APPENDIX 6: STORMWATER MANAGEMENT PLAN

ERF 61 LINCOLN MEADE DEVELOPMENT

STORMWATER MANAGEMENT PLAN

REVISION 0

UMSUNGULI PROJECT MANAGEMENT

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ERF 61 LINCOLN MEADE
PIETERMARITZBURG

RESIDENTIAL DEVELOPMENT

STORMWATER MANAGEMNT PLAN
REVISION 0

INDEX

1. INTRODUCTION

In support of the rezoning and environmental applications for the proposed development, Umsunguli Project Management cc has been appointed by Person Drive Trading (Pty) Ltd to undertake a Stormwater Management Plan for the proposed development to establish 24 residential units on Erf 61 along Grimthorpe Avenue in Lincoln Meade, located within Msunduzi Municipality.

The purpose of the Storm Water Management Plan is

- The protection of development and public interests
- The preservation of the natural environment
- The preservation of the existing stream, wetlands and drainage lines
- The management of the expected increase of surface runoff into natural drainage areas
- Protection of underground resources and water quality
- Conservation of water and making it available to public
- The desire to provide optimum methods of controlling runoff
- Striving for sustainable environment while pursuing economic development

2. EXISTING SYSTEM

The land development area is overgrown vegetation including a small dwelling and outbuildings. It was not possible to walk down to the stream due to the thickness of the vegetation on site. The site has a gentle slope towards the stream and there is no formal stormwater system in place, with all run-off from gutters, roofs and unpaved parking area flowing towards the stream. Stormwater from Grimthorpe Avenue does not enter the site and this should be maintained.

3. PROPOSED SYSTEM

a. Overview

The proposed storm water system must be designed to have minimal impact on the stream, through the careful implementation of sustainable drainage systems (SuDS) and stormwater management systems.

The transformation of the undeveloped land to hardened surfaces increases the surface runoff from the transformed areas, which reduces the infiltration of surface water into the underground resources. It is thus important to create artificial filtration areas, through the encouragement of rainwater harvesting, construction of two strategically located attenuation ponds along the edge of the development footprint as illustrated in Annexure A. The attenuation ponds will blend into the landscaping of the development and should be located outside the main channel of the stream, but be along the edge of the degraded wetland area.

All stormwater related structures, pipes, attenuation ponds and drains must be designed by the project engineer in consultation with the project Environmental Control Officer.

This can be achieved through three main stormwater management systems, namely:

- The encouragement of rainwater harvesting tanks to act as the first form of attenuation;
- The construction of two, off channel, attenuation ponds within the degraded wetland area with controlled outlets into the stream; and
- The construction of stormwater catchpits and pipes along the hardened road areas

b. Erosion Control

The design of the storm water system must make provision for erosion protection, as the transformed area, after construction will have a greater surface run-off that will contribute to higher flows. It is therefore essential that the transformed areas have to be vegetated and rehabilitated as soon as possible after the completion of bulk earthworks, roadworks and foundation work. Erosion control measures could be a combination of attenuation ponds, grass sods, soilsaver, stone pitching, silt traps, geofabrics, gabion baskets and mattresses, energy dissipaters and grass lined drains.

Additional methods to minimise erosion within the development area include:

- Open exposed areas should be planted with grass or landscaped into gardens.
- Using natural rock and boulders to act as energy dissipaters.
- All exposed embankments should be covered in 100mm topsoil and planted with grass sods and staked to prevent washing away.
- All cut/fill embankments steeper than 1:2 should be covered in Soilsaver with sufficient overlaps, covered in 100mm topsoil and planted with grass.
- Reducing the velocity of all stormwater run-off through energy dissipaters
- Promotion of infiltration of surface run-off through the introduction of sustainable drainage systems, especially at the outlets from the stormwater attenuation ponds

c. Surface run-off

The implementation of rainwater harvesting must form part of the Home Owners Association rules and rainwater harvesting tanks will act at the first form of attenuation, whilst it could also serve other uses. It should however be noted, that rainwater tanks are not recognized by the municipality as a form of attenuation, as the tanks could be full and not attenuate any flow – thus the surface run-off must be calculated by excluding the rainwater harvesting tanks in order to size pipes and attenuation ponds. Run-off from roofs should be collected in gutters and stored in rainwater tanks for the utilization of gardening and other domestic activities. Any overflow from the tanks or gutters will be dispersed into swales and thereafter directed and collected into

attenuation ponds. Surface run-off from roads, parking areas and other hardened areas will be collected in kerb and channels along the roads and diverted into the two strategically positioned stormwater attenuation ponds. The stormwater attenuation ponds should be located outside the main stream area within the rehabilitated wetland buffer area and be fenced off to ensure contractors do not interfere with the wetland rehabilitation program.

