2015

Storm-water Management Plan

NTATSHANA ACCESS ROAD AND BRIDGE

Umzumbe
MUNICIPALITY

PREPARED FOR:
UMZUMBE LOCAL MUNICIPALITY
SIPOFU ROAD
MATHULINI TRADITIONAL COUNCIL
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1. Brief Description of the Project and Study Area

The District Municipality appointed PGA Consulting Engineers (PGA) to evaluate the current level in terms of storm water management for the Ntatshana Access Road and Bridge development. Ntatshana road is located in the Umzumbe rural area under a village called KwaMaqhikizane within Umzumbe Local Municipality in Ward 08 on the Lower South Coast under the UGU District Municipality Area in Kwazulu Natal. KwaMaqhikizane village in the Ward 8 area is a medium size rural area which is approximately 120km from Hibberdene which is 25km north of Port Shepstone. The Ward 08 population is estimated to 36624 as projected from the 2011 census report and approximately 80% of this population is unemployed and has no personal income. The majorities of the people in Ward 8 have no formal education and are illiterate. Most people earn a living from governmental social grants, Pensions and others from informal trading. This report outlines the design carried out in fulfilment of the requirements of this assignment.
The extent of the Ntatshana Access Road and Bridge (2.50Km) is shown on Drawing No 1051/07
The total area of the site is 1.25 ha, a large surrounding portion of which is agricultural use.
Several notable features on the site are as follows –

- Low density residential township
- Generally covered with open veld
- Dwelling houses

2. IMPACT OF DEVELOPMENT ON EXISTING CATCHMENTS

The impacts of the proposed Ntatshana Access Road and Bridge on the environments in the affected catchments will range from negative to positive.
It is recognised that development impacts negatively on the natural drainage systems in several ways:

- Increase in hardened areas and reduced infiltration areas.
- Loss of vegetation and reduced evapo-transpiration potential.
- There will be an overall increase in surface runoff.
- Increase in the speed of runoff and peak flow rates in the watercourses.
- Permeability of the development area is decreased by the introduction of impervious areas such as surfaced streets.
- Decrease in the time runoff takes to reach the natural watercourses.
- Quicker responses in larger catchments make them more susceptible to the effects of high intensity, shorter duration storm events.
- The drainage systems are exposed to flows more frequent.
- The quality of the runoff deteriorates form the runoff from man-made environments which conveys spillages and discharges from vehicles, as well as eroded soil.

3. MITIGATION OF DEVELOPMENT CONSEQUENCES

The recommendations in the specialist studies highlight the importance of adequate attention to the following key issues:

- Protection of the natural watercourses to prevent pollution, erosion and retain runoff
- Provision of indigenous vegetation along watercourses and stabilisation of banks

• Local flood risk reduction by selection of appropriate design standards for culverts and stormwater attenuation facilities
• Attenuation of flood peaks to predevelopment levels at the 50-year & 100-year
• The potential increase in catchment runoff must be balanced against the combined effects of evapo-transpiration from catchment vegetation, evaporation from water bodies plus the retention and re-use of storm runoff.

4. OBJECTIVES

This stormwater management plan for the Ntatshana Access Road and Bridge has the following objectives:
1. To reduce flood damage, including damage to life and property.
2. Maintain the integrity of stream channels for their biological functions, as well as for drainage.
3. To conserve the flora and fauna of the natural environment.
4. To protect and enhance water resources in the catchments from pollution from new and existing development.
5. To protect and enhance the local and downstream water courses.
6. Minimize, to the extent practical, any increase in stormwater runoff from any new development.
7. Reduce soil erosion from any development or construction project as well as prevent erosion of soil by wind and water.

5. MAJOR RISKS

5.1 Flooding

The proposed development will tend to reduce the natural rainfall infiltration and increase storm runoff. Downstream flood damage risks will therefore increase unless adequate attenuation of flood runoff is provided collectively in the watercourses. The design of the major stormwater system must address this issue as far as possible and must be designed such that the downstream post-development flood risks are no greater than the pre-development flood risks.
As a guide to the degree of runoff attenuation required, pre-development and post development 50-year flood estimates are given in the attached appendices.

