DRAKENSTEIN MUNICIPALITY

STORMWATER MANAGEMENT PLAN

FOR

THE PROPOSED DEVELOPMENT OF ERF 8378, PAARL, VLAKKELAND TOWNSHIP

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1 INTRODUCTION AND SCOPE OF WORK

Lyners was appointed by Drakenstein Municipality as part of the Jubelie Professional Resource Team (PRT) as Consulting Civil Engineers for the preparation of a Stormwater Management Plan for erf 8378, Paarl, Drakenstein.

This report is based on a draft town planning layout by Nuplan Africa dated 29 July 2013, site inspections, detailed survey, liaison with local authority, previous studies and available existing services information.

2 LOCATION AND BACKGROUND

A locality plan is attached in Annexure A. Erf 8378, Paarl is approximately 100ha and is situated east of Jan van Riebeeck Drive and west of Bo-Dal Road. It is bordered in the south by erf 1341 and the north by erven 2569 and 361 as well as Newton residential area.

During this study, a flood study and an Aquatics Assessment were completed by Sinske Consult and DH Environmental Consulting (DHEC) respectively to ensure that the correct design parameters were used during design and that no environmental issues could arise during the development of Vlakkeland.

After the aforementioned reports were completed, the PRT discussed the proposed house placement layout with Drakenstein Municipality for approval. During these discussions a report conducted by Ninham Shand (November 2002) was submitted to Lyners for assessment.

Drakenstein Municipality requested this study from the PRT to enable them to make an informed decision regarding the proposed layout.

3 INFORMATION UTILIZED

The following information was provided :

- Drommedaris Emergency Housing project report on bulk stormwater management by Ninham Shand Consulting Engineers (November 2002). Hereafter referred to as Shand Report. (Annexure A)

The following information was used in the preparation of this report :

- A detailed topographical survey of the entire site, including of existing culverts and existing channels,
- Site visits,
- Aerial photographs,
- A flood study Erf No 8378 (Vlakkeland), Paarl - Mbekweni, Kleinbosch and Dal Rivers by Sinske Consult, June 2013. Hereafter referred to as Sinske Report. (Annexure B)
- An Aquatics Assessment by DHEC, June 2013. (Annexure C)
- Layout of proposed development by Nuplan Africa (2.551-houseplacements-01)

4 GOALS OF THE STORMWATER MANAGEMENT PLAN

The goal of the stormwater management plan are to :

- Reduce possible flood damage including damage to life, property and the environment.
- Minimize, to the extent practical, any increase in stormwater runoff from the new development.
- Reduce soil erosion caused by new development.
- Assure the adequacy of existing stormwater infrastructure.
- Maintain and prevent further damage to existing stormwater canals.

- Maintain the integrity of stream channels for their biological functions, as well as for drainage.
- To minimize pollution in stormwater runoff from new and existing developments and enhance the physical and biological integrity of stormwater and aquatic life.
- To protect the public safety through a proper design and operation of existing stormwater and additional runoff as a result of the proposed development.

To achieve these goals this plan outlines specific stormwater design and performance for the proposed development.

5 EXISTING STORMWATER DRAINAGE AND SERVICES

As prescribed in detail in the flood study, completed by Sinske Consult, the Vlakkeland development is affected by four rivers, namely :

- Mbekweni River,
- Seven Springs,
- Kleinbosch River; and
- Dal River

In Annexure D the proposed stormwater layout and culverts are indicated. All the above streams flow in a westerly direction towards Jan van Riebeeck Drive and ultimately flow through the three culverts (C, G and I) under Jan van Riebeeck Drive. The flow of culverts C and G joins west of Jan van Riebeeck Drive and continue to flow in the northern channel in a westerly direction.

Stormwater flow through culvert H and I, drains via in the southern channel in a westerly direction.

In the Drommedaris emergency housing project report on bulk stormwater management, certain constraints are stipulated which limits the amount of stormwater released from the Vlakkeland development. Three scenarios were evaluated and analyzed during the aforementioned study.

6 CONCLUSION FROM STUDIES

6.1 DROMMEDARIS EMERGENCY HOUSING PROJECT REPORT ON BULK STORMWATER MANAGEMENT

6.1.1 Summary

The peak flow rate for the Mbekweni catchment was determined as follows:

Flood	**1:50**	**1:100**
Peak flow rate	119m^3/s	135m^3/s

Three scenarios were evaluated. Scenario 1 represents that two boxes of (southern culvert) Culvert I are blocked and one partially blocked with an invert level of approximately 104.23 masl. Scenario 2 assumed that sediment in one of the blocked boxes of the culvert I is removed to an invert level of approximately 104.23 masl (same level of partially blocked box); and scenario 3 assumes that the entire culvert I are cleared to provide three 3m span x 2.5m rise openings.

