



Australian Government

BUILDING OUR FUTURE



mainroads
WESTERN AUSTRALIA

NorthLinkWA

Perth-Darwin National Highway

Condition Environmental Management Plan

Inland Waters Environmental Quality – Hydrological Processes

Perth–Darwin National Highway (Swan Valley Section)

JANUARY 2019





This page is intentionally blank.

CONTENTS

1	INTRODUCTION	1
2	CONTEXT AND SCOPE	3
2.1	Description of the Proposal	3
2.2	Key Environmental Factors	3
2.3	Requirements of the Conditions	6
2.4	Management Approach	9
2.5	Key Assumptions and Uncertainties	9
3	TRIGGER AND THRESHOLD CRITERIA	11
3.1	Trigger and Threshold Criteria	11
3.2	Rationale for Selection of Trigger and Threshold Criteria	11
3.2.1	Baseline Surveys and Assessments	12
3.2.2	Analytes	12
3.2.3	Method for Setting Threshold Criteria	13
3.2.4	Method for Setting Trigger Criteria	14
3.2.5	Summary of Framework for Setting Trigger and Threshold Criteria	15
4	MONITORING	17
4.1	Monitoring Provisions	17
4.2	Monitoring Method	23
4.3	Rationale for Monitoring Provisions	24
4.3.1	Methods	24
4.3.2	Monitoring Site Locations	24
4.3.3	Acid Sulfate Soils	24
5	TRIGGER LEVEL ACTIONS AND THRESHOLD CONTINGENCY ACTIONS	25
5.1	Trigger Level Actions	25
5.2	Threshold Contingency Actions	26
6	OTHER CONDITIONED REQUIREMENTS.....	27
7	REPORTING	29
7.1	Monitoring Report	29
7.2	Annual Compliance Assessment Report	29



7.3	Reporting on Exceedance of the Trigger and/or Threshold Criteria	31
8	ADAPTIVE MANAGEMENT AND REVIEW	33
8.1	Adaptive Management	33
8.2	Review	33
9	STAKEHOLDER CONSULTATION	35
10	REFERENCES	37

Tables

1	Inland Waters Environmental Quality – Hydrological Processes – Condition EMP summary	1
2	Key environmental factors	3
3	Condition requirements and in-plan section references	6
4	Trigger and threshold criteria	11
5	Analytes to be monitored under this plan	13
6	Framework for setting trigger and threshold criteria	15
7	Monitoring provisions	18
8	Trigger level actions	25
9	Threshold contingency actions	26
10	Other conditioned requirements	27
11	Condition EMP reporting table	29
12	Reporting requirements	31
13	Stakeholders consulted, comments and responses	35

Figures

1	Proposal overview	5
2	Monitoring network for groundwater and surface water features	19

Appendices

A	Monitoring Locations
B	Groundwater Quality Criteria
C	Surface Water Quality Criteria
D	Typical Bio-retention Swale and Basin Design
E	Individual Parameters to be Analysed

Document Control

Revision	Date	Description	Prepared	Reviewed	Approved
A	11/07/2016	Draft (Coffey v1)	T. Vu	E. Waterhouse	B. Napier
B	12/08/2016	Draft (Coffey v2)	T. Vu	C. Baldock	D. Morley
0	08/12/2016	Final for submission to OEPA (Coffey v3)	T. Vu	D. Morley	D. Morley
1	10/02/2017	Addressed OEPA comments (Coffey v4)	D. Morley	B. Napier	D. Morley
2	08/03/2017	Addressed OEPA comments (Coffey v5)	D. Morley	B. Napier	D. Morley
3	09/03/2017	Addressed OEPA comments (Coffey v6)	D. Morley		D. Morley
4	03/11/2017	Revised draft (Coffey v7)	R. Bunbury	C. Baldock	D. Morley
5	07/12/2017	Revised for submission to DWER (Coffey v8)	R. Bunbury	C. Baldock	D. Morley
6	23/02/2018	Addressed contractor comments and revised for submission to DWER (Coffey v9)	R. Bunbury	D. Morley	D. Morley
7	02/01/2019	Amended following annual review (ELA v10)	D. Morley	J. Longstaff	J. Longstaff

Prepared by:



Coffey Services Australia Pty Ltd
Level 1, Bishops See, 235 St Georges Terrace
Perth WA 6000 Australia
t: +61 8 6218 2100
ABN: 55 139 460 521
coffey.com

ENAUPERT04483AA_62_InlandWater_CEMP_v10
EP2016/049



Eco Logical Australia Pty Ltd
Level 1, Bishops See, 235 St Georges Terrace
Perth WA 6000 Australia
t: +61 8 6218 2200
ABN: 87 096 512 088
ecoaus.com.au



This page is intentionally blank.

1 INTRODUCTION

This Inland Waters Environmental Quality – Hydrological Processes – Condition Environmental Management Plan (Condition EMP) (this plan) is submitted in accordance with Ministerial Statement No. 1036 conditions 8-1 and 13-1 for the Perth–Darwin National Highway (Swan Valley Section) by Main Roads Western Australia (MRWA). It is a revision of the previous version approved by the Department of Water and Environmental Regulation (DWER) on 26 March 2018 (reference NLWA-03-EN-RP-0054 / Rev 6).

Table 1 presents a summary of this plan including the environmental criteria against which the environmental outcomes are measured.

Table 1 Inland Waters Environmental Quality – Hydrological Processes – Condition EMP summary

Item	Detail	
Title of proposal	Perth–Darwin National Highway (Swan Valley Section)	
Proponent	Commissioner for Main Roads Western Australia	
Ministerial Statement No.	1036	
Purpose of this Condition EMP	The Inland Waters Environmental Quality – Hydrological Processes – Condition Environmental Management Plan is submitted to fulfil the requirements of conditions 8-1 and 13-1 of the above Statement.	
EPA’s environmental objective for the key environmental factor inland waters environmental quality	To maintain the quality of groundwater and surface water so that environmental values are protected.	
EPA’s environmental objective for the key environmental factor hydrological processes	To maintain the hydrological regimes of groundwater and surface water so that environmental values are protected.	
	Trigger criteria	Threshold criteria
Condition environmental outcome:	The construction and operation of the proposal shall not result in an unacceptable decline in water quality of the Gnangara Underground Water Pollution Control Area (GUWPCA).	
Environmental criteria 1:	Groundwater quality trigger criteria listed in Appendix B.	Groundwater quality threshold criteria listed in Appendix B.
Condition environmental outcome:	The construction and operation of the proposal shall not result in an unacceptable decline in water quality of the Ellen Brook as confirmed by monitoring for a period of 5 years post construction.	
Environmental criteria 2:	Surface water quality trigger criteria listed in Appendix C.	Surface water quality threshold criteria listed in Appendix C.



This page is intentionally blank.

2 CONTEXT AND SCOPE

2.1 Description of the Proposal

Main Roads Western Australia (MRWA) proposes to construct a new 38 km section of the Perth-Darwin National Highway (PDNH) (Figure 1) between Malaga and Muchea in Western Australia (the proposal). The proposal is a dual carriageway highway and will connect the intersection of Tonkin Highway and Reid Highway in the south with Great Northern Highway and Brand Highway in the north.

2.2 Key Environmental Factors

This plan addresses the Inland Waters Environmental Quality and Hydrological Processes environmental factors of the Water theme (EPA, 2013).

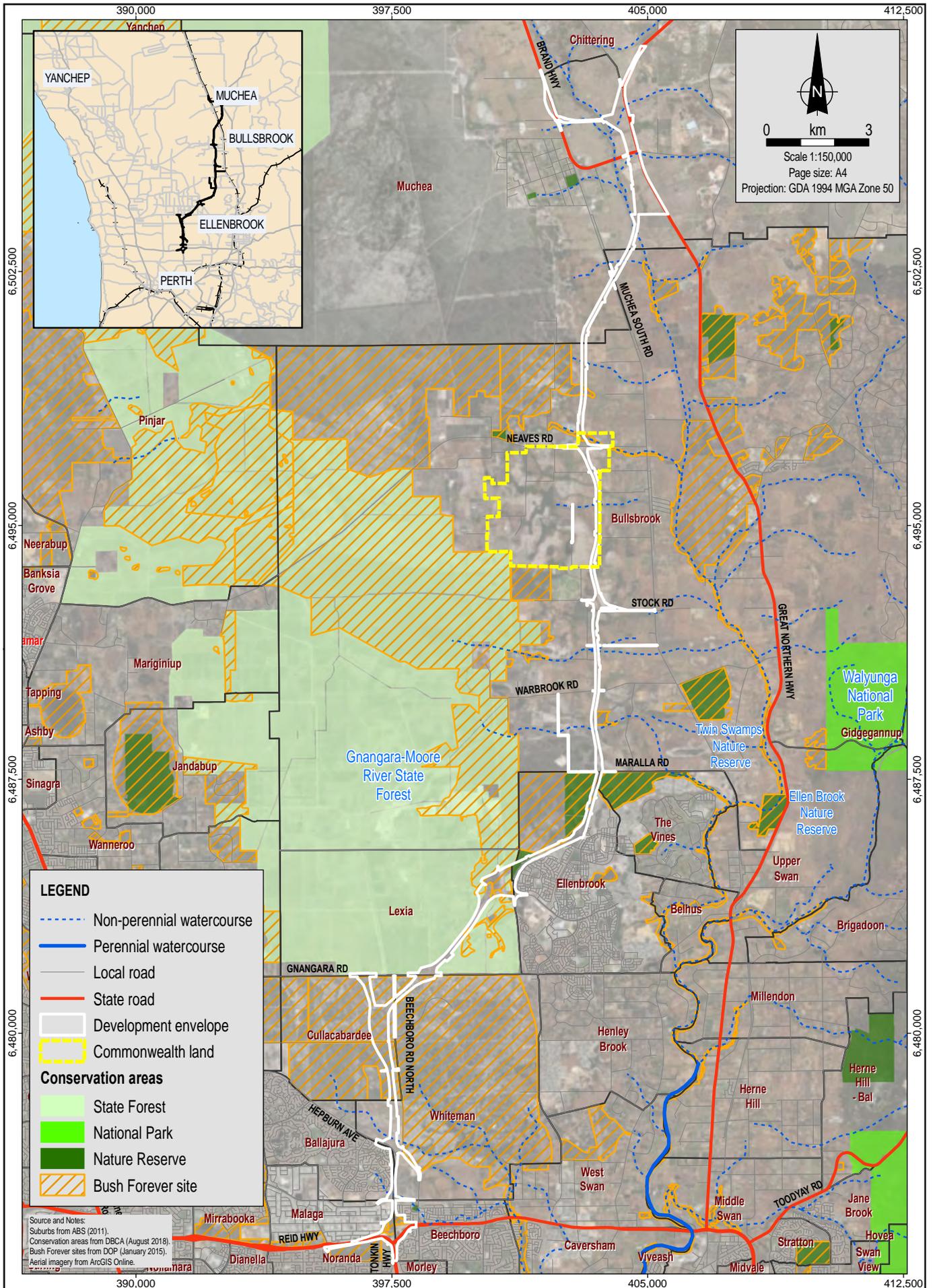
Water quality of the GUWPCA and the Ellen Brook are at risk of impacts as a result of proposal activities. The relevance of the environmental factors, GUWPCA and the Ellen Brook to the proposal is presented in Table 2.

Table 2 Key environmental factors

Environmental aspect of the proposal	Affected environmental value	Impact	Activity/Threatening process
Hydrocarbon or hazardous material spills from plant, vehicles and equipment and road users during operation	<ul style="list-style-type: none"> Groundwater quality of GUWPCA Surface water quality of the Ellen Brook 	Degradation of water quality from contaminants such as nutrients, heavy metals and elemental compounds (i.e., nickel, copper, zinc, cadmium and lead) and hydrocarbons (diesel and petrol).	Contaminated runoff from the road or spills introducing contaminants to the groundwater of the GUWPCA and the surface water of the Ellen Brook during operation.
Earthworks causing sediment transport	<ul style="list-style-type: none"> Surface water quality of the Ellen Brook 	Increased turbidity in the surface water of the Ellen Brook.	Construction earthworks mobilising sediment to the surface water of the Ellen Brook.
Dewatering and excavating – disturbance of ASS	<ul style="list-style-type: none"> Groundwater quality of GUWPCA Surface water quality of the Ellen Brook 	Degradation of water quality from exposure of ASS during construction resulting in decrease in pH and mobilisation of increased concentrations of dissolved heavy metals.	Ground disturbance of ASS during construction has the potential to impact groundwater of the GUWPCA and the surface water of the Ellen Brook.
Dewatering discharge	<ul style="list-style-type: none"> Surface water quality of the Ellen Brook 	Degradation of water quality from contaminants such as nutrients, heavy metals and elemental compounds (i.e., nickel, copper, zinc, cadmium and lead) and hydrocarbons (diesel and petrol).	Dewatering discharge has the potential to contaminate surface water in the Ellen Brook. Pumping and recharge of groundwater from dewatering and construction water abstraction activities has the potential to re-distribute existing contamination.

Environmental aspect of the proposal	Affected environmental value	Impact	Activity/Threatening process
Stormwater infiltration basins	<ul style="list-style-type: none"> Groundwater quality of GUWPCA Surface water quality of the Ellen Brook 	Degradation of water quality from contaminants such as nutrients, heavy metals and elemental compounds (i.e., nickel, copper, zinc, cadmium and lead) and hydrocarbons (diesel and petrol).	Contaminated runoff from the road or spills from ineffective infiltration basins, including bio-retention basins introducing contaminants to the groundwater of the GUWPCA and the surface water of the Ellen Brook.

