Roe Highway Extension

Drainage Management and Monitoring Plan

August 2016

Prepared for
Main Roads Western Australia
by Strategen

August 2016

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1. Context, scope and rationale

This Drainage Monitoring and Management Plan (DMMP) presents the management program for the drainage associated with the Roe Highway Extension (the Project). The plan is will be implemented until otherwise agreed by the CEO of the OEPA.

1.1 Context

1.1.1 Project description

Main Roads Western Australia (Main Roads) propose to construct the Project (Figure 1) as part of the Perth Freight Link Project. The Project involves the construction of approximately 5 km of highway, extending Roe Highway from its current terminus at the Kwinana Freeway in Jandakot to Stock Road in Coolbellup.

The Project is located approximately 14 km south of Perth within the Swan Coastal Plain Bioregion. The Project is largely contained within the City of Cockburn, however, parts of the design extend northward in to the City of Melville along Murdoch Drive and Kwinana Freeway. Generally, the Project is oriented east-west largely, within a road reserve that was set aside in the Metropolitan Region Scheme (MRS) in 1963. The alignment is between North and Bibra Lakes, which are part of the Eastern Chain of the Beeliar Wetlands.

The Project will consist of a dual carriageway with two lanes in each direction, separated by a concrete barrier in place of a median strip. The Project was approved by the Minister for Environment on the 2 July 2015, with the release of Ministerial Statement 1008 (Statement 1008) establishing conditions for the Project implementation.

1.1.2 Project activities

Construction of the Project is described in the PER (South Metro Connect 2011) as requiring the following key activities:

- construction of road formation and associated infrastructure including, road drainage basins, principal Shared Paths (pedestrian and cycle paths), retaining walls, fauna underpasses and culverts, bridges and overpasses and noise attenuation walls
- installation of street and PSP lighting
- realignment of a short section of Murdoch Drain
- rehabilitation of areas disturbed for construction.

Operation of the proposed Project will result in the following key activities:

- freight transport
- private and commercial vehicle movements
- operation of street lighting
- maintenance.

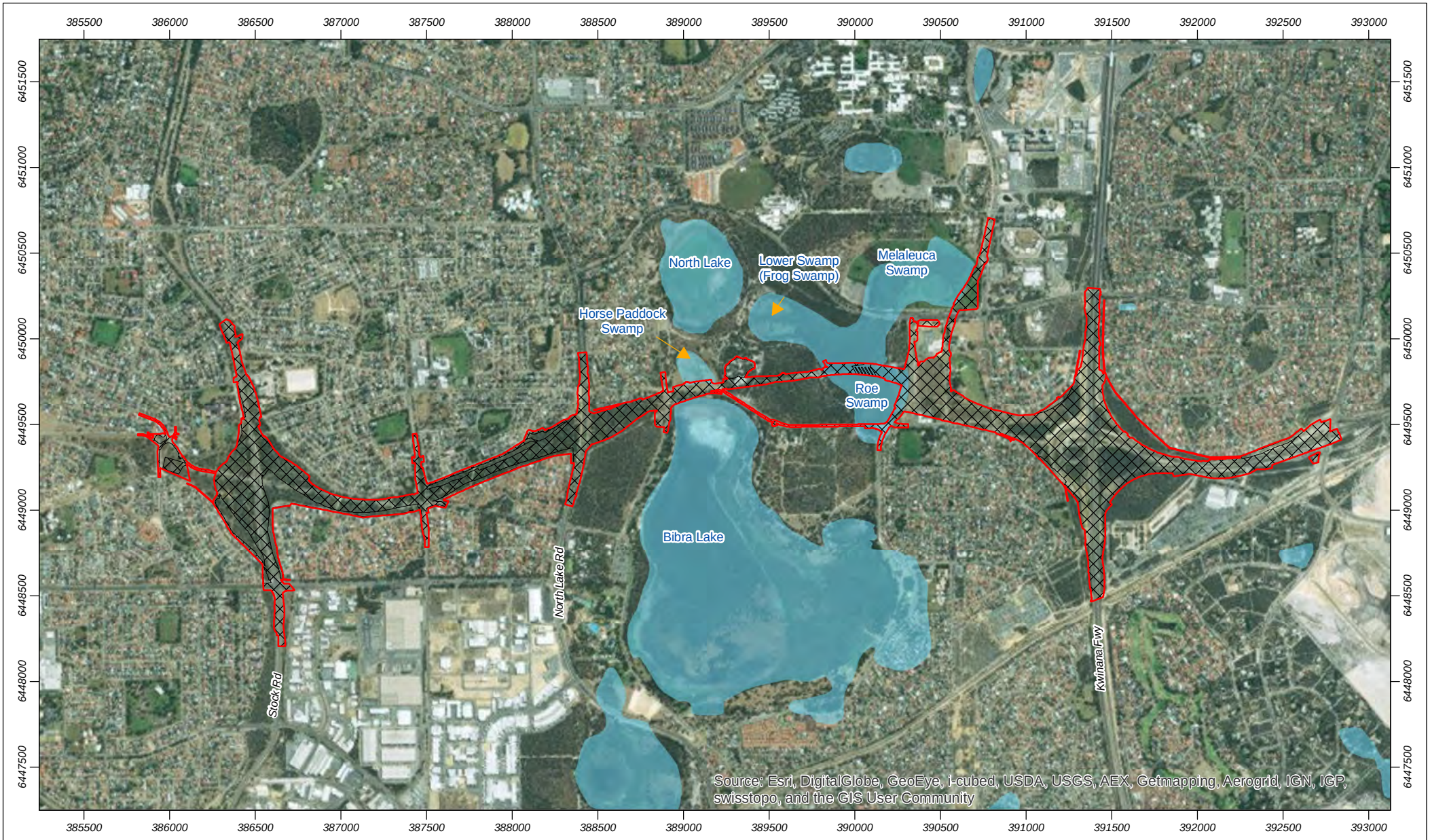

Figure 1: Project development envelope

Scale 1:30,000 at A4

0 200 400 600 800 1,000 Meters

Coordinate System: GDA 1994 MGA Zone 50

Note that positional errors may occur in some areas

Date: 13/11/2015

Author: DWhite

Source: Aerial image: ESRI, approx.2010; Client 2015; Wetlands: DPaW 2015.

Legend

- Project development envelope
- Proposed construction footprint
- Wetlands

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1.1.3 Stormwater management strategy

A conceptual stormwater system has been prepared as part of the Water Management Strategy (AECOM 2013) to provide a concept for drainage infrastructure. The conceptual stormwater management system involves the use of pits, pipes, infiltration basins, bio-retention basins and culverts to manage the potential hydrological impacts from the project. This DMMP focuses specifically on the management and monitoring of the bio-retention and infiltration basins within the stormwater management system. The locations of the bio-retention and infiltration basins are shown in Figure 2. Three key elements guided the locations of these basins including:

- minimising the clearing of native vegetation by locating the basins in areas that are predominantly cleared or in degraded condition
- infiltrating stormwater as close to the source as possible, by taking into consideration the road design, topography and soil types of the area
- providing protection against accidental spills and road pollutants by directing stormwater through gross pollutant traps and oil separator systems prior to entry into the basins in wetland areas.

Drainage basin design

All basins have been designed with capacity for a 20 yr ARI event or a 5 yr ARI event (where an overflow route is available to mimic natural drainage paths, Appendix 2, Appendix 3). All infiltration basins include a small bio-retention basin (approximately 2% of the constructed, directly connected impervious area as per DoW guidance), apart from one basin, which is a large bio-retention only basin (Basin I, Figure 2). All small and large bio-retention basins are designed to treat frequent rainfall events (up to the 1 year 1 hr ARI event).

The key features of basin design include:

1. Basins are designed as infiltration systems, with a bio-retention component.
2. The majority of the basins are located the Bassendean Sands, whilst those near the western margins of the project development envelope are likely to be within the Tamala Limestone.
3. Individual basin surface area is variable, but typically ranges from approximately 2000 – 15 000 m^2.
4. Storage capacity of the majority of the basins has been designed to accommodate 20 yr ARI event for a basin water height of 1.2 m.
5. Sub-surface permeability range from 8 – 30 m/day depending on area.
6. Basin base RL's have been set at or above maximum groundwater levels as defined by the Department of Water (DoW) Groundwater Atlas and published maximum contours (2001). The depth to (maximum) water table heights in the basin areas is variable and ranges from negligible (0.1) in low-lying areas, to typically 40 m (in the area west of Stock Road).

A summary of the basin design specifications is provided in Appendix 2 and basin design locations are provided in Appendix 3. These specifications will be reviewed and refined once baseline groundwater levels have been collected in accordance with an approved DMMP.

Basin water quality management

The bio-retention basins will be planted with indigenous wetland species and include a filter media layer to manage the water quality of stormwater runoff. Stormwater will be directed through the surface vegetation and allowed to filter and percolate through the filter media layer. During this process pollutants will be retained through fine filtration, adsorption and biological uptake. Vegetation is a vital functioning element in this process, providing a substrate for biological activity, facilitating gaseous exchange to the soil, and aids microbial communities in biodegradation and assimilation of contaminants (AECOM 2013).

The larger bio-retention basin (Basin I) will contain filter media to a depth of 600 mm and have an extended detention depth of 350 mm (Figure 3, AECOM 2013). Basin I has also been designed with impermeable barriers preventing the horizontal flow of pollutants and a weir that directs overflow into the basin. Basin I was modelled to achieve reductions of:

- 85% in total suspended solids
- 65% in total phosphorus
- 45% in total nitrogen (AECOM 2013).

Basin construction timing

Basin structures may be constructed prior to road works being completed; however, biofilters (i.e. installation of filter media and planting) will not be installed until after road construction to prevent the build up of sand and other materials used during construction.

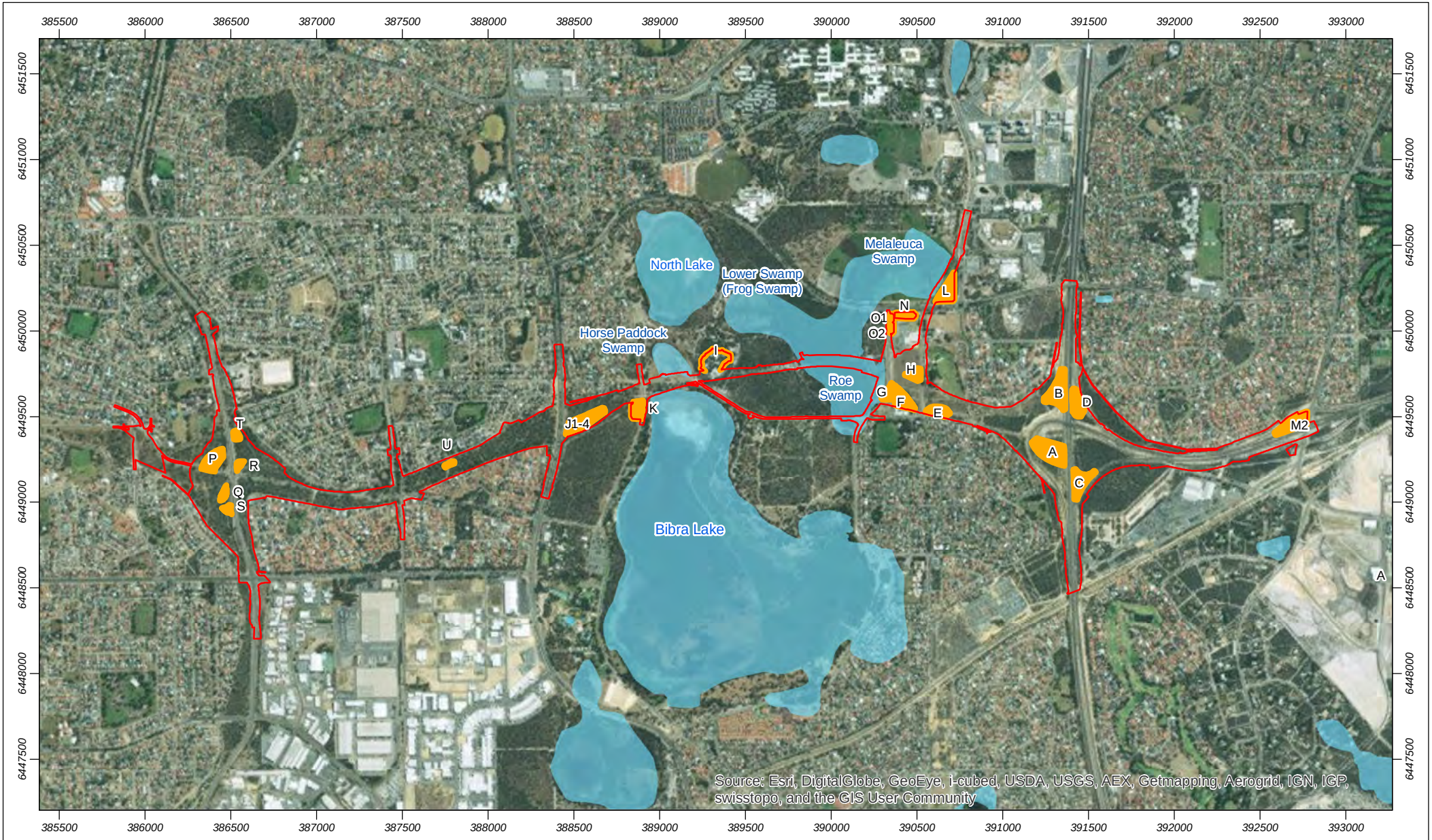

Figure 2: Basin locations

Scale 1:30,000 at A4

0 200 400 600 800 1,000 m

Coordinate System: GDA 1994 MGA Zone 50

Note that positional errors may occur in some areas

Date: 13/11/2015

Author: DWhite

Source: Aerial image: ESRI online approx. 2010. Envelope: Client 2015. Regional Park & wetlands: DPAW 2014.

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Legend

- Project development envelope
- Basin footprint
- Wetlands

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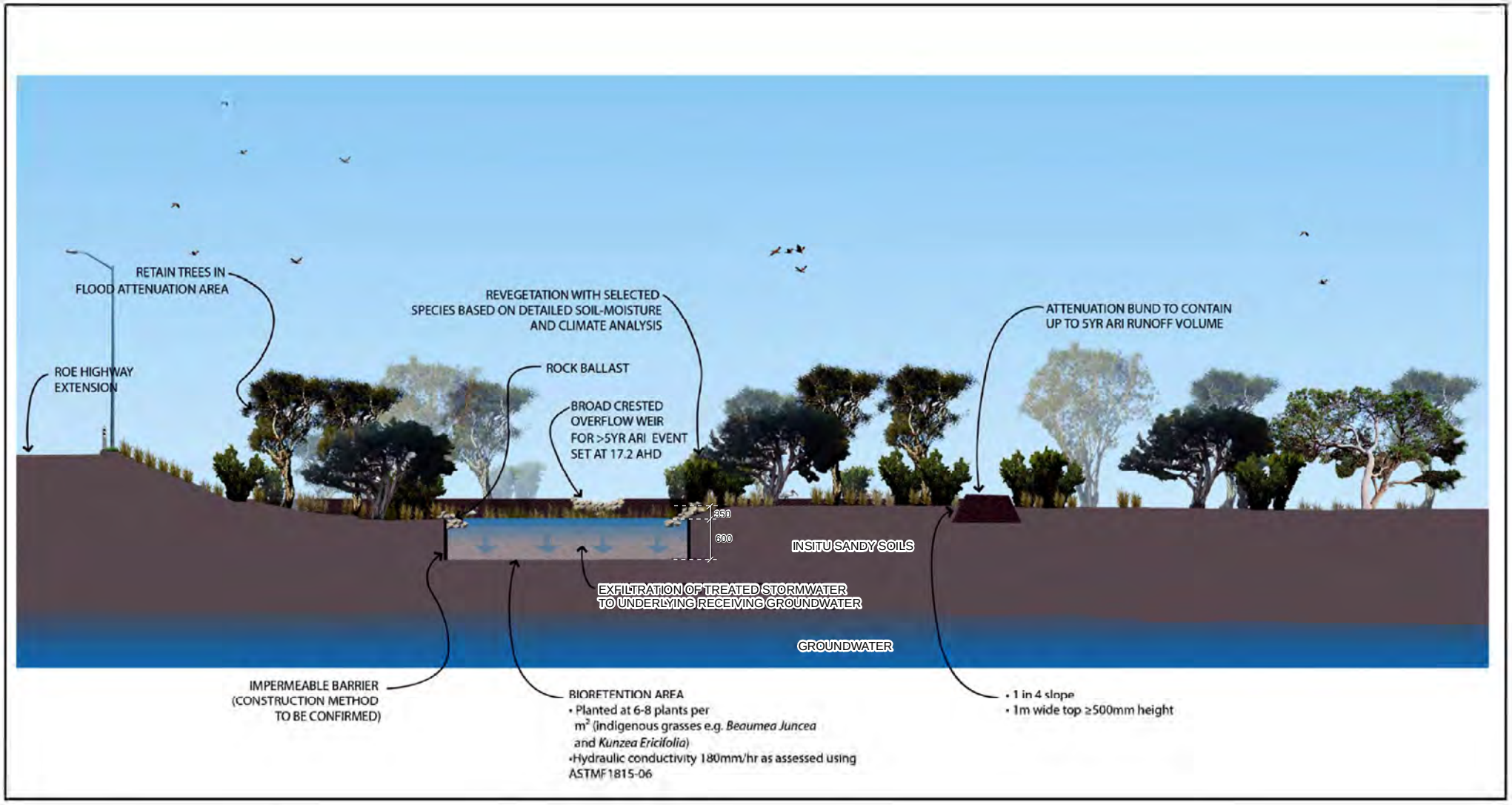

Figure 3: Dixon Road Bioretention Basin Cross Section

Note that positional errors may occur in some areas
Date: 13/11/2015
Author: DWhite
Source: AECOM (2013)
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1.2 Scope

Condition 8-2 of Statement 1008 requires the proponent to prepare a DMMP to ensure that stormwater runoff from the Project is being appropriately managed through the Project's drainage basins.

1.2.1 Key environmental factors and aspects

The key environmental factors, Environmental Protection Authority (EPA) objectives and environmental aspects of the Project relevant to the factor is summarised in Table 1.

Table 1: Key environmental factors, objectives and environmental aspects

Factor	EPA objective	Environmental aspects of the Project
Inland Waters Environmental Quality	Maintain the quality of groundwater and surface water, sediment and biota so that the environmental values, both ecological and social, are protected.	Design of basins may cause the leakage of contaminants to groundwater.

1.2.2 Requirements of Statement 1008

This DMMP addresses the requirements under conditions 8-2 and 8-3 of Statement 1008 dated 2 July 2015, as outlined in Table 2.

