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NL171426.B01 [D]

27th September 2019

AVEO
Attention: Kegan Lacey
kegan.lacey@aveo.com.au

Dear Kegan,

Re: 79 Cabbage Tree Road, Bayview
Concept Stormwater Management Strategy

Northrop Consulting Engineers have been engaged by AVEO to provide civil design services for the proposed Independent Living Unit (ILU) addition to the Peninsula Gardens site located at 79 Cabbage Tree Road, Bayview, herein known as 'the site'. The intent of this letter is to present the proposed stormwater management strategy, as well as assess the impacts the development may have on the existing flooding regime. The letter should be read in conjunction with drawings NL171426/C01DA-C21DA.

This letter does not attempt to provide detailed design solutions to all issues; rather it will investigate the feasibility of solutions based on information that we have gathered to date from a number of sources and provide outcomes which will be developed further at Construction Certificate and Construction phases of the project. This letter has been updated to reflect the request for additional information received from Northern Beaches Council.

1. Proposed Stormwater Management Strategy

The proposed stormwater management strategy for the additions, which develops approximately 1.0Ha of the site, can be summarised as follows;

- Runoff from new roof areas will be collected and diverted to above ground re-use tanks. Each unit will be provided with a 3kL rainwater tank. Harvested runoff shall be reused for external irrigation, toilet flushing and clothes washing. A first flush device shall be provided upstream of each tank. Overflow from the tanks will be directed to the underground pipe network for the site;

- Runoff from the internal road network and landscaped areas will be collected via surface inlet pits and conveyed to the stormwater quantity and quality treatment devices for the site via the underground pipe network. All pits collecting road runoff shall be fitted with Stormwater360 Enviropods (or equivalent) to provide pre-treatment to the stormwater runoff;

- Stormwater quantity targets will be achieved by providing 105^3 of On Site Detention (OSD) located under the internal roadway for the western portion of the site. Refer to section 2. *Stormwater quantity assessment* for further details;

- Stormwater quality targets will be achieved by providing a biofiltration basin downstream of the works, followed by a proprietary SPEL Hydrosystem 1000. The basin shall provide a minimum of $40m^2$ of biofiltration media with an extended detention depth of 0.3m. Refer to section 3. *Stormwater quantity assessment* for further details;

- Outflow from the biofiltration basin will be directed to the existing in ground drainage network to the lawful point of discharge into Councils piped system. Site survey and hydraulic calculations confirm the existing in ground drainage connecting to Councils infrastructure has

sufficient capacity to cater for the anticipated minor storm event flows. Refer to the DRAINS model supplied to Council;

- Runoff from the upstream catchment will be cut off and re-directed around the proposed development. Details pertaining to the upstream cutoff swale are provided below in section 4.

The proposed stormwater management strategy is depicted on drawing NL171426/C02DA.

2. Stormwater Quantity Assessment

In order to minimise the impact of the development on the wider catchment runoff regime, hydrological and hydraulic modelling has been undertaken using the software package DRAINS. In particular, the modelling was undertaken to achieve the objectives outlined in the Pittwater DCP 2014 Section B5.7. A schematic of the DRAINS model is shown below in Figure 1.