6. METHODOLOGY

The major stormwater system consists of all natural water ways, including springs, streams, rivers, wetlands. It includes detention dams and other devices constructed to control stormwater. Roadways and their associated drainage structures are also part of the major stormwater system if they result in a significant deflection of stormwater from its natural overland flow path.

The minor stormwater system consists of any measures provided to accommodate stormwater runoff within sites and road reserves and convey the runoff to the major stormwater system. These measures include gutters, channels, road verges and small watercourses.

The Stormwater Management Philosophy for the Ntatshana Access Road and Bridge developers, their professional teams, contractors and property owners to do the following:
• Maintain adequate ground cover at all places and at all times to negate the erosive forces of wind, water and all forms of traffic.
• Prevent concentration of stormwater flow at any point where the ground is susceptible to erosion.

• Ensure that development does not increase the rate of stormwater flow above that which the natural ground can safely accommodate at any point in the sub-catchments.
• Ensure that all stormwater control works are constructed in a safe and aesthetic manner in keeping with the overall development.
• Prevent pollution of water ways and water features by suspended solids and dissolved solids in stormwater discharges.
• Contain soil erosion, whether induced by wind or water forces, by constructing protective works to trap sediment at appropriate locations. This applies particularly during construction.
• Avoid situations where natural or artificial slopes may become saturated and unstable, both during and after the construction process.

7. STORMWATER MANAGEMENT POLICY

The following rules are to be observed by all developers, property owners, their professional teams, contractors and sub-contractors:
1. Designs for the buildings and site development in general must avoid concentration of stormwater runoff both spatially and in time and may be required to provide for on-site attenuation of stormwater runoff to limit peak flows to pre-development levels.
2. Detailed plans to control and prevent erosion by water must be agreed prior to the commencement of any works, including site clearance, on any portion of the site.
3. Removal of vegetation cover must be carried out with care and attention to the effect, whether temporary or long term, that this removal will have an erosion potential.
5. Landscaping and re-vegetation of areas not occupied by buildings or paving shall be programmed to proceed immediately after building works have been completed, or have reached a stage where newly established ground cover is not at risk from the construction works.
6. On-site stormwater control systems, such as swales, berms, soil fences and detention ponds are to be constructed before any construction commences on the site. As construction progresses, the stormwater control measures are to be monitored and adjusted to ensure complete erosion and pollution control at all times.
7. Where embankments have to be formed, stabilization and erosion control measures shall be implemented immediately.
8. Stormwater must not be allowed to pond in close proximity to existing building foundations.

8. MAJOR STORMWATER SYSTEMS

A plan indicating the sub-catchment delineation for this project is attached as an appendix with details and possible stormwater impacts indicated to advise the planning process and highlight critical areas for attention during the design phase.
The future results obtained should be documented in a Stormwater Systems Report that advises designers on the hydraulic capacities of the major system and provides parameters for further detailed design at specific locations within the overall development.
The parameters should include:
• Average depression storage values for pervious and impervious areas
• Equivalent Rational Method coefficients and unit area runoffs for developments