Table 2: Condition 8 requirements under Statement 1008

Condition	Requirement	Section
8-1	The proponent shall ensure that impacts to groundwater quality from the ongoing operation of the proposal are maintained relative to pre-construction conditions established in baseline surveys required by condition 8-3.	DMMP
8-2	Prior to commencement of construction, the proponent shall prepare a Drainage Management and Monitoring Plan to the requirements of the CEO, on advice of the Department of Water. The Drainage Management and Monitoring Plan shall:	N/A
	1. when implemented, substantiate whether condition 8-1 is being met	DMMP
	2. identify the locations, capacity and dimensions of bioretention and infiltration basins consistent with the Water Management Strategy (AECOM) dated 16 January 2013	Appendix 2, Figure 2 & Figure 3
	3. include ongoing maintenance measures to ensure the bioretention and infiltration basins are performing effectively	Section 3.1
	4. include protocols and procedures for baseline monitoring of groundwater levels and groundwater quality	Section 2 & Appendix 4
	5. include protocols and procedures for monitoring contaminant and nutrient levels within the bioretention and infiltration basins	Section 2
	6. include protocols, procedures and locations for monitoring contaminants and nutrient levels of groundwater upstream and downstream of the bioretention and infiltration basins	Section 2, Figure 2 & Figure 4
	7. identify criteria to trigger implementation of management measures to remediate contaminants within the bioretention and infiltration basins and ensure the basins are performing effectively	Section 2
	8. include management measures referred to in condition 8-2(7)	Section 2
	9. determine the timing and frequency of reporting to the CEO.	Section 4
8-3	Prior to commencement of construction, the proponent shall implement the approved Drainage Management and Monitoring Plan in order to collect baseline data and continue implementation until otherwise agreed by the CEO.	Section 1
8-4	The proponent may review and revise the Drainage Management and Monitoring Plan to the requirements of the CEO.	Section 4
8-5	The proponent shall review and revised the Drainage Management and Monitoring Plan as and when directed by the CEO.	Section 4
8-6	The proponent shall implement the approved revisions of the Drainage Management and Monitoring Plan required by conditions 8-4 and 8-5.	Section 4
8-7	The Drainage Management and Monitoring Plan required by condition 8-2 shall be made publically available in a manner approved by the CEO.	Section 4.4

1.3 Rationale and approach

Baseline Wetland Condition Survey and Baseline Drainage Monitoring Program

A Baseline Wetland Condition Survey and Baseline Drainage Monitoring Program (BWCS) will to be undertaken to inform drainage management and development decisions as required by 8-3. The Scope for the Baseline Survey is provided in Appendix 4. A summary of the results of that baseline survey will be incorporated into this DMMP following its completion and the results will also be provided to the OEPA prior to construction.

The DMMP has been prepared with consideration for the following guidelines and policy documents:

- *State Planning Policy 2.9 Water Resources* (WAPC 2006)
- *Stormwater Management Manual for Western Australia* (DoW 2004-2007)
- *Decision Process for Stormwater Management in WA* (DoW 2009)
- *Better Urban Water Management* (DoW 2008)
- *Environmental Guidance for Planning and Development, Guidance Statement No. 33* (EPA 2008)
- *Beeliar Regional Park Management Plan* (CALM 2006)
- *Cockburn Groundwater Area Management Plan* (DoW 2007)
- *Water Monitoring Guidelines for Better Urban Water Management Strategies and Plans* (DoW 2012)
- *Water Management Strategy, Roe Highway Extension* (AECOM 2013)
- *Water Monitoring Guidelines for Better Urban Management Strategies and Plans* (DoW 2012).

1.3.1 Management approach

The management approach for drainage within this plan focus on implementing a comprehensive monitoring, contingency and maintenance program that identifies indicators of groundwater quality and basin condition. Basin monitoring will focus on basins in proximity to wetlands areas, specifically basins G, I, L and K (Figure 4). Maintenance measures will, however, apply to all basins associated with the Project.

Monitoring subsequent to basin completion will comprise:

- basin condition monitoring to assess the basin condition (e.g. vegetation condition, sediment build-up, filter media performance)
- groundwater monitoring to assess the impacts of the basin on groundwater levels and quality.

Five years of monitoring will be undertaken, as bio-retention areas can take up to two years to become established and operate with full efficiency (FAWB 2009). The rationale for this monitoring program is provided below and the detailed monitoring requirements and methodology are outlined in Table 3 and Appendix 1. In the event that trigger values are exceeded monitoring will continue beyond the proposed five years, until trigger values are no longer being exceeded or as agreed by the OEPA.

Basin condition monitoring

The objective of basin condition monitoring is to determine if maintenance and/or contingency actions are required (e.g. sediment removal, vegetation thinning). Basin condition monitoring parameters and methodology applied are based on the following guidance:

- *Vegetation Guidelines for Stormwater Biofilters in the South-west of Western Australia* (Monash University 2014)
- *Stormwater Biofiltration Systems Adoption Guidelines* (FAWB 2009)
- *Stormwater Management Manual for Western Australia* (DoW 2004-8).

Basin condition monitoring will address:

- deposition of material and litter
- erosion and damage to basins
- vegetation condition
- weed occurrence
- filter media hydraulic conductivity
- surface water (i.e. evidence of extended ponding).

In most rainfall events, stormwater is anticipated to infiltrate relatively quickly, with little or no standing water within a period of hours to days. Therefore it is likely that the basins will be dry at the time of monitoring. If sufficient water is present at the time of monitoring, water quality samples will be taken and analysed.

Groundwater monitoring

The objective of groundwater monitoring is to demonstrate that groundwater quality from the ongoing operation of the Project is maintained relative to pre-construction conditions. Groundwater monitoring will monitor groundwater levels and quality upgradient and downgradient of key basins (basins G, I, L and K), to assess impacts of stormwater treatment and infiltration on groundwater. Monitoring locations are provided in Figure 4, monitoring parameters and methodologies are consistent with the baseline monitoring program.

1.3.2 Trigger value determination

Trigger levels have been defined for basin condition and groundwater quality to determine if contingency measures are required to be implemented (Table 3).

Groundwater quality

The parameters have been divided into primary (key) parameters and secondary parameters. Primary parameters have been assigned trigger values, with secondary parameters do not have triggers values but will be monitored to inform management (Table 3). Water quality trigger values for key parameters will be set for all groundwater quality monitoring sites downgradient (west) of the basins and compared with sites upgradient of the basins and baseline data. Groundwater quality parameters that will be monitored include:

- parameters that may be potentially impacted by the Project, such as hydrocarbons and heavy metals
- basic physicochemical parameters that reflect regional water quality and are unlikely to be impacted, such as total dissolved salts and basic anions and cations (e.g. calcium and chloride), which assist in determining the source of waters.

Where no baseline or reference data is available, default ANZECC and ARMCANZ trigger values or National Environmental Protection Council (NEPC 1999) investigation levels are assigned.

Basin condition

Trigger values for filter media quality are based on the Environmental Investigation Levels (EILs) and Environmental Screening Levels (ESLs) for Soils from the *National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (No. 1*) (2013). The trigger value for filter media hydraulic conductivity was based on existing data; however, was modified to allow some flexibility to allow for root development and sedimentation. Remaining trigger values for basin condition are based on basin maintenance, functionality and design requirements as per the guidance mentioned previously.

Trigger values for basin condition and groundwater quality will be reviewed as part of the annual reporting process and revised if required to reflect appropriate and relevant guidelines and available monitoring data including:

- monitoring water levels and ecological health as a condition of the approval of groundwater abstraction from the Jandakot Groundwater Mound by DoW
- a Perth shallow groundwater systems investigation for North Lake undertaken by Department of Water (DoW 2015)
- monitoring data for this area from the Department of Water website and will be reviewed as part of the baseline survey
- groundwater data undertaken by the Project to date (AECOM 2011)
- targeted monthly groundwater monitoring undertaken by AECOM (2012) over a 13 month period to support the Project
- baseline data to be collected through the baseline monitoring program, which represents as a continuation and supplementation of the AECOM (2011; 2012) programs (Strategen 2015).

Any amendments to the trigger values will be undertaken in accordance with condition 8-2 and provided to the CEO of the OEPA for approval prior to implementation.

Figure 4: Proposed groundwater monitoring locations

Scale 1:8,000 at A4

0 50 100 150 200 m

N

Coordinate System: GDA 1994 MGA Zone 50

Note that positional errors may occur in some areas

Date: 13/11/2015

Author: DWhite

Source: Heritage: DIA 2012. All other data: Client 2015.

Legend

- Proposed monitoring bores
- Project development envelope
- Basin footprint

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2. Monitoring program

The purpose of monitoring is to inform, through the trigger and threshold target/s, if the environmental objective for inland water quality is being achieved, and when contingency management actions have to be implemented, reviewed and revised.

The parameters to be monitored and the trigger levels associated with these parameters are provided in Table 3. The methodology to measure the parameters is described in Appendix 1.

Table 3: Monitoring program

Parameter	Parameter/Analytes to be tested*	Trigger	Source/comment	Timing/ frequency
Groundwater monitoring - Primary parameters				
Physiochemical properties	Water levels	• Bore is dry or unable to be pumped • Change >0.5 m from previous reading	Trigger values were determined to enable samples to be collected and to allow for natural variability in groundwater levels (AECOM 2012).	Monthly
	pH	• pH >7.5 • pH < 5.6 • Change in pH >1 since last reading	See Table A 4 in Appendix 5.	Monthly for the first year. Frequency will be reviewed at the end of the first year and adjusted if necessary
	TDS	950 mg/L	See Table A 3 in Appendix 5.	
	EC	>1500 µS/cm	ANZECC & ARMCANZ (2000) guidelines for slightly disturbed ecosystems in the south-west Australia – Lakes, reservoirs & wetlands.	
	Redox potential	No trigger level proposed	Redox potential will be monitored to inform management but is not considered relevant to the impacts of the proposal and therefore is not proposed to have a trigger.	
	DO	No trigger level proposed	DO will be monitored to inform management but is not considered relevant to the impacts of the proposal and therefore are not proposed to have a trigger.	
	Temperature (profiling)	No trigger level proposed	Temperature (profiling) will be monitored to inform management but is not considered relevant to the impacts of the proposal and therefore is not proposed to have a trigger.	
	TN	2.6 mg/L	See Table A 3 in Appendix 5.	Quarterly during construction (January, May, August, October), then six monthly
	TP	0.2 mg/L	See Table A 3 in Appendix 5.	
	ammonia	0.04 mg/L	ANZECC & ARMCANZ (2000) guidelines for slightly disturbed ecosystems in the south-west Australia – wetlands.	
	nitrate/nitrite	0.1 mg/L	ANZECC & ARMCANZ (2000) guidelines for slightly disturbed ecosystems in the south-west Australia – wetlands.	
	total Kjeldahl nitrogen (TKN)	1.8 mg/L	See Table A 3 in Appendix 5.	
	orthophosphate	30 µg/L	ANZECC & ARMCANZ (2000) guidelines for slightly disturbed ecosystems in the south-west Australia – wetlands.	
	TN:TP ratio	No trigger level proposed	N/A.	
	As	8.4 µg/L	See Table A 3 in Appendix 5.	
	Al	650 µg/L	See Table A 3 in Appendix 5.	
	Cd	0.2 µg/L	ANZECC & ARMCANZ (2000) guidelines for slightly disturbed ecosystems in the south-west Australia (95% level of protection for freshwater).	
	Cr	1 µg/L as Cr(VI)-	ANZECC & ARMCANZ (2000) guidelines for slightly disturbed ecosystems in the south-west Australia (95% level of protection for freshwater).	
	Cu	26 µg/L	See Table A 3 in Appendix 5.	
	Mn	50 µg/L	See Table A 3 in Appendix 5.	

Parameter	Parameter/Analytes to be tested*	Trigger	Source/comment	Timing/ frequency
	Ni	11 µg/L	Based on ANZECC & ARMCANZ (2000) guidelines for slightly disturbed ecosystems in the south-west Australia. Trigger levels for freshwater (95% level of protection.	
	Pb	10 µg/L	See Table A 3 in Appendix 5.	
	Se	5 µg/L	ANZECC & ARMCANZ (2000) guidelines for slightly disturbed ecosystems in the south-west Australia. Trigger levels for freshwater (99% level of protection).	
	Zn	40 µg/L	See Table A 3 in Appendix 5.	
	Fe	1900 µg/L	See Table A 3 in Appendix 5.	
Groundwater monitoring - Secondary parameters				
Physiochemical properties	total TPH	No trigger level proposed	Awaiting results of baseline.	Annually, in October during construction and post-construction
	BTEX	No trigger level proposed	Awaiting results of baseline.	
	total acidity	No trigger level proposed	Total acidity will be monitored to inform management but is not conserved relevant to the impacts of the proposal and therefore is not proposed to have a trigger.	
	total alkalinity	No trigger level proposed	Total alkalinity will be monitored to inform management but is not conserved relevant to the impacts of the proposal and therefore are not proposed to have a trigger.	
	chloride	400 mg/L	ANZECC & ARMCANZ (2000) guidelines for recreational purposes.	
	sulfate	400 mg/L	ANZECC & ARMCANZ (2000) guidelines for recreational purposes.	
	carbonate	500 mg/L	ANZECC & ARMCANZ (2000) guidelines for recreational purposes.	
	bicarbonate	No trigger level proposed	Bicarbonate will be monitored to inform management but is not conserved relevant to the impacts of the proposal and therefore are not proposed to have a trigger.	
	calcium	No trigger level proposed	Calcium will be monitored to inform management but is not conserved relevant to the impacts of the proposal and therefore are not proposed to have a trigger.	
	magnesium	No trigger level proposed	Magnesium will be monitored to inform management but is not conserved relevant to the impacts of the proposal and therefore are not proposed to have a trigger.	
	sodium	300 mg/L	ANZECC & ARMCANZ (2000) guidelines for recreational purposes.	
	potassium	No trigger level proposed	Potassium will be monitored to inform management but is not conserved relevant to the impacts of the proposal and therefore are not proposed to have a trigger.	

Parameter	Parameter/Analytes to be tested*	Trigger	Source/comment	Timing/ frequency
Basin Condition				
Surface water	Water levels	• No surface water present • Surface water standing for more than 5 days after rainfall event • Surface water present after previously being dry	Trigger values were determined to enable samples to be collected and to allow for natural variability in surface water levels.	Opportunistically, during quarterly monitoring events
Filter media quality	Total Organic Carbon	No trigger level proposed.	Total Organic Carbon will be monitored to inform management but is not conserved relevant to the impacts of the proposal and therefore are not proposed to have a trigger.	At commissioning, at the end of the first year of operation, and then every two years
	pH	• pH >7.5 • pH < 5.6 • Change in pH >1 since last reading	See Table A 4 in Appendix 5.	
	redox potential	No trigger level proposed	Redox potential will be monitored to inform management but is not conserved relevant to the impacts of the proposal and therefore are not proposed to have a trigger.	
	As*	40 mg/kg	National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (No. 1) (2013).	
	Cd	No EIL trigger level available	Awaiting results of baseline.	
	Cr*	Approximate range from 60-660 mg/kg for Cr(III) depending on %clay content	National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (No. 1) (2013).	
	Cu*	Approximate ranges from 20-270 mg/kg depending on pH and Cation Exchange Capacity	National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (No. 1) (2013).	
	Mn	No trigger level proposed	Mn will be monitored to inform management but is not conserved relevant to the impacts of the proposal and therefore are not proposed to have a trigger.	
	Ni*	Ranges from 5-95 mg/kg depending on Cation Exchange Capacity.	National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (No. 1) (2013).	
	Pb*	470 mg/kg	National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (No. 1) (2013).	
	Se	No EIL trigger level available	Awaiting results of baseline.	
	Zn*	Ranges from 15-280 mg/kg depending on pH and Cation Exchange Capacity	National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (No. 1) (2013).	
	Fe	No EIL trigger level available	Fe will be monitored to inform management but is not conserved relevant to the impacts of the proposal and therefore are not proposed to have a trigger.	
	total TPH	No EIL trigger level available	Awaiting results of baseline.	
	Total PAHs	No EIL trigger level available	Awaiting results of baseline.	
	Organophosphate Pesticides	Above level of detection	N/A.	

Parameter	Parameter/Analytes to be tested*	Trigger	Source/comment	Timing/ frequency
	Clay content	No trigger level proposed	Clay content will be monitored to inform management but is not conserved relevant to the impacts of the proposal and therefore are not proposed to have a trigger.	
	Cation Exchange Capacity	No trigger level proposed	Cation Exchange Capacity will be monitored to inform management but is not conserved relevant to the impacts of the proposal and therefore are not proposed to have a trigger.	
	Hydraulic conductivity*	Average hydraulic conductivity is outside the range of 60 to 540 mm/hr	National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (No. 1) (2013).	
Vegetation condition and weeds	Density of live native vegetation	Native vegetation cover is less than 25%	Remaining trigger values for basin condition are based on basin maintenance, functionality and design requirements as per the guidance mentioned previously.	Quarterly for the first three years, then six monthly
		Live native vegetation cover is greater than 90%		
	Presence of 'high priority' weeds	Presence of high priority weeds (defined as aggressive weeds as advice by a botanist or plants listed as Declared Pests under *Biosecurity and Management Act 2007*)		
	Percentage weed cover	Weeds comprise greater than 10% of the groundcover		
Deposition of material, litter and erosion	Deposition of material and debris accumulation	Excessive deposition of material and debris build up in inlet area with potential to reduce inflow rates		Opportunistically, during quarterly monitoring events
	Litter accumulation	Litter accumulation causing visual amenity issues or with potential to reduce inflow rates		
	Erosion	Erosion affecting inlet stability and/or vegetation		
Damage	Damage, vandalism or dumping	Presence of damage, vandalism or dumping		Opportunistically, during quarterly monitoring events

*Clay content, pH and Cation Exchange Capacity are required to determine guideline level under Environmental Investigation Levels (EILs) and Environmental Screening Levels (ESLs) for Soils based on the National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (No. 1) (2013).

3. Management

Contingency actions as described in Table 4 and Table 5 will be implemented in the event that monitoring indicates that a trigger value has been exceeded.

Any contingency actions undertaken shall be recorded and included in the annual compliance reporting described in Section 4.

Table 4: Groundwater quality contingency actions

Parameter	Trigger	Contingency action
Groundwater levels	Bore is dry or unable to be pumped	1. If bore is dry determine reason why (low groundwater, blocked bore). 2. Determine if trigger is within normal seasonal range. 3. If drying/wetting event is unseasonal, determine cause of event and remediate if required until trigger value is no longer being exceeded. Remedial actions that will be considered include review stormwater system, performing maintenance activities, installing additional monitoring bore. 4. Continue monitoring ground water levels and the effectiveness of remedial actions.
	Change >0.5 m from previous reading	1. Determine cause for rapid change in groundwater level including determining if upgradient groundwater level also exceeds the trigger value. 2. Determine if trigger is within normal seasonal range. 3. If drying/wetting event is unseasonal, determine cause of event and remediate if required until trigger value is no longer being exceeded. Remedial actions that will be considered include review stormwater system, performing maintenance activities, installing additional monitoring bore. 4. Continue monitoring groundwater levels and the effectiveness of remedial actions.
Groundwater quality	Groundwater quality exceeds trigger values (refer to Table 3)	1. Determine if upgradient water quality also exceeds the trigger value. 2. Resample affected bore within four weeks of original sampling event. 3. If both rounds show that groundwater quality at the downstream bore exceeds trigger values and concentrations are 20% above concentrations at the upgradient bores, identify cause. 4. If the stormwater system is considered to be the source of the contaminants, perform remedial actions such as the maintenance activities described in Table 6 as required. This may involve cleaning out of GPTs and oil separators and/or increasing vegetation density within the basin. 5. Continue monitoring groundwater quality and the effectiveness of remedial actions until trigger value is no longer being exceeded.
pH	pH exceeds trigger values (refer to Table 3)	1. Measure pH daily for seven days to ensure recording is not an anomaly. 2. Determine if upgradient groundwater bore water quality also exceeds targets. 3. Determine cause of pH change/low pH and remediate if required until trigger value is no longer being exceeded. Remedial actions that will be considered include review stormwater system and performing maintenance activities, 4. Continue monitoring groundwater quality and the effectiveness of remedial actions.

