



SMEC INTERNAL REF. 3002750

Water Quality /
Hydrology Report

William Hovell Drive Duplication

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Prepared for Infrastructure Development Partners Group on behalf of Transport Canberra and City Services

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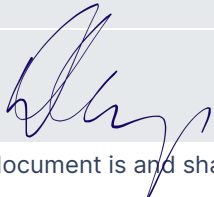
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1 Introduction

SMEC has been engaged by Infrastructure Delivery Partners Group (IDPG) on behalf of Transport Canberra and City Services (TCCS) to undertake the detailed design of the duplication of a 4.9 km portion of William Hovell Drive (WHD) between John Gorton Drive (JGD) and Drake-Brockman Drive (DBD).

An initial Scoping Report was provided to the Australian Capital Territory Planning and Land Authority (ACTPLA) on 4 September 2020. ACTPLA’s Scoping Document for the Project was thereafter provided on 19 October 2020 in accordance with Section 212 of the P&D Act.

The Scoping Document requires various matters to be addressed in an EIS, including matters regarding water quality which are detailed in the following table:

Scoping Document Reference	Description
8.2 Detailed Requirements / 8.2.7	<ul style="list-style-type: none"> Describe the impacts of construction and operation on water quality in downstream waterways, including the Molonglo River and Deep Creek, including the proposed future Deep Creek Water Quality Control Pond Describe the impact of sediment and road surface run-off entering nearby waterways Describe the impacts of changes to water flow regimes, including consequences of increased water flow during large rainfall events

Table 1: Scoping document - water quality requirements

This report provides an assessment of potential water quality and hydrology impacts as identified above.

1.1 Project Location

The proposed road duplication is to be completely contained to the road reserve extending from JGD to DBD. This Site is unleased Territory land, with TCCS – Roads ACT as the custodian. The land is zoned TSZ1 – Transport under the Territory Plan, and runs adjacent to parcels of leased rural land, nature reserves and existing and future urban areas.

Proposed locations for site compounds and stockpile areas include:

- Site Compound 1 located adjacent JGD intersection, approximate size 19,000m²
- Site Compound 2 located at DBD intersection, approximate size 10,000m²
- Stockpile Site 1 located at CH3500, approximate size 10,000m²
- Stockpile Site 2 located at CH2100, approximate size 6,000m².

Figure 1 provides a map of the Project Site and surrounding study area more broadly.

The Project Site crosses a hillside that sweeps to the south of The Pinnacle Extension Nature Reserve and to the north of the Kama Nature Reserve. From the intersection with JGD, WHD declines slightly and then steadily increases in gradient toward the Kama and Pinnacle Extension Nature Reserves. The road turns slightly to the north and continues to increase in gradient with the highest point located near the Old Weetangera Cemetery.

Centrally through the alignment, the embankment on the south-western side of WHD becomes relatively steep, with views from the road reserve over rural rolling hills toward development in the Molonglo Valley. Mounds of fill from the previous construction of WHD are located along the north-eastern side of the alignment and generally obscure views from the road.

The Project is located entirely within the Murrumbateman Interim Biogeographic Regionalisation of Australia (IBRA) Subregion of the South Eastern Highlands IBRA Bioregion (IBRA v.7). The Murrumbateman IBRA Subregion covers an area of approximately 630,454ha.



Figure 1: Project Site

1.2 Project Area

The current natural flow of surface water occurs from the Pinnacle Nature Reserve and passes beneath WHD through existing transverse culverts, and discharges into the future Deep Creek Dam on the western side of Whitlam and tributaries of Molonglo River to the northern section of the project. Deep Creek runs south west, towards the Molonglo River, Refer to Figure 2 below. The Molonglo River flows to the north-west of the Project, towards the ACT/NSW border.



Figure 2: Deep Creek Tributary

There are twenty-seven culvert crossings within the proposed upgrade section of the road. The culvert catchments generally comprise non-residential areas which includes the nature reserve and native open areas. The proposed road upgrade is only impacted by the local catchments which drain to the cross-drainage systems.

2 Water quality and hydrology assessment

An assessment of water quality and hydrology was carried out by reviewing aerial photographs and the following previous studies:

- Molonglo Catchment and Scrivener Dam Flood Hydrology Review - Phase 2 (SKM, 10 June 2011)
- Molonglo 3 - Stormwater Masterplan- Deep Creek - (GHD, July 2015)
- Molonglo 3 - Stormwater Management WSUD Strategy - (GHD, December 2015)
- Whitlam Concept Masterplan - (Roberts Day, June 2016)
- Deep Creek Corridor Water Quality Pond, Concept Design Report - (GHD, March 2019)
- Memo - Whitlam / Molonglo 3 Regional Pond - (Calibre, September 2018).

The existing transverse drainage systems under the proposed upgrade have been retained where practically possible to ensure consistency in the flow regime between existing and post-developed conditions. There are six additional proposed cross drainage pipes that have been proposed since the PSP design to improve water quality outcome for the project. These additional proposed pipes will drain road pavement only for treatment in swales. As such, there will only be minor change in flow attenuation between the present day and post construction. The drainage plans provide the details and locations of the proposed culverts to protect the road from flooding for events up to 1% AEP.

Previous flood studies carried out for Lake Burley Griffin and Scrivener Dam shows the proposed road upgrade is further upstream of Molonglo River and is not impacted by the river for rainfall events up to 1% AEP. A relevant flood impact map (SKM for ACTPLA, 2011, 'Molonglo Catchment and Scrivener Dam Flood Hydrology Review - Phase 2') is included below:

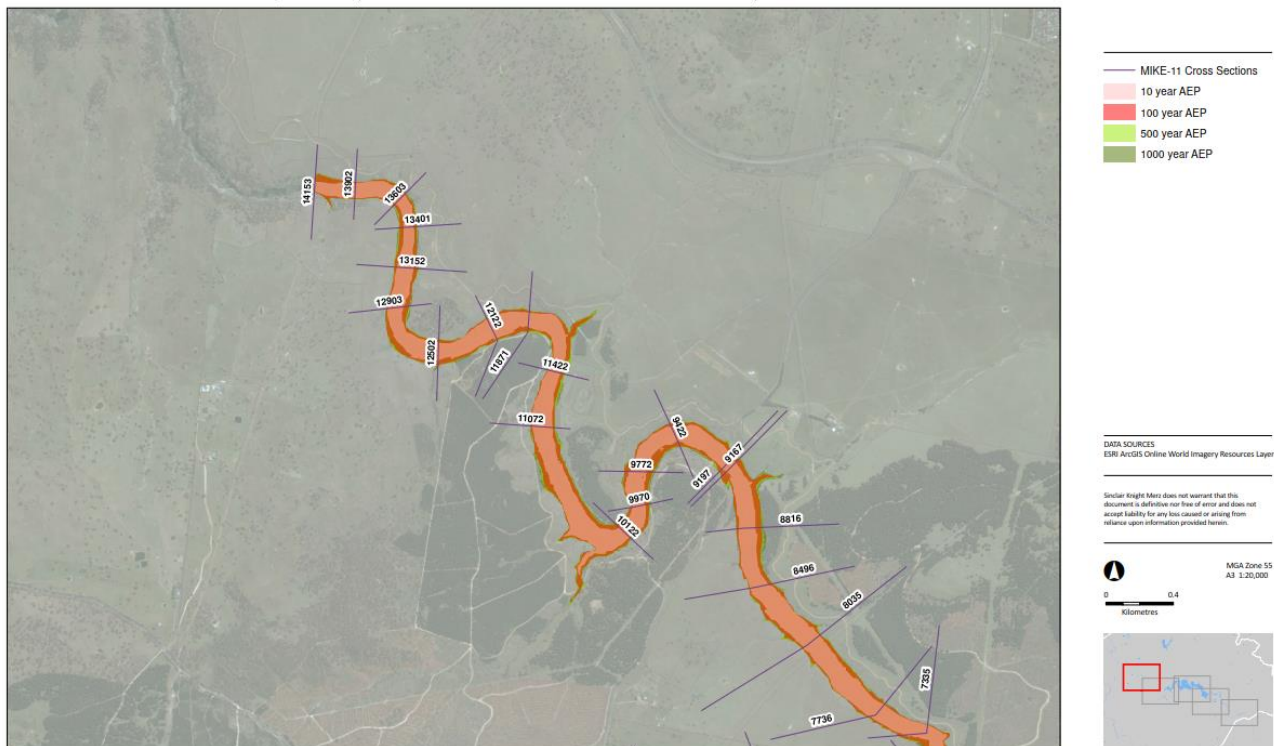


Figure 3: Flood Inundation Map (Sheet 5 of 5) 10, 100, 500 and 1000 Year Annual Exceedance Probability Flood (SKM for ACTPLA, 2011, 'Molonglo Catchment and Scrivener Dam Flood Hydrology Review - Phase 2')

2.1 Climate change

Climate change analysis was conducted on the proposed drainage network. The rainfall intensities were increased by 20% to account for the potential future effects of climate change in accordance with Section 3.1.4 of MIS08.

Analysis found no ponding onsite, and surface flow for the 20% AEP flood widths remained within limits stipulated in MIS08.

2.2 Water quality

The proposed drainage catchments reflect the existing drainage catchment scenario where practically possible. The main catchment characteristics is dense grass with sparse trees. WHD also contains three existing underpasses which help provide some additional relief for the transverse culverts during larger storm events.

Vegetated swales are an effective way of reducing sediment transportation. Generally vegetated swales would be provided within the road verge on both sides of the road to collect runoff from the road surface to remove pollutant particles including sediments. This will continue the current characteristics of WHD and provide ease of maintenance. As the runoff passes through the swales, the contaminants will be removed by via filtration and infiltration.