9. CRITICAL ASPECTS

1. Stormwater drainage is a crucial aspect in the development of the Ntatshana Access Road and Bridge and will require careful planning, designing and managing.
2. To ensure that water quality is not compromised, open ditches, drains and channels will need to be provided within the system. Attention must be given to the erodibility of channels where flow velocities are high and appropriate lining provided. Forms of lining will vary from natural vegetation to stone pitching.
3. While the stormwater management objective of the development should be to minimize the concentration of stormwater and attenuate flows as much as possible, roads and driveways cut into steeper slopes will cause storm runoff to be channelled and focused. Exit points should be located over flat ground, where sheet flow can be re-established or into culverts that convey the flow to a water body.
4. In preparing the sub-catchment boundaries, account has been taken of the natural watersheds and the probable impact of proposed roads on the flow of stormwater runoff.
5. The proposed development should not adversely impact on the environments of the development node and surrounding areas in terms of erosion and sediment deposition, but the frequency of flooding and the total runoff volume will increase unless adequate provision can be made to maintain the current natural rate of stormwater retention and infiltration in the sub-catchments.
6. An overall stormwater systems model should be developed to determine peak flood flow rates and flood levels for the main watercourses and assess the collective impacts of developments on runoff patterns. The outputs from the modelling will provide the input data required for the design of culverts, channels and other stormwater infrastructure associated with the proposed developments.
7. Detailed hydraulic analysis will be required during the design stage to assess storm runoff and flood levels at specific locations, such as bridges, road culverts and where properties are affected by the 100-year flood. It is important to note that although a structure may be designed for a return period less than 1 in 100 years, the design analysis must still assess the consequences resulting from a 100-year storm event.
10. The proposed development layouts will impact on storm runoff to varying degrees.
Adequate provision will have to be made for the management and disposal of stormwater runoff from the various internal developments as they are planned and this must be done in an integrated and coordinated process to avoid stormwater damage in the future.
11. Steeper watercourses will require protection from erosion through the use of appropriate channel lining, detention dams, or controlled drops to dissipate flow energy.
12. All natural and unlined channels should be inspected for adequate binding of soil by sustainable ground cover. Stone pitching should be used to reinforce channel inverts on steep slopes. Existing wetlands and stormwater detention areas should be protected from encroachment by the development.

10. GUIDELINES FOR OWNERS AND DEVELOPERS

All sub-developments within Ntatshana Access Road and Bridge will be required to control stormwater runoff in accordance with the stormwater management philosophy and policies of the Umzumbe Local Municipality.

10.1 STORMWATER RUNOFF CONTROL

Formal surface and underground stormwater systems are provided in the overall development for the acceptance of stormwater drainage, but it is important that the peak runoff rate from sites does not exceed the hydraulic capacities of the elements in the major stormwater system. The following are general guidelines for stormwater control from sites.

10.1.2 Roads

a) The principle of overland flow should apply to roadways where possible and roads should be designed and graded to avoid concentration of flow along and off the road.
b) Where flow concentration is unavoidable, measures to incorporate the road into the major stormwater system should be taken, with the provision of detention storage facilities at suitable points.
c) Inlet structures at culverts must be designed to ensure that the capacity of the culvert does not exceed the pre-development stormwater flow at that point and detention storage should be provided on the road and/or upstream of the stormwater culvert.
d) Outlet structures at a road culvert or a natural watercourse must be designed to dissipate flow energy and any unlined downstream channel must be adequately protected against soil erosion

10.1.3 Channels

a) Lined and unlined channels may be constructed to convey stormwater to a natural watercourse where deemed necessary and unavoidable.
b) Channels must be constructed with rough artificial surfaces, or lined with suitable, hardy vegetation, to be non-erodible and to provide maximum possible energy dissipation to the flow.

10.1.4 Energy Dissipaters

a) Measures should be taken to dissipate flow energy wherever concentrated stormwater flow is discharged down an embankment or erodible slope.
b) Attenuation dams should be provided at the head of the energy dissipating structure if possible.
c) A means of dissipating energy must be provided at the outfall of any drop structure to ensure stormwater flow is returned to a safe sub-critical state, or to disperse the flow.

10.1.5 Flow Retarders

a) Stormwater flow should be retarded wherever possible through the use of surface roughening or other flow restricting devices, provided these are designed and built to avoid blockages that could result in environmental and structural damage.
b) All such constructions must be regularly maintained by the owner and may be inspected at any time by Umzumbe Local Municipality or their appointed representatives.