With reference to Table 4 : “Maximum routed outflow and headwater elevation at Jan van Riebeeck Road culvert system” from the above mentioned report, the following are calculated.

Return Period	Culvert	Maximum discharge (m^3/s)			Maximum headwater elevation (masl)			Overtopping level (masl)
		Scenario			Scenario			
		1	2	3	1	2	2	
1:50 Year	Northern (culvert C)	24.0	19.0	10.0	106.84	106.61	106.24	106.91-107.0
	Middel (culvert G)	64.0	56.0	42.0				
	Southern (culvert I)	21.0	36.0	68.0				
	Total	**109.0**	**111.0**	**120.0**				

For each of the scenarios certain upgrades were proposed for each constraint. The report recommended that Scenario 2 should be implemented to accommodate the 1:50 year flood.

As discussed with Mr J Knaggs of Drakenstein Municipality, he also recommended that Scenario 2 must be further investigated for design purposes.

Therefore the upgrades required (according to scenario 2) on the west side of Jan van Riebeeck Drive should include the following:

6.1.2 Proposed upgrades to be completed west of Jan van Riebeeck Drive.

6.1.2.1 Northern Channel

The northern channel requires the following upgrades.

Location	Additional culverts/raise bank or bridge
Northern branch	0.9
Relocation bridge between Jan van Riebeeck and Pinzi Road culverts	New clear span bridge
Pinzi Road culverts (4x3mx2m)	1 x 3.0m x 2.0m
Zingizani Road culvert (4x3.4mx1.7m)	1 x 3.4m x 1.7m
Railway culvert (3x3mx2m)	1 x 3.0m x 2.0m

6.1.2.2 Southern Channel

The following two alternatives were proposed for a section of the southern channel in the Shand Report:

Alternative 1

The installation of culverts would minimize the risk, safety and would have considerable social benefits of facilitating access between adjacent communities as they will be divided by a channel.

Alternative 2

The flow in this section of the channel for this alternative will reach velocities of up to 4m/s and will be lined with concrete blocks or 300mm thick RENO mattresses. This channel will be easily maintained but the high velocities in this open channel would present a possible health and safety risk although the channel would be fenced. Therefore alternative 1 would be preferable.

The following table summarizes the proposed amendments to the southern channel.

Location	**Proposed amendments**	
Reach between Jan van Riebeeck and Mbekweni Road	Trapezoidal channel with 1:2 side slopes and base width of 4m	
Mbekweni Road culverts	3 x (2.4m x 1.8m) box culverts (one additional culvert barrel)	
Steep reach between Mbekweni Road culvert and stilling basin	**Alternative 1**	**Alternative 2**
	1 x (3.6m x 2.4m) box culvert	Trapezoidal channel with 1:2 side slopes and base width of 4m
Reach between stilling basin and Drommedaris Road	Trapezoidal channel with 1:2 side slopes and bose width of 4m	
Drommedaris Road culvert	2 x (3.6m x 1.5m) box culverts (one additional culvert barred)	
Reach between Drommedaris Road and Railway culverts	Trapezoidal channel with 1:2 side slopes and base width of 8m	
Railway culverts	Existing 1 x (6m x 1.6m) box culvert	

6.1.3 Cost estimates

The capital cost estimates for scenario 2 are summarized in the table below. It should be noted that this cost estimate was conducted in November 2005 and should therefore be escalated.

Location	**Cost Scenario 2 (2005)**	**Total Cost Scenario 2 (2005)**	**Total Cost Scenario 2 (2013)**
Northern Channel	R 382 157.00	R 9 533 723.00	R 20 436 381.94
Southern Channel - Alternative 1	R 9 151 567.00		
Northern Channel	R 382 157.00	R 5 409 317.00	R 11 595 351.39
Southern Channel - Alternative 2	R 5 027 161.00		

The estimated cost to complete the upgrades of the Northern Channel and Southern Channel, Alternative 1 is R 9 533 723.00 and for Alternative 2 the estimated cost is R 5 409 317.00. These costs include contingencies and VAT, but exclude professional fees and disbursements. These costs escalated at 10% per annum to 2013 will be approximately R 20 436 381.94 and R 595 351.39 for alternative 1 and 2 respectively.