Table 5: Basin condition contingency actions for Basins G, I, L and K

Parameter	Trigger	Contingency action
Vegetation condition and weeds		
Density of native vegetation	Native vegetation cover is less than 25%	1. Identify cause. 2. Consider appropriateness of species. 3. Replant with appropriate species until trigger value is no longer being exceeded. 4. Consider fencing or feral animal control if grazing of concern.
	Native vegetation cover is greater than 90%	1. Identify cause. 2. Thin vegetation to a cover of 50% or less. 3. Remove pruned material.
Presence of 'high priority' weeds	Presence of high priority weeds	1. Identify the weeds, their location and coverage. 2. Undertake targeted weed control until trigger value is no longer being exceeded.
Percentage weed cover.	Weeds comprise greater than 10% of the groundcover	1. Identify the weeds, their location and coverage. 2. Undertake targeted weed control until trigger value is no longer being exceeded.
Filter media		
Hydraulic conductivity	Average hydraulic conductivity is outside the range of 60 to 540 mm/hr	1. Identify cause. 2. Assess whether standing water is of concern such that it exceeds the stand water trigger detailed below. 3. Perform maintenance as required. This may include scarifying the filter surface between plants and/or increase planting density to break up the clogging layer or replacement of filter media. 4. Retest hydraulic conductivity within three months of maintenance actions being undertaken and implement remedial actions (scarifying the filter surface between plants and/or increase planting density to break up the clogging layer or replacement of filter media) until trigger value is no longer being exceeded.
Filter media quality	Filter media quality exceeds (refer to Table 3)	1. Repeat sampling at a minimum of four locations within the basin. 2. If the median filter media quality exceeds triggers in Table 3 then identify if there is a specific cause and advise DoW of the exceedence and the cause. If required review the drainage design and/or perform maintenance activities as per Table 6 over either a portion or the whole basin. 3. Continue monitoring filter media quality and the effectiveness of remedial actions until trigger value is no longer being exceeded.
Surface water levels		
Surface water standing time	Surface water standing for more than 5 days after rainfall event	1. Identify cause. 2. Test media hydraulic conductivity and hydraulic conductivity of the broader basin, based on the methodology outlined in Appendix 1. 3. Perform maintenance as required. This may include scarifying the filter surface between plants and/or increase planting density to break up the clogging layer. 4. Continue monitoring until trigger value is no longer being exceeded. If problem persists, consider modifications to stormwater system.

Parameter	Trigger	Contingency action
Deposition of material and litter		
Deposition of material and debris accumulation	Excessive deposition of material and debris build up in inlet area with potential to reduce inflow rates	1. Identify cause. 2. Remove material from affected area. 3. Clean out upstream GPT. 4. Thin vegetation at inlet area if required. 5. Continue monitoring until trigger value is no longer being exceeded. If problem persists, consider modifications to stormwater system (e.g. change inlet design).
Litter accumulation	Litter accumulation causing visual amenity issues or with potential to reduce inflow rates	1. Identify cause. 2. Remove litter from affected area. 3. Clean out upstream GPT. 4. Thin vegetation at inlet area if required. 5. Continue monitoring until trigger value is no longer being exceeded. If problem persists, consider modifications to stormwater system (e.g. modify GPT).
Erosion		
Erosion	Erosion affecting inlet stability and/or vegetation	1. Identify cause. 2. Reinstate affected areas with media, soil and/or vegetation. 3. Continue monitoring until trigger value is no longer being exceeded. If problem persists, consider modifications to stormwater system (e.g. change inlet design).
Damage, vandalism or dumping		
Damage, vandalism or dumping	Presence of damage, vandalism or dumping	1. Identify location where access occurred. 2. Remove material and reinstate any damaged infrastructure until trigger value is no longer being exceeded. 3. Consider signage, fencing and/or bollards if problem reoccurs.

3.1 Maintenance measures

Maintenance actions for all basins within the drainage system are outlined in Table 6. These actions will be undertaken on a ongoing basis as per the timing indicate below, as well as if required as part of the contingency actions detailed in Table 5.

Table 6: Maintenance actions for all basins

Item	Management action	Timing
1.	Remove and replace dead and diseased plants	Annually for the first three years, then six monthly
2.	Infill planting to retain desired planting densities	Annually for the first three years, then six monthly
3.	Undertake weed control	Twice per year
4.	Pruning of excess vegetation	Twice per year
5.	Removal of the deposition of material, debris and litter	Annually
6.	Fill in any holes or scour in the filter media	Quarterly for the first three years, then six monthly
7.	Replacement of filter media and removal to an appropriate facility	Every 10-25 years, dependent on basin performance
8.	Maintain GPTs and oil separators	As per manufacturer specifications

4. Review and reporting

4.1 Review and revision

The DMMP will be reviewed on an annual basis to ensure that the plan takes into consideration amendments to operations, monitoring results, audits, continuous improvement and changes in regulatory and corporate requirements. Amendments to the plan will be undertaken in accordance with condition 8-4, 8-5 and 8-6 and provided to the CEO of the OEPA for approval prior to implementation. The DMMP will also be made publically available in a manner approved by the CEO.

4.2 Reporting

An annual report summarising all previous monitoring results will be produced prior to the preparation of the Annual Compliance Report.

The annual report will include:

- climate and rainfall information
- demonstration of compliance with maintenance requirements
- documentation of monitoring undertaken
- comparison of monitoring results to trigger values
- documentation of any management actions undertaken.

These results will be submitted to the CEO of OEPA as part of the Annual Compliance Report.

4.3 Auditing

Auditing of the DMMP shall be conducted in accordance with Main Roads Corporate Procedure 6707/044 Environmental Auditing. Internal audits will be undertaken every three months during construction, and compliance audits will be undertaken annually during construction and annually for the first five years of operation.

An annual compliance report, detailing the results of the compliance audit, shall be provided to the CEO of the OEPA as required by Condition 8-2.

4.4 Public availability

Main Roads will ensure the DMMP is made publicly available in a manner approved by the CEO of the OEPA.

4.5 Responsibility

This section provides a summary of the key personnel involved in implementation of the DMMP and their roles and responsibilities.

Table 7: Roles and responsibilities

Role	Responsibility
Main Roads	• Main Roads has the overall responsibility for the implementation of this DMMP • the roles below may be delegated to a contractor by Main Roads • if the roles are delegated, Main Roads has the responsibility to audit compliance and ensure any contingency actions are implemented.
Construction contractors	• overall accountability for auditing and compliance assessment with this DMMP to ensure it is maintained and meets objectives and targets • provide technical support to all Project personnel to ensure this DMMP is implemented correctly and complied with • implement and maintain this DMMP, review its effectiveness and review the implementation as required • undertaking ongoing monitoring and documenting monitoring results • assess the performance against targets • liaise with stakeholders and technical advisors for advice and resolution of management aspects/objectives as required • review and close out any contingency actions • report as required to regulating authorities • may delegate all or part responsibility to an appropriately qualified person • providing data to Main Roads for inclusion in the annual compliance report. • comply with all legal requirements and the requirements of this DMMP • ensure staff employed are adequately trained in DMMP requirements • ensure all personnel involved in the project will adhere to DMMP requirements • seek advice from proponent when in doubt about requirements.
All personnel	• must receive induction prior to commencement of work on site • comply with all legal requirements and the requirements of this DMMP • report incidents to their Supervisor or Site Environmental Coordinator • attend environmental inductions and any other training required • participate in toolbox meetings and suggest improvements to the DMMP.

5. Consultation

5.1 Consultation

As part of the preparation of the DMMP, consultation with stakeholders was undertaken as detailed in Table 8.

Table 8: Stakeholder consultation

Stakeholder	Date	Outcome
Department of Water (DoW)	27 July 2015	The Scope of Works for the Baseline Wetland Condition and Baseline Drainage Monitoring Program was provided to DoW for comment and comments were received from DoW on the 27 July 2015.
	8 September 2015	A meeting held with DoW to discuss their comments on the Scope of Works for the Baseline Wetland Condition and Baseline Drainage Monitoring Program, The DMMP has been updated based on this discussion and to address relevant comments that were received on the Scope.
	26 October 2015	The DMMP was provided to DoW for comment and comments were received 26 October 2015. The DMMP has been updated to address relevant comments.
OEPA	24 November 2015	The DMMP was provided to OEPA for comment and comments were received 24 November 2015. The DMMP has been updated to address relevant comments.

6. References

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Appendix 1
Post construction drainage monitoring methodology

Table A 1: Post-construction monitoring program for Basins G, I, L and K

Parameter/analytes to be tested	Methodology	Timing/ frequency
Basin condition		
Vegetation condition and weeds • flora species composition • density of vegetation • weed occurrence • percentage weed cover	Five 2 m x 2 m monitoring quadrats will be established within each drainage basin covering both the biofiltration area and broader basin to enable monitoring data to be collected. Data will be collected from each of the quadrats, in order to enable collection of representative data from each quadrat. Data collected from each quadrat will include: • flora species composition • density of vegetation • weed occurrence • percentage weed cover. A photograph of each quadrat will be taken at the time of monitoring.	Quarterly for the first three years, then six monthly
Filter media • hydraulic conductivity	In situ hydraulic conductivity (K) will be measured using a single ring infiltrometer under constant head consistent with FAWB (2009). The single ring infiltrometer consists of a small plastic or metal ring that is driven 50 mm into the filter media. It is a constant head test that is conducted for two different pressure heads (50 mm and 150 mm). The head is kept constant during all the experiments by pouring water into the ring. The frequency of readings of the volume poured depends on the filter media, but typically varies from 30 seconds to 5 minutes. The test is stopped when the infiltration rate is considered steady (i.e., when the volume poured per time interval remains constant for at least 30 minutes). Filter media conductivity within the biofilter will be sampled at three points that are spatially distributed (one should be located near the inlet) for systems with an area of 0.01 ha or less. Where the biofilter area is greater than 0.01 ha, an extra monitoring point should be added for every additional 0.01 ha.	At commissioning, at the end of the first year of operation, and then every two years
Filter media • Total Organic Carbon • pH • redox potential • TN, TP, nitrate/nitrite, total Kjeldahl nitrogen, ammonia, orthophosphate, TN:TP ratio • Metals (As, Cd, Cr, Cu, Mn, Ni, Pb, Se, Zn) • TPH and BTEX • Clay content, pH and Cation Exchange Capacity	Sediment samples will be taken using a stainless steel hand spade. Samples were separated based on depth intervals. Upper horizon surface samples were collected from the upper 5 cm of sediment and the lower horizon samples from 10–20 cm depth. **Duplicate samples** Each batch of samples will include one duplicate for every 10 samples submitted to the laboratory. The purpose of these duplicates was to allow the laboratory to perform internal quality assurance and the results were included in the laboratory report.	At commissioning, at the end of the first year of operation, and then every two years
Deposition of material, litter and erosion	Deposition of material, litter and erosion shall be monitored at the inlet(s) to each basin through visual inspection, to assess the rate and density of build up. A photograph of each inlet will be taken at the time of monitoring. Remove when restricting inlets, reducing infiltration or impacting amenity.	Quarterly for the first three years then six monthly
Surface water levels	Monitor water levels manually if standing water present in basin using the staff gauge, including taking a photograph if water is present.	Opportunistically, during quarterly monitoring events

Parameter/analytes to be tested	Methodology	Timing/ frequency
Damage, vandalism and dumping	Damage, vandalism and dumping shall be monitored in each basin through visual inspection. Where damage, vandalism and dumping are found: • the location of the incident shall be recorded using a GPS • the nature of the incident noted and • a photo of the affected area taken.	Quarterly for the first three years, then six monthly
Groundwater		
Groundwater levels	Monitoring bores to be located upgradient and downgradient of the basins. Water levels in groundwater bores will be manually dipped using a water level instrument.	Monthly
Groundwater quality Quarterly parameters • pH, TDS, EC, redox potential, DO, temperature • TN, TP, nitrate/nitrite, total Kjeldahl nitrogen, ammonia, orthophosphate, TN:TP ratio, • metals (As, Al, Cd, Cr, Cu, Mn, Ni, Pb, Se, Fe, Zn)	Groundwater sampling will be undertaken in accordance with *AS/NZS 5667.11:1998, Water quality – Sampling, Part 11: Guidance on sampling of groundwaters.* The bore will be purged until field parameters become stabilised. Purged water will be collected in a pail and disposed of away from the bore site. During the purging process, physical water parameters (pH, DO, conductivity, temperature, and redox potential) will be measured using a multi-parameter probe. The readings will be taken at 5 minute intervals and recorded. Water samples will be collected from the bore once field readings are stabilised (i.e. the difference between successive readings is within 10%, except for pH which will be within 0.1). Water samples will be collected from the bore once field readings are stabilised. A peristaltic pump will be used to collect water from bores with a depth of less than 15 m. A foot valve pump will be used to collect samples from deeper bores. For both collection methods, site-specific tubing will be used to avoid cross-contamination between sites. Water samples will be discharged into sample bottles directly from the tubing. **Decontamination** Re-useable equipment will be washed and rinsed using a 2% solution of Decon 90 and finally rinsed with laboratory supplied de-ionised water. This was to minimise the potential for cross-contamination between sites. **Blank samples** Rinsate blanks will also be collected and analysed for elements throughout the groundwater sampling rounds. Laboratory provided deionised water will be used to rinse the equipment. **Duplicate samples** Each batch of samples will include one duplicate for every 10 samples submitted to the laboratory. The purpose of these duplicates was to allow the laboratory to perform internal quality assurance and the results were included in the laboratory report.	Monthly for the first year. Frequency will be reviewed at the end of the first year and adjusted if necessary
Annual parameters • total acidity and total alkalinity • major anions and cations (chloride, sulfate, carbonate, bicarbonate, calcium, magnesium, sodium and potassium) • TPH and BTEX	As per quarterly parameters.	Annually, in October

Appendix 2
Basin specifications

Basins that are located in areas that have the ability to over-flow into natural drainage paths have been designed with a capacity for a 5 yr ARI, all other basins are designed with a capacity of 20 yr ARI. Table A 2 includes the specifications of each Basin which indicates that only basins F, G, H, I and O are designed with a capacity of 5 yr ARI and therefore include overflow routes. In rainfall events higher than 5 yr ARI overflow will be

- directed from Basin F to Basin G and directed from these basins to Roe Swamp as shown in Figure A3 in Appendix 3
- directed from Basin H to Basin F and will follow the same drainage pathway described above as shown in Figure A3 in Appendix 3
- directed from Basin I through an overflow weir into Horse Paddock Swamp as shown in Figure A5 in Appendix 3
- directed into the existing pipe network located at the intersection of Bibra Drive and Farrington Road, which discharges to Murdoch Drain as per Figure A4 in Appendix 3.

Table A 2: Basin specifications

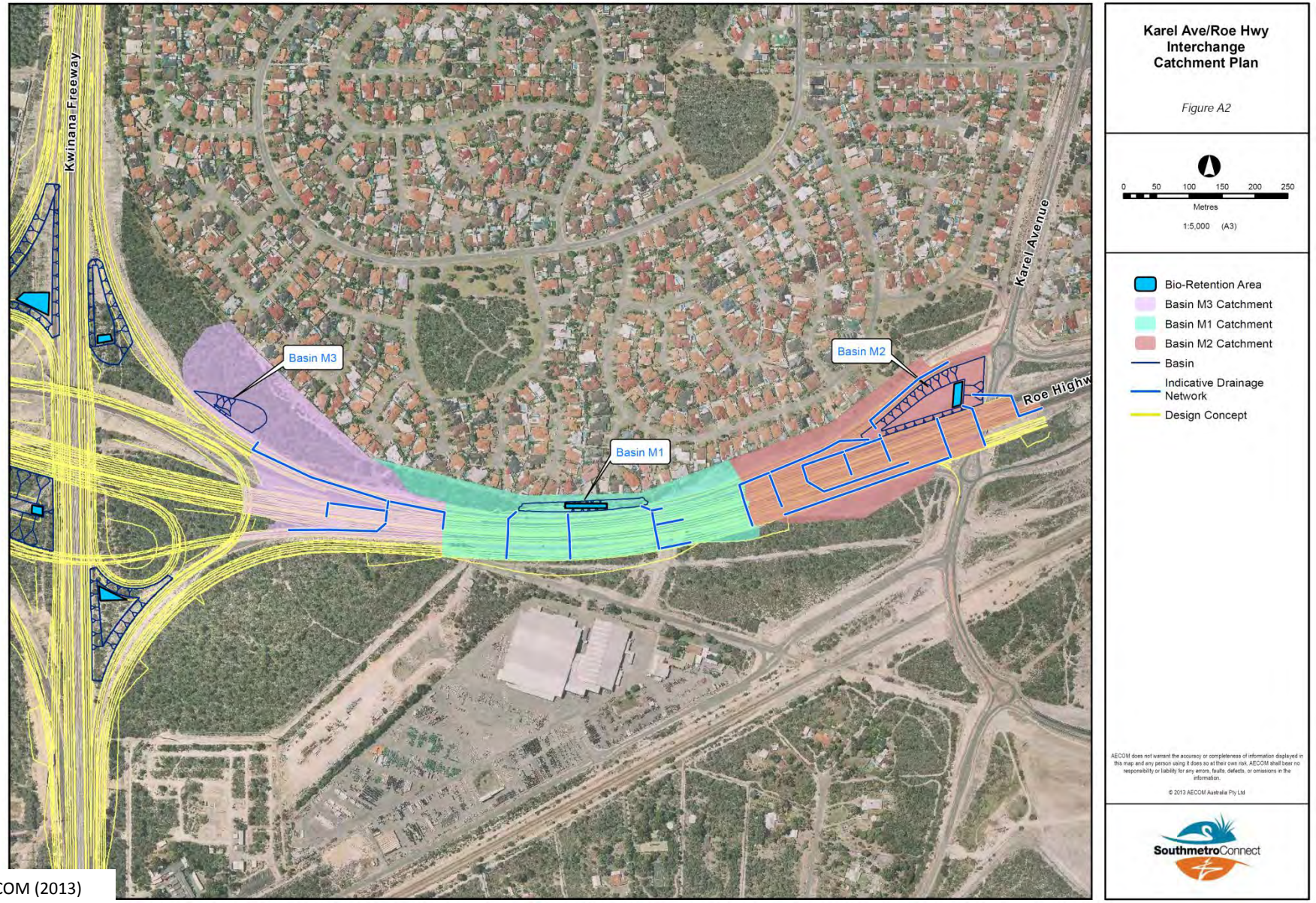
Basin reference	Design event	Storage required (m^3)	Calculated basin storage (m^3)	Water depth (m)	Side slope	Basin RL (mAHD)	GW level (mAHD)	Impervious catchment area (ha)	Bioretention basin area (ha)
Basin A	20 yr	2,918	3,025	1.2	1:3	24.5	23	1.19	0.024
Basin B	20 yr	10,060	10,113	1.2	1:4	25.4	23	6.08	0.122
Basin C	20 yr	3,410	4,041	1.2	1:4	28.3	23	2.47	0.049
Basin D	20 yr	3,907	3,936	1.2	1:4	26	23	1.74	0.034
Basin E	20 yr	1,545	1,854	1.2	1:3	20.5	18.3	0.75	0.015
Basin F	5 yr	6,044	6,118	1.2	1:4	17.9	17.75	4.48	0.090
Basin G	5 yr	1,891	1,978	0.85	1:4	17.65	17.6	1.36	0.027
Basin H	5 yr	330	379	1.2	1:3	18.7	17.9	0.14	0.002
Basin I	5 yr	3,365	3,387	0.225	1:3	~17 (varies)	15	3.06	0.061
Basin J (1-4 combined)	20 yr	6,030	5,624	1.2	1:4 Roe side 1:3 Off ramp	28 (av)	13 (av)	3.21	0.064
Basin K	20 yr	2,832	4,159	1.2	1:03	15.1	13.8	1.61	0.032
Basin L	20 yr	6,883	7,300	1.2	1:6	18.3	18.15	3.17	0.063
Basin M1	20 yr	2,375	2,525	2.4	1:5	31.4	24.5	2.38	0.048
Basin M2	20 yr	4,821	4,821	1.2	1:3	26.4	24.5	2.55	0.051
Basin M3	20 yr	1,734	1,743	1.22	1:15	32	24.5	1.47	0.029
Basin N	20 yr	2,036	2,096	1.2	1:3	18	17.65	1.02	0.020
Basin O (combined)	5 yr	490	536	0.7	1:3	18.5	17.4	2.48	0.050
Basin P	20 yr	3,415	3,465	1.2	1:3	37	3.5	3.10	0.062
Basin Q	20 yr	254	285	1.2	1:13	47.8	3.5	0.16	0.003
Basin R	20 yr	457	522	1.1	1:11	47	3.5	0.55	0.011

