter to the soil profile and stabilize the soil structure;

- Clearing and grubbing of unwanted materials (weeds and roots) and conserving and chipping good quality vegetation for mulch.
- Identifying good quality topsoil for finishing, avoiding and removing poorer soils, and other excavated materials and wastes.
- Correct stockpiling procedures for topsoil to maintain the soil structure and integrity throughout the duration of the project, stockpile's are to be managed in accordance with the Stockpile Management Protocol (Appendix I of the SWMP) and must be <2.5m high.

5.1.2. Virgin excavated natural material (VENM)

VENM will be encountered in areas that have not in any way been impacted by development or industry (e.g. natural clay road embankments). During the Project VENM will be confirmed as clean through visual observation of landform, understanding of past land uses and based on findings from the geotechnical reports and site assessments.

5.1.3. Fill material (classified as Excavated Natural Material – ENM)

ENM Fill material's will be encountered in areas typically associated with previously developed lands (e.g. private property lands that may have been previously disturbed by development, road embankments of the existing highway).

5.1.4. Recovered Materials

The Project may seek to reuse materials recovered from the alignment during construction. This may include:

- recovered aggregates;
- reclaimed asphalt pavement; and
- Excavated public road material (EPRM).

Recovered resource use must comply with the relevant resource recovery exemptions discussed in the Waste and Energy Management Sub-plan (WEMP). EPRM can only be reused within the road corridor.

Refer to the most up to date waste exemptions available on the EPA website http://www.epa.nsw.gov.au/waste/exemptfs.htm.

5.1.5. Acid Sulfate Material

Acid Sulfate Materials (ASM's) comprise Acid Sulfate Soils (ASS), Acid Sulfate Rock (ASR) and Monosulfidic Black Ooze (MBO). Disturbance of ASM will be minimized and impacted ASMs will be managed in accordance with the Acid Sulfate Materials Management Procedure (ASSMP). Potential locations identified as potential Acid Sulfate Soils and potential acid forming rock as Acid Sulfate Rock are summarized in Table 2. Further detail is provided in the Environmentally Sensitive Area Maps, which are found in Appendix 6 of the CEMP.

Table 2: Summary of Potential Acid Sulfate Materials

Location (Ch)	Description	Acid Sulfate Material
42250	Drainage Culvert	Potential Acid Sulfate Soils
44480	Drainage Culvert C44.48	Potential Acid Sulfate Soils

Location (Ch)	Description	Acid Sulfate Material
45580	Drainage Culvert C45.50	Potential Acid Sulfate Soils
47550 to 47900	Cut 10	Potential Acid Sulfate Rock
48600 to 49000	Cut 11	Potential Acid Sulfate Rock
53025	Culvert C53.02	Potential Acid Sulfate Soils
54350	Culvert C 54.35	Potential Acid Sulfate Soils

To mitigate the effects of ASM, management measures will be implemented in accordance with the ASSMP. Acid Sulfate Material Treatment Areas will be located, designed, constructed and operated in accordance with the requirements of ASMMP, Stockpile Management Protocol and Earthworks Management Plan.

5.1.6. Arsenic Rock

The presence of elevated levels of naturally occurring arsenic in rock has been identified to be present in the following chainages for cutting:

- Cut 11 (48520-49000)
- Cut 12 (49200-49680)
- Cut 25 (57820-57920)

The materials located in cut 11, 12 and 25 will be designed for use in accordance with the Arsenic Rock Management (ASM) Strategy (refer to Appendix K of the Soil and Water Management Plan). The ASM Strategy covers the management requirements for Arsenic Rock in accordance with SWTC Appendix 4 Additional Environmental Requirements, section 4.32.

5.1.7. Potentially contaminated material

Environmental studies of the project area did not detect any widespread contamination. Isolated contamination "hotspots" (four locations) have been identified. Table 3 summarises the potential locations and sources of contamination existing within the Project Boundary requiring further investigation and potential for remedial actions may be required.

Additional investigations will aim to determine extent, level and options for remediation, if required, prior to the commencement of clearing, excavation or piling works in the vicinity of these areas.

In addition to these areas, other unexpected contamination finds may arise during the course of construction works. Potentially contaminated material identified during the course of the Project will be handled in accordance with the Unexpected Discovery of Contaminated Land Procedure (Appendix F of the SWMP).

Table 3 Known contamination areas within project boundary

Location (Ch)	Description	Nature of Contamination	Current Construction Works
43050	Sawmill at Cockburns Lane	Localised Petroleum	Current extent of clearing and road excavation works will avoid this location.

Location (Ch)	Description	Nature of Contamination	Current Construction Works
		Contamination (TpH)	Establish a no-go zone around contaminated area and implement "Unexpected Contaminated Land Procedure" if any unexpected contamination encroaches into the Project Boundary.
52450	Former Oyster/Boat Shed	Petroleum Hydrocarbons (Benzo (a) Pyrene, PAH)	Piling works may avoid the contamination hot spot. Establish a no-go zone around contaminated area and implement "Unexpected Contaminated Land Procedure" if any unexpected contamination encroaches into the Project Boundary.
59250	Former Narwee Creek Landfill	Unknown	Current extent of clearing and road excavation works may avoid this location. Establish a no-go zone around contaminated area and implement "Unexpected Contaminated Land Procedure" if any unexpected contamination encroaches into the Project Boundary.
58800	Localised Illegal dump of mixed wastes	Unknown	Within road clearing and excavation works. Additional investigations to determine extent, level and options for remediation prior to the commencement of clearing in this area.

5.2. Reuse on-site

The demand for excavated material to be used for fill onsite is estimated at approximately 2.5 million cubic metres, and demand for use in pavements is approximately 300,000 cubic metres. This will be supplied through the estimated material won from site excavation as discussed in section 4.1. A minor potential surplus volume of excavated spoil is anticipated to require offsite reuse/disposal.

Topsoil

Topsoil assessed as clean, and fertile will be stockpiled for reuse on site during revegetation and rehabilitation works. Mulch is to be used for the purposes of erosion and sediment control, soil conditioning or composting on site.

The Urban Design and Landscape Plan has identified key areas within the northern section of the Project where a topsoil/mulch mix will be used and applied to batters during revegetation. This will allow native vegetation species to regenerate from the seed bank stored within the mulch and topsoil and provide additional organic matter to the soil which will improve soil structure and integrity.

Surplus topsoil that is considered to be poor quality or contaminated with weed species may be reused on site and buried in noise mounds or visual barriers.

Additional surplus topsoil that cannot be reused on site will follow the reuse strategy outlined in Section 5.3.

VENM

The Project can reuse material on-site that has been classified as VENM. No sampling or testing is required if the material is being re-used within a road corridor, unless there is evidence that potentially contaminating activities previously took place on or adjacent to the excavation site (e.g. former landfill, waste dump). If there is a potential that the material is contaminated, it is must be tested and classified according to the Waste Classification Guidelines, DECCW 2009.

There is a potential that surplus VENM will be available for permanent reuse. Section 5.3 discusses options for permanent reuse off-site.

Fill Material

Fill materials including ENM and recovered resources can be reused within the road corridor for construction. If surplus material occurs, the reuse of these materials must conform with the Resource Recovery Exemptions of the Protection of the Environment Operations (Waste) Regulation 2005. Refer to section 5.2 of the Waste and Energy Management Plan (WEMP) on waste exemptions for reuse on site.

There may be a potential surplus of fill material generated from the Project earthworks. The Project will seek to reuse this material within the road corridor in the following scenarios:

1) Adjust the design of the fill embankments to allow for use of surplus materials;
2) Use as fill in noise mounds and visual barriers; and
3) Use to reduce the slope of batters and noise mounds prior to topsoiling;

Acid Sulfate Materials

ASM's reused on site will be treated to comply with the excavated Public Road Material Exemption 2012. The management for the treatment and reuse of ASM onsite is provided in the Acid Sulfate Material Management Procedure.

Currently, all ASSM will be treated and reused on site.

Arsenic Rock

The Arsenic Rock Management Strategy specifies the management practices for the reuse and placement requirements of all excavated material sourced from the cuttings identified as potentially containing Arsenic Rock. Currently, all arsenic rock material will be reused within the alignment. Any surplus material will be classified in accordance with the NSW Waste Classification Guidelines as outlined in the WEMP.

Contaminated Material

In accordance with the remedial actions of the Unexpected Discovery of Contaminated Land Procedure, potentially contaminated materials should be stockpiled on site separately and resultant excavations validated to confirm removal of contaminated materials from the excavated area. If contaminated soils are intended for reuse, these stockpiled soils must be remediated and validated for suitable re-use on site. In most cases, the contaminated spoil will be disposed of off-site at a suitably licenced waste disposal facility.

5.3. Reuse and Disposal off- site

Reuse off-site will only occur for material surplus to project needs (ie spoil) or if the material is unsuitable for on-site placement (eg fill that is not considered suitable for engineered road embankments). Preference for uncontaminated surplus spoil will be for offsite reuse purposes in accordance with the principles of the Resource Recovery Exemptions.

Prior to transporting spoil material off-site, suitable reuse locations must be determined. The locations can be:

- Land on which the land developer holds a current Development Approval that allows for the importation of earth/mulch materials;
- Land on which the land owner wishes to develop the land and allows AFJV to obtain a development approval from Council on their behalf;
- Permanent land re-shaping works on RMS residual land which are approved by RMS and the Director General or the DPE; and
- Provision of small quantities of earth/mulch material to landholders covered under the Resource Recovery Exemptions that meet the Local Council requirements for exempt development (or development without consent).

Reuse and disposal of all spoil from the site must be classified in accordance with the NSW OEH Waste Classification Guidelines, Part 1: Classifying Waste (NSW DECCW 2009) and be managed in accordance with the requirements specified in the WEMP (refer to section 5.3 to 5.6 on waste classification for offsite reuse/recycling and disposal).

In general top soils, VENM, ENM and mulch may be reused offsite subject to site classification being carried out, and where necessary, based on soil tests to verify the quality of the material.

Reuse of ENM off-site to a private or publically owned site requires the landholder to be issued a written statement of compliance to the ENM exemptions and a Section 143 Notice, and where necessary it is confirmed that the landowner has an appropriate development approval from the relevant planning authority (Council).

Permanent placement of spoil on RMS residual land will be determined with RMS. Any proposals will demonstrate beneficial re-use of the spoil material. The placement of the material will be incorporated into the landscape to ensure visual amenity is not impacted and the future value of the land is not compromised. Permanent placement of spoil on RMS residual land will be agreed with RMS and approved by the Department of Planning prior to the permanent placement of the spoil.

For all spoil unsuitable for reuse and requires disposal to a landfill, the landfill facility must be appropriately licenced to receive waste to be disposed. Refer to section 5.6 of the WEMP for further details on disposal.

5.4. Spoil and fill storage

Stockpiles will be established in the locations identified in the Stockpile Management Protocol (*Appendix I*), and be managed in accordance with the Protocol and the Erosion and Sediment Control Plan. Where possible, topsoil, mulch and fill to be used for construction will be placed in the location it is required to prevent double handling.

5.5. Spoil and fill transportation

Transport and haulage of earthwork materials will be undertaken in accordance with the construction Traffic Management Plan (refer to CEMP Appendix B1). In accordance with the Traffic Management Plan, the following controls will be implemented:

- Minimise exposure to noise sensitive areas: transportation only within the approved construction hours(between 7:00 am and 6:00 pm Mon.- Fri and 8am-1pm Saturdays, unless otherwise approved.) and on approved traffic routes to minimise the passage of material through nearby towns.
- Avoid identified protected areas and no-go zones to minimise potential for impact on biodiversity and heritage values. This includes:
  - minimum impact to local wildlife respecting biological rest periods: it has been embedded in earth moving schedule to avoid the Flying Fox habitat area during September - May and any other measures for threatened species included in the Flora and Fauna Management Sub-plan.
  - temporary works designed to avoid or minimise removal of vegetation;
  - Use rumble pads or stabilized exit points for all access ways to public roads.
- The reduction in transport distance to minimize greenhouse gas emissions.
- The minimal use of existing roads and tracks: using the Project alignment as the main material transport route to avoid negative community outcomes.
- Reduction of dust generated: loads of earthern materials are to be covered when entering public roads and roads are to remain swept clean and free of mud/debris.

5.6. Record Keeping

Section 143 certificates are required for any material to be reused outside the Project boundary and landfill disposal tickets for material disposed of to landfill will be completed/obtained by engineers and/or the site foreman. Records of any laboratory analysis required to determine compliance with waste exemptions will also be retained.

A spoil tracking register is to be maintained which includes details of each truck load of material sent for reuse outside of the Project Boundary. The truck load register will record where the material is coming from on site and where it is placed on the receiving site. The register will record the classification of the material which will correspond with the Section 143 and waste classification certificate provided to the landholder/developer for the material by the generator (AFJV).

The Project Waste Register will also be maintained which will track the quantities of material being reused/disposed of off-site.

6. Training and Awareness

Personnel involved in Spoil and Fill management will be trained in the requirements of this Procedure during the Project induction and/or regular toolbox talks. This will be provided by the Environmental Manager and Environmental Coordinators.

7. Stakeholder Consultation

Relevant stakeholders include the RMS and ER, EPA, DPI (Fisheries), DPE and Nambucca Shire Council. These organisations will be consulted with throughout the project via the regular ERG meeting.

8. Procedure Review

The Environmental Manager in consultation with RMS and the ER, will modify the Procedure where improvements are identified.

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Appendix C
Acid Sulfate Soil Management Procedure

Pacific Highway Upgrade:
Warrell Creek to Nambucca Heads

APPENDIX C: Acid Sulfate Materials Management Procedure
WC2NH-EN-PRO-0002 Acid Sulfate Materials Management Procedure Rev 0

Rev	Description	Originator	Reviewed	Approved	Date
A	Appendix C Acid Sulfate Materials Management Procedure	Richard Peterson Claudio Senese	Noelene Rutherford		
B	Appendix C Acid Sulfate Material Management Procedure – RMS / ER Comments Incorporated	Alex Dwyer	Noelene Rutherford		10/11/2014
C	Further comments from Roads and Maritime incorporated	Noelene Rutherford			18/11/2014
D	Further comments from Roads and Maritime and ER incorporated	Noelene Rutherford			26/11/2014
0	Finalised and Approved	Noelene Rutherford	Roads and Maritime	DPE	10/12/2014

Details of Revision Amendments

Procedure Control

The latest approved version of this Procedure will be available for all Project personnel on the Electronic Document Management System - TeamBinder. The functional manager will maintain, review and update this Procedure in accordance with the Revision requirements of the Construction Environmental Management Plan (Refer to section 1.6 of the CEMP).

Amendments

Each new revision to the Procedure will be distributed to all required personnel for review and approval. The revision number is included at the end of the document number, which is noted in the footer of each page. The document will be allocated a new revision number each time a change is made to the document.

When a new revision to the document is available, a notification email will be distributed to all project personnel by the Document Control Team advising of the update.

The functional Manager is responsible for the implementation and review of the Procedure. The Project Director will approve new revisions of the Procedure via the review and approval process as detailed in the Document Control Procedure.

Functional Manager Authorisation	Distribution List	
Name: Noelene Rutherford Date: 10 December 2014 Position: Environment Manager Signature: NRutherford Comments: —	Project Director	
	Design Manager	
	Quality Manager	
	Procurement Manager	
	Construction Manager	
	Safety Manager	
	Commercial Manager	
	Environmental Manager	
Project Director Authorisation	Finance Manager	
Name: C. Guillermo Ripado Date: 10/12/14 Signature: Comments: —	Engineer Manager	
	Area Manager	
	Human Resources Manager	
	Site Superintendents	
	Roads and Maritime Services	
	IMS Manager	
	Other:	

Contents

Terms and Abbreviations

AADJV	Arup and Aurecon Design Joint Venture
ACCIONA	ACCIONA Infrastructure Australia Pty Ltd
AFJV	ACCIONA and Ferrovial Joint Venture
AS/NZS	Australian and New Zealand Standard
ASM	Acid Sulfate Materials
ASMMP	Acid Sulfate Materials Management Procedure
ASR	Acid Sulfate Rock
ASS	Acid Sulfate Soils
CEMP	Construction Environmental Management Plan
CLM	Contaminated Land Management Act, 1995
CoA	Minister's Conditions of Approval
CRS	Chromium Reducible Sulfur
D&C	Design and Construction
DJV	Design Joint Venture
DoE	Department of Environment (Commonwealth)
DPE	NSW Department of Planning and Environment
EA	Environmental Assessment – Warrell Creek to Urunga, Upgrading the Pacific Highway, Roads and Maritime Services, January 2010
EC	Environmental Coordinator
EEC	Endangered Ecological Communities
EDMS	Electronic Document Management System (TeamBinder)
ENM	Excavated Natural Materials
EPA	Environment Protection Authority (part of OEH)
EP&A Act	Environmental Planning and Assessment Act 1979
EPBC	Environmental Protection and Biodiversity Conservation
EPL	Environment Protection Licence
EPRM	Excavated public road material
ER	Environmental Representative
ERG	Environmental Review Group (consists of EPA, DPI, Nambucca Shire Council, the Environmental Representative and the RMS)
ESCP	Erosion and Sedimentation Control Plans
EWMS	Environmental Works Method Statement
Ferrovial	Ferrovial Agroman (Australia) Pty Ltd
FM Act	Fisheries Management Act, 1994
GHD	GHD Australia Pty Ltd
ID Planning	ID Planning Pty Ltd
IMS	Integrated Management System
ISO	International Standards Organisation
KPI	Key Performance Indicator
MBO	Monosulfidic Black Ooze

MCoA	Minister's Conditions of Approval
MNES	Matters of National Environmental Significance
NSW	New South Wales
O&M	Operations and Maintenance
PAF rock	Potentially Acid-Forming rock
PASS	Potential Acid Sulfate soils
PCBU	Person Conducting a Business or Undertaking
PMP	Project Management Plan
PMT	Project Management Team
PoEO Act	Protection of the Environment Operations Act, 1997
PV	Project Verifier
RMS	Roads and Maritime Services
SPOCAS	Suspension peroxide oxidation combined acidity sulfur
SWMP	Soil and Water Management Sub Plan (CEMP Appendix B4 Soil and Water Management Sub Plan)
TS	Total Sulfide
VENM	Virgin Excavated Natural Materials
WC2NH	Warrell Creek to Nambucca Heads (the Project)
WEMP	Waste and Energy Management Plan (CEMP Sub plan)

Definitions

Acid Sulfate Soils	Acid Sulfate Soils include actual acid sulfate soils (AASS) or potential acid sulfate soils (PASS). Actual and potential acid sulfate soils are often found in the same soil profile, with actual acid sulfate soils generally overlying potential acid sulfate soil horizons.
Aglime	Finely crushed limestone – Agricultural Lime
Client	An organisation inviting and receiving tenders and letting contracts. For the purposes of this project - Roads and Maritime Services
Contractor	An organisation that contracts with a client to carry out construction and related services. For the purposes of this Project - ACCIONA Ferrovial Joint Venture.
Chromium Reducible Sulfur (CRS)	A commonly used, low cost method of determining reducible inorganic sulfur compounds. Often used where results are close to trigger values and where significant organics are present although does not quantify the actual acidity resulting from actual acid sulfate soils.
Chromium Suite	The Chromium suite (or CRS Suite) is a collection of independent analytical methods, each of which determines a component of the acid base accounting.
Davis Langdon	Davis Langdon Australia Pty Ltd
Deed	D&C Project Deed, IC-DC-C91-1, Pacific Highway Warrell Creek to Nambucca Heads
Design Joint Venture	Joint Venture consisting of Arup and Aurecon
Government Agency	NSW government department, authority, corporation or entity established by an Act of the NSW Parliament
Persons Conducting a Business or Undertaking	Is an employer, corporation, partnership, unincorporated association that has the primary duty of care for workplace health and safety - (AFJV and Contractors are a PCBU)
Principal Contractor	A person conducting a business or undertaking that commissions a construction project. For the purposes of this project - AFJV
Project	The design and construction of the upgrade to the Pacific Highway between Warrell Creek and Nambucca Heads
Project Verifier	For the purpose of the Project, this is Davis Langdon Australia Pty Ltd
Proof Engineer	For the purpose of the Project, Cardno Pty Ltd
Subcontractor	Organisation that contracts with a principal contractor as the client to carry out construction and related services
Supplier	Organisation that contracts with a client to provide a product and / or service.
TeamBinder	The project Electronic Document Management System software
Worker	Is anyone who carries out work for a PCBU and includes: an employee, contractor or sub-contractor or an employee of, labour hire personnel, apprentice or trainee, work experience student

1. Introduction

The Warrell Creek to Nambucca Heads Pacific Highway Upgrade project (the WC2NH Project) is being designed and constructed in a joint venture consisting of ACCIONA Infrastructures Pty Ltd (ACCIONA) and Ferrovial Agroman (Australia) Pty Ltd (Ferrovial), in liaison with various other pre-qualified construction contractors, with overall project management and site supervision of the project by Roads and Maritime Services (RMS).

The *Warrell Creek to Urunga, Upgrading the Pacific Highway – Environmental Assessment* (Roads and Maritime Services, January 2010) assessed the impacts of construction and operation of the Project on potential Acid Sulfate Material (ASM). ASM includes the potential for Acid Sulfate Soils (ASS), Acid Sulfate Rock (ASR) and Monosulfidic Black Ooze (MBO).

Construction activities such as land clearing and excavation have the potential to expose ASM that could potentially cause oxidation of sulfides and sulfuric acid to be produced. The recognition and sustainable management of ASM during road planning and construction is an important element to achieve and maintain sound environmental management across the Project.

1.1. Project Background

The WC2NH project consists of the detailed design and construction of 19.6 km of new dual carriageway road on the Pacific Highway between the northern end of the existing Allgomera Deviation south of Warrell Creek and the southern end of the Nambucca Heads to Urunga Pacific Highway upgrade project west of Nambucca Heads. The project includes:

- two grade separated interchanges at Warrell Creek and Bald Hill Road south of Macksville. Roads and Maritime is also investigating the provision of north facing ramps at North Macksville;
- longitudinal bridges across Upper Warrell Creek (including North Coast Railway Line), Williamson Creek, Warrell Creek, Nambucca River floodplain (2 of) and Nambucca River;
- overbridges on Rosewood Road, Albert Drive, Scotts Heads Quarry access road, Bald Hill Road, Old Coast Road South, Mattick Road and Old Coast Road North;
- an underpass at Cockburns Lane;
- local roads and drainage and fauna crossing structures; and
- associated infrastructure.

1.2. Purpose

The purpose of this Acid Sulfate Materials Management Procedure (this ASMMP and Procedure) is to describe how the Acciona Ferrovial Joint Venture (AFJV) proposes to manage the potential discovery and disturbance of ASM during the construction of the Project.

This Procedure addresses the requirements of the Minister's Conditions of Approval (CoA) and the RMS Statement of Commitments (SoC), applicable legislation and relevant standards.

The Procedure details the actions that will be taken by AFJV to identify the types of materials expected to be encountered and ensure effective controls are established and maintained to manage potential environmental impacts during the construction of the WC2NH project.

1.3. Scope

This Procedure is applicable to all design and construction activities conducted by personnel on the Project that involve earthworks. The Procedure forms Appendix C of the Soil and Water Management Subplan (SWMP) within the Construction Environmental Management Plan (CEMP) for the Project.

Relevant management measures identified in this Procedure will be incorporated into site or activity specific construction plans, procedures and Environmental Work Method Statements (EWMS), involving earthworks.

1.4. Objectives

The key objective of this Procedure is to provide instruction on potential Acid Sulfate Material (ASM) during design and construction to protect the environment. To achieve this objective, AFJV will undertake the following:

- Ensure all activities which may potentially expose, impact on, or handle ASM include procedures and controls into relevant EWMS;
- Ensure all Project personnel involved in activities which may potentially expose, impact on, or handle ASM are aware of the requirements for ASM management;
- Maximise the reuse of earthen materials generated on site.

2. References

The following Project documents are referenced in conjunction with this Procedure:

- Project Approval (Minister's Conditions of Approval (CoA) up to Modification 6) – refer to Section 3.2 of this procedure for detailed requirements;
- Construction Environmental Management Plan (CEMP);
- Soil and Water Management Plan (SWMP);
- SWMP Appendix B Spoil and Fill Management Procedure;
- SWMP Appendix F - Unexpected Discovery of Contaminated Land Procedure;
- SWMP Appendix I – Stockpile Management Protocol;
- Waste and Energy Management Sub Plan;
- Earthworks Management Plan.

These documents are available in Teambinder. Enquiries in relation to the this Procedure and all related CEMP Sub plans and procedures should be notified to the Environmental Manager.

3. Legislative and other Requirements

3.1. Legislation

The key legislation relevant to ASM management includes:

- Environmental Planning and Assessment Act, 1979 (EP&A Act);
- Protection of the Environment Operations Act, 1997 (PoEO Act);
- Fisheries Management Act, 1994;
- Contaminated Land Management Act, 1997.

3.2. Minister's Conditions of Approval, Statement of Commitments

The CoA relevant to this Procedure are listed Table 1 below.

Table 1: CoA relevant to this Procedure

CoA	Condition / commitment requirements
B.31 (in part)	(d) a Construction Water Quality Management Plan to manage surface water quality and groundwater impacts during construction of the project. The Plan shall be developed in consultation with EPA, DPI (Fisheries and NOW) and include, but not necessarily be limited to: (i) a contingency plan, consistent with the Acid Sulfate Soils Manual, to deal with the unexpected discovery of actual or potential acid sulfate soils

Table 2 outlines the Statement of Commitments (SoC) related to ASM including outcomes to be achieved, details of the commitment, and reference to the timing of when the commitment applies.

Table 2 SoC relevant to this Procedure

Ref number	Outcome	Commitment	Timing
S1	Minimise impact of exposing acid sulphate soil	Identification and management of Acid Sulphate Soils will be in accordance with the Guidelines for the Management of Acid Sulphate materials: Acid Sulphate Soils, Acid Sulphate Rock and Monosulphidic Black Ooze (RTA 2005)	Pre-construction and construction

3.3. Environment Protection Licence

The project is subject to an Environment Protection Licence (EPL) as a scheduled activity - Road Construction. Activities in the handling, transportation and movement, stockpiling, treatment for reuse and disposal of ASM during construction will be subject to EPL requirements, particularly in respect to the potential to discharge to air, water, land and the generation of waste.

EPL criteria for all discharges must be referenced for monitoring and compliance requirements in the management of ASM.

3.4. Relevant Standards

Guidelines and Standards relevant to ASM management include:

- Guidelines for the Management of Acid Sulfate Material Acid Sulfate soils, Acid Sulfate Rock and Monosulfidic Black Ooze, RTA 2005;

- Acid Sulfate Soil Manual, NSW Acid Sulfate Soil Management Advisory Committee, 1998;
- NSW Environment Protection Authority publication "Assessing and Managing Acid Sulphate Soils";
- Acid Sulphate Soils Manual, Department of Urban Affairs and Planning;
- Waste Classification Guidelines, (EPA);
- Australian and New Zealand Guidelines for Assessment and Management of Contaminated Sites, ANZECC/NHMRC, 1992;
- Assessment Classification and Management of Liquid and Non-Liquid Waste (EPA), 1999;
- RMS Specification D&C R44; and
- Stockpile Site Management Guideline, RMS 2011.

4. Responsibilities and Accountabilities

4.1. Key Staff

The overall roles and responsibilities for environmental management are outlined in Section 4.2 of the CEMP. The responsibilities and accountabilities for key Project staff in the implementation of this Procedure include:

4.1.1. Project Director

- Approve this Procedure for implementation and all subsequent revisions;
- Instruct all Project personnel on adherence to this Procedure.

4.1.2. Project Manager

- Ensure appropriate resources are available for the implementation and maintenance of ASM management measures.

4.1.3. Construction Manager

- Ensure the requirements of this procedure are referenced within earthworks requirements for all construction packages;
- Liaise with the Environmental Manager for each package of work involving potential acid sulfate materials generation and handling;
- Respond to identified potential or actual breaches, and take appropriate corrective or preventative actions in accordance with this procedure.

4.1.4. Environmental Manager

- Ensure the Procedure remains current and is reviewed and consulted with RMS and the Environmental Representative (ER);
- Ensure ASM related management controls are implemented and relevant EWMSs include requirements of this Procedure;
- Provide project-wide training and awareness to ensure consistent approach and outcomes are achieved;
- Liaise with relevant authorities and organisations as necessary.

4.1.5.Environmental Coordinators

- Provide assistance and advice to AFJV personnel to fulfil the requirements of this Procedure;
- Coordinate testing and assess data from inspections, monitoring and reporting;
- Investigate potential areas identified as containing ASMs and provide guidance and assistance to implement requirements of this Procedure.

4.1.6.Design Manager

- Liaise with the Environmental Manager for each design package of work within identified potential ASM locations;
- Ensure the design avoids or minimises the disturbance of ASM where feasible.

4.1.7.Project Engineers

- Provide necessary data on ASM investigations as part of site geotechnical works;
- Ensure site management measures are implemented and maintained for earthworks

4.1.8.Site Superintendents/Foremen

- Ensure earthworks involving ASM accord with this Procedure in regards to handling, storage, stockpiling (in temporary and treatment areas), and the placement of treated materials for reuse;
- Coordination of ASM for offsite disposal, if required.

4.1.9.All Other Managers and Workers

Be familiar with this Procedure and comply with the requirements incorporated within construction management plans and procedures, including EWMS in relation to earthworks and piling where applicable.

5. Description of ASM Aspects and Impacts

Acid Sulfate Soils are generally distributed in estuaries and coastal floodplains, back swamps and coastal areas in elevations <5m AHD. Monosulfidic Black Ooze potentially exists in drains and waterways in acid sulfate areas and saline areas. Acid Sulfate Soil risk maps were reviewed and indicated a high potential for the presence of Potential Acid Sulfate Soils (PASS) in the project area as shown in Figure 1 shown in Appendix E.

Based on the Environmental Assessment, Potential Acid Sulfate Soils are likely to be present at the following locations.

- Adjacent to and north of Warrell Creek;
- In the low lying area of the Nambucca River floodplain, adjacent to and north of the Nambucca River.

Potentially acid forming rock may be present in all sedimentary, metamorphic and igneous rock types with higher risk metaliferous ores, coal and sulfate/sulfide materials.

Review of geology maps and investigations by AFJV on project-wide rock material examined Total Sulphide (TS) conditions in regards to Phillite, Hornfels and Granodiorite material types present. Of these material types, Hornfels show a greater likelihood of mean TS levels linked to potential for acid-forming rock. The preliminary geotechnical sampling of rock further identified potential hot-spot areas of acid forming rock. Key areas include locations for Cut 10 and Cut 11. Cut 7, 8 and 9 also pose a moderate risk of Acid Forming Rock (AFR).

Construction activities that have the potential to impact ASM's are:

- Excavations (shallow and deep);
- Piling;
- Dewatering;
- Dredging;
- Diverting small open drainage lines;
- Blasting (of ASR).

Potential causes during construction activities that can result in ASM impacts include (as referenced in the RMS Guideline for Acid Sulfate Materials):

- Excavation in coastal floodplain and wetland areas, excavation includes minor disturbance of soil for installation of signs and traffic signals, through to makor earthworks;
- Building embankments across low strength swamp sediments;
- Dredging of coastal rivers (estuarine reaches) for roadmaking materials;
- Sinking bridge and roadworks piles;
- Importing materials for fill from areas of potential ASS;
- Lowering the water table by installing subsoil drains, deepening table drains or pumping water out of excavations in ASS areas (unlikely to have a significant impact on ASR);
- Raising the water table by filling in drains;
- Uncontrolled surface runoff in areas of exposed ASM, causing the release of acid into the environment;
- Changes to surface run-off patterns promoting the release of acid into the environment;
- Leaching of acid into the environment at treatment sites;
- Exposing ASM at/near new drains or realigned creeks, thus causing the release of acid into the environment in the short and long term;
- Exposure of ASM to the air, in new drains or realigned creeks, thus causing increased oxidisation and increased release of acid into the environment;
- Inadequate treatment of ASR reused for construction material;
- Unintentional use of excavated ASR as fill material or for other road making purposes;
- Potential ASR affects on concrete structures, road surfaces and road railings and potential destabilisation of fill; and
- Changes to groundwater levels resulting from surcharging, construction of fill embankments and hardstand areas.

Once the acid sulfate soil tests have confirmed the presence of ASS/PASS an EWMS will be prepared in accordance with this Procedure. Acid Sulfate Material treatment areas will be located, designed, constructed and operated in accordance with the requirements of this Procedure, the Stockpile Management Protocol and the Earthworks

Management Plan. The EWMS will include liming rates, PESCP for the treatment area and management requirements for any potential leachate encountered.

6. Procedures for Managing and Treating Acid Sulfate Materials

6.1. Design and Construction Planning Procedures

6.1.1. Identified Areas of ASM

When planning any works, the potential areas where ASM are likely to occur must be considered. Locations identified as potentially containing Acid Sulfate Materials are summarised in Table 3. Further detail is provided in the Environmentally Sensitive Area Plans (refer to Appendix A6 of the CEMP).

Table 3: Summary of Potential Acid Sulfate Materials

Location (Ch)	Description	Acid Sulfate Material
42250	Drainage Culvert	Potential Acid Sulfate Soils
44480	Drainage Culvert C44.48	Potential Acid Sulfate Soils
45580	Drainage Culvert C45.50	Potential Acid Sulfate Soils
45840 to 47500	Cut 7 - 9	Potential Acid Forming Rock
47550 to 47900	Cut 10	Potential Acid Forming Rock
48600 to 49000	Cut 11	Potential Acid Forming Rock
53025	Culvert C53.02	Potential Acid Sulfate Soils
54350	Culvert C 54.35	Potential Acid Sulfate Soils

In addition to the identified areas of potential acid forming (PAF) rock in Table 3, assessment of all areas for determining the potential for Acid Sulfate Rock will be based on the following hierarchy:

(i) Assessment by Material Type

Investigation of rock within the project area has identified PAF characterization associated with the Hornfels, and potentially to a lesser extent with Granodiorite. Material comprising substantially of Phyllites would be excluded from further Total Sulfides assessment.

(ii) Assessment by Source (by Cut)

Material source (ie. generated in a cut) will be assessed on the basis of data obtained prior to excavation, enabling classification of material prior to excavation, improving predictability of material handling. Sampling will be undertaken by the drilling of air track holes to create rock dust for sampling purposes. In the instance of a cut subject to basting, the blast holes may be utilized within the sampling program. Sub-division of lots would be established to isolate identified "hot zones" to enable more beneficial use of excavated materials.

(iii) Assessment by Stockpile

Material will be stockpiled in accordance with these Procedures (see section 6.3) and the Stockpile Management Protocol, and will be sampled for determination of ASR or PAF rock.

The Environmentally sensitive area plans shall be "ground truthed" on site for the presence of ASM, taking supplementary tests where required during the geotechnical investigations. The sensitive area plans shall be updated based on findings of ground truthing and testing.

6.1.2.ASM Avoidance and Mitigation

The following steps must be considered in design and construction planning:

- Avoid the disturbance of ASM where practical to do so by locating temporary facilities, temporary inground services etc away from identified potential areas;
- Risk of disturbance to potential ASM should be reduced to as low as reasonably practicable taking into account engineering and economic constraints;
- Avoid or minimise excavation and lowering of the water table in areas known to potentially contain ASM;
- Acid resistant construction materials to be applied in areas known to contain high risk ASM;

The following construction preparations must be taken when planning to work in areas identified as potentially containing ASM:

- Minimise the time of exposure of ASM to air by planning the works, keeping the material wet and covering with clean material;
- Where impacts to areas containing ASM is unavoidable, the excavation, stockpiling and containment, treatment and reuse or disposal of ASM will be pre-planned in accordance with the requirements of this Procedure to minimise environmental impacts to acceptable levels. Refer to sections 7.3 of this Procedure for treatment of ASM;

Small quantities of PASS excavated in the field and field tested to confirm low level (minor reaction to peroxide), may be reburied on site within 24hours of excavation covered by either surface or standing awater or beneath the groundwater table (below compacted non-ASS or neutralized material) in accordance with the Strategic Reburial requirements of the RMS Guideline. In this case, care will be taken to ensure the soil horizons are excavated and placed separately to enable reinstatement in the same order from which they were excavated and that natural groundwater fluctuations are maintained

ASM that shows a highly reactive field test and/or geotechnical investigations have confirmed reactive PASS/ASS will be transported to the designated treatment area.

6.1.3.Safety First in the Field

Prior to field works and handling of any ASM, safety instructions must be adhered to as per the relevant SWMS and EWMS for the activity and in accordance with any safety data sheets for products being used (e.g MSDS for lime).

PPE will typically include: Eye Goggles and/or Face Mask; Hard Hat; Rubber boots and gloves; Appropriate clothing (e.g. long sleeved shirts).

Seek the advice of the safety officer if required to ensure that correct protocols are applied.

6.2. Unexpected Discovery of Acid Sulfate Soils

The potential risk for unexpected discovery of ASM can arise, particularly in working within the low-lying flood plain areas, eg adjacent to and within Warrell Creek and Nambucca River.

Appendix A provides the specific procedures to be followed when ASS or MBO are unexpectedly encountered during excavation / construction activities. The procedures for field testing in the potential discovery of ASM is provided in Appendix B.

6.3. ASM Storage and Handling

The following procedures will be followed when storing and handling ASM.

6.3.1.Interim Stockpiling of ASM

For unexpected finds of suspected ASM, which cannot be immediately transported to the specific treatment area, may be stockpiled in temporary locations near to the excavation. Any interim stockpiles must be located a minimum of 10m from waterways and drainage lines in accordance with the Stockpile Management Protocol.

If the material is to be stored for more than 24 hours, a bed of agricultural lime (aglime) (5kg/m^2) must be spread over the storage location and contained within an impermeable earth bund or similar. All runoff from the interim storage sites shall be treated in the same way as leachate from ASM treatment areas prescribed below (ASM Treatment Area Layout) in Section 6.3.2. A capping layer of aglime will be spread over the top of the stockpile to minimise oxidation of material.

Interim ASM stockpiles, within adequately bunded areas may be left in situ for up to 5 days, to facilitate laboratory testing of the material to confirm the ASM testing regime. If the material is determined to be ASM, if practical, the material may be treated in the bunded area. The material will be treated with aglime to the quantity nominated on the test results. Further sampling will then be undertaken after the aglime has been adequately mixed through the material to confirm it has been neutralised. If it is not practical to treat the material in-situ it will be transported and treated in an ASM Treatment Area. If the material is determined to be non-ASM, it may be reused on the project.

6.3.2.ASM Treatment Area Layout

Estimate the potential amount of ASM that may be disturbed and determine a treatment area large enough to contain all, or the progressive treatment of loads, of excavated ASM. Refer to Figure 2 for an indicative example of an ASM treatment area layout. The Environmental Coordinator and Project soil conservationist should be involved to advise on the establishment of a treatment area. Treatment areas shall meet the following requirements:

- Be located at least 50m from waterways;
- Be located above the 1 in 20 year ARI flood levels;
- Be constructed with impervious material (eg clay) bunds to prevent leachate runoff. The base of layout area should be approximately 200m thick;
- Be lined with aglime on the floor of the treatment area at a rate capable of neutralising all acid waters that might infiltrate through ASS, prior to placing ASS in the treatment areas;
- **Be located on relatively level ground. Locations will be approved by Environmental manager prior to stockpiling of any ASM.**
- Be clearly signposted.

The treatment area will require a settlement pond or sump to collect any runoff. The pond or sump must be designed to capture the ASM treatment area runoff a 1 in 10 year (1 hour) storm event.

It is noted that an EPL will cover the treatment of ASM on site and particular requirements may be included in the licence. This Plan will be updated with any changes from the EPL.