The stormwater system must be kept separate from the sewage system and any contamination of surface runoff must be avoided.

4. INTERNAL ROADS AND PARKING AREAS

A site development plan has been produced by the architect and environmentalist, showing the various residential sites and road reserves in relation to the land development area. The hardened surface areas from the roads, house roofs and other buildings are the main contributing factors in the increased run-off within the development. Where possible, grass blocks and rain gardens should be introduced along roads and in parking areas to promote infiltration of storm water run-off.

The geometric design of the internal road network will include crossfalls that direct the run-off along kerbs into grid inlets and catchpits. Once collected, stormwater will be conveyed through underground concrete pipes, with an outlet into the respective stormwater attenuation pond. As mentioned in “section 3.b”, methods of dissipating the kinetic energy of run-off and silt collection will be incorporated into the design of stormwater infrastructure serving the road network.

The storm water infrastructure will be constructed in accordance with the *“Guidelines for Human Settlement Planning and Designs”,* service agreements concluded or municipal bylaws, where applicable.

For sizing and design of storm water infrastructure and the attenuation pond, calculation of the anticipated storm water run-off will be determined on the assumption that all roofed areas, roads and parking are considered hardened with an appropriate run-off co-efficient. Roof and gutter run-off will be included in the calculations due to the fact that rainwater tanks are not recognized by the municipality as a form of attenuation.

The standards for the storm water infrastructure to be installed in the proposed development can be summarised as follows:

- Flood recurrence interval : 5 years and at critical points 10 years
- Attenuation structures : 50 years
- Pipe material : Concrete
- Pipe Class : 100D in traffic areas, 75D in other areas
- Pipe diameters : 300mm Ø (minimum)
- Bedding : Class C
- Inlets : Catchpits / Steel Grid Inlets
- Outlets : Headwalls
- Junctions : Points of deflection on pipelines
- Road / Parking surface : Asphalt/concrete/pavers

5. STORMWATER MANAGEMENT

The objective of a storm water management plan should be to manage the storm water resources of the collective watersheds to:

- Prevent flood damage or concentration of run-off
- Divert storm water and surface run-off from buildings, roads and parking areas into rainwater harvesting tanks, swales or a piped system flowing into a stormwater attenuation pond
- Protect the stream and keep all construction outside the 1:100 year floodline
- Preserve the natural and beneficial functions of the natural drainage system downstream
- Preserve and enhance storm water quality
- Attenuate the difference between pre and post development flows

The proposed storm water management system has been designed to be self-regulating with no external control. It will aim to collect run-off into rainwater harvesting tank, swales, underground pipes with an attenuation pond to attenuate and manage the increase in flow between the pre and post development stages from the transformed areas.

The run-off from the roofs, gutters and downpipes shall be collected in rainwater harvesting tanks taking into account any overflows being dispersed overland into swales and ultimately collected into underground stormwater systems and contained in two stormwater attenuation ponds. Hardened areas, like roads and parking areas will be routed overland, collected in kerbs and channels and into grid inlets or catchpits where it is collected in concrete stormwater pipes and diverted into the two stormwater attenuation ponds along the lower boundary of the site where increased flow will be attenuated, whilst silt is deposited. The stormwater attenuation ponds should be located along the lower end of the site, but outside the main stream area to encourage the infiltration of stormwater, whilst silt is collected. The outlet or discharge from the attenuation pond will be protected with gabion mattresses and other energy dissipaters from where it will be released into the natural drainage areas and stream in a controlled manner. Both attenuation ponds will form part of the rehabilitation program of the wetland buffer zones, which are fairly degraded.

