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8th January 2018

Signature Project Management
Attention: Anthony Marsic
PO Box 507,
DRUMMOYNE NSW 2047

Dear Anthony,

Re: Sydney Zoo, Bungarribee Stormwater Management Plan for Section 96 Application

Northrop Consulting Engineers have been requested by Signature Project Management to prepare detailed civil design documentation for the proposed Sydney Zoo development. The purpose of this letter is to summarise the proposed stormwater management strategy for the site to support a Section 96 application.

The previously issued Development Consent for the project (File Ref: 15/13166), Condition C11 requires the following:

C11. The Applicant shall prepare a final Stormwater Drainage Plan for the Development in consultation with Council and in accordance with the Blacktown Development Control Plan 2015. The final Stormwater Drainage Plan shall form part of the application for a construction certificate.

In developing a revised stormwater strategy for the site, Northrop have made modifications to, but generally stayed in accordance with, the methodology outlined in the previously approved stormwater design for the site, described in the document "Stormwater Management Plan for Sydney Zoo" (Lindsay Dynan, REF 00012082, November 2015).

Site Description

The subject site is located within the Bungarribee Precinct of the Western Sydney Parklands, on Lot 101 of DP1195067 (herein referred to as the 'site'). The site covers an area of approximately 16.5 hectares and is currently comprised of open grassy paddocks with patches of Cumberland Plain Woodland.

The site is bounded by Eastern Creek to the west, the Great Western Highway to the South, Bungarribee Parkland to the north and Doonside Road to the east. Topographically, the site is located on the crest of a hill, falling at around 3 to 5% to the eastern and western boundaries, steepening towards Eastern Creek to the west. For the purposes of stormwater management, the development can be broken into three distinct areas:

- The primary sealed carpark;
- The unsealed overflow carpark; and
- The Zoo grounds.

Prepared	ABK	08.01.2017
Reviewed	CS	09.01.2017
Admin	BM	13.12.2017

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Table 2 – Stormwater Reuse Demands.

Activity	Usage	Equivalent Daily Usage
Irrigation (Tropical)	22.7 L/m^2/week	11,850 L/day
Irrigation (Turf)	22.7 L/m^2/week	17,300 L/day
Toilet Usage	100 L/day/toilet	5,300 L/day
Back of House Hose Down	5 mm/m^2/day	5,750 L/day
Basin/Moat Evaporation	1500 mm/year/m^2	17,150 L/day
TOTALS		
Total Annual Demand (PET Minus Rainfall Distribution)	16,900 kL/year	
***Plus* Total Daily Demand (Uniform Distribution)**	11.05 kL/day	

With the revised storage layout, an estimated reuse efficiency of 80.8% was achieved in MUSIC. This meets Blacktown City Council's requirements for development and is generally in agreement with the reuse efficiency achieved under the original DA documentation.

Onsite Detention (OSD)

As per the previously approved stormwater management plan, OSD measures have been provided to ensure runoff from all portions of the site will be less than or equal to the pre-developed catchment. As described in the previous section, three detention storages have been provided to limit site discharge:

- Within raingardens built into medians in the eastern carpark;
- Within the proposed wetland at the north-eastern corner of the site; and
- Within open space at the north-western corner of the site.

To size the required detention storage and outlet controls, modelling was undertaken using the DRAINS software. In accordance with Blacktown City Council's requirements, OSD measures were designed to limit runoff in the 5 to 100 year ARI storm events, for all storm durations between 5 minutes and 4.5 hours. The adopted ILSAX and antecedent moisture condition (AMC) parameters were in accordance with the Blacktown City Council Drainage Design Manual. The following tables summarise the configuration of the proposed detention measures for each portion of the site and the estimated post-developed runoff rates. For brevity, only the peak outflow for each ARI has been provided here.

Table 3 – Peak Site Discharge for Zoo Grounds West

Contributing Catchment	10.18 ha	
Percentage Impervious	37%	
Storage	Open Space Detention Basin	
Total Storage Volume	1,850 m^3	
ARI	**Peak Pre-Developed Discharge (m^3/s)**	**Peak Post-Developed Discharge (m^3/s)**
5	0.58	0.56
10	1.31	0.85
20	1.72	1.15
50	2.58	1.51
100	3.00	2.07

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Stormwater Quality

Pollutant Load Reduction Targets

The water quality objectives for the site are generally unchanged from the previous stormwater proposal. Stormwater pollutant reduction targets are those required under the BCC 2015 DCP and are reproduced in Table 7.

