Stormwater Management Plan

Forresters Beach Planning

80514013

Prepared for
Terrigal Grosvenor Lodge Pty Ltd

26 April 2021

Cardno
Shaping the Future

Contact Information

Cardno NSW/ACT Pty Ltd
ABN 95 001 145 035

Suite 34/207 Albany St Nth

Telephone: (02) 4320 01000
Facsimile: (02) 4324 3251
International: 612 4320 1000

gosford@cardno.com.au
www.cardno.com.au

Author(s): Jason Stewart
Civil/Env.Engineer

Tarni Penn
Graduate Civil Engineer

Approved By:

Sara Belgrove
Principal Civil Engineer

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1 Introduction

Cardno was engaged by Terrigal Grosvenor Lodge Pty Ltd to undertake the preparation of a Water Cycle Management study in relation to the proposed rezoning of No. 957 and Nos. 987-991 The Central Coast Highway (CCH) and Nos. 137,139, 143 and 145 Bakali Road, Forresters Beach (Lots 1-4 DP1000694, Lot 51 DP 1028301 and Lot 522 DP 1077907).

This report has been prepared in support of a planning proposal to Gosford City Council seeking rezoning of the subject land. The rezoning application seeks to rezone the flood free and non-environmentally sensitive parts of the site to R2 to support low density residential development. Towards this end, an indicative staging layout has been prepared by Bannister and Hunter.

This report outlines the methodology for the analysis of on-site stormwater detention (OSD) and water quality requirements and presents the investigation outcomes. The information presented is to indicate the potential sizes/locations of proposed elements and is not intended to present DA level detail.

2 Existing Site Conditions

The land to be rezoned covers an area of 9.855ha and is located between the CCH and Bakali Rd. The site is bound to the north by Lot 5 DP 1082979, to the east and south-east by existing residential properties which front on to the CCH, to the west by Bakali Road (formed and unformed sections). The existing site falls from the CCH to the western boundary at an approximate grade of 3%. Refer to the survey plan in Appendix A for the existing site survey. Figure 2-1 below shows the site location and existing development form.

Figure 2-1 Satellite Image of Rezoning Area

The existing development on the site consists of open rural grassed paddocks with four residences and a large cluster of trees present towards the top north-western corner of the site. An existing open channel runs through the site which starts directly behind the existing residential allotments fronting the CCH and is situated opposite Maas Parade on the western side of the CCH. A stormwater drainage easement is located on No. 971 CCH, which drains the upstream catchment to the east of the CCH. A dam is present on No. 137 Bakali Road which receives runoff from portions of Nos. 137, 139 and 143 Bakali Road.

3 Proposed Development

For the purposes of this report, an indicative subdivision layout has been prepared by Bannister and Hunter (refer to Appendix A). The proposed layout allows for the development to be undertaken in 6 stages corresponding with different land owners. For the current planning proposal, Stage 3 will initially remain as vacant land with no proposed development except for a section of road to connect the Stage 1 and Stage 2 developments. As such, no stormwater management infrastructure is proposed to detain and treat runoff from the vegetated Stage 3 area. Residential development is proposed over the Stage 3 area following completion of the Central Coast Highway road and drainage upgrades, at which point additional stormwater management measures may be required for this area. Stages 5 and 6 will share OSD and water quality infrastructure and as such have been treated as a single stage for the purpose of this analysis.

Internal road infrastructure is proposed for each stage of development.

It should be noted that the subdivision layout proposed is indicative only and allows for the assessment of required stormwater management infrastructure. Future development past rezoning may differ from the indicative layout provided.

Figure 3-1 below shows the proposed development boundaries.

Figure 3-1 Proposed Development Boundaries

4 On-Site Detention

Section 6.7.7.4.4 of Gosford City Council's DCP 2013 requires on-site detention to ensure that post developed flows from a development site do not exceed pre-development flows for all storm events up to and including the 1% AEP storm events.

Four OSD basins are proposed for the site, one for each stage of development. The Stage 1 OSD basin is proposed to be located adjacent to the western Stage 1 boundary and immediately north of Stage 3. The Stage 2 basin will be located adjacent to the western Stage 2 boundary, immediately north of the existing open channel and immediately south of Stage 3. The Stage 4 basin will be located at site of the existing dam. Finally, the Stages 5+6 basin will be located in the southern corner of the site.

A DRAINS computer model (Version 2020.036) was developed to demonstrate compliance with DCP 2013.

4.1 Base Information

The DRAINS computer model was prepared in accordance with the requirements of Central Coast Council's Civil Works Specification, Volume 1 – Design (2020). Australian Rainfall and Runoff (AR&R) 2019 rainfall data was adopted from Bureau of Meteorology IFD tables for Forresters Beach, accessed from the AR&R data hub.

4.1.1 Catchment Losses

An Initial Loss - Continuing Loss (IL-CL) model has been adopted in accordance with AR&R 2019 procedures. Pervious area loss values were obtained from the AR&R data hub.

Due to the urban nature of the catchment, loss values have been defined for Impervious Areas and Pervious Areas and are presented in Table 4-1below.

Table 4-1 IL-CL Parameters

Parameter	Adopted Value
Effective Impervious Area Initial Loss (mm)	1
Effective Impervious Area Continuing Loss (mm/hr)	0
Pervious Area Initial Loss (mm)	1
Pervious Area Continuing Loss (mm/hr)	2.5

Probability Neutral Burst Initial Losses (PNBIL) were used for the Pervious Areas with differing values based on duration and annual exceedance probability. PNBIL values from the AR&R data hub are within the typical range for pervious areas in urban catchments and were thus left unaltered. The adopted PNBIL values are presented Figure 4-1.

Figure 4-1 Probability Neutral Burst Initial Loss

Probability Neutral Burst Initial Loss

min (h)\AEP(%)	50.0	20.0	10.0	5.0	2.0	1.0
60 (1.0)	31.3	16.5	15.5	16.2	17.1	17.5
90 (1.5)	31.2	18.1	17.4	18.9	17.7	15.2
120 (2.0)	29.4	17.7	17.1	18.1	17.5	14.2
180 (3.0)	26.6	18.0	17.5	18.0	16.8	10.8
360 (6.0)	26.2	17.5	16.9	14.9	14.8	8.3
720 (12.0)	33.1	23.6	22.2	19.9	18.6	9.0
1080 (18.0)	33.7	25.0	24.2	22.5	21.4	9.6
1440 (24.0)	39.5	29.6	28.0	25.3	25.8	11.3
2160 (36.0)	42.7	32.6	32.5	30.0	29.6	12.9
2880 (48.0)	48.3	38.9	38.7	38.4	32.7	19.2
4320 (72.0)	51.3	43.4	42.3	47.6	38.0	22.2

Indirectly Connected Area continuing loss has been set at 2.5mm/hr which is considered typical for urban areas as per Section 3.5.2.2 of AR&R 2019.

4.2 Catchments

For the existing and proposed development cases, four catchments were modelled corresponding to the Stages 1, 2, 4 and 5+6 development boundaries shown in Figure 2-1. For the developed cases, it was assumed that runoff from external catchments will be diverted and thus will not contribute to peak runoff from the subject sites. Consequently, runoff from external catchments was not considered for the existing cases as doing so would not allow for an accurate comparison of pre and post development flows.

The existing catchments were assumed to be in a natural state (0% imperviousness) in accordance with Section 6.7.7.4.4 of DCP 2013.

4.2.1 Stage 1 Catchment

The existing Stage 1 site was modelled as a single catchment of 1.948ha with 0% imperviousness. Time of concentration was estimated at 10.2 minutes using Equation 5.4 in AR&R 1987.

The developed Stage 1 site was modelled as a single catchment of 1.948ha with 70% imperviousness. It is proposed that the entire developed area will drain to an OSD basin. Time of concentration for the developed site was assumed as 5 and 6 minutes for impervious and pervious areas respectively.

4.2.2 Stage 2 Catchment

The existing Stage 2 site was modelled as a single catchment of 1.869ha with 0% imperviousness. Time of concentration was estimated at 10.1 minutes using Equation 5.4 in AR&R 1987.