6. STORMWATER RUNOFF

Current storm water runoff volumes are based on the following information and assumptions:

- Site Development Plan provided by the architect and environmentalist
- Internal roads areas calculated from layout
- The hardened transformed area for the proposed type of units varies between 82m^2 (two bedroom) and 105m^2 (three bedroom) per residential site
- The use of grid inlets and storm water pipe network to collect, transport and divert run-off into the two attenuation ponds
- Constructing two stormwater attenuation ponds along the lower portion of the site

The storm water run-off has been calculated using the accepted "Rational Method" that takes into account the drainage area, nature of the soil surface and the storm intensity. The storm intensity used for calculation purposes is:

- 25,0mm for a 1:10 year return period; and
- 41,3mm for a 1:50 year return period
- Time of Concentration is 15 minutes
- Retention time is 15 minutes

This equates to a storm intensity of 100mm/hour and 165mm/hour for a 1:10 and 1:50 year storm return period respectively. These values are the norm for Msunduzi Municipality.

Allowances have been made for the various areas and their contribution to the flow and the coefficient of discharge for the various areas is as follows:

- Pre development grassed areas are taken as 0,29
- Post development grassed areas are taken as 0,45
- Buildings are taken as 0,85
- Roads and Parking areas are taken as 0,85

The changes in the ground cover in the post development phase are tabulated in Table 1.

Table 1: Site Coverage

ERF 61 LINCOLN MEADE - SUMMARY OF SITE COVERAGE									
Area	Site Size (m^2)	Pre Development		Post Development					
		Grass	%	Grass	%	Buildings	%	Roads / Parking	%
AP1	3 779	3 779	100%	1958	52%	978	26%	843	22%
AP2	5 152	5 152	100%	3118	61%	1518	29%	516	10%

The Pre and Post Development storm water runoff has been calculated for buildings, parking areas and roads within the development and are summarised in Table 2 below.

Table 2: Summary of Storm Water Calculations

ERF 61 LINCOLN MEADE SUMMARY OF STORMWATER CALCULATIONS					
Site Number	Site Size (m^2)	Pre Development Flow (m^3/s)	Post Development Flow (m^3/s)	Increase in Flow (m^3/s)	Attenuation Volume Required (m^3)
AP1	3 779	0,041	0,092	0,051	46
AP2	5 152	0,057	0,119	0,062	56
TOTALS	**8 931**	**0,098**	**0,212**	**0,114**	**102**

The detailed calculations of the storm water run-off for the pre and post development are attached as Annexure B for reference purposes.

7. STORMWATER FLOW ATTENUATION

The need for attenuation of the storm water flow is recognised in order to minimise the peak flow across the property and from each of the buildings, hardened parking areas and roads before its eventual discharge. The distribution of the increase flow is of importance to ensure that any downstream facility is not negatively affected.

The proposed development will be transformed from the existing overgrown vegetation, gradually sloped profile to levelled platforms. This transformation in ground profile will reduce the velocity as the new platforms will be flatter than the original ground profile. However, it's the transformation of natural vegetation to grass embankments, buildings, roads and parking areas that will increase the run-off and storm water flow. It is due to this increase from the pre-development flow to the post-development flow that attenuation of this increased run-off would be required.

Refer to Annexure C to see examples of the stormwater attenuation pond, whilst Annexure A shows the proposed stormwater infrastructure on the site development plan.

Storm water attenuation calculations have been using:

The Rational Method $Q=f_t \times C \times I \times A/360$, where

Q = the maximum/peak rate of run-off in cumecs (m^3/s)
f_t = an adjustment factor for the recurrence interval storm considered
C = run-off coefficient
I = rainfall intensity (mm/hour)
A = area of the catchment in hectares (1ha = 10,000m^2)

The following basic factors were used during the calculations, being:

- Return Period of 1:50 years
- Rainfall intensity of 165mm/hour
- f_t of 0,83 is used for 1:50 year return period
- C-factor of 0,29 for pre development areas
- C-factor of 0,45 for post development grassed areas
- C-factor of 0,85 for building and roof areas
- C-factor of 0,85 for roads and parking areas
- Time of Concentration = 15 minutes
- Retention Time = 15 minutes