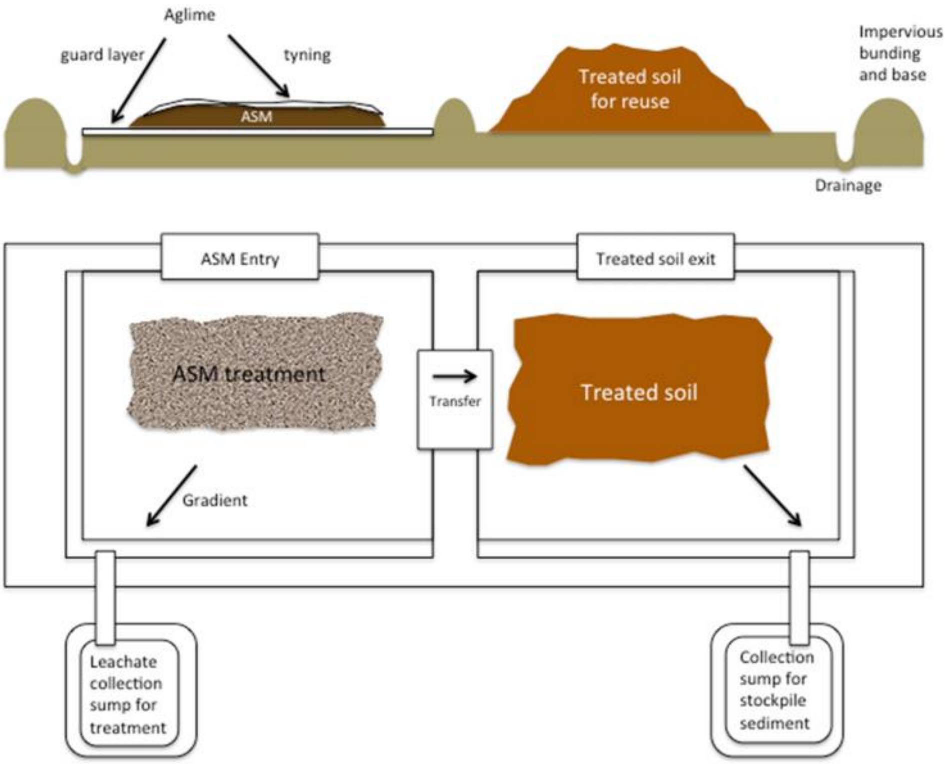


Figure 2 ASM Treatment Area Layout (Example)

6.3.3.Transport of ASM

Transport will be made via haulage trucks with adequate tailgates to prevent spillage of material onto public or construction access roads. Haulage routes would be monitored routinely for ASM and any spills are to be cleaned up immediately and material transported to the ASM treatment area as soon as practicable. Refer to section 6.8 in the transport for offsite disposal.

6.3.4. Testing of ASM

The testing and treatment of ASM will depend on the quantities excavated on site. The RMS Guideline nominates a testing regime for quantities of ASM less than 1000 tonnes and over 1000 tonnes. Although it is unlikely that larger quantities of ASM will be excavated on site, the Action Criteria adopted from the RMS Guideline will be used on the Project. The Action Criteria is summarised below in Table 4 and is based on the soil texture.

The ASM will be field tested to determine reactivity. If the soil has displayed a positive field test, a subsequent laboratory sample will be taken. Once the results are received, they will be compared with the below Action Criteria to determine if treatment of the material is required. If treatment of the material is required, refer to Section 6.4.

Table 4 – Action Criteria adopted from RMS Guideline

Texture-based Acid Sulfate Soil action criteria (after Ahern *et al.* 1998a)

Type of Material		***Action Criteria* if 1 to 1000 tonnes of material is disturbed**		***Action Criteria* if more than 1000 tonnes of material is disturbed**	
		Existing + Potential Acidity		**Existing + Potential Acidity**	
Texture range (McDonald *et al.* 1990)	Approx clay content (%)	Equivalent sulphur (%S) (oven-dry basis)	Equivalent acidity (mol H^{+}/tonne) (oven-dry basis)	Equivalent sulphur (%S) (oven-dry basis)	Equivalent acidity (mol $H^{+/}$tonne) (oven-dry basis)
Coarse texture *Sands to loamy sands*	= 5	0.03	18	0.03	18
Medium texture *Sandy loams to light clays*	5 – 40	0.06	36	0.03	18
Fine texture *Medium to heavy clays and silty clays*	= 40	0.1	62	0.03	18

Oven-dried basis means dried in a fan-forced oven at 80° - 85°C for 48 hours.

6.4. ASM Treatment methodology

In general, the base of the stockpile site will be lined with lime at 0.5kg/m^2 to neutralise any water that may seep into the ground water. A sump hole will be excavated near the stockpile to enable runoff to be captured and tested to confirm the water quality leaving the stockpiled material.

ASM shall be laid in 300mm layers and treated with lime. Laboratory results will identify the acid trail and sulphate trail of the material and will provide recommendations for final dosing rates discussed as follows.

6.4.1. ASS treatment based on pH and liming rates

An estimation on treatment levels and aglime required to treat the total weight of disturbed Acid Sulfate Soil is provided in Appendix C.

An process for estimating the ASR treatment levels is provided in Appendix D.
The liming rate will be provided with the laboratory results. Firstly, the laboratory results are to be compared with the Action Criteria provided in Table 4 above.
ASM will be spread out in a 300mm layer and aglime will be spread over the area at the required rate and tyned in prior to stockpiling of the material. Aglime may also be mixed through using an excavator. The material shall remain bunded until test results available to confirm neutralisation.

Treated material will be stockpiled separately within the bunded area depending on the location where the ASS/PASS was transported from and the dosing rate used.

This material shall remain bunded until test results available. The stockpile will then have additional lime added if required. After sufficient treatment has been achieved and the material is determined to be neutralised, this material can then be reused within the Project as non-engineered fill in accordance with Section 6.6.

6.4.2. ASR treatment based on pH and liming rates

A simple indicator for determining liming rates for Acid Sulfate Rock is provided in Appendix D to this Procedure. The indicator is extracted from the RMS Specification R44: Earthworks.

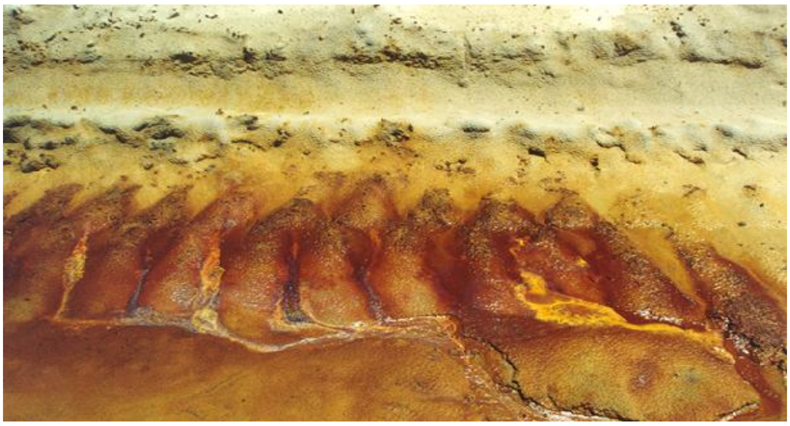
The pH testing procedure for ASR will be undertaken in accordance with the Field pH and Peroxide test applied to powdered rock material as conventionally applied to soils (refer to Appendix B). Sampling and testing protocols need to be implemented in a manner that accounts for mixing of 'hot spots', in order to provide an averaged basis for managing potential acid forming rock.

6.5. Monitoring

Where surface water and/or leachate collects within the bunded treatment area, the water shall be tested for pH, dissolved Aluminium, conductivity, dissolved Iron and TSS values prior to discharge. This section will be updated once the monitoring criteria in the EPL is established.

- Any runoff or fines collected in the settlement pond/sump will require assessment prior to decommissioning of the stockpile area.
- Regular visual monitoring of ASS areas and surrounds shall be undertaken to identify signs of ASS oxidation, see picture 1 and 2. This monitoring should include detecting:
  - Unexplained scalding, degradation or death of surrounding vegetation;
  - Unexplained death or disease in aquatic organisms;
  - Formation of the mineral jarosite and other acidic salts in exposed or excavated soils;
  - Areas of green-blue water or extremely clear water indicating high concentrations of aluminium;
  - Rust coloured deposits on plants and on the banks of drains, water bodies and watercourses indicating iron precipitates;
  - Exposed soil material forms orange crust;
  - Black to very coloured waters indicating de-oxygenation.

Picture 1 – Oxidised material with orange crust


Picture 2 – Acidic leachate forming an orange stain

6.6. Validation of Treated Material

Final validation sampling of treated soils will be conducted at the completion of treatment to determine if the neutralisation process has been successful.

Soils that have been mixed with aglime will be analysed (by laboratory analysis eg SPOCAS or Chromium Suite testing methods) at a rate of one sample per 250 m^3.

The following performance criteria must be attained for soil that has been treated using neutralisation:

- The neutralising capacity of the treated soil must exceed the existing plus potential acidity of the soil
- Soil pH > 5.5
- Soil has no further capacity to generate acidity.

Samples of the treated soil should be taken and laboratory tested to demonstrate compliance with the performance criteria. All validation samples are to be recorded by the Environmental Coordinator.

Any leachate collected in ASM treatment areas must not be released unless pH is 6.5-8.5.

6.7. Reuse of Treated Material

Once treatment has occurred and material validated, onsite re-use of the treated material shall be undertaken.

6.8. Disposal offsite

If off-site disposal is required, procedures outlined within the document Waste Classification Guidelines, Part 4: Acid Sulfate Soils (DECCW 2008) shall be implemented.

ASS must be treated before the material can be considered for disposal. Treatment should be in accordance with the neutralising techniques outlined in section 6.4 of this Procedure.

Following neutralisation, the waste must chemically assess the soil in accordance with Step 5 of the Waste Classification Guidelines: Part 1 – Classifying waste (available at www.environment.nsw.gov.au/waste/envguidlns). This will determine whether there are any other contaminants that may affect how the waste is classified for disposal.

Once classified, the waste must be taken to a landfill licensed to accept that class of waste. (Refer to the Environmental Coordinator to confirm AFJV approved location for offsite landfill for disposal).

Prior arrangements should be made with the occupier of the landfill to ensure that it is licensed to accept the waste. The landfill must be informed that the actual ASS has been treated in accordance with the neutralising techniques and classified in accordance with the Waste Classification Guidelines.

7. Contingency Measures

The following contingency measures outlined in Table 4 will be undertaken in the event of failure of proposed ASM management and treatment. The project soil conservationist will be involved in advisory support to implementing any contingency measures as required.

Table 4 Contingencies for potential failures in ASM management and treatment

Potential failure	Potential impact	Contingency measures
Unexpected find of ASM	Lack of preparedness in managing excavated ASM. Release of acidity into immediate surrounds including waterways.	• Apply Unexpected Finds Procedure • Provisioning of neutralising agent (aglime) when working in high risk ASM areas. • Prepare for temporary stockpile area when working in high risk ASM areas. • Monitoring by Environmental Coordinator and soil conservationist. • Follow treatment procedure.
Failure of batch treatment (neutralisation)	Constrain on stockpile treatment area capacity. Potential release of acidic material to environment.	• Verification of stockpile prior to reuse. • Creation of additional temporary stockpile site to be organised under coordination with Environmental Coordinator and soil conservationist for re-treatment.
Local flooding of stockpile treatment area or temporary stockpile area, causing overflow of sump collection.	Release of acidic 'leachate' water to land and waterways	• Treating stockpiles within 24 hours. Location of temporary stockpiles away from waterways and provide sufficient stormwater diversion around stockpiles (monitor short term weather information). • Liming of drainage lines. • Collect washed out sediments, test area and neutralise area if required.
Inflow of groundwater into soil and rock excavations subject to acidic conditions	Impact on groundwater quality and consequential impacts to aquatic environment.	• Provisioning of neutralising agent (aglime) when working in high risk ASM areas. • Pump out acid drainage into temporary storage tanks or lagoons for treatment • Install lime curtain in work area where appropriate • Monitoring of groundwater conditions

Spillage of ASM during transport	Release of acidity into immediate surrounds including waterways.	• Collect material, neutralise area if required. Provisioning of neutralising agent (aglime) when working in high risk ASM areas.

8. Training and Awareness

All relevant staff, workers and contractors will be trained in this Procedure. This will be provided by Pre- Works Site Induction as well as on going toolbox training. The following issues will be addressed by training.

- Location of identified potential ASM;
- How to identify ASS in the field;
- Unexpected ASM Discovery Procedure;
- Transport and Treatment of ASM;
- Testing and monitoring;
- Contingencies.

9. Stakeholder Consultation

Relevant stakeholders include the RMS, ER EPA, DPI (Fisheries), DPE and Nambucca Shire Council. These organisations will be consulted with throughout the project via the regular ERG meeting. The procedure will be modified if where improvements are identified.

10. Procedure Review

The Environmental Manager will undertake an assessment of the effectiveness of ASM treatment and management measures and implications that these Procedures may have for other projects.

The Environmental Manager, in consultation with the construction team and with RMS and the ER, will modify this Procedure where improvements are identified.

APPENDICES

Appendix A - Unexpected Acid Sulfate Soils Discovery Procedures

The following procedures will be followed when ASS (including actual acid sulphate soils – AASS, PASS and MBO) are unexpectedly encountered during excavation / construction activities. Key steps in this procedure are presented as a flow chart in Figure A1 for chance find of ASS.

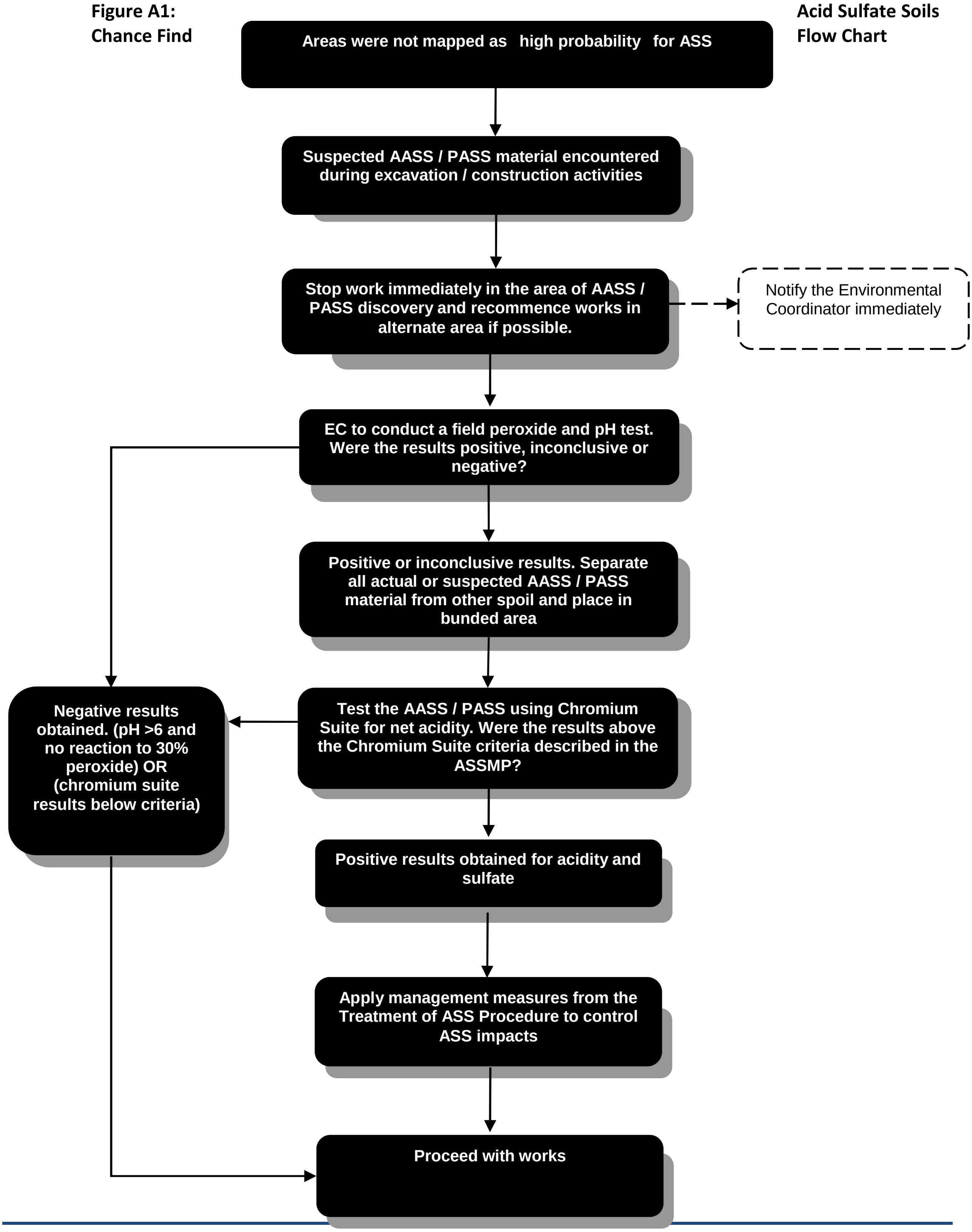
Procedures for Unexpected Discovery / Disturbance of ASS

Unexpected Discovery / Disturbance of ASS
If ASS are unexpectedly disturbed / encountered during excavation/construction activities: • STOP ALL WORK in the immediate/affected area • Isolate the area with NO GO Fencing/Signage as appropriate • Immediately notify the Environment Coordinator (EC) • Recommence works in an alternate area where practicable
ASS Characteristics: Any of the following characteristics may indicate the presence of ASS • Soil pH of <4 (Note - MBO may be higher) • A sulfurous smell following soil disturbance • Pale yellow/orange surface encrustations • Excessive iron/orange staining on drain surfaces or stream banks, or iron stained drain water and orange red ochre deposits around water bodies • Excessive corrosion of concrete and / or steel structures exposed to ground or drainage waters, or rapid corrosion of fresh steel in the soil • Blue-grey, blue-green or grey waterlogged soils which smell of rotten egg gas and tidally dominant vegetation (e.g. mangroves) High risk indicators for ASS could include: • Low position in the landscape or soil from beneath the water table • Heavy textures (MBO is characterised by black organic gels with a slightly oily appearance) • Dark colours • Sulfur odour (rotten egg odour)
Positive or Inconclusive Test for ASS
Undertake field tests – refer to Appendix B Field Testing Procedure. If field tests are positive or inconclusive, laboratory analysis (using the SPOCAS or Chromium Suite[1]) will be required to determine if the material is in fact ASS and/or the required treatment rates based on the net acidity. In this event all disturbed undetermined material must be temporarily stockpiled and bunded in accordance with this Procedure awaiting confirmation of laboratory analysis. If the net acidity results confirm the presence of ASS, the material will be treated in accordance with this

[1] SPOCAS – Suspension peroxide oxidation combined acidity sulfur', and Chromium suite (Chromium Reducible Sulfur - CRS Suite) are a collection of independent analytical methods, each of which determines a component of the acid base accounting.

Procedure with appropriate neutralisation analysis results.

Figure A1: Chance Find Acid Sulfate Soils Flow Chart



Appendix B - Field pH Testing Procedure

<u>Field Testing – Field pH and the 30% Peroxide Test</u>

Field testing provides rapid insitu techniques for assessing the likelihood of ASM. The test involves measuring soil pH before and after oxidation using the following parameters:

pH_F — measure of soil pH of a soil:water paste

pH_{FOX} — measure of soil pH after rapid oxidation with hydrogen peroxide (H_2O_2)

Field testing cannot be used as a substitute for laboratory analysis in the identification of acid sulfate soils for assessment purposes.

The techniques for field pH (pH_F) and field peroxide pH (pH_{FOX}) are detailed as follows:

1. Field pH Test (pH_F)

The pH_F readings should be taken at regular intervals down the soil profile. It is recommended this test be done every 0.25m down the profile but at least every 0.5m interval or horizon whichever is the lesser.

Notes on pH equipment and use
• A battery powered, field pH meter with a robust, spear point, double reference pH electrode should be used • Calibrate the field pH meter in accordance with the manufacturer's instructions • The probe can be inserted directly into soft wet soils or soil mixed up into a paste with deionised water. (Care must be exercised not to scratch the electrode on sandy or gravely soils) • Use of the meter and testing should be only undertaken by trained personnel

2. Field Peroxide pH Test (pH_{FOX})

To test for the presence of unoxidised sulfides and therefore PASS, the oxidation of the soil with 30% (100 volume) hydrogen peroxide can be performed in the field. The most common method is:

- A small sample of soil (approx. 5 g) is placed in a small glass container (e.g. short clear centrifuge tubes, clear tissue culture clusters or sample jar) and a small volume (20 mL) of peroxide is dropped onto the soil (Note: Allow the digested solution to cool after the reaction. A pH probe will only measure to 60°C.)

- The reaction should be observed and rated. In some cases, the reaction may be instantaneous; in others, it may take 10 minutes or more. Heating over hot water or in the sun may be necessary to start the reaction on cool days, particularly if the peroxide is cold.

- Potentially positive reactions for ASS include one or more of the following:
  - change in colour of the soil from grey tones to brown tones;
  - effervescence;

- the release of sulfurous odours;
- final pH of <3.5 and preferably < 3;
- lowering of soil pH by at least one pH unit.

The strength of the reaction is a useful indicator. Effervescence (or reaction rate) — a visual measure of the vigorousness of the oxidation reaction where: 1 = slight; 2 = moderate; 3 = high; and 4 = extreme.

When effervescence (sometimes violent) has ceased, a few additional mL of peroxide should be added until the reaction appears complete. If the reaction is violent, it is recommended that deionised water be added to cool and dilute the reaction. The test may have to be repeated with a small amount of water added to the soil prior to peroxide addition. The pH_{FOX} of the resultant mixture is then measured. The peroxide test is most useful and reliable with clays and loams containing low levels of organic matter. It is least useful on coffee rock, sands or gravels, particularly dredged sands with low levels of sulfuric material (e.g. <0.05 % S).

With soils containing high organic matter (such as surface soils, peats, mangrove / estuarine muds, and marine clays), care must be exercised when interpreting the reaction as high levels of organic matter and other soil constituents particularly manganese oxides can also cause a reaction.

Note of caution with the use of peroxide
30 % hydrogen peroxide is a strong oxidising agent and should be handled carefully with appropriate eye and skin protection. This test should be only undertaken by trained personnel. The pH of analytical grade peroxide may be as low as 3 as manufacturers stabilise technical grade peroxide with acid. The peroxide pH should be checked on every new container and regularly before taking to the field and adjusted to 4.5 - 5.5 with a few drops of 0.1M NaOH if necessary. False field pH_{FOX} readings could result if this step is not undertaken.

3. pH After Oxidation

The measurement of the change in the pH_{FOX} following oxidation can give a useful indication of the presence of sulfuric material and can give an early indication of the distribution of sulfide down a core/ profile or across the site. The following table provides an interpretation of the change in pH.

If one positive result is obtained, the required action should be followed. The ‘pH after oxidation’ test is not a substitute for analytical test results.

pH_F	pH_{FOX}	DpH	Reaction Rate	Action Required
≥ 5.0	≤ 5.0	≤ 2	1—2	If no other field indicators or acid sulfate soil risk indicators are present, no further action is required
> 4.0 and < 5.0	> 3.0 and < 5.0	> 2	≥ 2	PASS may be present, further assessment is required (laboratory analysis)

≤ 4.0	≤ 3.0	> 2	≥ 2	AASS or PASS are likely to be present, further assessment is required (laboratory analysis)

Care is needed with interpretation of the result on highly reactive soils. Some soil minerals other than pyrite react vigorously with peroxide, particularly manganese but may only show small pH changes.

Note of caution with testing of soil with high organic content
When selecting soil for testing it is advisable to avoid material high in organic matter as the oxidation of organic matter can lead to the generation of acid. However pH of soils containing organic matter and no pyrite do not generally stay below 4 on extended oxidation. In general positive tests on 'apparently well drained' surface soils should always be treated with caution and followed up with laboratory confirmation.

The field peroxide tests can be made more consistent if a fixed volume of soil (using a small scoop) is used, a consistent volume of peroxide is added and left to react for an hour, and the sample is made up to a fixed volume with deionised water before reading. However, such procedures take time in the field and are more suited to a 'field shed' situation.

Appendix C – Estimating ASS treatment levels and Aglime rates

The following extract is taken from “Guidelines for the Management of Acid Sulfate Material Acid Sulfate soils, Acid Sulfate Rock and Monosulfidic Black Ooze, RTA 2005” (refer to ASM Procedure No.4 – Attachment 2 of RTA Guidelines)

Estimating treatment levels and aglime required to treat the total weight of disturbed Acid Sulfate Soil – based on soil analysis (after Ahern et al 1998, *Queensland Acid Sulfate Soil Technical Manual, Soil Management Guidelines*)

The tonnes (t) of pure fine aglime, $CaCO_3$ required to fully treat the total weight/volume of Acid Sulfate Soils (ASS) can be read from the table at the intersection of the weight of disturbed soil [row] with the existing plus potential acidity [column]. Where the exact weight or soil analysis figure does not appear in the heading of the row or column, use the next highest value.

Disturbed ASS (tonnes) (~ m³ x BD) ‡	Soil Analysis# - Existing Acidity plus Potential Acidity (converted to equivalent S% units)													
	0.03	0.06	0.1	0.2	0.4	0.6	0.8	1	1.5	2	2.5	3	4	5
1	0	0	0	0	0	0.03	0.04	0.05	0.1	0.1	0.1	0.1	0.2	0.2
5	0	0	0	0.05	0.1	0.1	0.2	0.2	0.4	0.5	0.6	0.7	0.9	1.2
10	0	0.03	0.05	0.1	0.2	0.3	0.4	0.5	0.7	0.9	1.2	1.4	1.9	2.3
50	0.1	0.1	0.2	0.5	0.9	1.4	1.9	2.3	3.5	4.7	5.9	7.0	9.4	12
100	0.1	0.3	0.5	0.9	1.9	2.8	3.7	4.7	7.0	9.4	12	14	19	23
200	0.3	0.6	0.9	1.9	3.7	5.6	7.5	9.4	14	19	23	28	37	47
250	0.4	0.7	1.2	2.3	4.7	7.0	9.4	12	18	23	29	35	47	59
350	0.5	1.0	1.6	3.3	6.6	10	13	16	25	33	41	49	66	82
500	0.7	1.4	2.3	4.7	9.4	14	19	23	35	47	59	70	94	117
600	0.8	1.7	2.8	5.6	11	17	22	28	42	56	70	84	112	140
750	1.1	2.1	3.5	7.0	14	21	28	35	53	70	88	105	140	176
900	1.3	2.5	4.2	8.4	17	25	34	42	63	84	105	126	168	211
1000	1.4	2.8	4.7	9.4	19	28	37	47	70	94	117	140	187	234
2000	2.8	5.6	9.4	19	37	56	75	94	140	187	234	281	374	468
5000	7.0	14	23	47	94	140	187	234	351	468	585	702	936	1170
10000	14	28	47	94	187	281	374	468	702	936	1170	1404	1872	2340

L	Low treatment: (≤0.1 tonnes lime)	M	Medium treatment: (>0.1 to 1 tonne lime)	H	High treatment: (>1 to 5 tonnes lime)	VH	Very High treatment: (>5 to 25 tonnes lime)	XH	Extra High treatment: (>25 tonnes lime)

Note: Lime rates are for pure fine aglime, $CaCO_3$ assuming an NV of 100% and using a safety factor of 1.5. A factor that accounts for Effective Neutralising Value is needed for commercial grade lime. (See the *Information Sheets on Neutralising Agents – Neutralising Considerations*).

‡ An approximate soil weight (tonnes) can be obtained from the calculated volume by multiplying volume (cubic m) by bulk density (t/m^3). (Use 1.7 if BD is not known). Dense fine sandy soils may have a BD up to 1.7, and hence $100m^3$ of such soil may weigh up to 170t. In these calculations, it is necessary to convert to dry soil masses, since analyses are reported on a dry weight basis.

Potential acidity can be determined by Chromium Reducible Sulfur (S_{CR}), Peroxide Oxidisable Sulfur (S_{POS}) and Total Oxidisable Sulfur (S_{TOS}). For samples with pH <5.5, the existing acidity must also be determined by appropriate laboratory analysis eg. Titratable Actual Acidity (TAA). Soils with retained acidy eg. jarosite or other similar insoluble compounds have a less available acidity and will require more detailed analysis. The amount of treatment required may be reduced if the self-neutralising capacity of the soil is appropriately measured. Consult the ***Queensland Acid Sulfate Soils Technical Manual, Laboratory Methods Guidelines***.

Appendix D – Estimating ASR treatment levels and Aglime rates

Figure D1 provides an example flowchart for the treatment of Acid Sulfate Rock, based on pH and liming rates. The requirements for reuse of treated ASR will be undertaken in accordance with the Earthworks Management Plan to conform with RMS Specification R44: Earthworks. Management of stockpiles and monitoring will be undertaken in accordance with the requirements prescribed in section 7 and 8 of this Procedure.

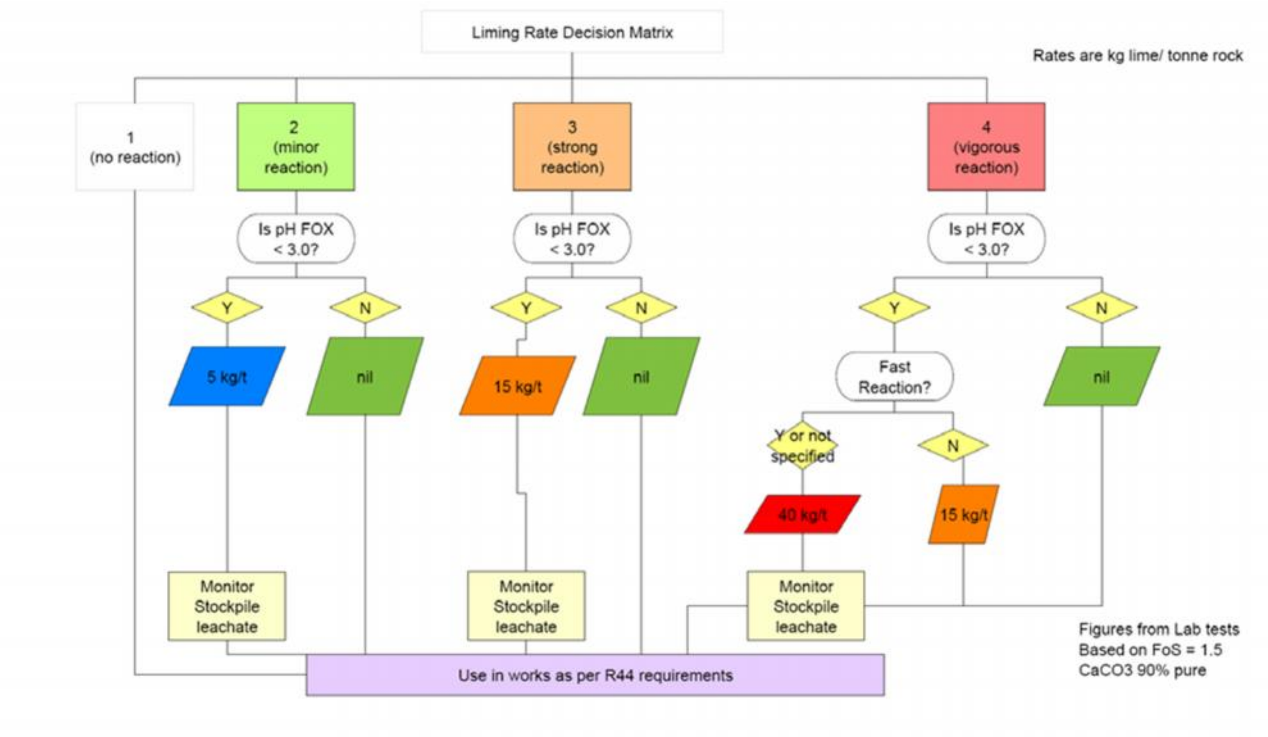
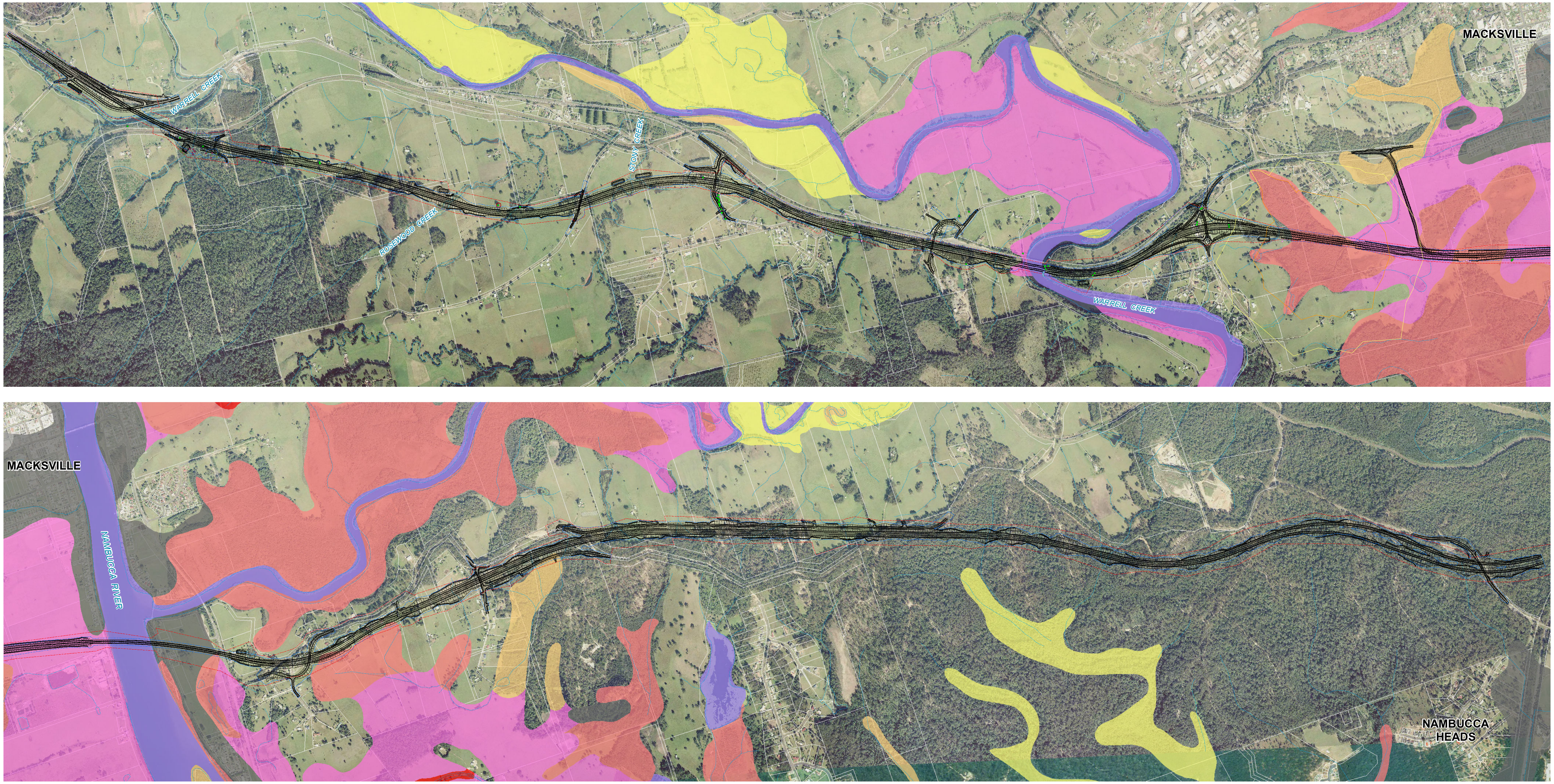


Figure D1: ASR pH and liming rates for treatment flowchart
(Source: RMS Specification R44 – Annexure D)

Appendix E – Figure 1 Acid Sulfate Material risk map

AFJV ARUP aurecon Design Joint Venture



W:\Projects\Design\GIS\WC2NH_Potential_ASSrisk.mxd\241993\12-09-14\Martin.Russell\Rev 0

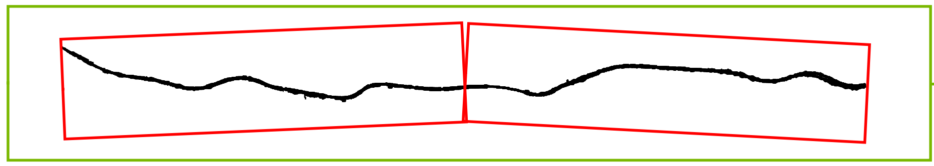
- SWTC clearing limit
- WC2NH project boundary
- 500m Grey-headed Flying Fox buffer zone
- 300m Grey-headed Flying Fox buffer zone
- Construction protection area
- Natural drainage
- Low Risk 1-2m
- Low Risk 2-4m
- Low Risk Sediments
- Disturbed Terrain

NSW Acid Sulfate Soils Risk Legend

- High Risk 1-2m
- High Risk 2-4m
- High Risk Sediments

1:25,000

0 500 1,000 m



PACIFIC HIGHWAY UPGRADE WARRELL CREEK TO NAMBUCCA HEADS

Projection: GDA 1994 MGA Zone 56

Source: AADJV

FIGURE: Acid Sulfate Soils Risk Plan

Appendix D
Management of Tannins from Vegetation Mulch

Transport
Roads & Maritime
Services

ENVIRONMENTAL DIRECTION

Management of Tannins from Vegetation Mulch

JANUARY 2012

ABOUT THIS RELEASE

Environmental Direction number	25
Environmental Direction title	Management of Tannins from Vegetation Mulch
Author	Environment Branch (Environmental Policy)

Issue	**Date**	**Revision description**
1	December 2011	Final draft
2	January 2012	Final

CONTENTS

1 PURPOSE

The purpose of this environmental direction is to set RMS's minimum management measures to minimise the generation and discharge of tannins from vegetation mulch on Roads and Maritime Services (RMS) construction projects. Additional background information on tannins and the use of mulch on construction sites is included in section 3 of this direction.

2 MANAGEMENT MEASURES

The primary focus must be to minimise tannin generation on construction sites.

2.1 General mulch management measures

These general mulch management measures are to be followed for all RMS construction projects.

2.1.1 Planning and works staging

The first step in planning and works staging is to identify the amount of mulch to be generated. With this information, a strategy can be prepared to manage mulch on site. Staging of chipping, tub grinding and/or mulching activities should be planned to reduce the volume of mulch to be managed at any one time. The volume of excess mulch can then be assessed and plans made to dispose of this off site.

Other general considerations at the planning and works staging phase are as follows:

- Mulch stockpile sites should be established with appropriate controls in place before the main site clearing activities commence. Limited clearing may be required earlier for establishment of stockpile areas and access.
- Stage the mulching of cleared vegetation to ensure that mulch can be progressively moved to elevated, or otherwise suitable, stockpile locations. It is preferred that mulch should be transferred to a stockpile or reused on the day of mulching.
- Plan to efficiently reuse mulch in progressive works to reduce the time that mulch is concentrated in stockpile locations.
- Excess mulch can be managed by community giveaway. This takes considerable time and mulch needs to be suitably located and managed as this occurs. The conditions for community giveaway of mulch are included as Appendix 3.
- Any other form of bulk offsite mulch disposal (eg to Council parkland or a development site) must be assessed to ensure waste management provisions are adhered to for off site disposal.

2.1.2 Stockpile location and management

- Mulch stockpile sites should be established on elevated ground where possible.
- Stockpile sites with a duration of not more than 1 month should be constructed not less than 20 metres from a watercourse, including floodplains.
- Stockpile sites with a duration of more than 1 month should be constructed not less than 50 metres from a watercourse, including floodplains.
- Mulch stockpiles should be designed and constructed to divert upgradient water to prevent it from entering the stockpile site.

2.1.3 Management measures for the use of mulch on site

- Do not use mulch for surface cover or sedimentation controls in any low lying areas of the site that remain consistently wet. Alternative controls such as geofabric (for surface protection) or sediment fence will be required in these areas.
- Do not spread surface mulch in thicker than 100mm layers. Mixing mulch with topsoil is encouraged for batters to prevent loss of topsoil during initial stabilisation. It should be noted that mulch will generally cause nitrogen draw down which may inhibit plant growth, unless mulch has been composted first.
- Care is to be taken to ensure that excessive mulch is not applied for sedimentation controls such as perimeter bunds or catch dams.

2.1.4 Monitoring and response

- Monitor the site for generation of tannins. Tannin impacts can be readily identified visually as dark coloured ponded water. Site staff should be trained to identify and report potential impacts to the site project management or environment staff.
- Review management practices where required to prevent the generation of tannins in identified problem areas.

2.2 Mulch management methods for high risk sites

2.2.1 High risk sites

High risk sites, where additional management measures may be required, include:

- where large quantities of mulch will be generated and stockpiled.
- where high tannin generating vegetation types are to be mulched (see 3.1).
- where the receiving environment is identified as sensitive (eg Marine Park, threatened aquatic species habitat).
- where tannins have been observed to be generated or discharged from an operating site with standard management controls.

2.2.2 Stockpile management measures for high risk sites

- Mulch stockpiles for high tannin generating vegetation types should incorporate an impermeable bund to capture stockpile leachate or tannin impacted water. Impervious bunds must be a minimum of 300 mm high, preferably higher to capture tannin impacted water. All bunded stockpiles that are in place for a period longer than one month must include a lined discharge point for overflow in extreme rainfall events.
- Stockpiles established on sloping sites must be designed to provide temporary stormwater containment equivalent to a 300 mm minimum height bund on a flat site.
- Tannin impacted water should be pumped out of bunded stockpiles within 5 days of the end of a rainfall event to maintain the storage capacity. This water should be used for on site purposes including dust suppression and landscape watering. These activities must be managed to prevent any pooling or runoff of tannin impacted water.
- Bunded stockpiles must be inspected within 24 hours of cessation of any rainfall event greater than 10mm to ensure tannin impacted water does not overflow.

2.3 Site management procedures

Site management procedures must be prepared for all sites where tannins are identified as a potential issue. Site management procedures should be based on the management measures provided in this Environmental Direction.