The developed Stages 2 site was modelled as a single catchment of 1.869 ha with 70% imperviousness. It is proposed that the entire developed site will drain to an OSD basin. Time of concentration for the developed site was assumed as 5 and 6 minutes for impervious and pervious areas respectively.

4.2.3 Stage 4 Catchment

The existing Stage 2 site was modelled as a single catchment of 1.617ha with 0% imperviousness. Time of concentration was estimated at 9.5 minutes using Equation 5.4 in AR&R 1987.

The developed Stage 2 site was modelled as a single catchment of 1.617ha with 70% imperviousness to account for the developed area. It is proposed that the entire developed area will drain to an OSD basin. Time of concentration for the developed site was assumed as 5 and 6 minutes for impervious and pervious areas respectively.

4.2.4 Stages 5+6 Catchment

The existing Stages 5+6 site was modelled as a single catchment of 2.017ha with 0% imperviousness. Time of concentration was estimated at 10.4 minutes using Equation 5.4 in AR&R 1987.

The developed Stages 5+6 site was modelled as a single catchment of 2.017 ha with 70% imperviousness. It is proposed that the entire developed site will drain to an OSD basin. Time of concentration for the developed site was assumed as 5 and 6 minutes for impervious and pervious areas respectively.

4.3 Results

Indicative detention basin volume requirements are identified below. During the DA stage of the project, each detention basin will need to be designed to the meet depth, freeboard and embankment slope requirements specified in Section 10.13 of Council's Civil Works Specification, Volume 1 – Design (2020). DRAINS Data and Results are included in Appendix B for reference.

4.3.1 Stage 1 OSD

The DRAINS model shows that an OSD basin with a 1% AEP storage volume of approximately 275m^3 is required to restrict post development flows to no greater than predeveloped flows.

Discharge from the OSD basin will be controlled via 3 x 375 mm diameter Reinforced Concrete Pipes (RCPs) as a primary outlet and a 3.5m wide broad crested weir as a secondary outlet.

Results of peak outflows from the DRAINS model are summarised in Table 4-1.

Table 4-2 Summary of DRAINS Peak Outflows (Stage 1)

Storm Event	Predeveloped Flows	Developed Flows (Without OSD)	Developed Flows (With OSD)	Comments
20% AEP	0.626 m^3/s (10 min, Storm 5)	0.786 m^3/s (5 min, Storm 1)	0.542 m^3/s (10 min, Storm 8)	Developed flows less than predeveloped
10% AEP	0.766 m^3/s (10 min, Storm 2)	0.965 m^3/s (5 min, Storm 1)	0.637 m^3/s (15 min, Storm 6)	Developed flows less than predeveloped
5% AEP	0.918 m^3/s (10 min, Storm 2)	1.15 m^3/s (5 min, Storm 1)	0.736 m^3/s (15 min, Storm 6)	Developed flows less than predeveloped
2% AEP	1.138 m^3/s (10 min, Storm 5)	1.428 m^3/s (5 min, Storm 1)	1.032 m^3/s (10 min, Storm 7)	Developed flows less than predeveloped
1% AEP	1.325 m^3/s (10 min, Storm 6)	1.656 m^3/s (5 min, Storm 1)	1.322 m^3/s (10 min, Storm 7)	Developed flows equal to predeveloped

4.3.2 Stage 2 OSD

The DRAINS model shows that an OSD basin with 1% AEP storage volume of approximately 271m^3 is required to restrict post development flows to no greater than predeveloped flows.

Discharge from the OSD basin will be controlled via 3 x 375 mm diameter RCPs as a primary outlet and a 4m wide broad crested weir as a secondary outlet.

Results of peak outflows from the DRAINS model are summarised in Table 4-2.

Table 4-3 Summary of DRAINS Peak Outflows (Stage 2)

Storm Event	Predeveloped Flows	Developed Flows (Without OSD)	Developed Flows (With OSD)	Comments
20% AEP	0.610 m^3/ s (10 min, Storm 1)	0.754 m3/s (5 min, Storm 1)	0.513 m3/s (10 min, Storm 8)	Developed flows less than predeveloped
10% AEP	0.747 m^3/ s (10 min, Storm 1)	0.926 m3/s (5 min, Storm 1)	0.60 m3/s (15 min, Storm 6)	Developed flows less than predeveloped
5% AEP	0.895 m^3/ s (10 min, Storm 1)	1.104 m3/s (5 min, Storm 1)	0.691 m3/s (15 min, Storm 6)	Developed flows less than predeveloped
2% AEP	1.109 m^3/ s (10 min, Storm 7)	1.37 m3/s (5 min, Storm 1)	1.016 m3/s (10 min, Storm 7)	Developed flows less than predeveloped
1% AEP	1.292 m^3/ s (10 min, Storm 6)	1.589 m3/s (5 min, Storm 1)	1.273 m3/s (10 min, Storm 7)	Developed flows equal to predeveloped

4.3.3 Stage 4 OSD

The DRAINS model shows that an OSD basin with 1% AEP storage volume of approximately 200m^3 is required to restrict post development flows to no greater than predeveloped flows.

Discharge from the OSD basin will be controlled via 3 x 375 mm diameter RCPs as a primary outlet and a 3.5m wide broad crested weir as a secondary outlet.

Results of peak outflows from the DRAINS model are summarised in Table 4-3.

Table 4-4 Summary of DRAINS Peak Outflows (Stage 4)

Storm Event	Predeveloped Flows	Developed Flows (Without OSD)	Developed Flows (With OSD)	Comments
20% AEP	0.533 m^3/ s (10 min, Storm 7)	0.653 m3/s (5 min, Storm 1)	0.504 m3/s (10 min, Storm 3)	Developed flows less than predeveloped
10% AEP	0.651 m^3/ s (10 min, Storm 8)	0.801 m3/s (5 min, Storm 1)	0.587 m3/s (10 min, Storm 6)	Developed flows less than predeveloped
5% AEP	0.781 m^3/ s (10 min, Storm 8)	0.955 m3/s (5 min, Storm 1)	0.679 m3/s (10 min, Storm 6)	Developed flows less than predeveloped
2% AEP	0.972 m^3/ s (10 min, Storm 8)	1.185 m3/s (5 min, Storm 1)	0.808 m3/s (10 min, Storm 7)	Developed flows less than predeveloped
1% AEP	1.133 m^3/ s (10 min, Storm 8)	1.375 m3/s (5 min, Storm 1)	1.097 m3/s (10 min, Storm 7)	Developed flows less than predeveloped

4.3.4 Stages 5+6 OSD

The DRAINS model shows that an OSD basin with 1% AEP storage volume of approximately 296m^3 is required to restrict post development flows to no greater than predeveloped flows.

Discharge from the OSD basin will be controlled via 3 x 375 mm diameter RCPs as a primary outlet and a 3.5m wide broad crested weir as a secondary outlet.

Results of peak outflows from the DRAINS model are summarised in Table 4-4.

Table 4-5 Summary of DRAINS Peak Outflows (Stage 5+6)

Storm Event	Predeveloped Flows	Developed Flows (Without OSD)	Developed Flows (With OSD)	Comments
20% AEP	0.639 m^3/ s (10 min, Storm 2)	0.814 m3/s (5 min, Storm 1)	0.553 m3/s (10 min, Storm 8)	Developed flows equal to predeveloped
10% AEP	0.782 m^3/ s (10 min, Storm 7)	0.999 m3/s (5 min, Storm 1)	0.651 m3/s (15 min, Storm 6)	Developed flows less than predeveloped
5% AEP	0.938 m^3/ s (10 min, Storm 9)	1.191 m3/s (5 min, Storm 1)	0.751 m3/s (15 min, Storm 6)	Developed flows less than predeveloped
2% AEP	1.162 m^3/ s (10 min, Storm 10)	1.478 m3/s (5 min, Storm 1)	1.036 m3/s (10 min, Storm 7)	Developed flows less than predeveloped
1% AEP	1.354 m^3/ s (10 min, Storm 10)	1.715 m3/s (5 min, Storm 1)	1.354 m3/s (10 min, Storm 7)	Developed flows less than predeveloped

5 Water Quality

Section 6.7.7.3.3 of DCP 2013 requires, as a minimum, the following reductions in total pollutant load compared to untreated runoff from the developed site.

