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EDUCATION

RETHUSHENG SPECIAL NEEDS SCHOOL

PRELIMINARY STORMWATER MANAGEMENT PLAN

PREPARED FOR:

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MUTEO CONSULTING

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TITLE		***RETHUSHENG SPECIAL NEEDS SCHOOL : PRELIMINARY STORMWATER MANAGEMENT PLAN***
Client	:	*LIMPOPO DEPARTMENT OF PUBLIC WORKS, ROADS AND INFRASTRUCTURE*
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For NNB Engineering Consultants:

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Project Manager: ______ ______ ______

Date

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Date

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1. INTRODUCTION

Muteo Consulting cc has been appointed by the Department of Public Works to provide professional civil and structural engineering services for the construction of Rethusheng Special School.

The scope of services includes the following project stages:

- Scoping
- Preliminary Design
- Detailed Design
- Tender Documentation
- Construction Supervision
- Project Closure

Subsequently NNB Engineering Consultants were appointed by Muteo Consulting to conduct a stormwater management plan for the proposed school and to assess the flood risks of the site which will inform the project as well.

1.1 Scope

The purpose of this report is to present stormwater management strategies for flood control measures, managing stormwater within the proposed development, and reduction in post development runoff flows to ensure appropriate stormwater disposal.

2. SITE DETAILS

2.1 Locality and Land use

The proposed site for the construction of Rethusheng Special School is situated in Mamehlabe Village, along Juno Road, within the Capricorn District Municipality, Limpopo Province. The general geographical coordinates of the site are 23°33′21″S, 28°57′24″E. Figure 2-1 provide a general locality map for the proposed school.

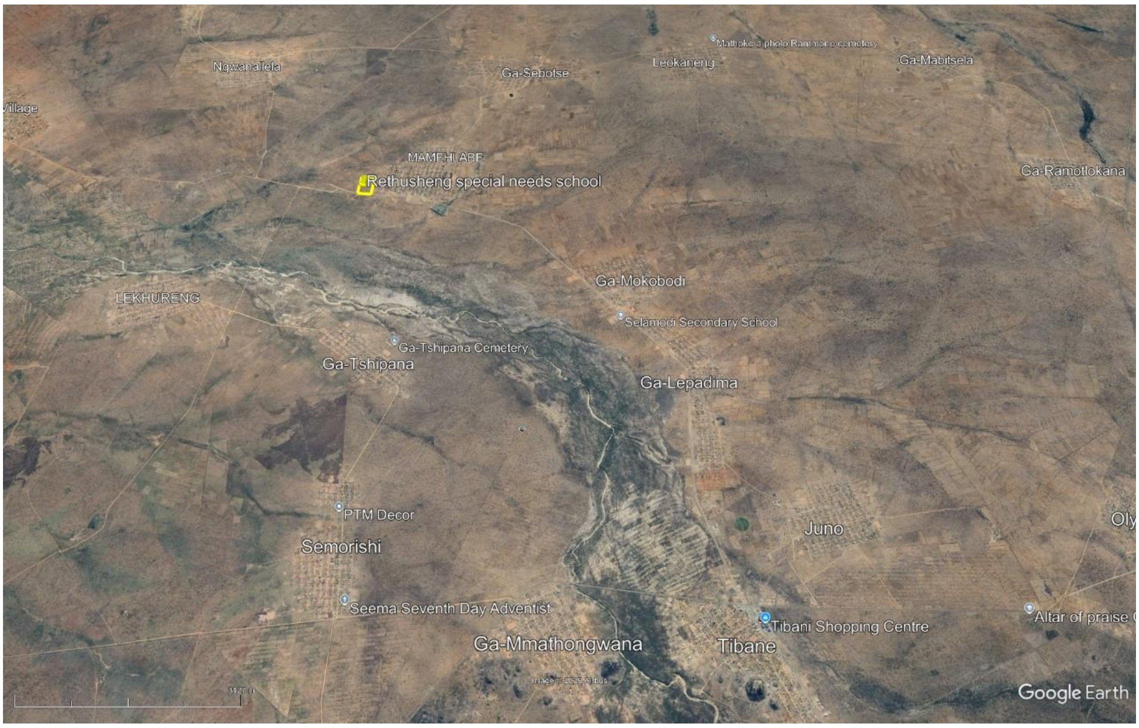


Figure 2-1 – Locality (Google Earth)

The proposed site boundary that is envisaged to be acquired for the school is depicted in Figure 2-2 and has an area of approximately 886150m^2 (88.61Ha)

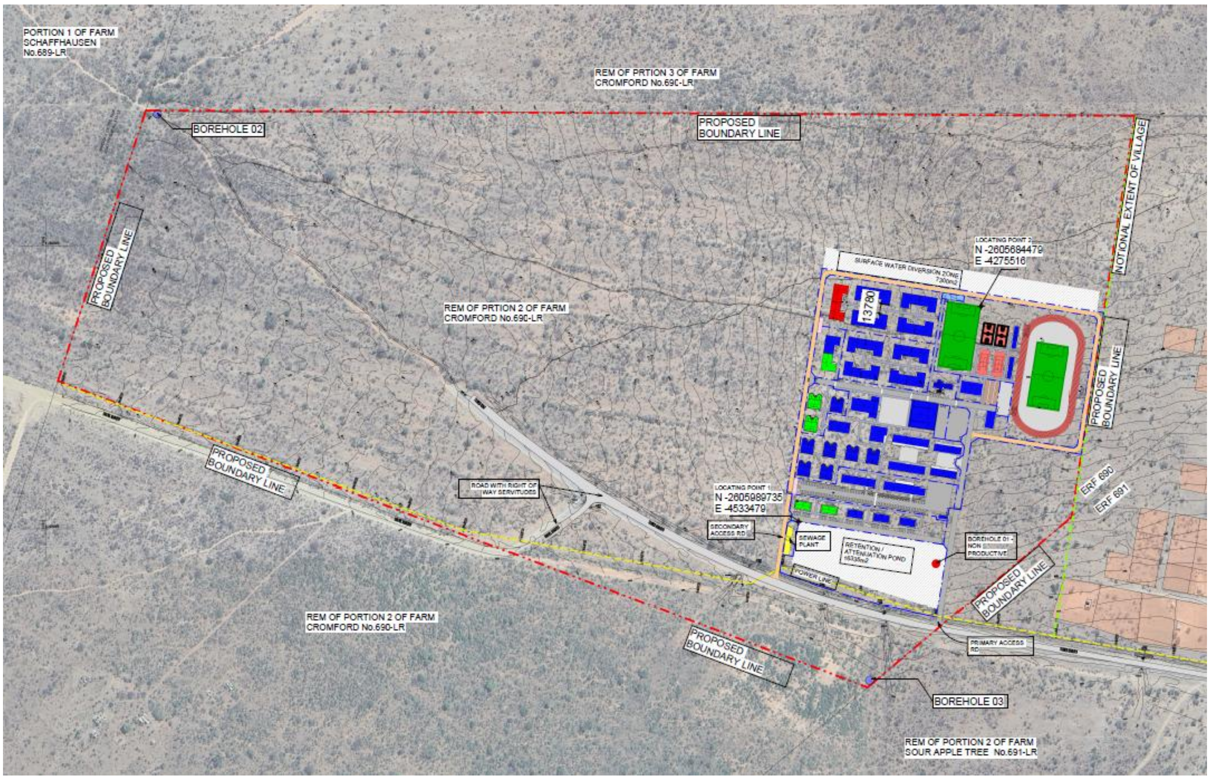


Figure 2-2 - Proposed site boundary (Drawing produced by IDC Architects, 2025)

The proposed site development plan of the school is depicted in Figure 2-3 and has a catchment area of approximately 167000m^2 (16.70Ha). It should be noted that this stormwater management plan will be based on the proposed site development plan area (16.70Ha) and not the proposed site boundary area (88.61Ha). This stormwater management plan must be updated when details of future surround developments are proposed.