3 BACKGROUND

3.1 Tannin generation from vegetation mulch

See Plates 1 – 3 in Appendix 1.

Tannins are naturally occurring plant compounds. Tannin generation from vegetation mulch is likely to be highest from low-lying coastal floodplain areas. The species of vegetation (eg *Melaleuca*) will have a major impact on the likelihood of tannin generation.

Tannin generation is generally highest from mulched vegetation that is stockpiled in areas that are subject to inundation. Placement in wet areas will result in accelerated leaching of tannins into water, concentration of tannins in pooled water, and greater impacts on water quality.

3.2 Tannin impacts on water quality

See Plates 4 – 5 in Appendix 1.

The main concern with the discharge of water that is high in tannins is that it may increase the biological oxygen demand (BOD) of the receiving environment. Increases in BOD may result in a decrease in available dissolved oxygen. A lack of dissolved oxygen is identified as the main cause of about 80 percent of fish kills in NSW rivers and estuaries.

Tannin impacts may result in dark coloured water discharge from construction sites. This impact can be obvious and may raise the concern of the community and other stakeholders including regulatory authorities. Once discharged to the environment, tannins may reduce visibility and light penetration and change the pH of receiving waters. These impacts may affect aquatic ecosystems in receiving environments.

Tannins cannot be readily treated with standard construction site water quality controls. Once water on site is impacted with tannins it is not possible to treat effectively with currently approved flocculants. Minimisation of tannin generation in the first place is the management strategy that must be applied.

3.3 Use of mulch on construction sites

See Plates 10 – 16 in Appendix 2.

The RMS Biodiversity Guidelines provide guidance on the benefits of reusing various sizes of vegetation for different purposes. Mulch is a readily available and cheap source of material for temporary site stabilisation and sedimentation control. The re-use of mulch reduces the need to transport this material off-site and reduces handling and disposal costs for construction contracts.

Unprotected mulch sedimentation controls should not be placed in concentrated flow lines where mulch may be washed away. Mulch may be protected by wrapping it with geofabric or other materials to provide a stable control. All temporary catch dams constructed from mulch must have a stable outlet to minimise the washing away of mulch in high rainfall events, and the possible failure of the control.

4 ADDITIONAL RESOURCES

- RTA Biodiversity Guidelines- Protecting and Managing Biodiversity on RTA Projects, 2011
- Pacific Highway Mulch Protocol 2011

5 APPENDICES

Appendix 1: Plates showing tannin generation & water quality impacts

Plate 1: Melaleuca vegetation community – mulch from this vegetation type will generally produce high amounts of tannins.

Plate 2: Vegetation mulching activity – mulch should be progressively moved into prepared stockpile areas.

Plate 3: Tannin generation from recently felled and partially mulched vegetation in an area subject to localised inundation. Mulched vegetation should be progressively moved to prepared stockpiles to manage tannin impacted water.

Plate 4: Tannin impact in stormwater at the discharge point from a road construction site. The discharge of impacted water may be obvious to community and other stakeholders.

Plate 5: Tannins in a drainage line generated from very thickly applied mulch on the batter above. Note that the sedimentation fence is not effective in treating the tannins.

Appendix 2: Plates showing the use of mulch for erosion & sedimentation controls

Plate 6: Mulched vegetation stockpiled in a low-lying area subject to inundation. This is not an appropriate stockpile location and may increase the generation of tannins from stockpiled mulch.

Plate 7: Mulch being placed as batter erosion control. Mulch should not be applied in layers more than 100 mm thick for surface stabilisation.

Plate 8: Site showing recent application of a mulch/topsoil mix on batters (40% mulch to 60% topsoil). Mulch mixes are used to provide temporary stabilisation to prevent the loss of topsoil from batters in heavy rainfall events. Mulch use is also shown as a mounded sedimentation control to prevent sediment entering the median drain.

Plate 9: A mulch/topsoil mix used to provide temporary batter stabilisation and to assist cover crop establishment.

Plate 10: Successful establishment of cover crops on batters where mulch has been used with topsoil to assist temporary stabilisation.

Plate 11: Geofabric wrapped mulch bunds used for sedimentation control

Plate 12: Mulch used as a bund for a temporary sedimentation catch dam. Mulch is effective as it can provide both containment and filtering of site water. Mulch should not be used as a control in areas of concentrated flow where it may be washed away. Any mulch containment control should have a defined and lined outlet that allows discharge from the control without washing mulch away. Note that this control does not have a defined discharge outlet which should be installed to prevent failure of the control in heavy rainfall events.

Appendix 3: Minimum requirements for community mulch giveaways

The purpose of community mulch giveaways is to provide mulch for residential landscaping purposes.

The activities of a community mulch giveaway are permissible under the *Protection of the Environment Operations (Waste) Regulation 2005 – General Exemption Under Part 6, Clause 51 and 51A* (the Raw Mulch Exemption 2008). However, the activities remain subject to other relevant environmental regulations within the Act and Regulations. The Raw Mulch Exemption 2008 is subject to the following conditions:

- The raw mulch can only be applied to land for the purposes of filtration or as a soil amendment material or used either singularly or in any combination as input material(s) to a composting process.
- The consumer must land apply the raw mulch within a reasonable period of time.

Further information can be found at: www.environment.nsw.gov.au/resources/waste/ex08mulch.pdf

It is the mulch generators responsibility to ensure that the mulch is reused in an environmentally responsible manner.

A safe work method statement (SWMS) must be prepared that identifies potential OHS risks and all prevention and mitigation measures. The SWMS must apply to both the community and site workers involved in the mulch giveaway.

Each member of the community who participates in the mulch giveaway must read and understand a site specific information sheet. A template information sheet is attached as Appendix 4.

The site occupier must maintain written records for each load of mulch that is taken away and to ensure that each community participant understands the conditions of the community mulch giveaway information sheet. A suggested template to record this information is attached as Appendix 5.

Appendix 4: Community mulch giveaway information sheet

The following community mulch giveaway information sheet must be populated with site specific information.

Community Mulch Giveaway
Information Sheet

Details of Mulch Supply	
Site Occupier	<insert name of contractor / alliance etc>
Project Name	<insert project name>
Location	<insert location of mulch stockpile>
Mulch stockpile access directions	<insert adequate directions for community members to find the stockpile location>

Background

- This information sheet supports the non-commercial giveaway of mulch for local residents.
- The product is raw vegetation mulch from <insert project location / name>.

Conditions

- Any one individual may only take a maximum of 5 trailer loads from this project.
- The mulch may only be used for residential landscaping purposes.
- Mulch must not be placed in or immediately adjacent to waterways.
- The raw mulch can only be applied to land for the purposes of filtration or as a soil amendment material or used either singularly or in any combination as input material(s) to a composting process.
- The consumer must apply the raw mulch to land within a reasonable period of time.

Community Safety Requirements

- <add in any safety requirements or mitigation measures from the SWMS that apply to the community>
- <add in any safety requirements or mitigation measures from the SWMS that apply to the community>
- <add in any safety requirements or mitigation measures from the SWMS that apply to the community>
- <add in any safety requirements or mitigation measures from the SWMS that apply to the community>

Appendix 5: Records template for community mulch giveaway

The records in the following suggested template must be kept as a minimum.

Community Mulch Giveaway
Record Sheet

Date	Car Registration	I have read and understand the 'Community Mulch Giveaway Information Sheet'	Name	Signature
		❑ Yes		
		❑ Yes		
		❑ Yes		
		❑ Yes		
		❑ Yes		
		❑ Yes		
		❑ Yes		
		❑ Yes		
		❑ Yes		
		❑ Yes		
		❑ Yes		

Appendix E
Groundwater Management Strategy

coffey

Acciona & Ferrovial Joint Venture

Groundwater Management Strategy

Pacific Highway Upgrade - Warrell Creek to Nambucca Heads

11 November 2014

When you think with a global mind problems get smaller

Groundwater Management Strategy

Prepared for
Acciona & Ferrovial Joint Venture

Prepared by
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11 November 2014

GEOTCOFH03148AB-AB

Quality information

Revision history

Revision	Description	Date	Originator	Reviewer	Approver
Original	Groundwater Management Strategy	19/09/2014	Corinna De Castro Andrew Ballard	Ross Best	Andrew Ballard
Revision One	Groundwater Management Strategy	26/09/2014	Joel Parkin	Andrew Ballard	Andrew Ballard
Revision Two	Groundwater Management Strategy	11/11/2014	Noelene Rutherford	Andrew Ballard	Andrew Ballard

Distribution

Report Status	No. of copies	Format	Distributed to	Date
Revision One	1	PDF	AFJV	26/09/2014
Revision One	1	PDF	Coffey	26/09/2014
Revision Two	2	PDF	Coffey, AFJV, RMS/ER, Agencies	11/11/2014

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1. Introduction

The Groundwater Management Strategy (GMS) has been prepared to supplement the Acciona & Ferrovial Joint Venture (AFJV) Construction Environment Management Plan (CEMP) for the Warrell Creek to Nambucca Heads (WC2NH) Pacific Highway Upgrade Project. The project location is presented in Figure 1.

The purpose of the GMS is to describe how the AFJV will manage groundwater issues during design and highway construction activities for the WC2NH Upgrade. The GMS is relevant to all AFJV activities during the design and construction phases for this project.

The GMS has been prepared to address the requirements of the NSW Roads and Maritime Services (RMS) project approval conditions, the RMS statement of commitments, and current NSW legislation and guidelines for the management of groundwater.

1.1. Overview Pacific Highway - WC2NH Upgrade

The WC2NH Upgrade will involve the development of a dual carriageway with a widened median in a Class M motorway configuration from the end of the existing dual carriageway at the Allgomera Deviation, south of Warrell Creek, then north bypassing the towns of Macksville and Nambucca Heads to its end north of Old Coast Road to the west of Nambucca Heads.

The objective of the Pacific Highway Upgrade is to provide a standard of road that will reduce accidents, travel times, freight transport costs while providing a route that supports economic development. The route development involved the community and considered their interests, expenditure and ecological sustainability.

1.2. Objectives

The objectives of the GMS are to provide information and guidance to AFJV and their contractors during construction of the project on:

- Background information relating to groundwater conditions across the project area;
- Licence and regulatory requirements to fulfil commitments made within the project's Environmental Assessment (EA);
- Potential impacts to groundwater during construction and management measures to be adopted;
- Groundwater monitoring program;
- Initial baseline data and interim groundwater threshold criteria;
- Contingency plan measures; and
- Reporting requirements.

Objectives of the groundwater monitoring program include assessment of construction impacts on the local aquifer and associated groundwater dependent ecosystems (GDEs), including:

- Changes in groundwater levels;
- Changes in groundwater flow direction;
- Changes in aquifer properties;
- Changes in surface water-groundwater interaction;
- Changes in residence time; and
- Changes in water quality.

1.3. Targets

The target relating to this GMS is to have zero incidents relating to changes to the groundwater environment and to ensure there is no groundwater contamination during the construction phase of the project.

1.4. Roles and Responsibilities

Personnel responsible for implementing this GMS include the following:

- AFJV to develop project-specific CEMP, incorporating a Soil and Water Management Sub-plan that is consistent with the controls set out in Planning Approval, AFJV's EMP and GMS;
- AFJV responsible for informing all site personnel of the required procedures for the protection of groundwater via an induction program;
- AFJV Construction Manager responsible for the direction of the overall project;
- AFJV Environment Manager responsible for:
    - coordination of environmental responsibilities and approvals;
    - ensuring that monitoring of groundwater is undertaken in accordance with relevant guidelines, legislation, planning approvals and this GMS;
    - management of complaints in relation to groundwater issues;
- AFJV Environment Coordinator at each site responsible for:
    - ensuring reasonable and feasible groundwater/surface water controls are installed and maintained, consistent with this GMS;
    - undertaking periodic checks to ensure compliance with this GMS;
- AFJV Project Superintendent responsible for day to day construction activities and oversees other site foremen;
- All employees, contractor personnel and sub-contractors responsible for working in accordance with this GMS so as to minimise impacts to groundwater.

1.5. Previous Reports

The following reports provide information on the groundwater conditions across the project area:

- Coffey Geotechnics (2014a) Surface Water and Groundwater Monitoring Program – 1st Data Report, Pacific Highway Upgrade – Warrell Creek to Nambucca Heads. Report reference GEOTCOFH03148AA-AC, dated 24 March 2014.
- Coffey Geotechnics (2014b) Surface Water and Groundwater Monitoring Program – 2nd Data Report, Pacific Highway Upgrade – Warrell Creek to Nambucca Heads. Report reference GEOTCOFH03148AA-AD, dated 30 May 2014.
- Coffey Geotechnics (2014c) Surface Water and Groundwater Monitoring Program – 3rd Data Report, Pacific Highway Upgrade – Warrell Creek to Nambucca Heads. Report reference GEOTCOFH03148AA-AE, dated 14 July 2014.
- Sinclair Knight Merz (SKM) (2010) Warrell Creek to Urunga Upgrading the Pacific Highway Environmental Assessment, Volume 1 Environmental Assessment, dated January 2010.

These reports provide information on groundwater levels and quality that will be encountered during construction of the project.

2. Groundwater Sensitive Receptors

Sensitive receptors which may be affected by changes in groundwater conditions during the construction phase of the project include registered groundwater bores and GDEs described in the following sections.

2.1. Registered Groundwater Bores

A number of licensed groundwater bores registered with the NSW Office of Water are located along the length of the WC2NH Upgrade. 37 bores are located within 500m of the alignment and 54 bores are located within 1km of the alignment. The bores are predominantly used for domestic and stock purposes.

Locations of registered groundwater bores are illustrated in Figures 1 to 17 and are based on data obtained from the NSW Office of Water database on 8 September 2014. Bore details are attached in Appendix A.

2.2. Groundwater Dependent Ecosystems

There are no government registered GDEs identified across the Project area. There are low-lying areas within the floodplains where potential GDE vegetation types have been identified previously as part of the Environmental Assessment (EA) (SKM, 2010). Five of the six endangered ecological communities (EECs) are listed in the EA as GDEs:

- Swamp oak floodplain forest;
- Swamp sclerophyll forest;
- Subtropical coastal floodplain forest;
- Lowland rainforest; and
- Freshwater wetlands.

Locations of GDE areas are illustrated in Figures 2 to 17 and are based on mapping presented in the EA (SKM, 2010).

3. Requirements

3.1. Ministers Conditions of Approval and RMS Statement of Commitments

The Ministers Conditions of Approval (MCoA) and the RMS statement of commitments that are applicable to management of groundwater on the WC2NH Upgrade are provided in Table 1.

Table 1 – Approval Conditions and Commitments Applicable to Groundwater Management

Condition	Action	Timing	Basis / Reference	Document Reference
MCoA Construction Water Quality Management Plan B31(d)(vi)	A Construction Water Quality Management Plan is to be prepared as a sub plan for the CEMP to manage surface water quality and groundwater impacts during construction of the project. The Plan shall be developed in consultation with EPA, DPI (Fisheries and NOW) and include, but not necessarily be limited to: vi) a groundwater management strategy, including (but not necessarily limited to): 1. Description and identification of groundwater resources (including depths of the water table and groundwater quality) potentially affected by the proposal based on baseline groundwater monitoring undertaken in accordance with condition B17(c); 2. Identification of surrounding licensed bores, dams or other water supplies and groundwater dependent ecosystems and potential groundwater risks associated with the construction of the project on these groundwater users and ecosystems; 3. Measures to manage identified impacts on water table, flow regimes and quality to groundwater users and ecosystems; 4. Groundwater inflow control, handling, treatment and disposal methods; and 5. A detailed monitoring plan to identify monitoring methods, locations, frequency, duration and analysis requirements.	Pre-Construction Construction	Good Practice	Section 4 for impacted areas and management measures, Monitoring requirements in Section 5.
MCoA Water Quality B17	The Proponent shall prepare and implement a Water Quality Monitoring Program to monitor the impacts of the project on SEPP 14 wetlands, surface water quality and groundwater resources during construction and operation. The program shall be developed in consultation with EPA and DPI and shall include but not necessarily be limited to: a) Identification of surface water and groundwater quality monitoring locations which are representative of the potential extent of impacts from the project; c) Representative background monitoring of surface water and groundwater quality parameters for a minimum of six (6) months (considering seasonality) prior to the commencement of construction to establish baseline water conditions; f) A minimum monitoring period of three years following the completion of construction or until any disturbed waterways/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).	Pre-Construction Baseline Construction Post-Construction	Good Practice	Water Quality Monitoring Program – Appendix A of the SWMP.
RMS Statement of Commitments				
RMS SoC W3	Monitoring of groundwater impacts and surface water quality upstream and downstream of the site during construction will determine the effectiveness of mitigation strategies. Implementation of additional feasible and reasonable management measures will occur if necessary.	Pre-construction and construction	Draft DECC *"Managing Urban Stormwater: Soils and Construction, Volume 2, Book 4, Main Road Construction* (2006)". *Managing Urban Stormwater: soils and construction* (Landcom 2004). RTA *Code of Practice for Water Management – Road Development and Management (1999).* RTA *QA Specification G38 Soil and Water Management.* RTA *QA Specification G39 Soil and Water Management (Erosion and Sediment Control Plan).*	Section 4, monitoring discussed in Section 5.
RMS SoC W6 Minimise Groundwater related impacts	Investigation of the potential for changes in the groundwater table will take place before starting any major earthworks. Where a potential for change is identified, the significance of the change and any resultant impacts will be determined and measures to manage the changes will be designed and implemented as necessary.	Pre-construction and construction	Section 16.4 and Table 16-4 of the EA. *RTA Code of Practice for Water Management – Road*	Table 3

Condition	Action	Timing	Basis / Reference	Document Reference
			Development and Management (1999). RTA *QA Specification G38 Soil and Water Management.* *Water Act 1912.*	
RMS SoC W7	Baseline monitoring of groundwater levels and chemical levels at cutting sites near springs, creeks or endangered ecological communities prior to construction commencing.	Pre-construction and construction	Section 16.4.1.3 and Table 16-4 of the EA. RTA *Code of Practice for Water Management – Road Development and Management (1999).* RTA *QA Specification G38 Soil and Water Management.* *Water Act 1912.*	Appendix A of the SWMP, baseline monitoring has been undertaken by RMS.

3.2. Key Legislative and Regulatory Requirements

Groundwater management activities carried out for the project shall comply with relevant policy, legislation, regulations and guidelines. These include but are not limited to the policy, legislation, regulations and guidelines listed in Table 2.

The Water Sharing Plans for the Coffs Harbour area and Bellinger River area are north of the WC2NH Upgrade and are therefore not included below.

Table 2 – Key Policy, Legislation and Regulations

Legislation / Policy	Relevance
Water Management Act 2000 ***NSW Aquifer Interference Policy 2012*** ***Water Act 1912***	The *Water Management Act 2000 (NSW)* (WM Act) aims to ensure the sustainable management of water resources in NSW for present and future generations, primarily through the issue of licenses and approvals for the extraction and use of water from rivers and groundwater aquifers. The WM Act applies to parts of NSW that are subject to Water Sharing Plans (WSPs). Those areas of NSW not covered by such plans are managed in accordance with the *Water Act 1912* (NSW). The Department of Primary Industries Office of Water NSW Aquifer Interference Policy (March 2012 Draft) considers the scale of a development, as measured by rate and volume of dewatering, for the purposes of dewatering licencing requirements. The policy notes (Section 2.5.1) that aquifer interference activities exempt from requiring volumetric access licences include those where the dewatering rate is less than 5 L/s (432 m^3 /day) and where the total volume extracted is less than 3 ML per annum. The expected rate of inflow to the various road cuts intersecting groundwater is expected to be greater than this and therefore the exemption is not likely to apply for the WC2NH project. For the WC2NH project area where water sharing plans do not yet apply, an aquifer interference activity that is taking groundwater is required to hold a water licence under Part 5 of the *Water Act 1912*. The final issue of the NSW Aquifer Interference Policy (September 2012) does not discuss dewatering licencing exemptions conditions, but instead considers assessment of impacts of aquifer interference activities on water resources and the concept of ensuring "no more than minimal harm" referred to in the *Water Management Act 2000*. The management measures presented in this GMS take into account the above legislation and policies and are aimed to minimise potential impacts to groundwater.
Guidelines for Groundwater Protection in Australia	The Guidelines for Groundwater Protection in Australia (ARMCANZ and ANZECC, 1995) are part of the National Water Quality Management Strategy. The guidelines provide a framework for protecting groundwater from contamination in Australia and involve the identification of specific beneficial uses and values for every major aquifer. The guidelines outline a number of protection strategies to protect each aquifer and all involve groundwater monitoring. This GMS takes into account the above guidelines.
State Groundwater Policy Framework (NSW)	Groundwater management in NSW is guided by the State Groundwater Policy Framework Document developed by the NSW Department of Land and Water Conservation (DLWC) in 1997. A set of three component policies have been

Legislation / Policy	Relevance
	developed in association with stakeholder-based working groups, identifying management needs and providing management principles and guidelines. The policies commit agencies to the review and modification of related regulatory and operational activities, and to the support of cooperative management programs. The three policies are listed below: • Groundwater Quality Protection Policy (DLWC, 1998); • Groundwater Quantity Management Policy; and • Groundwater Dependent Ecosystems Policy (DLWC, 2002). This GMS takes into account the above principles.

4. Management Measures

A range of soil, surface water and groundwater control measures have been developed to minimise the impact of the project on the groundwater system. This section describes the management and mitigation measures that will be put into place during the construction phase of the project.

4.1. Potential Groundwater Impacts

The project activities are described in detail in the main body of the CEMP. During construction, including construction of the highway, embankments and bridge footings, the following potential groundwater impacts could occur:

- Local drawdown as a result of dewatering during excavation of road cuts below the water table;
- Local increases in groundwater level during surcharge of soft soils in low-lying areas such as the Nambucca River Floodplain and potential issues with acidic groundwater in acid sulfate soil (ASS) areas;
- Possible acidification of groundwater if earthworks such as bridge embankments in ASS areas lowers the groundwater table and oxidises potential ASS;
- Changes to local water levels as a result of reduced local rainfall recharge due to hardstand areas balanced by increased recharge to the aquifer as a result of the removal of vegetation;
- Discharge of water from stockpiles, sediment ponds or other excavations during construction that have been exposed to contaminated soil or ASS and that has elevated contaminant concentrations, including naturally mineralised areas with elevated arsenic levels such as Cut 12;
- Destroyed or abandoned water supply or monitoring bores that could threaten the groundwater resource; and
- Leaks and spills from construction equipment.

Potential groundwater impacts associated with each of the proposed road cut excavations are summarised in Table 3.

Cut details are sourced from the AFJV road alignment plans and longitudinal sections (15% detailed design drawings dated 25 August 2014, drawing reference series of sheets WC2NH-DD02-RA01 to WC2NH-DD05-RA01, longitudinal section along control MCN1).

Construction water supply for the project is likely to be sourced mainly from surface water including farm dams. Groundwater may be used during construction for project precast yards and concrete batch plants and if required, appropriate licence applications for groundwater use will be submitted to the NSW Office of Water.

Table 3 – Potential Groundwater Impacts

Cut Number	North Bound Chainage Start (m)	North Bound Chainage Finish (m)	North Bound Length (m)	Lowest Cut Elevation (mAHD)	Maximum Cut Depth (m)	Recorded Groundwater Level Range (mAHD)	Interpreted Maximum Height of Groundwater Above Cut (m)	Potential Impacts to Sensitive Receptors Due to Changes in Groundwater Regime	Level of Impact
1	41765	41800	35	15.4	2.5	<10mAHD (4LDBH001 dry)	N/A	North bound lanes over existing pavement. Minor side cut for south bound up to 2.5m depth. No impact anticipated for closest registered groundwater bore GW301008 located 300m south east of Cut 1 or GDEs north of Upper Warrell Creek.	No impact
North Coast Railway Ridge	42635	42800	165	NK*	NK*	5.5 to 3.1mAHD (7BH007)	NK*	GDEs are mapped across the highway alignment. Construction may alter GDE hydrology. Registered bore GW071716 is located 50m south east of the highway. Possible interception of groundwater depending on design level of tunnel (if tunnel constructed).	Possible impact
2	42875	43175	300	13.0	11.0	<23.5mAHD (7BH008 dry) <16.7mAHD (2aBH10 dry)	NK	If groundwater is found between 16.7mAHD and 13mAHD, possible minor impact to GDEs due to potential dewatering towards southern end of Cut 2 / northern end of Fill 2. No impact anticipated to registered groundwater bores as closest bore GW071715 located 400m north west of Cut 2.	Possible low impact
3	43500	43700	200	22.7	7.1	Piezometer in 2aBH13. No groundwater logger, dry <19mAHD	N/A	No impact anticipated to registered groundwater bores as closest bore GW071715 located 500m west of Cut 3. No GDEs in the area.	No impact
4	43950	44225	275	28.5	7.6	<31.3mAHD (4BH008 dry) 25 to <18.3mAHD (4BH007 dry except one rain event) <20.6mAHD (4LDBH006 dry)	N/A	No impact anticipated to registered groundwater bores as closest bore GW306921 located 250m north west of Cut 4. No GDEs in the area.	No impact
5	44600	44825	225	16.1	5.5	7.5mAHD (7LDBH001)	N/A	No impact to registered bores GW066911 and GW055965 located 300m north west and south east of Cut 5. No GDEs in the area.	No impact
6	45050	45360	310	12.8	12.6	12.5 to <9.9mAHD (2aBH16 dry since November 2013) <12.5mAHD (4BH011 dry) 10.5 to 6.0mAHD (4BH010) 11.3 to 5.0mAHD (4LDBH008)	N/A	Potential for higher groundwater levels and dewatering during extended periods of high rainfall. No impact anticipated to registered groundwater bores as closest bore GW305487 located 500m west of Cut 6. No GDEs in the area.	No impact
7	45850	46290	440	14.5	13.5	27.5 to 16.3mAHD (4LDBH009) 28.8 to <12.2mAHD (1BH04 dry since April 2014)	9	Minimal or no impact anticipated to registered groundwater bore GW303654 located 350m south west of Cut 7. Ground level at bore about 8mAHD, recorded groundwater level about -1mAHD, screen to -31mAHD. No GDEs in the area.	Possible low impact
8	46535	46870	335	9.5	6.0	26.9 to 25mAHD (4LDBH011)	5	Minimal or no impact anticipated to registered groundwater bore GW063730 located 200m north of Cut 8. Ground level at bore about 5mAHD, recorded water supply and screen from -16 to -22mAHD. GDEs mapped in the vicinity of Williamson Creek, about 150m north of Cut 8. Possible change to GDE recharge due to dewatering.	Possible impact
9	47150	47475	325	14.1	9.3	3.8 to 1.9mAHD (7BH022) 25 to 20mAHD (4LDBH012) 23 to <16.5mAHD (1BH10 dry since September 2013)	7	Registered bore GW304949 located on the southern edge of Cut 9 at Chainage 47430. Ground level at bore about 26mAHD, groundwater level about 17mAHD, water supply and screen from -5 to -17mAHD. GDEs are mapped within the northern part of the highway at Cut 9 and in the vicinity of Williamson Creek, about 20m south of Cut 9. Excavation likely to alter GDE hydrology.	Likely impact
10	47575	47910	335	14.2	18.5	38.8 to 36mAHD (1BH12)	16	GDEs are mapped across the highway for Cut 10. Excavation likely to alter GDE hydrology. Possible cumulative impact from Cut 9 and Cut 10 on registered bore GW304949.	Likely impact
11	48550	48975	425	17.9	10.8	23 to <12.8mAHD (1BH21) 12.5 to 10mAHD (4BH063) 9.5 to 2.5mAHD (4BH021) 30 to 17.5mAHD (4BH022) 21.3 to <15.4mAHD (4LDBH014)	8	GDEs are mapped across the highway for Cut 11. Excavation likely to alter GDE hydrology. No impact anticipated to registered groundwater bore GW303842 located 750m east of Cut 11, on the south side of Warrell Creek.	Likely impact

Cut Number	North Bound Chainage Start (m)	North Bound Chainage Finish (m)	North Bound Length (m)	Lowest Cut Elevation (mAHD)	Maximum Cut Depth (m)	Recorded Groundwater Level Range (mAHD)	Interpreted Maximum Height of Groundwater Above Cut (m)	Potential Impacts to Sensitive Receptors Due to Changes in Groundwater Regime	Level of Impact
12	49190	49650	460	8.4	8.6	16 to 8mAHD (4LDBH015) 19.5 to <15.3mAHD (4BH026 dry since February 2014) 11.3 to <7.2mAHD (4BH025) 16 to 6mAHD (4BH024) 17.5 to 10mAHD (4LDBH016)	6	Minimal or no impact anticipated to registered groundwater bore GW306682 located 500m east of Cut 12. Ground level at bore about 12mAHD, groundwater level -10mAHD, water supply and screen from -17 to -30mAHD. GDEs mapped in the vicinity of Warrell Creek to the south and the Nambucca River floodplain to the north, about 50m from each end of Cut 12. Possible change to GDE recharge due to dewatering. Surface water flooding likely to contribute to GDEs in this area.	Possible impact
13	52865	52910	45	12.4	1.0	1.5 to 0mAHD (7BH042) 5.6 to 2.5mAHD (7BH043)	N/A	No impact from Cut 13 anticipated to registered groundwater bores or GDEs in the area.	No impact
14	53210	53470	260	7.5	10.5	16.9 to <3.9mAHD (1BH47 dry since April 2014)	8	Three registered groundwater bores GW300211, GW063518 and GW066776 are located within or adjacent to the highway alignment at Cut 14. One registered bore GW302426 is located 100m north west of Cut 14. GDEs are mapped across the highway in the southern end of Cut 14 and on the western side of the highway. Excavation likely to alter GDE hydrology.	Likely impact
15	53590	53700	110	8.8	6.5	No piezometers installed	NK	No groundwater level data for this cut to date. Possible cumulative impact from Cut 14 and Cut 15 on registered bore GW302426. GDEs are mapped across the highway in the southern end of Cut 15 and on the western side of the highway. Excavation likely to alter GDE hydrology.	Likely impact
16	53775	53870	95	11.7	3.5	8 to <4mAHD (4LDBH021)	N/A	No impact from Cut 16 anticipated to registered groundwater bores or GDEs in the area.	No impact
17	54050	54250	200	13.1	12.8	8.8 to 2.5mAHD (1BH49) 10 to <3.8mAHD (4BH057) 11.3 to 3mAHD (4BH058)	N/A	One registered groundwater bore GW066960 is located 100m south of Cut 17 and 50m north of Cut 16 within the highway alignment at Fill 19. GW066953 is located about 30m east of Cut 17, with groundwater level around 13mAHD. Possible change to groundwater level in this bore.	Possible impact
18	54460	54670	210	15.1	9.7	12.5 to <7.5mAHD (1BH51 dry since October 2013) 11.9 to <3.8mAHD (4LDBH024 dry since February 2014)	N/A	No impact anticipated to closest registered groundwater bore GW301782 located 150m east of Cut 18, with groundwater level around 6mAHD.	No impact
19	54755	54860	105	16.5	4.1	Piezometer in 4LDBH025. No groundwater logger, dry <15.95mAHD	N/A	GDEs are mapped across the highway for Cut 19. Excavation likely to alter GDE hydrology.	Likely impact
20	55225	55345	120	18.8	5.7	<9.4mAHD (7LDBH007 dry)	N/A	GDEs are mapped across the highway for Cut 20. Excavation likely to alter GDE hydrology.	Likely impact
21	55570	55745	175	17.2	5.3	<9.2mAHD (4LDBH027 dry)	N/A	One registered groundwater bore GW066969 is located within the highway alignment at Cut 21.	Likely impact
22	56050	56200	150	16.7	12	No piezometers installed	NK	No groundwater level data for this cut to date, landowner requested no access. GDEs are mapped across the highway for Cut 22. Excavation likely to alter GDE hydrology.	Likely impact
23	56535	56660	125	11.1	6.9	No piezometers installed	NK	No groundwater level data for this cut to date, landowner requested no access. GDEs are mapped across the highway for Cut 23. Excavation likely to alter GDE hydrology.	Likely impact
24	57040	57585	545	26.5	9.5	30 to <17mAHD (4LDBH032 dry except one rain event) 30 to <21.8mAHD (2bBH04 dry except one rain event)	3m during high rainfall periods	No impact anticipated to closest registered groundwater bore GW066947 located 250m north west of Cut 24, with groundwater level around 16mAHD. GDEs are mapped across the highway for Cut 24. Excavation likely to alter GDE hydrology.	Likely impact
25	57825	58000	175	18.4	12.5	27.5 to <19.3mAHD (2bBH06)	9m during high rainfall periods	No impact anticipated to closest registered groundwater bore GW066947 located 400m south west of Cut 25, with groundwater level around 16mAHD. GDEs are mapped across the highway for Cut 25. Excavation likely to alter GDE hydrology.	Likely impact
26	58135	58380	245	15	16	<17.5mAHD (4BH061) 16 to <13.7mAHD (4BH062) 27.5 to <18.5mAHD (4LDBH034)	12m during high rainfall periods	GDEs are mapped across the highway for Cut 26. Excavation likely to alter GDE hydrology.	Likely impact
27	58685	58950	265	21	8	Piezometer in 4LDBH037. No groundwater logger, dry <17.44mAHD	N/A	GDEs are mapped across the highway for Cut 27. Excavation likely to alter GDE hydrology.	Likely impact

Cut Number	North Bound Chainage Start (m)	North Bound Chainage Finish (m)	North Bound Length (m)	Lowest Cut Elevation (mAHD)	Maximum Cut Depth (m)	Recorded Groundwater Level Range (mAHD)	Interpreted Maximum Height of Groundwater Above Cut (m)	Potential Impacts to Sensitive Receptors Due to Changes in Groundwater Regime	Level of Impact
28	59115	59225	110	21.8	5.5	17.5 to 14.4mAHD (4BH064) 17 to 15.6mAHD (4BH065)	N/A	GDEs are mapped across the highway for Cut 28. Excavation likely to alter GDE hydrology.	Likely impact
29	59375	59500	125	26.1	7.6	23 to 20.6mAHD (4LDBH039)	N/A	GDEs are mapped across the highway for Cut 29. Excavation likely to alter GDE hydrology.	Likely impact
30	59600	59720	120	23.5	7.6	No piezometers or groundwater level data available	NK	No SWL data for this cut to date. GDEs are mapped across the highway for Cut 30. Excavation likely to alter GDE hydrology.	Likely impact
31	59985	60225	240	31.5	10.8	28.8 to <26.6mAHD (2bBH10) 25 to <21.9mAHD (4LDBH041)	N/A	GDEs are mapped across the highway for Cut 31. Excavation likely to alter GDE hydrology.	Likely impact
32	60650	60750	100	27.1	4.3	28.8 to <25.2mAHD (4LDBH042)	2m during high rainfall periods	GDEs are mapped across the highway for Cut 32. Excavation likely to alter GDE hydrology.	Likely impact
33	60860	61075	215	20.1	11.2	<19mAHD (2bBH12 dry) 20.6 to <16.1mAHD (7BH048) 21.9 to <16.8mAHD (4LDBH043)	2m during high rainfall periods	GDEs are mapped across the highway for Cut 33. Excavation likely to alter GDE hydrology.	Likely impact

Notes:
Cut details are sourced from the AFJV road alignment plans and longitudinal sections (15% detailed design drawings dated 25 August 2014, drawing reference series of sheets WC2NH-DD02-RA01 to WC2NH-DD05-RA01, longitudinal section along control MCN1).
N/A: Not Applicable
NK: Not Known
*Design details for ridge north of Upper Warrell Creek not known. If adopted design is a bridge extending over Upper Warrell Creek and North Coast Railway line ridge, no groundwater impact is anticipated. If design includes a tunnel under the railway there is a potential for groundwater to be intercepted depending on design depth.

4.2. General Operating Principles

The GMS will be implemented as part of the CEMP and describes best practice control measures to reduce the risk of contamination of groundwater, or the substantial alteration of groundwater flows due to drawdown effects. Table 4 summarises the measures to be implemented to manage potential groundwater issues and outlines personnel responsibilities for their implementation.

Table 4 – Groundwater Management Measures

Number	Potential Impact	Management Measure	Responsibility	Source of Commitment
1	Local drawdown as a result of dewatering during excavation of road cuts below the water table, potential impact to registered groundwater bores and GDEs. Dewatering likely to occur for Cuts 7 to 12, 14, 24 to 26, 32 and 33.	In cuts where the groundwater level is above the base of the excavation, a drainage blanket would need to be constructed to prevent build-up of water within the pavement layers. The requirement for drainage blankets would be further investigated as part of the detailed design phase. Groundwater inflows to cuttings due to the intersection of the groundwater table and springs are expected to manifest in the form of localised seepages. These would be managed during construction through measures that transfer the seepage water into the ground ecosystem immediately down-slope of the cut. The collected water could then be returned to the ground through absorption trenches or discharged directly to the surface water system. Any flows from groundwater would be captured and directed into sediment basins before being discharged into the environment.	AFJV Environment Manager or Environment Coordinator (or delegates)	MCoA Construction Water Quality Management Plan – B31(d)(vi) RMS SoC EA GMS Good Practice
2	Local increases in groundwater level during surcharge of soft soils in low-lying areas such as the Nambucca River Floodplain and potential issues with acidic groundwater in ASS areas.	During surcharge of soft soil ASS areas, groundwater collected from wick drains and through the drainage layer will be managed appropriately including diversion to a holding/sediment pond and checking pH prior to discharge.	AFJV Environment Manager or Environment Coordinator (or delegates)	GMS Good Practice
3	Possible acidification of groundwater if earthworks in ASS areas lower the groundwater table and oxidises potential ASS.	Appropriate ASS management strategies will be adopted throughout the construction program including soil and water pH monitoring, minimisation and monitoring of groundwater drawdown, maintaining surface saturation in exposed clay soils and re-injection of groundwater which is more successful in sandy soils.	AFJV Environment Manager or Environment Coordinator (or delegates)	GMS Good Practice
4	Discharge of water from stockpiles, sediment ponds or other excavations during construction that have been exposed to contaminated soil or ASS and that has elevated contaminant concentrations, including naturally mineralised areas with elevated arsenic levels.	Diversion drains shall be constructed as necessary to divert surface water drainage away from soil stockpiles, excavations or other disturbed areas, particularly in known areas of natural arsenic mineralisation such as Cut 12. No area requiring diversion drains shall be left overnight without diversion drains unless approved by the Environment Officer (or delegate). Sediment control ponds for treatment of surface water shall be constructed on-site prior to construction work commencing.	AFJV Environment Manager or Environment Coordinator (or delegates)	MCoA Construction Water Quality Management Plan – B31(d)(vi) GMS Good Practice
5	Decommissioning Registered Groundwater Bores and Monitoring Piezometers. The majority of the project monitoring piezometers are located within the highway alignment and will be kept throughout the construction program until they are required to be decommissioned. Registered groundwater bores likely to be destroyed during the construction program include the three registered groundwater bores GW300211, GW063518 and GW066776 located within or adjacent to the highway alignment at Cut 14, GW304949 located on the southern edge of Cut 9 at Chainage 47430, GW066960 located within Fill 19 and GW066969 within Cut 21. These bores will require proper decommissioning prior to construction works in these areas.	Deteriorated, destroyed or abandoned water supply or monitoring bores which could threaten the groundwater resource would be decommissioned in such a way that the hydrogeological environment is maintained or returned as close as possible to the condition that existed prior to drilling. Minimum requirements for decommissioning bores are outlined in the document "Minimum Construction Requirements for Water Bores in Australia" (Land and Water Biodiversity Committee, 2003) and are summarised below: • Sealing - Any bore that is to be permanently decommissioned shall be completely sealed and filled in such a manner that vertical movement of water within the bore, including water within the annular space surrounding the casing, is prevented and the water is permanently confined to the specific zone in which it originally occurred. The sealing material should not have any potential health risk. Bores are to be filled, plugged and sealed. No part of the decommissioned bore shall remain as an open hole. • Sealing materials and placement - Concrete, cement grout, or bentonite grout shall be used as primary sealing materials and shall be placed from the bottom upward by methods that will avoid segregation or dilution of material and unnecessary contamination of the aquifer zone. • Surface caps - All bores shall be sealed from a depth of five metres to the surface, or to 300 mm below the surface where a native soil topping is required. The soil topping shall be compacted and mounded to prevent ponding of surface water above the bore.	AFJV Environment Manager or Environment Coordinator (or delegates)	GMS Good Practice
6	Construction Vehicles and Machinery	At the start of the construction period, hardstand and bunded areas for refuelling of construction machinery will be installed to mitigate potential risks to groundwater. Appropriate vehicle maintenance checks and spill containment equipment will also be adopted to mitigate potential risks of groundwater contamination.	AFJV Environment Manager or Environment Coordinator (or delegates)	GMS Good Practice

Further management measures that are also relevant for groundwater are outlined in the Construction Soil and Water Management Plan (SWMP including erosion and sediment controls and ASS management strategies).