6.2 FLOOD STUDY ERF NO 8378 (VLAKKELAND), PAARL – MBEKWENI, KLEINBOSCH AND DAL RIVERS

6.2.1 Summary

The peak flow rates (Post development) that cross Jan van Riebeeck Drive was determined and summarized in the table below.

Flood	**1:50 Year**	**1:100 Year**
Peak flow rate	88.7m^3/s	113.1m^3/s

All the post developments peak flow rates and requirements were determined and are summarized in the table below.

Culvert/Inlet Location	1:50 Year (m^3/s)	1:100 Year (m^3/s)
A	10.6	13.0
B	10.6	13.0
C	10.6	13.0
D	7.2	9.2
E	10.8	13.8
F	29.1	36.4
G	39.9	50.2
H	38.2	49.9
I	38.2	49.9

For the proposed development of Vlakkeland, the culverts, inlet and outlet structures should be designed to accommodate the above mentioned flow rates.

Several upgrades to existing culverts was proposed and will be implemented during the detailed designed of the proposed development.

6.3 AQUATICS ASSESSMENT (VLAKKELAND, PAARL, WESTERN PROVINCE)

6.3.1 Summary

The site encompasses a reach of highly degraded streamlines passing through the south western corner of the proposed development. Given that the streamline is already so degraded, from recent and historical abuse, it may be an option well-worth considering re-aligning the streamline.

The proposed position of the detention facility in the south-western corner of the site will be in a degraded area where a small dam once existed. A managed stormwater ponding system would serve the shortcoming of ponds in the area between Vlakkeland and Klein Vlakkeland properties.

7 STORMWATER DRAINAGE AND CONTROL SYSTEM

7.1 PURPOSE AND DESIGN PRINCIPLES

Stormwater system can be categorized into two systems, namely minor and major stormwater systems. The purpose and principle of stormwater control for the proposed development will be accommodated in a single system that includes a major and minor system.

7.2 MINOR SYSTEM

The primary goal of the minor system is to ensure convenience and safety to residents during normal rainfall. The minor system usually consist of road drainage channels and kerbs, kerb inlets, grid inlets, manholes, pipes and open channels to discharge runoff towards the major drainage system. The preliminary sizing of these elements are determined on the basis of short a duration, high intensity rainfall taking into account a concentrated flow entering the minor system.

7.3 MAJOR SYSTEM

The major system will not often be utilized to its full capacity as its purpose is to convey and control large floods. During more severe storms the minor stormwater networks will be flooded and allowance shall be made in the layout and design of roads for escape routes towards bulk stormwater channels and detention ponds. Trapped low points in the layout and design will be avoided as far as possible. These escape routes will consist of larger diameter pipes and channels to ensure stormwater is conveyed in a safe and efficient manner.

8 ANALYSIS OF THE PROPOSED STORMWATER DRAINAGE SYSTEM

8.1 GENERAL

The proposed site will be defined in one catchment area. Additional runoff will be conveyed towards Channel 1 (Seven Springs).

The Mbekweni River will be accommodated in open channel towards culverts B and C where it will flow in a westerly direction.

Runoff entering the proposed development on the eastern boundary will be directed through the stormwater system to culvert E. Channel 1 is proposed to accommodate the flow starting at D and flowing in a westerly direction towards culvert E and ultimately to culvert G. the streamline entering the site in the south will also be accommodated in this channel as proposed in the Aquatics Assessment by DH Environmental Consulting..

The Kleinbosch River will flow through culvert F and join Channel 1 and flow towards culvert G.

The Dal River will flow through culvert H towards culvert I.

8.2 CONSTRAINTS

Due to the constraints stipulated in the Shand Report, the amount of that may be released west of Jan van Riebeeck are summarized in the table below.

Table 8.2.1 : Flow rate capacity of Jan van Riebeeck culverts

Culvert	1:50 Year flood (Scenario 2)
C	19m^3/s
G	56m^3/s
I	36m^3/s
Total	**111m^3/s**

The required capacity of the culverts C, G and I according to the Sinske Report should be as follows :

Table 8.2.1 : Required flow rate of Jan van Riebeeck culverts

Culvert	1:50 Year flood (m^3/s)	1:100 Year flood (m^3/s)
C	15.9	19.5
G	39.9	50.2
I	38.2	49.9
Total	**94.0**	**119.6**

As the upgrades to the west of Jan van Riebeeck will only be able to accommodate the 1:50 year flood, therefore only the flow rates indicated in table 8.2.1 can be released even in a 1:100 year flood.