The project design includes retention and infiltration basins, spill management, local government area drainage systems, culverts and separation/buffer distances to water production wellheads as part of the drainage strategy (BG&E, 2015). Stormwater retention and infiltration basins will capture and control runoff from the road along the alignment. Their proposed locations and sizing are detailed in the drainage strategy. The final location of retention and infiltration basins will be confirmed in detailed design and reported in the pre-construction Infrastructure Plan required by condition 6 of Ministerial Statement No. 1036.



2.3 Requirements of the Conditions

This plan is submitted in accordance with Ministerial Statement No. 1036 conditions 8-1 and 13-1 to 13-10 for the proposal.

As required under condition 5-1, this plan will be made publicly available for the life of the proposal.

Condition requirements and in-plan section references are provided in Table 3.

Note that the former of Office of the Environmental Protection Authority (OEPA) was replaced by the DWER EPA Services Division on 1 July 2017. References to OEPA in this plan have been changed to DWER except for direct quotations of the condition text from Ministerial Statement No. 1036.

Table 3 Condition requirements and in-plan section references

Condition No.	Condition	Section in this plan
5-1	Subject to condition 5-2, within a reasonable time period approved by the CEO of the issue of this Statement and for the remainder of the life of the proposal the proponent shall make publicly available, in a manner approved by the CEO, all environmental plans and reports required under this statement.	Section 2.3
8-1	Prior to the commencement of ground disturbing activities, or as otherwise agreed in writing by the CEO, the proponent shall prepare and submit Condition Environmental Management Plan(s) to satisfaction of the CEO to demonstrate that the environmental outcomes in condition 13-1 will be met.	This plan
8-2	The Condition Environmental Management Plan(s) shall:	Section 3 and Appendices B and C
	1. Specify trigger criteria that will trigger the implementation of trigger level actions if exceeded.	
	2. Specify threshold criteria that:	
	a) Provides a limit beyond which the environmental outcomes identified in condition 13-1 are not achieved.	
	b) Will trigger the implementation of threshold contingency actions if exceeded.	
	3. Specify monitoring to determine if trigger criteria and threshold criteria are exceeded.	Section 4
	4. Specify trigger level actions to be implemented in the event that trigger criteria have been exceeded.	Section 5
5. Specify threshold contingency actions to be implemented in the event that threshold criteria are exceeded		
6. Provide the format and timing for the reporting of monitoring results against trigger criteria and threshold criteria to demonstrate that condition 13-1 have been met over the reporting period in the Compliance Assessment Report required by condition 4.	Section 7	
7. Provide for reporting of exceedances of the trigger and threshold criteria.		

Condition No.	Condition	Section in this plan
8-3	<p>After receiving notice in writing from the CEO that the Condition Environmental Management Plan(s) satisfies the requirements of condition 8-2 for condition 13-1, the proponent shall prior to the commencement of ground disturbing activities:</p> <ol style="list-style-type: none"> 1. Implement the provisions of the approved Condition Environmental Management Plan(s). 2. Continue to implement the approved Condition Environmental Management Plans until the CEO has confirmed by notice in writing that the proponent has met the relevant objectives specified in the approved Condition Environmental Management Plan and no longer needs to implement that particular Condition Environmental Management Plan. 	<p>Section 2.4</p> <p>Refer to the Compliance Assessment Plan (Coffey, 2016a) for details relating to annual compliance assessment reporting of implementation of the Condition Environmental Management Plans.</p>
8-4	<p>In the event that monitoring indicates exceedance of trigger criteria and/or threshold criteria specified in the Condition Environmental Management Plan(s), the proponent shall:</p> <ol style="list-style-type: none"> 1. Report the exceedance in writing within 7 days of the exceedance being identified. 2. Immediately implement the trigger level actions and/or threshold contingency actions specified in the Condition Environmental Management Plan(s) and continue implementation of those actions until the trigger criteria are being met, or until the CEO has confirmed by notice in writing that it has been demonstrated that the environmental outcomes in condition 13-1 are being met and implementation of the trigger level actions and/or threshold contingency actions are no longer required. 3. Investigate to determine the cause of the trigger criteria and/or threshold criteria being exceeded. 4. Identify additional measures required to prevent the trigger and/or threshold criteria being exceeded in the future. 5. Investigate to determine potential environmental harm or alteration of the environment that occurred due to threshold criteria being exceeded. 6. Provide a report to the CEO within 60 days of the exceedance being reported. The report shall include: <ol style="list-style-type: none"> a) Details of trigger level actions or threshold contingency actions implemented. b) The effectiveness of the trigger level actions or threshold contingency actions implemented, monitored and measured against trigger criteria and threshold criteria. c) The findings of the investigations required by conditions 8-4(3) and 8-4(5). d) Additional measures to prevent the trigger or threshold criteria being exceeded in the future. e) Measures to prevent, control or abate the environmental harm which may have occurred. 	<p>Sections 5 and 7.3</p>

Condition No.	Condition	Section in this plan
8-5	<p>The proponent:</p> <ol style="list-style-type: none"> 1. May review and revise the Condition Environmental Management Plan(s). 2. Shall review and revise the Condition Environmental Management Plan(s) as and when directed by the CEO. 	Section 8.2
8-6	<p>The proponent shall implement the latest revision of the Condition Environmental Management Plan, which the CEO has confirmed by notice in writing, satisfies the requirements of condition 8-2.</p>	Section 8.2
13-1	<p>The proponent shall manage the construction and operation of the proposal to meet the following environmental outcome:</p> <ol style="list-style-type: none"> 1. The construction and operation of the proposal shall not result in an unacceptable decline in water quality of the GUWPCA. 2. The construction and operation of the proposal shall not result in an unacceptable decline in water quality of the Ellen Brook as confirmed by monitoring for a period of 5 years post construction, <p>through implementation of the Inland Waters Environmental Quality – Hydrological Processes – Condition Environmental Management Plan approved by the CEO.</p>	Section 1
13-2	<p>The proponent shall prepare the Inland Waters Environmental Quality – Hydrological Processes – Condition Environmental Management Plan required by condition 8-1 on advice of the Department of Water.</p>	Section 9
13-3	<p>For the purpose of establishing trigger criteria required by condition 8-2(1), if adequate site specific water quality data is not available the proponent shall undertake baseline surveys prior to the commencement of ground disturbing activities in the GUWPCA and in the vicinity of Ellen Brook.</p>	Section 3 Refer to the Baseline Survey Plan (Coffey, 2017).
13-4	<p>In the event baseline surveys are required, the proponent shall prepare in consultation with the Department of Water, and submit a Baseline Survey Plan to the CEO. The Baseline Survey Plan shall:</p> <ol style="list-style-type: none"> 1. When implemented, determine the baseline water quality within the GUWPCA and the Ellen Brook. 2. Detail the proposed methodology for the baseline surveys. 3. Identify and spatially define the proposed survey locations and reference/control sites and provide rationale for the location of the sites. 4. Detail the proposed frequency and timing for the baseline surveys. 	Refer to the Baseline Survey Plan (Coffey, 2017).
13-5	<p>After receiving notice in writing from the CEO that the Baseline Survey Plan satisfies the requirements of condition 13-4, the proponent shall undertake the baseline surveys in accordance with the requirements of the Baseline Survey Plan.</p>	Refer to the Baseline Survey Plan (Coffey, 2017).

Condition No.	Condition	Section in this plan
13-6	On completion of the baseline surveys the proponent shall report to the CEO on the following: <ol style="list-style-type: none"> 1. Completion of the baseline surveys in accordance with the Baseline Survey Plan; and 2. The results of the baseline surveys. 	Upon completion of baseline surveys, a report detailing the results of the baseline survey will be provided to the CEO.
13-7	The proponent shall specify threshold criteria that are consistent with the Australian Drinking Water Guidelines (NHMRC & ARMCANZ 1996), or its revisions, as required by condition 8-2(2).	Section 3.2.3
13-8	The proponent shall not construct any laydown areas, stock piles or store chemicals within the well head protection zones in the GUWPCA.	Section 6
13-9	Any fuel or chemicals stored within the GUWPCA shall: <ol style="list-style-type: none"> 1. Be contained within double-lined fuel storage tanks. 2. Not exceed an individual storage tank capacity of 5,000 L. 3. Be placed in bunds capable of storing 125% of the capacity of the largest storage tank. 4. Not be located within well head protection zones. 	Section 6
13-10	The proponent shall not construct infiltration basins, including bio-retention basins, within 100 m of drinking water production wells within the GUWPCA.	Section 6

2.4 Management Approach

Implementation of a proposal-specific management approach will ensure the condition environmental outcome for the proposal is met. The management approach to meet the condition environmental outcome stated in Table 1 was developed using results of baseline surveys. Eleven sampling events comprise the baseline at the time of preparation of this plan.

Review of the baseline survey results identified key assumptions and uncertainties associated with the management approach. It also provided rationale to support trigger criteria, threshold criteria, trigger level actions and threshold contingency actions developed to ensure the condition environmental outcome is met.

The management approach for potential impacts from the proposal on the identified environmental values is a monitoring and management program that identifies, monitors and manages indicators (environmental criteria) for groundwater quality of the GUWPCA and surface water quality of the Ellen Brook. This program defines trigger and threshold criteria to determine whether the environmental outcome is being met or, if the criteria are exceeded, additional actions need to be taken.

In accordance with condition 8-3, this plan will continue to be implemented until the CEO of the DWER has advised that the environmental outcome has been met and the plan is no longer required to be implemented.

2.5 Key Assumptions and Uncertainties

The following assumptions have been made:

- 
- The majority of the proposal footprint is a highly altered environment, with a variety of land uses including residential properties, farming properties, plantations and recreational areas.
 - Dewatering, abstraction and/or ground disturbance activities in a known or suspected ASS risk area will be managed through site-specific ASS management plans (ASSMPs) in line with DER ASS management guidelines (Treatment and management of soil and water in ASS landscapes (DER, 2015)). As such, monitoring and management requirements for ASS and dewatering are not presented in this plan.
 - Dewatering and abstraction licence provisions are separate to this plan. Dewatering and abstraction activities will be avoided where possible by conducting construction activities in the appropriate season. If dewatering or abstraction activities are required, management conditions for dewatering and abstraction will be included in the relevant licence issued by the Department of Water (DOW) under the *Rights in Water and Irrigation Act 1914*. Where required, a hydrogeological assessment and an operating strategy will be developed to support the licence application informing the dewatering management strategy. Monitoring requirements as part of the licence will confirm predictions made by the hydrogeological assessment to minimise risks to key environmental factors.
 - The half-life of glyphosate in soils ranges from 2 to 197 days. However, it binds tightly to soil and is expected to be relatively immobile with low potential to contaminate groundwater. The use of glyphosate directly within surface water bodies is not proposed.

Key uncertainties are as follows:

- Final design and construction details of the proposal were not known at time of preparing this plan. Following final design, this plan may be revised in order to manage and target specific construction activities and locations within the proposal footprint.

3 TRIGGER AND THRESHOLD CRITERIA

This section sets out the trigger and threshold criteria adopted to meet the condition environmental outcome. A discussion on how the trigger and threshold criteria have been set follows.

3.1 Trigger and Threshold Criteria

Trigger criteria are set conservatively to ensure trigger level actions can be implemented well in advance of the environmental outcome being compromised.

Threshold criteria are designed to measure achievement of the environmental outcome. Failure to meet threshold criteria signals the environmental outcome is not being met.

Trigger and threshold criteria to meet the condition environmental outcomes are set out in Table 4.

Table 4 Trigger and threshold criteria

	Trigger criteria	Threshold criteria
Environmental criteria 1	Groundwater quality trigger criteria listed in Appendix B.	Groundwater quality threshold criteria listed in Appendix B.
Environmental criteria 2	Surface water quality trigger criteria listed in Appendix C.	Surface water quality threshold criteria listed in Appendix C.

Note: the trigger and threshold criteria are too numerous to detail in the body of this document and are instead listed in appendices to this Condition EMP. The trigger and threshold criteria in the appendices are summarised as high-level groundwater and surface water quality criteria in Table 4 for the purpose of overall compliance reporting.

Refer to Section 5 for trigger level actions and threshold contingency actions that must be implemented if the trigger criteria or threshold criteria are exceeded.

3.2 Rationale for Selection of Trigger and Threshold Criteria

In accordance with condition 13-7, threshold criteria are required to be consistent with the Australian Drinking Water Guidelines (ADWG) (NHMRC and NRMCC, 2011).

In accordance with condition 13-3, trigger criteria are required to be established with reference to site-specific water quality data or baseline survey water quality data. Trigger and threshold criteria have been set using water quality data obtained in a baseline survey that has included 16 sampling events undertaken by Coffey and four sampling events undertaken by Great Northern Connect (GNC), the construction contractor engaged by Main Roads to construct the southern section of the PDNH and conduct ongoing groundwater and surface water monitoring for that section in accordance with this plan.

Trigger criteria provide an advance warning that threshold criteria may be exceeded, which requires trigger criteria to be set below the corresponding threshold criteria.

Where baseline levels exceed the guideline values set out in the Australian Drinking Water Guidelines, threshold criteria (and trigger criteria) based on baseline levels will be proposed.

The following sections provide more detail and background on this approach.

3.2.1 Baseline Surveys and Assessments

A monthly baseline groundwater and surface water survey commenced in December 2015 and concluded in April 2017. Groundwater and surface water monitoring during road construction has continued using the same sampling methodology applied during the baseline survey. A review of the results collected by GNC has been undertaken and the data is considered suitable to supplement the baseline survey dataset. As such, results from 16 baseline survey and four construction monitoring events have informed the preparation of this plan.