Measures for preventing contamination of surface water described in the SWMP will assist in preventing the contamination of groundwater. Measures for preventing contaminated soils or ASS from contaminating surface water will prevent contamination of groundwater by negating the infiltration of contaminated surface water and the leaching of potential contaminants from the soil into the groundwater.

Management measures outlined in the SWMP relevant to the GMS include the following principles:

- Minimise land disturbance;
- Control stormwater runoff from construction sites;
- Provide sedimentation treatment for all surface runoff from disturbed areas;
- As far as practical, separate clean water (i.e., runoff from undisturbed areas), and potentially contaminated water at the construction sites;
- Build temporary or permanent infrastructure to capture any spills or leaks of potentially contaminating chemicals before they enter the environment;
- Collect and store amenities wastewater before transporting off-site for treatment or disposal;
- Undertake water quality monitoring to ensure that surface water management is meeting the objectives of the management plan and is within criteria limits.

To prevent surface water contamination including sedimentation runoff into surface water the following measures will be implemented:

- A SWMP that describes erosion and sediment control will be prepared in accordance with NSW DECC (2006) Managing Urban Stormwater: Soils and Construction, Volume 2, Book 4, Main Road Construction (DECC, 2006) and Managing Urban Stormwater: Soils and Construction (The Blue Book) (Landcom, 2004);
- Construct suitably lined sediment control ponds down-slope of construction work areas. Some ponds will subsequently be developed into permanent ponds during the operations stage; and
- Ensure that the banks of watercourses are not disturbed during construction.

5. Monitoring and Reporting

Groundwater monitoring programs allow for quantitative documentation of aquifer trends, and aquifer responses to changed land and water usage in the local area. Adhering to a comprehensive and rigorous program will help to ensure that the potential impacts of the construction phase are rapidly detected and remediated to avoid long-term or costly problems. Ultimately the proposed monitoring network will contribute to monitoring and understanding of baseline conditions prior to commencement of the construction phase of the project.

5.1. Monitoring Requirements

There are currently 67 monitoring piezometers installed as part of the baseline groundwater monitoring program. Piezometer details are attached in Appendix B.

5.1.1. Baseline Groundwater Level Monitoring

Groundwater level logger data from 67 monitoring piezometers has been collected since March 2013 to present. The latest hydrographs are provided as part of the 3rd data report (Coffey, 2014c).

5.1.2. Baseline Groundwater Quality Monitoring

Bi-monthly monitoring of the 67 piezometers has been conducted since February 2014, with the latest round conducted in August 2014.

Interim ranges in baseline water quality for pH and electrical conductivity (EC) measured during four rounds of groundwater monitoring (February, April, June and August 2014) are provided in Appendix B. pH ranges from acidic (pH 4.5) to alkaline (pH 8.1) and EC ranges from fresh water (82 µS/cm) to saline water (40,300 µS/cm).

Groundwater quality down gradient of the former Newee Creek Landfill has also been monitored on a bi-monthly basis since February 2014 at three piezometers (4BH064, 4BH065 and 4BH066) for a range of analytes tested at a NATA accredited laboratory. Results have been presented as part of the data reports (Coffey 2014a, 2014b and 2014c).

Management and monitoring details for the former Newee Creek Landfill area is included as part of the Contaminated Land Management Strategy (Coffey, 2014d). While baseline monitoring suggests no significant groundwater contamination is present as a precaution the groundwater piezometers installed around this landfill site are to be monitored to assess if leachate from this landfill poses a potential risk during construction of the WC2NH project.

5.1.3. Baseline Data and Interim Thresholds

Groundwater monitoring results will be evaluated against natural background concentrations (the primary comparison) and assessed against ANZECC 2000 ecosystem trigger values.

Interim thresholds for pH and EC are attached in Appendix B and are provided as a range of values for baseline data collected at each monitoring piezometer from February to August 2014. These values will be reviewed following the completion of the baseline monitoring period in December 2014 to provide an expected natural range of groundwater quality parameters across the WC2NH project area.

5.1.4. Groundwater Monitoring During Construction

Since the majority of the current baseline groundwater monitoring network is located within the highway alignment, replacement piezometers outside the construction footprint will be required at some stage during construction to allow continued monitoring of potential impacts to groundwater.

The proposed replacement monitoring network will be effective in identifying impacts during construction of the project and locations will be agreed by AFJV and RMS at the conclusion of the baseline monitoring program.

It is recommended that continued bi-monthly groundwater level and quality monitoring is conducted during the construction program, and this will be subject to review at the completion of the baseline monitoring program.

It is noted that daily visual monitoring of the cut activities will be undertaken by the area Foreman. If excessive groundwater leachate is noted, the Environmental Coordinator will be informed. The PESCP will be updated to address excessive inflow of groundwater to ensure the sediment controls contain adequate capacity. Groundwater monitoring will be undertaken to ensure the excessive inflow is not impacted on adjacent monitoring bores. Water quality of the groundwater entering the sediment controls will be monitored to ensure the groundwater can be released to the surface water.

5.1.5. Groundwater Monitoring Post Construction Maintenance Period

At this stage bi-annual groundwater level and quality monitoring is proposed for the post construction maintenance period, and this will be subject to review at the completion of the construction monitoring program.

5.1.6. Contingency Plan

The AFJV will address incidents or potential impacts in accordance with the RMS *Environmental Incident Classification and Reporting Procedure* (August 2014) and develop contingency plans in liaison with RMS and the Environmental Representative. The AFJV will develop and include Contingency Plans to respond to incidents or potential impacts on groundwater resources for inclusion in the CEMP for the following:

- Response to impacts from a chemical spill or leakage from storage tanks.
- Response to impacts that may result from groundwater drawdown in areas where acid sulfate soils are present.
- Response to impacts on groundwater where ASS are exposed and incorrectly managed.
- Response to impacts on other users of groundwater resources, including unexpected drawdown of groundwater in licensed bores.
- Response to adverse impacts from changes in groundwater condition on an environmental receptor.
- Response to adverse impacts from changes in groundwater on performance of the upgraded highway.

5.2. Reporting Requirements

Groundwater reporting requirements prior to commencement of construction include the final baseline monitoring report to be completed by Coffey and submitted to RMS and AFJV following collection of up to 21 months of groundwater level data and 12 months of groundwater quality data. The final baseline report will include review of the interim water quality ranges for pH and EC presented in this GMS.

During construction bi-monthly reporting of groundwater level and quality data is to be completed by AFJV. An annual interpretation report will be prepared for the surface water and groundwater monitoring program. The construction monitoring program will be reviewed after 12 months to determine whether analytical suites and monitoring frequencies should be increased or decreased.

5.3. Records

The following records relating to groundwater management and monitoring are to be maintained by AFJV:

- Spill or incident reports;
- Records of daily/weekly inspections during construction;
- Records of groundwater inflows into excavations, dewatering and re-injection rates;
- Monitoring data and analytical reports;
- Records of groundwater treatment;
- Records of groundwater disposal; and
- Annual interpretation reports for the surface water and groundwater monitoring program.

All records are to be maintained in compliance with record keeping requirements as outlined in the CEMP.

5.4. Site Specific Plans

Site specific plans may be developed in the future for construction works. These are to be made available to relevant personnel and read in conjunction with this GMS as required.

6. References

Agriculture and Resource Management Council of Australia and New Zealand and Australian and New Zealand Environment and Conservation Council (1995) National Water Quality Management Strategy – Guidelines for Groundwater Protection in Australia.

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

Coffey Geotechnics (2014a) Surface Water and Groundwater Monitoring Program – 1st Data Report, Pacific Highway Upgrade – Warrell Creek to Nambucca Heads. Report reference GEOTCOFH03148AA-AC, dated 24 March 2014.

Coffey Geotechnics (2014b) Surface Water and Groundwater Monitoring Program – 2nd Data Report, Pacific Highway Upgrade – Warrell Creek to Nambucca Heads. Report reference GEOTCOFH03148AA-AD, dated 30 May 2014.

Coffey Geotechnics (2014c) Surface Water and Groundwater Monitoring Program – 3rd Data Report, Pacific Highway Upgrade – Warrell Creek to Nambucca Heads. Report reference GEOTCOFH03148AA-AE, dated 14 July 2014.

Coffey Geotechnics (2014d) Contaminated Land Management Strategy, Pacific Highway Upgrade – Warrell Creek to Nambucca Heads. Report reference GEOTCOFH03148AB-AC, dated 19 September 2014.

Land and Water Biodiversity Committee (2003) Minimum Construction Requirements for Water Bores in Australia", Edition 2 Revised September, 2003.

Landcom (2004) Urban Stormwater: Soils and Construction (Blue Book).

National Health and Medical Research Council (2011) National Water Quality Management Strategy – Australian Drinking Water Guidelines 2011.

NSW DECC (2006) Managing Urban Stormwater: Soils and Construction, Volume 2, Book 4, Main Road Construction.

NSW Department of Land and Water Conservation (1997) The NSW State Groundwater Policy Framework Document.

NSW Department of Land and Water Conservation (1998) The NSW Groundwater Quality Protection Policy – A Component Policy of the NSW State Groundwater Policy.

NSW Department of Land and Water Conservation (2002) The NSW State Groundwater Dependent Ecosystems Policy – A Component Policy of the NSW State Groundwater Policy Framework Document.

RMS Environmental Incident Classification and Reporting Procedure (August 2014).

RTA Code of Practice for Water Management – Road Development and Management (1999).

RTA QA Specification G38 Soil and Water Management.

RTA QA Specification G39 Soil and Water Management (Erosion and Sediment Control Plan).

Sinclair Knight Merz (SKM) (2010) Warrell Creek to Urunga Upgrading the Pacific Highway Environmental Assessment, Volume 1 Environmental Assessment, dated January 2010.

7. Limitations

The findings contained in this report are the result of discrete/specific methodologies used in accordance with normal practices and standards. To the best of our knowledge, they represent a reasonable interpretation of the past and present uses of the site. Under no circumstances, however, can it be considered that these findings represent the actual state of the site at all points. If material is observed during construction that does not conform to that described in this report, or is suspicious in nature, then Coffey should be contacted and further assessments undertaken.

In preparing this report, current guidelines for assessment of groundwater and surface water were followed. This work has been conducted in good faith in accordance with Coffey's understanding of the client's brief and general accepted practice for environmental consulting.

This report was prepared for AFJV. The report is not intended for other parties or other uses. Anyone using this document does so at their own risk and should satisfy themselves concerning its applicability and, where necessary, should seek expert advice in relation to the particular situation.

We draw your attention to the attached sheet "*Important Information About Your Coffey Environmental Site Assessment"* which outlines or discusses limitations associated with interpreting environmental assessment reports and drawing conclusions based on the data.

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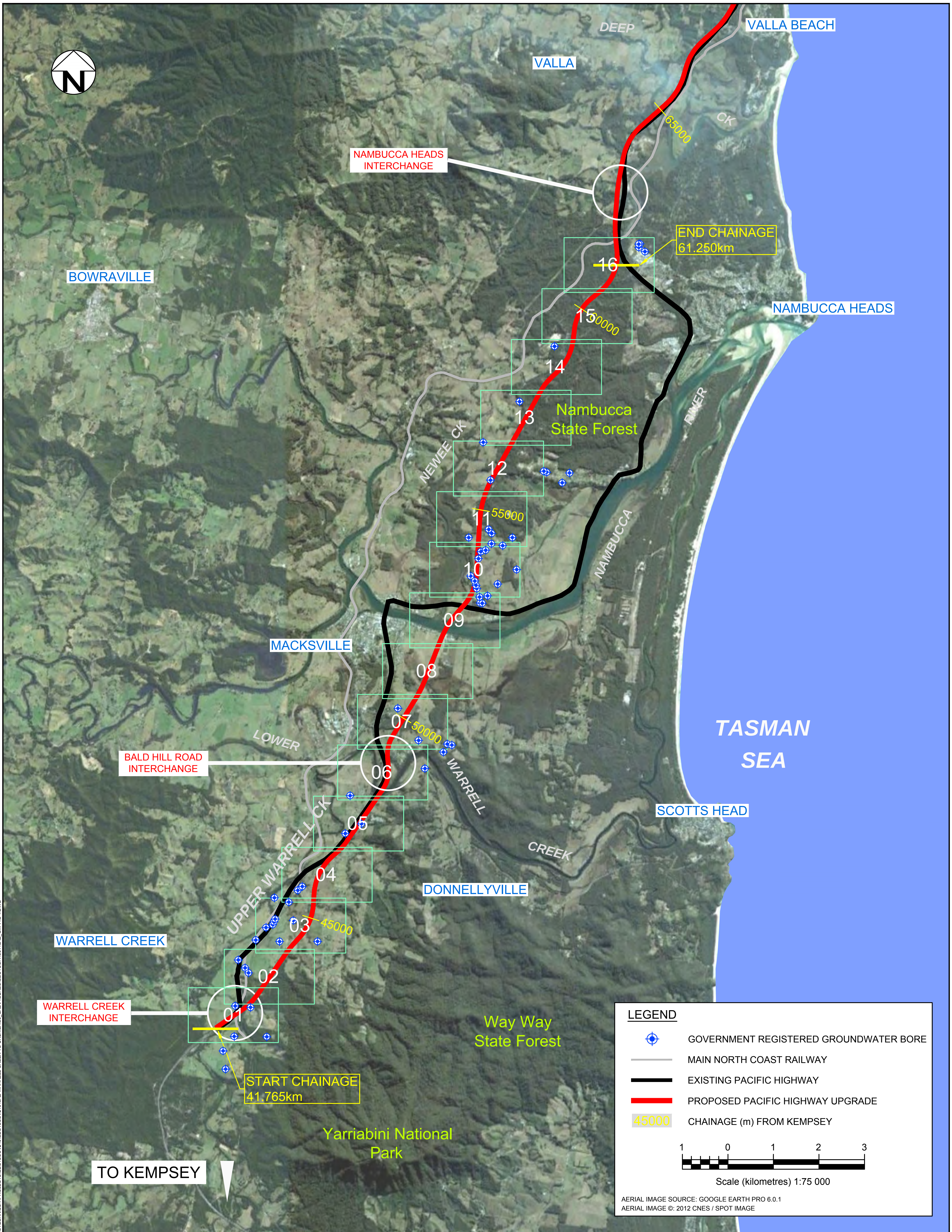
Figures



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coffey

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project:	PACIFIC HIGHWAY UPGRADE WARRELL CREEK TO NAMBUCCA HEADS GROUNDWATER MANAGEMENT STRATEGY
title:	LOCATION PLAN
project no:	GEOTCOFH03148AB
drg no:	FIGURE 1
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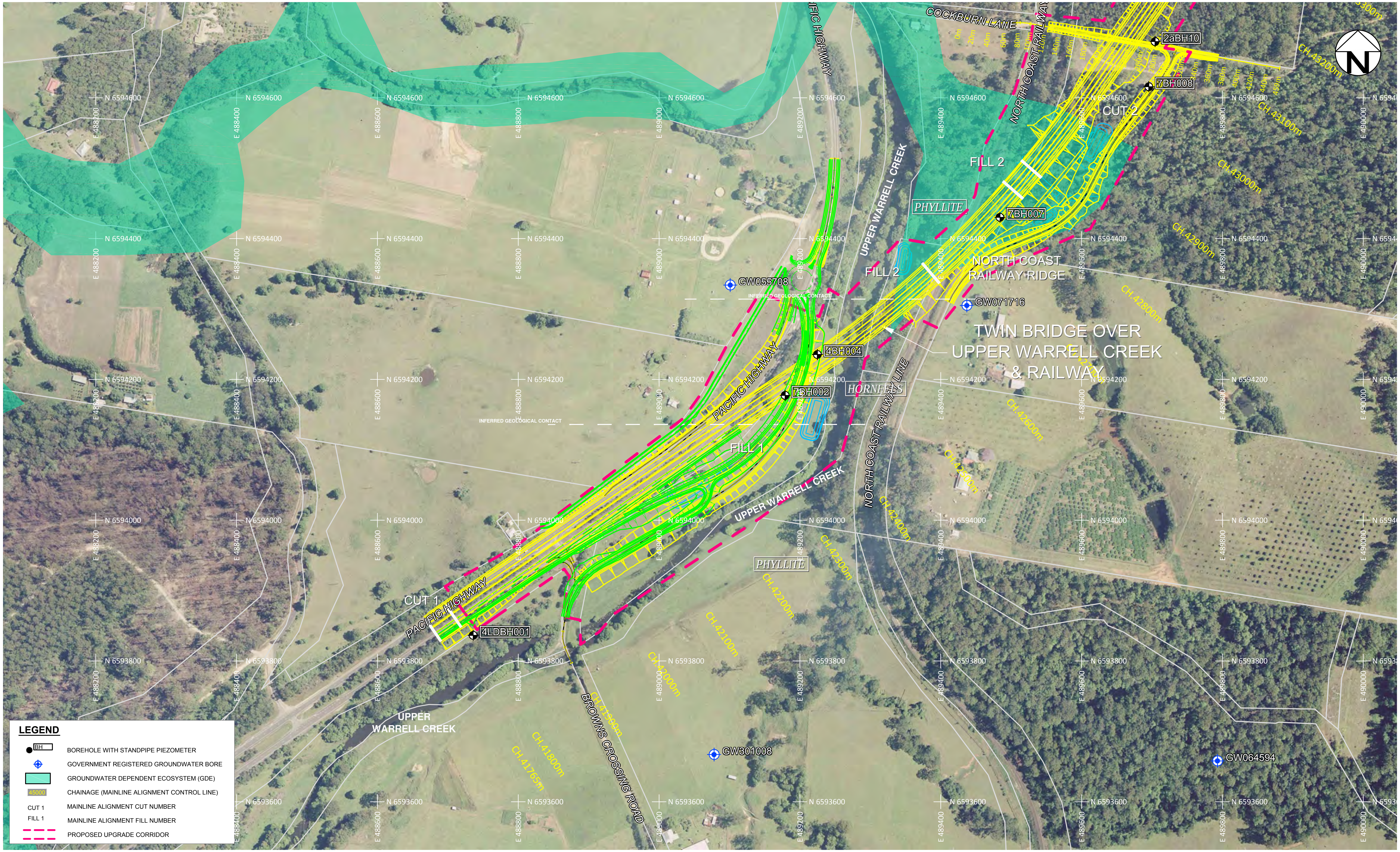

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client: ACCIONA & FERROVIAL JOINT VENTURE (AFJV)

project: PACIFIC HIGHWAY UPGRADE
WARRELL CREEK TO NAMBUCCA HEADS
GROUNDWATER MANAGEMENT STRATEGY

title: SITE PLANS
SHEET 01 OF 16

project no: GEOTCOFH03148AB drg no: FIGURE 2 rev: 0

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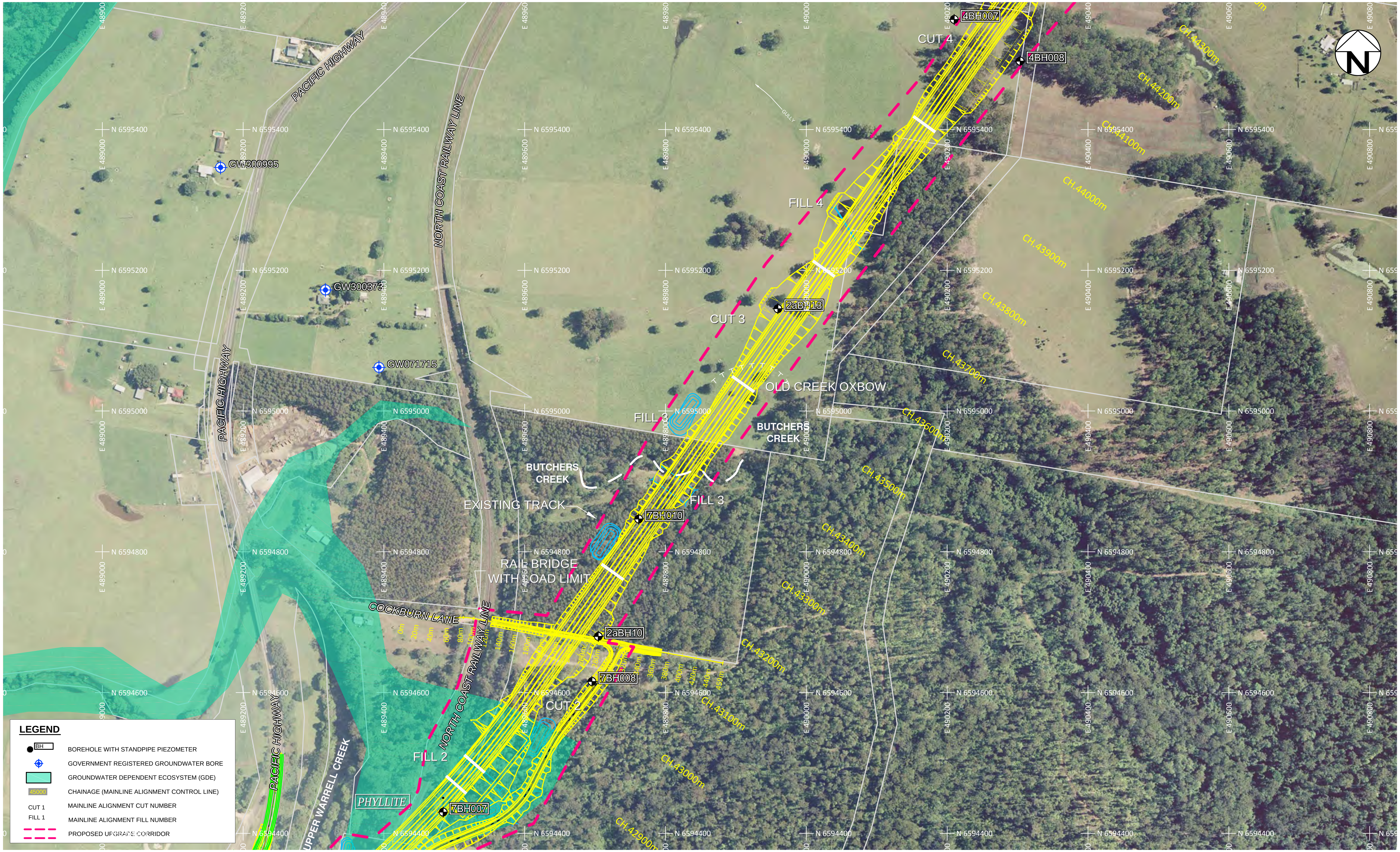

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project no:	GEOTCOFH03148AB
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revision no.	description	drawn	approved	date

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project: PACIFIC HIGHWAY UPGRADE
WARRELL CREEK TO NAMBUCCA HEADS
GROUNDWATER MANAGEMENT STRATEGY

title: SITE PLANS
SHEET 03 OF 16

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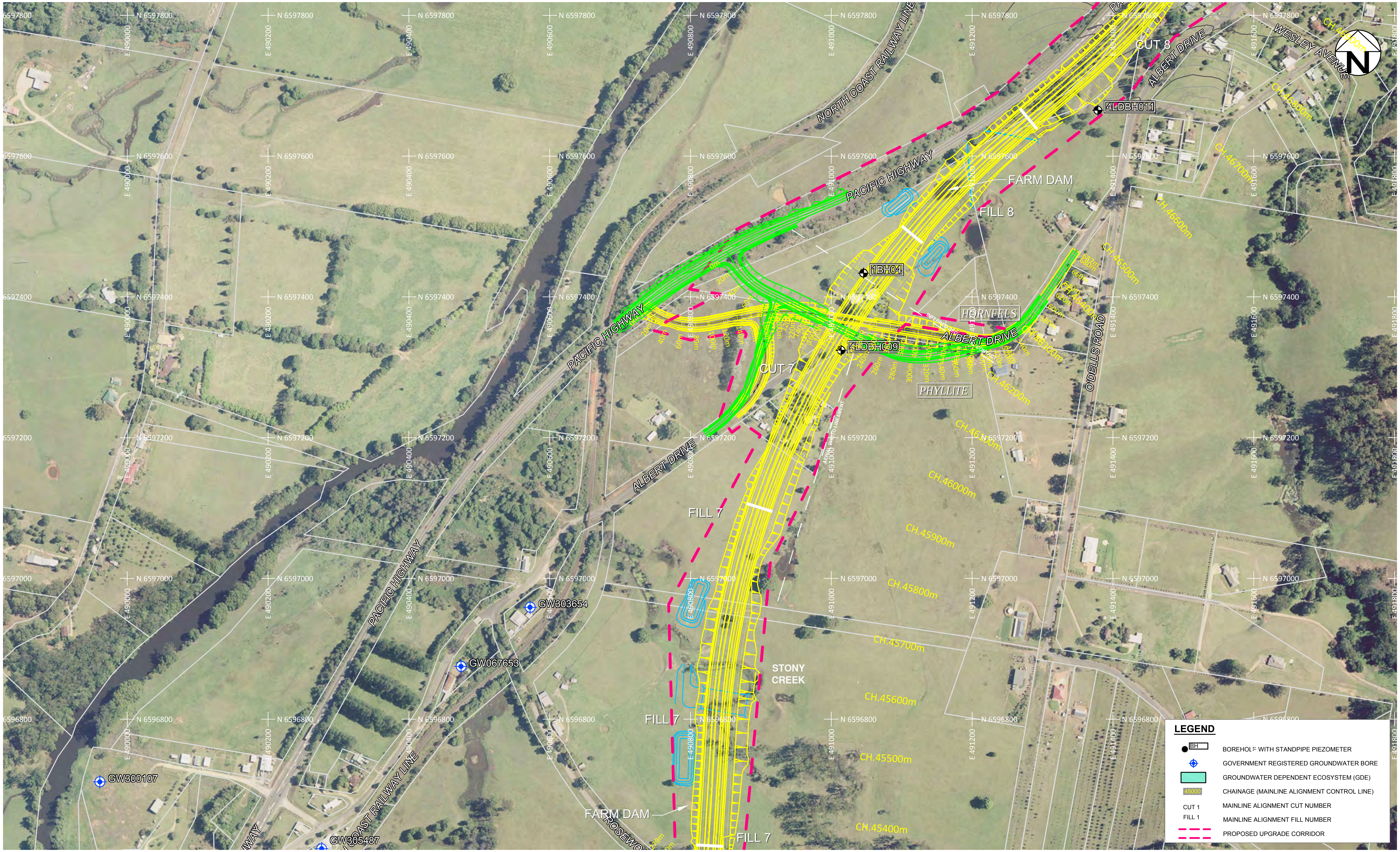

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client:	ACCIONA & FERROVIAL JOINT VENTURE (AFJV)
project:	PACIFIC HIGHWAY UPGRADE WARRELL CREEK TO NAMBUCCA HEADS GROUNDWATER MANAGEMENT STRATEGY
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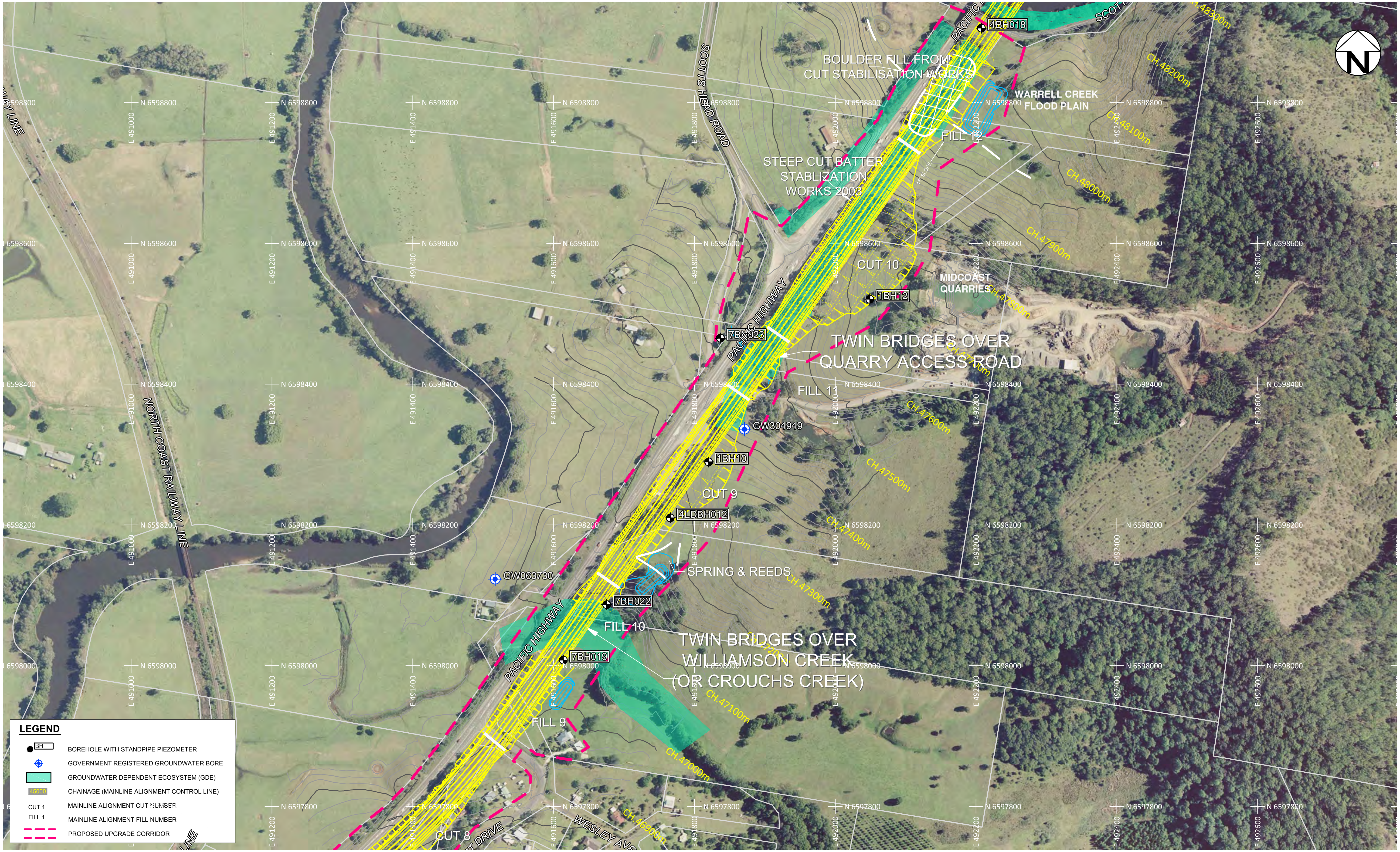

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WARRELL CREEK TO NAMBUCCA HEADS
GROUNDWATER MANAGEMENT STRATEGY

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SHEET 05 OF 16

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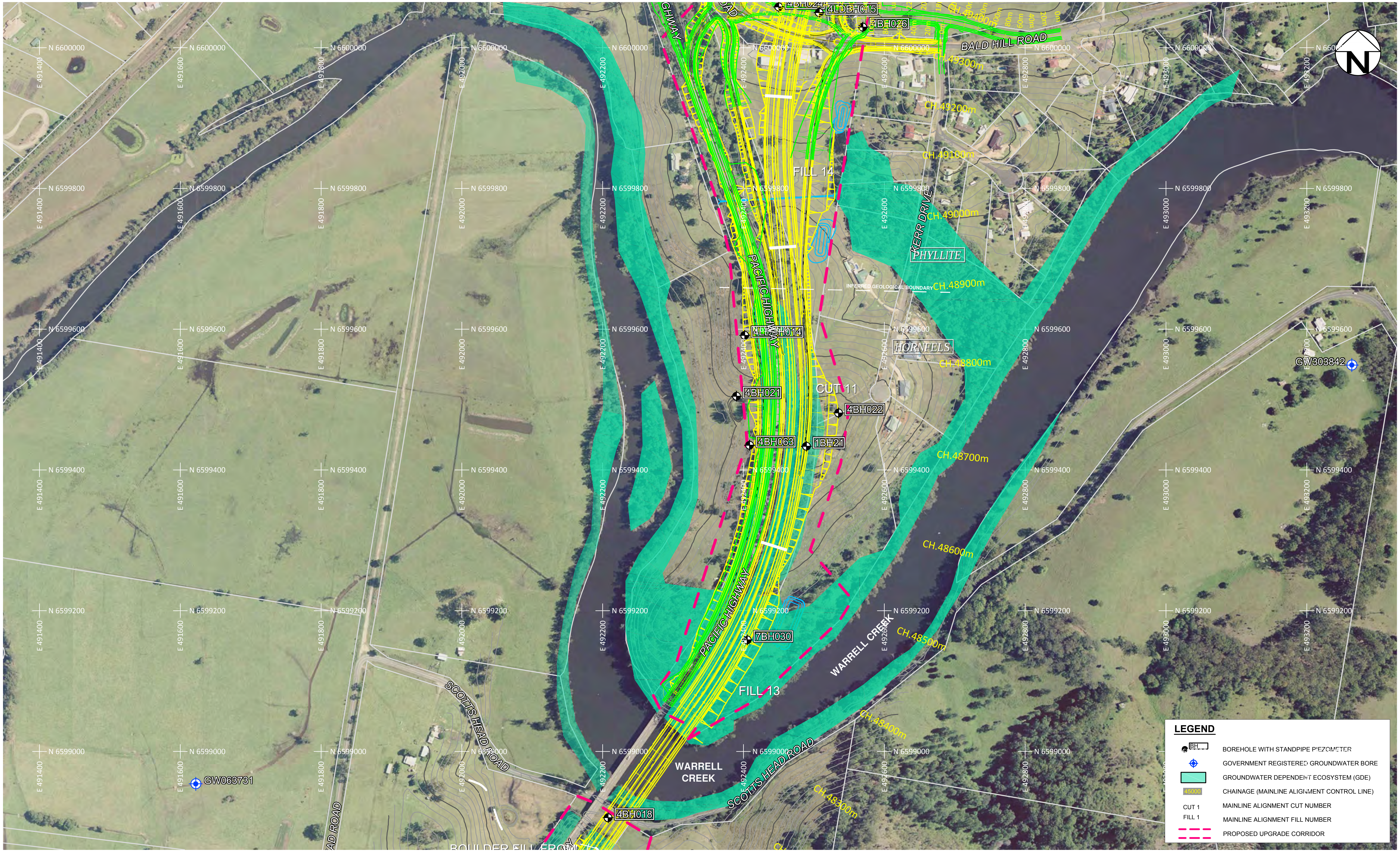

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project: PACIFIC HIGHWAY UPGRADE
WARRELL CREEK TO NAMBUCCA HEADS
GROUNDWATER MANAGEMENT STRATEGY

title: SITE PLANS
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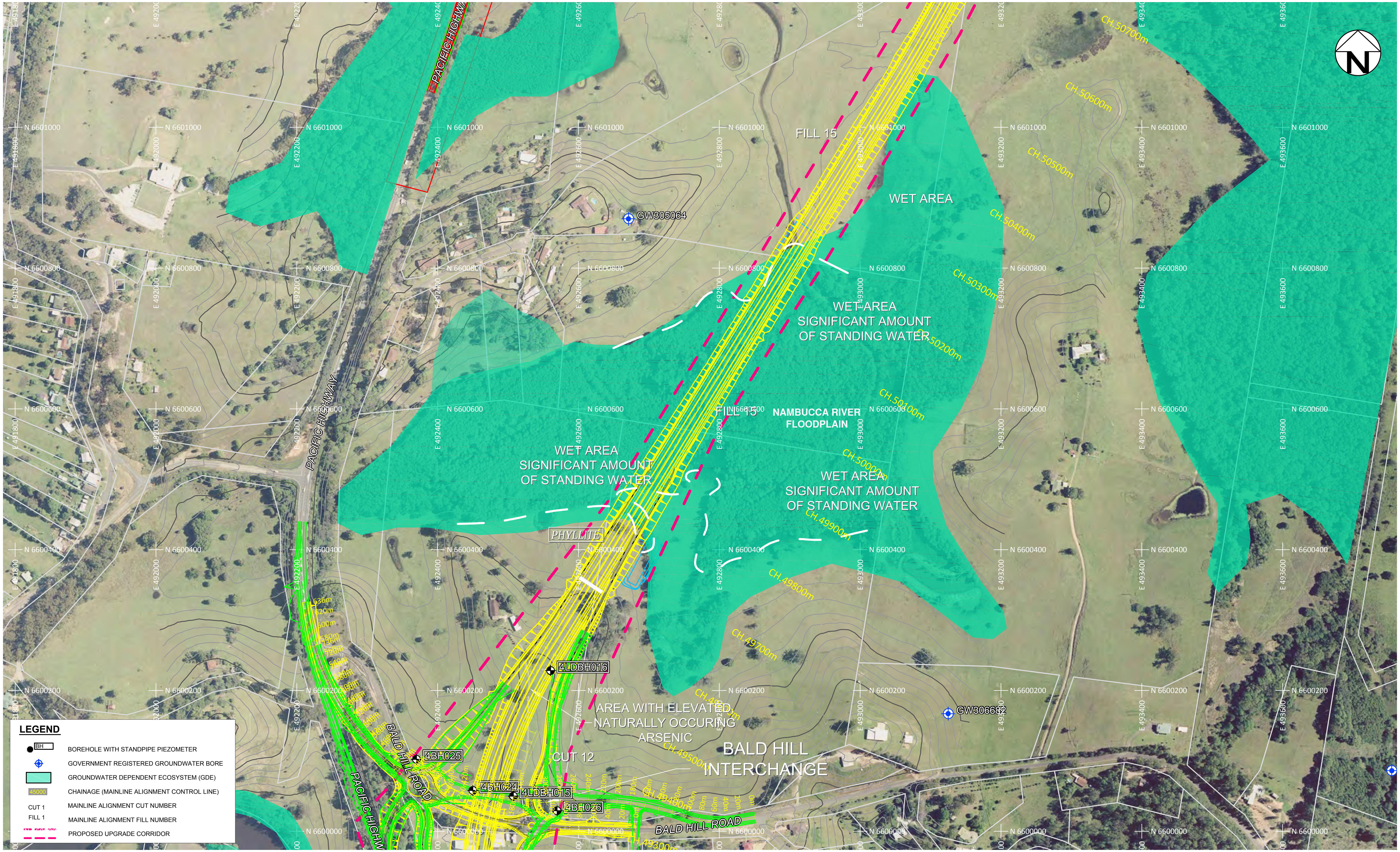

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WARRELL CREEK TO NAMBUCCA HEADS
GROUNDWATER MANAGEMENT STRATEGY

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SHEET 07 OF 16

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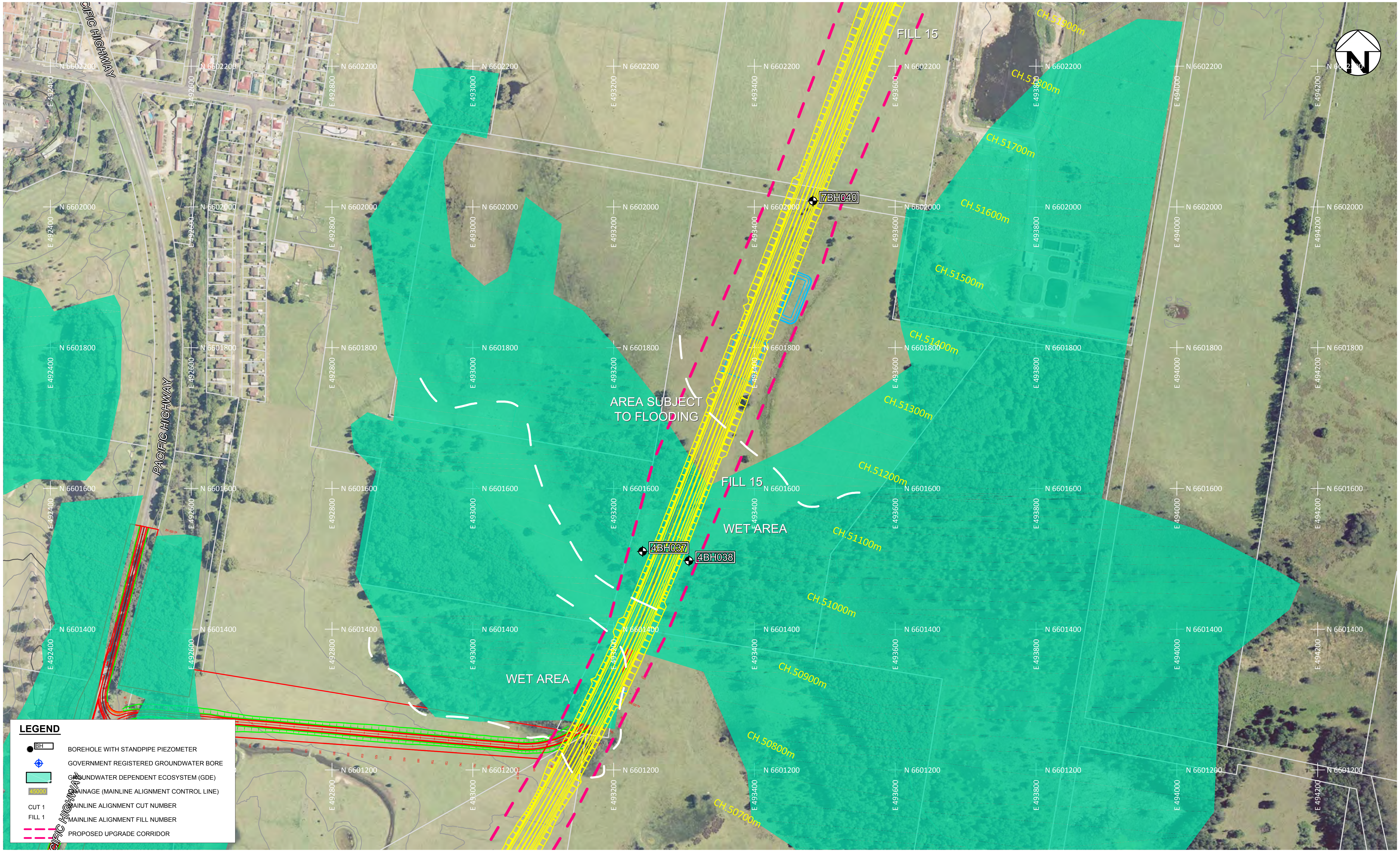