10.2 STORMWATER POLLUTION CONTROL

a) All property owners and developers shall ensure that no materials, fluids or substances are allowed to enter the stormwater system that could have a detrimental effect on the flora, fauna and aquatic life in the water courses.
b) Regular monitoring of sites within the catchment should be undertaken by Umzumbe Local Municipality or their appointed representatives.

c) The owner of any site that is required to store any substances that could be regarded as hazardous in terms of water pollution shall notify the Umzumbe Local Municipality and shall take measures to ensure spillages of the substance(s) can be adequately contained to prevent contamination of the water resources within the development area.
d) No stormwater, wash water, or waste water may be directed towards any permanent water body or wetland without the installation of a suitable filtration system to prevent pollution, including silt, from entering such water body.

10.3 STORMWATER EROSION CONTROL

Stormwater erosion is one of the most challenging factors of stormwater management as it happens quickly and destructively. With the slopes in the study area being fairly steeply, surface runoff on bare soil could have negative impacts. Should erosion occur the eroded soil may need to be replaced and awareness is necessary not to use unsuitable soil which may have negative impact on the natural surrounds.
Sand bags/Straw bales may be used to prevent erosion during the construction phase before stabilising vegetation is established. Planting of rapidly growing grasses is recommended after construction to stabilise disturb soil and to retard sheet flow.

The Umzumbe Local Municipality may inspect the Ntatshana Access Road and Bridge on a regular basis to:
a) Determine the effectiveness of the stormwater management policies and amend policy as and when necessary to meet the objectives of the Stormwater Management Plan.

11. STORMWATER PLAN IMPLEMENTATION PROCEDURES

The following procedures are to be followed by owners, developers, appointed agents, professional teams and contractors:
1. Application for Permission to Build
A copy of the Stormwater Management Plan shall be obtained from the Umzumbe Local Municipality.
2. Site Survey and Investigations
Anyone involved in site survey and investigation work shall be familiar with the contents of the Stormwater Management Plan.
3. Design Stage
The professional team shall take into account the stormwater management requirements contained in this document and shall clearly indicate on all plans and in any contract document where and how measures have been provided in the design to ensure the stormwater management requirements are implemented. Approval from the Umzumbe Local Municipality must be obtained before commencing construction.
4. Construction
The contractor shall prepare a Stormwater Control Plan to ensure that all construction methods adopted on site and within the Ntatshana Access Road and Bridge do not cause, or precipitate, soil erosion and shall take adequate steps to ensure that the requirements of the Stormwater Management Plan are met before, during and after construction.
5. Certificate of Occupation

On completion of the works, the Umzumbe Local Municipality, or their appointed professional person will inspect the site for compliance with the stormwater management requirements, prior to the issuing of a Certificate of completion by the Umzumbe Local Municipality.

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12. HYDROLOGY

12.1 Catchment Characteristics

Using topographical survey, the project area was delineated into 10 stormwater sub-catchments. The characteristics of these are tabled below:

Catchment	Area (ha)	Existing Land Use	Primary Proposed Land Use	Predominant Slope
1	0.2	Agriculture	Road	1:2
2	0.1	Agriculture	Road	1:2
3	0.15	Agriculture	Road	1:3
4	0.1	Agriculture	Road	1:4
5	0.2	Agriculture	Road	1:3
6	0.18	Agriculture	Road	1:5
7	0.06	Agriculture	Road	1:8
8	0.07	Agriculture	Road	1:10
9	0.4	Agriculture	Road	1:12
10	0.02	Agriculture	Road	1:6

12.2 Rational Method

(Refer to attached Appendix B)

The DWA Rational Method was used to estimate the peak stormwater runoffs per subcatchment as a result of this development. The results of these calculations are summarized in the attached appendices.

Rainfall data obtained from Umzumbe Local Municipality for the 1 in 50 and 1 in 100 year return periods was used in these calculations.

Following the delineation of the project area into subcatchments, the primary drainage lines were identified and analysed to determine the time of concentration

The Tc's were then used to select appropriate storm durations from the rainfall data available.