Where kerbs and gutters are provided, the stormwater runoff from the road surface would be collected in sumps which would then discharge into vegetated swales within the road verge. The proposed section of the road falls within Deep Creek catchments and the runoff from the road catchment will directed through vegetated swales for water quality treatment and eventually flow into Deep Creek.

ACT Waterways: WSUD General Code (February 2020) outlines the reduction of the pollutants target (Figure 2-2 WSUD General Code 3.2) for major road development. The targets are also consistent with ACT Government Municipal Infrastructure Standards 08 Stormwater, MIS08, April 2019.

Rules	Criteria
3.2 Stormwater quality target – major roads	
<p>R7</p> <p>This rule applies to development of major roads, including the duplication of an existing major road in full or in part.</p> <p>The average annual stormwater pollutant export is reduced when compared with a road catchment of the same area with no water quality management controls for all of the following:</p> <ul style="list-style-type: none"> a) gross pollutants by at least 90% b) suspended solids by at least 60% c) total phosphorous by at least 45% d) total nitrogen by at least 40%. <p>Note: Compliance with this rule is consistent with the ACT Practice Guidelines for Water Sensitive Urban Design and is demonstrated by a report by a suitably qualified person, using the MUSIC model. If a tool other than the MUSIC model is used then a report by an independent suitably qualified person must be submitted demonstrating and confirming compliance with the rule. If parameters that are non-compliant are used then a report must also be submitted by an independent suitably qualified person stating how and why the parameters are appropriate.</p>	<p>C7</p> <p>If it can be demonstrated that the stormwater quality measures specified in the rule are unable to be provided, then a contribution to the construction of offsite measures as a means of offset may be approved by the Planning and Land Authority.</p> <p>Note: Compliance with this criterion is consistent with the ACT Practice Guidelines for Water Sensitive Urban Design and is demonstrated by a report by a suitably qualified person, using the MUSIC model. If a tool other than the MUSIC model is used then a report by an independent suitably qualified person must be submitted demonstrating and confirming compliance with the criterion. If parameters that are non-compliant are used then a report must also be submitted by an independent suitably qualified person stating how and why the parameters are appropriate.</p>

Figure 2-2 WSUD General Code 3.2

The design was modelled using MUSIC Version 6 software to determine the water quality reduction factors for the project. The design was reviewed and updated from PSP to improve water quality outputs of the project by isolating road pavement runoff from clean water runoff from external catchments where possible and treating pavement runoff in grass channels. The grass channels help to remove pollutant particles as the runoff passes

through the grassed area, the contaminants are removed via filtration and infiltration. The grass channel approach will also continue the current characteristics of WHD and provide ease of maintenance.

SMEC has considered the following site-specific factors when reassessing the WHDD project water quality target. These are:

- PSP water quality strategy,
- MUSIC model design parameters, and
- Site constraints for the developed conditions such as:
- Space constraints and project boundary,
- Existing network outlets and connections,
- Ecological sensitive area, and
- Terrain surrounding the site.

Table 2 water quality targets and design outcomes, outlines the targets as per rule 7 in the WSUD general code and the design outcomes.

Table 2 water quality targets and design outcomes

	Targets (WSUD General Code R7)	Detailed Design Effectiveness
Gross Pollutants	90%	100%
Suspended Solids	60%	96.5%
Total phosphorus	45%	81.3%
Total Nitrogen	40%	40.4%

As shown above, the water quality reduction target for the detailed design, considering new pavement area only, is compliant with the WSUD General Code R7 requirements. For more detail refer to Appendix C

3 Impacts

As a result of the duplicated road, the area of hardstand would increase and there would be an associated minor increase in peak stormwater runoff. The Project would maintain or increase the stormwater drainage provisions to manage the surface water for events up to the one percent AEP, while also providing additional protection during and following major storm events. As such, there should be no change with regard to the risk for erosion and scour at the stormwater discharge points or potential for sediment discharge and pollution.

Other potential water and hydrological impacts include:

- Erosion and sedimentation during construction works
- Impact on flooding as some of the proposed civil works for the shared path and road widening may impact the existing head available for the transverse drainage culverts, which may affect capacity for events larger than the one percent AEP
- Spill management as a result of refuelling, maintenance of machinery and storage of potential pollutants
- Potential flood threats and appropriate protection or removal of dispersible materials, hazardous materials and equipment containing such materials
- Disturbed areas which have not undergone suitable stabilisation.

4 Mitigation

The following table sets out the proposed mitigation measures to manage the potential hydrological impacts of the WHD Duplication Project.

Potential Impact	Mitigation Measure	Effectiveness	Timing	Responsible Agency
Water quality impacts to Deep Creek	As Detailed Design progresses, consultation with the EPA would take place to confirm whether a WWL is required due to the proximity of Deep Creek. Water quality discharge from the site to meet the Waterways: Water Sensitive Urban Design General Code (21 Feb 2020)	High	Pre-construction and Construction	EPA
Local and regional drainage conditions altered Impact on flooding as some of the proposed civil works for the shared path and road widening may impact the existing head available for the transverse drainage culverts, which may affect capacity for events larger than the one percent AEP.	Stormwater assessments has concluded that the design of the development does not place unnecessary pressure on existing stormwater infrastructure. Existing flow paths has been maintained and further augmented to allow for flow capacity up to the 1% AEP event.	High	Construction and Operational	TCCS
Changes to existing flow paths and overland flow due to proposed Project				
Potential changes to groundwater availability due to vegetation removal or excavation including impacts on groundwater dependent ecosystems and water users within the catchment.	To mitigate the groundwater impacts, it is proposed to plant new evergreen trees alongside the locations where existing trees would be removed. Indeed, where possible, established trees would be retained to provide landscape screening. A schedule of additional plantings would therefore be provided to soften the impact on the predominantly rural landscape.	High	Operational	EPA
Additional run off from new impervious surfaces increases flow	An approved ESCP must be implemented to cover all construction works. Water	High		EPA

Potential Impact	Mitigation Measure	Effectiveness	Timing	Responsible Agency
downstream and impacts areas beyond the project boundaries.	quality discharged from the construction site is to meet the EPA requirements under the Environment Protection Act 1997 (the Act).		Construction and Operational	
Reduction in water quality in waterways due to runoff and sedimentation during Construction and operation	Permanent treatment swales also proposed to capture and treat pavement runoff to achieve the agreed water quality target.			
Change to water flow regimes in waterways due to construction and operation	<p>It is proposed to provide additional swales at the outlets to provide treatments and storage to mitigate the adverse impact on water quality and quantity. In addition, the effect of time of concentration and lag time is also taken into consideration for water quantity analysis.</p> <p>Implementing appropriate ESC treatments such as check dam, sediment fences, and straw bale barriers at the outlets during construction will provide a positive outcome.</p>	High	Construction and Operational	EPA

Table 3: Water quality and hydrology mitigation measures

5 Residual risk

Based on the mitigation measures identified in Section 4, an assessment of the residual risks associated with the proposal have been considered. The following table sets out the residual risk assessment of the Project's hydrology impacts.

Risk (as per Section 4 and scoping document)	Original Risk Rating	Residual Likelihood	Residual Consequence	Residual Risk Rating
Scoping Report preliminary risks identified				
Local and regional drainage conditions altered	High	Possible	Minimal	Very Low
Changes to existing flow paths and overland flow due to proposed Project	High	Possible	Minimal	Very Low
Potential changes to groundwater availability due to vegetation removal or excavation including impacts on groundwater dependent ecosystems and water users within the catchment	Medium	Possible	Minimal	Very Low
Additional run off from new impervious surfaces increases flow downstream and impacts areas beyond the project boundaries.	High	Possible	Minimal	Very Low
Scoping Document risks identified				
Reduction in water quality in waterways due to runoff and sedimentation during construction and operation	High	Possible	Minimal	Very Low
Change to water flow regimes in waterways due to construction and operation	High	Possible	Minimal	Very Low
Rain event causing flooding, erosion or damage to road infrastructure.	High	Possible	Minimal	Very Low

Table 4: Water quality and hydrology residual risk assessment

Appendix A MUSIC Model and Catchment Plans

The MUSIC model that was developed and that catchments it was based on are included in the following pages.