Table 5-1 Minimum Pollutant Reduction Targets

Pollutant	Minimum Reduction
Total Suspended Solids (TSS)	80%
Total Phosphorus (TP)	45%
Total Nitrogen (TN)	45%
Gross Pollutants	80%

Section 6.7.7.3.3 of DCP 2013 discusses various options to achieve compliance with the minimum pollutant reduction targets as an area of specified treatment per 100m² of impervious area.

In order to optimise the treatment train while still demonstrating compliance with Section 6.7.7.3.3 of DCP 2013, a MUSIC model was prepared for the development site.

5.2 Base Information

The MUSIC model was prepared in computer model Version 6.3 (Build 0.1908) in accordance with the NSW MUSIC Modelling Guidelines, August 2015.

Meteorological stations near the development site were reviewed in reference to distance from the development site, completeness of data record, dates of data record and type of data record.

Historical pluviograph data was taken from Meteorology Station Number 061351 at Waratah Road, Peats Ridge. The station is approximately 15km from the development site with the rainfall record approximately 99% complete.

Over 25 years of historical rainfall data was analysed in 6 minute time steps from 3 October 1981 to 30 June 2007. The average annual rainfall over this period was 1,122mm.

Daily evapotranspiration data from Sydney was analysed over the same 25 year time period noted above.

5.3 Source Nodes

Pollutant loads for source nodes were adopted from Table 5-6 and 5-7 of the NSW MUSIC Modelling Guidelines (BMT WBM, 2015).

Stochastic pollutant generation was selected.

5.4 Treatment Nodes

Three treatment nodes are proposed as part of the water cycle treatment train for each stage of development:

1. Rainwater Tanks
2. HumeGuard GPT
3. Constructed Wetland

5.5 Stage 1 Treatment

The Stage 1 treatment train is presented in Figure 5-2 below.

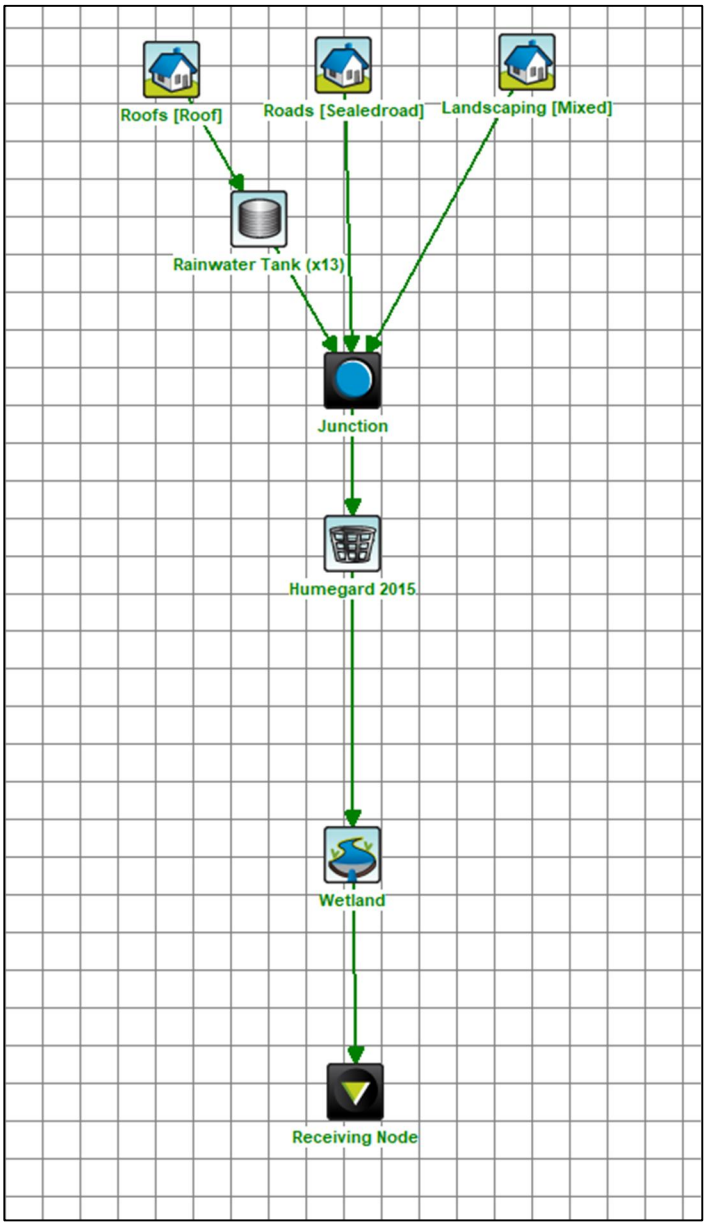

Figure 5-2 Stage 1 Treatment Train

5.5.1 Rainwater Tanks

It is assumed that rainwater tanks will be fitted to each property in the Stage 1 development. The rainwater tanks have been modelled with a nominal storage volume of 3kL per lot/dwelling, totalling 39kL for an assumed 13 lots.

Stormwater reuse was assumed to be used for the following:

1. Toilet
2. Laundry
3. External use

Reuse has been estimated with reference to BMT WBM's MUSIC Modelling Guidelines for urban dwellings with an average of 3.05 occupants. An internal reuse figure of 0.176kL/dwelling/day and an external reuse figure of 0.151kL/dwelling/day were adopted, totalling 4.25kL/day for the assumed 13 dwellings in Stage 1.

5.5.2 HumeGuard GPT

A Humegard GPT is proposed as a primary treatment device to remove gross pollutants and coarse sediments from stormwater runoff. The HumeGuard MUSIC treatment node was downloaded from the Humes website.

5.5.3 Constructed Wetland

A constructed wetland with a permanent pool volume of 343m^3 and minimum surface area of 400m^2 is proposed at the base of the Stage 1 OSD basin to facilitate the removal of finer nutrients and sediment from stormwater runoff. The combined volume of the Stage 1 rainwater tanks and wetland permanent pool volume meets the required Stage 1 Stormwater Retention Volume of 382m^3.

The wetland parameters were selected in accordance with Section 6.5.13 of the NSW MUSIC Modelling Guidelines (BMT WBM, 2015). The high-flow bypass was set at the 3-month ARI flow.

5.5.4 Results

Results of the MUSIC model show the nominated treatment train for Stage 1 exceeds the pollutant removal targets outlined in DCP 2013. Table 5-2 presents a summary of the MUSIC model results.

Table 5-2 Summary of MUSIC Model Results (Stage 1)

Pollutant	Minimum Reduction	Achieved Reduction	Comments
Total Suspended Solids (TSS)	80%	85.4%	Treatment exceeds minimum
Total Phosphorus (TP)	45%	72.7%	Treatment exceeds minimum
Total Nitrogen(TN)	45%	47.9%	Treatment exceeds minimum
Gross Pollutants	80%	100%	Treatment exceeds minimum

The above results demonstrate compliance with the minimum pollutant reduction detailed in Section 6.7.7.3.2 of DCP 2013.

5.6 Stage 2 Treatment

The Stage 2 treatment train is presented in Figure 5-3 below.