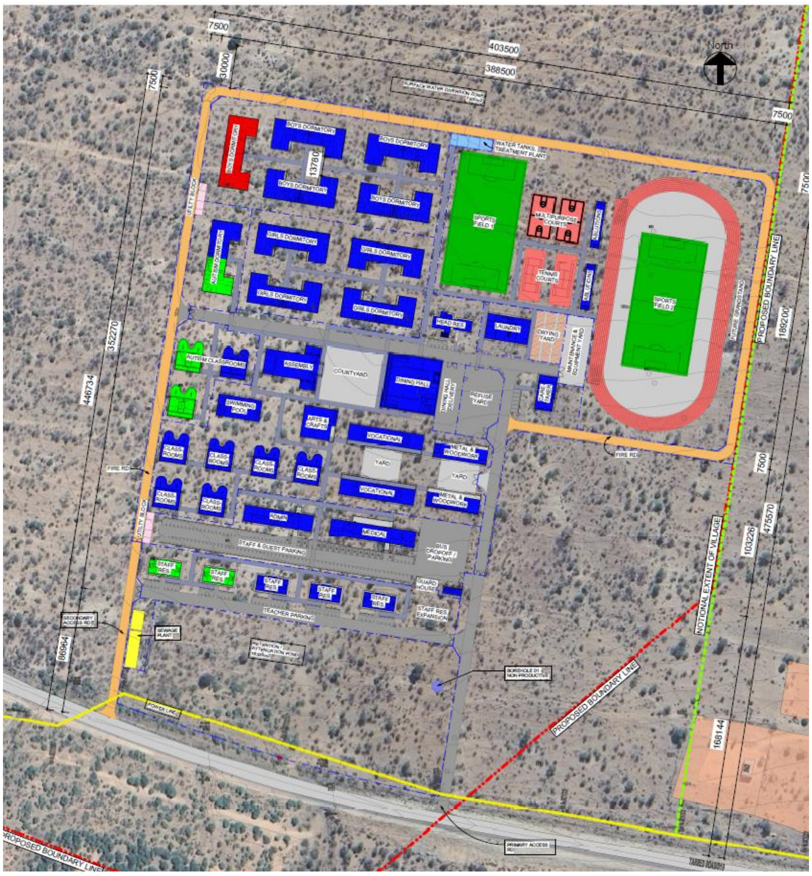


Figure 2-3 - Site development plan (Drawing produced by IDC Architects, 2025)

Proposed development land use and general site use are provided in Table 2-1 below:

Land use	General site use description
Educational	• Pupil residence • Common area facilities • Teaching facilities • Admin facilities • Staff residence • Sports facilities • Roads and parking facilities • Ablutions facilities

Table 2-1 - Land use and general site use description

For further details on the proposed site boundary and site development details, please refer to the drawings produced by IDC Architects, Hybrid Option 3.

2.2 Topography

A detailed topographical survey was conducted by Thothome Geomatics cc which captured the ground levels, existing infrastructure and natural features for the site. The natural ground is noted to slope at 0%-4% on average from the northeast to the southwest direction. Figure 2-4, provides a general slope map and fall direction of the site.

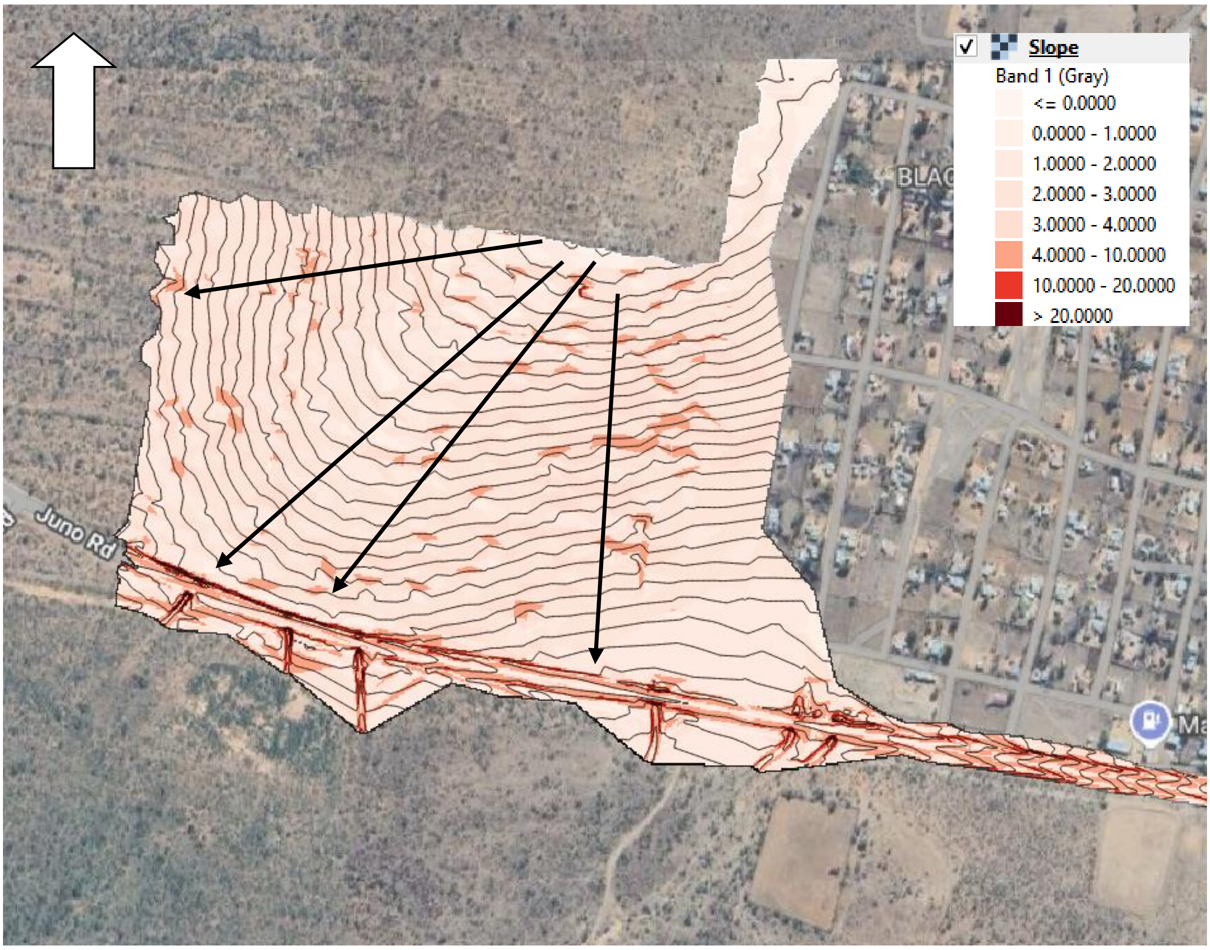


Figure 2-4 - General slope map and fall direction of site

As depicted in Figure 2-5, there are non-perennial rivers and tributaries that surround the proposed site boundary. The flooding impact of these rivers and tributaries are to be concluded with a floodline risk assessment.