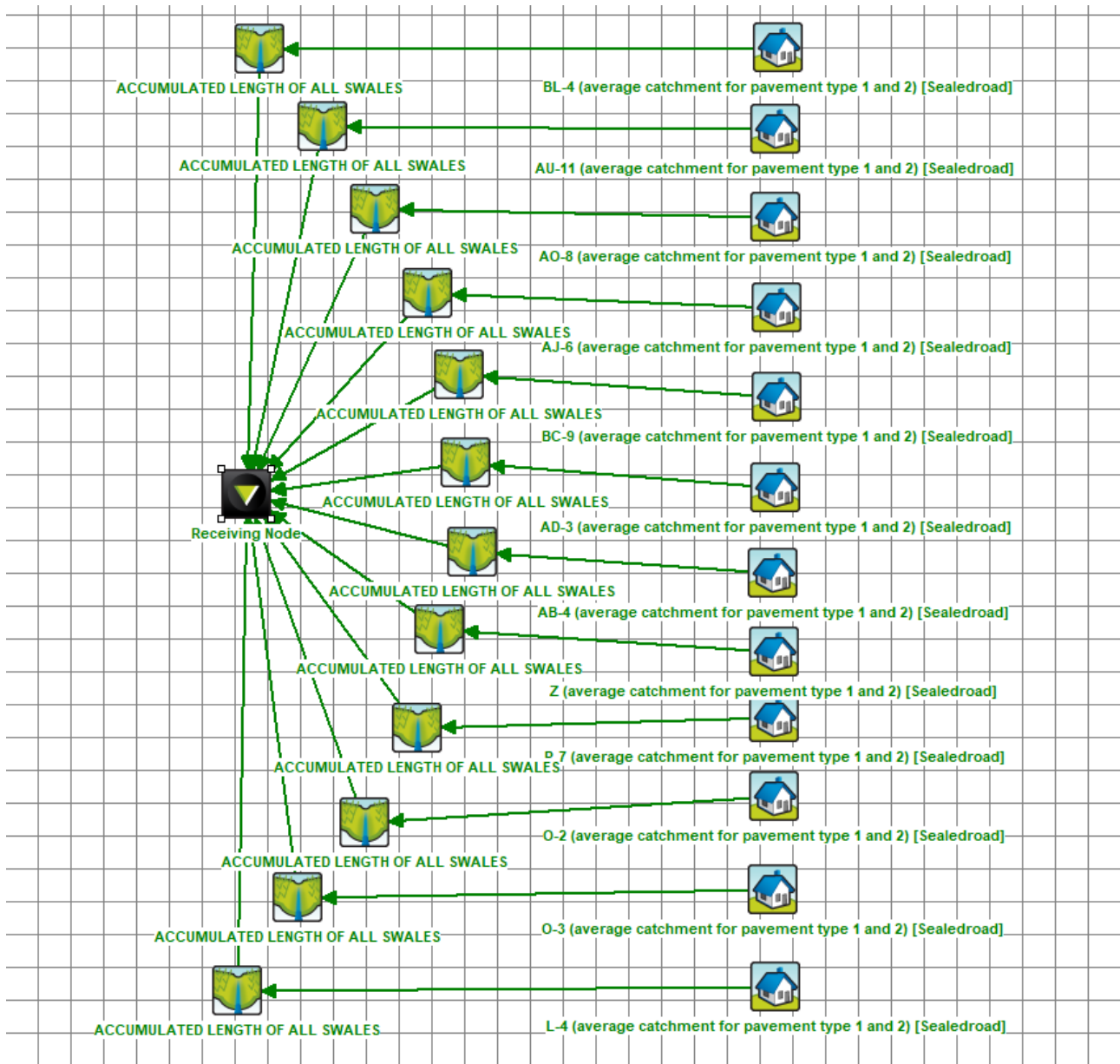


Figure 5: WHD Duplication MUSIC Model

The catchment areas and treatments are detailed in the following table:

Outlet Node	Treated Catchment (ha)	Non-treated Catchment (ha)
BL-4	0.000	0.224
AU-11	0.463	1.398
AO-8	2.135	0.983
AJ-6	1.510	1.464
BC-9	0.403	0.742
AD-3	1.048	1.480
AB-4	0.787	0.000
Z	1.119	1.219
R-7	0.716	1.557
O-2	1.540	0.448
O-3	0.501	1.048
L-4	2.532	0.240
TOTAL	12.753	10.803

Table 5: WHD Duplication Treated vs Non-treated areas

Appendix B Waterways: Water Sensitive Urban Design General Code

Table 6: Assessment against the Waterways: Water Sensitive Urban Design General Code (21 Feb 2020)

Rules	Criteria	Compliance
Element 1: Mains water use reduction		
1.1 Mains Water Use Reduction Target		
<p>R1</p> <p>This rule applies to all development currently connected or intended to be connected to mains water supply except any of the following:</p> <ul style="list-style-type: none"> a) development subject to the estate development code b) development for minor alterations or extensions involving 50% or less of the existing floor area. <p>Development achieves a minimum 40% reduction in mains water consumption compared to an equivalent development constructed in 2003.</p> <p>Note: Compliance with this rule is demonstrated through a report from a suitably qualified person consistent with the methods specified in the ACT Practice Guidelines for Water Sensitive Urban Design.</p>	<p>This is a mandatory requirement. There is no applicable criterion.</p>	<p>Not Applicable</p> <p>The development is for a major road duplication and no water consumption is proposed.</p>
Element 2: Stormwater Quantity		
2.1 On-site stormwater retention		
<p>R2</p> <p>This rule applies to development for at least one of the following:</p> <ul style="list-style-type: none"> a) development on sites greater than 2,000m² involving works that have the potential to alter the stormwater regime of the site, including sites subject to the estate development code 	<p>C2</p> <p>Development complies with all of the following:</p> <ul style="list-style-type: none"> a) It is demonstrated that stormwater retention measures can be more successfully met offsite b) development complies with at least one of the following stormwater 	<p>Not Applicable</p> <p>The development is for a major road duplication and no water consumption is proposed.</p>

Rules	Criteria	Compliance
<p>b) development within existing urban areas which increases impervious area by 100m².</p> <p>This rule does not apply to any of the following:</p> <ul style="list-style-type: none"> a) development of major roads b) sites identified in a precinct code that stormwater retention requirements for the site have been fully dealt with through an estate development plan. <p>Development complies with at least one of the following:</p> <ul style="list-style-type: none"> a) stormwater retention management measures are provided and achieve all of the following: <ul style="list-style-type: none"> i). Stormwater storage capacity of 1.4kL per 100m² of the total impervious area of the site is provided specifically to retain and reuse stormwater generated on site as a whole ii). Retained stormwater is used on site b) development captures, stores and uses the first 15mm of rainfall falling on the site. <p>For this rule, on-site stormwater retention is defined as the storage and use of stormwater on site.</p> <p>Note: Compliance with this rule is demonstrated through a report from a suitably qualified person consistent with the methods specified in the ACT Practice Guidelines for Water Sensitive Urban Design.</p>	<p>retention management measures:</p> <ul style="list-style-type: none"> i). An equivalent volume of stormwater is stored and used at an offsite location within the same catchment or a catchment in proximity to the site as part of a stormwater offset agreement ii). If it is demonstrated that the above stormwater retention measures are unable to be provided, then a contribution to the construction of offsite measures within the same catchment or a catchment in proximity to the site as a means of offset may be approved by the Planning and Land Authority. <p>For this criterion, the meaning of a stormwater offset agreement as defined and detailed in the ACT Practice Guidelines for Water Sensitive Urban Design.</p> <p>Note: Compliance with this criterion is demonstrated through a report from a suitably qualified person consistent with the methods specified in the ACT Practice Guidelines for Water Sensitive Urban Design.</p>	

Rules	Criteria	Compliance
<p>Note: ACT Practice Guidelines for Water Sensitive Urban Design defines acceptable uses of stormwater on site.</p> <p>Note: Any site specific stormwater retention requirements for new estates must be nominated on planning control plans submitted with the estate development plan.</p>		
<p>2.2 On-site stormwater detention</p>		
<p>R3</p> <p>This rule applies to development for at least one of the following:</p> <ul style="list-style-type: none"> a) development on sites greater than 2,000m² involving works that have the potential to alter the stormwater regime of the site, including sites subject to the estate development code b) development within existing urban areas which increases impervious area by 100m² <p>This rule does not apply to any of the following:</p> <ul style="list-style-type: none"> a) development of major road b) sites identified in a precinct code indicating that stormwater detention requirements have been fully met. <p>Stormwater detention measures are provided and achieve all of the following:</p> <ul style="list-style-type: none"> a) capture and direct runoff from the entire site b) Stormwater storage capacity of 1kL per 100m² of impervious area is provided to specifically detain stormwater generated on site c) The detained stormwater is designed to be released 	<p>C3</p> <p>Stormwater detention measures are provided and achieve all of the following:</p> <ul style="list-style-type: none"> a) ensure that the peak rate of stormwater runoff from the site does not exceed the peak rate of runoff from an unmitigated (rural) site of the same area for the 1 Exceedance per Year (1EY) b) A maximum of 30% of the runoff from the site may bypass the onsite stormwater detention system where it can be demonstrated that at least one of the following circumstances applies: <ul style="list-style-type: none"> i). Difficult ground levels ii). The nature of the receiving drainage system cannot receive runoff from the entire site iii). The need to retain significant trees or vegetation iv). other demonstrated circumstances. <p>Note: Compliance with this criterion is demonstrated through a report from a suitably qualified person consistent with the methods specified in the ACT Practice Guidelines for Water Sensitive Urban Design.</p> <p>Note: where an estate development plan has partially achieved the stormwater detention measures, this</p>	<p>Not Applicable</p> <p>The development is for a major road duplication and no water consumption is proposed.</p>

Rules	Criteria	Compliance
<p>over a period of 6 hours after the storm event.</p> <p>For this rule on-site stormwater detention is defined as the short term storage and release downstream of stormwater runoff.</p> <p>Note: Compliance with this rule is demonstrated through a report from a suitably qualified person consistent with the methods specified in the ACT Practice Guidelines for Water Sensitive Urban Design.</p> <p>Note: Calculating on-site detention can include 50% of the volume of rainwater tanks where stormwater is used on-site.</p> <p>Note: For new estates any stormwater detention must be nominated on planning control plans submitted with the estate development plan. In particular, where an estate development plan has partially achieved the stormwater detention measures, this can be taken into account for the detention measures on individual sites.</p>	<p>can be taken into account for the detention measures on individual sites.</p>	