The objectives of the baseline survey were to:

- Determine groundwater and surface water baseline values of the GUWPCA and Ellen Brook for monitoring future project environmental performance.
- Inform the selection of trigger and threshold criteria.

The compiled dataset has demonstrated some analytes (e.g., aluminium, cadmium, zinc) are commonly elevated within groundwater resources along the proposal alignment (Coffey, 2017). Recorded concentrations for some analytes at some sites exceed the guideline values in the ADWG by many multiples.

3.2.2 Analytes

Water quality is determined by a range of parameters relating to physical, chemical and other properties of water.

The analytes used to measure groundwater and surface water quality are based on the:

- Analytes listed in the ADWG (NHMRC and NRMCC, 2011).
- Contaminants that have the potential to be introduced to groundwater and/or surface water from activities (e.g., earthworks resulting in erosion and/or the disturbance of ASS) or incidents (e.g., accidental chemical/hydrocarbon spills).
- Potential contaminants that may be introduced from proposal activities including chemical/hydrocarbon spills, disturbance of ASS and erosion/earthworks.
- Disturbance of naturally occurring high levels of potential pollutants such as metals and nutrients.

Baseline survey monitoring for total recoverable hydrocarbons, benzene, toluene, ethylbenzene and xylenes (BTEX) and organochlorine and organophosphorus pesticides (OCP/OPP) occurred for baseline survey events 3, 6 and 12. There were no detections at the survey sites above the limit of reporting (LOR) for all TRH/BTEX and OCP/OPP analytes. Given that proposal activities include the use of hydrocarbons and BTEX, these analytes have been included in the monitoring provisions. Following the non-detection of OCP/OPP, these analytes will not be monitored, given that proposal activities do not include their use.

The analytes used to determine water quality in this plan are listed in Table 5.



Table 5 Analytes to be monitored under this plan

Group	Indicators/analytes
Metals	<ul style="list-style-type: none"> • Aluminium (Al) • Arsenic (As) • Cadmium (Cd) • Chromium (Cr) • Copper (Cu) • Iron (Fe) • Lead (Pb) • Manganese (Mn) • Mercury (Hg) • Nickel (Ni) • Selenium (Se) • Zinc (Zn)
Total recoverable hydrocarbons (TRH)/benzene, toluene, ethylbenzene and xylenes (BTEX)	<ul style="list-style-type: none"> • TRH C6-C10 • TRH >C10-C40
Polycyclic aromatic hydrocarbons (PAH)	<ul style="list-style-type: none"> • Total PAHs
Nutrients and physical parameters	<ul style="list-style-type: none"> • Acidity (as CaCO₃) • Nitrogen (total) • pH • Phosphate (total) (P) • Phosphorus (reactive as P) • TDS • Turbidity (surface water only)
Herbicide	<ul style="list-style-type: none"> • Glyphosate (during landscaping works)

3.2.3 Method for Setting Threshold Criteria

Threshold criteria for each analyte are set separately. Groundwater and surface water threshold criteria are also set separately.

The relevant drinking water health value from the ADWG (NHMRC and NRMCC, 2011) is adopted as the threshold criterion unless the relevant aesthetic value is a more onerous value, e.g. pH, where for aesthetic purposes a higher standard is required than for health.

In some instances, baseline levels of an analyte recorded at one or more survey sites exceed the guideline value provided in the ADWG. Where the maximum baseline value equals or exceeds the guideline value provided in the ADWG, a site-specific threshold criterion is set at one standard deviation of the baseline dataset for that site above the maximum baseline value for that site. Adding one standard deviation (representing the dispersion of the data set from the mean) to the baseline maximum, and also taking into



account the low range between minimum and maximum values at most locations, will allow for assessment of deviation from threshold levels whilst at the same time reducing the risk of a triggering a Type II error i.e. the risk of claiming a pollution event is acceptable. This method of setting site-specific threshold criteria is consistent with the condition environmental outcome in condition 13-1, which requires that the proposal not result in an unacceptable decline in water quality.

In accordance with condition 13-7, the latest revision (November 2016) of the ADWG (NHMRC and NRMCC, 2011) was used for setting threshold criteria. It is noted that the ADWG do not specify guideline values for all analytes listed in Table 5. In these cases, other appropriate references have been consulted in accordance with the ADWG in order to obtain the next most relevant and appropriate guidance. These include:

- Australian Water Quality Guidelines (ANZECC and ARMCANZ, 2000a).
- Treatment and Management of Soil and Water in Acid Sulfate Soil Landscapes (DER, 2015).

A modified method for determining threshold criteria applies for pH, which requires a range to be set. As stated in Table 2, the potential impacts of the proposal's construction on groundwater and surface water is a decrease in pH resulting from dewatering activities. The baseline survey showed pH to be already generally in the acidic range and often outside the guideline range of 6.5 to 8.5 (Coffey, 2016b). A site-specific lower threshold criterion for pH is set at the lower trigger criterion minus 1. The upper threshold criterion is set at the upper trigger criterion plus 1. This method is consistent with DER guidance for managing acid sulfate soils (DER, 2015), which recommends adopting a deviation of 1 from "baseline values" as a threshold for increased management. Baseline values are taken in this context to be equivalent to the baseline range, which, given the limited number of samples in the baseline, can be represented by the baseline maximum (or minimum) plus (or minus) one standard deviation, i.e. the trigger values as established in Section 3.2.4.

Standard deviations, maxima and minima are all calculated after discarding outliers from the dataset. Outliers are excluded in accordance with the statistical method suggested in the Australian Guidelines for Water Quality Monitoring and Reporting (ANZECC and ARMCANZ, 2000b), where results more than four standard deviations from the mean may be considered outliers.

3.2.4 Method for Setting Trigger Criteria

Trigger criteria for each analyte are set separately. Groundwater and surface water threshold criteria are also set separately.

Previously, due to the limited number of samples used to develop trigger criteria these were set at 75% of the guideline value in cases where the guideline value has been adopted as the threshold criteria. Upon review of the baseline data set comprising of 20 monitoring events, it is considered that trigger criteria can be set at 80% of the ADWG guideline value and provide adequate early warning of threshold criteria being approached. With reference to the baseline survey, all trigger criteria set in this way are greater than the relevant limits of reporting (LOR).

In some instances, baseline levels of an analyte recorded at one or more survey sites exceed the guideline value. Where two or more of the baseline dataset equals or exceeds the guideline value, a site-specific trigger criterion is set. Previously, using methods presented within ANZECC and ARMCANZ (2000), site-specific trigger was calculated using the 75th percentile of the baseline value as a trigger. However, additional data has provided confidence in the data set and it is considered the site specific trigger level can be set at the 80th percentile of the data set in accordance with the ANZECC and ARMCANZ (2000) methodology.

A modified method for determining trigger criteria applies for pH, which requires lower and upper limits to be set. Trigger criteria are set individually for each site. The lower trigger criterion is set at the minimum baseline value minus one standard deviation. Due to the generally low pH values already recorded in the

baseline survey (Coffey, 2016b), the upper trigger criterion is set at the maximum baseline value plus one standard deviation.

Minimum and maximum baseline values and standard deviations are calculated on a site-by-site basis. All standard deviations are currently less than 1, resulting in lower trigger criteria that are always greater than corresponding lower threshold criteria. However, if further baseline data is collected and standard deviations increase to values greater than 1, then the method for setting lower trigger criteria and lower threshold criteria will require review.

3.2.5 Summary of Framework for Setting Trigger and Threshold Criteria

A summary of the framework for setting threshold and trigger criteria is provided in Table 6. This framework is applied per analyte per site.

Table 6 Framework for setting trigger and threshold criteria

Scenario	Threshold criteria	Trigger criteria
Parameters other than pH		
All baseline values are less than the guideline value	Set at 115% of the trigger value.	Set at guideline value.
Two or more baseline values are equal to or exceed the guideline value	Set at one standard deviation above maximum baseline value.	Set at 80th percentile of baseline dataset.
pH		
Upper limit	Set at upper trigger criterion plus 1.	Set at maximum baseline value plus one standard deviation.
Lower limit	Set at lower trigger criterion minus 1.	Set at minimum baseline value minus one standard deviation.

Note: Outliers are excluded from baseline. Guideline values are as set out in the Australian Drinking Water Guidelines (NHMRC and NRMCC, 2011).



This page is intentionally blank.



4 MONITORING

This section sets out monitoring provisions for determining whether trigger and threshold criteria are exceeded, and ultimately whether the condition environmental outcomes are being achieved. A discussion on how the monitoring provisions have been developed follows.

4.1 Monitoring Provisions

Monitoring will be undertaken along the extent of the proposal to determine whether the trigger and threshold criteria are being met.

Monitoring will be undertaken at 19 groundwater monitoring wells within and adjacent to the GUWPCA, as well as four surface water locations along Ellen Brook.

Monitoring will occur during construction and post-construction. In accordance with condition 8-3, monitoring will continue to be implemented until the CEO of the DWER has advised that the environmental outcome has been met and the plan is no longer required to be implemented.

The monitoring provisions in this plan are set out in Table 7. The monitoring sites listed in Table 7 are shown on Figure 2 and their coordinates provided in Appendix A. Four groundwater monitoring wells (MW11, MW18, MW21 and MW24) have been relocated due to the road alignment covering these locations. The locations of the replacement wells (MW11A, MW18A, MW21A and MW24A) are presented on Figure 2.

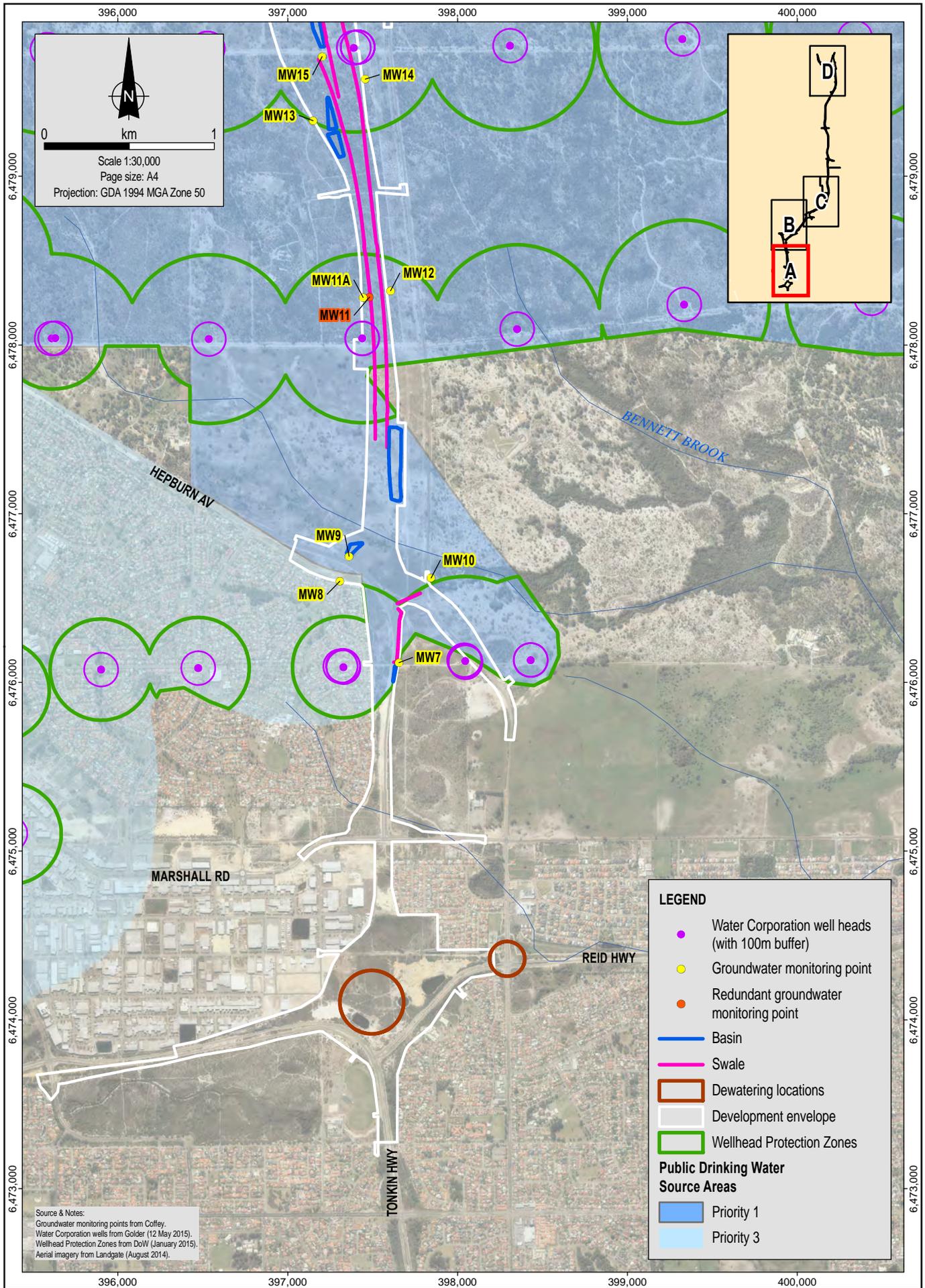
Note that sampling group GUWPCA (Whiteman-Yanchep Highway) is not currently being monitored. The monitoring sites within this group are associated with the section of the Whiteman-Yanchep Highway that will join the PDNH south of Gngara Road. Monitoring of this sampling group will commence when construction commences on the Whiteman-Yanchep Highway and its interchange with PDNH.