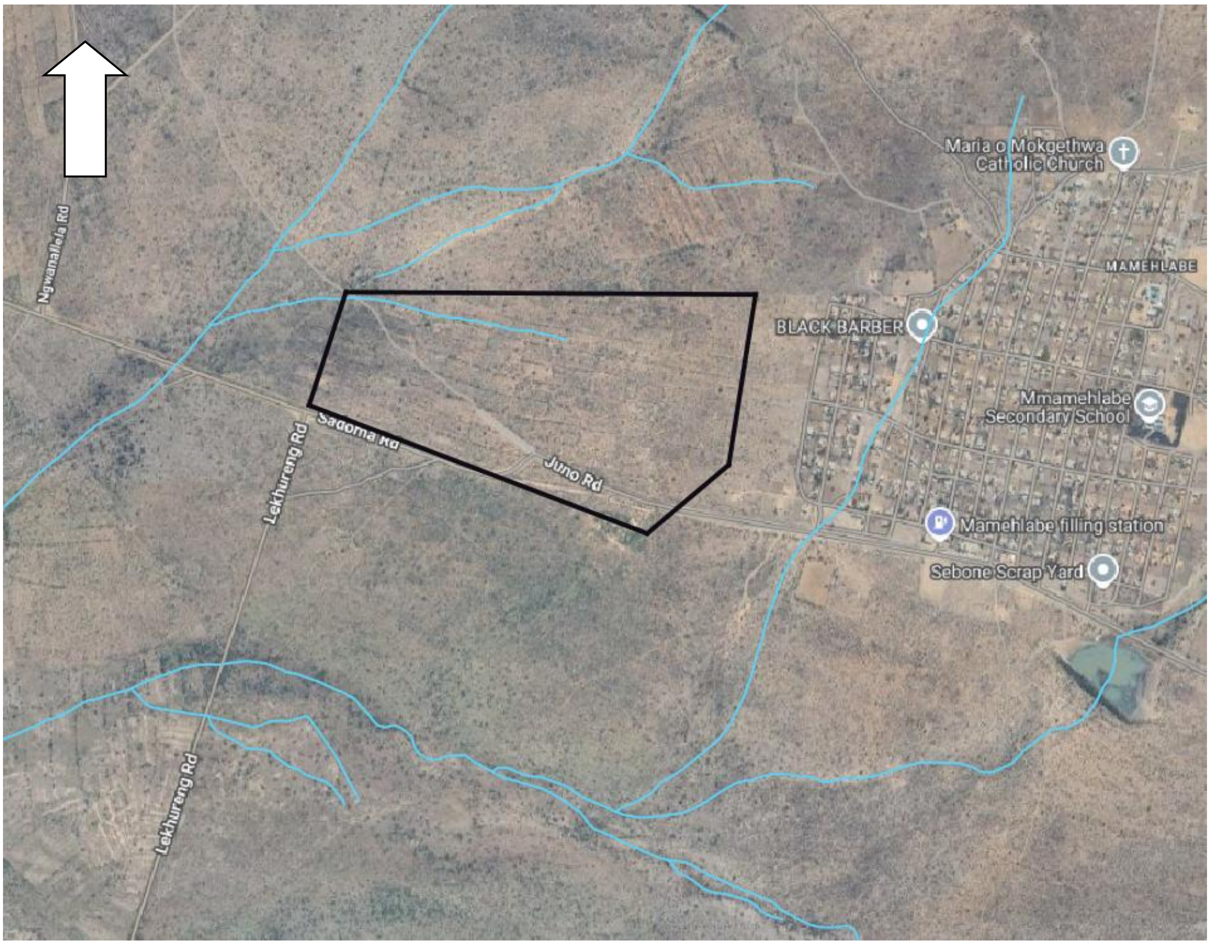


Figure 2-5 – Locality of proposed site boundary and surround rivers and tributaries.

2.3 Geology

Geological information for the site will become available upon the completion of specialist investigations and studies.

3. EXISTING STORMWATER MANAGEMENT

The site is currently undeveloped and predominately in a natural state with some gravel/ unpaved paths noted at the higher lying portions. A public road (Juno Road) is located adjacent to the site in the lower lying portions. This road consists of numerous stormwater pipe culvert crossings that serve the side drains of the road. 3no of 900mm pipe culvert crossings are noted to service the road in the vicinity of the site development area.

4. STANDARDS AND GUIDELINES.

The following standards and guidelines are applicable to this stormwater management plan and are not limited to :

- Guidelines for Human Settlement Planning and Design (Previous version).
- Department of Human Settlements' Neighbourhood Planning and Design Guide (2019).
- A best practice guideline for design flood estimation in municipal areas in South Africa (2023)
- PW347 Department of Public Works Specification: Civil Engineering Manual (2012).
- SANS (various) South African Bureau of Standards: National Standards

Furthermore, discussions with the Technical Department of Blouberg Local Municipality (BLM) concluded that BLM has not officially published stormwater bylaws for public adoption. In the absence of municipal specific guidelines, BLM adopts the Department of Human Settlements' Neighbourhood Planning and Design Guide, commonly referred to as the Red Book.

5. HYDROLOGICAL ANALYSIS

5.1 Area of Catchments

This section should be read in conjunction with drawing NNB-RETHU-25-SWMP-001 for further details on the catchment areas.

The catchment areas were determined by the site development plan and detailed topographical survey.

Given the location of the proposed site development, an external catchment is noted to impact the development with potential runoff from the higher lying area. The catchment areas specific to the site development will include the site development plan areas and form sub catchments internal to the site all of which is routed to the proposed attenuation pond.

5.1.1 External Catchment

Figure 5-1 below provides the delineated catchment boundary that contributes to runoff which flows into the site development posing a risk of flooding. This catchment was delineated with the use of a detailed topographical survey .

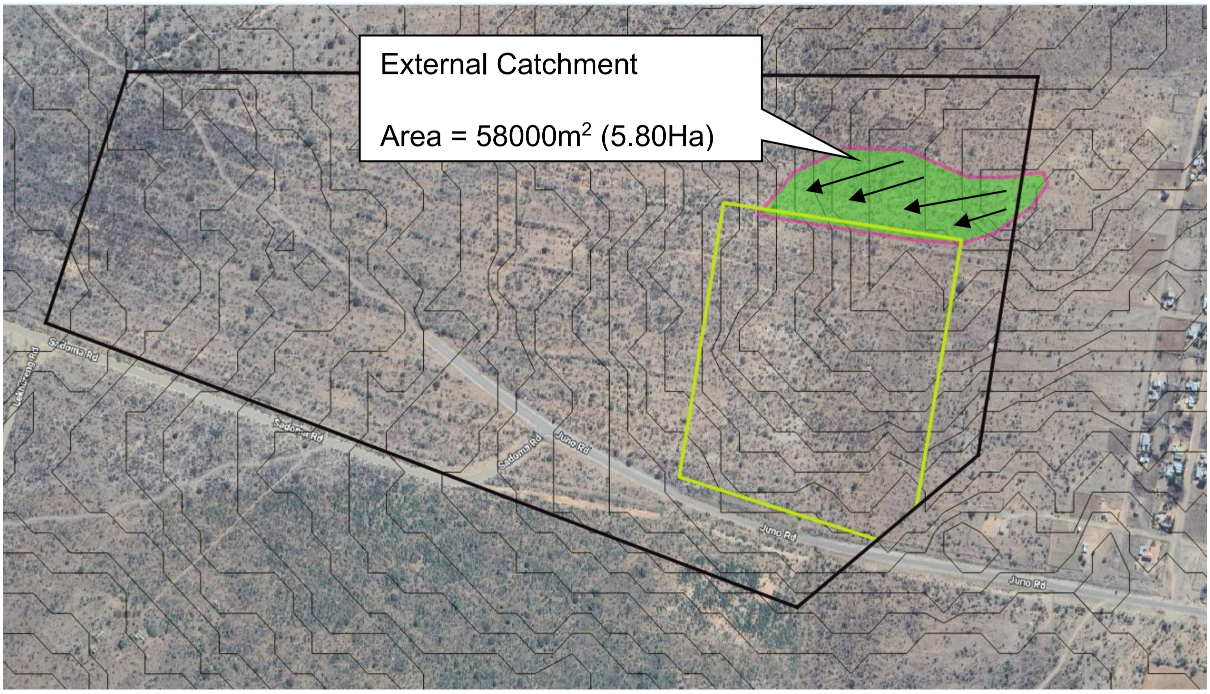


Figure 5-1 - External Catchment Boundary

The total area of the external catchment is approximately 58000m^2 in area and comprises the following runoff generating land uses

DESCRIPTION	AREA (m^2)	PERCENTAGE
Grassed	58000	0%
Total	**58000**	**100%**

Table 5-1 – External Catchment Area Land use.

5.1.2 Internal Site Development Catchment

As discussed in section 2.1, the development site plan area equates to approximately 167000m^2 (16.70Ha) and comprises the following estimated land uses contributing to runoff.

DESCRIPTION	AREA (m^2)	PERCENTAGE
Roofs	25150	15.06%
Driveways and parking	43800	26.23%
Sports field	8850	5.30%
* Aprons, channels and other	10000	5.99%
Green areas and Land Scaping	79200	47.43%
Total	**167000**	**100.00%**

Table 5-2 – External Catchment Area Land use.

*Assumptions were made for apron, channels and other hard areas possibly required for the proposed school. It should be noted that this stormwater management will be required to be updated should the hardened areas increase from the table above. In summary approximately 47% of the catchment area is hardened and 53% of the catchment area is soft (green/landscaped/natural).

5.2 Time of Concentration `Tc`

The estimated times of concentration for the pre-development and post-development scenarios are Tabulated below for the identified catchments.

5.2.1 External Catchment Tc

Description	Tc (min)
Pre-development	32.1
Post-development	NA

Table 5-3 – External catchment Time of Concentration

5.2.2 Internal Site Development Catchment Tc

Description	Tc (min)
Pre-development	42.12
Post-development	10

Table 5-4 – Site development Time of Concentration

5.3 Run-off Coefficient `C`

The pre-development and post-development run-off coefficients have been calculated using the Prescribed DWA method. Results are tabulated below (refer to Annexure A for detailed Calculation sheets.