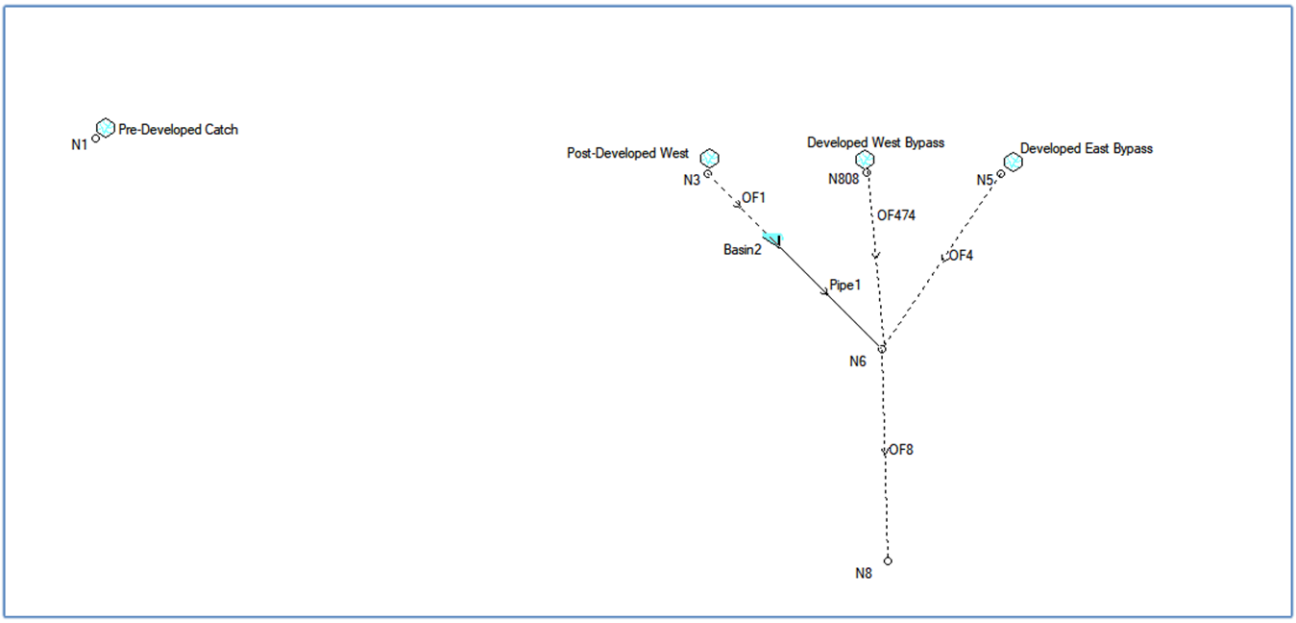

Figure 1 – DRAINS Schematic

A few key considerations in preparing the DRAINS model include;

- The existing catchment is characterised as bushland, with the average slope of approximately 30%. As such, the maximum length of sheet flow is considered to be 50m in accordance with the Table 4.6.4 of the *QUDM [2013]*. Applying Friends Equation for sheet flow, the pre-developed time of concentration to the point of discharge is calculated to be approximately 12 minutes.

- The detention system has been designed to over-detain flows from the western portion of the development (which accounts for approximately 62% of the development) in order to compensate for the eastern portion of the development which bypasses the detention system.

The target objectives can be achieved for the development by implementing 105m^3 of On Site Detention. The detention could be provided via an underground detention tank with flows being restricted via the outlet chamber configuration noted on drawing C21DA.

The results of the DRAINS analyses are summarized overleaf in Table 1.

Storm Event	Pre-developed	Post-developed
1 in 5 year ARI	171 L/s	167 L/s
1 in 10 year ARI	198 L/s	188 L/s
1 in 20 year ARI	233 L/s	215 L/s
1 in 100 year ARI	305 L/s	258 L/s

Table 1 – Estimated Peak Runoff

DRAINS data files can be provided upon request.

3. Stormwater Quality Assessment

In order to minimise any adverse impacts upon the ecology of the downstream watercourses; stormwater treatment devices have been incorporated into the design of the development. The stormwater quality treatment strategy has been assessed against the Pittwater DCP 2014 Section B5.9 for compliance. The DCP references *Australian Rainfall Quality – A Guide to Water Sensitive Urban Design*, of which the treatment targets for pollutant removal and replicated below in Table 2.

Further to the DCP/ARQ requirements, Council have advised additional reduction of stormwater pollutants will be required for the site, which are shown below in Table 2.

Pollutant	DCP/ARQ Target % post development average annual load reduction	Council Target % post development average annual load reduction
Gross Pollutants (P)	90 %	90 %
Total Suspended Solids (TSS)	80 %	85 %
Total Phosphorous (TP)	45 %	65 %
Total Nitrogen (TN)	45 %	45 %

Table 2 – ARQ & Council Pollutant Removal Targets

The performance of the proposed stormwater management strategy outlined in Section 1 was assessed against these targets using the conceptual software MUSIC (Version 6). The MUSIC model was developed in accordance with the Sydney Catchment Authority guide to “Using Music in Sydney’s Drinking Water Catchment”.

A schematic of the MUSIC model is shown overleaf in Figure 2.