Table 7 Monitoring provisions

Environmental value	Method summary	Monitoring sites ¹	Parameters to be analysed ²	Frequency (during construction)	Frequency (post-construction)
Groundwater quality in GUWPCA Surface water quality in Ellen Brook	<p>Groundwater quality:</p> <ul style="list-style-type: none"> Gauge 19 groundwater monitoring wells. Measure physicochemical water quality, using a calibrated water quality meter. Collect groundwater samples using a passive sampling device or other industry accepted method deemed suitable for groundwater monitoring purposes. <p>Surface water quality:</p> <ul style="list-style-type: none"> Measure physicochemical water quality at four surface water locations and collect samples. To ensure a representative and comparable baseline dataset, three surface water samples are to be collected from each wetland sampling location. <p>All sampling is to be undertaken in accordance with relevant guidelines and standard operating procedures.</p>	<p>Sampling group GUWPCA (PDNH)</p> <p>MW7, MW8, MW9, MW10, MW11A, MW12, MW13, MW14, MW15, MW18A, MW19, MW20, MW21A, MW22, MW23, MW24A, MW25</p>	<ul style="list-style-type: none"> Metals Nutrients and physical parameters 	<p>Fortnightly in active dewatering zones.</p> <p>Monthly in construction zones.</p> <p>Quarterly in all other areas (March, June, September and December).</p>	Biannually (March and September).
		<p>Sampling group GUWPCA (Whiteman-Yanchep Highway)³</p> <p>MW16, MW17</p>	<ul style="list-style-type: none"> Total PAHs TRH C6-C10 TRH >C10-C40 	<p>Monthly in construction zones.</p> <p>Quarterly in all other areas (March, June, September and December).</p>	
		<p>Sampling group Ellen Brook</p> <p>SWL18, SWL21, SWL22</p>	<ul style="list-style-type: none"> Herbicide (glyphosate) 	<p>Quarterly – only during landscaping works.</p>	

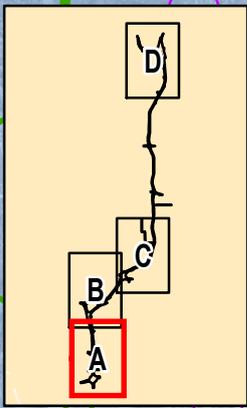
Notes:

1. Refer to Appendix A for monitoring site coordinates. The locations of monitoring sites are shown on Figure 2.
2. Refer to Table 5 for details of which parameters are included in each grouping.
3. Sampling group GUWPCA (Whiteman-Yanchep Highway) will be monitored only when construction on the Whiteman-Yanchep Highway interchange has commenced.



0 1 km

Scale 1:30,000
Page size: A4
Projection: GDA 1994 MGA Zone 50



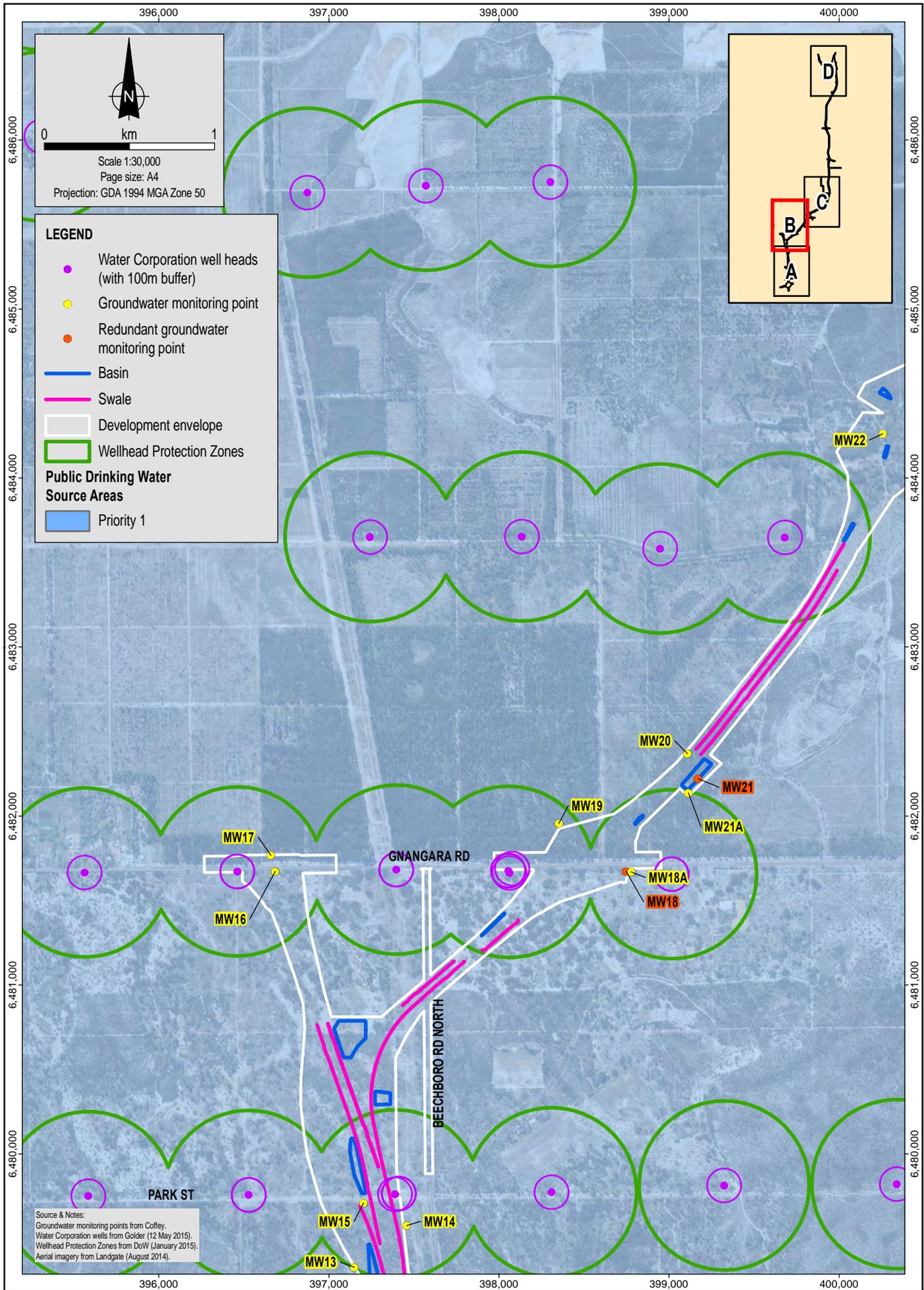
LEGEND

- Water Corporation well heads (with 100m buffer)
- Groundwater monitoring point
- Redundant groundwater monitoring point
- Basin
- Swale
- Dewatering locations
- Development envelope
- Wellhead Protection Zones

Public Drinking Water Source Areas

- Priority 1
- Priority 3

Source & Notes:
Groundwater monitoring points from Coffey.
Water Corporation wells from Golder (12 May 2015).
Wellhead Protection Zones from DoW (January 2015).
Aerial imagery from Landgate (August 2014).



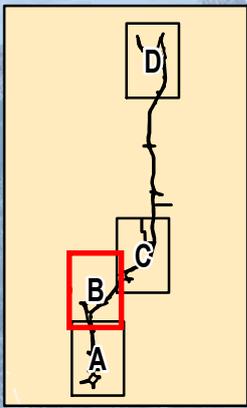
Scale 1:30,000
Page size: A4
Projection: GDA 1994 MGA Zone 50

LEGEND

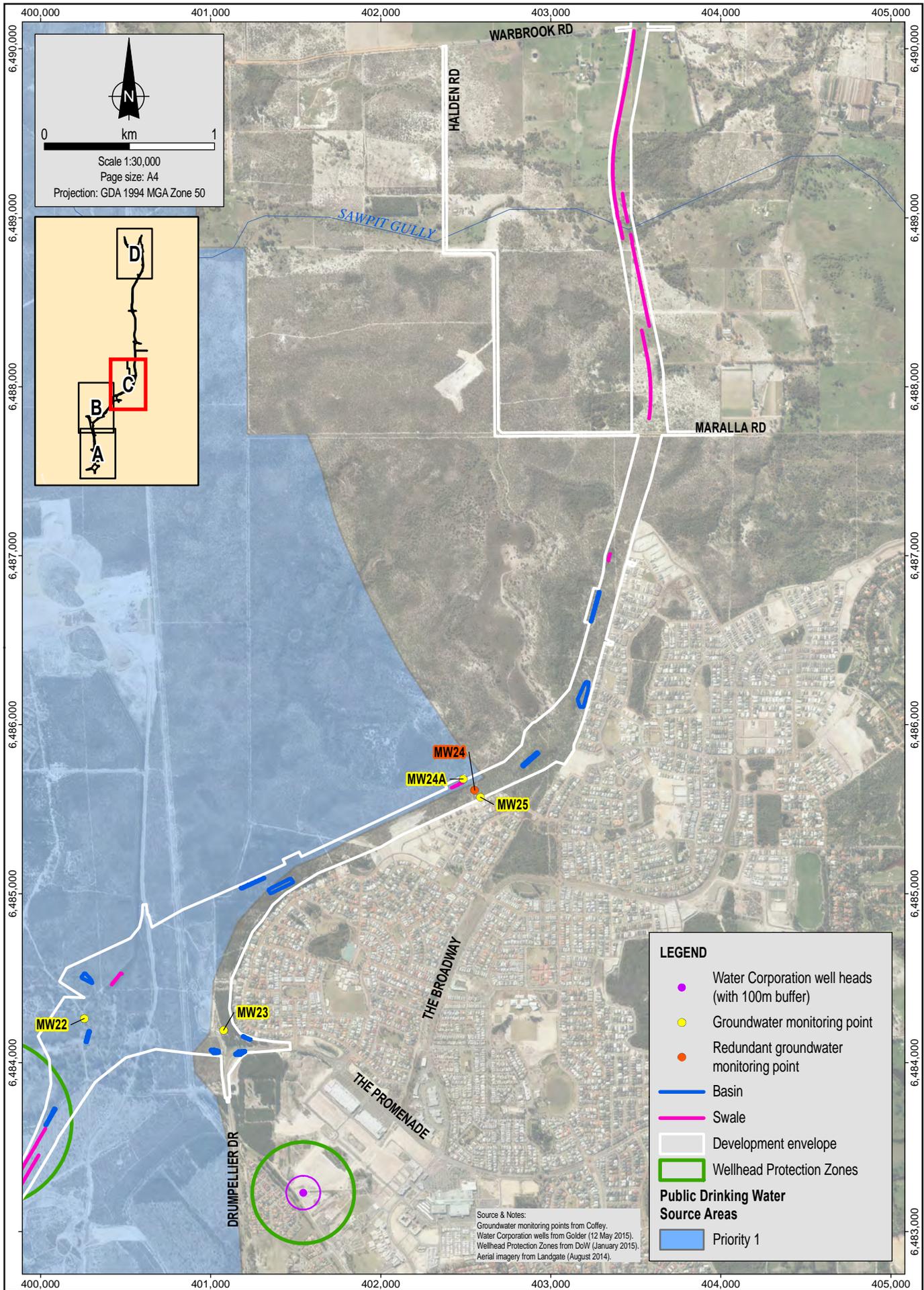
- Water Corporation well heads (with 100m buffer)
- Groundwater monitoring point
- Redundant groundwater monitoring point
- Basin
- Swale
- Development envelope
- Wellhead Protection Zones

Public Drinking Water Source Areas

- Priority 1

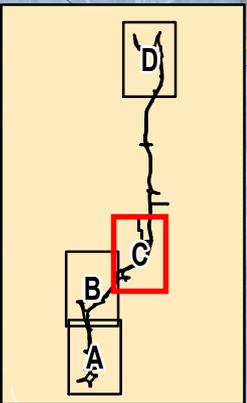


Source & Notes:
Groundwater monitoring points from Coffey.
Water Corporation wells from Golder (12 May 2015).
Wellhead Protection Zones from DoW (January 2015).
Aerial imagery from Landgate (August 2014).