5.3.1 External Catchment `C`

Description	C
Pre-development	0.281
Post-development	NA

Table 5-5 – External catchment Runoff Coefficients

5.3.2 Internal Site Development Catchment `C`

Description	C
Pre-development	0.281
Post-development	0.537

Table 5-6 – Site development catchment Runoff Coefficients

5.4 Rainfall Data

Point rainfall data were obtained from the "Design Rainfall and Flood Estimation in South Africa" by Prof Jeff Smithers and RE Schulz from The University of Natal (Pietermaritzburg). (The RLMA&SI method). This software enables the extraction of point rainfall at user defined intervals for site specific locations and is the recommended approach for design rainfall estimation in South Africa. (A best practice guideline for design flood estimation in municipal areas in South Africa.)

Average point rainfall data have been extracted over 1min grid and thereafter converted to rainfall intensity.

As discussed in the latter section 6. the impact of climate change on rainfall within the Blouberg Local Municipal is noted to increase annual rainfall by the year 2050. Therefore, as recommended by the best practice guidelines for design flood estimation in municipal areas in South Africa, the upper 90% rainfall values were considered.

The below Table 5-7 provides the estimated point rainfall for the various durations adopted for this study. An average mean annual precipitation of 449mm was extracted for this study area.

Duration	2 Year	5 Year	10 Year	20 Year	50 Year	100 Year
5min	9.6	13.1	15.692	18.328	22.128	25.228
10min	14.624	19.92	23.82	27.848	33.624	38.328
15min	18.692	25.432	30.416	35.588	42.94	48.956
30min	25.676	34.98	41.808	48.916	59.036	67.312
45min	30.928	42.124	50.364	58.928	71.128	81.072
1Hr	35.304	48.072	57.488	67.24	81.164	92.512

Table 5-7 - Point rainfall data for the various storm durations

5.4.1 External catchment rainfall Intensity

PRE-DEVELOPMENT (Tc = 32.10min)		
Storm Recurrence Interval	**Rainfall Depth (mm)**	**Intensity (mm/hr)**
5 year	35.98	67.3
50 year	60.73	113.5
100 year	69.24	129.4

Table 5-8 - External Catchment Pre-development Point Rainfall and Intensity

5.4.2 Internal Site Development Catchment rainfall intensity

PRE-DEVELOPMENT (Tc = 42.13min)		
Storm Recurrence Interval	**Rainfall Depth (mm)**	**Intensity (mm/hr)**
5 year	40.76	58.05
50 year	68.81	98.00
100 year	78.43	111.71

Table 5-9 - External Catchment Pre-development Point Rainfall and Intensity

POST-DEVELOPMENT (Tc = 10min)		
Storm Recurrence Interval	**Rainfall Depth (mm)**	**Intensity (mm/hr)**
5 year	19.92	119.52
50 year	33.62	201.74
100 year	38.33	229.97

Table 5-10 – Post-development Point Rainfall and Intensity

5.5 Discharge `Q`

Discharge has been calculated using the rational method. Results are tabulated below (refer to Annexure B for detailed calculation sheets).

5.5.1 External catchment peak flows

Storm Recurrence Interval	Pre-development (m^3/s)	Post-development (m^3/s)
50 year	0.4266	NA
100 year	0.5859	NA

Table 5-11 – External Catchment Peak Flows Internal

5.5.2 Internal Site Development Catchment

Storm Recurrence Interval	Pre-development (m^3/s)	Post-development (m^3/s)
5 year	0.75670	2.97513
50 year	1.27745	5.02187
100 year	1.45612	5.72443

Table 5-12 – Internal Site Development Peak Flows

6. CLIMATE CHANGE

Studies have shown that climate change is leading to more frequent and intense extreme rainfall events in South Africa. However, currently there are no definitive updated design rainfall figures which account for climate change. This means that current design rainfall estimates should, to some degree, account for these increased intensities.

The GreenBook (an online planning support tool) was utilised to inform the selection of design rainfall data for the purposes of climate change considerations in this stormwater management plan. The Blouberg Municipality in Limpopo was selected to extract related climate change data projected for the year 2050.

6.1 About the GreenBook

"The GreenBook is an online planning support tool that provides quantitative scientific evidence on the likely impacts that climate change and urbanisation will have on South Africa's cities and towns, as well as presenting a number of adaptation actions that can be implemented by local government to support climate resilient development. The GreenBook was co-funded by the CSIR and the International Development Research Centre (IDRC), over the past three years, between 2016 and 2019. The CSIR has partnered with the National Disaster Management Centre (NDMC) and co-developed this product with universities, government departments, NGOs and other peer groups". Further details about the GreenBook can be found at https://greenbook.co.za/index.html

6.2 Climate Change Impacts

As depicted in Figure 6-1, Blouberg Local Municipality average rainfall is expected to experience increases of 56mm. Furthermore, as depicted in Figure 6-2, the extreme rainfall days are expected to increase by +-1.

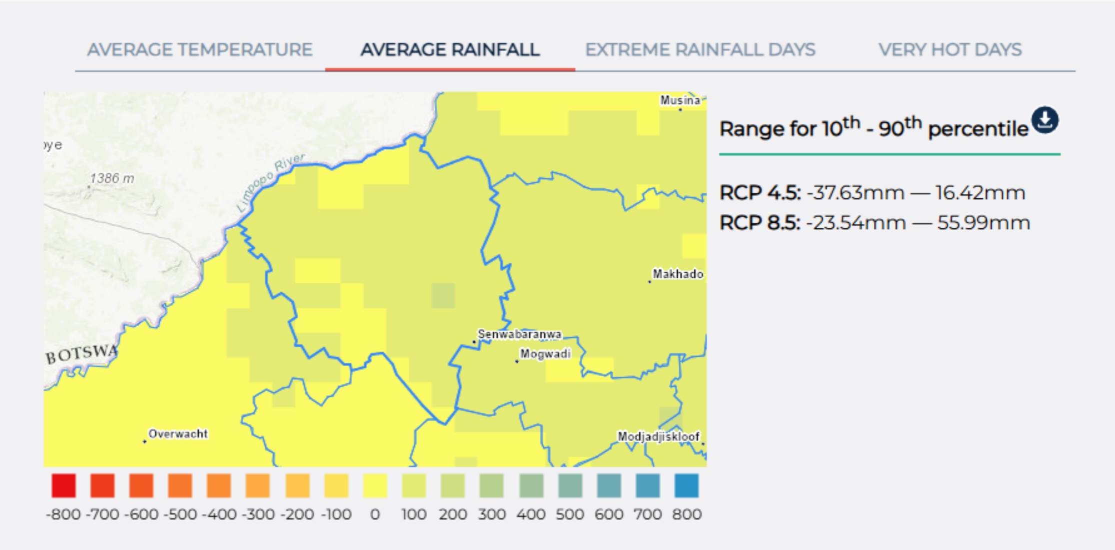


Figure 6-1 – GreenBook – Climate impact on Average rainfall in Blouberg Local Municipality.

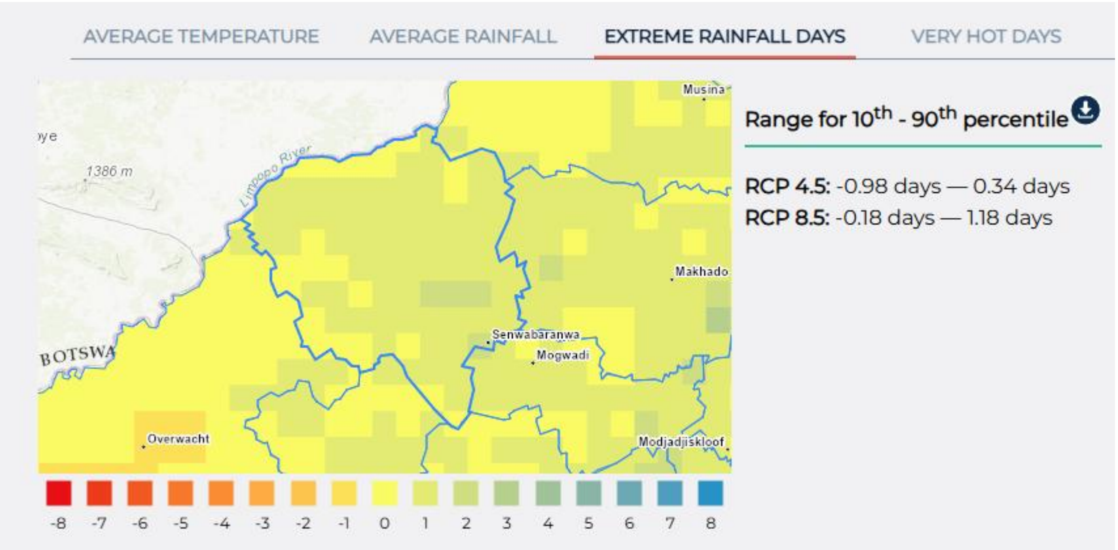


Figure 6-2 - GreenBook – Climate impact on Extreme rainfall days in Blouberg Local Municipality.