Typical open attenuation ponds can vary in depth depending on the requirements, slope at outlet, available space and downstream conditions although a water depth of 1,5m is normally acceptable, including a freeboard of at least 0,5m above the full water level to prevent overtopping. This depth can however vary, but not less than 1m should landscaping and aesthetics require it to be shallower. It should be noted that ponds less than 1m in depth could lead to plant growth covering the entire pond over time (depending on the type of plants and reeds used). This could seriously impact on the effectiveness of the attenuation pond during periods of high rainfall and flow. All attenuation ponds will also be provided with at

least 300mm silt trap, where the base of the attenuation pond is 300mm lower than the pre-development outlet structure – this allows for silt to settle in the pond and plants to grow in the shallow water.

The size of the various attenuation structures and supporting calculations are included as Annexure B with this report for reference purposes.

8. MONITORING AND MAINTENANCE

a. Monitoring

The storm water system must to be monitored during construction at regular intervals by the Environmental Control Officer (ECO) in terms of the Environmental Management Programme (EMPr). It is also critically important that the site is fenced off prior to construction, including the stormwater attenuation pond area, to ensure that the wetland rehabilitation process and area outside the site development area remains in its natural condition during the construction process.

During the construction phase of the development, the construction process should be monitored against the EMPr, but should pay attention to the following aspects:

- Implementing temporary attenuation measures, such as earth berms to retain surface run-off until the attenuation areas are complete and functional.
- Providing a silt screen at all grid inlets to collect debris and silt during times of heavy rain.
- Controlling dust, especially during the construction of roads and house platforms.
- Placing topsoil and grass sods onto cut/fill embankments to reduce runoff and velocity, including the use of Soilsaver where embankments are steep.
- Construction of the stormwater attenuation pond as soon as possible.
- Planting of grass and other vegetation as soon as open areas are complete to prevent scouring and erosion of the low cohesion soils found on site.
- Fencing off the construction area and keeping all construction vehicles off the undeveloped portions of vegetation and buffer areas.

On completion of the construction, the Home Owners Association will be responsible to monitor their internal storm water system and attenuation facilities to identify improvements / maintenance. The factors to be monitored include the functionality and impact of the rainwater harvesting tanks on the properties, internal roads, stormwater pipes and attenuation ponds and how they are functioning and if they are adequate.

The post development monitoring process should be done at regular intervals (suggested 6 monthly) to include the following activities:

- Product (catchpits, headwalls, concrete pipes, attenuation ponds and rainwater harvesting tanks)
- Type of maintenance (rehabilitation, improvement, new)
- Urgency (immediate, next 6 months, next 12 months) and description of work to be carried out

b. Operation and Maintenance

The system as designed requires no manual operation, and is self-regulating. Maintenance work should be undertaken as required to restore and maintain the system to its original design, especially to repair and maintain scouring and erosion, especially at the outlets from the stormwater attenuation ponds.

The operation and maintenance of the storm water system is essential to ensure it functions properly to prevent damages or failures and must receive high priority from the Home Owners Association.

During the construction period, it is important that surface runoff is monitored, controlled and temporary measures be implemented until the construction is complete and the system can function independently. This is therefore an important aspect to be monitored by the ECO during the construction stage.

Routine maintenance will be the responsibility of the Home Owners Association and should include:

- Clearing of kerb and channels, catchpits, stormwater pipes and attenuation ponds (rainwater harvesting tanks will be maintained by homeowners)
- Removal of silt from collection points and attenuation pond
- Plant/weed control
- Cutting grass on embankments

It is however recommended that specialist service providers implement more technical works like the replacement of storm water pipes and remedial work to the stormwater attenuation ponds, if required.

9. RECOMMENDATIONS

The following recommendations are made for the proposed development situated on Erf 61 Lincoln Meade:

9.1 That the storm water design parameters used in the design of the storm water management system are accepted and approved.

9.2 The detail design of the storm water system includes recommendations of this plan.

9.3 Rainwater harvesting should be encouraged at all residential dwellings.

9.4 Rainwater harvesting tanks should be included in building plans submitted to the municipality for building plan approval.