0 1 km

Scale 1:30,000
Page size: A4
Projection: GDA 1994 MGA Zone 50



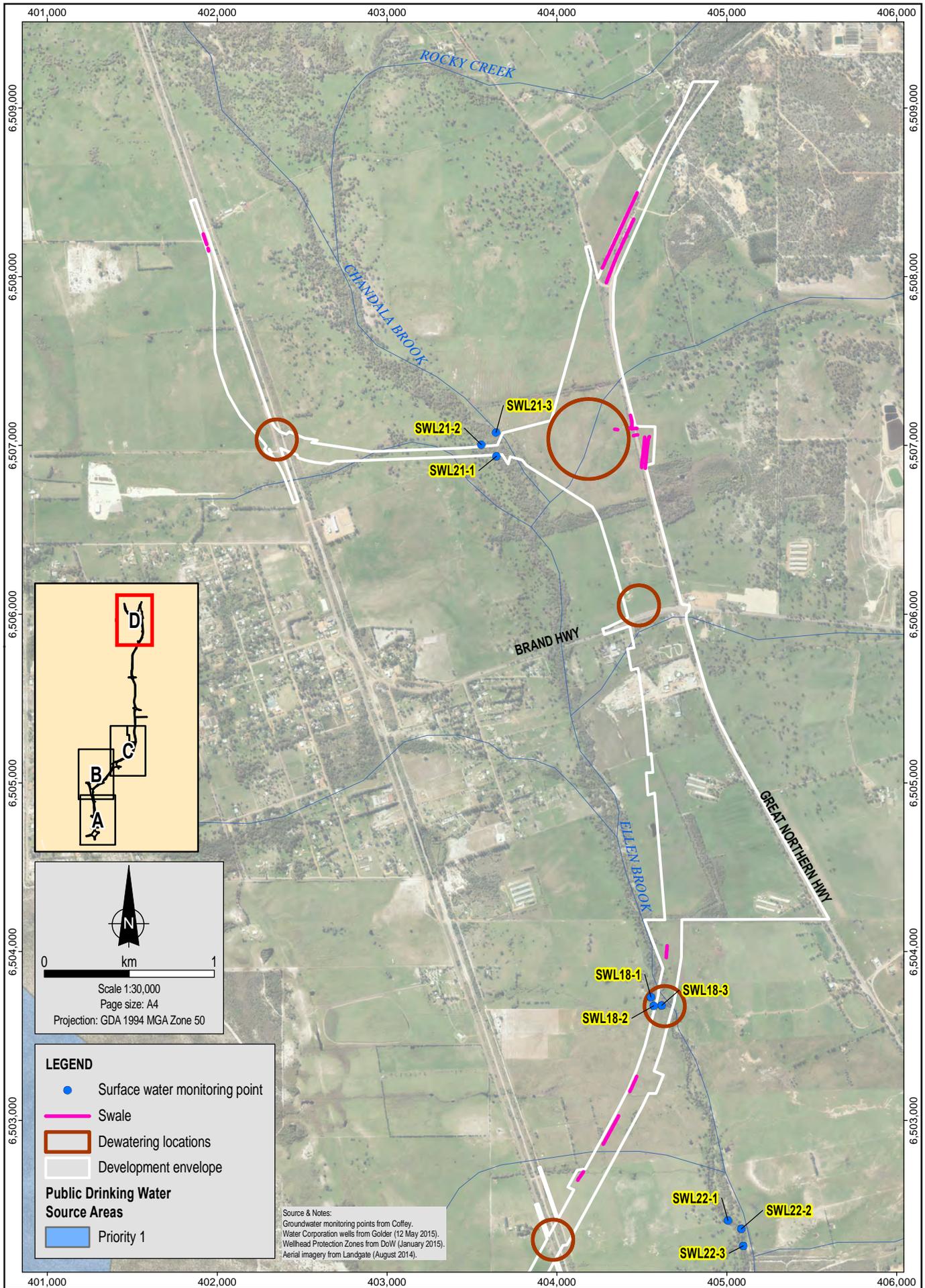
LEGEND

- Water Corporation well heads (with 100m buffer)
- Groundwater monitoring point
- Redundant groundwater monitoring point
- Basin
- Swale
- Development envelope
- Wellhead Protection Zones

Public Drinking Water Source Areas

- Priority 1

Source & Notes:
Groundwater monitoring points from Coffey.
Water Corporation wells from Golder (12 May 2015).
Wellhead Protection Zones from DoW (January 2015).
Aerial imagery from Landgate (August 2014).





4.2 Monitoring Method

The monitoring method to be used is summarised in Table 7.

At each surface water location, three samples will be taken to ensure a representative and comparable monitoring dataset is collected for the surface water monitoring site. Figure 2 shows the three sample locations for each surface water monitoring site.

Groundwater and surface water monitoring will be undertaken in accordance with the following regulatory guidelines and standards:

- National Environment Protection (Assessment of Site Contamination) Measure 1999 (amended 2013), Schedule B2: Guideline on Data Collection, Sample Design and Reporting.
- Department of Water Field Sampling Guidelines: A guideline for Field Sampling for Surface Water Quality Monitoring Programs (DOW, 2009).
- Department of Environment Regulation's Treatment and Management of Soil and Water in Acid Sulfate Soil Landscapes (DER, 2015).
- Department of Environment Regulation's Contaminated Sites Guidelines: Assessment and Management of Contaminated Sites (DER, 2014).
- Australian Standard AS 5667.4:1998 Water Quality-Sampling – Guidance on Sampling from Lakes, Natural and Man-made.
- Australian Standard AS 5667.6:1998 Water Quality Sampling – Guidance on Sampling of Rivers and Streams.
- Australian Standard AS 5667.11:1998 Water Quality-Sampling – Guidance on Sampling of Groundwaters.

Laboratories accredited by the National Association of Testing Authorities (NATA) will be used for the analyses.

The sites used as part of the baseline groundwater and surface water survey will be used as monitoring sites for this plan throughout the life of the project, wherever possible.

With regards to surface water pH and turbidity indicators, additional visual indicators that the Ellen Brook may be acidifying will also be noted during the monitoring program, including disappearance of fringing vegetation, increasing iron staining and appearance of flocculating yellow crusts of secondary iron and aluminium sulfate minerals in sediments near the water line in summer months (DER, 2015). If works occur in areas requiring an ASSMP, then the relevant ASS management guidelines, including trigger levels and thresholds, will be followed.

Further details on the monitoring method can be found in the Inland Waters Environmental Quality – Hydrological Processes – Baseline Survey Plan (Coffey, 2017).

In accordance with condition 13-1(2), monitoring of the Ellen Brook will be undertaken post-construction for five years, after which the monitoring provisions will be reviewed to determine if ongoing monitoring is required. Ongoing monitoring of the GUWPCA and the Ellen Brook will be undertaken biannually in March and September. Further details are set out in Table 7.



4.3 Rationale for Monitoring Provisions

4.3.1 Methods

The methods outlined in Table 7 and Section 4.2 are based on best practice and adherence to relevant guidelines and standard operating procedures. The methods has been kept as consistent as practicable with the monitoring method used for the baseline survey, which is set out in the Inland Waters Environmental Quality – Hydrological Processes – Baseline Survey Plan (Coffey, 2017).

4.3.2 Monitoring Site Locations

The location of groundwater and surface water monitoring sites is based on the known groundwater and surface water flow directions, location of infiltration and retention basins and risks to environmental values of the Gngangara Mound and the Ellen Brook. The monitoring site locations are also proxies for ecological sites relevant to the Gngangara Mound and Ellen Brook. Sampling groups have been defined for water quality in the GUWPCA and Ellen Brook. The monitoring sites are shown in Figure 2 and listed in Appendix A.

The groundwater and surface water monitoring network will enable identification of local and regional changes in water quality in the vicinity of identified sensitive receptors.

4.3.3 Acid Sulfate Soils

Environmental impacts may occur in ASS areas where dewatering or ground disturbance is proposed (Figure 2). Dewatering or groundwater disturbance in an ASS location (including dewatering discharge) will be managed through a site-specific ASSMP in accordance with the guideline Treatment and management of soil and water in acid sulfate soil landscapes (DER, 2015).

A sufficient level of ASS assessment pre-disturbance will be undertaken in accordance with DER guidelines, where groundwater disturbance activities are proposed in order to characterise ASS risk. As stated in Section 2.5.2, monitoring and management of ASS is not covered in this plan.

5 TRIGGER LEVEL ACTIONS AND THRESHOLD CONTINGENCY ACTIONS

This section details the trigger level actions and threshold contingency actions that will be implemented in the event that trigger criteria or threshold criteria are exceeded.

5.1 Trigger Level Actions

Trigger level actions have been developed and will be implemented immediately if the trigger criteria are exceeded.

Trigger level actions aim to prevent an exceedance of threshold criteria so that the threshold criteria are safeguarded. Trigger level actions will investigate the cause of exceedances and introduce measures to reduce the impact, including increasing the frequency of monitoring during high-risk activities or to determine if a trend is establishing. Trigger level actions will continue to be implemented until trigger criteria are met or the CEO of the DWER confirms in writing that the environmental outcome is being met and that trigger level actions are no longer required to be implemented.

Trigger criteria will be considered to be exceeded if it is determined following investigation that the exceedance is project-attributable.

Table 8 sets out the trigger level actions to be implemented immediately if trigger criteria are exceeded.

Table 8 Trigger level actions

Parameter	Trigger	Trigger level actions
Groundwater and surface water quality	Exceedance of water quality trigger criteria	<ol style="list-style-type: none"> 1. Confirm validity of result (i.e., review sampling procedures, review dataset). 2. Review results from nearby monitoring locations, where available. 3. Investigate if cause for change is due to the construction or operation of the proposal. If results are assessed to be likely due to the construction or operation of the proposal, the exceedance is considered to be project-attributable and the trigger criteria are considered to have been exceeded. <p>For project-attributable exceedances of trigger criteria:</p> <ol style="list-style-type: none"> 4. Resample affected monitoring location as soon as practicable and review the result no later than one week following resampling. If total TRH or total PAH trigger levels are exceeded, request speciation of the sample as per respective analytes shown in Appendix E to determine which constituents are present. 5. If both rounds of monitoring show trigger levels have been exceeded, increase frequency of monitoring in order to further assess changes. 6. Notify the CEO within 7 days of becoming aware of the exceedance. 7. Identify and implement relevant alternative activities that do not contribute to the exceedance. 8. Identify additional measures required to prevent the trigger level being exceeded in the future (refer to Section 8.1 for potential adaptive management actions).

Parameter	Trigger	Trigger level actions
		9. Provide a report to the CEO within 60 days from the date of awareness of the exceedance. For all exceedances of trigger criteria: 10. Document the trigger exceedance for later inclusion in the annual Compliance Assessment Report (see Section 7.2).

5.2 Threshold Contingency Actions

Threshold contingency actions have been developed and will be implemented immediately if threshold criteria are exceeded.

An exceedance of the threshold criteria indicates the environmental outcome is not being met. The aim of threshold contingency actions is to prevent further damage to the environment, ascertain the extent of impact and remediate or rectify damage, where required. Initial investigations will determine probable causes and halt activities that may be contributing.

Threshold contingency actions will be implemented to mitigate and manage the impact to below threshold and trigger criteria to achieve the environmental outcome. Threshold level actions will continue to be implemented until trigger criteria are met or the CEO of the DWER confirms in writing that the environmental outcome is being met and that threshold level actions are no longer required to be implemented.

Table 9 sets out the threshold contingency actions to be implemented immediately if the threshold criteria are exceeded.

Table 9 Threshold contingency actions

Parameter	Trigger	Threshold contingency actions
Groundwater and surface water quality	Exceedance of water quality threshold criteria	1. Confirm validity of result (i.e. review sampling procedures, review dataset). 2. Notify the CEO within 7 days of becoming aware of the exceedance. 3. Review results from nearby monitoring locations, where available. 4. Investigate if cause for change is due to construction or operation of the proposal. If results are assessed to be likely due to construction or operation of the proposal, the exceedance is considered to be project-attributable. 5. For a project-attributable exceedance, halt relevant activities. Remediate, where necessary. 6. Continue monitoring including effectiveness of remediation to determine potential environmental harm or alteration of the environment. 7. Identify additional measures required to prevent the threshold level being exceeded in the future (refer to Section 8.1 for potential adaptive management actions). 8. Regardless of whether the threshold exceedance is project-attributable, provide a report to the CEO within 60 days from the date of awareness of the exceedance. 9. Document the threshold exceedance for later inclusion in the annual Compliance Assessment Report (see Section 7.2).

6 OTHER CONDITIONED REQUIREMENTS

This section contains requirements of the conditions that are not provided for elsewhere in this plan.

Conditions 13-8, 13-9 and 13-10 of Ministerial Statement No. 1036 contain requirements that will be implemented as part of this outcome-based Condition EMP. These requirements are listed in Table 10. While the construction and operation of the proposal is required to meet the environmental outcome in condition 13-1, the requirements listed in Table 10 will only be implemented during construction, as they are only relevant to construction activities.

Table 10 Other conditioned requirements

Condition No.	Requirement
13-8	The proponent shall not construct any laydown areas, stock piles or store chemicals within the well head protection zones in the GUWPCA.
13-9	Any fuel or chemicals stored within the GUWPCA shall: <ul style="list-style-type: none">• Be contained within double-lined fuel storage tanks.• Not exceed an individual storage tank capacity of 5,000 L.• Be placed in bunds capable of storing 125% of the capacity of the largest storage tank.• Not be located within well head protection zones.
13-10	Infiltration basins, including bio-retention basins will not be constructed within 100 m of drinking water production wells within the GUWPCA.

Appendix D shows the typical design of bio-retention swales and basins. Appendix D and the locations of bio-retention swales and basins shown on Figure 2 are required to be included in this plan in order to enable the Infrastructure Plan to be approved with respect to condition 6-2(4). Aside from this purpose, Appendix D has no further relevance to or bearing on the provisions of this Inland Waters Environmental Quality – Hydrological Processes – Condition EMP.



This page is intentionally blank.

7 REPORTING

7.1 Monitoring Report

A monitoring report will be prepared after each monitoring event to summarise the results of monitoring. These results will be provided in the annual compliance assessment report (CAR).

7.2 Annual Compliance Assessment Report

The first CAR will be submitted to the CEO, 15 months from the date of issue of Ministerial Statement No. 1036, then annually from the date of submission of the first CAR, or otherwise agreed in writing by the CEO.

The annual CAR will include:

- Climate and rainfall information.
- Demonstration of management implemented.
- Documentation of monitoring undertaken.
- Comparison of monitoring results against baseline and evaluation against the trigger and threshold criteria.
- A listing of all exceedances of trigger criteria (whether project-attributable or not) and exceedances of threshold criteria.
- Any management or contingency actions undertaken where trigger criteria and/or trigger and threshold criteria are exceeded in the reporting period and an analysis of trends.

Table 11 sets out a reporting template for this plan against the condition environmental outcome and environmental criteria to be included in the CAR.