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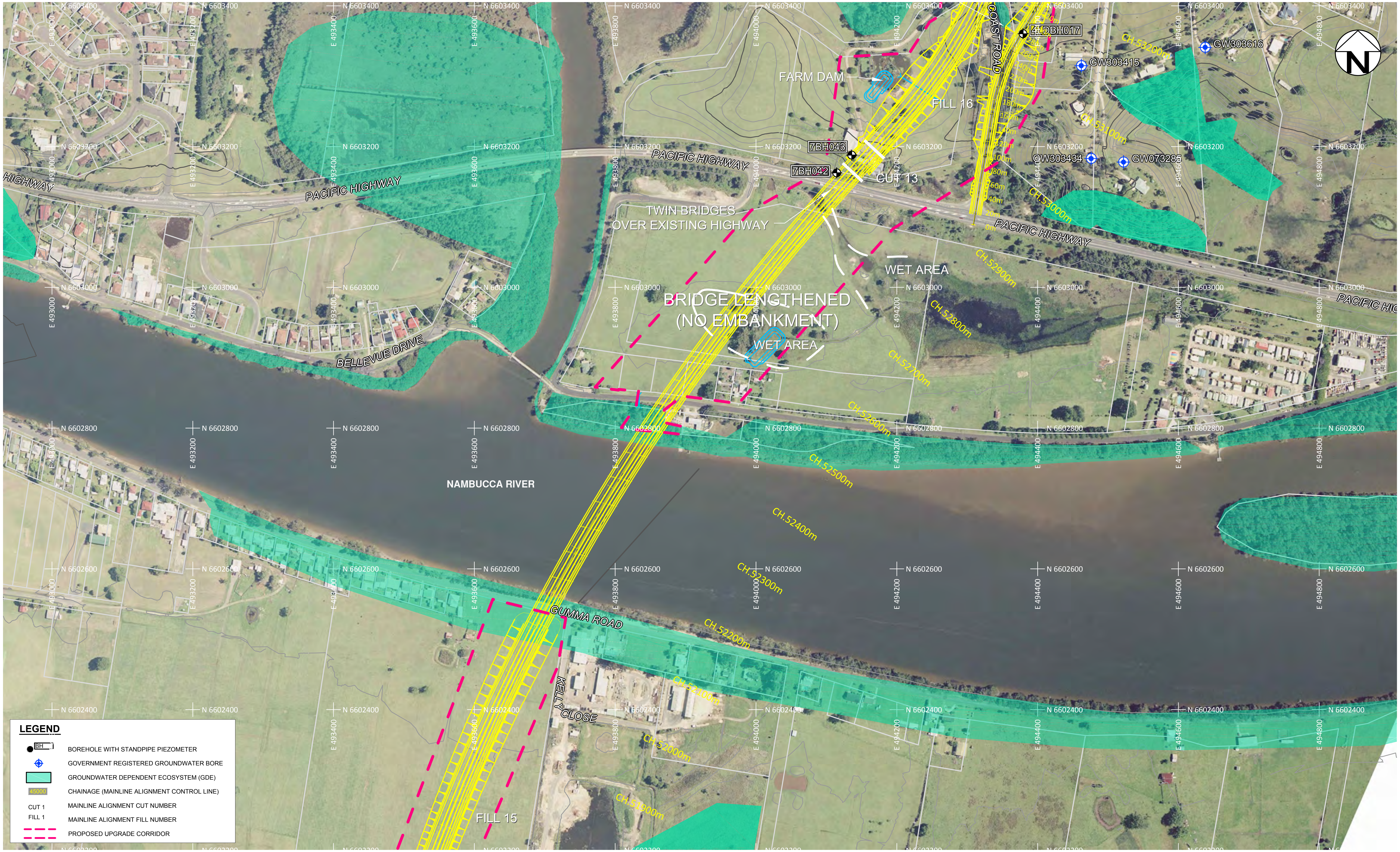

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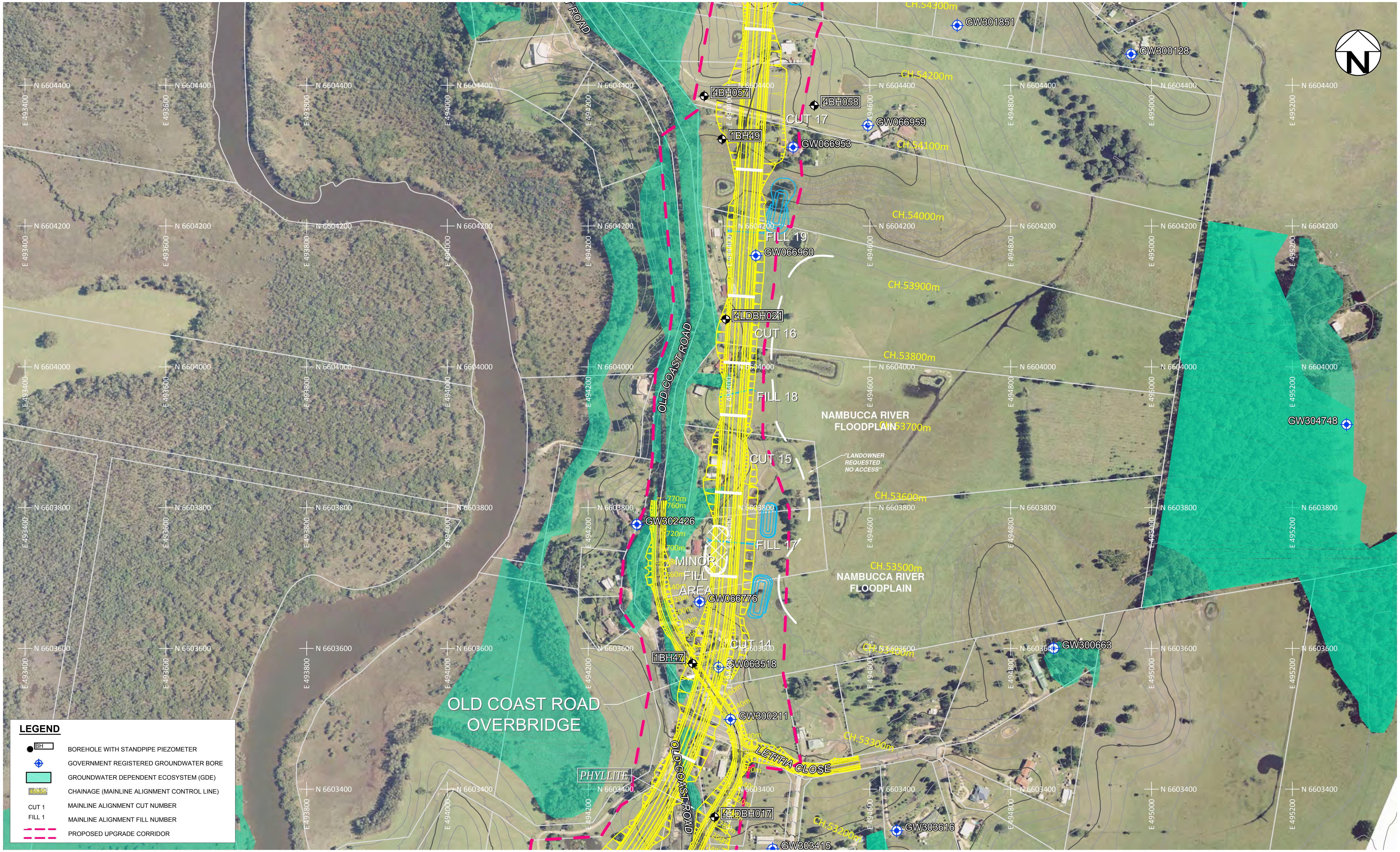

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client: ACCIONA & FERROVIAL JOINT VENTURE (AFJV)

project: PACIFIC HIGHWAY UPGRADE
WARRELL CREEK TO NAMBUCCA HEADS
GROUNDWATER MANAGEMENT STRATEGY

title: SITE PLANS
SHEET 10 OF 16

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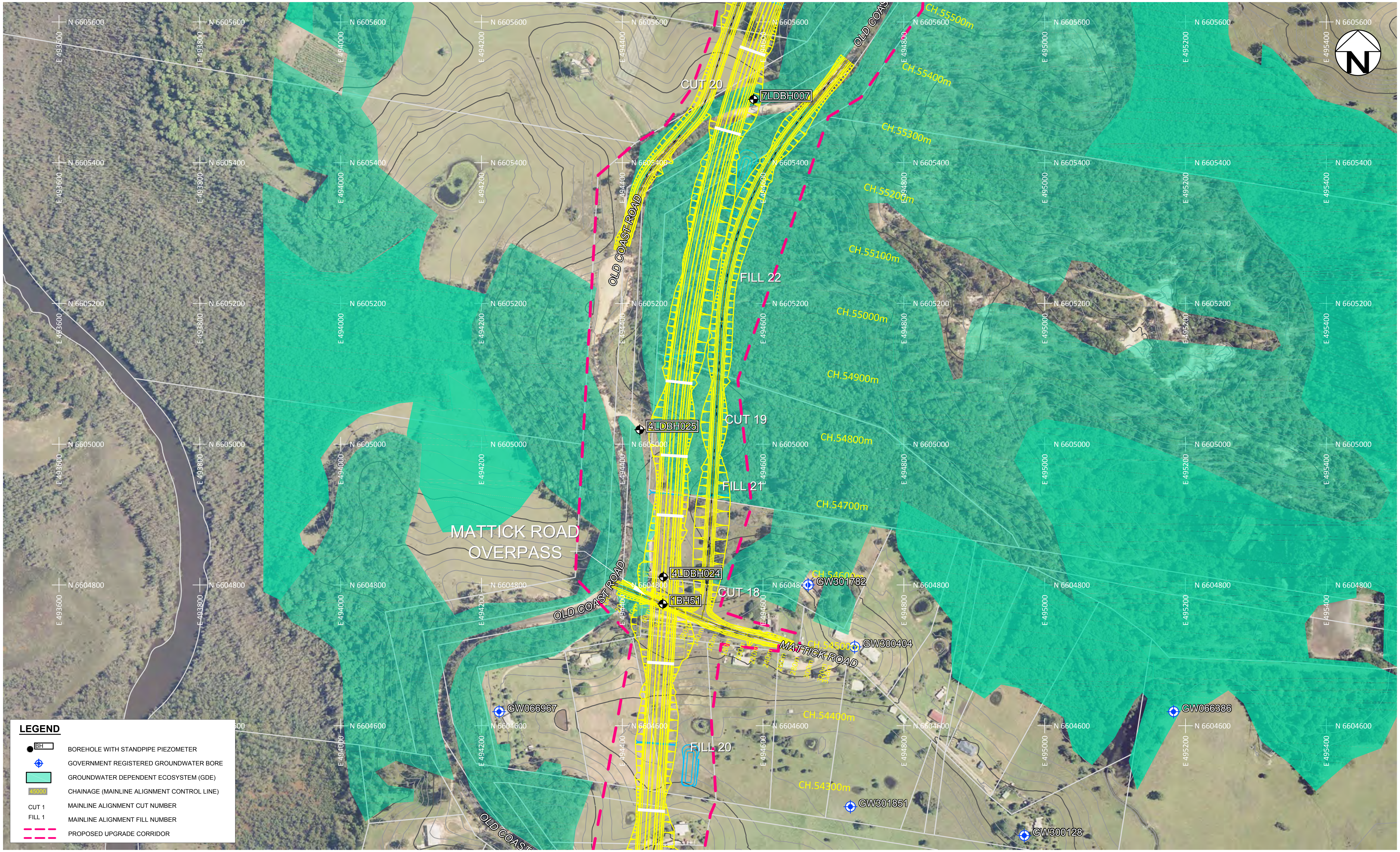

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project: PACIFIC HIGHWAY UPGRADE
WARRELL CREEK TO NAMBUCCA HEADS
GROUNDWATER MANAGEMENT STRATEGY

title: SITE PLANS
SHEET 11 OF 16

project no: GEOTCOFH03148AB | drg no: FIGURE 12 | rev: 0

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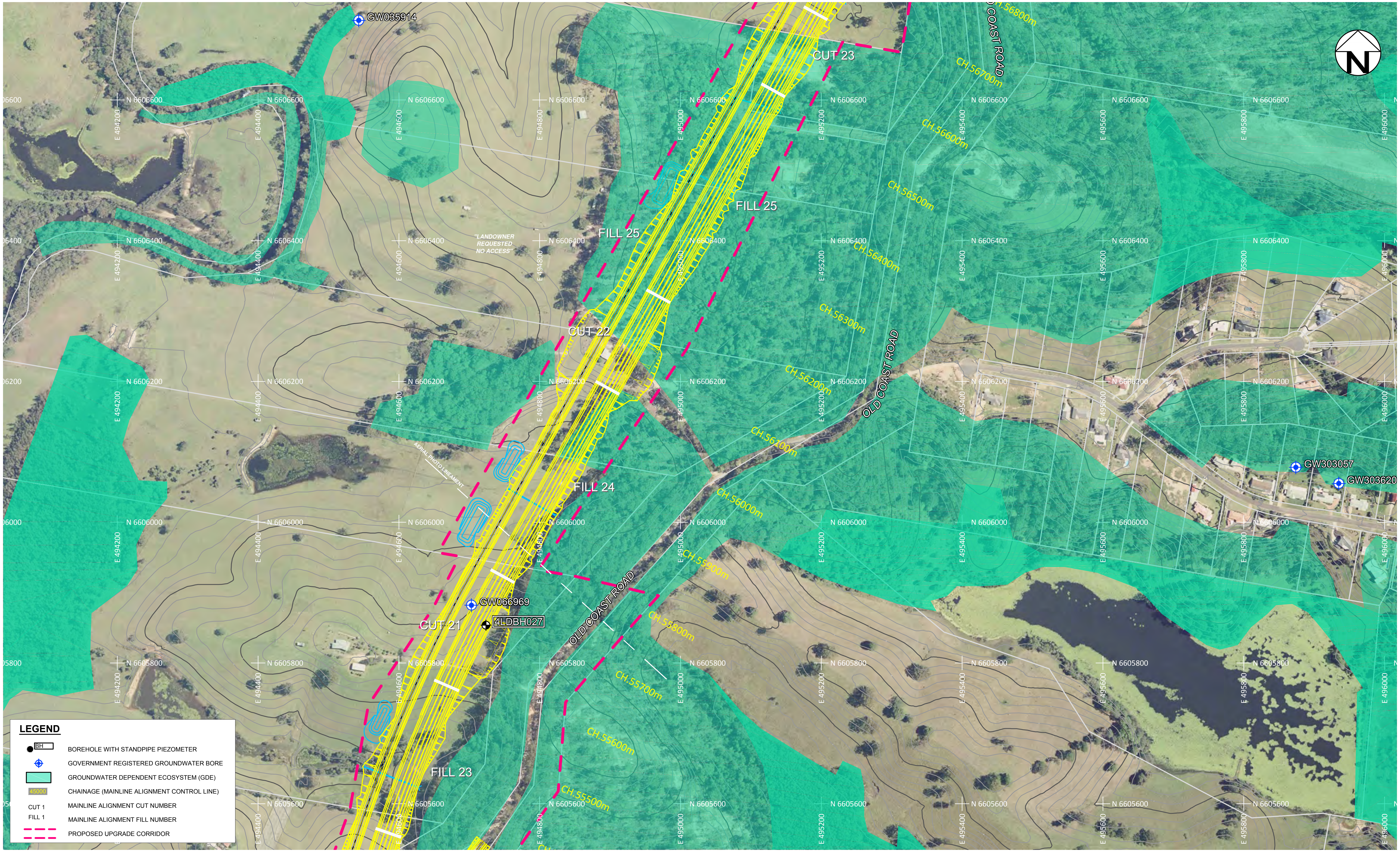

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coffey

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project: PACIFIC HIGHWAY UPGRADE
WARRELL CREEK TO NAMBUCCA HEADS
GROUNDWATER MANAGEMENT STRATEGY

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SHEET 12 OF 16

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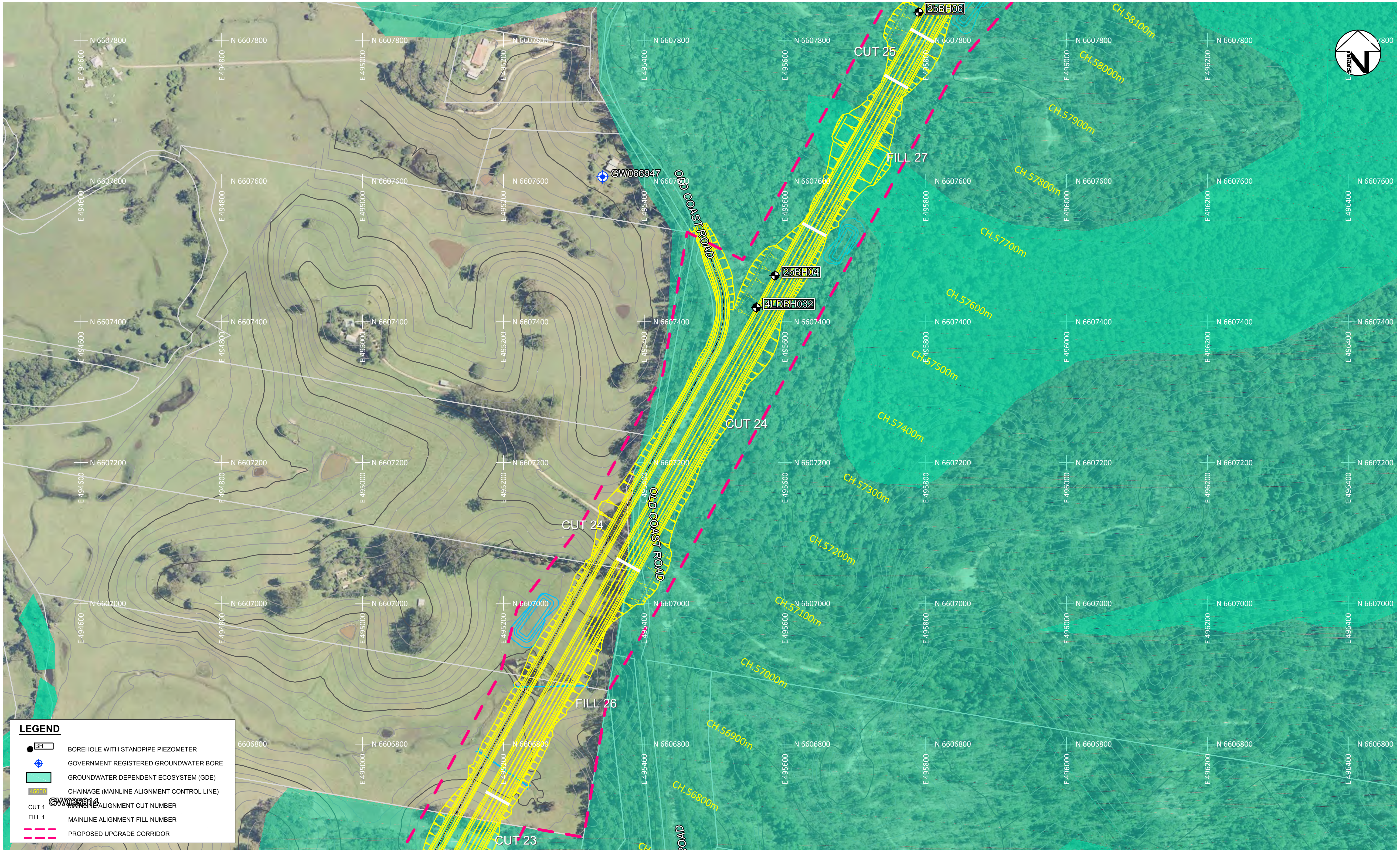

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coffey

client: ACCIONA & FERROVIAL JOINT VENTURE (AFJV)

project: PACIFIC HIGHWAY UPGRADE
WARRELL CREEK TO NAMBUCCA HEADS
GROUNDWATER MANAGEMENT STRATEGY

title: SITE PLANS
SHEET 13 OF 16

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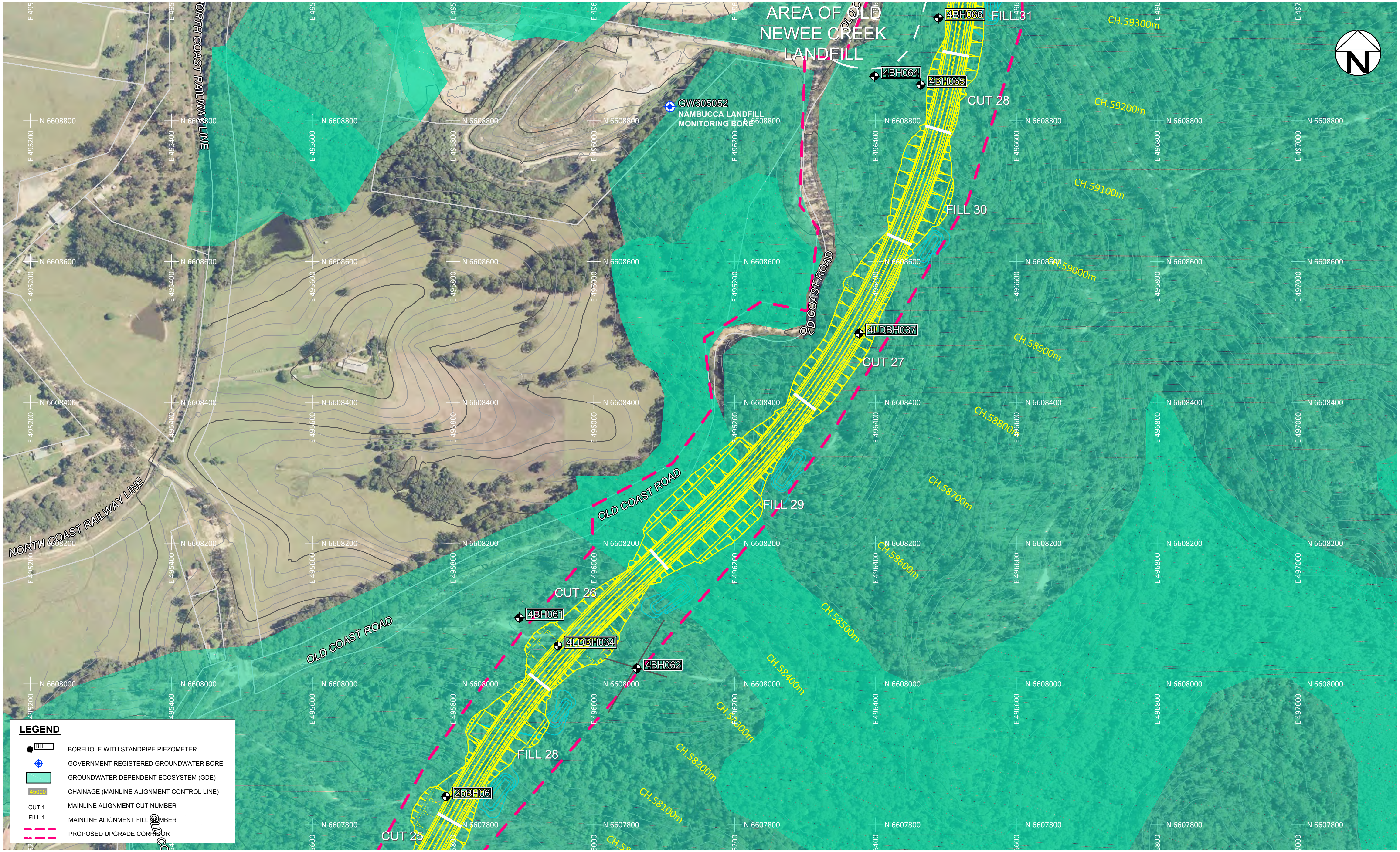

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client: ACCIONA & FERROVIAL JOINT VENTURE (AFJV)

project: PACIFIC HIGHWAY UPGRADE
WARRELL CREEK TO NAMBUCCA HEADS
GROUNDWATER MANAGEMENT STRATEGY

title: SITE PLANS
SHEET 14 OF 16

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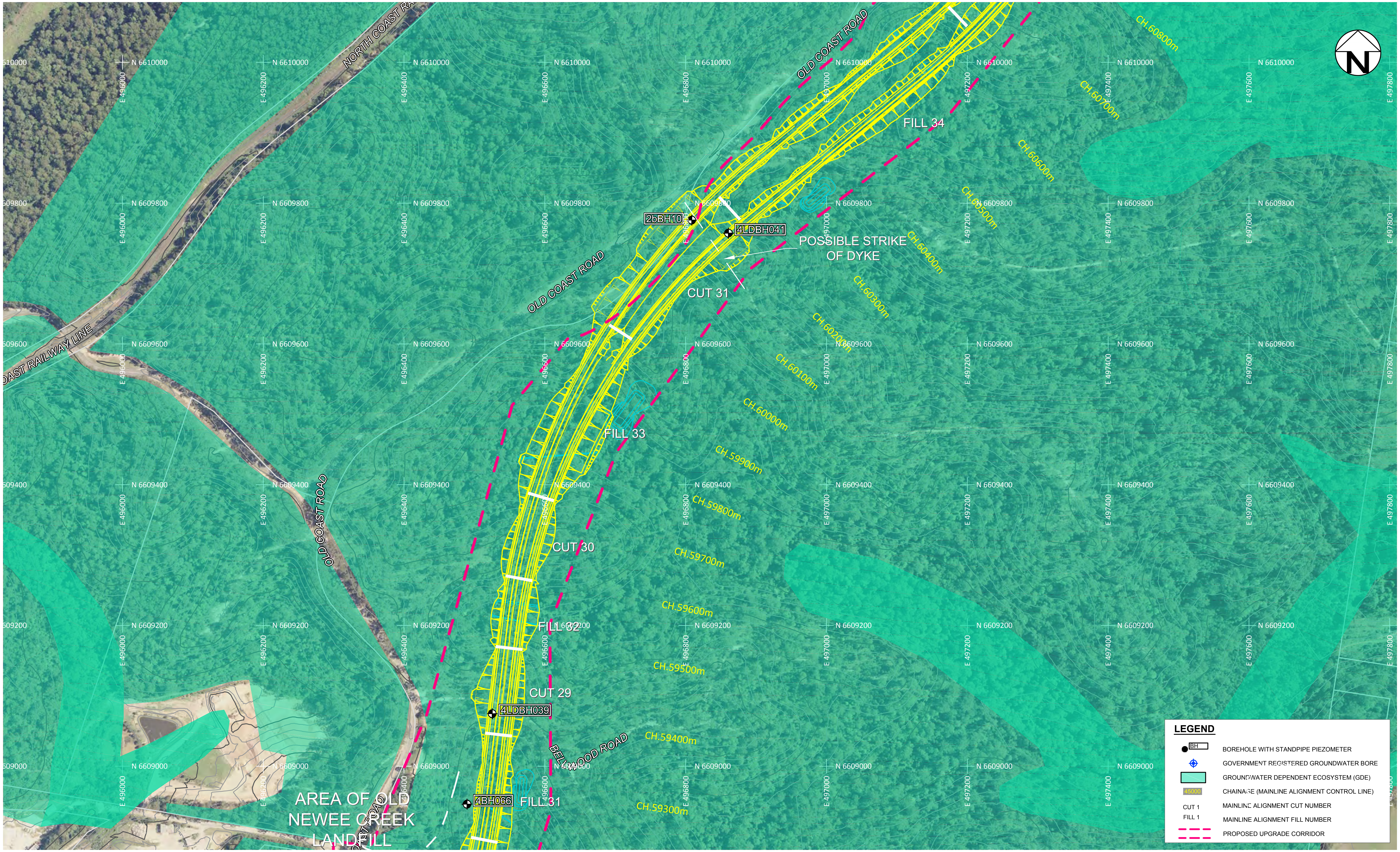

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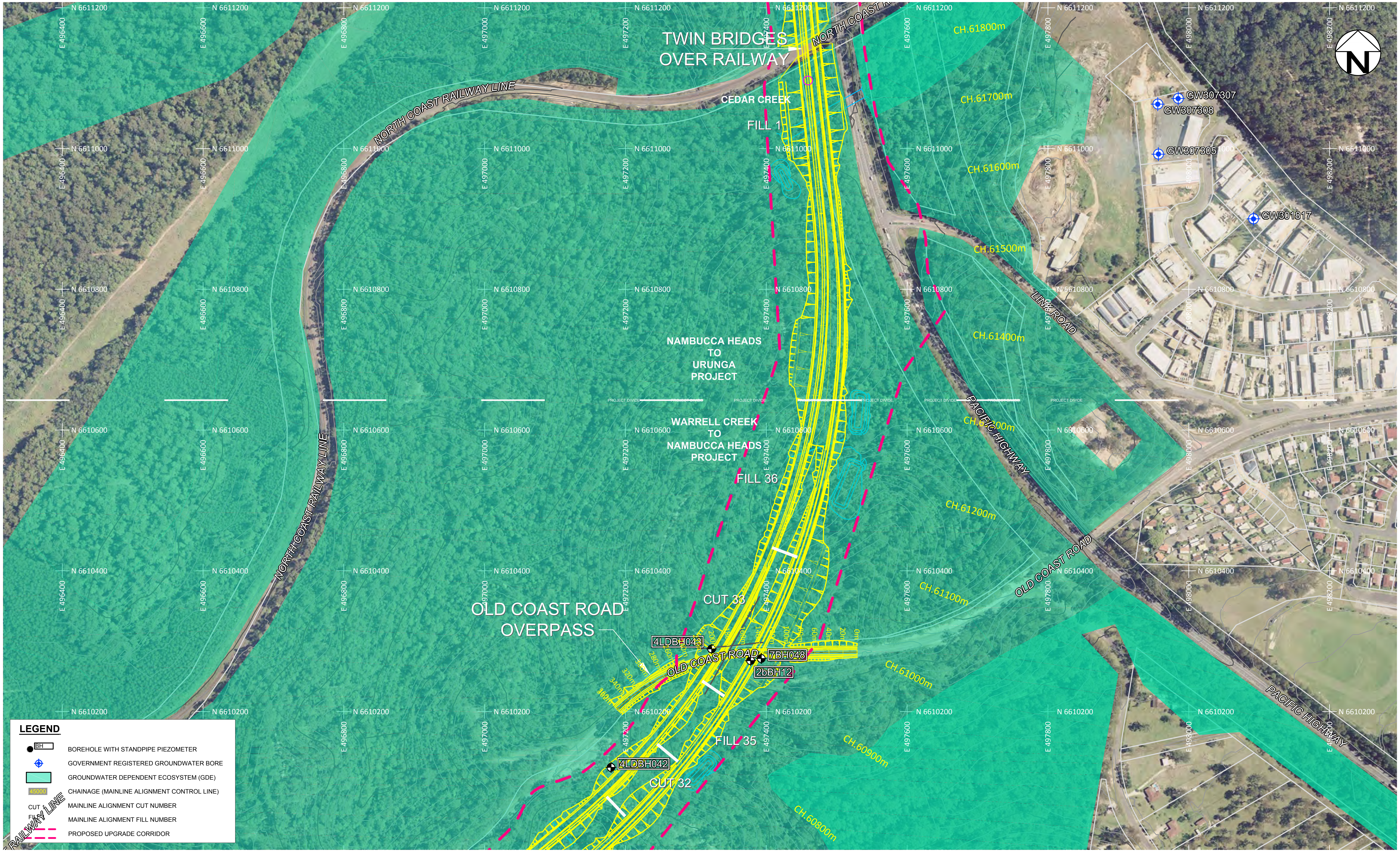
client: ACCIONA & FERROVIAL JOINT VENTURE (AFJV)

project: PACIFIC HIGHWAY UPGRADE
WARRELL CREEK TO NAMBUCCA HEADS
GROUNDWATER MANAGEMENT STRATEGY

title: SITE PLANS
SHEET 15 OF 16

project no: GEOTCOFH03148AB | drg no: FIGURE 16 | rev: 0



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client:	ACCIONA & FERROVIAL JOINT VENTURE (AFJV)
project:	PACIFIC HIGHWAY UPGRADE WARRELL CREEK TO NAMBUCCA HEADS GROUNDWATER MANAGEMENT STRATEGY
title:	SITE PLANS SHEET 16 OF 16
project no:	GEOTCOFH03148AB
drg no:	FIGURE 17
rev:	0

Appendix A - Registered Groundwater Bore Details

Appendix A – Registered Groundwater Bore Details

Registered Groundwater Bore ID	Easting (mMGA)	Northing (mMGA)	Distance and Direction from WC2NH Upgrade	Comments / Refer to Site Plan for Locations
GW301008	489078	6593667	300m SE	Figure 2
GW064594	489793	6593658	750m SE	Figure 2
GW071716	489437	6594305	50m SE	Figure 2
GW055708	489101	6594334	150m NW	Figure 2
GW071715	489393	6595062	400m NW	Figure 3
GW300373	489317	6595172	500m NW	Figure 3
GW300995	489168	6595346	750m NW	Figure 3
GW065647	489551	6595782	700m NW	Figure 4
GW306921	490074	6595751	250m NW	Figure 4
GW055965	490907	6595752	300m SE	Figure 4
GW302139	489776	6596057	650m NW	Figure 4
GW065575	489923	6596121	600m NW	Figure 4
GW063844	489950	6596182	600m NW	Figure 4
GW065576	489976	6596244	650m NW	Figure 4
GW066911	490375	6596213	300m NW	Figure 4
GW305487	490276	6596616	500m W	Figure 4
GW300107	489961	6596711	800m W	Figure 5
GW067653	490474	6596875	350m W	Figure 5
GW303654	490572	6596959	250m W	Figure 5
GW063730	491517	6598123	100m W	Figure 6
GW304949	491871	6598336	10m E	Figure 6
GW063731	491622	6598954	500m W	Figure 7
GW303842	493264	6599549	750m E	Figure 7
GW306682	493125	6600167	500m E	Figure 8
GW305064	492671	6600870	200m NW	Figure 8
GW303434	494476	6603183	250m E	Figure 10
GW073285	494522	6603178	300m E	Figure 10
GW303415	494462	6603315	50m E	Figure 11
GW303616	494638	6603341	250m E	Figure 11
GW300211	494402	6603499	Cut 14 - within side road alignment	Figure 11
GW063518	494385	6603573	Cut 14 - within highway alignment	Figure 11
GW066776	494358	6603666	10m W	Figure 11
GW302426	494269	6603776	100m W	Figure 11
GW300663	494861	6603600	400m E	Figure 11
GW304748	495277	6603918	800m E	Figure 11
GW066960	494438	6604158	Fill 19 - within highway alignment	Figure 11
GW066953	494491	6604312	30m E	Figure 11
GW066959	494597	6604343	150m E	Figure 11
GW301851	494724	6604485	250m E	Figure 11
GW300128	494971	6604444	500m E	Figure 11
GW066386	495183	6604620	700m E	Figure 12
GW300404	494730	6604712	250m E	Figure 12
GW301782	494664	6604800	150m E	Figure 12
GW066967	494225	6604620	200m W	Figure 12
GW066969	494703	6605882	Cut 21 - within highway alignment	Figure 13
GW303620	495935	6606055	1000m E	Figure 13
GW303057	495874	6606078	950m E	Figure 13
GW035914	494543	6606713	500m NW	Figure 13
GW066947	495341	6607606	250m NW	Figure 14
GW305052	496108	6608820	350m W	Figure 15 - Monitoring bore Nambucca Landfill
GW301817	498092	6610900	600m NE	Figure 17
GW307305	497957	6610992	550m NE	Figure 17 - Monitoring bore Essential Energy
GW307307	497985	6611071	600m NE	Figure 17 - Monitoring bore Essential Energy
GW307308	497956	6611063	600m NE	Figure 17 - Monitoring bore Essential Energy

Appendix B - Groundwater Monitoring Piezometer Details and Interim Thresholds for Baseline Water Quality Data

Appendix B – Groundwater Monitoring Piezometer Details and Interim Thresholds for Baseline Water Quality Data

Monitoring Piezometer ID	Easting (mMGA)	Northing (mMGA)	Ground Surface (mAHD)	Piezometer Depth (m)	WC2NH Upgrade Location (Cut/Fill)	Electrical Conductivity (µS/cm) Minimum	Electrical Conductivity (µS/cm) Maximum	pH (pH units) Minimum	pH (pH units) Maximum
4LDBH001	488736	6593836	19.4	10.0	Cut 1	Dry	Dry	Dry	Dry
7BH002	489179	6594177	5.0	21.4	Fill 1	309	431	6.4	7.3
4BH004	489225	6594235	4.8	25.0	Fill 1	1089	1089	6.5	6.5
7BH007	489484	6594430	20.4	25.0	Fill 2 / North Coast Railway Ridge	320	455	6.1	7.0
7BH008	489696	6594616	32.6	9.0	Cut 2	Dry	Dry	Dry	Dry
2aBH10	489704	6594680	29.0	12.3	Cut 2	Dry	Dry	Dry	Dry
7BH010	489762	6594847	11.5	15.0	Fill 3	252	327	6.3	7.9
4BH008	490304	6595497	41.3	10.0	Cut 4	4530	4880	5.0	5.1
4BH007	490210	6595556	31.1	11.0	Cut 4	Dry	Dry	Dry	Dry
4LDBH006	490287	6595595	36.3	15.7	Cut 4	Dry	Dry	Dry	Dry
7LDBH001	490656	6596046	22.8	17.5	Cut 5	920	920	6.3	6.3
2aBH16	490828	6596441	28.1	18.3	Cut 6	Dry	Dry	Dry	Dry
4BH011	490902	6596449	30.0	18.0	Cut 6	9590	16900	6.7	7.0
4BH010	490751	6596499	23.6	18.0	Cut 6	5440	5440	4.5	4.5
4LDBH008	490830	6596566	19.3	18.8	Cut 6	151	269	5.7	7.4
4LDBH009	491014	6597324	29.9	18.0	Cut 7	82	98	5.3	6.2
1BH04	491046	6597434	32.2	20.0	Cut 7	252	252	6.2	6.2
4LDBH011	491379	6597665	28.6	14.0	Cut 8	1338	1447	6.9	7.2
7BH019	491614	6598008	4.4	11.0	Fill 9	336	425	6.5	7.8
7BH022	491675	6598087	7.2	8.0	Cut 9	708	1114	6.3	7.0
4LDBH012	491766	6598210	25.4	15.0	Cut 9	781	891	6.7	8.1
1BH10	491820	6598290	34.5	18.0	Cut 9	Dry	Dry	Dry	Dry
7BH023	491837	6598465	17.1	11.0	Fill 11	713	753	6.1	6.8
1BH12	492049	6598521	44.9	30.0	Cut 10	1319	2105	6.8	7.3
4BH018	492208	6598906	2.3	26.5	Fill 12	107	5220	6.2	7.0
7BH030	492405	6599159	2.4	19.0	Fill 13	3760	3760	6.5	6.5
1BH21	492489	6599434	32.9	20.1	Cut 11	Dry	Dry	Dry	Dry
4BH063	492409	6599435	17.4	22.0	Cut 11	366	408	6.4	8.0
4BH022	492535	6599481	32.9	22.1	Cut 11	83	212	6.2	7.2
4BH021	492390	6599505	12.0	22.0	Cut 11	112	364	6.0	6.7
4LDBH014	492402	6599591	25.0	11.0	Cut 11	Dry	Dry	Dry	Dry
4BH026	492570	6600029	25.5	10.2	Cut 12	Dry	Dry	Dry	Dry
4LDBH015	492507	6600050	23.5	20.3	Cut 12	279	338	6.9	7.6
4BH024	492450	6600058	17.5	20.3	Cut 12	92	162	6.3	6.3
4BH025	492370	6600102	17.3	10.1	Cut 12	Dry	Dry	Dry	Dry
4LDBH016	492560	6600228	20.7	15.1	Cut 12	588	653	6.1	6.4
4BH038	493307	6601497	1.2	8.0	Fill 15	7320	7320	7.0	7.0
4BH037	493241	6601511	1.1	8.0	Fill 15	7770	11350	6.9	7.5
7BH040	493483	6602008	1.4	28.3	Fill 15	3540	7400	6.9	7.4
7BH042	494115	6603163	5.3	15.5	Cut 13	3420	40300	6.2	6.8
7BH043	494136	6603188	12.1	11.5	Cut 13	3140	3630	5.6	7.0
4LDBH017	494379	6603360	17.6	10.0	Cut 14	Dry	Dry	Dry	Dry
1BH47	494348	6603579	18.9	15.0	Cut 14	705	705	5.4	5.4
4LDBH021	494395	6604068	14.0	10.0	Cut 16	Dry	Dry	Dry	Dry
1BH49	494390	6604323	19.9	18.0	Cut 17	111	191	5.2	6.2

Monitoring Piezometer ID	Easting (mMGA)	Northing (mMGA)	Ground Surface (mAHD)	Piezometer Depth (m)	WC2NH Upgrade Location (Cut/Fill)	Electrical Conductivity (µS/cm) Minimum	Electrical Conductivity (µS/cm) Maximum	pH (pH units) Minimum	pH (pH units) Maximum
4BH058	494521	6604371	17.0	20.5	Cut 17	148	148	6.0	6.0
4BH057	494365	6604385	24.3	20.5	Cut 17	124	159	6.1	6.3
1BH51	494458	6604773	22.8	15.2	Cut 18	Dry	Dry	Dry	Dry
4LDBH024	494458	6604811	18.6	14.8	Cut 18	Dry	Dry	Dry	Dry
7LDBH007	494587	6605490	24.4	15.0	Cut 20	415	712	6.1	6.4
4LDBH027	494724	6605854	24.2	15.0	Cut 21	Dry	Dry	Dry	Dry
2bBH02	495400	6607130	47.0	15.0	Cut 24	Dry	Dry	Dry	Dry
4LDBH032	495559	6607420	32.1	15.0	Cut 24	Dry	Dry	Dry	Dry
2bBH04	495586	6607466	34.8	13.0	Cut 24	Dry	Dry	Dry	Dry
2bBH06	495790	6607840	31.3	12.0	Cut 25	1126	1209	6.9	8.0
4BH062	496061	6608022	29.7	16.0	Cut 26	Dry	Dry	Dry	Dry
4LDBH034	495949	6608054	33.5	15.0	Cut 26	Dry	Dry	Dry	Dry
4BH065	496464	6608851	29.0	16.6	Cut 28	482	548	5.0	5.4
4BH064	496399	6608863	23.1	15.8	Cut 28	1033	1223	5.6	6.1
4BH066	496489	6608946	25.1	17.0	Fill 31	103	752	6.0	6.2
4LDBH039	496525	6609075	32.4	15.0	Cut 29	1063	1216	6.0	6.6
4LDBH041	496861	6609757	37.1	18.0	Cut 31	670	761	5.3	5.9
2bBH10	496809	6609776	45.6	19.0	Cut 31	302	302	5.8	5.8
4LDBH042	497179	6610121	35.2	10.0	Cut 32	Dry	Dry	Dry	Dry
2bBH12	497378	6610272	34.1	15.0	Cut 33	224	224	6.0	6.0
7BH048	497393	6610275	34.3	18.2	Cut 33	2960	3560	5.7	5.9
4LDBH043	497322	6610289	34.8	18.0	Cut 33	Dry	Dry	Dry	Dry

Appendix G

Pacific Highway Projects Dewatering Practice Note

DEWATERING PRACTICE NOTE

Pacific Highway Projects

May 2012

Document control

Document Title	Dewatering Practice Note (Pacific Highway Projects)
Author	RMS Pacific Highway Office

Issue	Date	Revision Description
1	January 2012	Draft
2	February 2012	Draft
3	May 2012	Final

Disclaimer

The information contained within this practice note is for general information only and is not intended to constitute legal advice. RMS accepts no responsibility for any loss arising out of reliance on any information contained in this document.