9.5 The stormwater attenuation ponds should be constructed off-channel and within the buffer zone where the wetland rehabilitation process will be undertaken.

9.6 The storm water system must be kept separate from the sewerage system.

9.7 All chemicals, cement, fuel and other hazardous material used during construction should be stored in controlled areas and not lower than the internal road.

9.8 Concentration of storm water should be prevented where possible, but energy dissipaters should be provided in areas of concentration.

9.9 On completion of every construction phase within the development, comprising the construction of buildings, roads and parking areas, all remaining exposed embankments and open areas must be vegetated as soon as possible, including the use of “Soilsaver”, where necessary.

9.10 During the construction phase, the following aspects should be closely monitored by the ECO to ensure the contractor complies:

- Temporary berms and cut-off drains must be provided on site to collect run-off, especially until the stormwater attenuation pond is complete and functional.
- Silt screens must be provided at the catchpits during road/stormwater construction.
- Topsoil must be conserved on site and prevented from entering the stormwater system.
- Exposed embankments, cut/fill slopes and open areas must be vegetated as soon as possible to reduce runoff.
- Dust control during construction must be applied at all times.
- Excess spoil material from topsoil or bulk earthworks must be placed in areas or even removed entirely off site to minimise silt deposition, scouring and soil erosion.
- Post construction, all exposed areas must be covered in vegetation, grass or landscaped.

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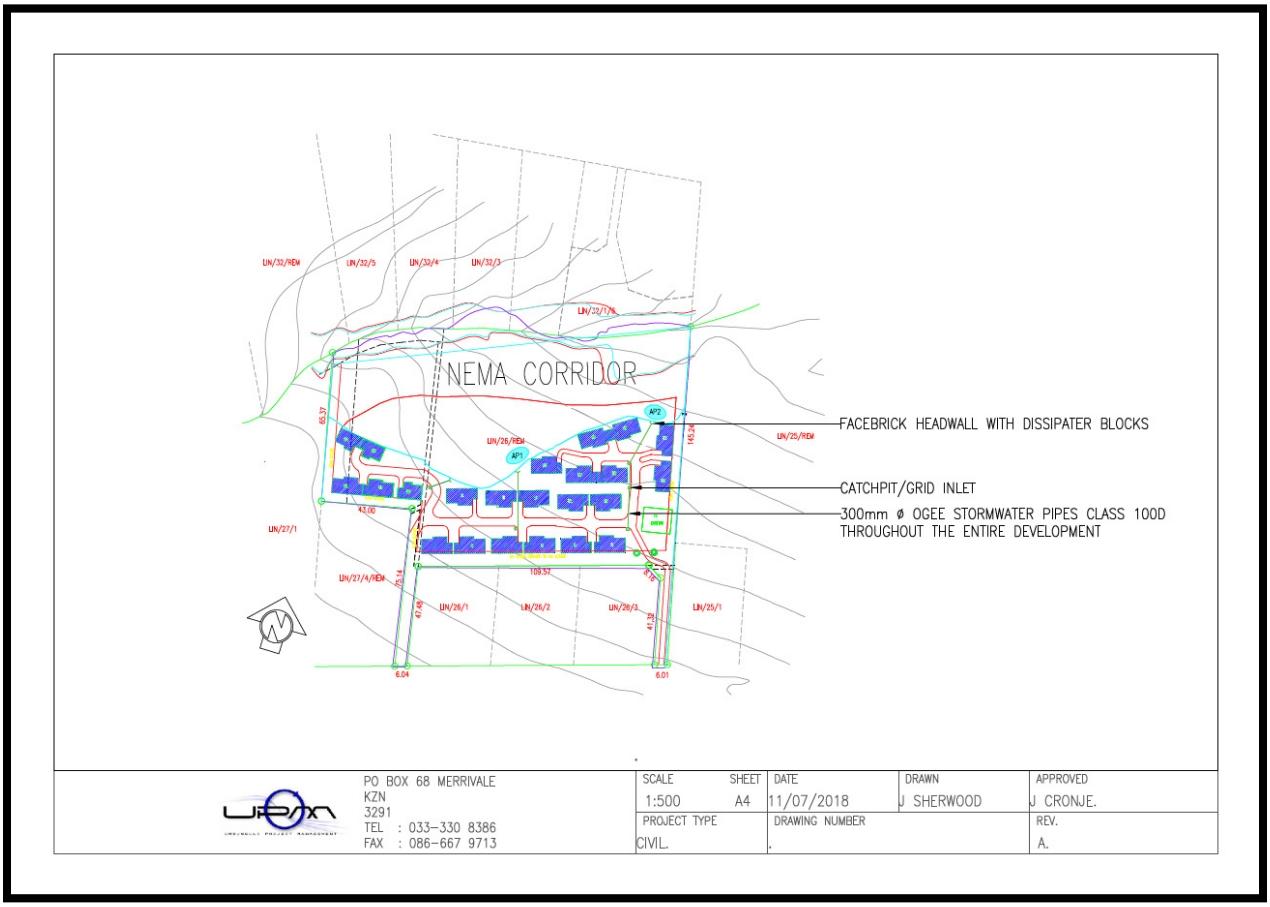
ANNEXURE A