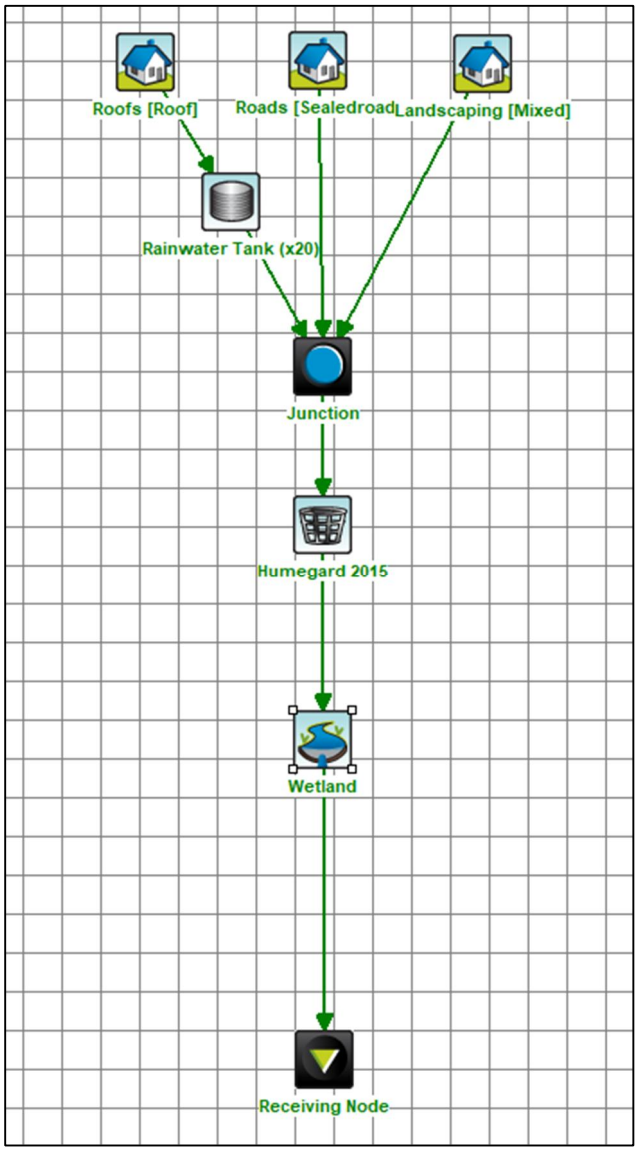

Figure 5-3 Stage 2 Treatment Train

5.6.2 Rainwater Tanks

It is assumed that rainwater tanks will be fitted to each property in the Stage 2 development. The rainwater tanks have been modelled with a nominal storage volume of 3kL per lot/dwelling, totalling 60kL for an assumed 20 lots.

Stormwater reuse was assumed to be used for the following:

4. Toilet
5. Laundry
6. External use

Reuse has been estimated with reference to BMT WBM's MUSIC Modelling Guidelines for urban dwellings with an average of 3.05 occupants. An internal reuse figure of 0.176kL/dwelling/day and an external reuse figure of 0.151kL/dwelling/day were adopted, totalling 6.54kL/day for the assumed 20 dwellings in Stage 2.

5.6.3 HumeGuard GPT

A Humegard GPT is proposed as a primary treatment device to remove gross pollutants and coarse sediments from stormwater runoff. The HumeGuard MUSIC treatment node was downloaded from the Humes website.

5.6.4 Constructed Wetland

A constructed wetland with a permanent pool volume of 310m^3 and minimum surface area of 400m^2 is proposed at the base of the Stage 2 OSD basin to facilitate the removal of finer nutrients and sediment from stormwater runoff. The combined volume of the Stage 2 rainwater tanks and wetland permanent pool volume meets the required Stage 2 Stormwater Retention Volume of 367m^3.

The wetland parameters were selected in accordance with Section 6.5.13 of the NSW MUSIC Modelling Guidelines (BMT WBM, 2015). The high-flow bypass was set at the 3-month ARI flow.

5.6.5 Results

Results of the MUSIC model show the nominated treatment train for Stage 2 exceeds the pollutant removal targets outlined in DCP 2013. Table 5-3 presents a summary of the MUSIC model results.

Table 5-3 Summary of MUSIC Model Results (Stage 2)

Pollutant	Minimum Reduction	Achieved Reduction	Comments
Total Suspended Solids (TSS)	80%	85.4%	Treatment exceeds minimum
Total Phosphorus (TP)	45%	72.7%	Treatment exceeds minimum
Total Nitrogen(TN)	45%	49.1%	Treatment exceeds minimum
Gross Pollutants	80%	100%	Treatment exceeds minimum

The above results demonstrate compliance with the minimum pollutant reduction detailed in Section 6.7.7.3.2 of DCP 2013.

5.7 Stage 4 Treatment

The Stage 4 treatment train is presented in Figure 5-4 below.

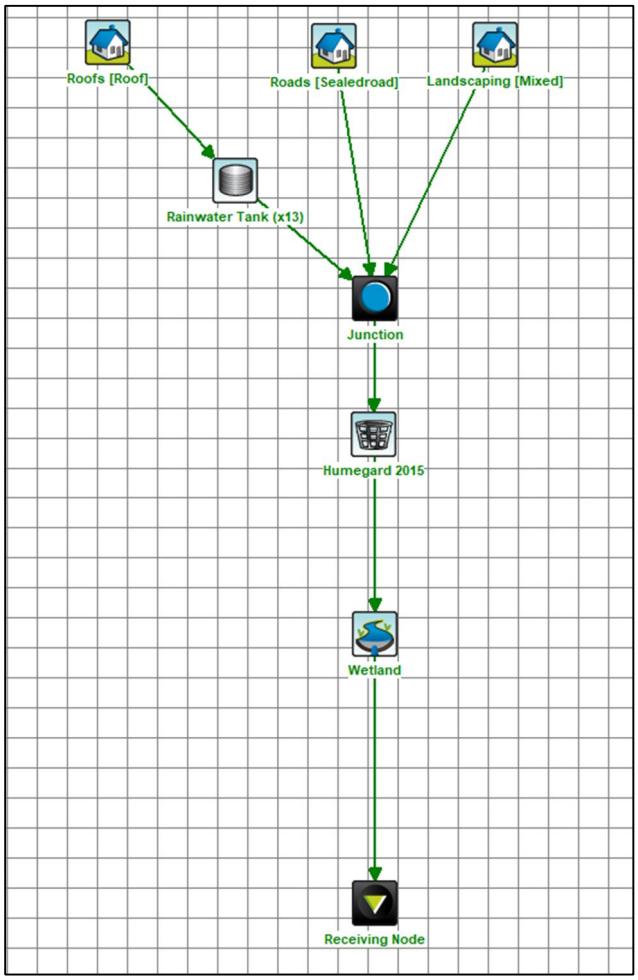

Figure 5-4 Stage 2 Treatment Train

5.7.2 Rainwater Tanks

It is assumed that rainwater tanks will be fitted to each property in the Stage 4 development. The rainwater tanks have been modelled with a nominal storage volume of 3kL per lot/dwelling, totalling 39kL for an assumed 13 lots.

Stormwater reuse was assumed to be used for the following:

7. Toilet
8. Laundry
9. External use

Reuse has been estimated with reference to BMT WBM's MUSIC Modelling Guidelines for urban dwellings with an average of 3.05 occupants. An internal reuse figure of 0.176kL/dwelling/day and an external reuse figure of 0.151kL/dwelling/day were adopted, totalling 4.25kL/day for the assumed 13 dwellings in Stage 4.

5.7.3 HumeGuard GPT

A Humegard GPT is proposed as a primary treatment device to remove gross pollutants and coarse sediments from stormwater runoff. The HumeGuard MUSIC treatment node was downloaded from the Humes website.

5.7.4 Constructed Wetland

A constructed wetland with a permanent pool volume of 280m^3 and minimum surface area of 400m^2 is proposed at the base of the Stage 4 OSD basin to facilitate the removal of finer nutrients and sediment from stormwater runoff. The combined volume of the Stage 4 rainwater tanks and wetland permanent pool volume meets the required Stage 4 Stormwater Retention Volume of 317m^3.

The wetland parameters were selected in accordance with Section 6.5.13 of the NSW MUSIC Modelling Guidelines (BMT WBM, 2015). The high-flow bypass was set at the 3-month ARI flow.

5.7.5 Results

Results of the MUSIC model show the nominated treatment train for Stage 4 exceeds the pollutant removal targets outlined in DCP 2013. Table 5-4 presents a summary of the MUSIC model results.

Table 5-4 Summary of MUSIC Model Results (Stage 4)

Pollutant	Minimum Reduction	Achieved Reduction	Comments
Total Suspended Solids (TSS)	80%	86.8%	Treatment exceeds minimum
Total Phosphorus (TP)	45%	71.5%	Treatment exceeds minimum
Total Nitrogen(TN)	45%	45.4%	Treatment exceeds minimum
Gross Pollutants	80%	100%	Treatment exceeds minimum

The above results demonstrate compliance with the minimum pollutant reduction detailed in Section 6.7.7.3.2 of DCP 2013.