Table 11 Condition EMP reporting table

Inland Waters Environmental Quality – Hydrological Processes – Condition Environmental Management Plan Ministerial Statement No. 1036, condition 13		
Condition environmental outcome	Reporting on the threshold criteria	Status¹
Condition environmental outcome 1: Construction and operation of the proposal shall not result in an unacceptable decline in water quality of the GUWPCA.	The groundwater quality threshold criteria listed in Appendix B were met.	Yes / No
Condition environmental outcome 2: Construction and operation of the proposal shall not result in an unacceptable decline in water quality of the Ellen Brook as confirmed by monitoring for a period of 5 years post construction.	The surface water quality threshold criteria listed in Appendix C were met.	Yes / No



Inland Waters Environmental Quality – Hydrological Processes – Condition Environmental Management Plan Ministerial Statement No. 1036, condition 13		
Conditioned management actions	Reporting on other conditioned requirements	Status ¹
<p>Condition 13-8:</p> <p>The proponent shall not construct any laydown areas, stock piles or store chemicals within the well head protection zones in the GUWPCA.</p>	No laydown areas or stockpiles were constructed and no chemicals were stored within the well head protection zones in the GUWPCA.	Yes / No
<p>Condition 13-9:</p> <p>Any fuel or chemicals stored within the GUWPCA shall:</p> <ol style="list-style-type: none"> 1. be contained within double-lined fuel storage tanks; 2. not exceed an individual storage tank capacity of 5,000 L; 3. be placed in bunds capable of storing 125% of the capacity of the largest storage tank; and 4. not be located within well head protection zones. 	All fuel and chemicals stored within the GUWPCA were contained within double-lined fuel storage tanks, were not stored in a tank with greater than 5,000 L capacity, were placed in bunds capable of storing 125% of the capacity of the largest storage tank, and were not located within well head protection zones.	Yes / No
<p>Condition 13-10:</p> <p>The proponent shall not construct infiltration basins, including bio-retention basins, within 100 m of drinking water production wells within the GUWPCA.</p>	No infiltration basins or bio-retention basins were constructed within 100 m of drinking water production wells within the GUWPCA.	Yes / No

Notes:

1. The status of achievement of the condition environmental outcomes and conditioned management actions is indicated as follows:
 Yes – condition environment outcome or conditioned management action achieved.
 No – condition environmental outcome or conditioned management action not achieved.

7.3 Reporting on Exceedance of the Trigger and/or Threshold Criteria

Table 12 lists exceedance of environmental criteria reporting requirements as specified in Ministerial Statement No. 1036.

Table 12 Reporting requirements

Condition	Reporting requirement	Reporting timeframe
4-5	Advise the CEO of any potential non-compliance within seven (7) days of that non-compliance being known.	Within 7 days of known non-compliance.
4-6(3)	The Compliance Assessment Report shall identify all potential non-compliances and describe corrective and preventative actions taken.	As required for the CAR (see Section 7.2).
8-4(1)	In the event that monitoring indicates exceedance of trigger criteria and/or threshold criteria specified in the Condition EMPs, the proponent shall: <ol style="list-style-type: none"> 1. Report the exceedance in writing within 7 days of the exceedance being identified. 	For exceedances of the threshold criteria and project-attributable exceedances of the trigger criteria – written notification to the CEO within 7 days becoming aware of the exceedance.
8-4(6)	Provide a report to the CEO within 60 days of the exceedance being reported. The report shall include: <ol style="list-style-type: none"> a) Details of trigger level actions or threshold contingency actions implemented. b) The effectiveness of the trigger level actions or threshold contingency actions implemented, monitored and measured against trigger criteria and threshold criteria. c) The findings of the investigations required by conditions 8-4(3) and 8-4(5). d) Additional measures to prevent the trigger or threshold criteria being exceeded in the future. e) Measures to prevent, control or abate the environmental harm which may have occurred. 	For exceedances of the threshold criteria and project-attributable exceedances of the trigger criteria – investigation report submitted to the CEO within 60 days of becoming aware of the exceedance.



This page is intentionally blank.

8 ADAPTIVE MANAGEMENT AND REVIEW

8.1 Adaptive Management

Adaptive management will be implemented to learn from the implementation of management measures, monitoring and evaluation against the environmental criteria, to more effectively meet the condition environmental outcome.

Potential adaptive management actions may include, but are not limited to, the following:

1. Identification of LOR equivalent trigger level value exceedance:
 - Determine/investigate cause/source.
 - Conduct different laboratory analysis with lower LOR value below trigger level value.
 - Revise trigger level value as necessary.
 - Improve and implement additional trigger level actions or threshold contingency actions as necessary.
 - Monitor the success of remedial actions.
2. Exceedance of water quality trigger or threshold levels:
 - Determine/investigate cause/source.
 - Improve and implement additional trigger level actions or threshold contingency actions as necessary.
 - Monitor the success of remedial actions.
3. Identification of herbicide glyphosate concentrations in groundwater or surface water quality samples:
 - Determine/investigate cause/source.
 - Investigate other herbicides or compounds used.
 - Improve training and education for construction personnel on herbicide application and disposal.
 - Improve and implement additional trigger level actions or threshold contingency actions as necessary.
 - Monitor the success of remedial actions.

8.2 Review

This plan has been reviewed in accordance with the provisions set out in Section 8.2 of the previously approved version of this document, specifically:

- **Upon completion of the baseline survey.** To review and refine trigger and threshold criteria.
- **Annually.** To review and refine trigger and threshold criteria and other provisions following construction works.

This plan will be reviewed in accordance with condition 8-5 of Ministerial Statement No. 1036. Timing of reviews for this plan include:

- 
- **As required.** To determine if management, trigger and threshold criteria and trigger level and threshold contingency actions require review and revision.
 - **When directed by the CEO.** In accordance with condition 8-5(2).
 - **Following construction.** To evaluate applicability of monitoring provisions for operation.
 - **In the event a project-attributable exceedance of a threshold criterion is recorded.** To review and revise the plan, if required by the findings of the investigation report.

In relation to reviews in line with annual monitoring reporting, the potential reasons or triggers for revising management, trigger and threshold criteria, and trigger level and threshold contingency actions include:

- Changes to road design, construction and operation.
- Results of trend analysis in monitoring results.
- New or revised information becoming available on groundwater and surface water behaviour.
- Changes to state or federal legislation.
- Changes to the regulatory framework.

The implementation of this plan will be audited.

The latest version of this plan shall be implemented once the CEO has confirmed in writing that it satisfies the requirements of condition 8-2.

9 STAKEHOLDER CONSULTATION

MRWA consulted with stakeholders while developing this plan. This section provides a summary of consultation that occurred. The comments raised during consultation with stakeholders were considered in preparing this plan.

DOW was consulted in accordance with condition 13-2. Table 13 presents a summary of consultation and MRWA's response.

Table 13 Stakeholders consulted, comments and responses

Date	Organisation	Summary of consultation	MRWA response to comment/concern
17 October 2016	DOW	Workshop to discuss this plan and other Condition Environmental Management Plans, which have overlapping themes with this plan.	MRWA has taken into account DOW's comments and revised the plan where appropriate.



This page is intentionally blank.



10 REFERENCES

- ANZECC and ARMCANZ. 2000a. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Volume 1. the Guidelines. October. Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand.
- ANZECC and ARMCANZ. 2000b. Australian Guidelines for Water Quality Monitoring and Reporting. National Water Quality Management Strategy. No. 7. October. Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand.
- BG&E. 2015. Drainage Strategy. NorthLink WA Perth–Darwin National Highway. May. Report prepared for NorthLink WA by BG&E Pty Ltd.
- Burbidge, A. A., Kuchling, G. Olejnik, C. and Mutter, L. 2010. Western Swamp Tortoise (*Pseudemydura umbrina*) Recovery Plan. Wildlife Management Program No. 50. Department of Environment and Conservation, Western Australia.
- Coffey. 2016a. Compliance Assessment Plan. NorthLink WA Perth–Darwin National Highway. December. Plan prepared for NorthLink WA by Coffey Services Australia Pty Ltd, Burswood, Western Australia.
- Coffey. 2016b. Baseline Survey (6 months). Preconstruction Groundwater and Surface Water Survey. Perth–Darwin National Highway (Swan Valley Section). September. Draft report prepared by Coffey Environments Australia Pty Ltd, Burswood, Western Australia.
- Coffey. 2017. Baseline Survey Plan – Inland Waters – Hydrological Processes. NorthLink WA Perth–Darwin National Highway. December. Plan prepared for NorthLink WA by Coffey Services Australia Pty Ltd, Burswood, Western Australia.
- DER. 2014. Contaminated sites guidelines. Assessment and management of contaminated sites. December. Department of Environment Regulation, Perth, Western Australia.
- DER. 2015. Treatment and Management of Soil and Water in Acid Sulfate Soil Landscapes. June. Department of Environment Regulation, Perth, Western Australia.
- DOW. 2006. Land use planning in Public Drinking Water Source Areas. Water Quality Protection Note 76. March. Department of Water, Perth, Western Australia.
- DOW. 2009. Field sampling guidelines: A guideline for field sampling for surface water quality monitoring programs. January. Department of Water, Perth, Western Australia.
- DOW. 2012. Dewatering of Soils at Construction Sites. Water Quality Protection Note 13. November. Department of Water, Perth, Western Australia.
- EPA. 2013. Environmental Assessment Guideline for Environmental Principles, Factors and Objectives. EAG 8. June. Environmental Protection Authority, Western Australia.
- Golder. 2014. Geotechnical, Hydrogeological and Pavement Desk Study. NorthLink WA Perth–Darwin National Highway. July. Report prepared for NorthLink WA by Golder Associates Pty Ltd.
- NHMRC and NRMCC. 2011. Australian Drinking Water Guidelines Paper 6 National Water Quality Management Strategy. November 2016 revision. National Health and Medical Research Council, National Resource Management Ministerial Council. Commonwealth of Australia, Canberra.



WHO. 2005. Petroleum Products in Drinking Water. A WWW publication accessed at http://www.who.int/water_sanitation_health/dwq/chemicals/Petroleum%20Productsrev071105.pdf. World Health Organization.



APPENDIX A

Monitoring Locations



This page is intentionally blank.

Table A1 Location of groundwater and surface water monitoring sites

Monitoring location	Easting	Northing
SWL18	404,668	6,503,678
SWL21	403,643	6,506,940
SWL22	405,084	6,502,429
MW7	397,646	6,476,115
MW8	397,305	6,476,607
MW9	397,357	6,476,750
MW10	397,844	6,476,609
MW11A (PCG94)	59432.312	277382.717
MW12	397,607	6,478,318
MW13	397,143	6,479,335
MW14	397,457	6,479,575
MW15	397,218	6,479,728
MW16	396,687	6,481,671
MW17	396,656	6,481,761
MW18A (PCG94)	60802.915	280756.768
MW19	398,355	6,481,955
MW20	399,110	6,482,360
MW21A (PCG94)	61144.468	281220.776
MW22	400,262	6,484,100
MW23	401,076	6,484,193
MW24A (PCG94)	64555.92	284727.0945
MW25	402,526	6,485,551

Note: Eastings and northings are in GDA 94 MGA Zone 50 unless otherwise stated.



This page is intentionally blank.



APPENDIX B

Groundwater Quality Criteria



This page is intentionally blank.