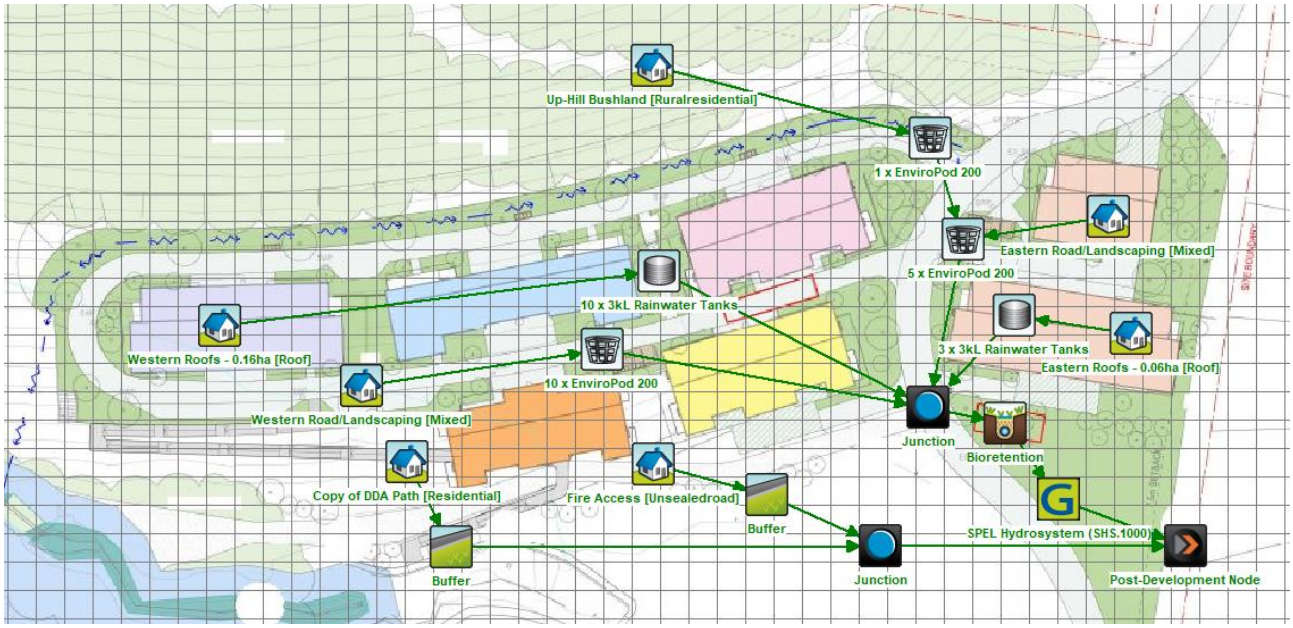

Figure 2 – MUSIC Schematic

The results from the MUSIC model are shown below in Table 3.

	Source Load (kg/yr)	Residual Loads (kg/yr)	Percentage Reduction	Target Objectives
Gross Pollutants (GP)	399	28.3	93 %	90 %
Total Suspended Solids (TSS)	2180	277	87 %	85 %
Total Phosphorous (TP)	4.17	1.31	69 %	65 %
Total Nitrogen (TN)	35.1	16.1	54 %	45 %

Table 3 – MUSIC Results

Table 3 demonstrates that the proposed stormwater management strategy is predicted to achieve the ARQ load reduction targets, as well as the Council specified targets, as estimated by MUSIC.

MUSIC data files can be provided upon request.

4. Management of Upstream Flows

The proposed development will re-direct upstream runoff around the proposed works, with the catchments re-distributed to avoid stormwater inundation to the proposed villas. Refer below to Figure 3 for the proposed diversion swale location and associated upstream catchment.