Basin reference	Design event	Storage required (m^3)	Calculated basin storage (m^3)	Water depth (m)	Side slope	Basin RL (mAHD)	GW level (mAHD)	Impervious catchment area (ha)	Bioretention basin area (ha)
Basin S	20 yr	1,248	1,371	2.4	1:8	46.6	3.5	1.26	0.025
Basin T	20 yr	577	577	1.2	1:3	42.4	3.5	0.69	0.013
Basin U[1]	20 yr	TBD	101	0.38	1:6	30.3	TBD	TBD	TBD

Source: AECOM (2013)

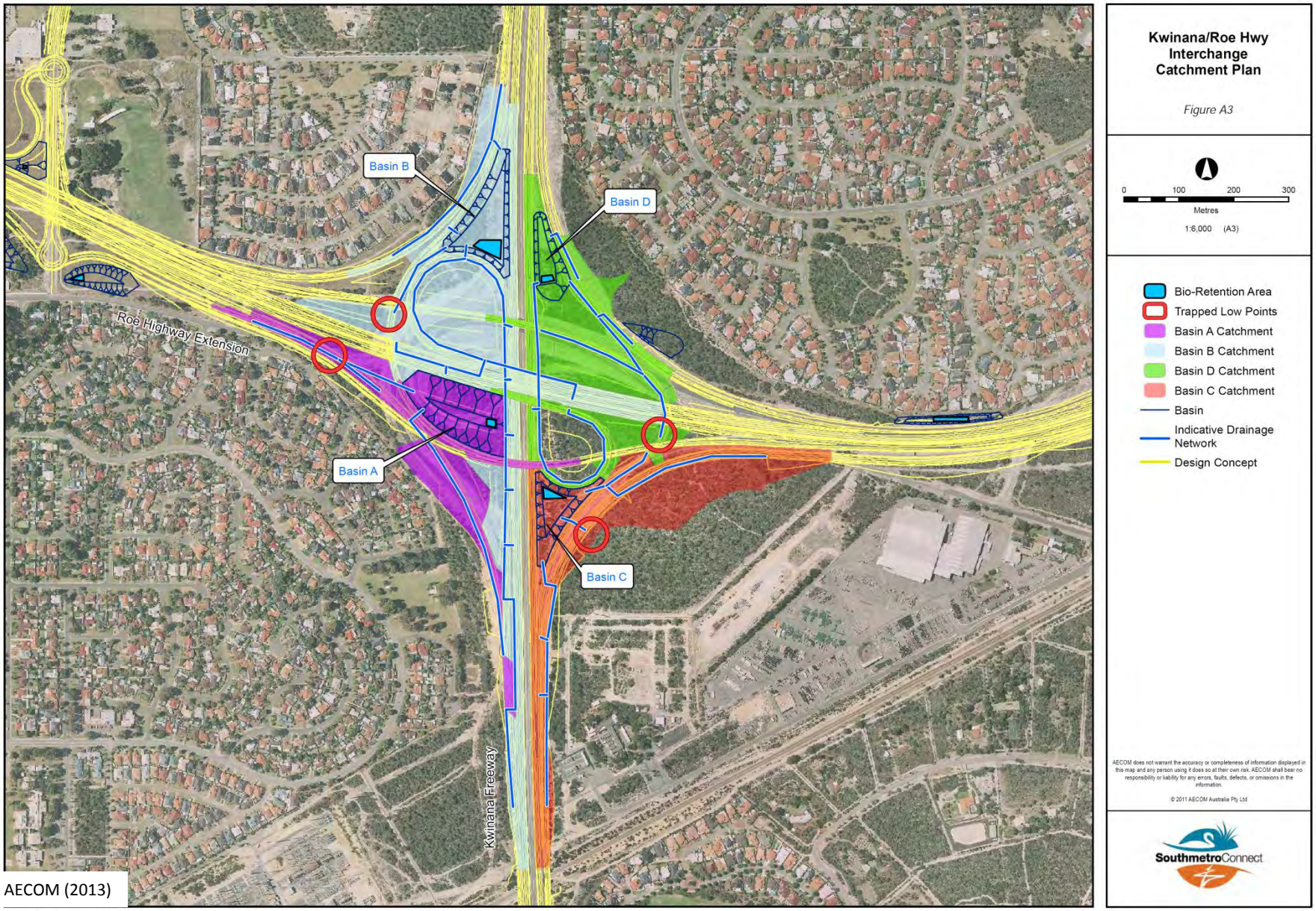
[1] Basin U has been designed as a provisional basin to allow for potential future design alterations of the Roe Highway in the vicinity of Sudlow Road and Coolbellup Avenue. The basins has not been designed for a particular catchment area, but is instead intended to manage water from a provisional future catchment (SMC 2011b).

Appendix 3
Basin design locations



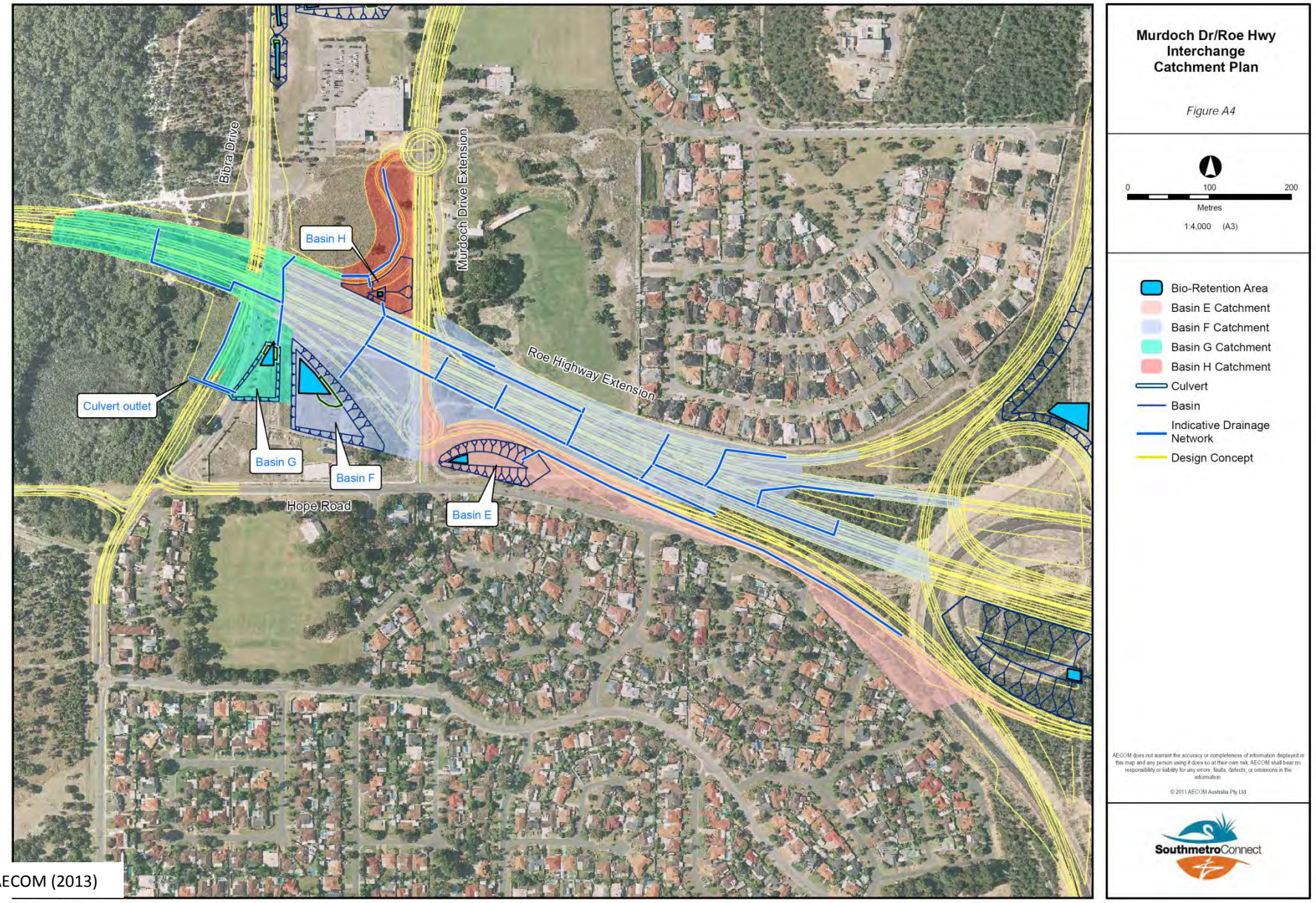
Source: AECOM (2013)

Figure A1: Karel Ave/Roe Hwy Interchange Catchment Plan



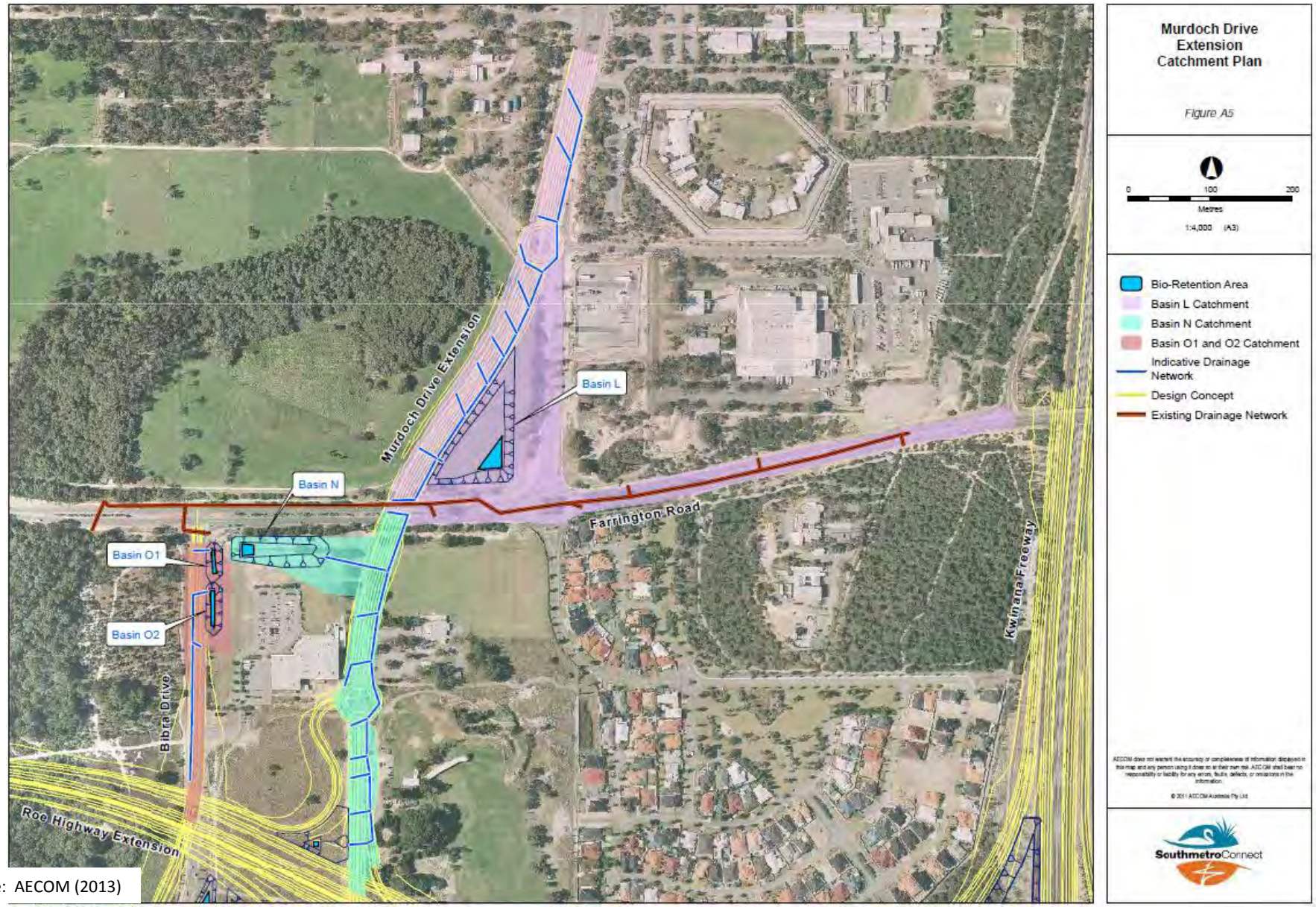
Source: AECOM (2013)

Figure A2: Kwinana/ Roe Hwy Interchange Catchment Plan



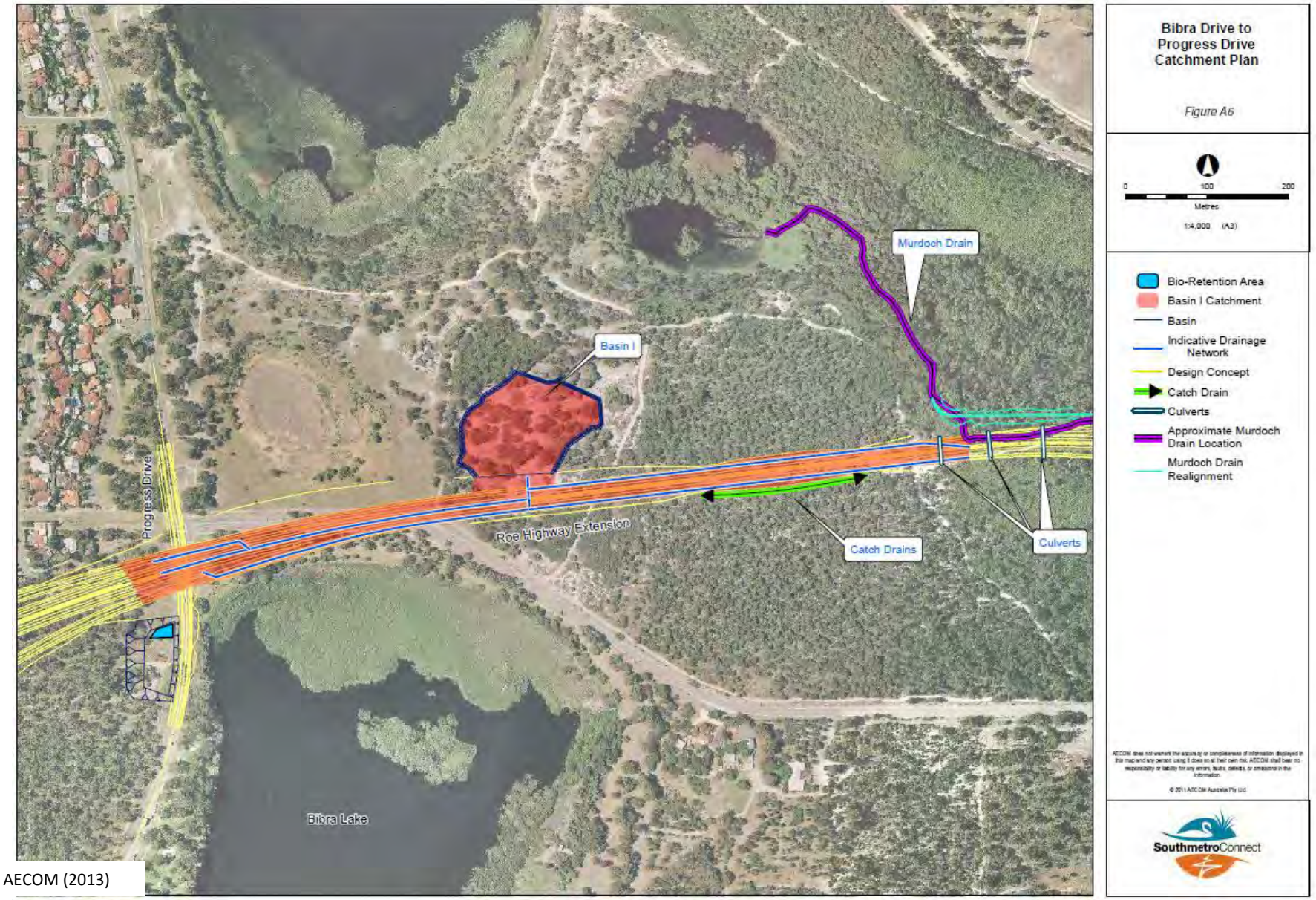
Source: AECOM (2013)