Table 7 – Pollutant Removal Efficiency Targets.

Pollutant	Treatment Efficiency Target
Total Suspended Solids (TSS)	85% reduction
Total Phosphorous (TP)	65% reduction
Total Nitrogen (TN)	45% reduction
Gross Pollutants (GP)	90% reduction

The proposed treatment measures were analysed using the MUSIC software, using parameters recommended by BCC's 2013 Water Sensitive Urban Design Developer Handbook and the 2010 Draft NSW MUSIC Modelling Guidelines. All MUSIC modelling requirements/assumptions requested by BCC to date have been incorporated into the revised MUSIC model.

Sealed Carpark East

Stormwater quality for the eastern portion of the sealed carpark will be achieved through a combination of vegetated swales, raingardens and proprietary pit filter inserts. MUSIC modelling results are provided in Table 8.

Table 8 – Sealed Carpark East MUSIC Results.

Pollutant		Sources	Residual	Reduction (%)
Total Suspended Solids (TSS)	kg/yr.	1140	165	86
Total Phosphorus (TP)	kg/yr.	1.91	0.4	78
Total Nitrogen (TN)	kg/yr.	7.8	3.8	51
Gross Pollutants (GP)	kg/yr.	84	0	100

Sealed Carpark West

Primary treatment for the western portion of the carpark will be provided by vegetated swales running the length of the carpark. The swales will discharge into pits fitted with filter inserts to screen gross pollutants. The pit and pipe network will then convey stormwater to a biofiltration basin located in open space at the south-west corner of the carpark. The MUSIC modelling results are provided in Table 9.

Table 9 – Sealed Carpark West MUSIC Results.

Pollutant		Sources	Residual	Reduction (%)
Total Suspended Solids (TSS)	kg/yr.	1970	53	97
Total Phosphorus (TP)	kg/yr.	3.3	0.4	87
Total Nitrogen (TN)	kg/yr.	13.4	4.3	68
Gross Pollutants (GP)	kg/yr.	144	0	100

Zoo Grounds and Unsealed Carpark

Stormwater runoff from the majority of zoo grounds and the unsealed carpark will be managed using a combination of vegetated swales, pit inserts and two biofiltration basins. The two biofiltration basins provide end-of-line treatment to stormwater runoff prior to discharging into either the storage basin or wetland area. The MUSIC modelling results are provided in Table 10.

Table 10 – Zoo Grounds and Unsealed Carpark MUSIC Results.

Pollutant		Sources	Residual	Reduction (%)
Total Suspended Solids (TSS)	kg/yr.	6910	934	87
Total Phosphorus (TP)	kg/yr.	13.2	3.4	75
Total Nitrogen (TN)	kg/yr.	92.1	35.1	62
Gross Pollutants (GP)	kg/yr.	783	18	98

Note: A copy of the MUSIC files are available upon request.

The above results demonstrate that the revised stormwater design is compliant with BCC's water quality objectives and commensurate with the previously submitted stormwater management plan. As a result, the proposed stormwater management plan should have a net-neutral to net-beneficial impact on background water quality from the site and the receiving waterway (Eastern Creek) compared to the previous proposal.

Flooding

Flooding considerations have been described in the previously submitted Stormwater Management Plan (Lindsay Dynan, 2015). The extent of the development within both the 1 in 100 year ARI and PMF flood events has not been altered.

Conclusion and Recommendations

The proposed stormwater management design presented above has been prepared to comply with Blacktown City Council's Development Control Plan 2015 and associated Design Guidelines, as well as the previously approved DA documentation and industry best practice. The design is therefore compliant with Development Consent Condition C11 (Stormwater Drainage) issued as part of the previously issued Development Consent for the site. Should you have any queries, please do not hesitate to contact the undersigned on (02) 4943 1777.

Yours faithfully,

Andrew Killen
Civil Engineer
BEng (Civil)

Reviewed by:

Chris Smith
Principal | Civil Engineer
BEng (Civil) MIEAust CPEng NER RPEQ

Limitation Statement

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