8.3 MINOR SYSTEM

The design of the minor stormwater system will allow for smaller floods as previously stated. Design principles will take into account engineering, environmental, ecological health and safety, aquatic, social, construction and design objectives.

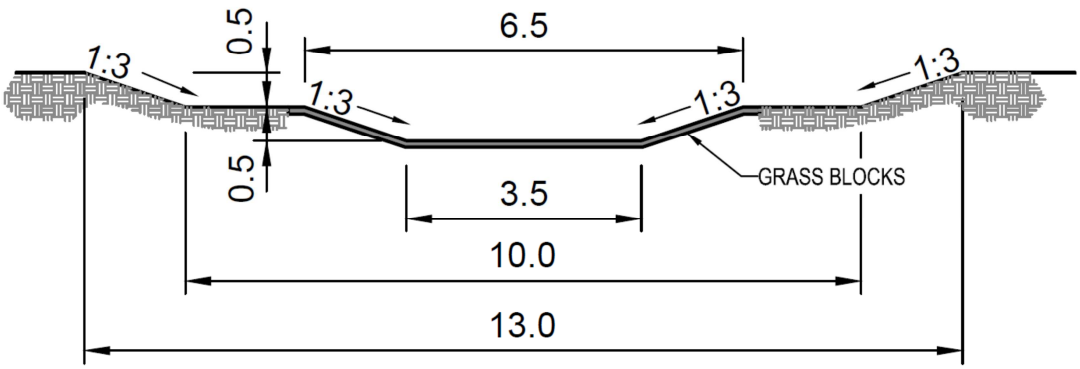
8.4 MAJOR SYSTEM

8.4.1 Preliminary design of channels

The following preliminary designs were prepared regarding the sizing of channels.

8.4.1.1 Channel 1

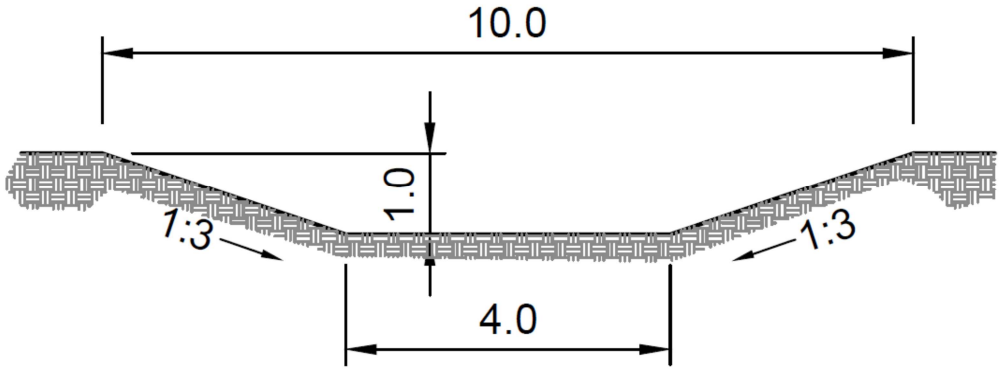
This channel flowing from culvert D towards culvert E and ultimately to culvert G will consists of a combined low flow channel and high flow channel. The channel will have the following estimated dimensions.



The maximum flow depth during a 1:100 year flood will approximately be 0.84m. The channel will mainly consist of grass and grass blocks to ensure a natural feel to the channel. Grass blocks will only be installed in the low flow channel to ensure soil protection during high flow rates.

8.4.1.2 Channel 2

This channel flowing from inlet A towards culvert B and through culvert C will have the following estimated dimensions.

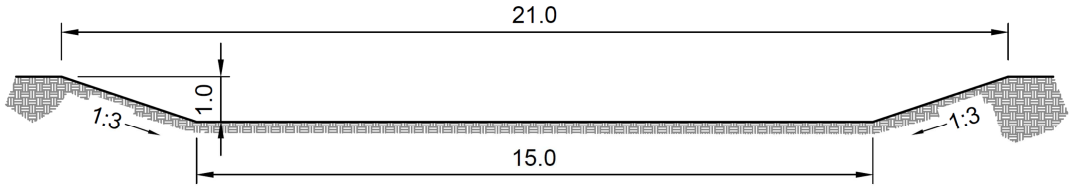


The channel will mainly consist of grass and grass blocks to ensure a natural feel to the channel.