Figure A3: Murdoch Dr/ Roe Hwy Interchange Catchment Plan



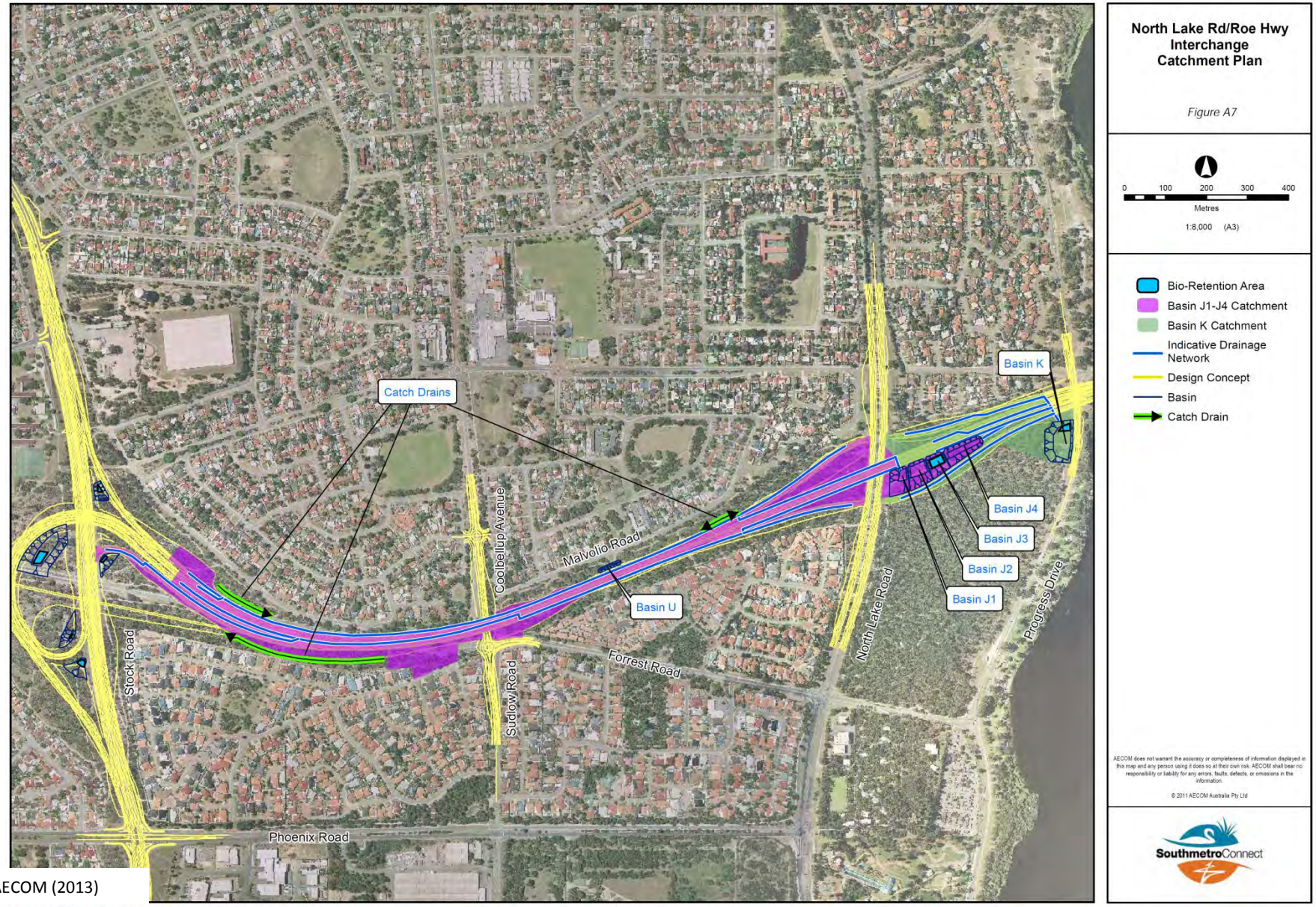
Source: AECOM (2013)

Figure A4: Murdoch Dr Extension Catchment Plan



Source: AECOM (2013)

Figure A5: Bibra Drive to Progress Drive Catchment Plan

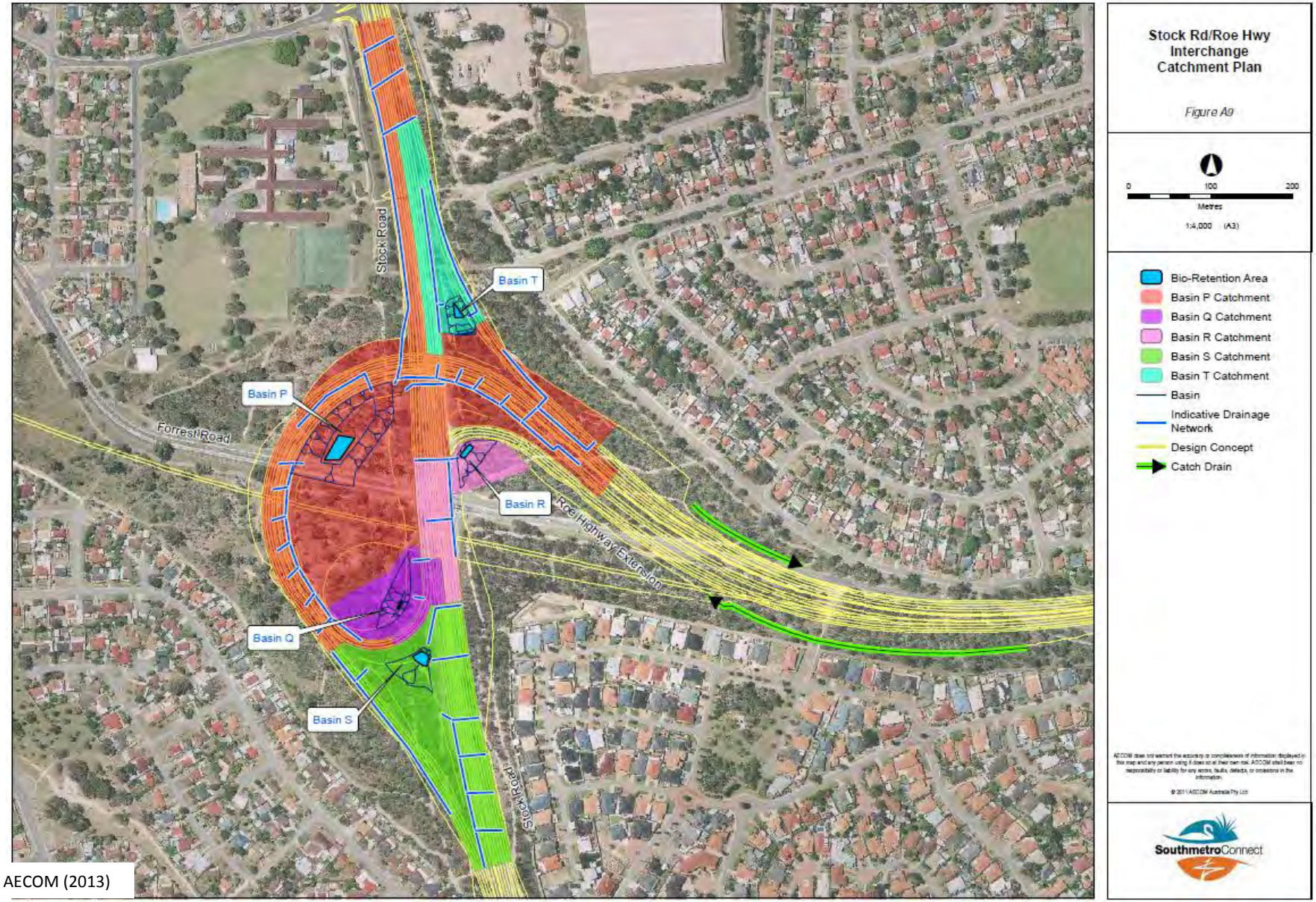


Source: AECOM (2013)

Figure A6: North Lake Rd/ Roe Hwy Interchange Catchment Plan

Source: AECOM (2013)

Figure A7: North Lake Rd/ Roe Hwy Interchange Basin Plan



Source: AECOM (2013)

Figure A8: Stock Rd/ Roe Hwy Interchange Catchment Plan

Source: AECOM (2013)

Figure A9: Malvolio Rd Basin Plan

Appendix 4
Scope for Baseline Wetland Condition and Baseline Drainage Monitoring Program

intelligent outcomes | respected experience

Roe Highway Extension

Scope of Works for Baseline Wetland Condition Survey and Baseline Drainage Monitoring Program

Prepared for
Main Roads
by Strategen

September 2015

strategen
ENVIRONMENTAL

Roe Highway Extension

Scope of Works for Baseline Wetland Condition Survey and Baseline Drainage Monitoring Program

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September 2015

Limitations

Scope of services

This report ("the report") has been prepared by Strategen Environmental Consulting Pty Ltd (Strategen) in accordance with the scope of services set out in the contract, or as otherwise agreed, between the Client and Strategen. In some circumstances, a range of factors such as time, budget, access and/or site disturbance constraints may have limited the scope of services. This report is strictly limited to the matters stated in it and is not to be read as extending, by implication, to any other matter in connection with the matters addressed in it.

Reliance on data

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The report is based on conditions encountered and information received at the time of preparation of this report or the time that site investigations were carried out. Strategen disclaims responsibility for any changes that may have occurred after this time. This report and any legal issues arising from it are governed by and construed in accordance with the law of Western Australia as at the date of this report.

Environmental conclusions

Within the limitations imposed by the scope of services, the preparation of this report has been undertaken and performed in a professional manner, in accordance with generally accepted environmental consulting practices. No other warranty, whether express or implied, is made.

Client: Main Roads

Report Version	Revision No.	Purpose	Strategen author/reviewer	Submitted to Client	
				Form	Date
Preliminary Draft Report	A	For client review	A Welker / D Newsome	Electronic	1 May 2015
Final Draft Report	B	For client approval	A Welker / D Goundrey	Electronic	29 May 2015
Final Draft Report	0	To submit to DoW and DPaW	D White / A Welker / D Goundrey	Electronic	1 July 2015
Final Report	1	For client approval	D White / A Welker / S Finning / D Goundrey	Electronic	19 August 2015
Final report	2	For submission	L Adams, A Welker / D Goundrey	Electronic	7 September 2015

Filename: MRO15099_04 R001 Rev 1 - 7 September 2015

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1. Introduction

Main Roads Western Australia (Main Roads) proposes to construct the Roe Highway Extension as part of the Perth Freight Link Project (the Project, Figure 1). This document presents the baseline wetland monitoring program and the baseline drainage monitoring program to manage the potential impacts from the operation of the Project.

The Project involves the construction of approximately 5 km of highway, extending Roe Highway from its current terminus at the Kwinana Freeway in Jandakot to Stock Road in Coolbellup. The proposed extension to Roe Highway is largely located within a primary regional road reserve which adjoins Beeliar Regional Park.

1.1 Background

The Project is located approximately 14 km south of Perth within the Swan Coastal Plain Bioregion. The Project is largely contained within the City of Cockburn, however, parts of the design extend northward in to the City of Melville along Murdoch Drive and Kwinana Freeway. Generally, the proposed Project is oriented east-west; largely within a road reserve that was set aside in the Metropolitan Region Scheme (MRS) in 1963. The alignment is between North and Bibra Lakes, which are part of the Eastern Chain of the Beeliar Wetlands.

The Project will consist of a dual carriageway with two lanes in each direction, separated by a concrete barrier in place of a median strip. The preferred design was selected following an extensive options analysis and consultative process. Once selected, the preferred design was optimised to avoid and minimise environmental impacts to the maximum extent possible.

In 2009 the Project was referred to the Environmental Protection Authority (EPA) under the *Environmental Protection Act 1986* (*EP Act*), and to then Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC), now the Department of the Environment (DotE), under the *Environment Protection and Biodiversity Conservation Act 1999* (*EPBC Act*). The Project was set a level of assessment of Public Environmental Review (PER) and the bilateral agreement between the State and Commonwealth governments was enacted. The PER was released on 20 June 2011 for a 12 week public review period.

The Project was approved by the Minister for Environment in 2 July 2015, with the release of Ministerial Statement 1008(Statement 1008) establishing conditions for the Project implementation.

Condition 8-3 and 9 of Statement 1008 requires the proponent to undertake a baseline survey to understand the baseline conditions around the proposed basins and the health and condition of Bibra Lake, Roe Swamp and North Lake in order to inform ongoing management.

1.2 Purpose and objectives

This document provides the scope of works that addresses the requirement for baseline monitoring around the proposed drainage basins required under condition 8-3 and the requirement for a Baseline Wetland Condition Survey for Bibra Lake, Roe Swamp and North Lake, required under Condition 9-2 of Statement 1008 dated 2 July 2015 which states:

> *8-3 Prior to commencement of construction, the proponent shall implement the approved Drainage Management and Monitoring Plan in order to collect baseline data and continue implementation until otherwise agree by the CEO.*
>
> *9-2 The proponent shall undertake a Baseline Wetland Condition Survey prior to commencement of construction to the requirements of the CEO on advice from the Department of Parks and Wildlife and the Department of Water. The Baseline Wetland Condition Survey shall:*
>
> *(1) have regard for Ramsar wetlands within the broader Beeliar Wetlands system;*
>
> *(2) cover Bibra Lake, Roe Swamp and North Lake areas adjacent to the road;*

(3) identify the indicators of wetland quality including physicochemical parameters and bio-indicators; and

(4) include protocols to measure the indicators of wetland quality as identified in condition 9-2(3) including duration, timing and frequency.

The objective of this baseline survey is to gain a greater understanding of the indicators that are proposed to be monitored during the implementation of the Project, to enable appropriate trigger levels to be determined. Ongoing monitoring will be undertaken immediately after baseline monitoring and will be consistent with the requirements of the Wetlands Monitoring and Management Plan (WMMP) and the Drainage Management and Monitoring Plan (DMMP), as required by condition 9-4 and 8-2 of Statement 1008.

The baseline scope of works will:

1. Ensure compliance with EPA ministerial statement condition 9-2 and 8-3 outlined above.
2. Establish a methodology to determine indicators for basin effectiveness.
3. Establish a methodology to determine indicators for wetland health for the nominated Beeliar Wetlands potentially impacted by Project activities.
4. Establish a baseline methodology to ensure sufficient baseline data is available to enable the development of appropriate trigger levels as required by condition 9-4 and 8-2 (7) of Statement 1008.

1.3 Relationship to other plans

Main Roads has also prepared the following related plans:

- Drainage Management and Monitoring Plan to meet Condition 8-2 which details the ongoing monitoring program proposed to be undertaken based on the baseline drainage monitoring program outlined in this Scope of Works
- Wetlands Monitoring and Management Plan to meet Condition 9-4 which details the ongoing monitoring program proposed to be undertaken based on the Baseline Wetland Condition Survey included in this Scope of Works.

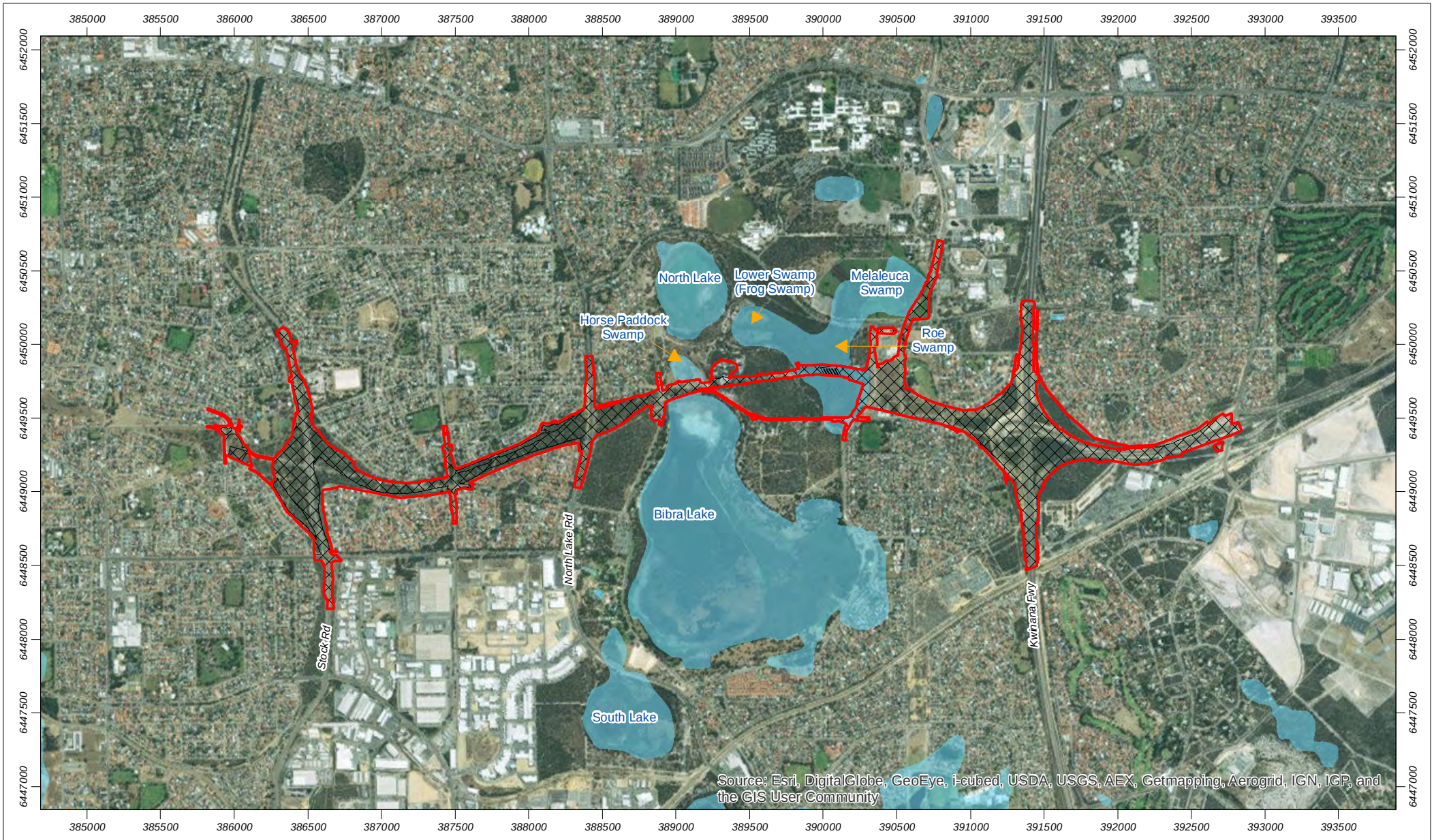

Figure 1: Project development envelope

Scale 1:35,000 at A4

0 200 400 600 800 1,000 Meters

Coordinate System: GDA 1994 MGA Zone 50

Note that positional errors may occur in some areas

Date: 19/08/2015

Author: jcrute

Source: Aerial image: ESRI, approx.2010; Wetlands: DPaW 2015, All other data: Client 2015.

Legend

- Development envelope
- Proposed construction footprint
- Wetlands

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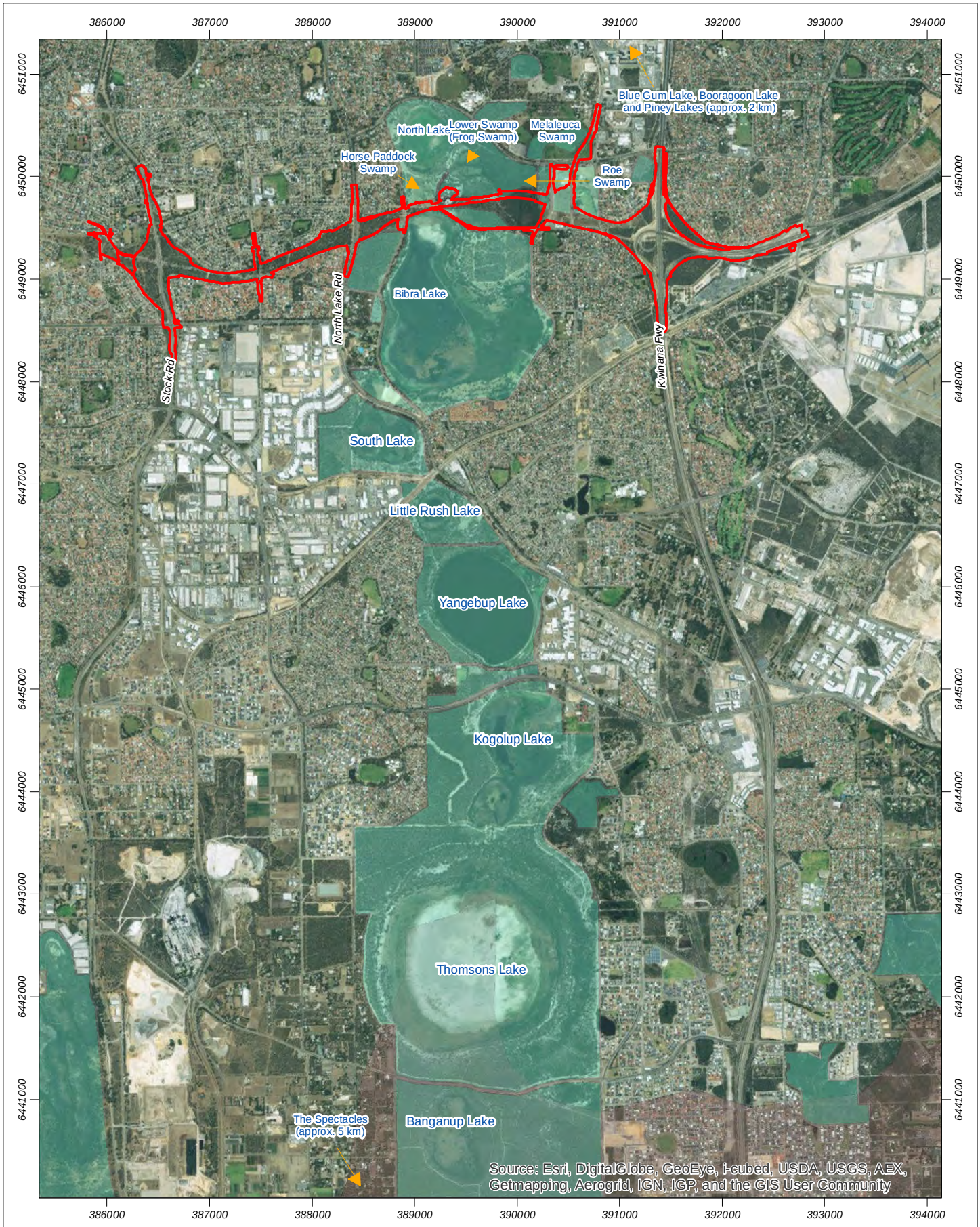

Figure 2: Beeliar wetland system

Scale 1:50,000 at A4

Meters
0 200 400 600 800 1,000

N

Legend

- Project development envelope
- Beeliar Regional Park

Coordinate System: GDA 1994 MGA Zone 50
Note that positional errors may occur in some areas
Date: 19/08/2015
Author: DWhite
Source: Aerial image: ESRI, approx. 2010, Development envelope: Client 2015; Regional Parks: DPaW 2015.