5.9 Stages 5+6 Treatment

The Stages 5+6 treatment train is presented in Figure 5-5 below.

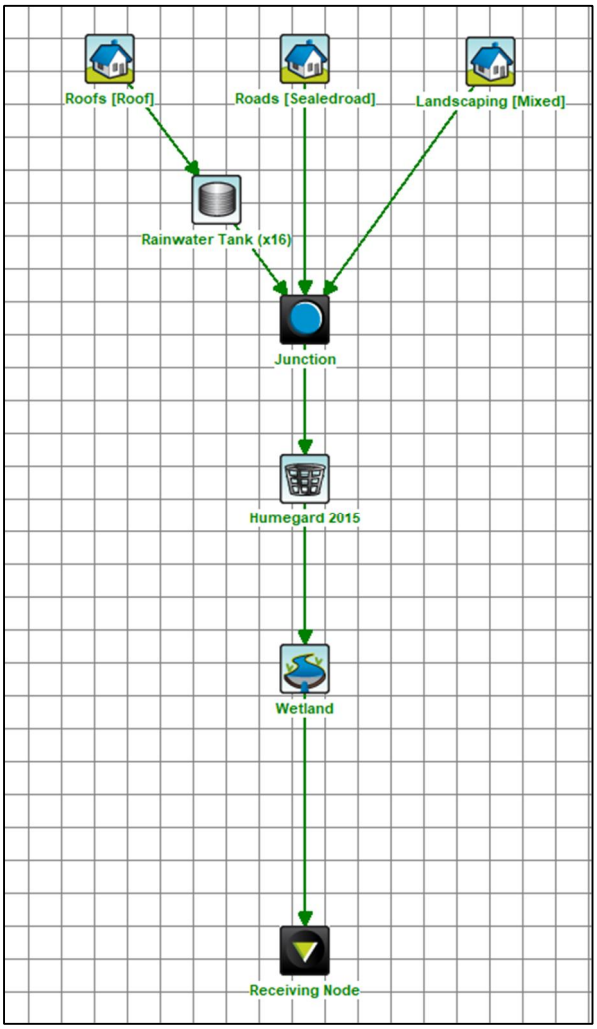

Figure 5-5 Stages 5+6 Treatment Train

5.9.2 Rainwater Tanks

It is assumed that rainwater tanks will be fitted to each property in the Stage 5+6 development. The rainwater tanks have been modelled with a nominal storage volume of 3kL per lot/dwelling, totalling 48kL for an assumed 16 lots.

Stormwater reuse was assumed to be used for the following:

10. Toilet
11. Laundry
12. External use

Reuse has been estimated with reference to BMT WBM's MUSIC Modelling Guidelines for urban dwellings with an average of 3.05 occupants. An internal reuse figure of 0.176kL/dwelling/day and an external reuse figure of 0.151kL/dwelling/day were adopted, totalling 5.23kL/day for the assumed 16 dwellings in Stage 5+6.

5.9.3 HumeGuard GPT

A Humegard GPT is proposed as a primary treatment device to remove gross pollutants and coarse sediments from stormwater runoff. The HumeGuard MUSIC treatment node was downloaded from the Humes website.

5.9.4 Constructed Wetland

A constructed wetland with a permanent pool volume of 350m^3 and minimum surface area of 500m^2 is proposed at the base of the Stage 5+6 OSD basin to facilitate the removal of finer nutrients and sediment from stormwater runoff. The combined volume of the Stage 5+6 rainwater tanks and wetland permanent pool volume meets the required Stage 5+6 Stormwater Retention Volume of 395m^3.

The wetland parameters were selected in accordance with Section 6.5.13 of the NSW MUSIC Modelling Guidelines (BMT WBM, 2015). The high-flow bypass was set at the 3-month ARI flow.

5.9.5 Results

Results of the MUSIC model show the nominated treatment train for Stages 5+6 exceeds the pollutant removal targets outlined in DCP 2013. Table 5-5 presents a summary of the MUSIC model results.

Table 5-5 Summary of MUSIC Model Results (Stages 5+6)

Pollutant	Minimum Reduction	Achieved Reduction	Comments
Total Suspended Solids (TSS)	80%	86.8%	Treatment exceeds minimum
Total Phosphorus (TP)	45%	71.6%	Treatment exceeds minimum
Total Nitrogen(TN)	45%	45.6%	Treatment exceeds minimum
Gross Pollutants	80%	100%	Treatment exceeds minimum

The above results demonstrate compliance with the minimum pollutant reduction detailed in Section 6.7.7.3.2 of DCP 2013.

6 Conclusion

This report has outlined the methodology behind the analysis of on-site detention and water quality requirements for the proposed rezoning development.

It was found that a single OSD basin for each stage of development (shared basin for Stages 5 and 6) will be sufficient to ensure developed flows do not exceed pre-developed flows for all storm events up to and including the 1% AEP event. Spatial requirements and details of the OSD basins will be confirmed during DA design.

It was found that a treatment train consisting of rainwater tanks, a HumeGuard GPT and a constructed wetland will be sufficient to meet Council's water quality requirements for each stage of development (shared treatment train for Stages 5 and 6).

Forresters Beach Planning

APPENDIX A

DEVELOPMENT LAYOUT

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STAGE 1 COMBINED OSD BASIN / WETLAND
1% AEP STORAGE VOLUME = 275 m³
WETLAND PERMANENT WATER VOLUME = 345 m³

STAGE 2 COMBINED OSD BASIN / WETLAND
1% AEP STORAGE VOLUME = 271 m³
WETLAND PERMANENT WATER VOLUME = 310 m³

STAGE 4 COMBINED OSD BASIN / WETLAND
1% AEP STORAGE VOLUME = 200 m³
WETLAND PERMANENT WATER VOLUME = 280 m³

STAGE 5+6 COMBINED OSD BASIN / WETLAND
1% AEP STORAGE VOLUME = 296 m³
WETLAND PERMANENT WATER VOLUME = 350 m³

NOTES:

- BASED ON MIN. LOT SIZE 550m²
- PLAN SUBJECT TO REVIEW OF ENGINEERING, BUSHFIRE & ENVIRONMENTAL CONTROLS
- ALL FINAL DIMENSIONS AND AREAS SUBJECT TO SURVEY

OPEN SPACE WITHIN STAGE 1 (4000m²)

STAGE 1

STAGE 2

STAGE 3 (RESIDENTIAL)