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Contents

1. How to use the Practice Note

The Dewatering Practice Note is intended for use by RMS project managers, staff and contractors on Pacific Highway construction projects. It has been designed as a means to ensure key mitigation and management principles for dewatering are indentified and included in project specific Environmental Work Method Statements (EWMS) to be implemented prior to the need to conduct dewatering activities. It should be employed by RMS project teams as a means to proactively plan, assess and improve on-site procedures involving dewatering. When used correctly the practice note will aid in the enhancement of RMS environmental procedures, ensuring detrimental environmental impacts from RMS construction projects are kept to a minimum.

Refer to this practice note when preparing or assessing EWMS for work activities associated with the removal of ponded stormwater or infiltrated groundwater from any location on site, as well as the subsequent reuse or discharge of that water.

2. Introduction

2.1. Background

Dewatering is considered as any activity involving the removal of ponded stormwater or infiltrated groundwater from any location on site. For the purposes of this practice note and other RMS documentation, dewatering also encompasses any activity involving the subsequent reuse or discharge of such water.

Dewatering is a necessary part of any construction or maintenance project as captured stormwater and infiltrating groundwater will fill and pool in low-lying areas of construction sites over time. Without dewatering, pooling water may otherwise adversely affect project objectives. Reduced sediment control effectiveness, damage to formations and excavations, decreased site-access and increased downtime may all result without dewatering activity.

2.2. Objective

It is a requirement of all RMS Pacific Highway construction projects that ALL dewatering activities are undertaken in a manner that does not pollute the environment. As such project teams working on Pacific Highway projects must develop and comply with appropriately planned, approved and supervised procedures to govern such activities. Documentation of such procedures shall be in the form of an environmental work method statement (EWMS). An EWMS shall be both activity related and project specific and ALL dewatering activities must be addressed for each project. Minimum requirements for each EWMS have been outlined within this practice note, although the use of innovation is encouraged to continually enhance RMS environmental best practice.

Specific aims of this practice note are to deliver best practise and due diligence requirements on Pacific Highway construction projects that enable:

- dewatering activities to be managed to avoid pollution and/or environmental harm as defined under the Protection of the Environment Operations Act (NSW, 1997), (POEO Act) and Regulation;
- that promote sustainability in reusing valuable resources; and
- compliance with conditions of approval, permits, and licence conditions.

3. Considerations in planning dewatering activities

Every dewatering activity must be planned to achieve satisfactory environmental outcomes. In the preparation of an effective and acceptable dewatering EWMS, the following actions must be undertaken:

- Identify areas of the site that will require dewatering
- Identify receiving environment where water will be discharged with consideration and assessment of the sensitivity of the receiving environment (E.g. threatened frog/fish species habitat, Marine Park Areas, etc) - wherever possible dewatering to environmentally sensitive areas should be avoided.
- Consider dewatering methods that will minimise potential environmental impacts
- Assess opportunities for reuse

- Assess limitations for any proposed reuse methods
- Select discharge locations and provide adequate energy dissipation
- Determine and document water quality criteria for discharge and/or reuse
- Assess the treatment techniques required to meet the water quality criteria
- Assess water sampling and testing requirements
- Where discharge to sensitive areas is unavoidable, discharge methods, monitoring, sampling and testing should all reflect the specific nature of that receiving environment, its sensitivity and potential threats. This includes specifically targeting relevant parameters based on consideration of the nature of these sensitive environments.
- Identification of any potential contaminants. It is possible that previous land use activity and or the natural geology may produce contaminants. Where there is evidence to suggest there may be contamination within the catchment of an area requiring dewatering the testing regime should identify any risk and be targeted to ensure that risk is managed.
- Indication of likely volumes and duration of dewatering
- Monitoring requirements / regime
- Ensuring that dewatering does not result in discharged water re-entering the site / disturbed surfaces.
- Considering and addressing potential impacts on natural flows / water levels down stream.
- Considering and addressing mixing rates and dilution to the receiving environment.
- Training requirements / assessment of competency
- Incident management response
- Arrangement and management of the pump inlet
- Bunding of the pump

The subsequent sections (*sections 3.1 to 3.8*) will outline considerations associated with each of the actions listed above. These actions are highly recommended in the early stages of preparing an EWMS although do not constitute necessary deliverable inclusions in an EWMS document. (for minimum deliverable requirements in an EWMS document refer *Section 4: Minimum requirements for dewatering environmental work method statements*)

In addition the *Appendix* of this document provides photographs taken of dewatering activities on RMS construction projects. The photographs may be used to illustrate example designs, aiding in the design consideration process.

3.1. Identify areas of the site that will require dewatering

Dewatering locations will be identified through detailed design, in the development of the CEMP and during construction phase as earthworks and construction processes result in changing site drainage conditions. Typically locations that will require dewatering on RMS projects include:

- Sedimentation controls (e.g. sedimentation basins and sumps)
- Excavations
- Culvert and drainage constructions
- Low lying areas of road formations

3.2. Consider dewatering methods to minimise potential environmental impacts

There are various methods for dewatering sedimentation controls and inundated areas of construction excavation and formations. Common dewatering methods for sedimentation controls such as basins include pumping, low flow pipes and siphon discharges.

When selecting dewatering methods, consideration should be given to alternatives to pumped discharges where practical. Pumped dewatering presents specific risks relating to the pump inlet falling to the level of deposited sediment. This would result in direct discharge of polluted water to the receiving environment. In situations where pumping is necessary, additional protection measures should be designed into the dewatering methodology to prevent this scenario from occurring. Likewise, deposited sediment in controls such as basins must be routinely maintained (removed) to ensure that inlets to dewatering pumps and pipes are always above the level of deposited sediment.

There are two general methods for achieving water quality objectives for any site discharge, these being:

1) Water quality treatment prior to discharge.

This is required for sedimentation basins and is the preferred method for any construction excavation of inundated area that has sufficient volume and depth of water to provide flocculation of sediments prior to discharge. Any area other than defined sedimentation basins that can be treated prior to discharge should have a designed dewatering method (e.g. a defined pumping point, low flow or siphon discharge). This method would be designed to address appropriate water quality parameters and limits, and the type and volume of treatments required.

2) Treatment with best practise controls prior to discharge.

Best practise controls are those referred to within Blue Book Volume 1 and Volume 2D. Controls may include sedimentation fences, mulch bunds, sedimentation sumps, geofabric wrapped gravel or mulch bunds, use of onsite grassed areas or a combination of techniques. Treatment with best practise controls is undertaken prior to discharge. These controls must be designed, implemented, monitored and maintained to prevent erosion of the receiving environment and pollution of waters.

Treatment with best practise erosion and sedimentation controls during discharge is only applicable for minor stormwater ponding and for activities such as individual culvert extensions where the volume of stormwater captured is minor and the dewatering activity is infrequent. Addressing due diligence, risk pollution and environmental harm, site conditions and receiving environment would still need to be considered when determining whether to treat or not to treat water prior to discharge, When considering discharge location and treatment method. The following factors should also be considered:

- application rates,
- soil types,
- hydraulic loading,
- evapo-transpiration rates (as per s6.2 Blue Book Volume 2D, page 28).

The effectiveness of treatments are to be monitored and assessed and need to rectify controls and management strategy as required.

3.3. Assess opportunities for reuse

Onsite reuse of stormwater or detained groundwater should be considered as a priority for all dewatering activities. Onsite reuse may include applications such as dust suppression, earthworks compaction, vegetation establishment/rehabilitation, and plant/vehicle wash-down.

Reuse of water on construction site may reduce the need for imported or extracted water and provide a lower risk to the environment than direct discharge to the environment. A common minimum requirement for any reuse activity is that any reuse should not cause the ponding or runoff of water, which may then cause concentrated runoff and unauthorised discharge.

3.4. Assess limitations for any proposed reuse methods

Any reuse activity may be limited by climatic or site conditions. During heavy rainfall periods, when there is the greatest need to remove treated stormwater from sedimentation basins, construction sites may be closed or access limited due to the wet conditions. In such cases, onsite reuse for dust suppression or compaction is neither feasible nor possible. In these cases the water must be discharged to meet the sedimentation basin maintenance timeframes specified in either the environmental protection licence or the CEMP (for non-licensed site).

Planning for any reuse activity and the EWMS for dewatering must take these limitations into consideration, and an EWMS developed for the management of discharge which may be required as a result of high rainfall events. Planning may include controls such as lining basins, sumps, and excavations with gypsum and/or ensuring the capacity of sumps, excavations are re-instated prior to forecast rain events.

3.5. Select discharge locations and provide adequate energy dissipation

It is important to ensure that dewatering activities do not cause erosion at the discharge location or in receiving environments. Consideration must be given to the potential for erosion at discharge locations when designing dewatering outlets. Preference for treated discharge should be given to locations with established drainage and outlet structures. Locations of designated discharge points should be included on all relevant erosion and sediment control plans for the specific construction activity.

Energy dissipation must be provided at all dewatering discharge points. This may include the use of surface protection such as concrete aprons, rock bunds, geofabric, shade cloth, gabions or form ply and will be dependent on the condition of the receiving environment.

Discharge locations should be chosen with consideration to the receiving environment that may contain environmentally sensitive receivers such as threatened frog/fish species, Marine Park, etc.

Where it is not possible to avoid discharges to sensitive areas, discharge methods, monitoring, sampling and testing should all reflect the specific nature of the receiving environment and relevant parameters should be targeted to monitor, control and minimise any potential impacts.

It is possible that previous land use activity and or the natural geology of the receiving environment may produce contaminants requiring identification and assessment. Where there is evidence to suggest there may be contamination within the catchment of an area requiring dewatering then the testing regime should also identify any risk and be targeted so that the risk is managed.

3.6. Determine and document water quality criteria for discharge and/or reuse

Sites with environmental protection licences will have defined water quality objectives for licensed discharge points. The water quality parameters are also only applicable to basin discharges registered under the license. A discharge that does not achieve the environmental outcomes permitted by an EPL is likely to be considered pollution under s120 of the POEO Act. Any discharges containing contaminants other than those specifically identified in the EPL must not result in pollution to waterways. Best management practice applies when discharging water from all other sites or non-licensed discharge points. This includes defining representative water quality criteria for the receiving environment and ensuring all discharges comply with these requirements as required under the license. For the majority of EPLs for Pacific Highway projects only the outlets of basins is a licensed discharge point registered under the EPL. Standard project water quality objectives criteria for Pacific Highway projects are as follows:

- Total suspended solids 50mg/L
- pH 6.5 – 8.5
- Oil and grease no visible trace

Additional specified receiving water quality criteria may be required for activities that have the potential to impact water quality through a range of pollutants including:

- general earthworks in soils with contamination issues
- earthworks in naturally occurring problematic soils such as acid sulphate soils, saline soil or high levels of other sulphide minerals
- lime storage areas
- tannin leachate
- hydrocarbon spills
- concrete works (including batching operations)
- stabilised pavements
- precoat aggregates and spray sealing
- polymers
- curing compounds

Generally a review of environmental assessment and approval conditions and onsite conditions will provide further information on potential pollutants that may be present onsite or in site waters. Other methods to determine water pollutants may include the use of a testing probe, indicator strips, laboratory analysis, local knowledge and consultation with environmental officers and regulatory agencies.

If reuse activities are properly designed and managed then ponded stormwater or groundwater may be able to be reused onsite without specific treatment.

3.7. Assess the treatment techniques required to meet the water quality criteria

Treatments should be designed to achieve the water quality outcome specified, as well as to cater for the time constraints that may be applicable to the activity (i.e. 5 day management period for sedimentation basins). Treatments should be applied to waters, and should be applied only by experienced and competent personnel. Care needs to be taken to ensure treatment methods do not adversely affect water quality or the receiving environment.

Examples of common treatment applicable to RMS projects may include:

- Flocculation of turbid waters to minimise the settling duration of suspended particles, as well as facilitate the clearing of waters exposed to dispersive soils. Flocculation enables water quality standards to be achieved within an acceptable time period. A suitable flocculent should be chosen for sites based on an impact assessment of the receiving environment. In most cases RMS projects would utilise gypsum, which is considered to be inert. There are other flocculants available; however the use of these must be subject to consultation with relevant stakeholders, including EPA and NSW DPI (Fisheries) prior to use.
- pH adjustment using a base such as hydrated lime (for acidic waters) and inversely an acid such as hydrochloric acid (for alkaline waters). Low volume trials for each location will need to be carried out to determine dosage rates. Special care must be taken when adjusting pH to understand the buffer capacity of the waters, ensuring the neutral point is not over-shot. Any personnel involved in the adjustment of pH must be suitably trained and competent in the use of any additives.
- Absorption of oils and grease is used to remove traces of hydrocarbons that may have been mobilised by rainfall. Sources of oil and grease on a project may include spills and leaks from machinery, runoff from precoat aggregate stockpiles and runoff from adjacent travel lanes. Generally oils and grease will be removed from the surface of water detention by the use of floating booms, pads and absorption socks.

Additional information is provided in Blue Book references:

- Appendix B, page 41 of Blue Book Volume 2D for basin management immediately after rain
- Appendix E of the Blue Book Volume 1 with regards to the best practice methodology of flocculation of basins.
- Attachment 5, page 51 of Blue Book V2D for managing pH.

3.8. Assess water sampling and testing requirements

Water quality sampling and testing may be required to ensure that the water quality objectives are met both prior to and during either reuse or discharge of the water. Techniques may include sample collection and laboratory testing or in-situ field assessment.

A list of approved testing methods for various analytes can be referenced from "Approved Methods for the Sampling and Analysis of Water Pollutant in New South Wales" (EPA 2004). All sampling should be representative of the water to be discharged and testing methods in accordance with this document. Licensed premises require approved testing methods as per the conditions of the environmental protection licence (EPL) unless formal agreement has been reached with the relevant agencies. Any such agreement must be documented, and records kept onsite at all times.

Using turbidity as a tool for Total Suspended Solids (TSS) requires an established NTU/TSS correlation and ongoing laboratory verification to ensure the NTU/TSS correlation being applied for the project is correct.

4. Minimum requirements for dewatering environmental work method statements (EWMS)

4.1. EWMS format

The format of site-specific EWMS is flexible according to the procedures used by each project team. This practice note and RMS specification G36 do not require an individual EWMS for each dewatering location on each site although it is necessary for ALL dewatering activities to be accounted for within a documented EWMS.

The EWMS should provide clear guidance for each dewatering activity utilising each of the following:

a) a map showing areas of the site/project that will require dewatering. This map should identify environmentally sensitive areas and features to be considered when planning discharge locations
b) detailed description and staged methodology of selected dewatering methods. This should include a clear and concise step by step procedure
c) description of onsite water reuse requirements
d) a map showing proposed discharge locations for any offsite discharge
e) design requirements for each offsite discharge location to prevent erosion at the discharge location or in the receiving environment
f) water quality objectives relevant to the type of dewatering activity
g) description of the water quality treatment techniques to be used
h) water sampling and testing regime to validate water quality prior to and (if required) during dewatering. Water quality sampling records should include, times, persons, method, parameters, treatment, consistent location, results etc.
i) Treatment volumes, time of application, who, how etc.
j) details of delegated approval of dewatering activities eg. Internal permit signed off by Environment Construction Manager.
k) proposed monitoring and supervision regimes.

If changes are proposed to the dewatering method used at any location or new dewatering requirements are identified during construction the project team must submit either of the following to the Principal before commencing the activity:

a) a revised and updated the site/project EWMS, or
b) a new stand-alone EWMS for the activity.

5. Document the site activity approvals process

All sites discharging water must have a robust procedure in place for the approval of all controlled discharges from dewatering activities and include a mechanism for quality assurance and verification. This process is to be clearly documented in the EWMS and must nominate specific personnel who can approve dewatering activities and specifically the controlled discharge of water. Delegates responsible for dewatering approval must be suitably trained and experienced in their duties. The approval process for dewatering activities is to be included in the worksite induction and training of onsite personnel. The inclusion and enforcement of these procedures will ensure that the risk of unauthorised discharges is significantly reduced.

The minimum requirements of this approval are:

- water quality is demonstrated to meet the objectives in the EWMS and this practice note
- inspections of intake and discharge locations, equipment and receiving environments are completed
- trained personnel are available to supervise and monitor the activity as specified on the EWMS.

5.1. Document training and induction requirements

All staff responsible for approval and/or execution of dewatering activities must be trained and inducted into use of the EWMS. The EWMS should include an induction register as a record of staff that are approved to conduct or approve dewatering activities.

5.2. Document the requirements for supervision of dewatering activities

The EWMS must provide a clear description of all supervision and monitoring required for each dewatering activity. All dewatering activities must be inspected by inducted, experienced and competent personnel. Prior to commencing any dewatering activity of the entire system including intake and outlet, pump, and discharge locations must be inspected.

All dewatering activities must be directly supervised for the entire duration of the dewatering. To remove the need for direct supervision, sites may carry out risk assessments and implement mitigation measures to ELIMINATE risks of causing environmental harm. Due diligence must be demonstrated to eliminate the possibilities of the following incidents:

- intakes dropping into deposited sediments and discharging sediment-laden waters
- erosion of the discharge locations and downstream environment
- inadvertent or intentional controlled discharge of untreated waters.

5.3. Record keeping for dewatering activities

You must keep the following records:

a) a copy of the dewatering EWMS
b) date, time and estimated volume of water released for each discharge location
c) water quality test results for each discharge
d) records to verify persons monitoring, and monitoring data including water quality parameters and criteria, timing and location of monitoring
e) records indicating who provides approval for each dewatering activity, and
f) evidence of discharge monitoring or risk assessment

Appendix:
Photographs of Dewatering Activity on RMS Projects

Figure 1. Application to a sediment basin allows faster settling of sediments and improvements to water quality prior to discharge.

Figure 2. Consideration should always be given to measures to prevent pumped inlets from falling into sediment zones at the bottom of basins. In this example an anchored bucket was seen to be effective.

Figure 3. Informal use of bunding and geotextile was assessed as a suitable outlet treatment for scour protection in this example. The use of a tyre provided both energy dissipation for the discharge flow and anchorage for the discharge pipe.

Figure 3. Use of formal signage indicating discharge procedures was an effective management tool to prevent unauthorised discharges.

Figure 4. A sump adjacent to a working area may require higher levels of maintenance in order to remain effective. Dewatering to a larger sediment basin will be a more viable treatment measure when compared to flocculating the sump itself. Consideration to minimising exposed fines around the immediate catchment (e.g. bottom left corner of the figure) will also reduce sediment entering the sump if deemed practical for construction purposes.

Figure 5. A siphon and float system used for discharging a basin without use of pumps. Floats may be useful for preventing inlets from falling into sediment zones.

Figure 6. An inlet designed with up-turned pipe to ensure settled sediment is not sucked up during discharge. Note that sediment storage zone needs regular maintenance to ensure levels do not reach the inlet level.

Appendix H

Sediment Basin Management and Discharge Procedure

Pacific Highway Upgrade:
Warrell Creek to Nambucca Heads

Sediment Basin Management and Dewatering Procedure
WC2NH-EN-SW-PRO-0005 Appendix H Rev 0

Rev	Description	Originator	Reviewed	Approved	Date
A	Draft Sediment Basin Management and Dewatering Procedure for RMS Review	TH - ERM	NR		25/09/14
B	Includes Comments from Roads and Maritime and ER	NR			4/11/14
C	Updated to include EPA comments	NR			08/12/14
0	Finalised and Approved	NR	Roads and Maritime	DPE	10/12/14

Details of Revision Amendments

Plan Control

The latest approved version of this Procedure will be available for all Project personnel on the Electronic Document Management System - TeamBinder. The functional manager will maintain, review and update this Procedure at least annually.

Amendments

Each new revision to the Procedure will be distributed to all required personnel for review and approval.
The revision number is included at the end of the document number, which is noted in the footer of each page. The document will be allocated a new revision number each time a change is made to the document.

When a new revision to the document is available, a notification email will be distributed to all project personnel by the Document Control Team advising of the update.

The functional Manager is responsible for the implementation and review of the Procedure. The Project Director will approve new revisions of the Procedure via the review and approval process as detailed in the Document Control Procedure.

Functional Manager Authorisation	Distribution List	
Name: Noelene Rutherford	Project Director	
Date: 10 December 2014	Design Manager	
Position: Environmental Manager	Quality Manager	
Signature:	Procurement Manager	
Comments: —	Construction Manager	
	Safety Manager	
	Commercial Manager	
	Environmental Manager	
Project Director Authorisation	Finance Manager	
Name: C. Guillermo Ripado	Engineer Manager	
Date: 10/12/14	Area Manager	
Signature:	Human Resources Manager	
Comments: —	Site Superintendents	
	Roads and Maritime Services	
	IMS Manager	
	Other:	

Contents

Terms and Abbreviations

AADJV	Arup and Aurecon Design Joint Venture
ACCIONA	ACCIONA Infrastructure Australia Pty Ltd
AFJV	ACCIONA and Ferrovial Joint Venture
AS/NZS	Australian and New Zealand Standard
CEMP	Construction Environmental Management Plan
D&C	Design and Construction
DJV	Design Joint Venture
DoE	Department of Environment (Commonwealth)
EEC	Endangered Ecological Communities
EDMS	Electronic Document Management System (TeamBinder)
EC	Environmental Coordinator
EPBC	Environmental Protection and Biodiversity Conservation
EPL	Environment Protection Licence
EWMS	Environmental Works Method Statement
Ferrovial	Ferrovial Agroman (Australia) Pty Ltd
IMS	Integrated Management System
ISO	International Standards Organisation
KPI	Key Performance Indicator
MCoA	Minister's Conditions of Approval
MNES	Matters of National Environmental Significance
NSW	New South Wales
O&M	Operations and Maintenance
PCBU	Person Conducting a Business or Undertaking
PMT	Project Management Team
PV	Project Verifier
RMS	Roads and Maritime Services
WC2NH	Warrell Creek to Nambucca Heads (the Project)

Definitions

Client	An organisation inviting and receiving tenders and letting contracts. For the purposes of this project - Roads and Maritime Services
Contractor	An organisation that contracts with a client to carry out construction and related services. For the purposes of this Project - ACCIONA Ferrovial Joint Venture.
Davis Langdon	Davis Langdon Australia Pty Ltd
Deed	D&C Project Deed, IC-DC-C91-1, Pacific Highway Warrell Creek to Nambucca Heads
Design Joint Venture	Joint Venture consisting of Arup and Aurecon
Government Agency	NSW government department, authority, corporation or entity established by an Act of the NSW Parliament
Persons Conducting a Business or Undertaking	Is an employer, corporation, partnership, unincorporated association that has the primary duty of care for workplace health and safety - (AFJV and Contractors are a PCBU)
Principal Contractor	A person conducting a business or undertaking that commissions a construction project. For the purposes of this project - AFJV
Project	The design and construction of the upgrade to the Pacific Highway between Warrell Creek and Nambucca Heads
Project Verifier	For the purpose of the Project, this is Davis Langdon Australia Pty Ltd
Proof Engineer	For the purpose of the Project, Cardno Pty Ltd
Subcontractor	Organisation that contracts with a principal contractor as the client to carry out construction and related services
Supplier	Organisation that contracts with a client to provide a product and / or service.
TeamBinder	The project Electronic Document Management System software
Worker	Is anyone who carries out work for a PCBU and includes: an employee, contractor or sub-contractor or an employee of, labour hire personnel, apprentice or trainee, work experience student

1. Introduction

The Pacific Highway Warrell Creek to Nambucca Heads Upgrade project (the Project) is being designed and constructed in a joint venture consisting of ACCIONA Infrastructures Pty Ltd (ACCIONA) and Ferrovial Agroman (Australia) Pty Ltd (Ferrovial), in liaison with various other pre-qualified construction contractors, with overall project management and site supervision of the project by Roads and Maritime Services (RMS).

1.1. Purpose

The purpose of the Sediment Basin Management Procedure (the Procedure) is to detail the actions to be taken in the construction and maintenance of sediment basins including steps to be taken prior to any discharge. The procedure outlines the methodology for dewatering of excavations and acid sulfate leachate ponds on the site. Adherence to the methodology outlined in procedure will ensure that works are carried out in accordance with industry standard and environmental conditions.

1.2. Scope

The Procedure applies to the following works:

- Sediment basin management and maintenance; and
- Dewatering of construction water and acid sulfate leachate ponds.

1.3. Objectives

The objectives of this Procedure are to:

- Ensure all Project personnel are aware of the requirements of this procedure
- Detail personnel responsible for undertaking actions relating to sediment basin, construction dewatering and acid sulfate leachate management on the site;
- Providing a uniform, controlled methodology and clear criteria for water releases from the site;
- Implement industry standard methods for managing sediment basins and dewatering in accordance with best practice guidelines such as Managing Urban Stormwater Soils and Construction (Landcom 2004) and Acid Sulfate Soil Manual (ASSMAC 1998);
- Ensure water discharges from site are compliant with:
    - the Environment Protection Licence;
    - Soil and Water Management Plan; and
    - Acid Sulfate Soil Management Plan; and
- Comply with environmental requirements of the Project, including all legal requirements and contractual obligations.

Overall the procedure shall ensure appropriate environmental protection measures are in place relating to sediment basins, construction water management (dewatering of excavations and the like) and management of leachate collected in ponds from acid sulfate material stockpiles.

1.4. References

The following documents are available in Teambinder and should be read in conjunction with this Procedure.

- Minister's Conditions of Approval;
- EPBC Referral (RMS);
- Soil and Water Management Plan (SWMP);
- Acid Sulfate Materials Management Procedure (Appendix C of the SWMP)
- Construction Environmental Management Plan; and
- Managing Urban Stormwater Soils and Construction (Landcom 2004).

Enquiries in relation to the CEMP and all Sub plans should be notified to the Environmental Manager.

2. Sediment Basin, Construction Water and Acid Sulfate Leachate Management Procedure

2.1. Scope

This procedure will ensure that sediment basins are constructed and managed in accordance with relevant legislation, standards and best practice guidelines to minimise the potential impact of dewatering sediment basins, Acid Sulfate Leachate ponds and construction water to the local environment.

A quick reference flow chart is provided as Figure 2.1 at the end of this document to provide a simple guide to the more detailed discussion provided below.

2.2. Record Keeping

Relevant data will be recorded on the AFJV Water Release Approval available in Appendix A and Sediment Basin Management Record Sheets available in Appendix B and given to the Environmental Manager (EM). All discharges including the final results will be recorded on Water Release Register. Sediment Basin Management Record sheets will be kept to track the treatment of each sediment basin and ensure efficient use of flocculants and treatment chemicals.

2.3. Location and Construction of Sediment Basin/Pond

Refer to the Soil and Water Management Sub-plan (SWMP), site Environment Protection Licence (EPL), Erosion Sediment and Control Plans (ESCPs) and Progressive Erosion and Sediment Control Plans (PESCP's) and also relevant Environmental Work Method Statements (EWMSs) for the location of all sediment basins.

If a sediment basin is considered necessary in a new location not covered in the SWMP, EPL, ESCP or EWMS, then an updated ESCP will need to be prepared and any proposed discharge points will also need to be added to the EPL. This process will take 7 days (timing to updated once the EPL is approved), therefore basin location and the preparation of PESCP's should be considered well in advance of each stage of construction. If a sediment basin is required and is not included in the EPL, then discharge to the environment from this basin shall be avoided until the discharge location has been included in the EPL as a licensed discharge point. In this situation any water in the basin can be pumped to a licensed discharge point for release, used for dust suppression or discharge must meet the same water quality of the receiving waters. Any discharge from unlicensed sediment basins will not be covered by the EPL until it is added to the license.

For each sediment basin the location and design detail (volume – length, width & depth) will be outlined in the relevant PESCP design drawings. The Soil Conservationist or qualified CPESC (Certified Professional in Erosion and Sediment Control) will be consulted when designing new basins to ensure the following criteria are met:

- All requirements of Managing Urban Stormwater, Soils & Construction Volume 1 (Landcom, 2004) and Volume 2D (DECC 2008) will be followed;
- Roads and Maritime Specification – G38 Soil and Water Management (Soil and Water Management Plan)
- The Pacifico Soil and Water Management Sub-plan;
- Impervious clay to be used in construction of the embankments;
- Embankments are to meet required compaction levels – 95% MMD is considered standard; and
- Spillways are to be appropriately designed to cater for the nominated rainfall event.

It is noted that sediment basins may be oversized in some locations to capture run-off for reuse in construction. Where the basin is oversized, appropriate markers will be placed in the basin to ensure adequate capacity for rainfall events is maintained.

The sediment basin inlets will be loaded with gypsum to pre-treat run-off before it enters the basin during rainfall. The internal sides of the basin will also be layered with gypsum after the basin is commissioned.

2.4. Monitoring

The AFJV Environmental Coordinator (EC) will undertake the following inspections and testing of sediment basins:

- Weekly during dry weather and will be recorded on the Weekly Environmental Inspection Checklist, any rectification actions will be recorded on the Environmental Action and Maintenance Record and provided to the area Foreman or Superintendent for action.
- Additionally after a storm event (no later than 24 hours or the next working day). Inspections will assess the integrity of the basin and the water holding capacity available within the basin.
- After rainfall events, prompt testing of sediment basin water and dewatering (once acceptable water quality has been achieved) will occur to ensure adequate capacity for the next storm event is available. Note that sediment basins must have 100% of their settling zone design capacity (5 day, 80%ile design capacity for general sediment basins or 85%ile design capacity for basins in sensitive areas) within 5 days of a rainfall event. Markers will be present to indicate adequate capacity levels are available, as well as monitor the volume of runoff into the sediment basin in order to assist in flocculation and time to discharge. Note that the water may be used for construction purposes, such as dust suppression or compaction. In some instances, the design capacity of the basins may be reduced to a 2-3 day event to allow for sediment basins to be fit within the alignment. This will only be undertaken in consultation with the EPA.
- During initial monitoring, a correlation will be established between TSS and turbidity so that turbidity can be used as a field indicator for TSS prior to discharge. Initially, TSS samples will be taken and analysed by a NATA accredited laboratory. Once a suitable correlation can be inferred, the use of Turbidity in lieu of TSS must be approved by the EPA prior to use as a field indicator. Ongoing verification of TSS and Turbidity will be undertaken, see Section 2.5 below.
- Prior to discharge, pH and turbidity will be measured. pH and Turbidity measurements will be taken by a calibrated field water quality probe. Visible oil and grease will also be recorded and a laboratory sample taken if an oily sheen is visible. Records must be maintained to for the purpose of the project EPL, the laboratory Chain of Custody and the Water Release Approval/Water Release Register should provide this information. The required records include:
    - The date(s) on which the sample was taken;
    - The time(s) at which the sample was collected;
    - The point at which the sample was taken; and
    - The name of the person who collected the sample.
- Results must meet the criteria set out in the Table 2.1 prior to discharge.
- Samples should be taken from approximately 15-30cm below the surface of the water in bottles appropriate for the analytes to be tested, with the mouth of the bottle facing the direction of flow (if applicable).
- Prior to discharge from ASS leachate ponds, water samples shall be sent to the laboratory to be tested for pH, TSS, Salinity, heavy metals (Refer to Table 2.1).

- Water quality management records will be recorded on the Water Release Approval Form and the Water Release Register. A Sediment Basin Management Record Sheet will also be completed for each basin and will include details such as:
  - times of flocculant addition,
  - amount of flocculant or pH correcting chemicals used,
  - water quality monitoring details (time, tests undertaken, results); and
  - time of commencement and cessation of discharge.

2.5. Water Quality Criteria for Discharge

Before any water can be discharged from sediment basins or acid sulfate leachate ponds to waterways it must meet the following criteria in Table 2.1. Water from open excavations should be used for dust suppression, assisting vegetation growth and to assist in earthworks meeting engineering specifications.

It is noted that the Project will be undertaking irrigation of run-off captured in sediment basins to nearby vegetation and grassed paddocks in accordance with the EPL. Water for irrigation will be required to meet the criteria outlined in Table 2.1 prior to discharge. Irrigation areas will be determined based on the soil characteristics, suitability of the landscape to receive irrigation water and proximity to adjacent watercourses. Locations of irrigation areas will be clearly identified and personnel trained in the appropriate use of these areas (such as not over-irrigating and ensuring that no run-off is caused).

Table 2.1: Sediment Basin and Discharge Criteria

Sediment Basin Discharge	ASS Leachate Ponds Discharge Criteria	Irrigation Criteria
• pH between 6.5-8.5; • TSS <50mg/L or equivalent Turbidity (NTU) as confirmed with the EPA; and • Nil visible oil and grease (if visible <10mg/L from lab sample)	• pH between 6.5-8.5; • TSS <50mg/L • Conductivity < 1500 micro Siemens per centimetre for estuarine environments and < 200 micro Siemens per centimetre for freshwater environments • Oil and Grease – nil visible (if visible <10mg/L from lab sample) • Total Iron <0.3 mg/L (if pH is <6.5 or >8.5)* • Total Aluminium <0.055 mg/L (if pH is <6.5 or >8.5)*	• pH between 6.5-8.5; • Nil visible oil and grease (if visible <10mg/L from lab sample).

*Iron and Aluminium samples are to be taken for all discharges from ASS leachate ponds and the EPA is to be notified of any breaches of Aluminium/Iron with 3 working days of the completion of testing. The correlation between dissolved Iron and Aluminium and pH will be subject to ongoing review with the EPA based on test results.

Quality assurance testing will be undertaken to verify the correlation between TSS and turbidity and to ensure the field probe is functioning correctly. A grab sample will be taken every 10th field test and sent to the laboratory. The laboratory sample will be tested for pH, TSS and turbidity. This will verify the use of turbidity as a field indicator and also allow for field probe results to be compared and ensure the field probe measurements are correct.

All equipment will be maintained and calibrated as per manufacturer’s specifications.

2.6. Treating Water

If all the criteria above are met, then the water is suitable for discharge. If the criterion is not met, the water will have to be treated in accordance with the treatment methods listed below:

<table>
<tr><td>pH Levels</td><td>If the pH of sediment pond water is outside the range 6.5-8.5 it needs to be neutralised. If the water is above 8.5, acid is used to lower the pH, if the water is below 6.5 a base is used to raise the pH; and
To treat water with acid, safety requirements must be followed as outlined in relevant MSDS’s and EWMSs.</td></tr>
<tr><td>If pH is >8.5: Treatment to lower pH</td><td>Hydrochloric acid (9.9%) is used to lower pH. A 300mL dose of acid lowers 40,000L of water by a pH of approximately 0.1.
Dilute acetic acid (in the form of vinegar) is a benign acid that may also be used to reduce pH in captured water.</td></tr>
<tr><td>If pH is <6.5: Treatment to raise pH</td><td>For water where pH is below 6.0 add agricultural lime to raise the pH. Dosing rates for lime should be taken from the supplier. Rates for pure lime ($CaCO_3$) to raise the pH of water to 7 are as follows:
<table>
<tr><th>Current water pH</th><th>Lime to neutralise 1000 KL of water (kg pure $CaCO_3$)</th></tr>
<tr><td>3.5</td><td>16</td></tr>
<tr><td>4.0</td><td>5</td></tr>
<tr><td>4.5</td><td>1.6</td></tr>
<tr><td>5.0</td><td>0.5</td></tr>
<tr><td>5.5</td><td>0.16</td></tr>
<tr><td>6.0</td><td>0.05</td></tr>
<tr><td>6.5</td><td>0.016</td></tr>
</table></td></tr>
<tr><td>Suspended Solids/Turbidity</td><td>If the water is visibly dirty and testing shows it is not suitable for discharge it will need flocculation prior to re-testing and subsequent discharge. Treating water with flocculant (e.g. gypsum) will make the sediments drop to the bottom. (An appropriate flocculant will be chosen after a trial has been undertaken to determine the most efficient product, this will be undertaken in consultation with EPA, RMS and ER.)
Dosing rates of 30kg per 100m^3 will be used initially, with adjustments to quantities for effective flocculation as required. Application methods will be applied as per methods recommended Department of Housings Managing Urban Stormwater, Soils & Construction (2004). Note that an even application over the captured water is essential for effective flocculation.
Other flocculants may be used following appropriate RMS and EPA approval. Full toxicity information for the flocculant is required before it will be considered for use.
Trials to confirm the most appropriate flocculant will be conducted to ensure the most effective product is used.</td></tr>
</table>

Hydrocarbons	• If an oily sheen is present on the surface of the water, a hydrophobic oil boom (or other suitable device) will be used to skim off the sheen. • where considerable volume of oil is on the surface, it can be removed by a liquid waste contractor and disposed of at an appropriately licensed facility approved by the Site Environmental Representative.
Metals	• Consult with the EC / EM for treatment options for heavy metals.

Once the water has been flocculated and appears clean, the EC must be contacted to re-test the water.

If the above criteria are not met, the EC will advise the Foreman or his delegate that further treatment and testing is necessary.