6.3 Climate Change Considerations

Based on the findings above, it is evident that Blouberg Local Municipality is expected to be impacted by climate change. Therefore, to account for climate change in the hydrological analysis of this stormwater management plan, the upper 90% design rainfall data was adopted as recommended by "A best practice guideline for design flood estimation in municipal areas in South Africa, July 2023."

The option of selecting higher design floods for minor systems is deemed a good consideration to account for the impact of climate change. For example, the minor stormwater system should consider a 10-year design flood rather than the 5-year.

However, such considerations are costly, and a cost benefit analysis should be conducted to assess its merit.

7. HYDRAULIC ANALYSIS

This section should be read in conjunction with drawing NNB-RETHU-25-SWMP-001 & 002 for further details on the proposed stormwater management systems.

7.1 Design Criteria

The "Neighbourhood Planning and Design Guide" (2019), known as the Red Book, was utilised to determine the required designs standards for the proposed minor stormwater systems. A 5 year design flood was adopted for minor stormwater systems.

Table L.4: Flood frequencies for minor system planning	
Land use	**Design flood recurrence interval**
Residential	1 - 5 years or more in informal areas to ensure sufficient space to convey runoff
Institutional (e.g. schools)	2 - 5 years
General commercial and industrial	5 years
High-value central business district	5 - 10 years

Table 7-1 - Minor System design floods

For major stormwater systems the 50 years to 100-year design flood was adopted with flow control to predevelopment conditions.

Furthermore, the Department of Public Works Specification: Civil Engineering Manual, recommends that for institutional land uses a 1 in 50-year design flood should be adopted.

7.2 Proposed Stormwater Systems and Design Considerations

The stormwater management plan differentiates between minor and major storm events to effectively manage on-site stormwater runoff. The proposed design incorporates the following methods:

Stormwater Management Methods

- Sheet Flow: Allowing stormwater to flow undisturbed across land.
- Pipe Flow: Conveying stormwater through an underground pipe system.
- Road Flow: Utilising the road network to convey stormwater runoff.
- Channel Flow: Directing stormwater runoff through open channels.
- Catchwater channel and berm: To divert external catchment flow passed the proposed development.
- Attenuation: Collecting stormwater in a detention pond for reuse or controlled release.

These methods will be used to manage stormwater runoff for both minor and major storm events, ensuring effective flood control and minimizing environmental impacts. The proposed methods indicated on drawing NNB-RETHU-25-SWMP-002 are subject to change during the design stages of the project.

7.2.1 Underground Pipes System:

A network of underground stormwater pipes, ranging from 300mm diameter to 900mm diameter., was preliminary sized using the Mannings formula for pipe flow and is proposed to accommodate the minor system for the 1:5-year flood. Refer to drawing NNB-RETHU-25-SWMP-002.

The stormwater pipe system should be designed with the following specifications:

- All pipes concrete pipes to be spigot and socket type, as per relevant SABS specifications.
- The minimum pipe diameter is 300mm.
- Maximum velocity in the pipelines to be set at 3.5m/s.
- Minimum velocity in the pipelines to be set at 0.9m/s to prevent siltation.
- Minimum gradient of the pipeline to be set at 1%.
- Depth of manholes and junctions must provide the opportunity for tie-in of adjacent building stormwater reticulation.

Short lengths major underground pipe system is proposed to convey the runoff from the large open channels low points to the attenuation pond.

7.2.2 Road System:

Generated stormwater run-off during major events will be collected using the road network and managed via kerb and channel flow along the road surface. Outlet chutes system are proposed to convey the stormwater from the road network to the side open channels, down to the attenuation pond where the stormwater will be temporality stored and released to predevelopment flow conditions. Refer to drawing NNB-RETHU-25-SWMP-002.

The road network should be designed with the following specifications:

- Maximum sheet flow velocity is not more than 3m/s.
- Minimum gradient set at 0.5% to eliminate ponding on road surfaces.
- crossfall range 2-4%.
- The road finished levels should be designed such that adjacent buildings and development have the opportunity to direct overland flow towards the roads as opposed to being flooded by the road.
- Side Chutes to be provided at frequent intervals so runoff does not overtop the kerb line of the road.

7.2.3 Open Channel Systems

Open channel systems are proposed to collect stormwater runoff in major stormwater events (50-year and 100-year) when the minor pipe systems cannot cope. These systems must channel the stormwater runoff downslope to a point for discharge into the attenuation pond for temporary storage. Robust inlet chambers are to be provided to receive runoff from major events.

Two large trapezoidal open channels are proposed along the secondary access road and southeast boundary of the site. Refer to drawing NNB-RETHU-25-SWMP-002.

Open channel systems should be designed with the following specifications:

- Earth lined channel maximum permissible velocity depends on the characteristics of the subgrade soil and the type of grass and grass length. Generally, less than 1m/s.
- Lined channels to be provided where velocity and erosion potential are high.
- Side slopes should be flatter than 1:3 V:H (18 degrees) for stability and maintenance.

The below Figure 7-1 provides an example of a typical stormwater channel and grass-lined swale.

Figure 7-1 - Example of a stormwater channel (L) and grass-lined swale (R) (Department of Human Settlements' Neighbourhood Planning and Design Guide)

7.2.4 Shaped earth overland flow paths.

Earth overland flow paths are proposed to direct stormwater to the adjacent roads in instances of return periods greater than 1:5year up to the 1:50year. Refer to drawing NNB-RETHU-25-SWMP-002.

The design and final alignment of the earth overland flow path should be considered during the design of the site earthworks, such that platforms and landings are sloped to fall strategically to adjacent road and parking infrastructure. Thereafter the roads should act as the conveyance system to the open channels. The design of low flow velocity must be considered to permit grass lining of overland flow paths.

The overland flow paths should not be obstructed and be designed to convey the 50-year design flow without causing significant damage. Pipe culverts should be provided in instances where overland flow paths intersect with walkways such that flow is not obstructed.

7.2.5 Attenuation Pond:

A dry attenuation pond system is proposed to store the difference between the pre-development and post- development stormwater run-off volumes. Refer to drawing NNB-RETHU-25-SWMP-002.

The final pond sizes will be designed to accommodate the 50-year and 100 year design storm with an overflow system to allow discharge into the existing roadside drainage system. The outlet of the attenuation pond will be sized accordingly to discharge runoff at predevelopment flow for the respective return periods until the pond is completely emptied. The attenuation pond will be designed with the following specifications:

- Pond base and embankments to be grassed with maximum side slopes of 1:3.
- Should infiltration pose challenges due to soil conditions, the pond should be lined with an impermeable liner.
- Maximum depth of attenuation pond prior to overflowing, to be such that the 100-year volume is achieved.
- The overflow system will be designed to handle the 1:50-year post development flood difference.

7.2.6 Erosion control and energy dissipation.

Erosion control and energy dissipation measures such as headwalls and gabion mattresses are proposed at outlets of all stormwater conveyance systems. This is to ensure a controlled discharge of stormwater runoff to mitigate negative impact to the receiving environment. Grouted and plain stone pitching are alternatives which can be explored during the design stages.

7.3 Attenuation Pond Sizing.

7.3.1 Synthetic Design Storm

The attenuation storage required can be assessed by plotting the peak runoff values Q calculated for the pre and post scenarios versus the Time/s of concentration (Tc) for each scenario. For this relatively large catchment runoff is assumed to be zero at both Time = zero and at 2.5 x Tc minutes. The peak of the storm is assumed to be at time Tc

Refer to Annexure B for details of the design storms.

7.3.2 Storage Volume of Attenuation Pond.

It should be noted that stormwater will be attenuated on the surface with an attenuation pond situated at the lower lying area of the site, thereafter, discharged via appropriately sized orifices. The volume of storage was by computing the area of the 1 in 50-year recurrence interval post development hydrograph which lies above the 1 in 50-year recurrence interval predevelopment hydrograph. Similarly, for the 100-year recurrence interval.

Storm events greater than the 1 in 100-year recurrence will be catered flow by an emergency overflow weir to discharge to adjacent Juno Road drainage system.