2.3 Stormwater quantity for major road on sites over 2000m²

R4	C4	Complies with R4
<p>This rule applies to development of major roads involving sites greater than 2000m².</p> <p>Development complies will all of the following:</p> <ul style="list-style-type: none"> a) The capacity of existing pipe (minor) stormwater connection to the site is not exceeded in the 1 in 10 year storm event <p>The capacity of the existing overland (major) stormwater system to the site is not exceeded in the 1 in 100 year storm event</p>	<p>Development for major roads on sites greater than 2000m² complies with at least one of the following:</p> <ul style="list-style-type: none"> a) A reduction of the 1 in 5 year and 1 in 100 year stormwater peak run off flow to predevelopment levels b) The capacity of the downstream piped stormwater system to its outlet with an open channel is not exceeded in the 1 in 10 year storm event. <p>Note: Compliance with this criterion is demonstrated through a report from a suitably qualified person consistent with the methods specified in the ACT</p>	<p>R4 applies as the development is for a major road duplication involving sites greater than 2,000m². The drainage is configured to ensure the duplication of William Hovell Drive does not place unnecessary pressure on existing stormwater infrastructure.</p> <p>There are 23 culvert crossings within the proposed upgraded section of the road, however these are generally within non-residential areas and capture flows into the nature reserves and open rural areas.</p> <p>The existing transverse drainage lines have been retained to provide consistency with the current drainage arrangement and</p>

Rules	Criteria	Compliance
	Practice Guidelines for Water Sensitive Urban Design.	<p>minimise impact to flora, fauna and nature reserves.</p> <p>The drainage designs and culverts have sufficient capacity to ensure the road is protected from flooding up to the 1 in 100 year storm event.</p>

2.4 On-site stormwater detention for estate development plans

There is no applicable rule.	<p>C5</p> <p>This criterion applies to estate development plans.</p> <p>Stormwater detention measures are provided and the peak rate of stormwater runoff from the estate does not exceed the peak rate of runoff from an unmitigated (rural) site of the same area for minor and major storms.</p> <p>Note: Compliance with this criterion is demonstrated through a report from a suitably qualified person consistent with the methods specified in the ACT Practice Guidelines for Water Sensitive Urban Design.</p> <p>Note: The Major (1% Annual Exceedance Probability (AEP)) and Minor storms are as defined by Transport Canberra and City Services Directorate (TCCS) or the agency responsible for stormwater management.</p> <p>Note: Stormwater detention measures required for each individual block may contribute toward meeting the overall detention requirements for the estate as demonstrated in an estate development plan. Note: Any site specific stormwater detention must be nominated on planning control plans submitted with the estate development plan.</p>	<p>Not Applicable</p> <p>The development is not for an EDP.</p>
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Element 3: Stormwater Quality

3.1 Stormwater Quality Target – sites greater than 2000m²

R6	C6	Not Applicable
This rule applies to development for all of the following:	It is demonstrated that at least one of the following applies:	

Rules	Criteria	Compliance
<p>a) where the development site is greater than 2,000m²</p> <p>b) where development involves works that have potential to alter the stormwater regime for the site.</p> <p>This rule does not apply to development of major roads.</p> <p>The average annual stormwater pollutant export is reduced when compared with an urban catchment of the same area with no water quality management controls for all of the following:</p> <p>a) gross pollutants by at least 90%</p> <p>b) suspended solids by at least 60%</p> <p>c) total phosphorous by at least 45%</p> <p>d) total nitrogen by at least 40%.</p> <p>Note: Compliance with this rule is consistent with the ACT Practice Guidelines for Water Sensitive Urban Design and is demonstrated by a report by a suitably qualified person, using the MUSIC model. If a tool other than the MUSIC model is used then a report by an independent suitably qualified person must be submitted demonstrating and confirming compliance with the rule. If parameters that are non-compliant are used then a report must also be submitted by an independent suitably qualified person stating how and why the parameters are appropriate.</p>	<p>a) stormwater quality measures can be more successfully met offsite</p> <p>b) a sensitive downstream environment will be negatively impacted.</p> <p>Development complies with at least one of the following:</p> <p>a) an equivalent load of pollutants is captured at an offsite location as part of a stormwater offset agreement</p> <p>b) if the above stormwater quality measures are unable to be provided, then a contribution to the construction of offsite measures as a means of offset may be approved by the Planning and Land Authority.</p> <p>For this criterion a stormwater offset agreement is defined as detailed in the ACT Practice Guidelines for Water Sensitive Urban Design.</p> <p>Note: Compliance with this criterion is consistent with the ACT Practice Guidelines for Water Sensitive Urban Design and is demonstrated by a report by a suitably qualified person, using the MUSIC model. If a tool other than the MUSIC model is used then a report by an independent suitably qualified person must be submitted demonstrating and confirming compliance with the criterion. If parameters that are non-compliant are used then a report must also be submitted by an independent suitably qualified person stating how and why the parameters are appropriate.</p>	<p>The development is for a major road duplication and no water consumption is proposed.</p>

3.2 Stormwater quality Target – major roads

R7	C7	Complies with R7
<p>This rule applies to development of major roads, including the</p>	<p>If it can be demonstrated that the stormwater quality measures specified in the rule are unable to</p>	<p>Vegetated swales are to be provided within the road reserve on both sides of the road to collect</p>

Rules	Criteria	Compliance
<p>duplication of an existing major road in full or in part.</p> <p>The average annual stormwater pollutant export is reduced when compared with a road catchment of the same area with no water quality management controls for all of the following:</p> <ul style="list-style-type: none"> a) gross pollutants by at least 90% b) suspended solids by at least 60% c) total phosphorous by at least 45% d) total nitrogen by at least 40%. <p>Note: Compliance with this rule is consistent with the ACT Practice Guidelines for Water Sensitive Urban Design and is demonstrated by a report by a suitably qualified person, using the MUSIC model. If a tool other than the MUSIC model is used then a report by an independent suitably qualified person must be submitted demonstrating and confirming compliance with the rule. If parameters that are non-compliant are used then a report must also be submitted by an independent suitably qualified person stating how and why the parameters are appropriate.</p>	<p>be provided, then a contribution to the construction of offsite measures as a means of offset may be approved by the Planning and Land Authority.</p> <p>Note: Compliance with this criterion is consistent with the ACT Practice Guidelines for Water Sensitive Urban Design and is demonstrated by a report by a suitably qualified person, using the MUSIC model. If a tool other than the MUSIC model is used then a report by an independent suitably qualified person must be submitted demonstrating and confirming compliance with the criterion. If parameters that are non-compliant are used then a report must also be submitted by an independent suitably qualified person stating how and why the parameters are appropriate.</p>	<p>runoff and remove pollutant particles and sediment. Where kerb and gutter is provided, surface water is collected and discharged to vegetated swales.</p> <p>For the portion of the duplication within the Deep Creek catchment, runoff is directed to vegetated swales before being discharged to Deep Creek.</p> <p>A MUSIC model was prepared for the road upgrade to determine if the proposed water quality measures meet the reduction targets.</p> <p>Modelling of the project indicates that the following reductions are achievable:</p> <ul style="list-style-type: none"> • 100% gross pollutants • 96.6% TSS • 81.2% TP and • 40.4% TN. <p>As shown above, the detailed design achieves reasonable compliance with the water quality targets for the WSUD General Code.</p>

Element 4: Climate change adaptation

4.1 Nuisance flooding – sites greater than 2000m²

<p>There is no applicable rule.</p>	<p>C8</p> <p>This criterion applies to development on sites greater than 2,000m² involving works that have potential to alter the existing drainage and overland flow regime for the site.</p> <p>Overland flow paths are provided and achieve all of the following:</p> <ul style="list-style-type: none"> a) accommodate overland stormwater flows up to the 1%AEP 	<p>Consistent with C8</p> <p>As a result of the duplicated road, the area of hardstand would increase and there would be an associated minor increase in peak stormwater runoff. The Project would increase the stormwater drainage to manage the increased surface water for events up to the 1% AEP, while also providing additional protection during and following major storm events. As such, there should be no change with regard to the risk for erosion</p>
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Rules	Criteria	Compliance
	<p>b) reduce nuisance flooding.</p> <p>Note: Compliance with this criterion is demonstrated through a report from a suitably qualified person consistent with the methods specified in the ACT Practice Guidelines for Water Sensitive Urban Design.</p>	<p>and scour at the stormwater discharge points or potential for sediment discharge and pollution.</p> <p>The existing transverse drainage systems under the proposed upgrade would be retained where practically possible. There would only be a minor change in flow attenuation between the present day and post construction. The drainage plans provide the details and locations of the proposed culverts to protect the road from flooding for events up to 1% AEP.</p>

4.2 Green/living infrastructure

<p>R9</p> <p>This rule applies to at least one of the following developments:</p> <ul style="list-style-type: none"> a) Development on sites greater than 2000m² involving works that have potential to alter the stormwater regime for the site b) Development within existing urban areas that increase the impervious area of the site by 100m² or more. <p>Development achieves a minimum of 20% of the site area to be permeable.</p> <p>Note: Compliance with this rule is demonstrated through a report from a suitably qualified person consistent with the methods specified in the ACT Practice Guidelines for Water Sensitive Urban Design.</p>	<p>C9</p> <p>It is demonstrated that the development achieves all of the following:</p> <ul style="list-style-type: none"> a) Increases permeable surfaces and living infrastructure through green spaces b) Plants that require irrigation are supported by sustainable water systems such as onsite stormwater harvesting to achieve microclimate benefits c) Promotes evapotranspiration to mitigate extreme temperatures, improve air humidity and overall human comfort. <p>Note: Compliance with this criterion is demonstrated through a report from a suitably qualified person consistent with the methods specified in the ACT Practice Guidelines for Water Sensitive Urban Design.</p>	<p>Not Applicable</p> <p>The development is for a major road duplication and it will not alter the stormwater regime for the site. The EIS chapter on Water Quality and Hydrology (Section 6.7.5) details the approach to stormwater management in the project. The use of vegetated swales provides an acceptable level of permeable surfaces in the road reserve to help manage stormwater flows and the water quality of runoff.</p>
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Element 5: Entity (Government agency) Endorsement

5.1 Water infrastructure

<p>There is no applicable rule.</p>	<p>C10</p> <p>This criterion applies to development that will result in</p>	<p>Noted</p> <p>An Operation and Maintenance Plan will be prepared and</p>
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Rules	Criteria	Compliance
	<p>municipal water sensitive urban design infrastructure being handed to the ACT Government.</p> <p>An operation and maintenance plan is to be endorsed by the ACT Government for the water sensitive urban design assets that are to be handed to the ACT Government.</p> <p>Note: Compliance with this criterion is demonstrated through a report from a suitably qualified person consistent with the methods specified in the ACT Practice Guidelines for Water Sensitive Urban Design.</p>	<p>endorsed by the EPA during the construction period. This would detail the vegetated swales proposed throughout the project.</p>

Appendix C **Water Quality Tech Note**

Memorandum

To	MPC/TCCS	Date	15/11/2021
From	SMEC	No of Pages	1 of 11
Reference	3002750 William Hovell Drive Duplication (WHDD)		
Subject	Treatment of Stormwater Pollutants		

1 Purpose of the Memo

The project team has reviewed the Water Sensitive Urban Design (WSUD) quality requirements for the William Hovell Drive Duplication (WHDD) Project and summarised the findings and recommendations in this memo. This memo seeks to confirm the approach to assessing the catchment of pollutant loads and agree on any further water quality treatment requirements.