2.7. Discharging Water

Once approval has been given, water may be discharged as directed. The method for discharge will depend upon the design of the sediment basin. Generally, discharge will either involve pumping, decanting or siphoning. The following tasks should be implemented prior to and during water discharge:

- Always check the discharge point will not result in scour or erosion when the water is released. The EC is to re-test the pH and turbidity (NTU) in-situ immediately prior to discharge. Where possible water is to be used for construction, such as dust suppression and watering of vegetation (the 5 day discharge period must be observed to ensure adequate capacity prior to the subsequent rainfall event).
- Only staff members who have been trained and authorised to release the sediment basin are to undertake discharge.
- If sedimentation basins are to be pumped out rather than discharged through a siphon or low flow outlet, a float will be attached to the hose to ensure that sediment on the basin floor is not sucked through the pump. The basin is to be continuously monitored during discharge.
- Pumps must only be operated by dedicated dewatering crews toolboxed on this procedure. During dewatering pumps must be supervised at all times to ensure that sediment is not picked up during discharge and water is discharged through ERSED controls.
- The Water Release Register will be completed when treated water is discharged from the basin.

It is noted that water reused for dust suppression in water carts does not require water release approval.

Construction water that is to be discharged to land will be within the areas approved in the EPL. A map of the licensed locations for discharging to land will be available to those responsible for dewatering. All water released to irrigation areas must not cause run-off into waterways or drainage lines. Personnel operating the irrigation area must regularly monitor dewatering to ensure no run-off is occurring.

Sediment laden water accumulated in trenches or excavations on site will not be discharged within 100m of any waterway or 200m of a wetland or spring. Any off-site dewatering will be manned at all times to ensure that quality of the water being released does not change.

There will be no release of site stormwater runoff that has been in contact with any chemical contaminants at the site. Contaminated runoff is to be captured, tested and classified and disposed of offsite by an appropriately licensed waste disposal contractor to a facility approved by the Site Environmental Coordinator.

2.8. Dewatering Pump Sentry

Any off-site dewatering activities must be under constant supervision by a nominated "Pump Sentry" to prevent the discharge of dirty water. If pumping is used, the pump is to be switched off before dirty water or sludge is discharged from the bottom of the basin. A concrete plinth or similar physical barrier may also be installed within the basin to prevent highly concentrated sediment from being drawn from the bottom of the sediment basin as the clear water becomes drawn down. The Pump Sentry must receive training and will be provided with a hardhat sticker prior to commencing dewatering. They must also have read and understood the relevant SHEWMS for the dewatering activity.

Basin dewatering will cease immediately if any negative environmental impact such as flooding, erosion or dirty water discharge is observed.

Any observations made should be recorded on the Water Release Approval form and kept on file.

2.9. Maintenance of Sediment Basins/Ponds

Maintenance of the sediment basins shall be ongoing for the duration of the Project and shall comprise the following:

- A marker will be installed inside the basin to mark the sediment storage capacity limit. Once this marker is reached and/or where there is a large build-up of sediment at the basin inlet, sediment will be removed.
- Sediment that is removed from basins shall be disposed of at locations as approved by the Environmental Coordinator and where it will not flow off site, sludge material will be appropriately stabilized.
- The results of maintenance inspections shall be recorded on the Weekly Environmental Site Inspection Checklist and any actions recorded on the Environmental Action and Maintenance Record.

2.10. Storage and Handling of Flocculants

Gypsum and agricultural lime will be stored on site as either bagged or bulk product. Storage of bulk gypsum and agricultural lime will be covered, within erosion and sediment controls in a position where run on water will not erode the stockpile.

All treatment chemicals particularly acids and basics will be stored in appropriately bunded and covered locations that are locked to prevent unauthorized access. Requirements of the Material Safety Data Sheets (MSDSs) will be met to ensure that storage with other chemicals will not result in safety issues.

All chemicals on site will be stored with MSDSs for ease of reference in the event of a spill or irritation/injury to handlers.

2.11. Training and Awareness

There will be three training sessions available for personnel. The first training session will include details of the Water Release Approval process and will cover the project obligations for dewatering from site. This training will be provided to all Supervisors, Superintendents, Environmental personnel and any relevant Work Crew members.

The second training session will include the requirements of sediment basin treatment and dewatering and will be provided to the Environmental team and Environmental Work Crew employees directly involved in the treatment and release of water, specifically from the Project Sediment Basins.

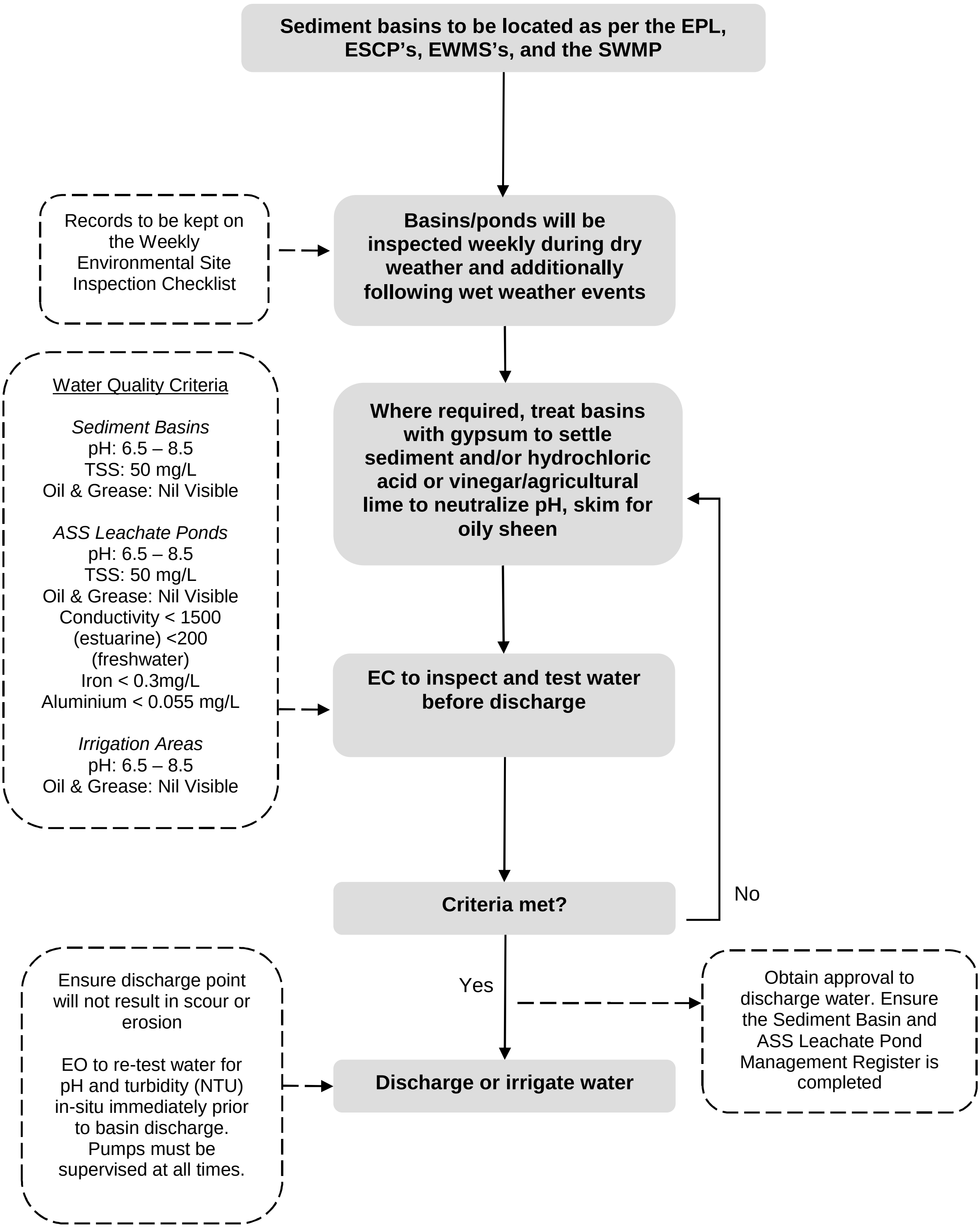
The third training session will be a toolbox talk undertaken with workforce employees that are responsible for monitoring pumps during dewatering activities. These employees will be known as "Pump Sentries" and will be provided with a hardhat sticker once they have undergone the specific toolbox talk training.

The AFJV EC will be responsible for preparing, scheduling and delivering the training session.

Training, instruction and equipment familiarisation for environmental personnel undertaking water quality monitoring, equipment calibration and maintenance will be the responsibility of the Environmental Manager. This will be completed prior to the initial use of equipment or as new equipment arrives on site.

Records of all training and competencies will be recorded on the site training register, attendance forms and toolbox records will be kept by the AFJV EC.

Figure 2.1: Sediment Basin Management and Discharge Procedure Flow Chart



3. Stakeholder Consultation

This document will be provided as an Appendices to the Soil and Water Management Sub-plan. This document will be reviewed by RMS and the ER prior to review by the EPA and the Department of Planning.

4. Procedure Review

The procedure will be regularly reviewed as part of the CEMP audit requirements. This document will be updated when needed in response to audit findings or changes to site conditions.

The Environmental Manager in consultation with RMS and the ER, will modify the procedure where improvements are identified.

Appendix A – Water Release Approval Forms

Water Release Approval – to Waters

Project: WC2NH **Project No:** **Date:**

Location of Sediment Basin / Dammed / Retained Water:
e.g. Sediment Basin name, drain, excavation description (including chainage)

Approx. Volume to be discharged :

Proposed Release Location:
e.g. grassed area, drain. Attach map as necessary.

Site Environmental Representatives Initial to Confirm Release / Actions:

Parameters	Release Criteria	Recorded Values	Acceptable / Actions Required to Meet Criteria	Comments
Time	N/A			Ensure pumping is supervised AT ALL TIMES Ensure that NO SCOURING occurs at outlet STOP PUMP/S if water quality change is observed Pump inlet/s to be floated or in perforated container Contact Enviro staff when water level reaches 0.4m PHONE: **Discharge Conditions:**
pH	6.5 to 8.5			
Turbidity – sediment basin discharge	TBA			
Total suspended solids (lab results)	< 50 mg/L			
Petro-hydrocarbons	No visible films (if visible <10mg/L from lab sample)			
Other pollutants	None noted			

Acid Sulfate Soil Treatment Ponds	(include the above parameters)		
Aluminium (dissolved) (lab results)	< 0.055 mg/L		
Conductivity	TBA – EPL licence		
Iron (dissolved) (lab results)	<0.3 mg/L		

Testing Completed By:
Name of Tester

Actions / Directions accepted and understood:
Signature of Discharge Supervisor

Water Release Approval – Land Irrigation

Project: WC2NH **Project No:** **Date:**

Location of Sediment Basin / Dammed / Retained Water:
e.g. Sediment Basin name, drain, excavation description (including chainage)

Approx. Volume to be discharged :

Proposed Release Location:
e.g. grassed area, drain. Attach map as necessary.

Site Environmental Representatives Initial to Confirm Release / Actions:

Parameters	Release Criteria	Recorded Values	Acceptable / Actions Required to Meet Criteria	Comments
Time	N/A			Irrigation must only occur to the designated irrigation areas as described in the EPL. Irrigation must be set to a given volume and this volume must be checked. The Discharge Supervisor is to check on the irrigation
pH	6.5 to 8.5			
Petro-hydrocarbons	No visible films (if visible <10mg/L from lab sample)			

Other pollutants	None noted			every 0.5hr to ensure there is no run-off occurring. If there is any sign of vegetation damage, soil erosion or scouring, switch off irrigation pump immediately. Phone Environmental Coordinator for assistance. PHONE: **Discharge Conditions:**

Testing Completed By:
Name of Tester

Actions / Directions accepted and understood:
Signature of Discharge Supervisor

Appendix B Sediment Basin Management and Dewatering Procedure

Sediment Basin Management and Discharge Sheet

Project: WC2NH	Project

All Construction Water discharges are to be conducted in accordance with the Project **Sediment Basin Management and Discharge Procedure WC2NH-EN-SW-PRO-0005**

Date Inspected:	**Basin/discharge point ID:**	**Location/Chainage:**

Date of last rainfall event:	Amount of rainfall received:
How full is the basin in %?	Quantity of water in basin prior to treatment:

Basin Monitoring Prior/During Treatment					
What is the turbidity reading of the basin? (Flocculate basin turbidity TBA NTU)	: NTU				
What is the pH of the basin? Required range: 6.5 – 8.5pH (Consider pH correction treatment)	: pH Detail any actions taken here (Date; Lime / Acid – Kgs?):				
How much flocculant was added? - 320kg Gypsum/ ML	Date	Type of Floc	Amount of Floc mixed	Amount of fresh water mixed	Turbidity 24hrs after treatment:
Is Basin Ok to Discharge??	**Y/N** **If Yes - Go to next section.** **If No - Repeat treatment process until basin ok to discharge**				

Basin Monitoring After Treatment Prior to Discharge			
Post Treatment testing:	: Date	:NTU	:pH
	Visible Oil/Grease: Y / N		
Laboratory TSS Result: (if applicable)	mg/L		
Time and Date valve / pump opened for discharge:	:Time	:Date	
	:Time	:Date	
	:Time	:Date	
Time and Date valve / pump closed after discharge?	:Time	:Date	
	:Time	:Date	
	:Time	:Date	
Number and size of pump used for discharge	Size: No.	No.	Size:
Supervisor responsible for discharge:	Name:		

Discharge to (please circle one):	Creek / Pump out for dust management / Land Irrigation Details:
Any other comments? (E.g next rainfall predicted? If rainfall received during treatment period start a new sheet)	Note here if rainfall received (that may cause run-off) during treatment period:
Environment Officer: **Signature:**	**Date:**

Appendix I
Stockpile Management Protocol

APPENDIX I

Stockpile management protocol

November 2014

Document control

File name	WC2NH-EN-PRO-0006 Appendix I Stockpile management protocol rev 0
Report name	Stockpile management protocol
Revision number	0

[signed]	*[signed]*	*[signed]*
Jose Miguel San Martin	Noelene Rutherford	Chris Clark
AFJV Project Director	AFJV Environment Manager	Roads and maritime Senior Project Manager

Revision history

Revision	Date	Description	Approval
A	20 Aug 2014	Issued for Roads and Maritime review	
B	26 Sep 2014	Issued addressing Comments	
C	17 Nov 2014	Updated to address Roads and Maritime Comments	
D	27 Nov 2014	Updated with further comments from Roads and Maritime	
0	10 Dec 2014	Finalised and Approved	DPE

Contents

1. Introduction

There are no restrictions on the distribution/circulation of this Protocol within the Warrell Creek to Nambucca Heads Project.

2. Purpose

This protocol outlines the locational criteria used to guide the placement of temporary stockpiles and provides both standard and site-specific mitigation measures to be implemented to minimise impacts on the environment. Stockpiles sites may typically be required to store material including, but not limited to:

- Temporary storage of excavated material to be used in fill embankments and other design features.
- Acid Sulfate Material (ASM) subject to treatment prior to reuse.
- Arsenic rock prior to reuse.
- Temporary storage of excavated material unsuitable for reuse in the formation.
- Excess concrete, pavement, rock, steel and other material stored for either future use in the Project or prior to removal from site.
- Topsoil, mulch, excess timber for landscaping and revegetation works.

Temporary stockpiles would be removed for re-use within the project or disposed off-site.

Note, the process for monitoring and managing spoil and fill including details of how excavated material would be handled, stockpiled, reused and disposed is detailed in Appendix B of the Soil and Water Management Sub Plan and the Waste and Energy Management Sub Plan. This includes ensuring the offsite disposal of materials to an appropriately licensed facility or in accordance with the waste exemptions; and records including section 143 certificates to be completed and retained for any material to be disposed of outside of the project boundary.

3. Induction / Training

Personnel involved in planning or managing stockpiles will be trained in the requirements of this Protocol. Training will also include inductions, toolbox talks, pre-starts and targeted training as required.

4. Scope

This protocol is relevant to the planning, placement and management of all stockpiles on/related to the Warrell Creek to Nambucca Heads Project.

5. Stockpile location criteria

Stockpiles on the Project will be located according to the following criteria:

- Be located at least 5 metres clear of all areas of possible concentrated water flow.
- Be located at least 10 metres from a waterway (except mulch).
- Mulch stockpiles are to be located more than 20m from a watercourse including floodplains (if in place for <1 month).
- Mulch stockpiles are to be located more than 50m from a watercourse including floodplains (if in place for >1 month).
- Be located on land with slopes less than 10%.
- Have ready access to the road network or direct access to the construction corridor.
- On land that does not require the removal of threatened species, Endangered Ecological Communities (EECs) or roosting habitat for listed threatened fauna species or native vegetation clearing beyond what is already required for the Project.
- Be located in areas of low heritage conservation significance (including identified Aboriginal cultural value) and not impact on heritage sites beyond those already impacted by the project.
- Be located within the approved EPL boundary (if the stockpile is located outside of the EPL a variation to the licence Premise Maps is required)

A copy of the Stockpile Site register required for the Project which demonstrates compliance with the above location criteria is provided in Table 1. The register will be kept updated on site when stockpile areas have been designated.

Where the stockpile location is either outside of the Project corridor, or does not meet all of the stockpile criteria, a Minor Consistency Review (using the Roads and maritime Minor Consistency Review template) will be undertaken and approved by RMS prior to the establishment of the stockpile. This assessment will include as a minimum a review of heritage, ecological and water quality issues, distance from receivers and may also detail ownership and lease agreements.

6. Protocol

Prior to the establishment of any stockpile on site as part of the Project, ensure that:

1. The location of the stockpile is considered against the site selection criteria contained in Section 5 and Table 1 and that detail of how the stockpile site meets each of the criteria is provided.

2. Site-specific mitigation measures, where they are necessary to further reduce impacts, are identified and detailed in Table 1.

3. Mitigation measures for each stockpile site include as a minimum:

- The perimeter of the stockpile (excluding vehicle access points) will be delineated with a bund (made out of earth/RAP or similar) or other type of fencing or barrier such as sediment fence.
- Materials will not be stockpiled under the drip line of trees or native vegetation to be retained, and never pushed up around the base of trees.
- Erosion and sedimentation controls will be erected between the site and any drainage lines or down-slope areas, an Erosion and Sediment Control Plan will be prepared or adjustments made to the existing Progressive Erosion and Sediment Control Plan.
- A diversion bund will be installed on the uphill side of the stockpile to divert water around the site.
- Stockpiles of topsoil containing noxious weeds will be kept separate and signage placed, the topsoil may be buried on site in noise/visual mounds or treated in-situ.
- Mulch stockpiles are to be managed in accordance with the Roads and Maritime Environmental Direction Management of Tannins from Vegetation Mulch, which requires all mulch stockpiles to be bunded and a sump provided to pump out excess tannin impacted leachate. Mulch must be stockpiled away from drainage lines and outside of low lying areas.
- Short-term stockpiles will be covered with plastic or kept damp to control dust where required. Long-term stockpiles (i.e. to remain for greater than 4 weeks) will be stabilised with cover crop or similar within 7 days of the completion of stockpiling as per the mitigation measures of Table 6-1 of the SWMP.
- Potentially affected residents within 200 metres of stockpiles will be notified regarding the location of the stockpile areas, the potential impact from constructing the stockpile (including visual and odour impacts) and proposed mitigation measures. Should a resident express concern or are not satisfied with the proposed mitigation measures, the stockpile location or associated mitigation measures would be revised accordingly.
- Where stockpiles are located within 200 metres of residences, these stockpile areas will be monitored for odour. If nuisance odours are generated and are impacting sensitive receivers, odour control measures will be implemented, if feasible and reasonable. If this is not possible, material found to be emitting odours will be relocated to an alternative stockpile location away from residences.
- ASM, Arsenic rock or mulch stockpile management, including leachate containment, will be in accordance with the SWMP.
- Dust management measures (including for vehicle movements associated with stockpiling activities) will be implemented in accordance with the requirements of the Project Air Quality Management Sub-Plan.
- All exit points from the stockpile area to public roads are to be stabilized and include rumble pads to prevent mud tracking.
- As per the mitigation measures in Table 6-1 of the SWMP, the rehabilitation of the stockpile areas following their removal will be as follows:
    - Where no further stockpiling or work is proposed on the disturbed site, they would be rapidly and progressively stabilized and/or rehabilitated as they are completed. Rehabilitation would aim to achieve at least 70% cover (ie C-factor of 0.05 or less) within 60 days.

- Where further works or stockpiling is proposed, temporary ground covers would be used for any temporary cessation in works in an area exceeding 20 days, to achieve at least 50% cover (i.e. a C-factor of 0.15 or less). This would apply to stockpile sites and other exposed areas and measures may include (but not limited to) biodegradable polymer soil binders, geotextile fabrics, erosion control blankets, temporary seeding and mulching.

4. In accordance with RMS Specification R44, topsoil stockpiles must:
   - be free from subsoil, other excavated materials, contaminated materials, refuse, clay lumps and stones, timber or other rubbish;
   - be trimmed to a regular shape to facilitate measuring with a height not exceeding 2.5m and batter slopes not steeper than 2H:1V;
   - have their batters track rolled or stabilized by other means; and
   - be sealed in accordance with Specification Roads and maritime D&C R178, to encourage vegetation cover.
   -
5. The AFJV Environmental Manager or approved delegate will sign off on the stockpile location against the protocol above.

Table 1 Stockpile requirements

Ref no.	Location (chainage)	Purpose	a) Be located at least 5 metres clear of all areas of possible concentrated water flow.	b) Be located at least 10 metres from a waterway (except mulch).	c) Be located on land with slopes less than 10%.	d) Have ready access to the road network or direct access to the construction corridor.	e) On land that does not require the removal of threatened species, EECs or roosting habitat for listed threatened fauna species	f) Be located in areas of low heritage conservation significance (including identified Aboriginal cultural value) and not impact on heritage sites beyond those already impacted by the project.	Site specific mitigation measures

Appendix J

Arsenic Rock Management Strategy

Pacific Highway Upgrade:
Warrell Creek to Nambucca Heads

APPENDIX J: Arsenic Rock Management Strategy
WC2NH-EN-SW-MPL_J Arsenic Rock Management Strategy Rev 0

Rev	Description	Originator	Reviewed	Approved	Date
A	Appendix J to the Soil and Water Management Sub Plan: Initial WC2NH Arsenic Rock Management Strategy	Coffey/Claudio Senese	Noelene Rutherford		
B	Updated to include Roads and Maritime and ER comments	Noelene Rutherford			
C	Updated to include further comments from Roads and Maritime the ER	Noelene Rutherford			
0	Finalised and Approved	Noelene Rutherford	RMS	DPE	10/12/14

Details of Revision Amendments

Strategy Control

The latest approved version of this Strategy will be available for all Project personnel on the Electronic Document Management System - TeamBinder. The functional manager will maintain, review and update this Strategy in accordance with the Revision requirements of the Construction Environmental Management Plan (Refer to section 1.6 of the CEMP).

Amendments

Each new revision to the Strategy will be distributed to all required personnel for review and approval.
The revision number is included at the end of the document number, which is noted in the footer of each page.
The document will be allocated a new revision number each time a change is made to the document.

When a new revision to the document is available, a notification email will be distributed to all project personnel by the Document Control Team advising of the update.

The functional Manager is responsible for the implementation and review of the Strategy. The Project Director will approve new revisions of the Strategy via the review and approval process as detailed in the Document Control Strategy.

<table>
<tr><th>Functional Manager Authorisation</th><th colspan="2">Distribution List</th></tr>
<tr><td rowspan="8">Name: Noelene Rutherford
Date: 10 December 2014
Position: Environment Manager
Signature: NRutherford
Comments: —</td><td>Project Director</td><td></td></tr>
<tr><td>Design Manager</td><td></td></tr>
<tr><td>Quality Manager</td><td></td></tr>
<tr><td>Procurement Manager</td><td></td></tr>
<tr><td>Construction Manager</td><td></td></tr>
<tr><td>Safety Manager</td><td></td></tr>
<tr><td>Commercial Manager</td><td></td></tr>
<tr><td>Environmental Manager</td><td></td></tr>
<tr><th>Project Director Authorisation</th><td>Finance Manager</td><td></td></tr>
<tr><td rowspan="9">Name: L. Guillermo Ripado
Date: 10/12/14
Signature:
Comments: —</td><td>Engineer Manager</td><td></td></tr>
<tr><td>Area Manager</td><td></td></tr>
<tr><td>Human Resources Manager</td><td></td></tr>
<tr><td>Site Superintendents</td><td></td></tr>
<tr><td>Roads and Maritime Services</td><td></td></tr>
<tr><td>IMS Manager</td><td></td></tr>
<tr><td>Other:</td><td></td></tr>
<tr><td></td><td></td></tr>
</table>

Contents

Terms and Abbreviations

AADJV	Arup and Aurecon Design Joint Venture
ACCIONA	ACCIONA Infrastructure Australia Pty Ltd
AFJV	ACCIONA and Ferrovial Joint Venture
AS/NZS	Australian and New Zealand Standard
ASM	Acid Sulfate Materials
ASMMP	Acid Sulfate Materials Management Plan
CEMP	Construction Environmental Management Plan
D&C	Design and Construction
DJV	Design Joint Venture
DoE	Department of Environment (Commonwealth)
EEC	Endangered Ecological Communities
EDMS	Electronic Document Management System (TeamBinder)
ENM	Excavated Natural Materials
EPBC	Environmental Protection and Biodiversity Conservation
EPRM	Excavated public road material
EWMS	Environmental Works Method Statement
Ferrovial	Ferrovial Agroman (Australia) Pty Ltd
GHD	GHD Australia Pty Ltd
ID Planning	ID Planning Pty Ltd
IMS	Integrated Management System
ISO	International Standards Organisation
KPI	Key Performance Indicator
MCoA	Minister's Conditions of Approval
MNES	Matters of National Environmental Significance
NSW	New South Wales
O&M	Operations and Maintenance
PCBU	Person Conducting a Business or Undertaking
PMT	Project Management Team
PV	Project Verifier
RMS	Roads and Maritime Services
SWMP	Soil and Water Management Plan (CEMP Appendix B4 Soil and Water Management Sub Plan)
VENM	Virgin Excavated Natural Materials
WC2NH	Warrell Creek to Nambucca Heads (the Project)
WEMP	Waste and Energy Management Plan (CEMP Sub plan)

Definitions

Client	An organisation inviting and receiving tenders and letting contracts. For the purposes of this project - Roads and Maritime Services
Contractor	An organisation that contracts with a client to carry out construction and related services. For the purposes of this Project - ACCIONA Ferrovial Joint Venture.
Davis Langdon	Davis Langdon Australia Pty Ltd
Deed	D&C Project Deed, IC-DC-C91-1, Pacific Highway Warrell Creek to Nambucca Heads
Design Joint Venture	Joint Venture consisting of Arup and Aurecon
Government Agency	NSW government department, authority, corporation or entity established by an Act of the NSW Parliament
Persons Conducting a Business or Undertaking	Is an employer, corporation, partnership, unincorporated association that has the primary duty of care for workplace health and safety - (AFJV and Contractors are a PCBU)
Principal Contractor	A person conducting a business or undertaking that commissions a construction project. For the purposes of this project - AFJV
Project	The design and construction of the upgrade to the Pacific Highway between Warrell Creek and Nambucca Heads
Project Verifier	For the purpose of the Project, this is Davis Langdon Australia Pty Ltd
Proof Engineer	For the purpose of the Project, Cardno Pty Ltd
Subcontractor	Organisation that contracts with a principal contractor as the client to carry out construction and related services
Supplier	Organisation that contracts with a client to provide a product and / or service.
TeamBinder	The project Electronic Document Management System software
Waterway	For the purposes of this Strategy a Waterway is defined as: (a) any Class 1 or Class 2 fish habitat waterways (as described in the NSW Fisheries guidelines); (b) any permanent or ephemeral drainage line with direct drainage to State Environmental Planning Policy No 14 Coastal Wetlands; and (c) waters that are used for the purposes of human consumption.
Worker	Is anyone who carries out work for a PCBU and includes: an employee, contractor or sub-contractor or an employee of, labour hire personnel, apprentice or trainee, work experience student

1. Introduction

The Warrell Creek to Nambucca Heads Pacific Highway Upgrade project (the WC2NH Project) is being designed and constructed in a joint venture consisting of ACCIONA Infrastructures Pty Ltd (ACCIONA) and Ferrovial Agroman (Australia) Pty Ltd (Ferrovial), in liaison with various other pre-qualified construction contractors, with overall project management and site supervision of the project by Roads and Maritime.

1.1. Project Background

The WC2NH project consists of the detailed design and construction of 19.6 km of new dual carriageway road on the Pacific Highway between the northern end of the existing Allgomera Deviation south of Warrell Creek and the southern end of the Nambucca Heads to Urunga Pacific Highway upgrade project west of Nambucca Heads. The project includes:

- 19.6 km of new divided dual carriageway;
- two grade separated interchanges at Warrell Creek and Bald Hill Road south of Macksville. Roads and Maritime is also investigating the provision of north facing ramps at North Macksville;
- longitudinal bridges across Upper Warrell Creek (including North Coast Railway Line), Williamson Creek, Warrell Creek, Nambucca River floodplain (2 of) and Nambucca River;
- overbridges on Rosewood Road, Albert Drive, Scotts Heads Quarry access road, Bald Hill Road, Old Coast Road South, Mattick Road and Old Coast Road North;
- an underpass at Cockburns Lane;
- local roads and drainage and fauna crossing structures; and
- associated infrastructure.

1.2. Purpose

This Arsenic Rock Management Strategy (the Strategy) forms Appendix J to the WC2NH Soil and Water Management Sub Plan (SWMP), as part of the Construction Environmental Management Plan (CEMP).

The Strategy details the actions that will be taken by ACCIONA Ferrovial Joint Venture (AFJV) to manage the identified areas of potential Arsenic Rock expected to be encountered as a result of natural arsenic mineralisation occurring within the project alignment, and ensure effective controls are established and maintained to manage potential environmental impacts during the construction of the WC2NH project. In particular, the Strategy prescribes how excavated material containing Arsenic Rock will be monitored, handled, stockpiled and reused on site as part of the construction earthworks.

It is noted that this document does not describe the level of Arsenic contamination and the potential environmental impacts, this is described in the technical documents listed below in Section 2.

1.3. Scope

This Strategy is applicable to all activities conducted by personnel on the Project that involve earthworks, including cut and fill management and temporary stockpiling. Relevant management measures identified in this Strategy will be incorporated into site or activity specific construction management plans and Environmental Work Method Statements (EWMS).

1.4. Objectives

The objectives of this Strategy are to:

- Identify Arsenic Rock issues potentially arising from the Project;
- Prescribe measures to be implemented for managing excavated material containing Arsenic Rock to avoid impact on the environment and local amenity; and
- Ensure all Project personnel are aware of the requirements of the Strategy.

2. References

The following documents are referenced in conjunction with this Strategy:

- Project Approval (Minister's Conditions of Approval up to Modification 6)
- Construction Scope of Works and Technical Criteria Appendix 4
- Construction Environmental Management Plan (CEMP)
- Soil and Water Management Sub-Plan (SWMP)
- Earthworks Management Plan
- Progressive Erosion and Sediment Control Plans (PESCPs)
- SWMP Appendix C - Acid Sulfate Material Management Strategy
- SWMP Appendix F - Unexpected Discovery of Contaminated Land Strategy
- SWMP Appendix I – Stockpile Management Protocol
- Waste and Energy Management Sub Plan

Technical Reports:

- Coffey Geotechnics. (2011). Pacific Highway Upgrade, Warrell Creek to Nambucca Heads – Stage 4 Geotechnical Investigations Contaminated Soils Investigation. Report Ref. GEOTLCOV024043AHBF.
- Coffey Geotechnics. (2011). Pacific Highway Warrell Creek to Urunga Upgrade Geotechnical Investigations – Contaminated Soils Investigation – Stages 1 and 2 Report. Report Ref. GEOTLCOV024043AB-BZ.
- Coffey Geotechnics. (2013). Pacific Highway Upgrade Warrell Creek to Nambucca Heads – Site Contamination Assessment for arsenic contamination AEC 2 and Cut 12, Bald Hill Road NSW. Report Ref. GEOTLCOV024043AH-CM.
- Coffey Geotechnics. 2013. Pacific Highway Upgrade - Warrell Creek to Nambucca Heads Geotechnical Investigations Report, Report Ref. GEOTLCOV024043AB-CH.
- Coffey Geotechnics. (2013). Warrell Creek to Nambucca Heads Pacific Highway Upgrade - Cut 12
- Arsenic Screening Results for Surface Soils Report. Report Ref. GEOTLCOV024043AJ-DD.

These documents are available in Teambinder. Enquiries in relation to the CEMP and all Sub plans and procedures should be notified to the Environmental Manager.

3. Legislative and other Requirements

3.1. Legislation

The key legislation relevant to arsenic rock materials management includes:

- Environmental Planning and Assessment Act, 1979 (EP&A Act)
- Protection of the Environment Operations Act, 1997 (PoEO Act)
- Contaminated Land Management Act, 1997

- Waste Avoidance and Resource Recovery Act 2001
- Resource Recovery Exemptions of the PoEO (Waste) Regulation 2005
- Fisheries Management Act, 1994.

3.2. Minister's Conditions of Approval

The CoA relevant to this Strategy is listed Table 1 below.

Table 1: CoA relevant to this Strategy

CoA	Condition requirements	Details of Compliance
B 30 (e) (iii) In part	Prior to the commencement of construction, the Proponent shall prepare and (following approval) implement a Construction Environmental Management Plan for the Project. The plan shall outline the environmental management practices and procedures that are to be followed during construction and shall be prepared in consultation with the EPA, DPI and relevant council and shall include but not necessarily be limited to............. (e) an environmental risk analysis to identify the key environmental performance issues associated with the construction phase and details of how environmental performance would be monitored and managed to meet acceptable outcomes including what actions will be taken to address identified potential adverse environmental impacts (including any impacts arising from concurrent construction works with adjacent Pacific Highway Upgrade projects, as relevant). In particular, the following environmental performance issues shall be addressed in the Plan: (i) measures to monitor and manage dust emissions including dust generated by haulage trucks, traffic on unsealed public roads and stockpile management; (ii) measures to monitor and manage waste generated during construction including but not necessarily limited to: general procedures for waste classification, handling, reuse, and disposal; how contaminated materials would be handled and disposed; use of secondary waste material in construction wherever feasible and reasonable; procedures for dealing with green waste including timber and much from clearing activities; and measures for reducing demand on water resources (including the potential for reuse of treated water from sediment control basins); (iii) measures to monitor and manage spoil and fill including details of how excavated material would be handled, stockpiled, reused and disposed and a stockpile management protocol detailing location criteria that would guide the placement of stockpiles and minimum management measures (including rehabilitation) that would be implemented to avoid/ minimise amenity impacts to surrounding residents and environmental risks (including to surrounding watercourses);	This Strategy in regards to the measures to monitor and manage spoil and fill including details of how excavated Arsenic Rock will be monitored, handled, stockpiled, reused and disposed (if required). Also refer to the Stockpile Management Protocol detailing location criteria that would guide the placement of stockpiles and minimum management measures including rehabilitation) that would be implemented to avoid / minimise amenity impacts to surrounding residents and environmental risks.

CoA	Condition requirements	Details of Compliance
	(iv) measures to monitor and manage hazard and risks including emergency management; and (v) the issues identified in condition B31	
B 31 (d) In part	(d) a Construction Water Quality Management Plan to manage surface water quality and groundwater impacts during construction of the project. The Plan shall be developed in consultation with EPA, DPI (Fisheries and NOW) and include, but not necessarily be limited to: (i) a contingency plan, consistent with the Acid Sulfate Soils Manual, to deal with the unexpected discovery of actual or potential acid sulfate soils;………… (iii) details of how construction activities would be managed and mitigated to minimise erosion and sedimentation consistent with condition C17; (iv) where construction activities have the potential to impact on waterways or wetlands (through direct disturbance such as construction of waterway crossings or works in close proximity to waterways or wetlands), site specific mitigation measures to be implemented to minimise water quality, riparian and steam hydrology impacts as far as practicable, including measures to stabilise bank structure and rehabilitate affected riparian vegetation to existing or better condition (including relevant performance indicators and monitoring requirements). The timing of rehabilitation of the waterways shall be as agreed to with DPI (Fisheries and NOW) shall be identified in the plan; (v) construction water quality monitoring requirements consistent with condition B17	This Strategy prescribes the requirements to ensure the requirements of the Soil and Water Management Plan (CEMP Sub Plan) and associated procedures and protocols are complied with when managing Arsenic Rock encountered during earthworks.

Table 2 – Scope of Works and Technical Criteria requirements

Clause	Clause Requirements	Details of Compliance
4.32	Further to the requirements of condition B30(e). and condition B31(d). of the Planning and Infrastructure Minister's Approval, the Contractor must prepare and implement an Arsenic Rock Management Strategy as part of the Construction Environmental Management Plan. The Arsenic Rock Management Strategy must be used to manage the cuttings and material excavated from the cuttings between Chainage 48km400 and Chainage 48km950, Chainage 49km200 and Chainage 49km650 and Chainage 57km800 and Chainage 58km000. The Arsenic Rock Management Strategy must be prepared in consultation with EPA, DPI (Fisheries) and the Environmental Representative. The Arsenic Rock Management Strategy must include: (a) the materials management practices detailed in Table 4.4 and a materials tracking register that details quantities and placement locations of material managed under the strategy.	Details of the locations are included in this Plan. SWTC requirements are addressed in Table 2

Clause	Clause Requirements	Details of Compliance
	(b) measures to minimise erosion and sedimentation. The measures must be applied within the cuttings, at stockpile sites that will receive, store or process material excavated from the cuttings and at the final location of the material within the Project Works. The measures must: (i) be developed in consultation with the Contractor's project soil conservationist and be consistent with best practice management; (ii) be included on progressive erosion and sediment control plan(s) which must be updated regularly; (iii) include the application of a suitable soil binder to disturbed surfaces to provide fast and efficient erosion protection. The soil binder must be applied in accordance with the manufacturers specifications; (iv) demonstrate priority to minimising erosion at source; and (v) require that sediment removed from the maintenance of sediment controls including sediment basins be disposed of at a licensed waste treatment facility where required by the procedure detailed in section (h) below; (c) measures to manage dust emissions. The measures must be applied within the cuttings, at stockpile sites that will receive, store or process material excavated from the cuttings and at the final location of the material within the Project Works. The measures must: (i) be developed in consultation with the Contractor's project soil conservationist and be consistent with best practice management; (ii) include the application of a suitable soil binder to disturbed surfaces to provide fast and efficient dust suppression. The soil binder must be applied in accordance with the manufacturers specifications; (iii) consider and be applied to drilling and blasting, haulage and processing activities; (iv) include a mechanism for temporary cessation of relevant works during periods when weather conditions are conducive to dust generation or dust management measures require modification; and (v) be consistent with Section 6.3.10 of "Managing Urban Stormwater – Soils and Construction (Landcom 2004)". (d) a monitoring program that includes: (i) water quality monitoring for total arsenic as outlined in the Surface Water Monitoring Program and the Ground Water Monitoring Program as detailed in Section 4.18 of this Appendix; (ii) dust monitoring that: A. includes specific dust deposition gauges for the purposes of monitoring arsenic concentrations only and are located adjacent representative sensitive receivers in accordance with "AS/NZS 3580.1.1:2007 : Methods for sampling and analysis of ambient air - Guide to siting air monitoring equipment"; and B. is undertaken in accordance with "Approved Methods for Sampling and Analysis of Air Pollutants in NSW (DEC 2007)" and reported in accordance with "Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (DEC 2005)". (iii) development of appropriate trigger levels for water quality and dust monitoring based on background levels or other relevant guidelines. (iv) a procedure for identifying and managing non-conformances of trigger levels associated with water quality and dust monitoring including the development and implementation of corrective/preventative action(s). (e) inspection procedures for the controls detailed in (b) and (c) including daily inspections, pre shut-down inspections and post rainfall inspections. Records of inspections must be appropriately maintained and all non-conformances addressed.	

<table>
<tr><th>Clause</th><th>Clause Requirements</th><th>Details of Compliance</th></tr>
<tr><td></td><td>(f) stakeholder and community engagement and communication protocol consistent with the draft “Guideline for the Management or Contamination (RMS 2013)”.

(g) work method statement(s) for management practices detailed in section 4.32(a) above and incorporate the implementation of the controls detailed in section 4.32(b) and 4.32(c) above. The work method statement(s) must address environmental awareness toolbox training regarding the practices and controls.

(h) waste classification and management procedure for material disposal off-site. The procedure must include:
(i) sufficient sampling and testing requirements to allow the material to be classified under the “NSW Waste Classification Guidelines (DECCW 2009)”;
(ii) how, and by whom, the waste will be transported;
(iii) protocols for verifying licenses and permits for handling, transportation and disposal of waste;
(iv) the identification of waste treatment facilities that are licensed to accept such waste; and
(v) protocols to comply with the legislative requirements and appropriate planning consent for any non-licensed waste activities that involve the storage, transport, treatment and/or disposal of waste.