In the DWA Rational Method, the pre-development C-factors are influenced by the steepness of the sub-catchment, the permeability of the soil and type of vegetal cover.

Surveys (analysis of the topographic survey) were undertaken and used to determine the range of pre-development slopes in each sub-catchment. These are summarized in Appendix B.

The post development C-factors were determined by measuring the area of each land use within a sub-catchment and then weighting the appropriate C-factors according to the ratio of land use versus overall area.

APPENDIX A

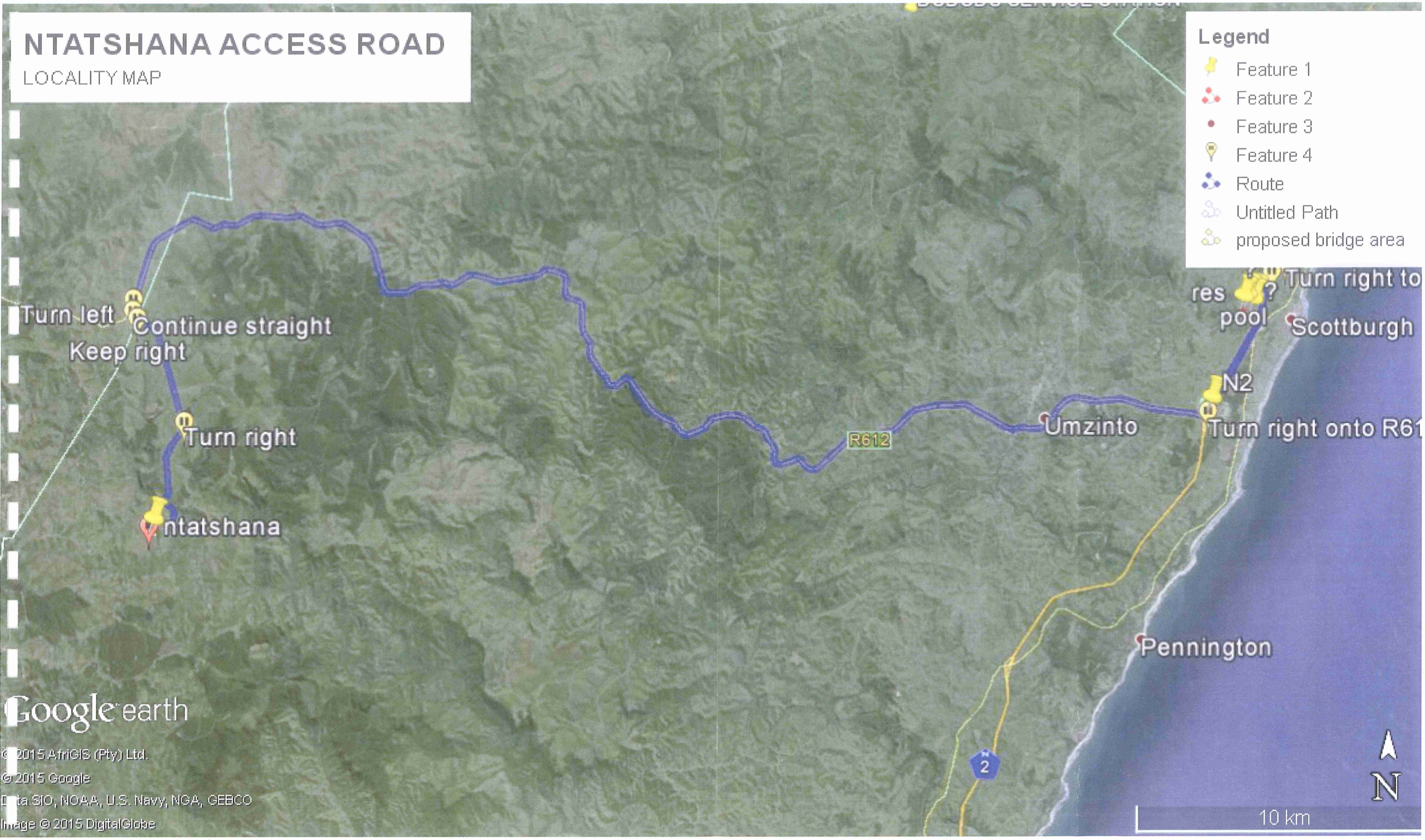
- Locality plan
- General layout

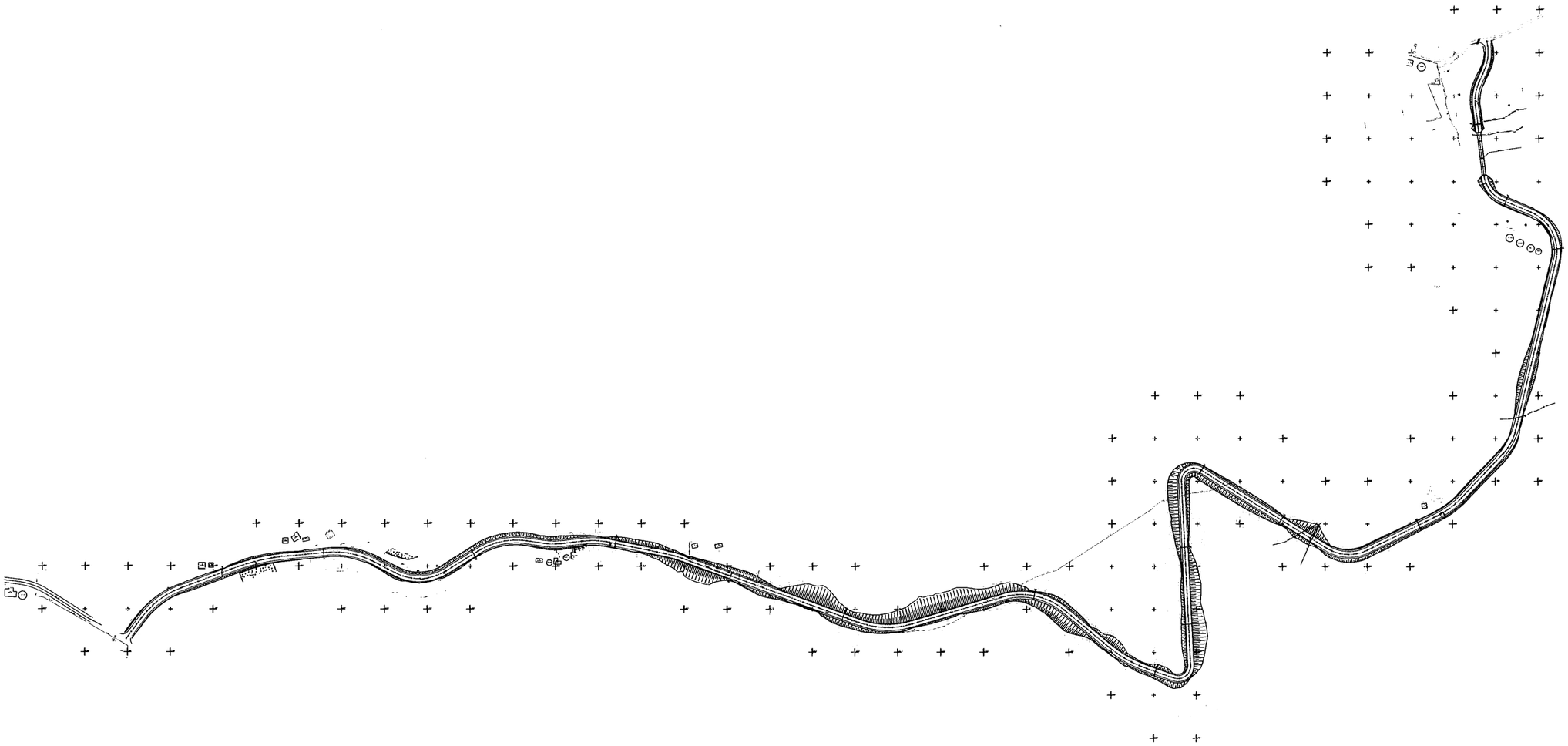
(1051/07-SHEET 00)