2 Design Criteria

ACT Waterways: WSUD General Code (February 2020) outlines the reduction of the pollutants target (Figure 1: WSUD General Code Section 3.2) for major road development. The targets outlined in Rule 7 (R7) are also consistent with ACT Government Municipal Infrastructure Standards 08 Stormwater, MIS08, April 2019.

Rules	Criteria
3.2 Stormwater quality target – major roads	
<p>R7</p> <p>This rule applies to development of major roads, including the duplication of an existing major road in full or in part.</p> <p>The average annual stormwater pollutant export is reduced when compared with a road catchment of the same area with no water quality management controls for all of the following:</p> <ul style="list-style-type: none"> a) gross pollutants by at least 90% b) suspended solids by at least 60% c) total phosphorous by at least 45% d) total nitrogen by at least 40%. <p>Note: Compliance with this rule is consistent with the ACT Practice Guidelines for Water Sensitive Urban Design and is demonstrated by a report by a suitably qualified person, using the MUSIC model. If a tool other than the MUSIC model is used then a report by an independent suitably qualified person must be submitted demonstrating and confirming compliance with the rule. If parameters that are non-compliant are used then a report must also be submitted by an independent suitably qualified person stating how and why the parameters are appropriate.</p>	<p>C7</p> <p>If it can be demonstrated that the stormwater quality measures specified in the rule are unable to be provided, then a contribution to the construction of offsite measures as a means of offset may be approved by the Planning and Land Authority.</p> <p>Note: Compliance with this criterion is consistent with the ACT Practice Guidelines for Water Sensitive Urban Design and is demonstrated by a report by a suitably qualified person, using the MUSIC model. If a tool other than the MUSIC model is used then a report by an independent suitably qualified person must be submitted demonstrating and confirming compliance with the criterion. If parameters that are non-compliant are used then a report must also be submitted by an independent suitably qualified person stating how and why the parameters are appropriate.</p>

Figure 1: WSUD General Code Section 3.2 Stormwater Quality Target – Major Roads

The water quality treatment target for the PSP design of the WHDD project has been reassessed where the PSP design previously adopted MIS08 water quality design parameters and criteria. The reassessment has considered factors such as water quality strategy, MUSIC model design parameters, and site specific constraints (noted in the following section).

3 Design Approach

3.1 Constraints

The WHDD Project site has significant constraints that have emphasised the need to minimise impacts on the surrounding land. These constraints include:

- Threatened and vulnerable ecological communities and habitats that are listed under the Environment Protection and Biodiversity Conservation (EPBC) Act 1999: This is a key consideration in the current draft EIS for the project. Maintaining connectivity between the Kama and Pinnacle Nature Reserves, which are present on both sides of the existing road, through minimising the footprint of the project has been a primary driver in the design.
- Steep Terrain: For much of the alignment, the terrain naturally falls from the north / northeast to the south / southwest, at a steep grade. This creates difficulties in utilising effective WSUD controls that are space efficient (i.e., aside from water retention basins, there are few other controls which would assist with effectively reducing pollutants).
- Space / Road Corridor: With a road corridor that is bounded by leased properties, nature reserves and NCA Designated Areas, there are limited areas where the project can extend beyond the current boundary.
- Existing network outlets and connections: With a large portion of the existing road (along with its current infrastructure) remaining in-situ, many of the drainage network outlets and connections are already in place which limits the opportunities for a new system to capture and treat runoff.

3.2 Catchment Areas

As noted in the WSUD General Code and Practice Guidelines, water quality targets are based on pollutant loads derived from the development of new major roads or duplication of existing major roads. Since the overall WHDD Project site comprises area of existing road, and new or duplicated road, it is important to understand the areas / quantities of both. An estimate of existing road vs new project footprint is described as follows:

Table 1: Existing road area as a percentage of the total project area

Existing road formation (generally impervious):	8.2 Ha
Total project footprint (incl. drainage areas):	23.5 Ha
Existing road surface as a % of total project area:	35%

The wording of the controls in the WSUD General Code and Practice Guidelines and the WSUD General Code is somewhat ambiguous when applied to a duplication project of this nature. The controls require a comparison of pre- and post-development water quality; however, it is unclear if the intent is for WSUD treatment of the entire duplicated road, or only *new* impervious areas.

Initially, the PSP has assessed the water quality with a conservative approach utilising the total project area (existing road + new road). Post-PSP assessments have been undertaken firstly using just the new road area, and then also the total project area (inclusive of existing road surface). We present both options in this memo for consideration by the Territory.

3.3 PSP Design Model

The PSP drainage design was originally developed based on the following principles:

- Tie into the nearest existing pit and pipe network (minimise pipe requirement under new pavement),
- External catchment flow not separated from dirty water generated from the impermeable road surface,
- Retain existing drainage networks and outlet structures where possible, and
- Grass swales were proposed where sufficient space and gentle terrain less than 3%, are present.

The PSP water quality strategy identified 12 discharge outlets, and the locations are illustrated in documents included at Attachments A and B. The documents show the breakdown of the treated and bypass water quality catchment area. For the PSP design assessment, this was based on the total project area (existing road + new road).

Using these areas, 14.31 ha was classified as a non-treated catchment area where a large portion of the road pavement (existing and new) is captured in pit and pipes, enters the existing pipe network, and bypasses the water quality treatment, replicating the current conditions of William Hovell Drive. On the other hand, 9.21ha of catchment area has been treated via grass swales. The following table outlines the constraints / opportunities per outlet node:

Table 2: Design opportunities to improve stormwater treatment

Outlet Node	Opportunity
BL-4	Opportunity very limited due to space constraints
AU-11	Opportunity very limited due to space constraints
AO-8	Opportunity very limited due to space constraints. Lease/acquisition of land may be required to provide treatment in this location
AJ-6	Opportunity very limited due to space constraints
BC-9	Opportunity very limited due to space constraints
AD-3	This outlet is close to a natural sag, however due to the cut batter required and daylighting constraints, bioretention basin treatment may deem more suitable at this location. Additional pit and pipe infrastructure is required to separate road pavement runoff from external catchment cross drainage. Swales have been identified in the location where sufficient space can be provided.
AB-4	Additional pit and pipe infrastructure and swale is a possibility on the eastern side of the WHD to capture and separate road pavement runoff for treatment and treatment. An elongated bioretention basin could be used to treat a section that is confined by space.
Z	Road catchment predominately in the cut batter. No opportunity to improve treatment at this node unless the road alignment is lifted.
R-7	Limitation due to Pink Tail Worm Lizard (PTWL) habitat areas and geographical constraints – additional pit and pipe would be required to separate pavement runoff and earthworks may be required to construct a swale in this area.
O-2	Minimal opportunity given the constrained location. To provide treatment in this area would require additional infrastructure which would impact the retaining wall structure.
O-3	Opportunity very limited due to space constraints.
L-4	Possible opportunity for to improve treatment at this outlet node. Noting risk due to identified ecologically sensitive areas including PTWL impact, and existing space constraints.

3.4 Post-PSP design development

Following the PSP Design, a number of adjustments were made to increase the treated catchment from the existing PSP design. A review of the stormwater design considering project boundary and ecological constraints has been performed to identify where pavement stormwater runoff can be separated from external catchment areas and treated to improve stormwater quality targets.

In addition, new infrastructure (pit and pipe networks) is required under the road pavement to ensure pavement runoff is captured and separated from external catchment runoff. This allows the 'dirty' pavement runoff to be treated before joining the 'clean' external catchment runoff. These adjustments can be made without creating excessive impact on the constraints noted earlier.

The assessment also checked the treatment effectiveness of grass swales against the MIS08 pollutant reduction target to confirm swale treatment node alone can meet the MIS08 pollutant reduction target.

4 MUSIC Results and Discussions

4.1 Post-PSP Design Results based on new road only (excludes pollutants from existing road)

Table 3 identifies the amount of total catchment that has been treated, compared to the catchment that bypasses any treatment. The percentage (%) reduction in pollutants that is presented is based on pollutant loads derived from the development of the new road / project area only (so the 'upstream' or 'existing' load has been removed from the numbers before the % reduction calculation has been undertaken).