I. Site development catchment area.

The 1 in 5-year return period volume was computed as **1950m^3.**

The 1 in 50-year return period volume was computed as **3250m^3.**

The 1 in 100-year return period storage volume was computed as **3700m^3.**

It is proposed that a volume of **approximately 3825m^3** is provided with pond dimensions of **85m long by 30m wide by 1.50m deep. A minimum 300mm Freeboard depth should be provided.**

The pond plan size and depth to be confirmed during the design stages for the project.

II. Orifice calculations

The orifice calculation was adopted to estimate the required diameter of the pond outlet pipe to achieve an outlet peak flow less than or equal to the pre-development flows for the respective return periods. The 50 year and 100yr return period outflow is managed by orifices.

Return Period	Permissible flow (Pre-development) (m^3/s)	Orifice Area (m^2)	Flood water Depth (m)
50 year	1.27745	0.385 (+-700 mm dia.)	1.170
100 year	1.45612	0.385 (+-700 mm dia.)	1.350

Table 7-2- Pond orifice sizing

Storm Recurrence Interval	Inflow (m^3/s)	Outflow (Permissible) (m^3/s)	Outflow (Actual)(m^3/s)
50 year	5.02187	1.27745	1.0535
100 year	5.72443	1.45612	1.1212

Table 7-3 – Attenuation Pond flood routing results

It is proposed that the ultimate disposal of stormwater will be catered for via a 750mm pipe culvert that crosses Juno Road with discharging towards the lower lying watercourse. This will ensure an independent stormwater disposal system with no reliance on the existing 900mm culvert crossings.

7.4 External Catchment Stormwater Diversion Catchwater channel and berm.

An external catchment is noted to contribute overland runoff towards the site, posing a risk to flooding. A catchwater channel and berm is proposed at the high lying site development boundary line to divert external stormwater runoff away from the site for the 100 year design storm. The discharge point of the catchment channel must be provided with appropriate erosion control measures to ensure controlled discharge. The design specification of the catchwater channel and berm are similar to that of open channel systems.

A benefit of this system is that the excavated material from the channel could be used for the construction of the adjacent berm. Furthermore, the hydraulic capacity of the channel is increased with the berm acting and a barrier for increased flow depth during major events.

It should be noted that any post development within the external catchment must ensure that runoff is attenuated and released as predevelopment flow towards the proposed catchwater channel and berm. A separate stormwater management plan will need to be developed for this area to not negatively impact neighboring properties and lower lying development.

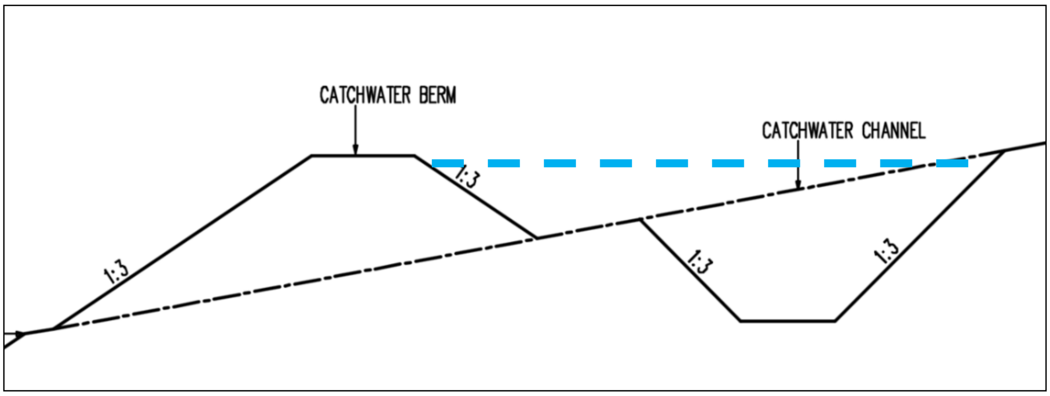


Table 7-4 - Typical Section of a catchwater channel and berm (typically earth lined)

7.5 Rainwater Harvesting

Considering all roof areas of the site (Approx. 25150m^2), the below provides a high-level estimate of the amount of roof runoff that could possibly be harvested.

Roof Area	25150	m^2
Coefficient	0.9	
Average Annual Rainfall	449	mm
Average Annual Harvest	10163115	Litres

Rainwater harvest tanks are recommended in applicable areas where space permits. However, due to the low annual rainfall of the area this may provide little benefit when compared to the space requirements for such infrastructure.

Furthermore, the use of rainwater is limited, and appropriate treatment is required for human consumption. Should a shortfall of water resources exist in the catchment, e.g. from bore holes and dams, the option of supplementing water recourse from rainwater harvesting will be beneficial.

8. SUMMARY OF RECOMMENDATIONS

a. The proposed site boundary (88.03Ha) is noted to be much larger than the currently proposed site development area (16.70Ha). The stormwater management plan only considers the site development area and the undeveloped external catchment that impacts on the site development area.

b. This stormwater management plan must be updated when further details of the site and surrounding developments are proposed.

c. The impact of surrounding rivers and tributaries must be concluded with a floodline assessment using accurate survey terrain data. Upon which, recommendations from the floodline assessment will be considered in this report.

d. 3no. of existing 900mm pipe culverts are noted to service the adjacent Juno Road. An independent stormwater outlet for the site is proposed and therefore not reliant on the existing 900mm pipe culverts.

e. The stormwater management system has been proposed in accordance with Red Book and applicable guidelines.

f. Minor and major stormwater systems must cater for the 5-year and 50-year design flood, respectively.

g. Climate change impacts for the Blouberg Local Municipality were extracted from the GreenBook. These impacts were considered by selecting upper limits of the currently available design rainfall values.

h. A good consideration to account for the impact of climate change is to adopt higher return periods (e.g 10-year) for the design of minor systems.

i. Minor and major stormwater systems should cater for the 5-year and 50-year design flood, respectively.

j. The stormwater management system comprises of stormwater pipes, roads, overland flow paths and open channels discharging into an attenuation pond (dry type), indicated on Drawing No. NNB-RETHU-25-SWMP-001 and 002.

k. Minor stormwater systems consist of underground pipe networks, and the major system consists of open channel flow.

l. External stormwater catchment diversion with use of a catchwater channel and berm is proposed to divert runoff away from the site for the 100-year return period, mitigating the risk overland runoff flooding the site.

m. The outlet orifices of the attenuation pond are to be appropriately sized for the 5yr, 50yr and 100yr return periods such that predevelopment flow conditions are met.

n. Stormwater discharge points to be provided with erosion control in the form of headwalls, gabion baskets and mattresses.

o. Stormwater runoff is proposed to ultimately discharge across Juno Road as predevelopment flow with a headwall and erosion protection to reduce flow velocities.

p. Rainwater harvest tanks are recommended in applicable areas where space permits. However, due to the low annual rainfall of the area this may provide little benefit when compared to the space requirements for such infrastructure.

q. Rainwater can be used for general maintenance of the site and not for human consumption. Appropriate treatment stormwater is required and can be used to supplement other water recourse shortfalls.

r. An ongoing maintenance management plan should be implemented to ensure that the stormwater network and storage facility are kept free of silt and debris to prevent any blockage that may arise.

s. This stormwater management plan is to be incorporated and be implemented into the proposed development drawings for submission by the Architect.

t. This stormwater management plan must be updated according to changes/revisions of the site development plan.

APPENDIX A

CALCULATIONS OF RUNOFF COEFFICIENT AND FLOW

– DWA METHOD

EXTERNAL CATCHMENT - RATIONAL METHOD.