STAGE 4

STAGE 5

STAGE 6

ABSORBING DRAIN 1m X 0.5m

20 10 0 20 40 60 80 100
SCALE IN METRES ON ORIGINAL DRAWING AT REDUCTION RATIO 1:1000

VPA PLAN - 12

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

DEVELOPMENT LAYOUT
WITH STORMWATER
MANAGEMENT MEASURES

APPENDIX B

DRAINS DATA AND RESULTS

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Shaping the Future

DRAINS Data																			
PIT / NODE DETAILS			Version 15																
Name	Type	Family	Size	Ponding	Pressure	Surface	Max Pond	Base	Blocking	x	y	Bolt-down	id	Part Full	Inflow	Pit is	Internal	Inflow is	Minor Safe
				Volume	Change	Elev (m)	Depth (m)	Inflow	Factor			lid		Shock Los	Hydrograph		Width	Misaligned	Pond Dept
				(cu.m)	Coeff. Ku			(cu.m/s)									(mm)		(m)
N1	Node							0		151.922	14.202		1		No				
N646	Node							0		335.215	10.439		1429		No				
N667	Node							0		505.608	0.226		1478		No				
N4824	Node					6.8		0		168.227	-113.19		11201		No				
N9626	Node					6.8		0		342.472	-119.461		22580		No				
N25731	Node					6.8		0		506.563	-126.403		61023		No				
N40223	Node					6.6		0		49.856	-71.565		93659		No				
N40224	Node					6.6		0		18.75	27.802		93665		No				
N40222	Node					8		0		60.614	-14.753		93643		No				
N74	Node					8.4		0		178.26	-55.675		149		No				
N660	Node					8		0		369.079	-49.763		1457		No				
N680	Node					8.4		0		530.334	-58.9		1513		No				
DETENTION BASIN DETAILS																			
Name	Elev	Volume	Not Used	Outlet Type	K	Dia(mm)	Centre RL	Pit Family	Pit Type	x	y	HED	Crest RL	Crest Leng	id				
BasinSt 2	8.15	0		Culvert	0.5					74.684	23.653	No			155907				
	9.15	271																	
BasinSt.1	8.05	0		Culvert	0.5					206.45	3.496	No			155910				
	9.2	275																	
BasinSt.4	7.6	0		Culvert	0.5					397.567	7.976	No			155914				
	8.8	200																	
BasinSt.5+6	8	0		Culvert	0.5					558.449	-1.729	No			155918				
	9.2	296																	
SUB-CATCHMENT DETAILS																			
Name	Pit or	Total	EIA	Perv	RIA	EIA	Perv	RIA	EIA	Perv	RIA	EIA	Perv	RIA	EIA	Perv	RIA	Rainfall	
	Node	Area		Area		Time	Time	Time	Length	Length	Length	Slope(%)	Slope	Slope	Rough	Rough	Rough	Multiplier	
		(ha)	%	%	%	(min)	(min)	(min)	(m)	(m)	(m)	%	%	%					
Pre-Dev St.1	N1	1.9477	0	100	0	5	10.21	2										1	
Pre-dev St.4	N646	1.617	0	100	0	5	9.51	2										1	
Pre-dev St.5+6	N667	2.017	0	100	0	5	10.35	2										1	
Pre-Dev St.2	N40224	1.8691	0	100	0	5	10.05	2										1	
Post Dev St.2	BasinSt 2	1.8691	70	30	0	5	6	2										1	
Post-Dev St.1	BasinSt.1	1.9477	70	30	0	5	6	2										1	
Post-Dev St.4	BasinSt.4	1.617	70	30	0	5	6	2										1	
Post-Dev St.5+6	BasinSt.5+	2.017	70	30	0	5	6	2										1	
PIPE DETAILS																			
Name	From	To	Length	U/S IL	D/S IL	Slope	Type	Dia	I.D.	Rough	Pipe Is	No. Pipes	Chg From	At Chg	Chg	RI	Chg	RL	etc
			(m)	(m)	(m)	(%)		(mm)	(mm)						(m)	(m)	(m)	(m)	(m)
Pipe STG2 Basin	BasinSt 2	N40222	10	8.15	7.95	2	Concrete,	375	375	0.011	NewFixed	3	N40222	0					
Pipe STG1 Basin	BasinSt.1	N74	10	8.05	7.85	2	Concrete,	375	375	0.011	NewFixed	3	N74	0					
Pipe STG 4 Basin	BasinSt.4	N660	10	7.6	7.4	2	Concrete,	375	375	0.011	NewFixed	3	N660	0					
Pipe STG 56 Basin	BasinSt.5+	N680	10	8	7.8	2	Concrete,	375	375	0.011	NewFixed	3	N680	0					
DETAILS of SERVICES CROSSING PIPES																			
Pipe	Chg	Bottom	Height of S	Chg	Bottom	Height of S	Chg	Bottom	Height of Service	etc									
	(m)	Elev (m)	(m)	(m)	Elev (m)	(m)	(m)	Elev (m)	(m)	etc									

CHANNEL DETAILS																			
Name	From	To	Type	Length	U/S IL	D/S IL	Slope	Base Widt	L.B. Slope	R.B. Slope	Manning	Depth	Roofed						
				(m)	(m)	(m)	(%)	(m)	(1:?)	(1:?)	n	(m)							
OVERFLOW ROUTE DETAILS																			
Name	From	To	Travel	Spill	Crest	Weir	Cross	Safe Depth	SafeDepth	Safe	Bed	D/S Area		id					
			Time	Level	Length	Coeff. C	Section	Major Stor	Minor Storms	DxV	Slope	Contributing							
			(min)	(m)	(m)			(m)	(m)	(sq.m/sec)	(%)	%							
OF STG 2	BasinSt 2	N40222	0.1	9	4	2	Dummy us	0.2	0.05	0.6	1	0		93645			10		
OF20073	N40222	N40223	0.5				Dummy us	0.2	0.05	0.6	1	0		93646					
OSD High Level STG1	BasinSt.1	N74	0.5	9.05	3.5	2	Dummy us	0.2	0.05	0.6	1	0		530					
OF1543	N74	N4824	0.5				Dummy us	0.2	0.05	0.6	1	0		11210					
OF STG4	BasinSt.4	N660	0.5	8.68	3.5	2	Dummy us	0.2	0.05	0.6	1	0		1464					
OF3746	N660	N9626	0.5				Dummy us	0.2	0.05	0.6	1	0		22581					
OF STG 56	BasinSt.5+	N680	0.5	9.05	3.5	2	Dummy us	0.2	0.05	0.6	1	0		1506					
OF12448	N680	N25731	0.5				Dummy us	0.2	0.05	0.6	1	0		61024					
PIPE COVER DETAILS																			
Name	Type	Dia (mm)	Safe Cover	Cover (m)															
Pipe STG2 Basin	Concrete,	375	0.6	-0.41	Unsafe														
Pipe STG1 Basin	Concrete,	375	0.6	-0.41	Unsafe														
Pipe STG 4 Basin	Concrete,	375	0.6	-0.41	Unsafe														
Pipe STG 56 Basin	Concrete,	375	0.6	-0.41	Unsafe														
This model has no pipes with non-return valves																			

DRAINS results prepared from Version 2020.036 - 20% AEP

PIT / NODE DETAILS				Version 8					
Name	Max HGL	Max Pond HGL	Max Surfac Flow Arrivi (cu.m/s)	Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint		
N40222	8.16		0						
N74	8.06		0						
N660	7.6		0						
N680	8.02		0						

SUB-CATCHMENT DETAILS									
Name	Max Flow Q (cu.m/s)	EIA Max Q (cu.m/s)	Remaining Max Q (cu.m/s)	EIA Tc (cu.m/s)	RIA Tc (min)	PA Tc (min)	Due to Storm (min)		
Pre-Dev St.1	0.626	0	0.626	5	2	10.21	20% AEP, 10 min burst, Storm 5		
Pre-dev St.4	0.533	0	0.533	5	2	9.51	20% AEP, 10 min burst, Storm 7		
Pre-dev St.5+6	0.639	0	0.639	5	2	10.35	20% AEP, 10 min burst, Storm 2		
Pre-Dev St.2	0.61	0	0.61	5	2	10.05	20% AEP, 10 min burst, Storm 1		
Post Dev St.2	0.754	0.558	0.196	5	2	6	20% AEP, 5 min burst, Storm 1		
Post-Dev St.1	0.786	0.582	0.204	5	2	6	20% AEP, 5 min burst, Storm 1		
Post-Dev St.4	0.653	0.483	0.17	5	2	6	20% AEP, 5 min burst, Storm 1		
Post-Dev St.5+6	0.814	0.602	0.212	5	2	6	20% AEP, 5 min burst, Storm 1		

PIPE DETAILS									
Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm				
Pipe STG2 Basin	0.513	2.75	8.454	8.156	20% AEP, 10 min burst, Storm 8				
Pipe STG1 Basin	0.542	2.79	8.361	8.063	20% AEP, 10 min burst, Storm 8				
Pipe STG 4 Basin	0.504	2.74	7.901	7.604	20% AEP, 10 min burst, Storm 3				
Pipe STG 56 Basin	0.553	2.8	8.315	8.016	20% AEP, 10 min burst, Storm 8				

CHANNEL DETAILS									
Name	Max Q (cu.m/s)	Max V (m/s)			Due to Storm				

OVERFLOW ROUTE DETAILS								
Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
OF STG 2	0	0	0.256	0	0	0	0	
OF20073	0.513	0.513	0.256	0.066	0.05	17.2	0.8	20% AEP, 10 min burst, Storm 8
OSD High Level STG1	0	0	0.256	0	0	0	0	
OF1543	0.542	0.542	0.256	0.068	0.05	17.56	0.81	20% AEP, 10 min burst, Storm 8
OF STG4	0	0	0.256	0	0	0	0	
OF3746	0.504	0.504	0.256	0.066	0.05	17.2	0.79	20% AEP, 10 min burst, Storm 3
OF STG 56	0	0	0.256	0	0	0	0	
OF12448	0.553	0.553	0.256	0.069	0.06	17.74	0.8	20% AEP, 10 min burst, Storm 8