APPENDIX B

NTATSHANA ACCESS ROAD

LOCALITY MAP





Designed :		Date
Drawn :		Date
Approved :		Date

Client :

UMZUMBE LOCAL MUNICIPALITY

Project :

NTATSHANA ACCESS ROAD

Drawing Description :

PLAN LAYOUT

Scale :

Drawing No : 1051/07 SHEET 00

APPENDIX B

Sub Catchment 1

PRE DEVELOPMENT CALCULATIONS

Size of Catchment:
A = 2000 m²
0,20 Ha

Longest Watercourse:
L = 200 m
0,20 km

Average Slope:
S = 0,01681

Area distribution:
Rural = 85%
Urban = 2%
Lakes = 13%

Type of Water Flow: Watercourse
Closest Weather Station: Durban
Mean Annual Rainfall (mm): 1000
Overland Properties: Sparse Grass
r Value = 0,3
Rainfall Region: Inland

Rural C1								
Surface Slope (%)			Permeability (%)			Vegetation (%)		
Cs	100	0,271	Cp	100	0,159	Cv	100	0,170
Vlei's & Pans (<3%)	0	0,000	Very Permeable	10	0,005	Thick Bush & Plant	30	0,015
Flat Areas (3% - 10%)	5	0,006	Permeable	40	0,044	Light Bush & Farm-	20	0,030
Hilly (10% - 30%)	20	0,040	Semi - Permeable	40	0,080	Grass-lands	50	0,125
Steep Areas (>30%)	75	0,225	Impermeable	10	0,030	No Vegetation	0	0,000

Urban C2			
Use (%)	100	Classification	0,355
Lawns & Parks	50	eavy Soil, Flat - Steep (2% - 7%	0,105
City / Residential	50	Houses - Per Family	0,250
Business	0	Suburban	0,000
Streets	0	Streets	0,000

Time of Concentration (tc): 0,0926 hrs | 15,00 min | 0,25 hrs

1	2	5	10	25	50	100	1:? YEAR
77,193	95,036	125,103	154,020	202,749	249,614	307,311	mm/h

Run off Factors C:								
	Rural C1	0,600	0,600	0,600	0,600	0,600	0,600	0,600
	Urban C2	0,355	0,355	0,355	0,355	0,355	0,355	0,355
	Average	0,485	0,485	0,517	0,550	0,582	0,614	0,647
Discharge (Q)		0,021	0,026	0,036	0,047	0,066	0,085	0,110 m³/s

POST DEVELOPMENT CALCULATIONS

Size of Catchment:
A = 2000 m²
0,20 Ha

Longest Watercourse:
L = 200 m
0,20 km

Average Slope:
S = 0,01681

Area distribution:
Rural = 77%
Urban = 10%
Lakes = 13%

Type of Water Flow: Watercourse
Closest Weather Station: Durban
Mean Annual Rainfall (mm): 1000
Overland Properties: sparse grass
r Value = 0,3
Rainfall Region: Inland

Rural C1								
Surface Slope (%)			Permeability (%)			Vegetation (%)		
Cs	100	0,050	Cp	100	0,159	Cv	100	0,170
Vlei's & Pans (<3%)	0	0,000	Very Permeable	10	0,005	Thick Bush & Plant	30	0,015
Flat Areas (3% - 10%)	5	0,003	Permeable	40	0,044	Light Bush & Farm-	20	0,030
Hilly (10% - 30%)	20	0,010	Semi - Permeable	40	0,080	Grass-lands	50	0,125
Steep Areas (>30%)	75	0,038	Impermeable	10	0,030	No Vegetation	0	0,000