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2. Wetlands

The alignment of the proposed Roe Highway Extension intersects the eastern chain of the Beeliar Wetlands within Beeliar Regional Park (Figure 2). The eastern chain of Beeliar Wetlands encompasses North Lake, Bibra Lake, South Lake, Little Rush Lake, Yangebup Lake, Kogolup Lake, Thomsons Lake and Banganup Lake, Blue Gum Lake, Booragoon Lake and Piney Lakes, and the Spectacles (Figure 2). Thomsons Lake is considered a Ramsar wetland which is recognised as a Matter of National Environmental Significance under the EPBC Act.

The wetlands that will be directly impacted by the proposed Project include Bibra Lake, Horse Paddock Swamp and Roe Swamp (includes Lower Swamp, Melaleuca Swamp, and surrounding sumplands). The direct impacts to these wetlands are described in Table 1. No other Beeliar wetlands or Ramsar sites are expected to be impact by this Project.

Table 1: Wetlands within the development envelope

Wetland	Management Category/Protection	Total Area of Wetland (ha)	Area to be cleared/ developed (ha)
Bibra Lake	*Environmental Protection (Swan Coastal Plain Lakes) Policy 1992 (Lakes EPP)*	138	0.95
Horse Paddock Swamp	*Lakes EPP* Conservation Category Wetland's (CCW) in the Geomorphic Wetlands of the Swan Coastal Plain	3.2	0.2
Roe Swamp (includes Lower Swamp, Melaleuca Swamp, and surrounding sumplands)	CCW in the Geomorphic Wetlands of the Swan Coastal Plain	53.7	5.6

Source: South Metro Connect 2013

Bibra Lake (Unique Feature Identifier (UFI) 6595 and 6522) has multiple UFIs and is classified as a Resource Enhancement Wetland sumpland (REW). Bibra Lake is also protected under the *Lakes EPP* (DEC 2009). The Lake and surrounding vegetation also forms part of Bush Forever Site 244. Bibra Lake is the largest lake located within the development envelope and consists of open water, which is a reflection of groundwater on the western side of the Jandakot Mound. Bibra Lake has relatively impermeable lake deposits, with sandy shores restricted to a small area to the west. As a consequence, groundwater inflow and outflow is restricted when the water level drops (EPA and Water Authority of Western Australia 1990).

North Lake (UFI 6599) is classified as a CCW and is protected under the Lakes EPP. North Lake is a surface expression of groundwater of the western Jandakot groundwater mound. Groundwater flows into the lake from the southeast and out to the northwest (DoW 2015). Surface water levels and pH have declined and the lake is at risk of acidification. Nutrient concentrations at North Lake exceed ANZECC guidelines for lakes and wetlands in southwest Western Australia.

Roe Swamp (UFIs 15240, 14425 and 14645) is a group of seasonally inundated wetlands, located to the east of North Lake. Roe Swamp is considered unique, diverse and of high fauna habitat value relative to other wetlands in the Perth region and is accordingly classified as a CCW. The majority of Roe Swamp (with the exception of the eastern section) is also located within Bush Forever Site 244, which describes the wetland vegetation as being equivalent to the Bassendean Complex. The northern portion of Roe Swamp (UFI 14645) (Lower Swamp) is protected under the *Lakes EPP*.

As required by condition 8 and 9 of Statement 1008, Main Roads will undertake a baseline wetland and drainage survey and an ongoing monitoring program around the wetlands to inform wetland and drainage management during operation, and to ensure it has regard for the wider Beeliar wetland system and associated Ramsar wetlands as per condition 9-2(1).

2.1 Previous studies

2.1.1 Hydrological studies

A number of studies have been undertaken both as part of the PER process and as part of other monitoring studies. All this information will be utilised to provide preliminary baseline information in relation to groundwater and surface water. Current existing studies include:

- a three phase baseline surface and groundwater monitoring program on the 19 and 20 November 2009 (spring), 4 February 2010 (summer), 26 August 2010 (winter) (AECOM 2011)
- monthly targeted groundwater monitoring between March 2011 and April 2012 (AECOM 2012)
- a Perth shallow groundwater systems investigation for North Lake undertaken by Department of Water (DoW 2015)
- the monitoring of water levels and ecological health data monitored as a condition of the approval of groundwater abstraction from the Jandakot Groundwater Mound by DoW
- the monitoring in Bibra Lake and North Lake as part of the City of Cockburn midge control program (CALM 2006)
- the triggers for minimum water levels in Bibra and North Lakes set as part of the approvals for the Jandakot Groundwater Scheme Stage 2 (Government of Western Australia 2005).

Monitoring data for this area is also available on the Department of Water website and will be reviewed as part of the baseline survey.

2.1.2 Ecological indicators of wetland quality

To supplement the understanding of baseline wetland health gained through measurement of physical parameters (water levels and quality) identified in hydrological surveys listed above, a study of aquatic macro-invertebrates has been conducted, as well as a wetland and migratory bird survey:

- survey of aquatic macroinvertebrates (Phoenix Environmental Services, October 2010)
- study of wetlands and migratory birds (Western Wildlife 2009-2010).

3. Baseline survey

A baseline survey is required under condition 8-3 and 9-2 of Statement 1008 dated 2 July 2015. The indicators of drainage condition and wetland quality, including physicochemical parameters and bio-indicators and their associated protocols, have been selected based on previous studies undertaken by AECOM (2011; 2012) and the Beeliar Regional Park Management Plan. The survey is proposed to include:

- a review of all available relevant monitoring data including the studies mentioned in Section 2.1 (Section 3.1)
- a baseline surface water, groundwater and sediment sampling program for Bibra Lake, North Lake and Roe Swamp (Section 3.1)
- a baseline groundwater and filter media sampling program associated with the drainage basins (Section 3.3)
- a baseline aquatic macroinvertebrate survey (Section 3.1).

These parameters have been chosen as they are independent indicators of wetland health and basin condition, and also have some measure of inter-dependence which will better inform when contingency actions are required.

3.1 Desktop assessment

A desktop assessment will be conducted in order to:

- collate all available groundwater, surface water and ecological health monitoring data relevant to the baseline data requirements of Condition 8-2 and Condition 9-2 of Statement 1008
- review the publicly available information relevant to establishing a baseline condition for Ramsar wetlands within the broader Beeliar Wetlands system.

The desktop assessment will include all studies outlined in Section 2.1 and any other relevant publicly available datasets.

3.2 Wetland sampling program

The wetland sampling program is based on the previous AECOM (2011, 2012) program which consisted of three baseline monitoring events and a targeted groundwater monitoring program between March 2011 and April 2012, and a survey of aquatic macroinvertebrates conducted as a baseline survey in 2010. The AECOM program has provided a preliminary understanding of the conditions around the wetlands and additional baseline water quality and level data is also available for this area from the studies listed in Section 2.1.1.

Due to the availability of extensive data for the area, a 6 month supplementary baseline wetland sampling program is proposed to be undertaken as part of this survey. This program is proposed to be undertaken utilising similar methodology as the AECOM (2011, 2012) program and will monitor for similar parameters to this program and the *Final Beeliar Regional Park Management Plan 2006.* It will also integrate an annual survey of aquatic macroinvertebrates as an additional indicator of wetland quality. The program will include monitoring sediment quality, water level, physiochemical parameters, nutrients, elements, hydrocarbons, organic and biological components (algae, chlorophyll-a and aquatic macroinvertebrates) as identified in Table 2.

The supplementary program will involve the installation of electronic data loggers at selected bores, which was not included in the previous AECOM program. These data loggers will provide daily readings of water levels during the monitoring period and will ensure that the data collected will supplement the existing information and provide a thorough understanding of the natural variation within the wetlands.

The proposed monitoring sites are located around Roe Swamp, North Lake and Bibra Lake utilising existing sites, where possible (Figure 3, Figure 4, and Appendix 1). Where possible, aquatic macroinvertebrate surveys will use sampling locations identified from 2010 (Figure 5) as well as additional reference sites (selected from other water bodies within the Beeliar wetlands chain including Thomsons Lake, Lake Yangebup, Lake Kogolup and a swamp to be confirmed based on seasonal water levels equivalent to target swamps). The exact location of monitoring sites will be determined during the initial site inspection based on site access, existing monitoring sites, hydrological gradient, Aboriginal Heritage and long term site availability. Additional surface and groundwater monitoring infrastructure (e.g. bores) may need to be installed and disturbance of wetlands may be required (e.g. sediment sample collection). All monitoring actions shall be undertaken in accordance with the Section 18 consent to disturb and the Aboriginal Heritage Management Plan. The monitoring sites will be confirmed with DoW and DPaW prior to the commencement of the baseline survey.

This baseline program and associated Wetland Monitoring and Management Plan will monitor and manage any potential impacts from the project, which will ensure the protection of the wider Beeliar wetland system and associated Ramsar wetlands as per condition 9-2(1).

3.2.1 Timing

Due to the availability of existing data for the area, a six-month supplementary baseline wetland sampling program is proposed to be undertaken, with aquatic macroinvertebrates sampled once in spring within this six-month period. Given the above, the proposed scope of works for baseline wetland monitoring presented in Table 2, is considered to provide sufficient data to supplement the existing information, in order to develop appropriate trigger levels.

Ongoing monitoring will be undertaken immediately after baseline monitoring and will be consistent with the requirements of the Wetlands Monitoring and Management Plan.

Figure 3: Proposed wetland groundwater monitoring locations

Scale 1:15,000 at A4

0 100 200 300 400 Meters

Coordinate System: GDA 1994 MGA Zone 50
Note that positional errors may occur in some areas
Date: 19/08/2015
Author: DWhite
Source: Aerial image: ESRI, approx. 2010; Development envelope: Client 2015; Wetlands: DPaW 2015.

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Legend

- Groundwater bores (AECOM)
- Project development envelope
- Wetlands

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Figure 4: Proposed wetland surface water monitoring locations

Scale 1:15,000 at A4

0 100 200 300 400 Meters

N

Coordinate System: GDA 1994 MGA Zone 50
Note that positional errors may occur in some areas
Date: 19/08/2015
Author: DWhite
Source: Aerial image: ESRI, approx.2010; Wetlands: DPaW 2015; Development envelope: Client 2015.

Legend

Sampling type

- Algae
- Sediment
- Surface Water
- Project development envelope
- Wetlands

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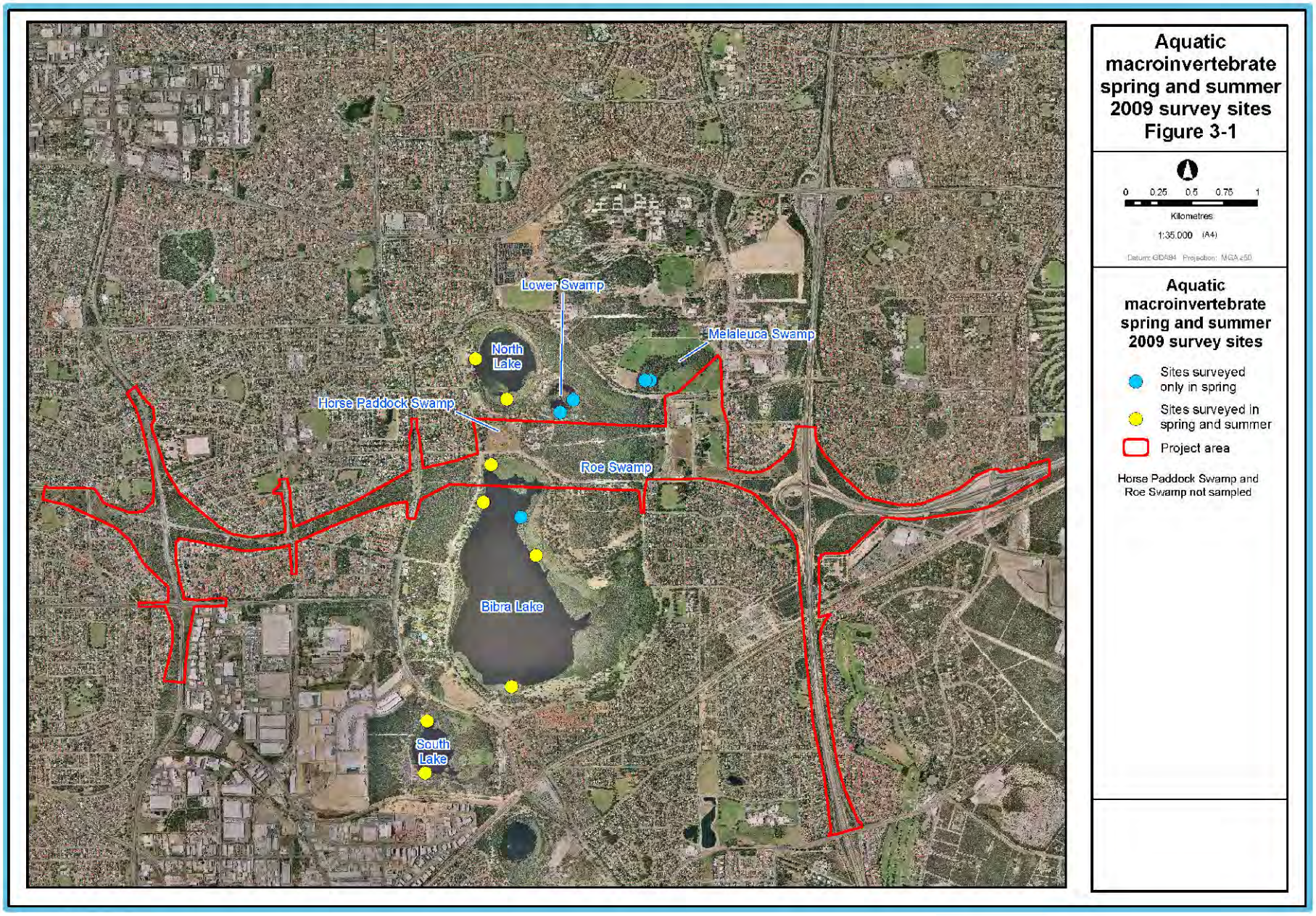

Figure 5: Proposed wetland surface water monitoring locations (for aquatic macroinvertebrate survey)

Date: 19/08/2015
Author: jcrute
Source: Phoenix Environmental Services 2010

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Table 2: Surface water and sediment wetland sampling program

Parameter	Parameter/Analytes to be tested	Methodology	Timing/ frequency
Surface water monitoring			
Physiochemical properties	Water levels	Water levels will be manually measured using a water level stake. Existing DoW water level stakes will be used where possible, with additional stakes installed if required.	Every month for 6 months
	• pH, TDS, EC , redox potential, DO , turbidity, colour, temperature (profiling) • total acidity and total alkalinity • nutrients including TN, TP, ammonia, nitrate/nitrite, total Kjeldahl nitrogen, orthophosphate, TN:TP ratio • metals (As, Al, Cd, Cr, Cu, Mn, Ni, Pb, Se, Zn, Fe) • TPH and BTEX (Benzene, toluene, ethyl benzene and xylenes) • major anions and cations (chloride, sulfate, carbonate, bicarbonate, calcium, magnesium, sodium and potassium).	Surface water sampling will be undertaken in accordance with *AS/NZS 5667.4:1998, Water quality – Sampling, Part 4: Guidance on sampling from lakes, natural and man-made*. Given the shallow depth of the lakes (<1 m), the water will be assumed to be well mixed, samples will be taken from the middle of the water column at each surface water sampling location during sampling events to represent characteristics at each selected sampling location. Existing monitoring sites will be utilised where possible. Water samples will be collected directly into laboratory provided sample bottles with preservatives. Samples will be chilled and delivered to a NATA accredited laboratory for analysis within the laboratory's stipulated holding time. **Profiling** Field water quality parameters will be obtained using a multi-parameter probe. Water physiochemical parameters such as pH, turbidity, DO, temperature and EC will be documented. **Blank samples** Rinsate blanks will also be collected and analysed for elements throughout the surface water sampling rounds. Laboratory provided deionised water will be used to rinse the equipment. **Duplicate samples** Each batch of samples will include one duplicate for every 10 samples submitted to the laboratory. The purpose of these duplicates will be to allow for the laboratory to perform internal quality assurance and the results will be included in the laboratory report.	Every month for 6 months
Bio-indicators	• Chlorophyll *a* and phytoplankton (algae) speciation	Algae samples will be collected from two locations in the lakes using a sampling bailer. One sampling point will be located in the middle of the lake; the other at the edge of the lake to capture floating algae close to the shore.	Every month for 6 months
	• Aquatic macroinvertebrates	Samples of aquatic macroinvertebrates will be collected along inundated sections of shoreline from target lakes and swamps (North Lake, Bibra Lake, Roe Swamp and Horse Paddock Swamp) and reference lakes and swamps (selected from other wetlands within Beeliar wetlands connected to Jandakot Mound that are not anticipated to be impacted by the development including Thomsons Lake, Lake Kogolup and Lake Yangebup, as well as a swamp depending on seasonal water levels). Samples will be collected using a 250µm net within each different habitat type (open water, nearshore reeds/grasses, nearshore paperbark forest). Results will be subject to a combination of field identification by experienced invertebrate biologists and laboratory identification to family level and considered in combination with surface water physicochemical properties.	Once in spring
Sediment monitoring			
Sediment quality	• Total Organic Carbon • pH • redox potential	Sediment samples will be taken using a stainless steel hand spade. Samples will be separated based on depth intervals. Upper horizon surface samples were collected from the upper 5 cm of sediment and the lower horizon samples from 10–20 cm depth. **Blank samples**	Once, during winter or spring

Parameter	Parameter/Analytes to be tested	Methodology	Timing/ frequency
	• Metals (As, Cd, Cr, Cu, Mn, Ni, Pb, Se, Zn) • TPH and BTEX	One rinse blank sample will be collected and analysed at the completion of the soil sampling. Laboratory provided deionised water will be used to rinse the equipment. The rinsate sample will be analysed for elements. As this parameter is anticipated to be less variable than water quality and levels only one sampling event is proposed. **Duplicate samples** Each batch of samples will include one duplicate for every 10 samples submitted to the laboratory. The purpose of these duplicates was to allow the laboratory to perform internal quality assurance and the results were included in the laboratory report.	