Sample ID	Analyte	Metals Dissolved																							
		Aluminium (Filtered)		Arsenic (Filtered)		Cadmium (Filtered)		Chromium (Filtered)		Copper (Filtered)		Iron (Filtered)		Lead (Filtered)		Manganese (Filtered)		Mercury (Filtered)		Nickel (Filtered)		Selenium (Filtered)		Zinc (Filtered)	
Units		mg/L		mg/L		mg/L		mg/L		mg/L		mg/L		mg/L		mg/L		mg/L		mg/L		mg/L		mg/L	
LOR		0.05		0.001		0.00005		0.001		0.001		0.05		0.001		0.005		0.0001		0.001		0.001		0.001	
NHMRC & NRMCC ADWG 6		0.2*		0.01		0.002		0.05**		2		0.3*		0.01		0.5		0.001		0.02		0.01		3*	
DER 2015		1		NE		NE		NE		NE		1		NE		NE		NE		NE		NE		NE	
Trigger / Threshold		Trigger	Thresh	Trigger	Thresh***	Trigger	Thresh	Trigger	Thresh***	Trigger	Thresh	Trigger	Thresh	Trigger	Thresh***	Trigger	Thresh***	Trigger	Thresh***	Trigger	Thresh	Trigger	Thresh***	Trigger	Thresh
MW7		0.94	1.59	0.01	0.02	0.002	0.0023	0.05	0.06	2	2.3	0.52	3.71	0.01	0.02	0.5	0.6	0.001	0.002	0.02	0.023	0.01	0.02	3	3.45
MW8		0.30	0.47	0.01	0.02	0.002	0.0023	0.05	0.06	2	2.3	0.3	0.35	0.01	0.02	0.5	0.6	0.001	0.002	0.02	0.023	0.01	0.02	3	3.45
MW9		0.52	0.88	0.01	0.02	0.002	0.0023	0.05	0.06	2	2.3	1.76	5.72	0.01	0.02	0.5	0.6	0.001	0.002	0.02	0.023	0.01	0.02	3	3.45
MW10		0.38	0.62	0.01	0.02	0.002	0.0023	0.05	0.06	2	2.3	3.50	9.03	0.01	0.02	0.5	0.6	0.001	0.002	0.02	0.023	0.01	0.02	3	3.45
MW11A		5.28	8.48	0.01	0.02	0.002	0.0023	0.05	0.06	2	2.3	5.68	11.38	0.01	0.02	0.5	0.6	0.001	0.002	0.02	0.023	0.01	0.02	3	3.45
MW12		3.52	6.63	0.01	0.02	0.002	0.0023	0.05	0.06	2	2.3	1.74	5.74	0.01	0.02	0.5	0.6	0.001	0.002	0.02	0.023	0.01	0.02	3	3.45
MW13		2.22	3.50	0.01	0.02	0.002	0.0023	0.05	0.06	2	2.3	1.42	4.49	0.01	0.02	0.5	0.6	0.001	0.002	0.02	0.023	0.01	0.02	3	3.45
MW14		0.69	0.89	0.01	0.02	0.002	0.0023	0.05	0.06	2	2.3	0.68	1.51	0.01	0.02	0.5	0.6	0.001	0.002	0.02	0.023	0.01	0.02	3	3.45
MW15		0.48	0.72	0.01	0.02	0.002	0.0023	0.05	0.06	2	2.3	5.6	9.50	0.01	0.02	0.5	0.6	0.001	0.002	0.02	0.023	0.01	0.02	3	3.45
MW16		5.40	7.14	0.01	0.02	0.002	0.0023	0.05	0.06	2	2.3	0.44	1.91	0.01	0.02	0.5	0.6	0.001	0.002	0.02	0.023	0.01	0.02	3	3.45
MW17		3.10	4.83	0.01	0.02	0.002	0.0023	0.05	0.06	2	2.3	0.88	2.65	0.01	0.02	0.5	0.6	0.001	0.002	0.02	0.023	0.01	0.02	3	3.45
MW18A		1.34	2.58	0.01	0.02	0.002	0.0023	0.05	0.06	2	2.3	4.70	7.97	0.01	0.02	0.5	0.6	0.001	0.002	0.02	0.023	0.01	0.02	3	3.45
MW19		21.20	44.22	0.01	0.02	0.002	0.0023	0.05	0.06	2	2.3	0.41	1.15	0.01	0.02	0.5	0.6	0.001	0.002	0.02	0.023	0.01	0.02	3	3.45
MW20		8.74	11.11	0.01	0.02	0.002	0.0023	0.05	0.06	2	2.3	1.12	2.04	0.01	0.02	0.5	0.6	0.001	0.002	0.02	0.023	0.01	0.02	3	3.45
MW21A		7.64	10.72	0.01	0.02	0.002	0.0023	0.05	0.06	2	2.3	19.6	32.06	0.01	0.02	0.5	0.6	0.001	0.002	0.02	0.023	0.01	0.02	3	3.45
MW22		7.40	21.15	0.01	0.02	0.002	0.0023	0.05	0.06	2	2.3	18.8	42.52	0.01	0.02	0.5	0.6	0.001	0.002	0.017	0.034	0.01	0.02	3	3.45
MW23		0.27	0.47	0.01	0.02	0.002	0.0023	0.05	0.06	2	2.3	0.3	0.35	0.01	0.02	0.5	0.6	0.001	0.002	0.02	0.023	0.01	0.02	3	3.45
MW24A		1.54	2.12	0.01	0.02	0.002	0.0023	0.05	0.06	2	2.3	0.43	0.77	0.01	0.02	0.5	0.6	0.001	0.002	0.02	0.023	0.01	0.02	3	3.45
MW25		1.20	1.84	0.01	0.02	0.002	0.0023	0.05	0.06	2	2.3	0.3	0.35	0.01	0.02	0.5	0.6	0.001	0.002	0.02	0.023	0.01	0.02	3	3.45

Notes:
NE = Not Established
mg/L = Milligrams per litre
µg/L = Micrograms per litre
LOR = Limit of reporting
Thresh = Threshold value criteria
MW = Monitoring well

Legend:

- Site Specific Trigger level, 80 percentile of the data set
- Site Specific Threshold, Baseline Max + one standard deviation
- Trigger Level is guideline value
- Threshold Level is 115% of the trigger level or LOR (where no guideline value is available)
- Lower trigger level is set at the baseline minimum minus one standard deviation
- Lower threshold trigger level is lower trigger level minus 1 pH
- Upper trigger level is set at the baseline maximum plus one standard deviation
- Threshold trigger level is upper trigger level plus 1 pH
- No guideline available, all samples below LOR, trigger level is equal to the LOR

Investigation Levels:

- NHMRC & NRMCC (2011) Australian Drinking Water Guideline 6.
- DER (2015) Treatment and management of soil and water in acid sulfate soil landscapes.

* NHMRC & NRMCC (2011) Australian Drinking Water Guideline Aesthetic values
** Chromium (hexavalent) guideline value adopted
*** Threshold calculations have been rounded up due to low values
In the instance of two or more relevant guideline criteria exist, the ADWG is used as the trigger in the first instance then the next most conservative value when the ADWG has no value.

Sample ID	Analyte	Other Parameters																			
		pH (Lab)		TDS	Acidity (as CaCO3)	Nitrogen (Total)	Phosphate total (P)	Phosphorus reactive (as P)	Total PAHs	TRH C6-C10	TRH >C10 - C40										
Units		pH_Units		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	µg/L	µg/L									
LOR		0.01		10	10	0.2	0.05	0.05	5	20	100										
NHMRC & NRMCC ADWG 6		Lower - 6.5	Upper - 8.5	600*	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	
DER 2015		Lower - 6.5	Upper - 8.5	NE	>40	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	
Trigger / Threshold		Lower Trigger	Lower Thresh	Upper Trigger	Upper Thresh	Trigger	Thresh	Trigger	Thresh	Trigger	Thresh	Trigger	Thresh	Trigger	Thresh***	Trigger	Thresh	Trigger	Thresh	Trigger	Thresh
MW7		<3.47	<2.47	>6.34	>7.34	600	690	>54	>118	5.3	11.1	0.08	0.15	0.05	0.06	5	5.75	20	23	100	115
MW8		<5.06	<4.06	>6.84	>7.84	600	690	>40	>46	6.5	10.5	0.06	0.18	0.05	0.06	5	5.75	20	23	100	115
MW9		<3.75	<2.75	>6.75	>7.75	600	690	>35	>58	2.3	5.0	0.13	0.21	0.05	0.06	5	5.75	20	23	100	115
MW10		<5.46	<4.46	>8.34	>9.35	600	690	>46	>99	6.1	24.4	0.14	0.18	0.05	0.06	5	5.75	20	23	100	115
MW11A		<3.35	<2.35	>5.05	>6.05	600	690	>69	>128	2.0	3.8	0.06	0.06	0.05	0.06	5	5.75	20	23	100	115
MW12		<3.73	<2.73	>4.78	>5.78	600	690	>48	>99	0.7	1.4	0.05	0.06	0.05	0.06	5	5.75	20	23	100	115
MW13		<3.69	<2.69	>4.71	>5.71	600	690	>64	>166	0.9	2.3	0.14	0.37	0.05	0.06	5	5.75	20	23	100	115
MW14		<4.15	<3.15	>4.95	>5.95	600	690	>46	>75	2.5	5.2	0.17	0.24	0.05	0.06	5	5.75	20	23	100	115
MW15		<3.22	<2.22	>6.18	>7.18	600	690	>41	>69	0.7	1.1	0.08	0.13	0.05	0.06	5	5.75	20	23	100	115
MW16		<3.69	<2.69	>5.01	>6.01	600	690	>73	>114	7.1	11.4	0.05	0.07	0.05	0.06	5	5.75	20	23	100	115
MW17		<3.79	<2.79	>4.31	>5.31	600	690	>69	>143	0.5	0.8	0.05	0.058	0.05	0.06	5	5.75	20	23	100	115
MW18A		<3.77	<2.77	>8.83	>6.83	600	690	>53	>107	3.0	10.6	0.11	0.15	0.05	0.06	5	5.75	20	23	100	115
MW19		<3.06	<2.06	>3.95	>4.95	600	690	>312	>604	3.9	11.3	0.29	0.93	0.05	0.06	5	5.75	20	23	100	115
MW20		<4.03	<3.03	>4.37	>5.37	600	690	>90	>126	1.9	3.3	0.07	0.08	0.05	0.06	5	5.75	20	23	100	115
MW21A		<3.80	<2.80	>4.40	>5.40	600	690	>114	>199	3.1	6.5	0.12	0.26	0.05	0.06	5	5.75	20	23	100	115
MW22		<2.96	<1.96	>4.34	>5.34	600	690	>142	>217	0.6	2.3	0.06	0.07	0.05	0.06	5	5.75	20	23	100	115
MW23		<4.92	<3.92	>7.48	>8.48	600	690	>40	>46	8.0	16.2	0.11	0.21	0.05	0.06	5	5.75	20	23	100	115
MW24A		<3.98	<2.98	>4.62	>5.62	600	690	>72	>118	3.2	21.6	0.11	0.20	0.05	0.06	5	5.75	20	23	100	115
MW25		<3.45	<2.45	>6.35	>7.35	600	690	>58	>121	13.4	19.3	0.19	0.34	0.05	0.06	5	5.75	20	23	100	115

Notes:

NE = Not Established
mg/L = Milligrams per litre
µg/L = Micrograms per litre
LOR = Limit of reporting
Thresh = Threshold value criteria
MW = Monitoring well

Legend:

- Site Specific Trigger level, 80 percentile of the data set
- Site Specific Threshold, Baseline Max + one standard deviation
- Trigger level is 80% of the threshold criteria or next most conservative value
- Threshold Level is 115% of the trigger level or LOR (where no guideline value is available)
- Lower trigger level is set at the baseline minimum minus one standard deviation
- Lower threshold trigger level is lower trigger level minus 1 pH
- Upper trigger level is set at the baseline minimum minus one standard deviation
- Threshold trigger level is lower trigger level minus 1 pH
- No guideline available, all samples below LOR, trigger level is equal to the LOR

Investigation Levels:

1. NHMRC & NRMCC (2011) Australian Drinking Water Guideline 6.
 2. DER (2015) Treatment and management of soil and water in acid sulfate soil landscapes.
- * NHMRC & NRMCC (2011) Australian Drinking Water Guideline Aesthetic values
** Chromium (hexavalent) guideline value adopted
*** Threshold calculations have been rounded up due to low values

In the instance of two or more relevant guideline criteria exist, the ADWG is used as the trigger in the first instance then the next most conservative value when the ADWG has no value.



APPENDIX C

Surface Water Quality Criteria



This page is intentionally blank.

Table C1
Surface Water Quality Trigger and Threshold Criteria
NorthLink
ENAUPT04483AA

Sample ID	Analyte	Aluminium (Filtered)	Arsenic (Filtered)	Cadmium (Filtered)	Chromium (Filtered)	Copper (Filtered)	Iron (Filtered)	Lead (Filtered)	Manganese (Filtered)	Mercury (Filtered)	Nickel (Filtered)	Selenium (Filtered)											
	Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L											
	LOR	0.05	0.001	0.0002	0.001	0.001	0.05	0.001	0.005	0.0001	0.001	0.001											
	NHMRC & NRMCC ADWG 6	0.2*	0.01	0.002	0.05***	2	0.3*	0.01	0.5	0.001	0.02	0.01											
	DER 2015	1.00	NE	NE	NE	NE	1	NE	NE	NE	NE	NE											
	ANZECC Lowland	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE											
	ANZECC FW 95%	0.055	0.024	0.0002	NE	0.0014	NE	0.0034	1.9	0.0006	0.011	0.011											
Trigger / Threshold		Trigger	Thresh	Trigger	Thresh****	Trigger	Thresh	Trigger	Thresh****	Trigger	Thresh	Trigger	Thresh****	Trigger	Thresh****	Trigger	Thresh****	Trigger	Thresh****	Trigger	Thresh	Trigger	Thresh
SWL18-1		0.2	0.23	0.01	0.02	0.002	0.0023	0.05	0.06	2	2.3	1.22	2.16	0.01	0.02	0.5	0.6	0.001	0.002	0.02	0.027	0.01	0.02
SWL18-2		0.2	0.23	0.01	0.02	0.002	0.0023	0.05	0.06	2	2.3	1.20	2.16	0.008	0.013	0.5	0.6	0.001	0.002	0.02	0.028	0.01	0.02
SWL18-3		0.2	0.29	0.01	0.02	0.002	0.0023	0.05	0.06	2	2.3	1.18	2.26	0.01	0.02	0.5	0.6	0.001	0.002	0.02	0.023	0.01	0.02
SWL21-1		1.74	5.47	0.01	0.02	0.002	0.0023	0.05	0.06	2	2.3	1.56	4.49	0.01	0.02	0.5	0.6	0.001	0.002	0.02	0.023	0.01	0.02
SWL21-2		0.21	0.40	0.01	0.02	0.002	0.0023	0.05	0.06	2	2.3	1.35	4.03	0.01	0.02	0.5	0.6	0.001	0.002	0.02	0.023	0.008	0.02
SWL21-3		0.24	0.45	0.01	0.02	0.002	0.0023	0.05	0.06	2	2.3	1.40	4.96	0.01	0.02	0.5	0.6	0.001	0.002	0.02	0.023	0.008	0.02
SWL22-1		0.19	0.28	0.01	0.02	0.002	0.0023	0.05	0.06	2	2.3	1.70	4.05	0.008	0.019	0.5	0.6	0.001	0.002	0.02	0.042	0.008	0.02
SWL22-2		0.2	0.23	0.01	0.02	0.002	0.0023	0.05	0.06	2	2.3	1.65	4.05	0.008	0.019	0.5	0.6	0.001	0.002	0.02	0.041	0.008	0.02
SWL22-3		0.2	0.23	0.01	0.02	0.002	0.0023	0.05	0.06	2	2.3	1.66	4.01	0.008	0.018	0.5	0.6	0.001	0.002	0.02	0.040	0.008	0.02