STORMWATER LAYOUT PLAN



ANNEXURE B

STORM WATER CALCULATIONS

ERF 61 LINCOLN MEADE - STORMWATER FLOW CALCULATIONS					
TIME OF CONCENTRATION:	15	minutes			**Attenuation Pond 1**
RETURN PERIOD:	1:50	years			
DEPTH INTENSITY:	165	mm/hour			
PRE DEVELOPMENT RUN OFF CALCULATIONS					
Surface Description	**Area (m^2)**	**C**	**Ft**	**A*C**	**Peak Flow (m^3/sec)**
Natural Veld/Grass	3779	0,29	0,83	894	0,041
TOTAL	**3779**			**Qri(pre)**	**0,041**
POST DEVELOPMENT RUN OFF CALCULATIONS					
Surface Description	**Area (m^2)**	**C**	**Ft**	**A*C**	**Peak Flow (m^3/sec)**
Grassed areas around buildings	1958	0,45	0,83	731	0,034
New Buildings	978	0,85	0,83	690	0,032
New internal roads and parking areas	843	0,85	0,83	595	0,027
TOTAL	**3779**			**Qri(post)**	**0,092**
AVERAGE RUN OFF COEFFICIENT IN DEVELOPED AREA		0,72			
PRE-DEVELOPMENT RUN OFF Vri(pre)=Qri*60*15(m^3)		37			
POST-DEVELOPMENT RUN OFF Vri(post)=Qri*60*15(m^3)		83			
REQUIRED STORAGE (m^3) [Vri(post) - Vri(pre)]		**46**			

ERF 61 LINCOLN MEADE - STORMWATER FLOW CALCULATIONS					
TIME OF CONCENTRATION:	15	minutes			**Attenuation Pond 2**
RETURN PERIOD:	1:50	years			
DEPTH INTENSITY:	165	mm/hour			
PRE DEVELOPMENT RUN OFF CALCULATIONS					
Surface Description	**Area (m^2)**	**C**	**Ft**	**A*C**	**Peak Flow (m^3/sec)**
Natural Veld/Grass	5152	0,29	0,83	1240	0,057
TOTAL	**5152**			**Qri(pre)**	**0,057**
POST DEVELOPMENT RUN OFF CALCULATIONS					
Surface Description	**Area (m^2)**	**C**	**Ft**	**A*C**	**Peak Flow (m^3/sec)**
Grassed areas around buildings	3118	0,45	0,83	1165	0,053
New Buildings	1518	0,85	0,83	1071	0,049
New internal roads and parking areas	516	0,85	0,83	364	0,017
TOTAL	**5152**			**Qri(post)**	**0,119**
AVERAGE RUN OFF COEFFICIENT IN DEVELOPED AREA		0,72			
PRE-DEVELOPMENT RUN OFF Vri(pre)=Qri*60*15(m^3)		51			
POST-DEVELOPMENT RUN OFF Vri(post)=Qri*60*15(m^3)		107			
REQUIRED STORAGE (m^3) [Vri(post) - Vri(pre)]		**56**			

ANNEXURE C

PRACTICAL EXAMPLES OF SWALES

AND ATTENUATION PONDS