The maximum flow depth of the proposed channel will approximately be 0.8m.

8.4.1.3 Channel 3

This channel flowing in a westerly direction from culvert H towards culvert I will have the following dimensions.



The channel will mainly consist of grass and grass blocks to ensure a natural feel to the channel.

The maximum flow depth of Channel 3 will be 0.88m.

8.4.2 Preliminary design of detention facilities

The Client requested that the additional runoff caused by the development of erf 2569 must also be accommodated by the Vlakkeland development. Currently the additional runoff caused by the development has not been confirmed, but is estimated at approximately 0.5m^3/s and 0.6m^3 for the 1:50 and 1:100 year floods. This additional detention was also accommodated in the design.

The detention ponds will accommodate the runoff and stormwater at two locations indicated on the layout in Annexure D.

Preliminary design calculations were carried out to determine the required volumes that will be required to return the 1:100 year flood for each detention pond. These calculations indicated that the 1:100 year flood can be accommodated in the detention ponds as described below.

8.4.2.1 Detention pond 1

Detention pond 1 situated to the north-western side of the proposed development next to Jan van Riebeeck Drive has an estimated 1:100 year peak inflow of (19.5 + 0.6 = 20.1m^3/s) and an maximum outflow of 19m^3/s.

The proposed detention pond will require to be able to retain approximately 358m^3 during a 1:100 year flood. The area available for detention is approximately 2.13ha (2130m^3). Therefore a water depth of approximately 0.2m can be expected during a 1:100 year flood in Pond 1. The overtopping level of Jan van Riebeeck Drive according to Ninham Shand report is approximately 106.94MSL. A freeboard of at least 300mm will be implemented.

8.4.2.2 Detention facility 2

Detention facility/pond is situated to the south west of proposed development next to Jan van Riebeeck Drive. As previously discussed in Section 8.2 will detention pond 2 have an maximum inflow (1:100 year flood) of 101.1m^3/s and an outflow of 92m^3/s.

The required capacity to accommodate the runoff and stormwater will be 4910m^3. An area of approximately 5.88ha (5880m^2) is available for detention. The maximum water depth of detention pond 2 will be approximately 0.8m.

The entire detention facility will be able to accommodate approximately 31 500m^3 before a level of 105.80MSL is achieved. The overtopping level of Jan van Riebeeck Drive according to Ninham Shand report is approximately 106.94MSL.

9 MANAGEMENT REQUIREMENTS

9.1 STORMWATER SYSTEM

Stormwater structures must be maintained and cleaned to remove silt and debris on a regular basis.

9.2 LITTER TRAPS

Liter traps should be cleaned on regular basis. Liter to be removed and disposed to municipal solid waste.

9.3 DETENTION FACILITIES AND CHANNELS

Detention facilities and channels should have a monthly maintenance program and must include moving of grass in ponds and channels as well asof alien vegetation if necessary. Rodding of drainage pipes must be conducted on a regular basis to ensure no debris are building up in the system.

10 CONCLUSOIN

This stormwater management plan gives a preliminary indication of how stormwater and runoff will be accommodated within the proposed development in terms of quantity and quality. It is however important to note that this report will have to be updated during the detail design phase as more information will be required and analyzed.

A possible Stormwater master plan must be conducted to ensure the assumption made during this report are acceptable.

Some of the existing structures and constraints (culverts, banks, ect) require to be upgraded west of Jan van Riebeeck. Some culverts on the proposed development can be removed while other must be replaced.

With reference to the Aquatics Assessment and the Flood study report there will be no insurmountable issues and constraints. Therefore is the proposed location, erf 8378, favorable for the development of Vlakkeland and will all requirements and constraints can be accommodated during the development thereof.

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for LYNERS

ANNEXURE A :

DROMMEDARIS EMERGENCY HOUSING PROJECT REPORT ON BULK STORMWATER MANAGEMENT (SHAND REPORT)

ANNEXURE B :

FLOOD STUDY ERF NO 8378 (VLAKKELAND), PAARL – MBEKWENI, KLEINBOSCH AND DAL RIVERS (SINSKE REPORT)

ANNEXURE C :

AQUATICS ASSESSMENT

ANNEXURE D :

PROPOSED STORMWATER LAYOUT

ANNEXURE E :

PROPOSED STORMWATER CHANNEL SECTIONS

ANNEXURE F :

ADDITIONAL CALCULATIONS