DETENTION BASIN DETAILS									
Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level				
BasinSt 2	8.67	140.5	0.513	0.513	0				
BasinSt.1	8.62	135.2	0.542	0.542	0				
BasinSt.4	8.1	83.9	0.504	0.504	0				
BasinSt.5+6	8.58	143.9	0.553	0.553	0				

Run Log for Forresters OSD v6 ARR2019 SJB.drn run at 15:03:16 on 26/4/2021 using version 2020.036

The maximum flow in these overflow routes is unsafe: OF20073, OF1543, OF3746, OF12448

DRAINS results prepared from Version 2020.036 - 10% AEP

PIT / NODE DETAILS				Version 8					
Name	Max HGL	Max Pond HGL	Max Surfac Flow Arrivi (cu.m/s)	Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint		
N40222	8.18		0						
N74	8.09		0						
N660	7.62		0						
N680	8.04		0						

SUB-CATCHMENT DETAILS									
Name	Max Flow Q (cu.m/s)	EIA Max Q (cu.m/s)	Remaining Max Q (cu.m/s)	EIA Tc (cu.m/s)	RIA Tc (min)	PA Tc (min)	Due to Storm		
Pre-Dev St.1	0.766	0	0.766	5	2	10.21	10% AEP, 10 min burst, Storm 2		
Pre-dev St.4	0.651	0	0.651	5	2	9.51	10% AEP, 10 min burst, Storm 8		
Pre-dev St.5+6	0.782	0	0.782	5	2	10.35	10% AEP, 10 min burst, Storm 7		
Pre-Dev St.2	0.747	0	0.747	5	2	10.05	10% AEP, 10 min burst, Storm 1		
Post Dev St.2	0.926	0.685	0.241	5	2	6	10% AEP, 5 min burst, Storm 1		
Post-Dev St.1	0.965	0.714	0.251	5	2	6	10% AEP, 5 min burst, Storm 1		
Post-Dev St.4	0.801	0.592	0.209	5	2	6	10% AEP, 5 min burst, Storm 1		
Post-Dev St.5+6	0.999	0.739	0.26	5	2	6	10% AEP, 5 min burst, Storm 1		

PIPE DETAILS									
Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm				
Pipe STG2 Basin	0.6	2.85	8.513	8.178	10% AEP, 15 min burst, Storm 6				
Pipe STG1 Basin	0.637	2.89	8.452	8.087	10% AEP, 15 min burst, Storm 6				
Pipe STG 4 Basin	0.587	2.84	7.949	7.624	10% AEP, 10 min burst, Storm 6				
Pipe STG 56 Basin	0.651	2.9	8.417	8.04	10% AEP, 15 min burst, Storm 6				

CHANNEL DETAILS									
Name	Max Q (cu.m/s)	Max V (m/s)			Due to Storm				

OVERFLOW ROUTE DETAILS									
Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm	
OF STG 2	0	0	0.256	0	0	0	0		
OF20073	0.6	0.6	0.256	0.07	0.06	18.1	0.84	10% AEP, 15 min burst, Storm 6	
OSD High Level STG1	0	0	0.256	0	0	0	0		
OF1543	0.637	0.637	0.256	0.072	0.06	18.46	0.85	10% AEP, 15 min burst, Storm 6	
OF STG4	0	0	0.256	0	0	0	0		
OF3746	0.587	0.587	0.256	0.07	0.06	17.92	0.83	10% AEP, 10 min burst, Storm 6	
OF STG 56	0	0	0.256	0	0	0	0		
OF12448	0.651	0.651	0.256	0.073	0.06	18.64	0.85	10% AEP, 15 min burst, Storm 6	

DETENTION BASIN DETAILS									
Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level				
BasinSt 2	8.81	180.2	0.6	0.6	0				
BasinSt.1	8.78	174.7	0.637	0.637	0				
BasinSt.4	8.24	106.9	0.587	0.587	0				
BasinSt.5+6	8.76	186.4	0.651	0.651	0				

Run Log for Forresters OSD v6 ARR2019 SJB.drn run at 15:02:00 on 26/4/2021 using version 2020.036

The maximum flow in these overflow routes is unsafe: OF20073, OF1543, OF3746, OF12448

DRAINS results prepared from Version 2020.036 - 5% AEP

PIT / NODE DETAILS				Version 8					
Name	Max HGL	Max Pond HGL	Max Surfac Flow Arrivi (cu.m/s)	Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint		
N40222	8.2		0.077						
N74	8.11		0.004						
N660	7.65		0						
N680	8.07		0						

SUB-CATCHMENT DETAILS									
Name	Max Flow Q (cu.m/s)	EIA Max Q (cu.m/s)	Remaining Max Q (cu.m/s)	EIA Tc (cu.m/s)	RIA Tc (min)	PA Tc (min)	Due to Storm (min)		
Pre-Dev St.1	0.918	0	0.918	5	2	10.21	5% AEP, 10 min burst, Storm 2		
Pre-dev St.4	0.781	0	0.781	5	2	9.51	5% AEP, 10 min burst, Storm 8		
Pre-dev St.5+6	0.938	0	0.938	5	2	10.35	5% AEP, 10 min burst, Storm 9		
Pre-Dev St.2	0.895	0	0.895	5	2	10.05	5% AEP, 10 min burst, Storm 1		
Post Dev St.2	1.104	0.816	0.288	5	2	6	5% AEP, 5 min burst, Storm 1		
Post-Dev St.1	1.15	0.85	0.3	5	2	6	5% AEP, 5 min burst, Storm 1		
Post-Dev St.4	0.955	0.706	0.249	5	2	6	5% AEP, 5 min burst, Storm 1		
Post-Dev St.5+6	1.191	0.88	0.311	5	2	6	5% AEP, 5 min burst, Storm 1		

PIPE DETAILS									
Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm				
Pipe STG2 Basin	0.691	2.93	8.612	8.201	5% AEP, 15 min burst, Storm 6				
Pipe STG1 Basin	0.736	2.94	8.563	8.115	5% AEP, 15 min burst, Storm 6				
Pipe STG 4 Basin	0.679	2.92	8.049	7.648	5% AEP, 10 min burst, Storm 6				
Pipe STG 56 Basin	0.751	2.95	8.531	8.069	5% AEP, 15 min burst, Storm 6				

CHANNEL DETAILS									
Name	Max Q (cu.m/s)	Max V (m/s)			Due to Storm				

OVERFLOW ROUTE DETAILS								
Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
OF STG 2	0	0	0.256	0	0	0	0	
OF20073	0.691	0.691	0.256	0.075	0.06	19	0.86	5% AEP, 15 min burst, Storm 6
OSD High Level STG1	0	0	0.256	0	0	0	0	
OF1543	0.736	0.736	0.256	0.077	0.07	19.36	0.88	5% AEP, 15 min burst, Storm 6
OF STG4	0	0	0.256	0	0	0	0	
OF3746	0.679	0.679	0.256	0.074	0.06	18.82	0.87	5% AEP, 10 min burst, Storm 6
OF STG 56	0	0	0.256	0	0	0	0	
OF12448	0.751	0.751	0.256	0.078	0.07	19.54	0.88	5% AEP, 15 min burst, Storm 6

DETENTION BASIN DETAILS									
Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level				
BasinSt 2	8.98	225.1	0.691	0.691	0				
BasinSt.1	8.97	219.5	0.736	0.736	0				
BasinSt.4	8.41	134.9	0.679	0.679	0				
BasinSt.5+6	8.95	234	0.751	0.751	0				

Run Log for Forresters OSD v6 ARR2019 SJB.drn run at 15:00:35 on 26/4/2021 using version 2020.036

The maximum flow in these overflow routes is unsafe: OF20073, OF1543, OF3746, OF12448