Table 3: Post PSP Design Water Quality – Reduction in Pollutants, derived from new road construction

Treated / Bypassed Area (ha)		
Area treated (ha):		12.75
Area bypassing treatment (ha):		10.80
% Reduction in Pollutants		
	WSUD Code Requirements	Post-PSP Design
Gross Pollutants	90%	100%
Suspended solids	60%	96.6%
Total Phosphorus	45%	81.2%
Total Nitrogen	40%	40.4%

This shows that the Post-PSP design conforms to the WSUD targets when assessing pollutant load from the new project area only.

4.2 Post-PSP Design Results if assessment considers pollutant loads from new and existing road

If the assessment of pollutant loads includes the existing road catchment, then the Post-PSP design does not meet the WSUD code requirements without the inclusion of extensive treatment options such as bioretention basins. Table 4 details the outcomes when load from the existing road is included in the assessment.

Table 4: Design Options Water Quality – Reduction in Pollutants, derived from existing road + new road construction

Option	WSUD Code Requirements	PSP Design	Post-PSP Design	WSUD code conforming Option*
Treated / Bypassed Area (ha)				
Area Treated (ha):	N/A	9.21	12.75	21.86
Area Bypassed (ha):	N/A	14.31	10.80	1.70
% Reduction in Pollutants				
Gross Pollutants	90%	27.0%	45.2%	90.3%
Suspended solids	60%	23.7%	37.0%	85.4%
Total Phosphorus	45%	15.5%	22.3%	46.2%
Total Nitrogen	40%	14.3%	20.3%	48.3%

*In order to meet WSUD targets (WSUD General Code, February 2020), extensive additional project scope is required, in particular:

- New castellated kerb on both sides of WHD near the tie-in to Kingsford Smith Drive
- Additional swale drains, pits and pipe along the project to treat runoff
- 7 x bioretention basins as follows:
 1. MC00 Ch1840: 150m²
 2. MC00 Ch2430: 150m²
 3. MC00 Ch3270: 150m²
 4. MC00 Ch3130: 150m²
 5. MC00 Ch640: 150m²
 6. MC00 Ch700: 40m² (constrained space)
 7. MC00 Ch1260: 50m² (constrained space)

Whilst this additional scope will meet WSUD targets, it will have significant negative impact on the constraints identified earlier (impact on biodiversity and potential land acquisition). Additionally, there would be considerably more earthworks and civil construction required with an ongoing maintenance liability.

It is also noted that the bioretention basins will require design and analysis to determine optimum effectiveness, subject to access to infrastructure for maintenance, space constraints and daylighting.

4.3 Additional options for stormwater quality improvements

Gross Pollutant Traps (GPTs) can be added as the end treatment node to treat gross pollutant and suspended solids. Consideration for GPTs should also include the ongoing maintenance requirements, the possible space constraints and maintenance access limitations of the project site.

5 Recommendations

If the Territory agrees to the approach of assessing water quality targets based on pollutant loads derived from the new road formation only (i.e. excluding load from existing road surfaces), then it is recommended to proceed with the drainage design as currently shown at Attachment A, which conforms to the WSUD targets.

If the assessment of water quality targets are to include both the existing road surfaces and the new project area, then it is recommended to pursue an option for offsetting as permitted under Criteria 7 of Section 3.2 of the WSUD General Code and as detailed in the ACT Practice Guidelines for WSUD, as the inclusion of 7 x bioretention basins is not considered practical due to the impact on key constraints such as threatened and endangered ecological communities (including those listed under the EPBC Act), spatial limitations and ongoing maintenance liabilities.

Yours sincerely,



Dan Keep
Project Manager

Attachments:



- A. Post-PSP Design Catchments, nodes, treated areas (conforming if only assessing load from new pavement)
- B. Post-PSP Design Catchments, nodes, treated areas (WSUD code conforming options if assessing load from existing + new pavement)

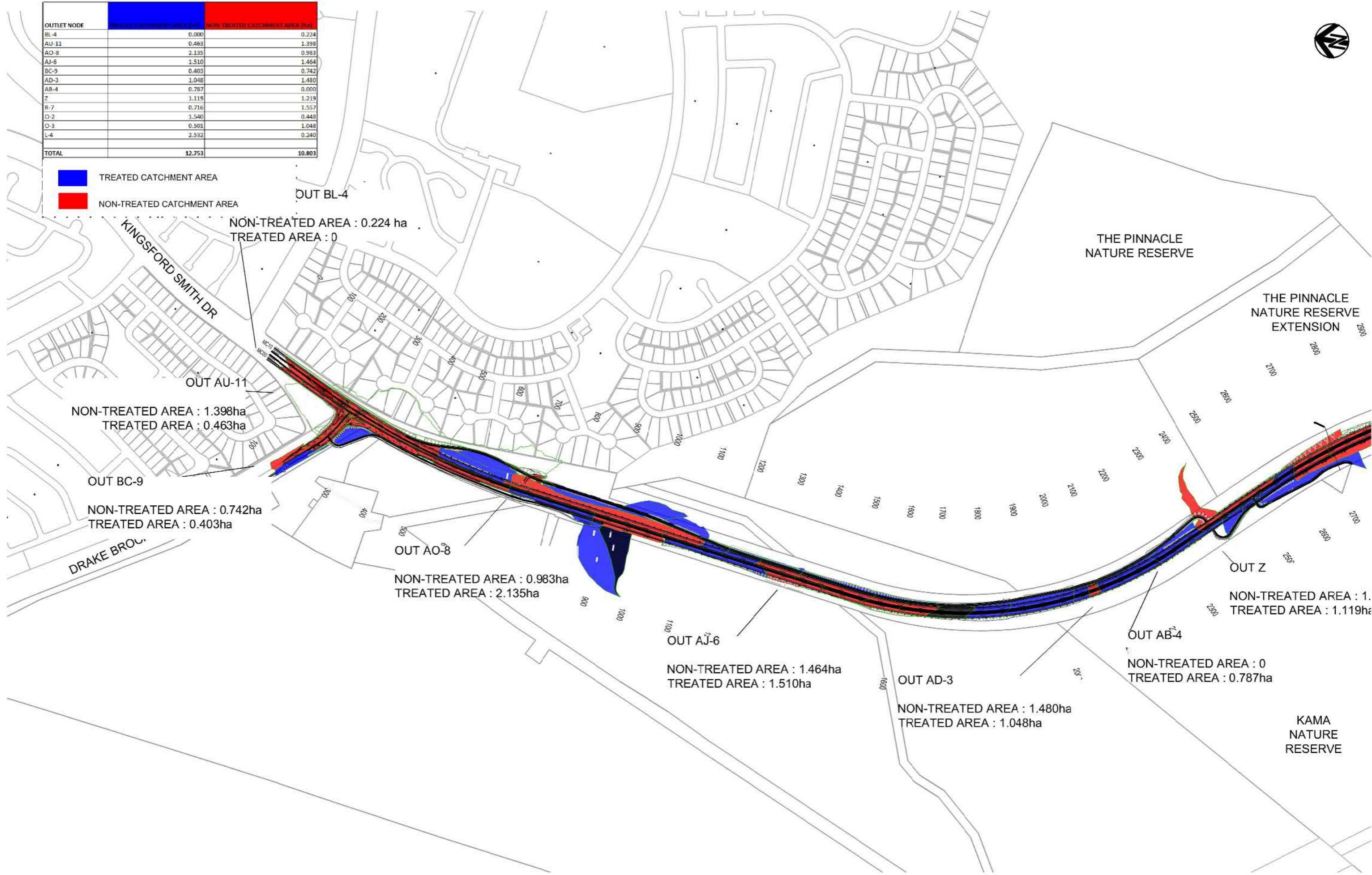
Attachment A

Post-PSP Design Catchments, nodes, treated areas (conforming if only assessing load from new pavement)

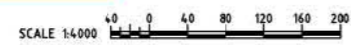


OUTLET NODE	TREATED CATCHMENT AREA (ha)	NON-TREATED CATCHMENT AREA (ha)
BL-4	0.000	0.224
AU-11	0.463	1.398
AO-8	2.135	0.983
AJ-6	1.510	1.464
BC-9	0.403	0.742
AD-3	1.048	1.480
AB-4	0.787	0.000
Z	1.119	1.219
R-7	0.716	1.557
O-2	1.540	0.448
O-3	0.501	1.048
L-4	2.532	0.240
TOTAL	12.753	10.803