Description of Catchment	**External Catchment**		
River detail			
Calculated by	**NB**	**Date**	**11 August 2025**

Physical characteristics

Size of catchment (A)	**0.0580000**	km²	Rainfall Region			
Longest Watercourse	**0.255**	km	**Area Distribution Factors**			
Average slope (S_{av})	**0.0175**	m/m	Rural (α)	Urban (β)	Lakes(γ)	
Dolomite Area ($D_{\%}$)	**0**	%	**100.0%**	**0.0%**	**0**	
Mean Annual Rainfall (MAR)	**449**	mm				
Catchment Characteristics	**Flat/permeable**	%				
r - look up from Table 3C.3	**Medium grass cover**	0.4				

Rural (1)				**Urban (2)**			
Surface Slope	**%**	**Factor**	**C_s**	**Description**	**%**	**Factor**	**C_2**
Vleis and Pans	**50**	0.01	0.005	**Lawns**			
Flat Areas	**50**	0.06	0.030	Sandy, flat (<2%)	**0**	0.10	-
Hilly	**0**	0.12	-	Sandy, steep (>7%)	**0**	0.20	-
Steep Areas	**0**	0.22	-	Heavy soil, flat (<2%)	**0**	0.17	-
Total	100	-	0.035	Heavy soil, steep (>7%)	**0**	0.35	-
Permeability	**%**	**Factor**	**C_p**	**Residential Areas**			
Very Permeable	**0**	0.03	-	Houses	**0**	0.50	-
Permeable	**60**	0.06	0.036	Flats	**0**	0.70	-
Semi-permeable	**40**	0.12	0.048	**Industry**			
Impermeable	**0**	0.21	-	Light industry	**0**	0.80	-
Total	100	-	0.084	Heavy Industry	**0**	0.90	-
Vegetation	**%**	**Factor**	**C_v**	**Business**			
Thick bush and plantation	**5.0**	0.03	0.002	City Centre	**0**	0.95	-
Light bush and farm-lands	**10.0**	0.07	0.007	Suburban	**0**	0.70	-
Grasslands	**75.0**	0.17	0.128	Streets and Roofs	**0**	0.95	-
No Vegetation	**10.0**	0.26	0.026	Maximum flood	**0**	1.00	-
Total	100	-	0.162	Total	0	-	0.000

Time of concentration (T_c)	**Overland**	Notes:	
Overland flow	Defined watercourse		
$T_c = 0.604\left(\frac{rL}{\sqrt{S_{av}}}\right)^{0.467}$	$T_c = \left(\frac{0,87L^2}{1000S_{av}}\right)^{0,385}$		
0.53 Hours	0.1099 Hours	32.09630844	Minutes

Run-off coefficient

Return period (years), T	**2**	**5**	**10**	**20**	**50**	**100**	**200**
Run-off coefficient, C_1 ($C_1 = C_s + C_p + C_v$)	0.281	0.281	0.281	0.281	0.281	0.281	0.281
Adjusted for dolomitic areas, C_{1D} ($= C_1(1-D_{\%})+C_1D_{\%}(\Sigma(D_{factor} \times C_{s\%}))$)	0.281	0.281	0.281	0.281	0.281	0.281	0.281
Adjustment factor for initial saturation, F_t	0.5	0.55	0.6	0.67	0.83	1	1
Adjusted run-off coefficient, C_{1T} ($= C_{1D} \times F_t$)	0.141	0.155	0.169	0.188	0.233	0.281	0.281
Combined run-off coeffiecient C_T ($= \alpha C_{1T} + \beta C_2 + \gamma C_3$)	0.141	0.155	0.169	0.188	0.233	0.281	0.281

Rainfall

Return period (years), T	**2**	**5**	**10**	**20**	**50**	**100**	**200**
Point Rainfall (mm), P_T	**26.41**	**35.98**	**43.00**	**50.32**	**60.73**	**69.24**	**78.31**
Point Intensity (mm/hour), P_{IT} ($=P_T/T_C$)	49.4	67.3	80.4	94.1	113.5	129.4	146.4
Area Reduction Factor (%), ARF_T	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Average Intensity (mm/hour), I_T ($= P_{IT} \times ARF_T$)	49.4	67.3	80.4	94.1	113.5	129.4	146.4
Return period (years), T	**2**	**5**	**10**	**20**	**50**	**100**	**200**
Peak flow (m³/s), $Q_T = \frac{C_T I_T A}{3,6}$	0.1118	0.1675	0.2184	0.2853	0.4266	0.5859	0.6627

INTERNAL SITE DEVELOPMENT CATHMENT - RATIONAL METHOD.

SITE AREA		*167000*	m^2

TIMES OF CONCENTRATION			
	PRE	POST	
Tc	*42.13*	*10*	min

RAINFALL DATA			
	PRE	POST	
50 YEAR	*68.81197046*	*33.624*	mm
100 YEAR	*78.43649169*	*38.328*	mm

RAINFALL INTENSITIES			
	PRE	POST	
50 YEAR	97.99948321	201.744	mm/hr
100 YEAR	111.7063732	229.968	mm/hr

CALCULATION OF RUNOFF COEFFICIENT (Post-development) DWA METHOD							
PRE/RURAL Runoff Coefficient				**POST/URBAN Runoff Coefficient**			
RURAL				**URBAN**		%	
Steepness/Slope Cs		%	< 900mm	Lawn sandy<2%		0	0.10
< 3%		50	0.01	Lawn sandy>7%		0	0.20
3-10 %		50	0.06	Lawn heavy<2%		53	0.17
10 - 30 %		0	0.12	Lawn heavy>7%		0	0.35
> 30 %		0	0.22	Residential single		0	0.50
	Cs	100	0.04	Flats/dense townships		0	0.70
Permeability Cp		%		Industry , light		0	0.80
Very perm (Dunes)		0	0.03	Industry , Heavy		0	0.90
Perm (light soil)		60	0.06	Business local		0	0.60
Semi (most soils)		40	0.12	Business CBD		0	0.85
Imperm (rock, paving)		0	0.21	Streets/roofs		47	0.95
	Cp	100	0.08		Total	100	0.54
Vegetal growth Cv		%					
Dense bush, forest		5	0.03		**AREA WEIGHTING FACTORS**		
Cult land, sparse bush		10	0.07			%	DWA
Grassland		75	0.17		RURAL	0	0.281
Bare Surface		10	0.26		URBAN	100	0.537
	Cv	100	0.16		LAKES	0	0.00
Rural coeff		Total (Ct)	0.28		C_{design}	100	0.54

50YR PEAK FLOWS

PRE			
	TIME(min)	*Q(m^3/s)*	*Q(l/S)*
START	0	0.00	0.00
PEAK	42.13	1.27745	1277.45
END	84.26	0.00	0.00

POST			
	TIME	*Q(m^3/s)*	*Q(l/s)*
START	0	0.00	0.00
PEAK	10	5.02187	5021.87
END	25	0.00	0.00

100YR PEAK FLOWS

PRE			
	TIME (min)	*Q(m^3/s)*	*Q(l/S)*
START	0	0.00	0.00
PEAK	42.13	1.45612	1456.12
END	84.26	0.00	0.00

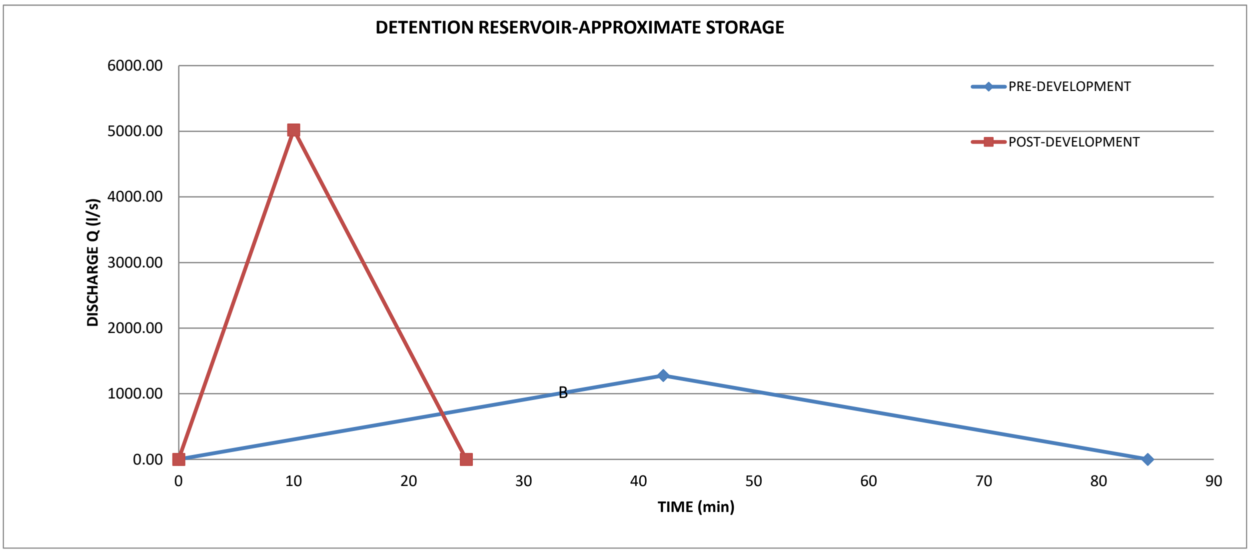
POST			
	TIME(min)	*Q(m^3/s)*	*Q(l/s)*
START	0	0.00	0.00
PEAK	10	5.72443	5724.43
END	25	0.00	0.00