DRAINS results prepared from Version 2020.036 - 2% AEP									
PIT / NODE DETAILS				Version 8					
Name	Max HGL	Max Pond	Max Surfac	Max Pond	Min	Overflow	Constraint		
		HGL	Flow Arrivi	Volume	Freeboard	(cu.m/s)			
			(cu.m/s)	(cu.m)	(m)				
N40222	8.22		0.535						
N74	8.14		0.478						
N660	7.68		0.217						
N680	8.09		0.468						
SUB-CATCHMENT DETAILS									
Name	Max	EIA	Remaining	EIA	RIA	PA	Due to Storm		
	Flow Q	Max Q	Max Q	Tc	Tc	Tc			
	(cu.m/s)	(cu.m/s)	(cu.m/s)	(cu.m/s)	(min)	(min)	(min)		
Pre-Dev St.1	1.138	0	1.138	5	2	10.21	2% AEP, 10 min burst, Storm 5		
Pre-dev St.4	0.972	0	0.972	5	2	9.51	2% AEP, 10 min burst, Storm 8		
Pre-dev St.5+6	1.162	0	1.162	5	2	10.35	2% AEP, 10 min burst, Storm 10		
Pre-Dev St.2	1.109	0	1.109	5	2	10.05	2% AEP, 10 min burst, Storm 7		
Post Dev St.2	1.37	1.012	0.358	5	2	6	2% AEP, 5 min burst, Storm 1		
Post-Dev St.1	1.428	1.054	0.373	5	2	6	2% AEP, 5 min burst, Storm 1		
Post-Dev St.4	1.185	0.875	0.31	5	2	6	2% AEP, 5 min burst, Storm 1		
Post-Dev St.5+6	1.478	1.092	0.386	5	2	6	2% AEP, 5 min burst, Storm 1		
PIPE DETAILS									
Name	Max Q	Max V	Max U/S	Max D/S	Due to Storm				
	(cu.m/s)	(m/s)	HGL (m)	HGL (m)					
Pipe STG2 Basin	0.753	2.95	8.684	8.22	2% AEP, 10 min burst, Storm 7				
Pipe STG1 Basin	0.823	2.99	8.669	8.141	2% AEP, 10 min burst, Storm 7				
Pipe STG 4 Basin	0.808	2.98	8.201	7.686	2% AEP, 10 min burst, Storm 7				
Pipe STG 56 Basin	0.844	3	8.646	8.097	2% AEP, 10 min burst, Storm 7				
CHANNEL DETAILS									
Name	Max Q	Max V			Due to Storm				
	(cu.m/s)	(m/s)							
OVERFLOW ROUTE DETAILS									
Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm	
OF STG 2	0.263	0.263	0.256	0.051	0.03	14.15	0.66	2% AEP, 10 min burst, Storm 7	
OF20073	1.016	1.016	0.256	0.088	0.08	21.51	0.96	2% AEP, 10 min burst, Storm 7	
OSD High Level STG1	0.209	0.209	0.256	0.046	0.03	13.25	0.62	2% AEP, 10 min burst, Storm 7	
OF1543	1.03	1.03	0.256	0.088	0.08	21.69	0.96	2% AEP, 10 min burst, Storm 7	
OF STG4	0	0	0.256	0	0	0	0		
OF3746	0.808	0.808	0.256	0.079	0.07	19.9	0.91	2% AEP, 10 min burst, Storm 7	
OF STG 56	0.192	0.192	0.256	0.044	0.03	12.89	0.61	2% AEP, 10 min burst, Storm 7	
OF12448	1.033	1.033	0.256	0.088	0.08	21.69	0.96	2% AEP, 10 min burst, Storm 7	
DETENTION BASIN DETAILS									
Name	Max WL	MaxVol	Max Q	Max Q	Max Q				
			Total	Low Level	High Level				
BasinSt 2	9.1	258.2	1.016	0.753	0.263				
BasinSt.1	9.15	262.2	1.032	0.823	0.209				
BasinSt.4	8.67	177.6	0.808	0.808	0				
BasinSt.5+6	9.14	281.5	1.036	0.844	0.192				
Run Log for Forresters OSD v6 ARR2019 SJB.drn run at 14:59:11 on 26/4/2021 using version 2020.036									
The maximum flow in these overflow routes is unsafe: OF STG 2, OF20073, OF1543, OF3746, OF12448									

DRAINS results prepared from Version 2020.036 - 1% AEP

PIT / NODE DETAILS				Version 8					
Name	Max HGL	Max Pond HGL	Max Surfac Flow Arrivi (cu.m/s)	Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint		
N40222	8.22		0.847						
N74	8.15		0.825						
N660	7.7		0.523						
N680	8.11		0.843						

SUB-CATCHMENT DETAILS									
Name	Max Flow Q (cu.m/s)	EIA Max Q (cu.m/s)	Remaining Max Q (cu.m/s)	EIA Tc (cu.m/s)	RIA Tc (min)	PA Tc (min)	Due to Storm (min)		
Pre-Dev St.1	1.325	0	1.325	5	2	10.21	1% AEP, 10 min burst, Storm 6		
Pre-dev St.4	1.133	0	1.133	5	2	9.51	1% AEP, 10 min burst, Storm 8		
Pre-dev St.5+6	1.354	0	1.354	5	2	10.35	1% AEP, 10 min burst, Storm 8		
Pre-Dev St.2	1.292	0	1.292	5	2	10.05	1% AEP, 10 min burst, Storm 6		
Post Dev St.2	1.589	1.173	0.416	5	2	6	1% AEP, 5 min burst, Storm 1		
Post-Dev St.1	1.656	1.223	0.433	5	2	6	1% AEP, 5 min burst, Storm 1		
Post-Dev St.4	1.375	1.015	0.36	5	2	6	1% AEP, 5 min burst, Storm 1		
Post-Dev St.5+6	1.715	1.266	0.449	5	2	6	1% AEP, 5 min burst, Storm 1		

PIPE DETAILS									
Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm				
Pipe STG2 Basin	0.779	2.96	8.716	8.228	1% AEP, 10 min burst, Storm 7				
Pipe STG1 Basin	0.855	3.01	8.71	8.15	1% AEP, 10 min burst, Storm 7				
Pipe STG 4 Basin	0.863	3.01	8.272	7.703	1% AEP, 10 min burst, Storm 7				
Pipe STG 56 Basin	0.878	3.02	8.692	8.107	1% AEP, 10 min burst, Storm 7				

CHANNEL DETAILS									
Name	Max Q (cu.m/s)	Max V (m/s)			Due to Storm				

OVERFLOW ROUTE DETAILS								
Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
OF STG 2	0.494	0.494	7.665	0.065	0.05	17.02	0.79	1% AEP, 10 min burst, Storm 7
OF20073	1.273	1.273	7.665	0.097	0.1	23.31	1.01	1% AEP, 10 min burst, Storm 7
OSD High Level STG1	0.467	0.467	7.665	0.063	0.05	16.66	0.79	1% AEP, 10 min burst, Storm 7
OF1543	1.319	1.319	7.665	0.097	0.1	23.49	1.03	1% AEP, 10 min burst, Storm 7
OF STG4	0.234	0.234	7.665	0.048	0.03	13.61	0.64	1% AEP, 10 min burst, Storm 7
OF3746	1.094	1.094	7.665	0.09	0.09	22.05	0.98	1% AEP, 10 min burst, Storm 7
OF STG 56	0.475	0.475	7.665	0.064	0.05	16.84	0.78	1% AEP, 10 min burst, Storm 7
OF12448	1.351	1.351	7.665	0.098	0.1	23.67	1.04	1% AEP, 10 min burst, Storm 7

DETENTION BASIN DETAILS									
Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level				
BasinSt 2	9.16	272.8	1.273	0.779	0.494				
BasinSt.1	9.21	278.6	1.322	0.855	0.467				
BasinSt.4	8.78	197.3	1.097	0.863	0.234				
BasinSt.5+6	9.22	300.1	1.354	0.878	0.475				

Run Log for Forresters OSD v6 ARR2019 SJB.drn run at 14:57:14 on 26/4/2021 using version 2020.036

The maximum water level in these storages exceeds the maximum elevation you specified: BasinSt.5+6, BasinSt.1, BasinSt 2.

DRAINS has extrapolated the Elevation vs Storage table to a higher Elevation. Please provide accurate values for higher elevations.

Flows were safe in all overflow routes.