Table 3: Groundwater wetland sampling program

Parameter	Location	Parameter/Analytes to be tested	Methodology	Timing/ frequency
Physiochemical properties	All bores	Water levels	Monitoring bores will be placed up and down gradient of the wetlands. Actual locations will be confirmed based on site access and long term site availability. Existing monitoring sites will be utilised where possible. **Bore installation** Groundwater bores will be installed to a depth of 3 m below the groundwater table to account for natural fluctuations in the height of the groundwater table. The screen will be set so a 2 m section is above the water table where possible. Installation of groundwater monitoring bores will be conducted with the use of a stem auger drill rig or similar, which allows the collection of soil samples/cores to a depth of 10 m below surface level and will allow a better description of the deep lithology. This style of drilling rig allow for the installation of monitoring bores without the potential for the bore hole collapsing and are therefore ideal for wetland conditions. Pre-drilling safety works will include Dial Before You Dig searches and cable location to confirm that services will not be impacted by the drilling process. All bores drilled will be geologically logged and surveyed for top of casing and ground levels for use in the Wetland Condition Monitoring and Management Plan. Further details of the bores are provided in Appendix 1. **Manual readings** Water levels in groundwater bores will be manually dipped using a Heron Dipper- T water level instrument or similar. Manual dipping of water bores will be undertaken at the time of data downloads.	Every month for 6 months
	BH10, BH12, T2F and T3E*	Water levels	**Data loggers** Daily readings will be undertaken using an automatic data logger installed into selected bores. Loggers will be downloaded during water quality monitoring events.	Daily for 6 months.
	All bores	• pH, TDS, EC, redox potential, DO, colour, temperature • total acidity and total alkalinity • TN, TP, ammonia, nitrate/nitrite, total Kjeldahl nitrogen, orthophosphate, TN:TP ratio	Groundwater sampling will be undertaken in accordance with *AS/NZS 5667.11:1998, Water quality – Sampling, Part 11: Guidance on sampling of groundwaters*. The bore will be purged until field parameters become stabilised. Purged water will be collected in a pail and disposed of away from the bore site. During the purging process, physical water parameters (pH, DO, conductivity, temperature, and	Every month for 6 months

Parameter	Location	Parameter/Analytes to be tested	Methodology	Timing/ frequency
		• metals (As, Al, Cd, Cr, Cu, Mn, Ni, Pb, Se, Zn, Fe) • TPH and BTEX • major anions and cations (chloride, sulfate, carbonate, bicarbonate, calcium, magnesium, sodium and potassium)	redox potential) will be measured using a multi-parameter probe. The readings will be taken at 5 minute intervals and recorded. Water samples will be collected from the bore once field readings are stabilised (i.e. the difference between successive readings is within 10%, except for pH which will be within 0.1). Water samples will be collected from the bore once field readings are stabilised. A peristaltic pump will be used to collect water from bores with a depth of less than 15 m. A foot valve pump will be used to collect samples from deeper bores. For both collection methods, site-specific tubing will be used to avoid cross-contamination between sites. Water samples will be discharged into sample bottles directly from the tubing. **Decontamination** Re-useable equipment will be washed and rinsed using a 2% solution of Decon 90 and finally rinsed with laboratory supplied de-ionised water. This was to minimise the potential for cross-contamination between sites. **Blank samples** Rinsate blanks will also be collected and analysed for elements throughout the groundwater sampling rounds. Laboratory provided deionised water will be used to rinse the equipment. **Duplicate samples** Each batch of samples will include one duplicate for every 10 samples submitted to the laboratory. The purpose of these duplicates was to allow the laboratory to perform internal quality assurance and the results were included in the laboratory report.	

* depending on the condition of the bore and ability to access groundwater.

3.3 Drainage sampling program

Management of water following development involves maintaining the hydrological regime and mitigating the impacts from construction and flooding through the design of a suitable stormwater system. The proposed stormwater management systems involves the use of pits, pipes, infiltration basins, bio-retention basins and culverts to minimise impacts on the hydrological regime by the proposed road alignment as detailed in the DMMP. All basins will incorporate smaller bio-retention basin to reduce the impacts from road runoff nutrients and pollutants on the surrounding environment by treatment of the more frequent storm events (AECOM 2013). Vegetated bioretention basins primarily operate by directing stormwater through surface vegetation and allowing runoff to filter and percolate through a prescribed filter media layer (AECOM 2013). During filtration, pollutants are retained through fine filtration, adsorption and some biological uptake (AECOM 2013). T

The purpose of the baseline drainage sampling program is provide sufficient baseline data to enable trigger levels to be set around these basins as part of the DMMP. This will require baseline monitoring of both groundwater and filter media in the vicinity of the proposed basins as identified in Table 4. The sampling program will focus on groundwater and filter media sampling as stormwater will be infiltrated in all events up to the 1 in 5 or 1 in 20 year ARI event within the basins. The indicative groundwater monitoring sites are shown in Figure 6, while the filter media will be sampled at three locations within each basin that is within 100 m of a wetland. This includes:

- Basin G
- Basin I
- Basin K
- Basin L (Figure 6).

Indicative groundwater monitoring sites for the drainage sampling plan is provided in Appendix 1.

3.3.1 Timing

Due to the availability of existing data for the area, a 6 month supplementary baseline drainage sampling program is proposed to be undertaken.

Ongoing monitoring will be undertaken immediately after baseline monitoring and will be consistent with the requirements of the Drainage Management and Monitoring Plan.

Figure 6: Proposed drainage groundwater monitoring locations

Scale 1:8,000 at A4

0 50 100 150 200 m

Coordinate System: GDA 1994 MGA Zone 50

Note that positional errors may occur in some areas

Date: 7/09/2015

Author: DWhite

Source: Heritage: DIA 2012. All other data: Client 2015.

Legend

- Proposed monitoring bores
- Project development envelope
- Basin footprint

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Table 4: Drainage sampling program

Parameter		Parameter/Analytes to be tested	Methodology	Timing/ frequency
Groundwater monitoring				
Physiochemical properties	All bores	Water levels	Monitoring bores will be placed up and down gradient of the wetlands. Actual locations will be confirmed based on site access and long term site availability. Existing monitoring sites will be utilised where possible. **Bore installation** Groundwater bores will be installed to a depth of 3 m below the groundwater table to account for natural fluctuations in the height of the groundwater table. The screen will be set so a 2 m section is above the water table. Installation of groundwater monitoring bores will be conducted with the use of a stem auger drill rig or similar, which allows the collection of soil samples/cores to a depth of 10 m below surface level and will allow a better description of the deep lithology. This style of drilling rig allow for the installation of monitoring bores without the potential for the bore hole collapsing and are therefore ideal for wetland conditions. Pre-drilling safety works will include Dial Before You Dig searches and cable location to confirm that services will not be impacted by the drilling process. All bores drilled will be geologically logged and surveyed for top of casing and ground levels for use in the Wetland Condition Monitoring and Management Plan. **Manual readings** Water levels in groundwater bores will be manually dipped using a Heron Dipper- T water level instrument or similar. Manual dipping of water bores will be undertaken at the time of data downloads.	Every month for 6 months
	D5, D4, D7 and T3E*	Water levels	**Data loggers** Daily readings will be undertaken using an automatic data logger installed into selected bores. Loggers will be downloaded during water quality monitoring events.	Daily for 6 months.
	All bores	• pH, TDS, EC, colour, redox potential, DO, temperature • total acidity and total alkalinity • TN, TP, ammonia, nitrate/nitrite, total Kjeldahl nitrogen, orthophosphate, TN:TP ratio • metals (As, Al, Cd, Cr, Cu, Mn, Ni, Pb, Se, Zn, Fe) • TPH and BTEX • major anions and cations (chloride, sulfate, carbonate, bicarbonate, calcium, magnesium, sodium and potassium)	Groundwater sampling will be undertaken in accordance with *AS/NZS 5667.11:1998, Water quality – Sampling, Part 11: Guidance on sampling of groundwaters.* The bore will be purged until field parameters become stabilised. Purged water will be collected in a pail and disposed of away from the bore site. During the purging process, physical water parameters (pH, DO, conductivity, temperature, and redox potential) will be measured using a multi-parameter probe. The readings will be taken at 5 minute intervals and recorded. Water samples will be collected from the bore once field readings are stabilised (i.e. the difference between successive readings is within 10%, except for pH which will be within 0.1). Water samples will be collected from the bore once field readings are stabilised. A peristaltic pump will be used to collect water from bores with a depth of less than 15 m. A foot valve pump will be used to collect samples from deeper bores. For both collection methods, site-specific tubing will be used to avoid cross-contamination	Every month for 6 months

Parameter		Parameter/Analytes to be tested	Methodology	Timing/ frequency
			between sites. Water samples will be discharged into sample bottles directly from the tubing. **Decontamination** Re-useable equipment will be washed and rinsed using a 2% solution of Decon 90 and finally rinsed with laboratory supplied de-ionised water. This was to minimise the potential for cross-contamination between sites. **Blank samples** Rinsate blanks will also be collected and analysed for elements throughout the groundwater sampling rounds. Laboratory provided deionised water will be used to rinse the equipment. **Duplicate samples** Each batch of samples will include one duplicate for every 10 samples submitted to the laboratory. The purpose of these duplicates was to allow the laboratory to perform internal quality assurance and the results were included in the laboratory report.	
Filter media monitoring				
Filter media monitoring	All bores	• Total Organic Carbon • pH • redox potential • nutrients including TN, TP, ammonia, nitrate/nitrite, total Kjeldahl nitrogen, orthophosphate, TN:TP ratio • Metals (As, Cd, Cr, Cu, Mn, Ni, Pb, Se, Zn) • TPH and BTEX • Clay content, pH and Cation Exchange Capacity	Sediment samples will be taken using a stainless steel hand spade. Samples were separated based on depth intervals. Upper horizon surface samples were collected from the upper 5 cm of sediment and the lower horizon samples from 10–20 cm depth. **Duplicate samples** Each batch of samples will include one duplicate for every 10 samples submitted to the laboratory. The purpose of these duplicates was to allow the laboratory to perform internal quality assurance and the results were included in the laboratory report.	Once after construction prior to first rainfall.

* depending on the condition of the bore and ability to access groundwater.

4. Reporting and review process

Baseline wetland monitoring

Monitoring will occur each month for a period of six months once the baseline survey scope has been approved by the OEPA. A brief summary report will be produced 2 weeks following each monitoring events for submission to Main Roads. A final report, which summarises the results of all monitoring events will be produced following the final monitoring baseline monitoring event and will be submitted to the CEO of OEPA prior to construction commencing. Monitoring will continue following the completion of baseline surveys as per the WMMP.

Baseline drainage monitoring

Monitoring will occur each month for a period of six months prior to each drainage basin being installed. A brief summary report will be produced 2 weeks following each monitoring events for submission to Main Roads. A final report, which summarises the results of all monitoring events will be produced following the final monitoring baseline monitoring event and will be submitted to the CEO of OEPA prior to construction of each drainage basin. Monitoring will continue following the completion of baseline surveys as per the DMMP.

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Appendix 1
Bores proposed for use in wetland and drainage baseline monitoring program

Table A 1: Proposed groundwater bores for wetland monitoring

Bore ID	Diameter (mm)*	Purpose	Description	Coordinates	
				Easting	Northing
T2F	25	To establish baseline water level and water quality data for wetland health.	Reference site	389498	6450298
T3E	25		Construction footprint	389242	6449817
CPT07C	25		Construction footprint	389467	6449765
CPT07A	25		Construction footprint	389685	6449793
T3D	25		Construction footprint	389832	6449786
T3C	25		Construction footprint	390003	6449795
T3B	25		Construction footprint	390280	6449816
BH10	50		Construction footprint	390260	6449758
BH12	50		Construction footprint	390836	6449532
T4B	25		Reference site**	390119	6449482
T4C	25		Reference site**	389899	6449448
T4D	25		Reference site**	389577	6449434

* all bores are existing bores, diameters are assumed to be 25 mm for all bores apart from BH10 and BH12
** minimal construction works are proposed only this section

Table A 2: Proposed groundwater bores for drainage monitoring

Bore ID	Proposed Diameter (mm)	Purpose	Description	Coordinates	
				Easting	Northing
D1	50	To establish baseline water level and water quality data for drainage basins	Upgradient of drainage basin L	390792	6450190
D2	50		Downgradient of drainage basin L	390659	6450261
D3	50		Upgradient of drainage basin F and G	390511	6449530
D4	50		Downgradient of drainage basin F and G	390285	6449602
D5	50		Upgradient of drainage basin I	389430	6449785
T3E	25*		Downgradient of drainage basin I	389242	6449817
D7	50		Upgradient of drainage basin K	388927	6449528
D8	50		Downgradient of drainage basin K	388825	6449535

* existing groundwater bore.

Appendix 5
Trigger values derived from existing data

Trigger values derived from existing data

Trigger values derived from existing data were calculated based on groundwater quality data obtained from the DoW bores in the immediate vicinity of the lakes and up gradient from Bibra Lake and North Lake, to the top of the Jandakot Mound (AECOM 2012).

The 80th percentile values were used to allow for benchmarking groundwater tested as part of the baseline monitoring program. This method was derived from methods presented in ANZECC/ARMCANZ (2000) Section 3.3.2.4 for stressors that cause environmental problems at high concentrations. For pH, which may stress both low and high values, the 20th percentile of the reference data was also used to define a lower guideline value (AECOM 2012). The pH trigger values described below were also used as the trigger values for surface water and sediment quality as these are more likely to be closer to baseline condition than the ANZECC/ARMCANZ (2000) guideline values. The adopted trigger values will also be revised, if required, once the baseline survey has been completed. Any changes to the plan and trigger values will be provided to OEPA for approval.

Table A 3: Descriptive statistics for physiochemical, dissolved elements and nutrients (Department of Water 2010)

Analytes	Units	n	No. of sites sampled	Min	Max	Mean*	80th percentile (adopted guideline value)
Physicochemical							
Bicarbonate Alkalinity	mg/L	25	23	7	330	68	220
Hardness	mg/L	30	24	12	390	85	190
Total Dissolved Salts	mg/L	90	7	180	2,300	500	950
Elements – dissolved							
Aluminium	µg/L	85	8	5	16,000	190	650
Arsenic	µg/L	2	23	2	10	4.5	8.4
Copper	µg/L	3	23	20	30	23	26
Iron	µg/L	113	30	53	170,000	960	1,900
Manganese	µg/L	11	23	20	140	32	50
Lead	µg/L	2	23	10	10	10	10
Zinc	µg/L	19	19	20	50	27	40
Nutrients							
Total Nitrogen	mg/L	57	11	0.3	8	1.2	2.6
Total Kjeldahl Nitrogen	mg/L	60	12	0.3	6.6	1.1	1.8
Total Phosphorus	mg/L	58	12	0.01	0.4	0.1	0.2

Notes:
n = number of readings
*geometric mean

Source: AECOM 2012

Table A 4: Groundwater PH summary (Department of Water 2010)

	units	n	No. of sites sampled	Min	Max	Mean*	20th percentile (site specific lower guideline value)	80th percentile (site specific upper guideline value)
pH	pH unit	217	31	2.6	8.5	6.2	5.6	7.5

Notes:
n = number of readings
*geometric mean

Source: AECOM 2012

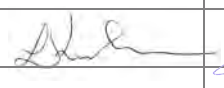
Metropolitan Road Improvement Alliance

Roe Highway Extension

Addendum to Drainage Monitoring and Management Plan

17 January 2020

Document Approval

Rev.	Date	Prepared by	Reviewed by	Recommended by	Approved by	Remarks
D	07/08/2019	C. House	L. Kirchner	J. Shaw		
Signature:						
E	24/10/19					
Signature:						
1	17/01/2020	C. House	L. Kirchner	J. Shaw		
Signature:						
Signature:						
Signature:						

Revision Recording

Revision	Details
A	Internal drafting
B	Revised as per internal review
C	Revised as per review
D	Final for issue
E	Update as per MRWA comments
0	Final

PURPOSE

The Drainage Monitoring and Management Plan (DMMP) is implemented to ensure that stormwater runoff from the Project is being appropriately managed through the Project's drainage basins through baseline data collection and post-construction / operation monitoring of the Roe Highway Extension (the Project). The DMMP was approved prior to changes being made to the Project's active construction area.

There are currently eight groundwater locations to be monitored under the approved DMMP Rev 1. Out of the eight locations, four are located where there will no longer be drainage basins as per the revised proposal for MS1008. Additionally, a number of the drainage basins have been redesigned, and basin monitoring locations have been adjusted accordingly.

The purpose of this addendum is to amend the monitoring locations in the DMMP to match the basins constructed as part of the revised proposal for MS1008.

1 INTRODUCTION

1.1 Project Background

Main Roads Western Australia (MRWA) established the 'Building Roe 8 Alliance' to complete Stage 8 of the Roe Highway Extension project, which had received approval by the Western Australian Minister for Environment in 2015 under the Ministerial Statement 1008 (MS 1008). Following the election of the Labor Government on 11 March 2017, construction of Roe 8 was suspended. In response, funds were re-allocated to several projects to improve road safety and reduce congestion. One of the projects is the Murdoch Drive Connection (MDC), which is being delivered by MRWA through the Metropolitan Road Improvement Alliance (MRIA). The MDC is being carried out under MS 1008 and therefore is subject to all management plans required under MS1008 conditions of approval.

Condition 8-2 of MS1008 requires the preparation and implementation of a Drainage Monitoring and Management Plan (DMMP), which was approved by the EPA in September 2016. The plan established a network of monitoring sites located within and adjacent to proposed drainage basins, with the objective *"to demonstrate that groundwater quality from the ongoing operation of the Project is maintained relative to pre-construction conditions"*. That is, to monitor the impacts of the drainage basins on groundwater quality once in operation and trigger management actions if specified parameters are exceeded.

As a result of the change to MDC, none of the proposed drainage basins located to the west of Bibra Drive will be constructed. In accordance with Condition 8.4 of MS 1008, the DMMP has been amended to remove the requirement to continue monitoring bores associated with the drainage basins that have not been constructed.

1.2 Ministerial Statement 1008

Table 1 details the conditions for managing Drainage Basins (Inland Water Environmental Quality) in MS 1008.