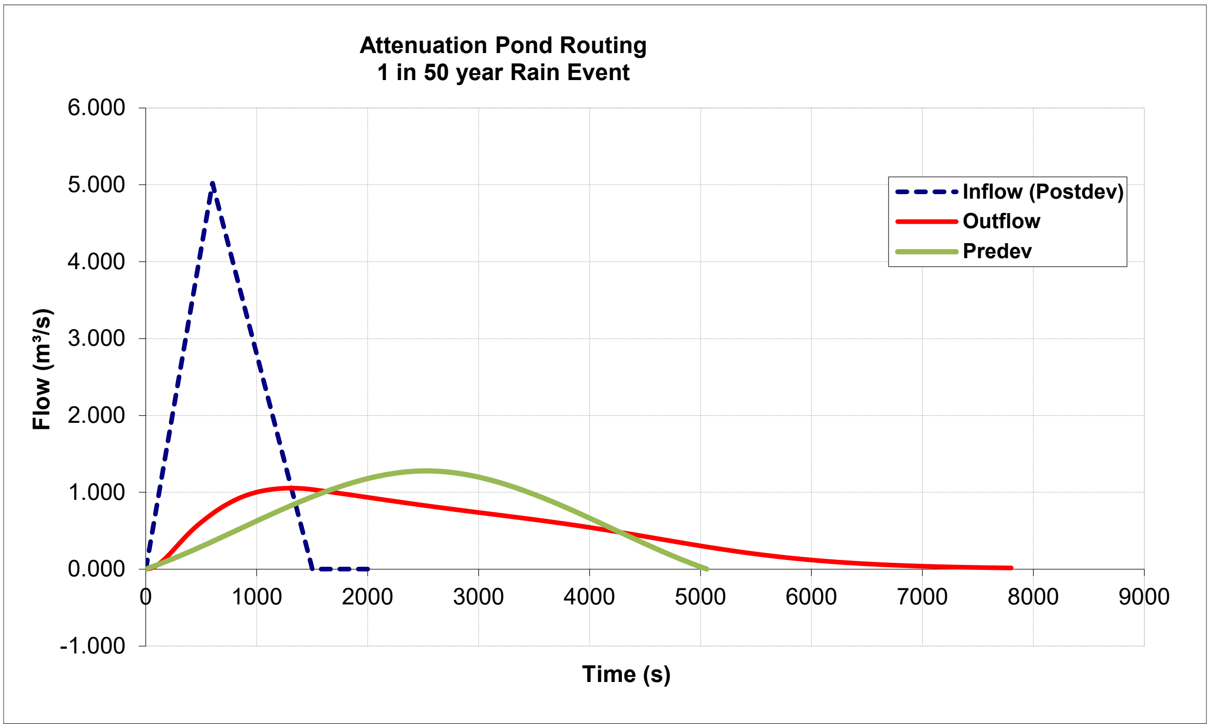
APPENDIX B

FLOOD HYDROLOGY ROUTING– STORM RECURRENCE INTERVAL 1 :50yr

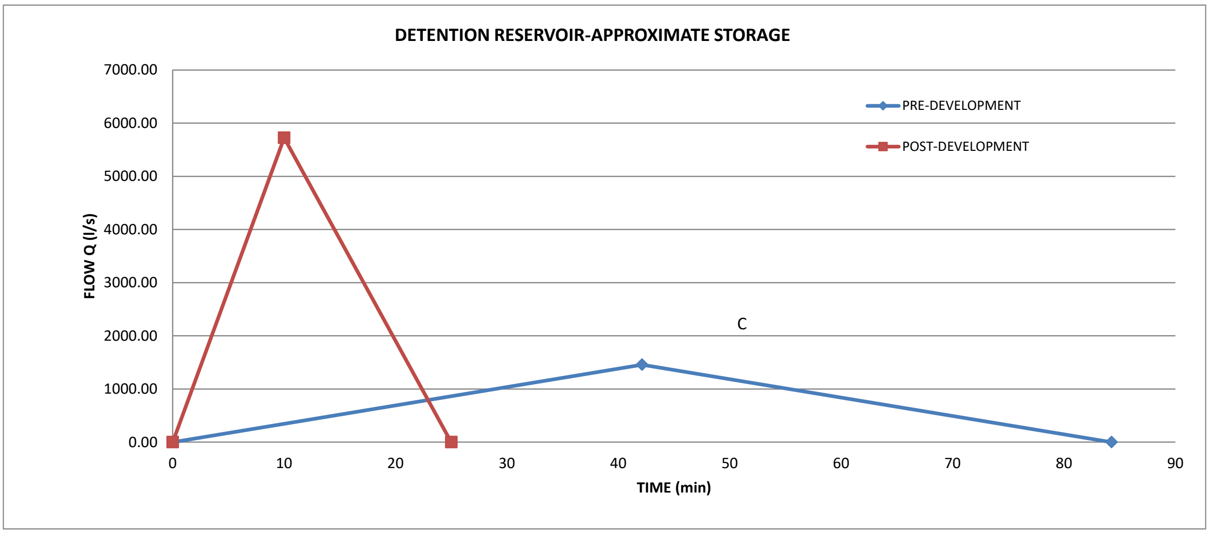
FLOOD HYDROLOGY ROUTING – STORM RECURRENCE INTERVAL 1 : 100yr

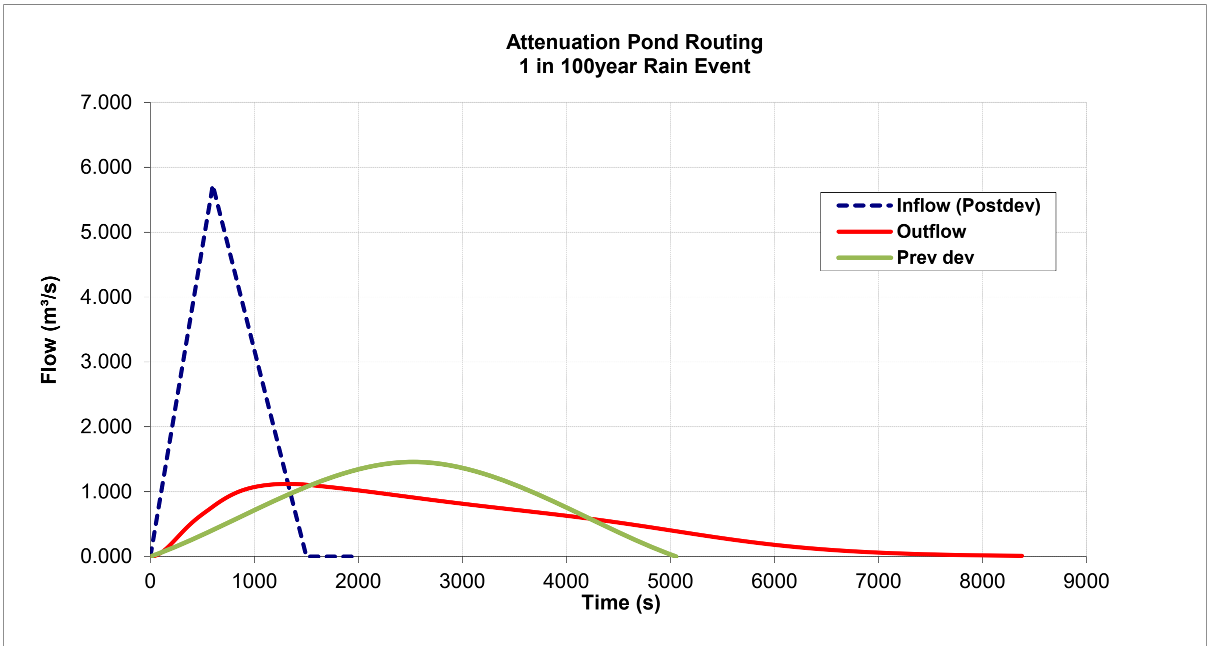
FLOOD HYDROLOGY ROUTING– STORM RECURRENCE INTERVAL 1 :50yr





FLOOD HYDROLOGY AND ROUTING – STORM RECURRENCE INTERVAL 1 : 100yr





APPENDIX C

STORMWATER MANAGEMENT PLAN DRAWINGS

NNB-RETHU-25-SWMP-001

NNB-RETHU-25-SWMP-002