 TREATED CATCHMENT AREA
 NON-TREATED CATCHMENT AREA



NOT FOR CONSTRUCTION



**WILLIAM HOVELL DRIVE DUPLICATION MUSIC MODEL
 CATCHMENTS RELATED TO WHDD WATER QUALITY - SHEET 1**



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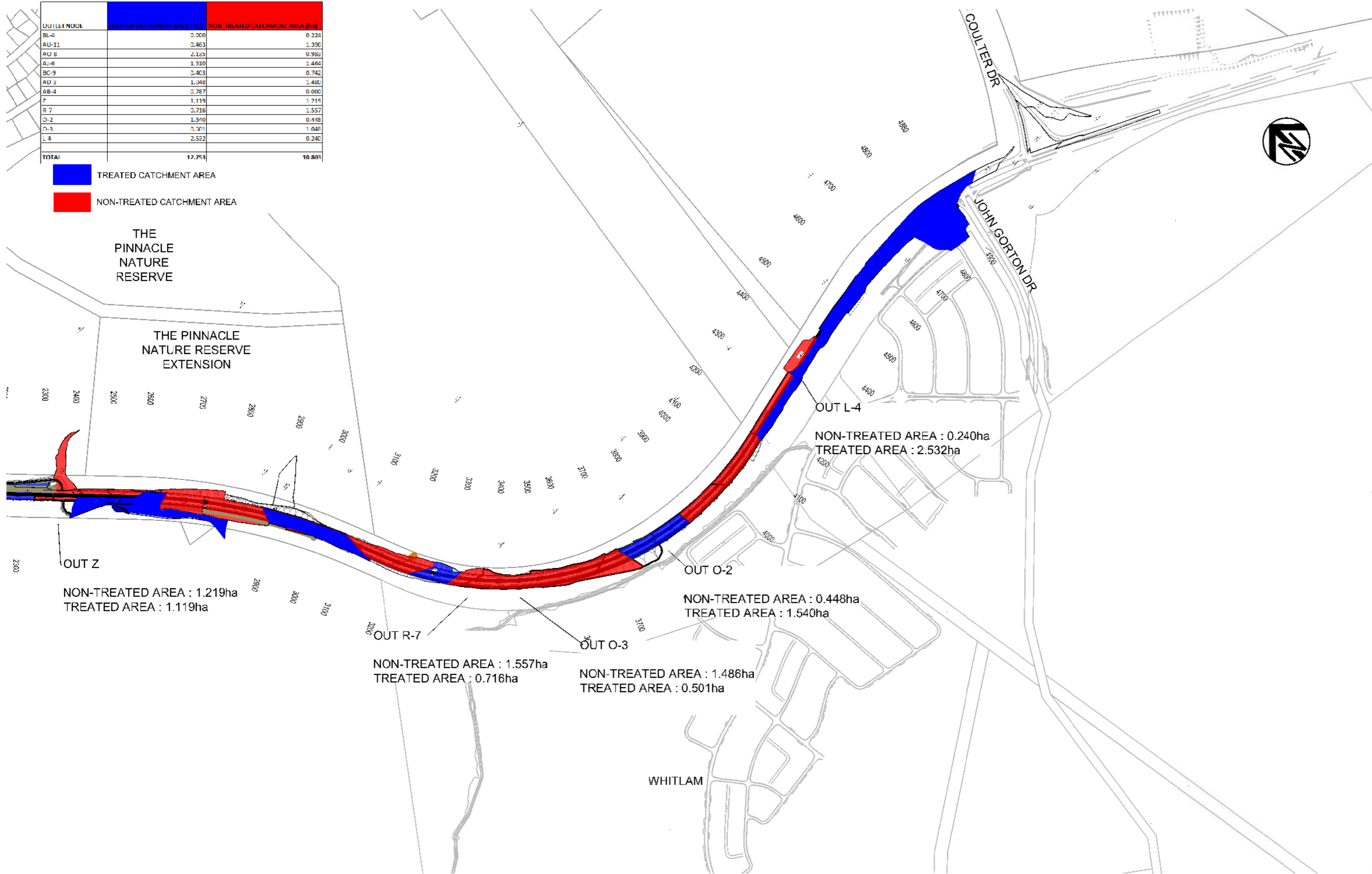
3002750-210527-INF-0021



Member of the Surbana Jurong Group
 © ABN 47 065 475 149
 LEVEL 5, 20 BERRY STREET
 NORTH SYDNEY NSW 2060

OUTLET NODE	TREATED CATCHMENT AREA (ha)	NON-TREATED CATCHMENT AREA (ha)
BL-4	0.000	0.224
AU-11	0.463	1.396
AU-8	2.125	0.982
AJ-6	1.510	1.464
BC-9	0.403	0.742
AD-2	1.048	1.481
AB-4	0.787	0.000
Z	1.119	1.219
R-7	0.716	1.557
O-2	1.510	0.448
O-3	0.501	1.486
L-4	2.532	0.240
TOTAL	12.753	10.803

 TREATED CATCHMENT AREA
 NON-TREATED CATCHMENT AREA



OUT Z
 NON-TREATED AREA : 1.219ha
 TREATED AREA : 1.119ha

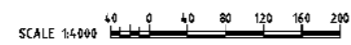
OUT R-7
 NON-TREATED AREA : 1.557ha
 TREATED AREA : 0.716ha

OUT O-3
 NON-TREATED AREA : 1.486ha
 TREATED AREA : 0.501ha

OUT O-2
 NON-TREATED AREA : 0.448ha
 TREATED AREA : 1.540ha

OUT L-4
 NON-TREATED AREA : 0.240ha
 TREATED AREA : 2.532ha

NOT FOR CONSTRUCTION



**WILLIAM HOVELL DRIVE DUPLICATION MUSIC MODEL
 CATCHMENTS RELATED TO WHDD WATER QUALITY - SHEET 2**

INFORMATION DOCUMENT
3002750-200527-INF-0022

Attachment B

Post-PSP Design Catchments, nodes, treated areas (WSUD code conforming options if assessing load from existing + new pavement)

OUTLET NODE	TREATED CATCHMENT AREA (ha)	NON-TREATED CATCHMENT AREA (ha)	POSSIBLE TREATMENT (20211103) (ha)
BL-4	0.000	0.224	0.224
AU-11	0.463	1.398	1.398
AO-8	2.135	0.983	0.350
AJ-6	1.510	1.464	1.295
BC-9	0.403	0.742	0.742
AD-3	1.048	1.480	1.185
AB-4	0.787	0.000	N/A
Z	1.119	1.219	0.847
R-7	0.716	1.557	1.278
O-2	1.540	0.448	1.548
O-3	0.501	1.048	0.000
L-4	2.532	0.240	0.240
TOTAL	12.753	10.803	9.106

- TREATED CATCHMENT AREA
- NON-TREATED CATCHMENT AREA
- POSSIBLE TREATMENT

BIORETENTION BASIN WILL REQUIRE:

- POSSIBLE SIGNIFICANT EARTHWORKS FOR CONSTRUCTION
- ONGOING MAINTENANCE
- ACCESS FOR MAINTENANCE VEHICLES (NOT BEEN CONSIDERED)

SUBJECT TO ADDITIONAL KERB AND/OR NEW OUTLET STRUCTURES

TREATMENT NOT POSSIBLE (BL-4):

- MATCHING EXISTING KERB AND FOOTPATH DOES NOT ALLOW FOR RUNOFF INTO SWALE
- TIEING INTO EXISTING PIPE NETWORK THAT IS TOO DEEP TO DAYLIGHT

UPDATE SWALE/ DRAIN SOUTHBOUND ROAD VERGE INCREASE SWALE DIMENSIONS (1.5m BASE 1:2 BATTERS AND MIN 0.5M DEPTH) - WILL REQUIRE ADDITIONAL EARTHWORKS TO SHIFT BATTER.

BIORETENTION BASIN PROPOSED BETWEEN CH 700 AND 740 TO TREAT 0.350ha

EXTEND PROPOSED SWALE TO CAPTURE RUNOFF FROM PIT BH-1 (CH 290) SWALE DEPTH WILL NEED TO INCREASE

POSSIBLE CASTELLATED KERB BOTH SIDES OF ROAD AND ADDITIONAL SWALE TO DRAIN RD PAVEMENT: FURTHER INVESTIGATION TO NETWORK AND FLOW WIDTH REQUIRED. IMPACT TO PROPOSED FOOTPATH.

NO OPPORTUNITY TO TREAT DUE TO GRADIENT (CH 480)

UNDERPASS AND BARRIERS - NO PROPOSED TREATMENT

UPDATE SWALE/DRAIN SOUTHBOUND VERGE, INCREASE SWALE DIMENSIONS (1.5m BASE 1:2 BATTERS AND MIN 0.5m DEPTH) - SIGNIFICANT ADDITIONAL EARTHWORKS TO SHIFT BATTER. SWALE LENGTH APPROX 170m INTO PIT AK-4 TO TREAT 0.4223ha

85m SWALE DIMENSION A/A TREAT 0.203ha INTO PIT AK-5

**NON-TREATED AREA : 1.620ha
TREATED AREA : 0.463ha**

**NON-TREATED AREA : 0.742ha
TREATED AREA : 0.403ha**

**NON-TREATED AREA : 0.983ha
TREATED AREA : 2.135ha**

REDESIGN PIT AND PIPE NETWORK TO REDIRECT FLOW INTO PROPOSED AND ADDITIONAL SWALES - TREAT 0.31ha

**DUAL SWALE APPROX CH1000 TO 1260 CHANNEL ON NORTHBOUND VERGE APPROX LENGTH 160m
BIORETENTION BASIN REQUIRED AT CH1260 DUE TO STEEP GRADIENT (MAX 50m2 DUE TO SPACE CONSTRAINTS) WITH BUND TO SEPARATE FROM CLEAN WATER
TREAT 0.67ha**

**NON-TREATED AREA : 1.464ha
TREATED AREA : 1.510ha**

**NON-TREATED AREA : 1.480ha
TREATED AREA : 1.048ha**

**NON-TREATED AREA : 0
TREATED AREA : 0.787ha**

REFER TO INFO DOC-0022

**NON-TREATED AREA : 1.
TREATED AREA : 1.119ha**

POSSIBLE CASTELLATED KERB AND ADDITIONAL SWALE TO DRAIN RD PAVEMENT: FURTHER INVESTIGATION TO NETWORK AND FLOW WIDTH REQUIRED. NOTE IMPACT TO EXISTING DRAINAGE NETWORK AND POSSIBLE IMPACT BETWEEN SWALE AND EXISTING STORMWATER PIPE

BIORETENTION BASIN AT CH 1860 TREATMENT OF APPROX 1.2ha RD PAVEMENT REQUIRE:

- UPDATE TO PIPE NETWORK INCREASE PIPE SIZE OF AW-2 AND CONNECT LONGITUDINAL DRAINAGE HERE TO AF-7. REMOVE PIPE AF-7 TO AE-2. SEPARATE CROSS DRAINAGE AE-1 TO AE-4
- BIORETENTION BASIN AT CH 1820 TO 1860 DUE TO STEEP GRADIENT