Table 1. Condition requirements under MS 1008 for Drainage Management and Monitoring

Condition	Requirement
8-1	The proponent shall ensure that impacts to groundwater quality from the ongoing operation of the proposal are maintained relative to pre-construction conditions established in baseline surveys required by condition 8-3.
8-2	Prior to commencement of construction, the proponent shall prepare a Drainage Management and Monitoring Plan to the requirements of the CEO, on advice from the Department of Water. The Drainage Management and Monitoring Plan shall:
	1. when implemented, substantiate whether condition 8-1 is being met
	2. include the locations, capacity and dimensions of bioretention and infiltration basins consistent with the Water Management Strategy (AECOM) dated 16 January 2013
	3. include ongoing maintenance measures to ensure the bioretention and infiltration basins are performing effectively
	4. include protocols and procedures for baseline monitoring of groundwater levels and groundwater quality
	5. include protocols and procedures for monitoring contaminant and nutrient levels within the bioretention and infiltration basins
	6. include protocols, procedures and locations for monitoring contaminants and nutrient levels of groundwater upstream and downstream of the bioretention and infiltration basins
	7. identify criteria to trigger implementation of management measures to remediate contaminants within the bioretention and infiltration basins and ensure the basins are performing effectively
	8. include management measures referred to in condition 8-2(7)
	9. determine the timing and frequency of reporting to the CEO.
8-3	Prior to commencement of construction, the proponent shall implement the approved Drainage Management and Monitoring Plan in order to collect baseline data and continue implementation until otherwise agreed by the CEO.
8-4	The proponent may review and revise the Drainage Management and Monitoring Plan to the requirements of the CEO.
8-5	The proponent shall review and revise the Drainage Management and Monitoring Plan as and when directed by the CEO.
8-6	The proponent shall implement the approved revisions of the Drainage Management and Monitoring Plan required by conditions 8-4 and 8-5.
8-7	The Drainage Management and Monitoring Plan required by condition 8-2 shall be made publicly available in a manner approved by the CEO.

1.3 Amendments

This addendum amends the monitoring program (DMMP Section 2) with reference to removing monitoring locations located within and adjacent to drainage basins that were not constructed.

Noting the stated objective for groundwater monitoring is *"to demonstrate that groundwater quality from the ongoing operation of the Project is maintained relative to pre-construction conditions"* monitoring sites located adjacent to formerly proposed basins that will no longer be constructed is outside the intent of Condition 8. As such, these bores are deleted from the DMMP. Figure 2 of this addendum illustrates the location of the monitoring bores to be removed from the program (in red) and those to be retained (in green). New bores are shown in Figure 3. Monitoring bores retained are designed to measure the groundwater flow from south-east to north-west.

1.4 Groundwater flow

Historical maximum groundwater contours from DoW (WRC 1997) and modelling undertaken for the Roe 8 project demonstrated that the project area generally has parallel groundwater contours with groundwater flow in an east-west direction trending south-east to north-west at the location of drainage basin L at the intersection of Murdoch Drive and Farrington Road (Figure 1). While this modelling was undertaken for the Roe 8 project it is still valid.

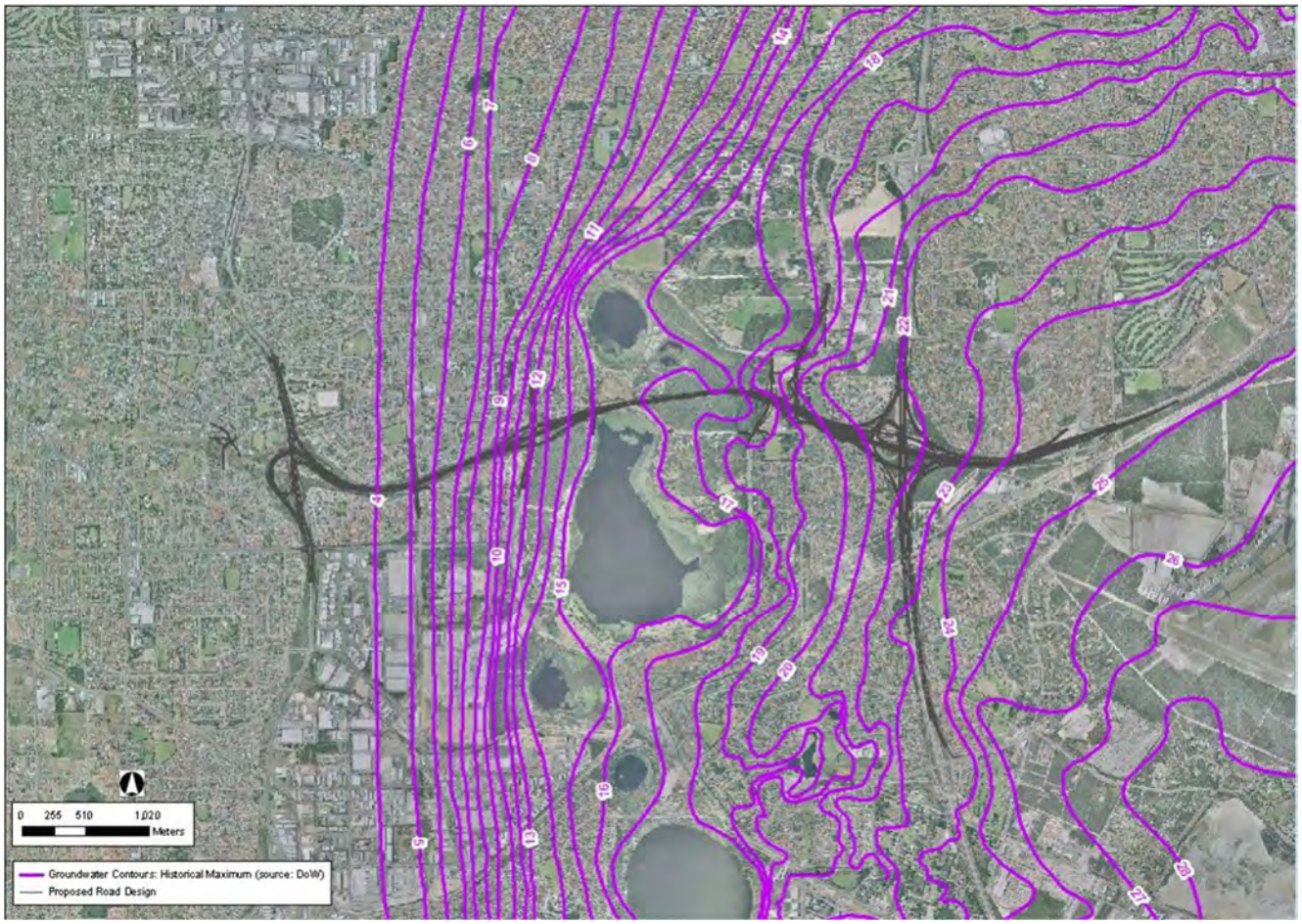


Figure 1. Groundwater contours from original Roe 8 modelling report (AECOM, 2011) hence Roe 8 footprint shown rather than MDC footprint

1.5 Basin design

The design of the basins still retains the same key features:

- All basins are designed as infiltration systems
- Most basins are located within the Bassendean Sands.
- Basin area size is variable, but typically ranges from about 200 – 8,000 m^3.
- The storage capacity of most basins has been designed to accommodate the critical 1 in 20-year ARI event (5% AEP) for a basin water height of 1.2 m.
- Basin base RL's have been set at or above maximum groundwater levels as defined by the Department of Water (DoW) Groundwater Atlas and published maximum contours.

1.6 Justification

The DMMP Rev 1 sets out a monitoring regime for eight groundwater monitoring bores and identifies parameters for monitoring basin condition. Of the groundwater bores, four (GW-D5, GW-D7, GW-D8 and GW-T3E) are located within the Rehabilitation Zone as defined in Attachment 2 to Ministerial Statement 1008.

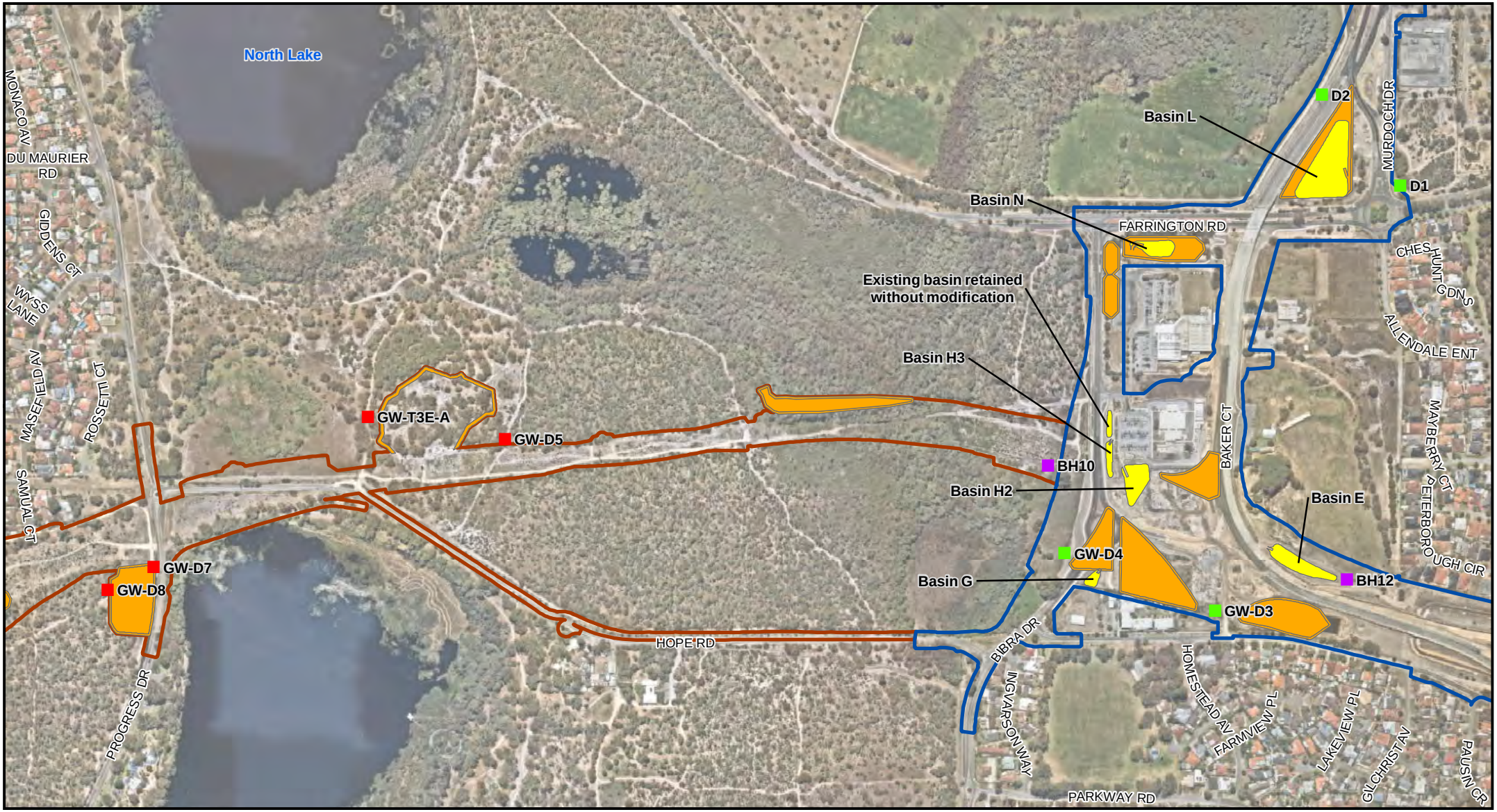
The drainage basins that have been constructed for MDC are generally significantly smaller than those in the original design. Basin specifications are in Appendix A.

The capacity of Basin L has been reduced by 22% and will be monitored using bores D1 upstream and D2 downstream. Bore D2 has been moved north from the location specified in the DMMP as modifications in the road design placed the original location under the road. It was moved to the closest location possible and an arrangement was made with Murdoch University for monitoring access. Groundwater flow in this location is in a more north-westerly direction (Figure 1), as groundwater discharges into Melaleuca Swamp.

Basin N, adjacent to Farrington Road has been reduced in capacity from 2,036m^3 to 1,278m^3 and is located near existing basins of twice the capacity. Monitoring is unnecessary as it would not be possible to measure impacts from the new basin separately from the existing basins. Monitoring of this basin was not proposed in the DMMP Rev 1.

Basin E has been reduced in size from (1,545m^3 to 977m^3) and moved 60m north of the previous location. Basins H3 and H2 replace original Basin H are downstream from Basin E. It is proposed that these basins are monitored using additional bore BH12 upstream of Basin E and BH10 downstream of Basins H2 and H3.

Basin G has a smaller capacity (181m^3) than planned (1,891m^3) and will be monitored using GW-D3 upstream and GW-D4 downstream. Basin F (6,044m^3) will not be constructed.



PROJECT ID 60550185
CREATED BY RNM
APPROVED BY JShaw
LAST MODIFIED 16 JAN 2020

Metropolitan Road Improvement Alliance

N

DATUM GDA 1994, PROJECTION PERTH COASTAL GRID 1994

0 40 80 120 160
metres

1:8,000 when printed at A4

LEGEND

- Groundwater Monitoring Location - New
- Groundwater Monitoring Location - Retained
- Groundwater Monitoring Location - Proposed to be Removed
- Drainage Basins as Constructed
- Drainage Basins as per MS1008
- Construction and Operation Zone
- Rehabilitation Zone

Comparison of Basin Design and Monitoring Locations between DMMP Revision and this Addenda

Main Roads Western Australia

Figure

2

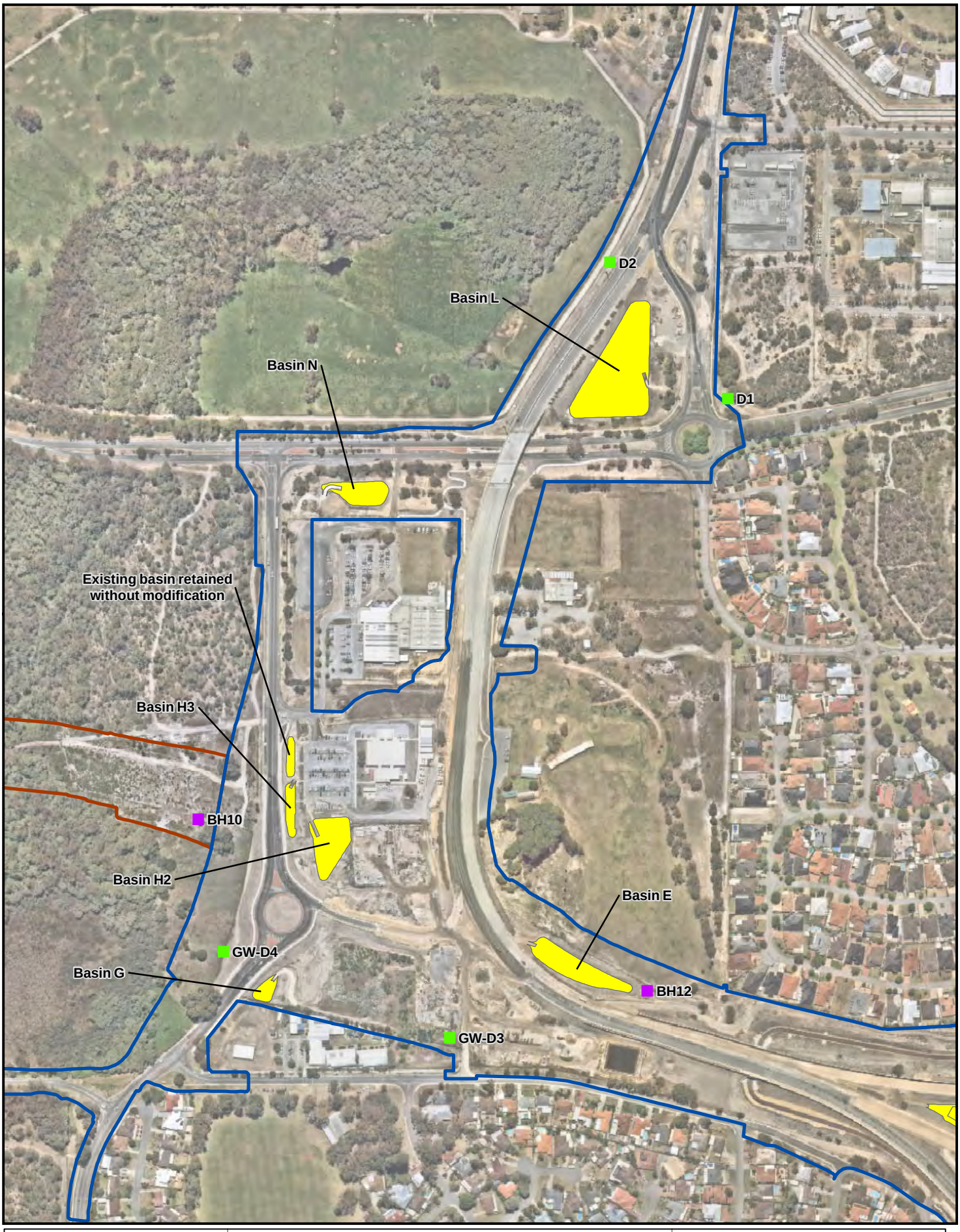
Map Document: \\AUPER1FP001.AU.AECOMNET.COM\Projects\605X\60550185\4. Tech Work Area\4.99 GIS\20190731_DMMP Addendum\60550185_Fig2_Drainage_Mon_Locs_v1.mxd (rob.mcgregor)

A4 size

2 AMENDMENT TO MONITORING LOCATIONS

The objective of the drainage monitoring program is to monitor the effect of road drainage basins on groundwater quality. Monitoring therefore is focused on locations where new basins have been installed. As a result of the change to the project, a number of the drainage basins previously planned for the Roe 8 project are no longer required. Accordingly, in line with the objective of the monitoring program, there is no value in monitoring these locations.

This addendum replaces Figure 4 within the approved DMMP Rev 1 with the figure provided below (Figure 3), which illustrates the proposed amended groundwater and basin monitoring locations.



PROJECT ID 60478410
CREATED BY RNM
APPROVED BY JShaw
LAST MODIFIED 16 JAN 2020

Metropolitan Road Improvement Alliance

N

DATUM GDA 1994, PROJECTION PERTH COASTAL GRID 1994

0 50 100 150 200
metres

1:5,000 when printed at A4

Legend

- Groundwater Monitoring Location - New
- Groundwater Monitoring Location - Retained
- Drainage Basins To Be Constructed
- Construction and Operation Zone
- Rehabilitation Zone

Amended Groundwater and Basin Monitoring Locations

MAIN ROADS WESTERN AUSTRALIA

Figure 3

Map Document: \\AUPER1FP001.AU.AECOMNET.COM\Projects\605X\60550185\4. Tech Work Area\4.99 GIS\20190731_DMMP Addendum\60550185_Fig3_BoreToBeMonitored_v1_A4P.mxd (rob.mcgregor)

A4 size

3 REFERENCES

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Appendix 1 - Basin Specifications as per Condition 8-2(2)

These basin specifications replace those listed in Appendix 2 of DMMP Rev 1.

Basin reference	Design event	Storage required (m3)	Calculated basin storage (m3)	Water depth (m)	Side slope	Basin RL (mAHD)	GW level (mAHD)	Impervious catchment area (ha)	Bioretention basin area (ha)
L	20yr ARI (5% AEP)	5373	8463	1.21	1V:11.7H	18.80	18.7	3.65	0
E	20yr ARI (5% AEP)	977	1414	0.59	1V:3H	25.00	19.7	1.51	0
H3	20yr ARI (5% AEP)	226	352	0.75	1V:4H	18.00	17.8	0.18	0
H2	20yr ARI (5% AEP)	1413	2393	0.86	1V:3H	18.25	18.0	0.74	0
N	20yr ARI (5% AEP)	1278	1868	1.37	1V:3H	20.00	17.9	1.4	0
G	20yr ARI (5% AEP)	181	296	0.62	1V:3.2H	17.80	17.7	0.13	0