(i) procedures for review and amendment of the Arsenic Rock Management Strategy.</td><td></td></tr>
<tr><td>Table 4.4</td><td><table>
<tr><th>Material source</th><th>Management practices</th></tr>
<tr><td>Cutting between Chainage 48km400 and Chainage 48km950</td><td>• Material excavated from this cutting must be placed within the Site or Local Road Corridors
• Material excavated from this cutting must not be placed as a drainage blanket or bridging layer material.
• Material excavated from this cutting which is incorporated within the Project Works located on the Nambucca River, Warrell Creek or Upper Warrell Creek floodplains may only be placed above the level of any bridging layers and must not be placed within 2 metres (minimum) of the face of the embankment batter.</td></tr>
<tr><td>Cuttings between</td><td>• Material excavated from this cutting must be placed within the Site or Local Road Corridors.
• Precedence and priority must be given to the use of the material from these cuttings in areas of the Site and Local</td></tr>
</table></td><td>This requirement of the SWTC has been factored into the AFJV Earthworks Management Plan and the mass haul requirements. The requirements are also considered in Table 3 below.</td></tr>
</table>

Clause	Clause Requirements	Details of Compliance
	Chainage 49km200 and Chainage 49km650; and between Chainage 57km800 and Chainage 58km000 — Road Corridors outside of the Nambucca River, Warrell Creek or Upper Warrell Creek floodplains. • Material excavated from these cuttings which is incorporated within the Project Works and Temporary Works on the Nambucca River, Warrell Creek or Upper Warrell Creek floodplains: ○ may only be placed above the level of any bridging and drainage layers ; and ○ must not be placed within 2 metres (minimum) of the face of the embankment batter, except for Temporary Works (including use as a surcharge) that are located above the level of the 1 in 20 year ARI event. • Within the Project Works outside of the Nambucca River, Warrell Creek or Upper Warrell Creek floodplains, material excavated from these cuttings must be placed above the level of any E2 or E7 bridging layers. Fill embankments must be progressively topsoiled and revegetated with temporary vegetation and/or final landscaping • The material from these cuttings must not be placed as, drainage blanket or bridging layer material.	
	Cuttings between Chainage 48km400 and Chainage 48km950, between Chainage 49km200 and Chainage 49km650 and between Chainage 57km800 and — Stockpiles that contain material excavated from these cuttings must: • be located within the Site or Local Road Corridors. • be located more than 50 metres from a waterway as described in Section 4.26 of this appendix. • be located on land with a slope less than 10 per cent. • be separated from the nearest residences by at least 200 metres. • be above the level of the 1 in 20 year ARI event .	

Clause	Clause Requirements	Details of Compliance
	Chainage 58km000	
	Topsoil excavated from the cuttings identified in this Table 4.4: • Topsoil excavated from these cuttings must be placed within the Site or Local Road Corridors. • Topsoil excavated from these cuttings must not be placed on fill embankments on the Nambucca River, Warrell Creek or Upper Warrell Creek floodplains. • Precedence and priority must be given to the use of the topsoil in areas of the Project Works and Temporary works that are not prone to erosion.	

3.3. Relevant Standards

Guidelines and Standards relevant to this Strategy include:

- Waste Classification Guidelines, Part 1: Classifying Waste (NSW DECCW 2009)
- Australian and New Zealand Guidelines for Assessment and Management of Contaminated Sites, ANZECC/NHMRC, 1992
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality ANZECC, 2000
- Assessment Classification and Management of Liquid and Non-Liquid Waste (EPA), 1999
- NEPC (1999). National Environmental Protection (Assessment of Site Contamination) Measure
- DUAP EPA. (1998). Managing Land Contamination Planning Guidelines, SEPP 55 – Remediation of Land
- Guidelines for the Management of Acid Sulfate Material: Acid Sulfate Soils, Acid Sulfate Rock and Monosulfidic Black Ooze, RTA 2005
- NSW EPA (2007) Guidelines for the Assessment and Management of Groundwater
- Roads and Maritime Specification D&C R44
- Stockpile Site Management Guideline, Roads and Maritime 2011
- Managing Urban Stormwater, 4th Edition, Landcom 2004
- AS/NZS 3580.1.1:2007 : Methods for sampling and analysis of ambient air - Guide to siting air monitoring equipment
- Approved Methods for Sampling and Analysis of Air Pollutants in NSW (DEC 2007)
- Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (DEC 2005).

4. Key Responsibilities and Accountabilities

4.1. Organisational Chart

An updated version of the organisational chart shall be maintained and available on the Project site, displayed in clear accessible locations and available upon request. The organisational chart is available on the Electronic Document Management System (EDMS) – TeamBinder.

4.2. Key Staff

The overall roles and responsibilities for environmental management are outlined in Section 4.2 of the CEMP. The responsibilities and accountabilities for key Project staff in the implementation of this Strategy include:

4.2.1. Project Director

- Approve this Strategy for implementation and all subsequent revisions;
- Instruct all Project personnel on adherence to this Strategy.

4.2.2. Construction Manager

- Ensure the requirements of this Strategy are referenced within earthworks plans and requirements for all construction packages;
- Liaise with the Environmental Manager for each package of work involving earthworks.

4.2.3. Environmental Manager

- Ensure the Strategy remains current and is reviewed and consulted with Roads and Maritime and the Environmental Representative (ER);
- Assist the Construction team.

4.2.4. All Other Managers, Superintendents and Workers

- Be familiar with this Strategy and comply with the requirements incorporated within construction management plans and procedures, including Environmental Works Method Statements (EWMS) that are imposed in relation to excavation and fill where applicable.

5. Arsenic in Naturally Mineralised areas

Naturally mineralised soil and rock deposits, in particular arsenic, were found to be present within the WC2NH upgrade alignment. There is potential for mineralised areas within the upgrade alignment to be exposed during excavations of cuttings during highway construction activities.

The presence of elevated levels (ie above background levels) of naturally occurring arsenic in rock has been identified in the following chainages for cutting and are discussed as follows:

- Cut 11 (48520-49000)
- Cut 12 (49200-49680)
- Cut 25 (57820-57920)

Measures to avoid or manage the potential risk from naturally mineralized areas during construction of the highway upgrade are provided in Section 6.

The investigation levels presented in the National Environmental Protection Council (NEPC) National Environmental Protection (Assessment of Site Contamination) Measure (NEPM) (NEPM, 2013) is generally the primary guideline used in NSW when setting (acceptance) criteria for chemical concentrations in soil.

The NEPM (2013) presents health based investigation levels for different land uses (e.g. industrial / commercial, residential, recreational etc.) as well as ecological investigation levels. For the WC2NH Upgrade initial contaminated land investigations were undertaken by Coffey (2014) who conservatively adopted the Health Screening Level (HSL) for recreational/open space (HSL C) which includes public space such as parks, playgrounds, playing fields (eg. Ovals), secondary schools and footpaths as investigation levels. This provides a HSL for arsenic in soils 300mg/kg As.

5.1. Cut 11

Cut 11 (Ch48,500 – Ch48,850) is located on a ridgeline to the north of the proposed bridge crossing over Warrell Creek. Previous investigations had identified an area of elevated arsenic around test pit location 1TP13. A surface soil sample collected from 1TP13 (0-0.15m bgs) reported 180 mg/kg arsenic. This test pit location was within forest regrowth on the north side of Warrell Creek (Ch48,500), see Figure 1.

Further investigations to assess extent of arsenic in soil at this site in February 2013 involved the collection of an additional five (5) samples from locations around test pit 1TP13 to assess the extent of arsenic contamination. The test results from these additional samples reported lower concentrations with all the results below 52 mg/kg arsenic and well below the HSL C. Three of the five samples reported arsenic levels <20 mg/kg which represents the background arsenic concentration. These previous investigations were limited to the immediate area around location 1TP13 and did not extend to the remainder of Cut 11.

To assess the level of arsenic in surface soils across the balance of Cut 11 a total of 40 discrete sampling locations at a nominal spacing of 25m were sampled in December 2013. One sample 7CS063 reported an elevated level of 320 mg/kg arsenic, above the HSL C of 300mg/kg, see Figure 1.

5.2. Cut 12

Cut 12 (Ch 49,500 – Ch49,650) is located to the north of Bald Hill Road. Initial screening of contamination in surface soils (0-0.15m) found marginally elevated levels of arsenic above the background level (<20mg/kg) in three soil samples: CS107 (130mg/kg), CS108 (55mg/kg) and CS109 (44mg/kg).

In May 2011, further testing identified an arsenic hotspot in the south west of the paddock at Lot 23 which reported elevated levels of arsenic > 500mg/kg in three samples collected from two sampling locations. The highest arsenic concentration reported for these samples was 750mg/kg in sample 4CS023 (0.3m-0.5m bgs).

A further investigation of this area was undertaken in February 2013 to assess the extent of naturally mineralized arsenic. An additional 20 samples collected from seven test pits. The south west of the paddock at Lot 23 was once again determined to be a hot-spot for arsenic concentration above the HSL C.

The investigation results found that elevated concentrations of arsenic are present within the near surface (<0.3m bgs) soil profile at AEC 2, see Figure 2. The findings of both the test pitting program and additional soil and rock material analysis shows that elevated arsenic concentrations also occur at various locations and are not localised to a single area within Cut 12.

The full extent of arsenic impact within the deeper soils and rock materials of Cut 12 was not able to be assessed based on the limited analysis undertaken. However, the available laboratory results indicate that there is potential for elevated concentrations of arsenic to be present at varying depths within Cut 12.

There is potential for construction of road cuttings within Cut 12 to disturb groundwater, which may lower the water table through dewatering. When Arsenopyrite present in Cut 12 is exposed to the atmosphere the mineral will oxidise and this may result in acid rock drainage issues and impacted leachate from this cutting.

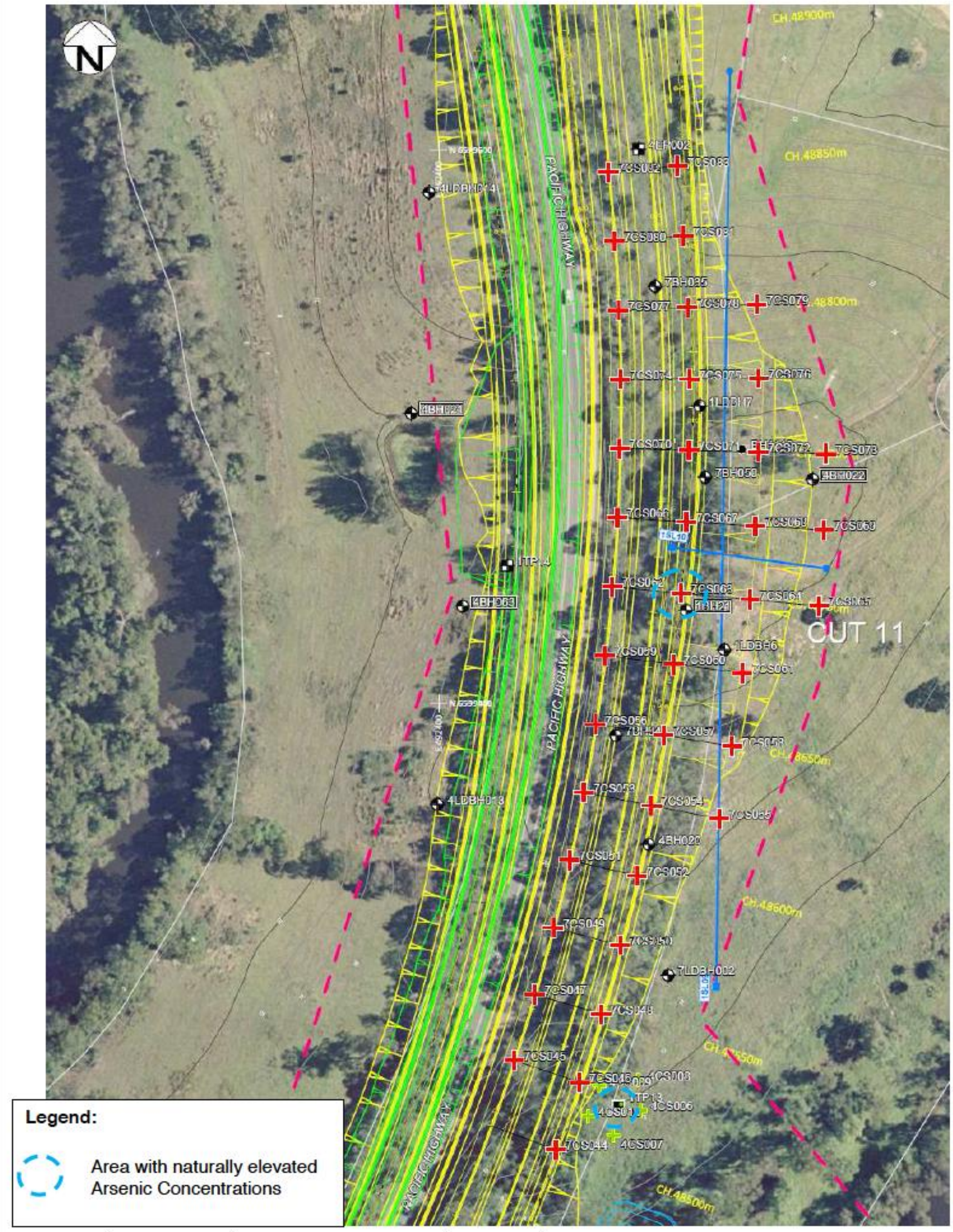
5.3. Cut 25

Cut 25, (Ch57,800 – Ch58,000) is located in the Nambucca State Forest to the east of Old Coast Road. A sample recovered from core recovered from borehole 2bBH06 (9.9m bgs) reported an elevated arsenic concentration of 450 mg/kg, see Figure 3.

Other results from this location also showed presence of arsenic with sample 2bBH06 (10.9m bgs) reporting 180 mg/kg arsenic. However, a nearby borehole 2bBH05 (Ch57,870) located to the south reported lower values of 8.8 mg/kg – 6.65m bgs and 8.2 mg/kg – 9.1m bgs which are within adopted background concentration. These samples were collected from rock core material recovered during earlier geotechnical investigations and did not provide any information on the level of arsenic present in soils at this location.

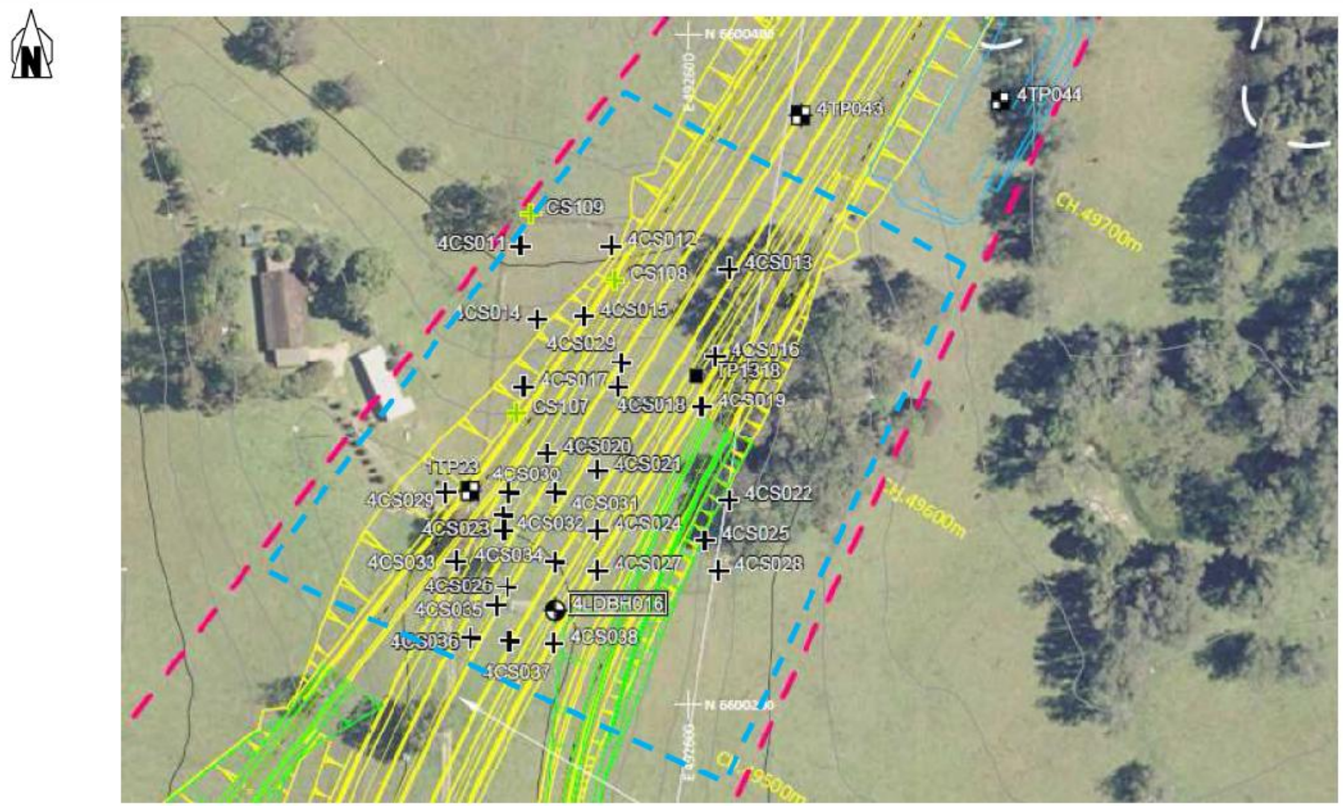
To assess the level of arsenic in surface soils across the balance of Cut 25 a total of 23 sampling locations at a nominal spacing of 25m were sampled in December 2013, see Figure 3. Concentrations of arsenic were below the adopted investigation level of 300mg/kg in the samples analysed. Marginally elevated level of arsenic were reported in three samples; 7CS100 (110 mg/kg), 7CS103 (100 mg/kg) and 7CS105 (240 mg/kg). Each of these samples were collected from locations adjacent to or nearby to 2bBH06.

Figure 1: Cut 11



drawn:	JP	coffey	client:	Acciona & Ferrovial Joint Venture
approved:	AB		project:	Contaminated Land Management Strategy – Pacific Highway Upgrade – Warrell Creek to Nambucca Heads
date:	19-Sep-14			
scale:	NTS		title:	Areas with naturally elevated Arsenic in Cut 11
original size:	A3		project no.:	GEOTCOFH03148AB-AC drawing no: Figure 4

Figure 2: Cut 12

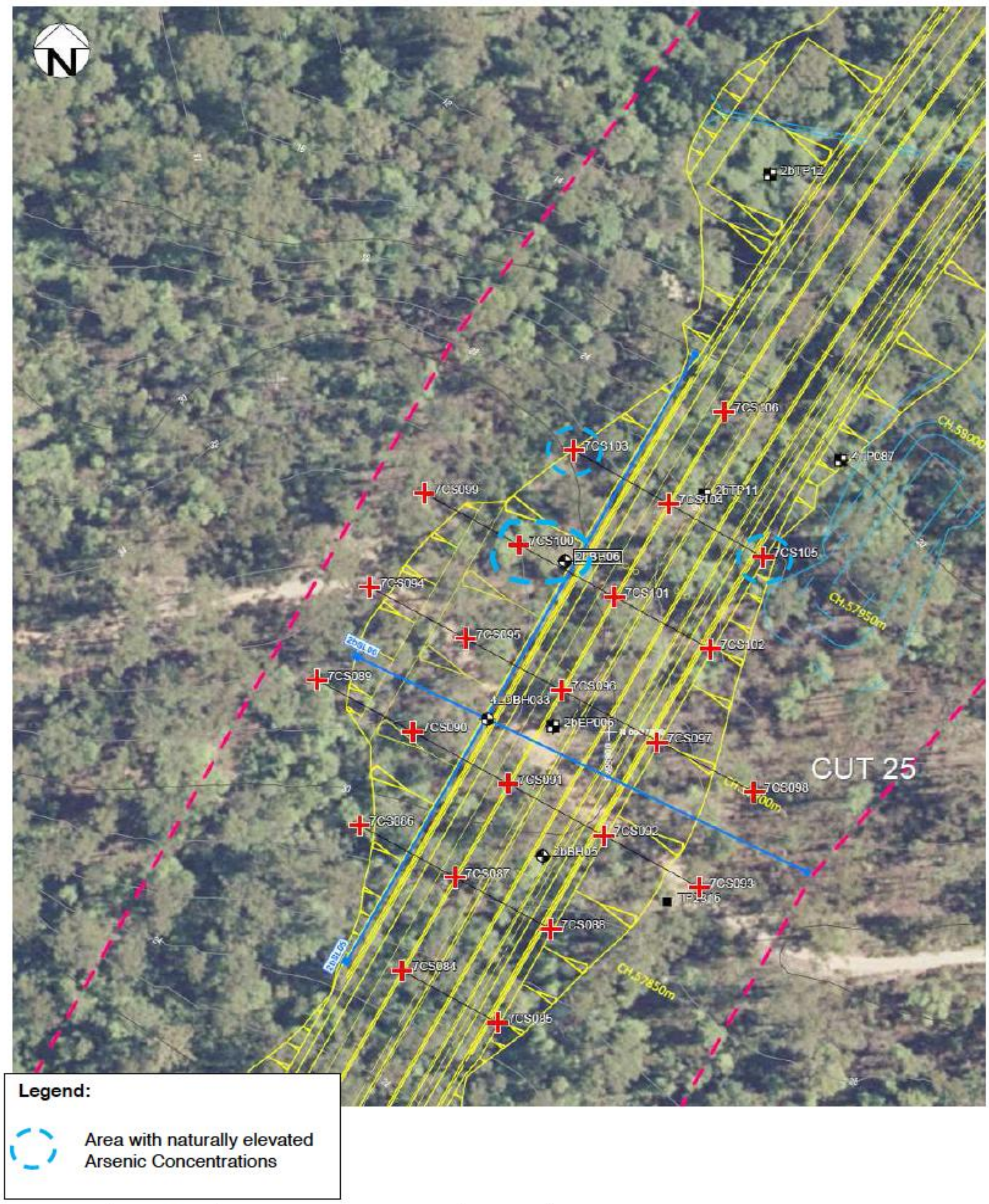


Legend:

AEC 12 – Cut 12

drawn	JP	coffey	client:	Acciona & Ferrovial Joint Venture
approved	AB		project:	Contaminated Land Management Strategy – Pacific Highway Upgrade – Warrell Creek to Nambucca Heads
date	19-Sep-14		title:	AEC 2 - Arsenic in Naturally Mineralised Cut 12
scale	NTS			
original size	A3		project no: GEOTCOFH03148AB-AC	figure no: Figure 5

Figure 3: Cut 25



drawn:	JP	coffey	client:	Acciona & Ferrovial Joint Venture		
approved:	AB		project:	Contaminated Land Management Strategy – Pacific Highway Upgrade – Warrell Creek to Nambucca Heads		
date:	19-Sep-14					
scale:	NTS		title:	Area with naturally elevated arsenic in Cut 25		
original size:	A3		project no.:	GEOTCOFH03148AB-AC	drawing no:	Figure 6

6. Management Measures

This section describes the management and mitigation measures that will be put into place during the pre-construction, construction, and post-construction phases of the Project. A range of management actions and measures have been developed to minimise the impact of Arsenic Rock within naturally mineralized areas during excavation and to optimize the reuse of this excavated material within the WC2NH Project as a material resource. These are outlined in Table 2 as follows.

Table 3: Management Measures for Arsenic Rock

Activity	Management Action	Rationale	Responsibility
Identify areas containing Arsenic Rock	Areas of known arsenic rock are clearly shown on site plans for the WC2NH Upgrade, as defined in Section 5 of this Strategy and in the Reuse activity table below. These areas are surveyed and marked by pegging so as to be readily identifiable during construction.	Survey will show project personnel when works are within or nearby to areas where arsenic rock are known to be present.	Environment Manager Environment Coordinator Project Superintendent
Establishing erosion and sediment controls for Arsenic Rock Areas	Erosion and sedimentation management must be implemented within the cuttings in accordance with the progressive Erosion and Sedimentation Control Plans (PESCPs), and appropriately designed so that stormwater runoff and future leachate from cuttings is directed via drainage structures and collected within sedimentation basins. Where groundwater leachate testing within the cuttings has identified elevated Arsenic Levels, additional controls will be implemented to capture leachate and minimize the potential for contaminated run-off, especially at Cut 12 where the risk of leachate is potentially higher. The clearing of vegetation prior to excavating the cut will only occur when earthworks is required to commence shortly thereafter. Leaving disturbed areas of exposed soil will be avoided. Whilst the cut is being excavated, finished surfaces will be progressively topsoiled and re-seeded to encourage fast stabilization.	Prevent pollution of surface waters by collecting leachate and stormwater in sedimentation ponds.	

Activity	Management Action	Rationale	Responsibility
	Dust and soil stabilizers will be used on open cut surfaces, stockpiles and access/haul roads to minimize dust and to reduce sediment mobilization. Erosion controls such as jute mesh, geofabric, hydromulch, etc will be used to stabilize site drains to minimize sediment mobilization. The Soil and Water Management Sub-plan (SWMP) provides further details for erosion and sediment control requirements. Sediment removed from sediment basins and other controls during routine maintenance is to be stockpiled and tested for appropriate Waste Classification in accordance with the WEMP.		
Excavation cuttings in areas of Arsenic Rock (Cut 11, 12 and 25)	AFJV plans and coordinates excavation of materials containing arsenic rock so as to ensure these materials are handled appropriately. Decision on the appropriate use of materials recovered from these cuttings will be planned in advance of excavation occurring in consultation with Roads and Maritime and EPA. Potential Arsenic Rock materials will be handled separately. Separate stockpile areas will be set up and signage placed. Rock faces in cuttings in NMA are to be inspected daily by the Site Foreman to identify if leachate is occurring. If leachate is found to be present then sampling and further testing for pH and metals, principally arsenic, is to be undertaken. Groundwater monitoring will be conducted in accordance with the Groundwater Management Strategy (in Appendix E of the SWMP) and the Groundwater Monitoring Program (in Appendix A of the SWMP)	To prevent contamination of other materials or pollution from the excavated material containing Arsenic Rock. To prevent groundwater draw-down and potential acidification of mineralized arsenic	Project Superintendent Environment Manager Environmental Coordinator

Activity	Management Action	Rationale	Responsibility
	Groundwater leachate will be monitored in Cut 12 especially in accordance with the risk identified in Section 5.2. Should the cut appear to intersect the groundwater table and cause draw-down, the Project will investigate recharge options to ensure the groundwater table is not impacted. Further controls will be implemented to capture contaminated leachate if elevated levels are detected. The potential for dust from cuttings must be managed and controlled in accordance with the requirements of the Air Quality Management Sub Plan (AQMP), including dust suppression controls and temporary cessation of works if necessary during high risk weather conditions (eg extremely dry and strong winds). Dust stabilisers will be used on open cut surfaces, stockpiles and access/haul roads to minimize dust. If Arsenic Rock materials are being crushed, operations will be closely monitored to ensure dust is not being produced and water sprays will be used to minimize dust. Workers are to wear appropriate PPE including dust masks (if appropriate) when working in the vicinity of NMA excavation areas. Should weather conditions create excessive dust that is difficult to manage with water sprays and other controls, excavation works will be temporarily ceased until the weather conditions are more favourable.	Prevent pollution offsite due to dust deposition from cuttings.	
Siting Temporary Stockpiles of excavated material	Stockpiles will be established in the locations identified in the Stockpile Management Protocol (*Appendix I*), and be managed in accordance with the Protocol and progressive Erosion and Sediment Control Plans. Stockpiles of NMA will be delineated and kept separate from non-NMA material.	To prevent contamination of other materials or pollution the excavated material containing	Project Superintendent Environment Manager Environment Coordinator

<table>
<tr><th>Activity</th><th>Management Action</th><th>Rationale</th><th>Responsibility</th></tr>
<tr><td>containing Arsenic Rock</td><td>Where possible, Arsenic Rock and associated topsoil and fill to be used for construction will be placed in the location it is required to prevent double handling.

The location of temporary stockpiles must meet the following requirements:

<table><tr><td>Cuttings between:
• Chainage 48km400 and Chainage 48km950
• Chainage 49km200 and Chainage 49km650
• Chainage 57km800 and Chainage 58km000</td><td>Stockpiles that contain material excavated from these cuttings must:
• be located within the Site or Local Road Corridors.
• be located more than 50 metres from a waterway.
• be located on land with a slope less than 10 per cent.
• be separated from the nearest residences by at least 200 metres.
• be above the level of the 1 in 20 year ARI event .</td></tr></table>
Arsenic rock material stockpiles will be appropriately signed and will not be mixed with other materials.

Erosion and sedimentation management must be implemented for temporary stockpiles in accordance with PESCPs. A sump will be used to collect run-off and the water will be tested in accordance with the proposed trigger levels provided below.

The potential for dust from cuttings must be managed and controlled in accordance with the requirements of the AQMP.</td><td>arsenic rock is to be managed separately.</td><td></td></tr>
</table>

<table>
<tr><th>Activity</th><th>Management Action</th><th>Rationale</th><th>Responsibility</th></tr>
<tr><td></td><td>Stockpiles of NMA materials are clearly identified and their dimensions surveyed so as to maintain an accurate record of volume of these materials and traceability between excavation and areas that they are used on the project.</td><td></td><td></td></tr>
<tr><td>Use of Arsenic Rock material within the Project</td><td>Reuse of excavated material containing arsenic rock for earthworks within the Project must conform to the following requirements.
<table>
<tr><td>Cutting between:
• Chainage 48km400 and Chainage 48km950</td><td>• Material excavated from this cutting must be placed within the Site or Local Road Corridors
• Material excavated from this cutting must not be placed as a drainage blanket or bridging layer material.
• Material excavated from this cutting which is incorporated within the Project Works located on the Nambucca River, Warrell Creek or Upper Warrell Creek floodplains may only be placed above the level of any bridging layers and must not be placed within 2 metres (minimum) of the face of the embankment batter.</td></tr>
<tr><td>Cuttings between:
• Chainage 49km200 and Chainage 49km650; and
• Chainage 57km800 and Chainage 58km000</td><td>• Material excavated from this cutting must be placed within the Site or Local Road Corridors.
• Precedence and priority must be given to the use of the material from these cuttings in areas of the Site and Local Road Corridors outside of the Nambucca River, Warrell Creek or Upper Warrell Creek floodplains.
• Material excavated from these cuttings which is incorporated within the Project Works and Temporary Works on the Nambucca River, Warrell Creek or Upper Warrell Creek floodplains:</td></tr>
</table></td><td>To implement measures to avoid potential for future environmental impacts to occur from arsenic containing materials.</td><td>Project Superintendent
Environment Manager
Environment Coordinator</td></tr>
</table>

Activity	Management Action	Rationale	Responsibility
	o may only be placed above the level of any bridging and drainage layers ; and o must not be placed within 2 metres (minimum) of the face of the embankment batter, except for Temporary Works (including use as a surcharge) that are located above the level of the 1 in 20 year ARI event. Within the Project Works outside of the Nambucca River, Warrell Creek or Upper Warrell Creek floodplains, material excavated from these cuttings must be placed above the level of any E2 or E7 bridging layers. Fill embankments must be progressively topsoiled and revegetated with temporary vegetation and/or final landscaping. • The material from these cuttings must not be placed as, drainage blanket or bridging layer material. The Pacifico AFJV Earthworks Management Plan includes specific reuse locations for the Arsenic Rock and the Project mass haul has incorporated the above measures to ensure the material is used appropriately. Testing of material excavated from NMR areas will be tested to confirm the levels of arsenic present and to confirm the reuse options within the Project alignment are suitable. A material tracking system will be used to ensure the material removed from NMA areas is used in the designated location on the worksite. A material tracking register will record quantities of material that are removed and transported from NMA areas and quantities of material received at the approved fill location. Should any fill material be received at a location that is not approved, the load		

Activity	Management Action	Rationale	Responsibility
	will be turned away and returned to the designated stockpile area at the NMA site.		
Topsoils excavated from these cuttings	• Topsoil excavated from these cuttings must be placed within the Site or Local Road Corridors. • Topsoil excavated from these cuttings must not be placed on fill embankments on the Nambucca River, Warrell Creek or Upper Warrell Creek floodplains. • Precedence and priority must be given to the use of the topsoil in areas of the Project Works and Temporary works that are not prone to erosion.		Project Superintendent Environment Manager Environment Coordinator
Potential Acid Forming Rock (Cut 7 -12)	Cut 7 – 12 are potential locations containing Acid Forming Rock (AFR). Current test results show only low levels of sulfides present, therefore no treatment is required. However further testing will be undertaken throughout the geotechnical investigation phase to determine the presence of any 'hot spots'. If any suspected AFR areas are excavated during construction, testing can be undertaken to determine if treatment is required. Potential Acid Sulfate Material Treatment Areas will be located, designed, constructed and operated in accordance with the requirements of ASMMP, Stockpile Management Protocol and Earthworks Management Plan if required. In accordance with the ASMMP, acid sulfate materials reused on site will be treated to comply with the RMS Specification and/or the excavated Public Road Material Exemption 2012.	Ensure potential ASM is managed to avoid impacts to environment.	Project Superintendent Environment Manager Environment Coordinator

Activity	Management Action	Rationale	Responsibility
	Groundwater leachate will be monitored in Cut 12 especially in accordance with the risk identified in Section 5.2. Should the cut appear to intersect the groundwater table and cause draw-down, the Project will investigate recharge options to ensure the groundwater table is not impacted.		
Disposal Offsite	It is proposed that all Arsenic Rock material excavated from Cut 11, 12 and 25 will be reused on site. Sediment removed from erosion and sediment controls will be stockpiled and tested for Waste Classification. Reuse and disposal of all spoil from the site must be classified in accordance with the NSW OEH Waste Classification Guidelines, Part 1: Classifying Waste (NSW DECCW 2009) and be managed in accordance with the requirements specified in the WEMP (refer to section 5.3 to 5.6 on waste classification for offsite reuse/recycling and disposal). For all spoil containing Arsenic Rock unsuitable for reuse and requires disposal to a landfill, the landfill facility must be appropriately licenced to receive waste to be disposed. Refer to section 5.6 of the WEMP for further details on disposal.	Avoid potential for offsite impacts of any surplus material	Project Superintendent Environment Manager Environment Coordinator
Transport of material from cuttings	Haulage of earthwork materials including Arsenic Rock will be kept within access roads and the project site where practicable. Should public roads or areas outside of the project site be required, it will be undertaken in accordance with the construction Traffic Management Plan (refer to CEMP Appendix B1). In	Minimise potential for impacts to environmental and local amenity from transportation/haulage.	Project Superintendent Environment Manager Environment Coordinator

Activity	Management Action	Rationale	Responsibility
	accordance with the Traffic Management Plan, the following controls will be implemented: • Minimise exposure to noise sensitive areas: transportation only within the approved construction hours (between 7:00 am and 6:00 pm Mon.-Fri and 8am-1pm Saturdays, unless otherwise approved.) and on approved traffic routes to minimise the passage of material through nearby towns. • Avoid identified protected areas and no-go zones to minimise potential for impact on biodiversity and heritage values. • The reduction in transport distance to minimize greenhouse gas emissions. • The minimal use of existing roads and tracks: using the Project alignment as the main material transport route to avoid negative community outcomes. Reduction of dust generated: loads of earthern materials are to be covered when entering public roads and roads are to remain swept clean and free of mud/debris.		
Monitoring	A monitoring program will be implemented for excavation, handling, temporary stockpiling, reuse and disposal (if required). Monitoring will include: **Water Quality Monitoring** • Water quality monitoring for total arsenic as outlined in the Surface Water Monitoring Program and the Ground Water Monitoring Program (refer to Appendix A of the SWMP)	Prevent pollution by ensuring that waters are tested and assessed as suitable prior to release. Where required treatment may be necessary to make water suitable for its reuse or discharge.	Environment Manager Environment Coordinator

Activity	Management Action	Rationale	Responsibility
	• Visual monitoring of groundwater leaching from the cut face will be undertaken daily and the Environmental Team advised of any changes to leachate quantity. The following trigger levels will apply: • Waters within sedimentation basins are to be monitored to ensure that pH is within a range 6.5 – 8.5 prior to approving release from site. The water quality results are to also be within all approved criteria, including total suspended solids. • If waters are found to have pH <6.5 then undertake further testing for arsenic, levels must be below ANZECC criteria below before it is released. For pond waters with low pH (<5) then treatment, including liming, may be required to correct pH values prior to release from site. • The ANZECC criteria for arsenic concentrations for 95% level of species protection in freshwater slightly – moderately disturbed ecosystems is 13 ug/L for Arsenic (IV). **Air Quality Monitoring** Dust deposition gauges will be placed at strategic locations to be representative of potential dust deposition within potential dust catchment areas near potential sensitive receivers off site (refer to the AQMP). Dust monitoring will be undertaken in accordance with the following standards: • AS/NZS 3580.1.1:2007 : Methods for sampling and analysis of ambient air - Guide to siting air monitoring equipment • Approved Methods for Sampling and Analysis of Air Pollutants in NSW (DEC 2007)		

Activity	Management Action	Rationale	Responsibility
	• reported in accordance with Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (DEC 2005). Appropriate trigger levels for arsenic measured from dust deposition will be obtained after baseline sampling has been undertaken. Naturally occurring levels of arsenic within the area will be assessed and an appropriate level that complies with World Health Organisation Levels will be determined. It may be more appropriate to monitor particulate levels (PM10, PM2.5) rather than specific Arsenic concentrations to determine the concentration of respirable particulates. This will be determined and refined after baseline sampling is conducted. It is noted that concentrations of arsenic and soluble compounds (as As) are not to exceed the eight hour time weighted average (TWA) exposure standard of 0.05mg/m3 for work place health and safety requirements (NOHSC 3008, 1995). **Routine Inspections** A daily inspection of work areas will be performed by the relevant work area Supervisor. A Weekly Environmental Inspection will be conducted by the Environmental Team. Pre shut-down inspections and post rainfall inspections will also be undertaken for earthworks during works for Cuttings 11, 12 and 25. Records of actions will be in the Environmental Actions Register and the Environmental Action and Maintenance Record which is distributed to relevant parties for action. Records of inspections must be appropriately maintained and all non-conformances addressed within nominated timeframes.		

Activity	Management Action	Rationale	Responsibility
Tracking of Material from cuttings	Details of quantities excavated, temporarily stockpiled and placement locations of materials containing arsenic rock will be tracked and registered. A material tracking register is to be maintained which includes details of quantities and transportation of material excavated from the cuttings sent for stockpiling and reuse within and outside (if required) of the Project Boundary. The material tracking register will record where the material is coming from on site and where it is placed on the receiving site. Section 143 certificates are required for any material to be reused outside the Project boundary and landfill disposal tickets for material disposed of to landfill will be completed/obtained by engineers and/or the site foreman. Records of any laboratory analysis required to determine compliance with waste exemptions and classification of the material (in accordance with EPA Waste Classification Guidelines). The Project Waste Register will also be maintained which will track the quantities of material being reused/disposed of off-site.		

7. Non Conformances, Corrective and Preventive Actions

Any non-conformances with this plan will be recorded within the project systems in accordance with the Quality Management Plan.

Table 3 - Potential Incidents pertaining to this plan

Potential incidents	Potential Corrective Action
Discharge of water that does not meet the trigger levels provided in Table 2;	Notify the EPA immediately, sample the receiving water upstream and downstream to determine potential impact. Environmental Manager to determine appropriate course of action and seek expert advice if needed.
Excessive leaching of groundwater from the cut face which causes groundwater draw-down and acidification of mineralized sulfides;	Investigate recharge potential in consultation with an expert. Undertake sampling to determine extent of acidification. Undertake remedial actions if required and as directed by an expert.
Use of ARM in flood plain areas or non-approved locations;	Retrieve material or encapsulate in accordance with the SWTC and/or advice from an expert.
Elevated arsenic in sediment basins that requires further treatment.	Seek advice from a water treatment expert as to treating elevated levels of arsenic.
Elevated arsenic in dust monitoring	Immediately review work practices that are causing dust emissions and minimize dust occurring. Alter practices to ensure dust is minimized. Use soil stabilisers to reduce dust emissions.

All incidents must be recorded and reported in accordance with the Environmental Incident Classification and Reporting Procedure and the Project Pollution Incident Response Management Plan.

8. Training and Awareness

All personnel involved in earthworks or working in close proximity to the natural mineralization areas will receive awareness training of this Strategy. Training will include information on the naturally occurring mineralization of arsenic present on the project, their known locations, appropriate OHS controls and PPE that is required and management measures to manage excavated materials from these areas.

Training will occur during the Project induction and/or regular toolbox talks on earthworks management. Training will be provided by the Environmental Manager and Environmental Coordinators.

9. Stakeholder Consultation

Relevant stakeholders include the RMS and ER, EPA, DPI (Fisheries), DPE and Nambucca Shire Council. These organisations will be consulted with throughout the project via the regular ERG meeting.

10. Strategy Review

The Environmental Manager in consultation with RMS and the ER, will modify the Strategy where improvements are identified.