NOT FOR CONSTRUCTION



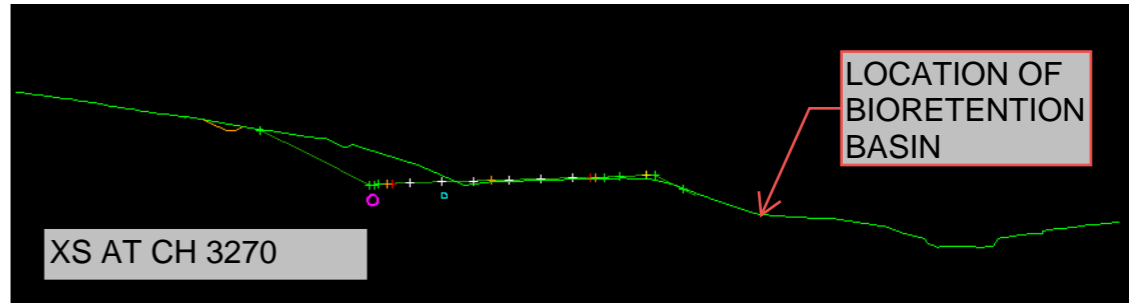
OUTLET NODE	TREATED CATCHMENT AREA (ha)	NON-TREATED CATCHMENT AREA (ha)	POSSIBLE TREATMENT (20211103) (ha)
BL-4	0.000	0.224	0.224
AU-11	0.463	1.398	1.398
AO-8	2.135	0.983	0.350
AJ-6	1.510	1.464	1.295
BC-9	0.403	0.742	0.742
AD-3	1.048	1.480	1.185
AB-4	0.787	0.000	N/A
Z	1.119	1.219	0.847
R-7	0.716	1.557	1.278
O-2	1.540	0.448	1.548
O-3	0.501	1.048	0.000
L-4	2.532	0.240	0.240
TOTAL	12.753	10.803	9.106

- TREATED CATCHMENT AREA
- NON-TREATED CATCHMENT AREA
- POSSIBLE TREATMENT

BIORETENTION BASIN WILL REQUIRE:

- POSSIBLE SIGNIFICANT EARTHWORKS FOR CONSTRUCTION
- ONGOING MAINTENANCE
- ACCESS FOR MAINTENANCE VEHICLES (NOT BEEN CONSIDERED)

SUBJECT TO ADDITIONAL KERB AND/OR NEW OUTLET STRUCTURES



SO KERB/CATCH-DRAIN TO SEPARATE ROAD PAVEMENT RUNOFF FROM CH 3060 TO CH 3270 WILL REQUIRE ADDITIONAL CROSS DRAINAGE PIPE UNDER ROAD PAVEMENT AT CH 3270

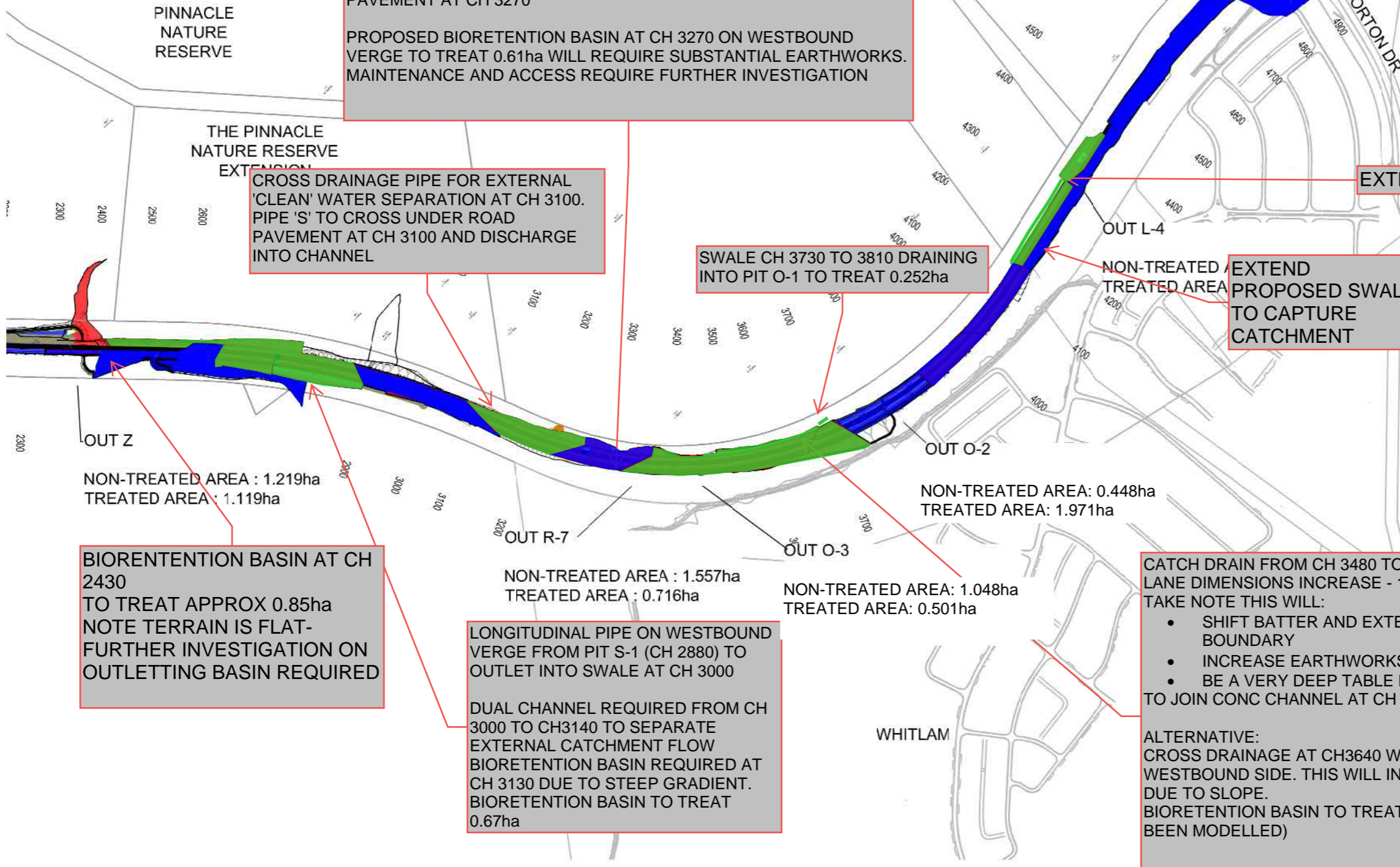
PROPOSED BIORETENTION BASIN AT CH 3270 ON WESTBOUND VERGE TO TREAT 0.61ha WILL REQUIRE SUBSTANTIAL EARTHWORKS. MAINTENANCE AND ACCESS REQUIRE FURTHER INVESTIGATION

CROSS DRAINAGE PIPE FOR EXTERNAL 'CLEAN' WATER SEPARATION AT CH 3100. PIPE 'S' TO CROSS UNDER ROAD PAVEMENT AT CH 3100 AND DISCHARGE INTO CHANNEL

SWALE CH 3730 TO 3810 DRAINING INTO PIT O-1 TO TREAT 0.252ha

EXTEND SWALE, TIE INTO PIT L-2

EXTEND PROPOSED SWALE TO CAPTURE CATCHMENT



OUT Z
NON-TREATED AREA : 1.219ha
TREATED AREA : 1.119ha

OUT O-2
NON-TREATED AREA: 0.448ha
TREATED AREA: 1.971ha

OUT R-7
NON-TREATED AREA : 1.557ha
TREATED AREA : 0.716ha

OUT O-3
NON-TREATED AREA: 1.048ha
TREATED AREA: 0.501ha

BIORETENTION BASIN AT CH 2430 TO TREAT APPROX 0.85ha
NOTE TERRAIN IS FLAT-FURTHER INVESTIGATION ON OUTLETING BASIN REQUIRED

LONGITUDINAL PIPE ON WESTBOUND VERGE FROM PIT S-1 (CH 2880) TO OUTLET INTO SWALE AT CH 3000

DUAL CHANNEL REQUIRED FROM CH 3000 TO CH3140 TO SEPARATE EXTERNAL CATCHMENT FLOW
BIORETENTION BASIN REQUIRED AT CH 3130 DUE TO STEEP GRADIENT. BIORETENTION BASIN TO TREAT 0.67ha

CATCH DRAIN FROM CH 3480 TO CH3660 ON EDGE OF EASTBOUND LANE DIMENSIONS INCREASE - 1.2M BASE 0.5-0.8M DEPTH. TAKE NOTE THIS WILL:

- SHIFT BATTER AND EXTERNAL CONC CHANNEL TOWARD BOUNDARY
- INCREASE EARTHWORKS
- BE A VERY DEEP TABLE DRAIN TO JOIN CONC CHANNEL AT CH 3660 TO AVOID PAD1

ALTERNATIVE:
CROSS DRAINAGE AT CH3640 WITH BIORETENTION BASIN ON WESTBOUND SIDE. THIS WILL INVOLVE SIGNIFICANT EARTHWORKS DUE TO SLOPE.
BIORETENTION BASIN TO TREAT APPROX 1.05ha (THIS OPTION HAS BEEN MODELLED)

NOT FOR CONSTRUCTION



**WILLIAM HOVELL DRIVE DUPLICATION MUSIC MODEL
CATCHMENTS RELATED TO WHDD WATER QUALITY - SHEET 2**

INFORMATION DOCUMENT

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