Notes:

NE = Not Established
mg/L = Milligrams per litre
µg/L = Micrograms per litre
LOR = Limit of reporting
Thresh = Threshold value criteria
SWL = Surface water location

Legend:

	Site Specific Trigger level, 80 percentile of the data set
	Site Specific Threshold, Baseline Max + one standard deviation
	Trigger Level is guideline value
	Threshold Level is 115% of the trigger level or LOR (where no guideline value is available)
	Threshold criteria is calculated using hardness modification in accordance with ANZECC & ARMCANZ (2000) guidance
	Lower trigger level is set at the baseline minimum minus one standard deviation
	Lower threshold trigger level is lower trigger level minus 1 pH
	Upper trigger level is set at the baseline maximum minus one standard deviation
	Threshold trigger level is upper trigger level plus 1 pH unit
	No guideline available, all samples below LOR, trigger level is equal to the LOR

Investigation Levels:

- NHMRC & NRMCC (2011) Australian Drinking Water Guideline 6
- DWER (2015) Treatment and management of soil and water in acid sulfate soil landscapes
- ANZECC & ARMCANZ (2000) Lowland River default trigger levels for physical and chemical stressors for S/W Australia - Slightly disturbed ecosystems
- ANZECC & ARMCANZ (2000) Fresh water 95% level protection - Slightly to moderately disturbed ecosystems

* NHMRC & NRMCC (2011) Australian Drinking Water Guideline Aesthetic values

** LOR needs to be lowered for future monitoring to compare against adopted guideline values as LOR is higher than guideline values

*** Chromium (hexavalent) guideline value adopted

**** Threshold calculations have been rounded up due to low values

In the instance of two or more relevant guideline criteria exist, the ADWG is used as the trigger in the first instance then the next most conservative value when the ADWG has no value.

Table C1
Surface Water Quality Trigger and Threshold Criteria
NorthLink
ENAUPT04483AA

Sample ID	Analyte	Zinc (Filtered)	pH (Lab)		TDS	Turbidity	Acidity (as CaCO3)	Nitrogen (Total)	Phosphate total (P)	Reactive Phosphorus as P	Total PAHs	TRH C6-C10	TRH > C10 - C40												
	Units	mg/L	pH Units		mg/L	NTU	mg/L	mg/L	mg/L	mg/L	µg/L	µg/L	µg/L												
	LOR	0.001	0.01		10	1	10	0.2	0.05	0.05**	5	20	100												
	NHMRC & NRMCC ADWG 6	3*	Lower - 6.5	Upper - 8.5	600*	5*	NE	NE	NE	NE	NE	NE	NE												
	DER 2015	NE	Lower-6	Upper-8.5	NE	NE	>40	NE	NE	NE	NE	NE	NE												
	ANZECC Lowland	NE	Lower-6.5	Upper-8	NE	NE	NE	1.2	0.065	0.04	NE	NE	NE												
	ANZECC FW 95%	0.008	NE		NE	NE	NE	2	0.6	0.03	NE	NE	NE												
Trigger / Threshold		Trigger	Thresh	Lower Trigger	Lower Thresh	Upper Trigger	Upper Thresh	Trigger	Thresh	Trigger	Thresh	Trigger	Thresh	Trigger	Thresh	Trigger	Thresh	Trigger	Thresh	Trigger	Thresh****	Trigger	Thresh	Trigger	Thresh
SWL18-1		3	3.45	<6.53	<5.53	>8.78	>9.78	2600	5594	19	33	>40	>46	2.2	3.5	0.65	1.12	0.40	0.87	5	6	20	23	100	115
SWL18-2		3	3.45	<6.59	<5.59	>8.81	>9.81	2840	7179	15	36	>40	>46	2.4	4.1	0.70	1.79	0.39	0.89	5	6	20	23	100	115
SWL18-3		3	3.45	<6.49	<5.49	>8.50	>9.50	2440	5439	14	38	>40	>46	2.6	3.5	0.72	1.80	0.41	0.86	5	6	20	23	100	115
SWL21-1		3	3.45	<6.95	<5.95	>8.50	>9.50	1500	2883	85	277	>40	>46	1.9	3.5	0.89	2.07	0.39	0.55	5	6	20	23	100	115
SWL21-2		3	3.45	<6.82	<5.82	>8.50	>9.50	1400	2237	76	343	>40	>46	2.0	3.3	0.94	2.03	0.37	0.67	5	6	20	23	100	115
SWL21-3		3	3.45	<6.80	<5.80	>8.50	>9.50	1400	2234	61	267	>40	>46	2.8	7.2	1.62	2.90	0.37	0.79	5	6	20	23	100	115
SWL22-1		3	3.45	<6.70	<5.70	>8.50	>9.50	3080	5341	25	34	>40	>46	3.9	7.5	2.01	3.35	0.79	1.42	5	6	20	23	100	115
SWL22-2		3	3.45	<6.65	<5.62	>8.52	>9.52	3040	5592	25	32	>40	>46	3.0	3.8	1.50	2.07	0.77	1.28	5	6	20	23	100	115
SWL22-3		3	3.45	<6.87	<5.82	>8.50	>9.50	3040	5072	25	35	>40	>46	2.5	3.8	1.46	2.03	0.88	1.72	5	6	20	23	100	115

Notes:
NE = Not Established
mg/L = Milligrams per litre
µg/L = Micrograms per litre
LOR = Limit of reporting
Thresh = Threshold value criteria
SWL = Surface water location

Legend:

- Site Specific Trigger level, 80 percentile of the data set
- Site Specific Threshold, Baseline Max + one standard deviation
- Trigger Level is guideline value
- Threshold Level is 115% of the trigger level or LOR (where no guideline value is available)
- Threshold criteria is calculated using hardness modification in accordance with ANZECC & ARMCANZ (2000) guidance
- Lower trigger level is set at the baseline minimum minus one standard deviation
- Lower threshold trigger level is lower trigger level minus 1 pH
- Upper trigger level is set at the baseline minimum minus one standard deviation
- Threshold trigger level is lower trigger level minus 1 pH
- No guideline available, all samples below LOR, trigger level is equal to the LOR

Investigation Levels:

- NHMRC & NRMCC (2011) Australian Drinking Water Guideline 6
- DWER (2015) Treatment and management of soil and water in acid sulfate soil landscapes
- ANZECC & ARMCANZ (2000) Lowland River default trigger levels for physical and chemical stressors for S/W Australia - Slightly disturbed ecosystems
- ANZECC & ARMCANZ (2000) Fresh water 95% level protection - Slightly to moderately disturbed ecosystems

* NHMRC & NRMCC (2011) Australian Drinking Water Guideline Aesthetic values
 ** LOR needs to be lowered for future monitoring to compare against adopted guideline values as LOR is higher than guideline values
 *** Chromium (hexavalent) guideline value adopted
 **** Threshold calculations have been rounded up due to low values
 In the instance of two or more relevant guideline criteria exist, the ADWG is used as the trigger in the first instance then the next most conservative value when the ADWG has no value.

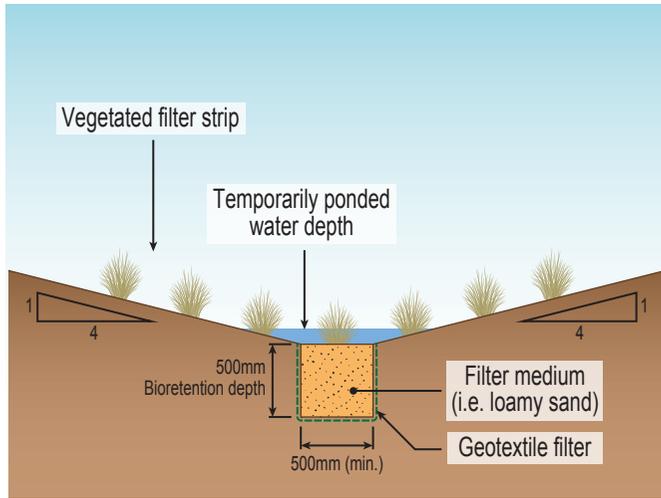


APPENDIX D

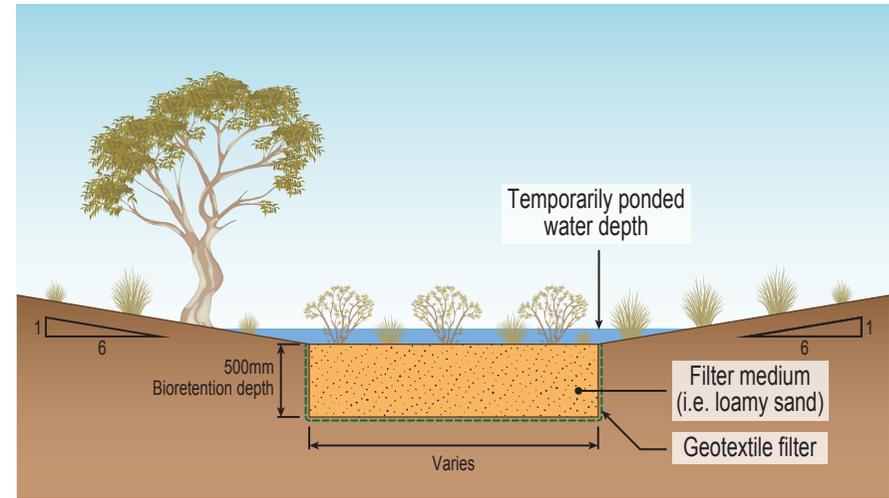
Typical Bio- retention Swale and Basin Design



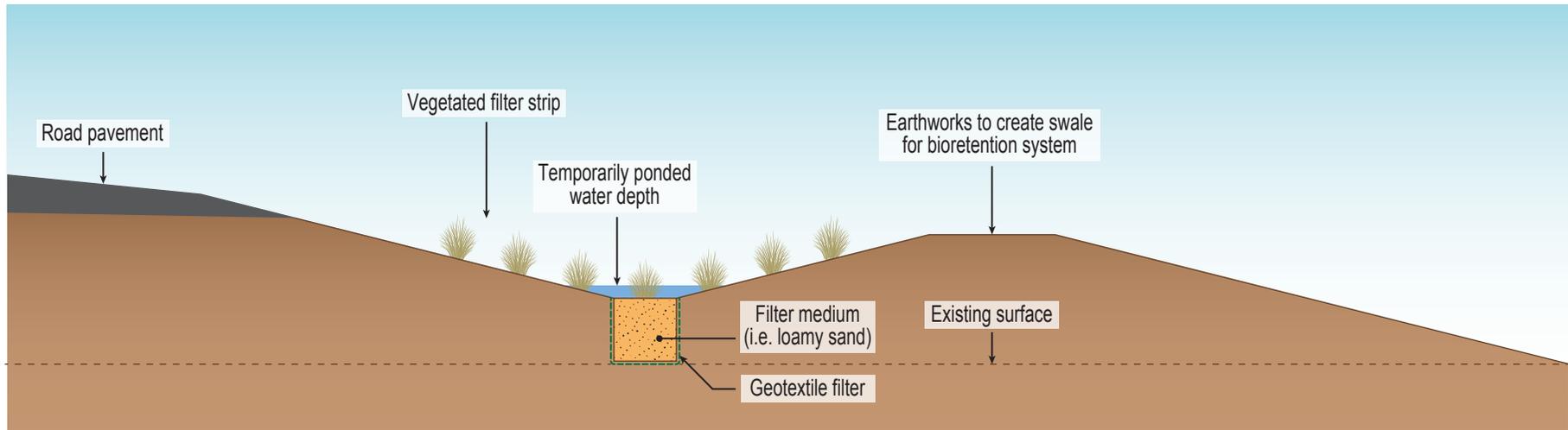
This page is intentionally blank.



Typical bioretention swale



Typical bioretention basin



Typical bioretention swale in Palusplain Zone

AI Reference: 4483AA_63_GRA002.ai_v1

Note:
Drawing is not to scale and is for illustrative purposes only.

NorthLinkWA

coffey
A TETRA TECH COMPANY

Date:
09.02.2017
File Name:
4483AA_62_C_F001_GRA

Perth-Darwin National Highway
Inland Waters Environmental Quality –
Hydrological Processes – Condition EMP

Example of bioretention swale and basin

Figure No:

1



This page is intentionally blank.



APPENDIX E

Individual Parameters to be Analysed



This page is intentionally blank.

Table E1 Total PAH and total TRH individual constituents

Group	Individual constituents
Total TRH	<ul style="list-style-type: none"> • Benzene • Ethylbenzene • Toluene • Xylene total • TRH C6-C10 • TRH >C10-C16 • TRH >C16-C34 • TRH >C34-C40
Total PAH	<ul style="list-style-type: none"> • Acenaphthene • Acenaphthylene • Anthracene • Benzo(a)anthracene • Benzo(a)pyrene • Benzo(g,h,i)perylene • Benzo(k)fluoranthene • Chrysene • Benzo[b+j]fluoranthene • Dibenz(a,h)anthracene • Fluoranthene • Fluorene • Indeno(1,2,3-c,d)pyrene • Naphthalene • Phenanthrene • Pyrene

BG&E NorthLinkWA
GPO Box 2776
Cloisters Square
Perth WA 6850



Australian Government



NorthLinkWA