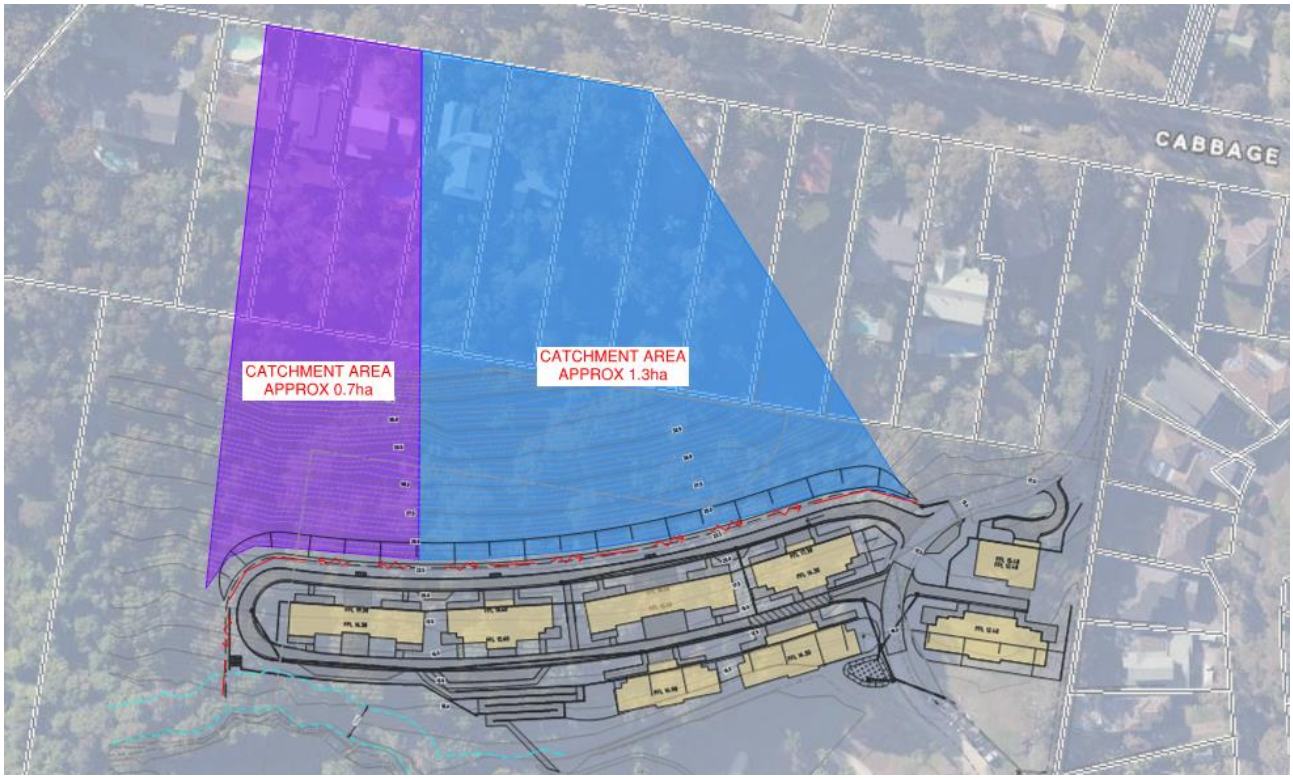

Figure 3 – Upstream Catchment Schematic

Swales have been sized based on the largest upstream catchment, which as noted above is approximately 1.3ha, with Cabbage Tree Road as the catchment boundary. As such, the estimated 1% AEP rainfall runoff utilising the Probabilistic Rational Method is approximately 0.8m^3/s (48% impervious assuming development of lots fronting Cabbage Tree Road). The cut-off swale has been sized utilising Mannings Formula for channalised flow as below;

$$Q = \frac{1}{n}.A.(\frac{A}{P})^{0.666}.\sqrt{s}$$

Where; n = Mannings roughness coefficient = 0.035 (maintained grass)
A = Flow Area = 0.73m^2
P = Wetted Perimeter = 2.39m
s = hydraulic grade = 1% (minimum)

As such, the capacity of the diversion channel noted on Northrop drawing C20DA is 0.98m^3/s (based on the conservative flattest section of the swale), exceeding the predicted peak 0.8m^3/s during the 1% AEP rainfall event. In addition to the cut-off channel, redundancy is provided though the cross-sectional capacity of the internal access loop.

5. Flood Impact Assessment

Northrop have undertaken a 2D Flood Impact Assessment for the proposed development. It was determined that the proposed development has no significant impacts on flood behavior and affectation in the vicinity of the subject site.

For further information on the 2D Flood modelling methodology and results, refer to report *NL171426.B03 – Flood Impact Assessment.*

6. Structural Soundness From Floodwaters

Northrop confirm the design for such structural elements to withstand the forces of floodwater, wave action, flowing water with debris, buoyancy and immersion for flood events up to and including the PMF (i.e. the Flood Planning Level) is feasible and within the capacity of conventional construction methodologies.

For further information, including design calculations and structural certification, refer to report *NL171426.B04 – Structural Flooding Assessment* [A].

7. Flood Emergency Response Commentary

Northrop have reviewed Councils TUFLOW model and undertaken an assessment for the maximum time of inundation of the existing private connection road. The outcomes from this assessment, along with modelling methodology, are noted in the report *NL171426.B03 – Flood Impact Assessment.*

8. Conclusions

Given the results of the above investigations, it is concluded that the proposed development meets the requirements of the former Pittwater Council DCP. In particular:

- The attenuation of stormwater runoff to match the pre developed scenario has been achieved via the use of On Site Detention;
- The treatment of stormwater runoff for waterborne pollutants is achieved through the proposed treatment train. This includes the use of rainwater harvesting tanks, pit filter inserts, end of line biofiltration system and SPEL Hydrosystem 1000; and
- The minor filling and obstructions within the flood fringe of the drainage gully is expected to have no significant adverse impact on the existing flood behavior on the subject site and within the adjacent properties. Floor levels are located above the PMF event with the substructure proposed to be designed to withstand the anticipated flood forces through traditional construction methodologies.

I trust the above meets your requirements; however, if you would like to discuss the development further, then please do not hesitate to contact the undersigned on 0403 101 140.

Yours sincerely,

Aaron Knight
Senior Civil Engineer
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