Urban C2			
Use (%)	100	Classification	0,355
Lawns & Parks	50	eavy Soil, Flat - Steep (2% - 7%	0,105
City / Residential	50	Houses - Per Family	0,250
Business	0	Suburban	0,000
Streets	0	Streets	0,000

Time of Concentration (tc): 0,0926 hrs | 15,00 min | 0,25 hrs

1	2	5	10	25	50	100	1:? YEAR
77,193	95,036	125,103	154,020	202,749	249,614	307,311	mm/h

Run off Factors C:								
	Rural C1	0,379	0,379	0,379	0,379	0,379	0,379	0,379
	Urban C2	0,355	0,355	0,355	0,355	0,355	0,355	0,355
	Average	0,457	0,457	0,457	0,457	0,457	0,457	0,457
Discharge (Q)		0,020	0,024	0,032	0,039	0,052	0,063	0,078 m³/s

Flow to Attenuate 0,022 m³/s
Volume to Attenuate 20 m³
Plan Area of Pond 20 m²
Depth of Pond 1,00 m

Outlet Slope 0,0125
Mannings Value (n) 0,010
owed discharge (Q) 0,047 m³/s
Number of Outlets 1

Outlet Diameter 199 mm

Sub Catchment 2

PRE DEVELOPMENT CALCULATIONS

Size of Catchment:
A = 1000 m²
0,10 Ha

Longest Watercourse:
L = 200 m
0,20 km

Average Slope:
S = 0,01681

Area distribution:
Rural = 85%
Urban = 2%
Lakes = 13%

Type of Water Flow: Watercourse
Closest Weather Station: Durban
Mean Annual Rainfall (mm): 1000
Overland Properties: Sparse Grass
r Value = 0,3
Rainfall Region: Inland

Rural C1								
Surface Slope (%)			Permeability (%)			Vegetation (%)		
Cs	100	0,271	Cp	100	0,159	Cv	100	0,170
Vlei's & Pans (<3%)	0	0,000	Very Permeable	10	0,005	Thick Bush & Plant	30	0,015
Flat Areas (3% - 10%)	5	0,006	Permeable	40	0,044	Light Bush & Farm-	20	0,030
Hilly (10% - 30%)	20	0,040	Semi - Permeable	40	0,080	Grass-lands	50	0,125
Steep Areas (>30%)	75	0,225	Impermeable	10	0,030	No Vegetation	0	0,000

Urban C2			
Use (%)	100	Classification	0,355
Lawns & Parks	50	eavy Soil, Flat - Steep (2% - 7%	0,105
City / Residential	50	Houses - Per Family	0,250
Business	0	Suburban	0,000
Streets	0	Streets	0,000

Time of Concentration (tc): 0,0926 hrs | 15,00 min | 0,25 hrs

1	2	5	10	25	50	100	1:? YEAR
77,193	95,036	125,103	154,020	202,749	249,614	307,311	mm/h

Run off Factors C:								
	Rural C1	0,600	0,600	0,600	0,600	0,600	0,600	0,600
	Urban C2	0,355	0,355	0,355	0,355	0,355	0,355	0,355
	Average	0,485	0,485	0,517	0,550	0,582	0,614	0,647
	Discharge (Q)	0,010	0,013	0,018	0,024	0,033	0,043	0,055 m³/s

POST DEVELOPMENT CALCULATIONS

Size of Catchment:
A = 1000 m²
0,10 Ha

Longest Watercourse:
L = 200 m
0,20 km

Average Slope:
S = 0,01681

Area distribution:
Rural = 77%
Urban = 10%
Lakes = 13%

Type of Water Flow: Watercourse
Closest Weather Station: Durban
Mean Annual Rainfall (mm): 1000
Overland Properties: sparse grass
r Value = 0,3
Rainfall Region: Inland

Rural C1								
Surface Slope (%)			Permeability (%)			Vegetation (%)		
Cs	100	0,050	Cp	100	0,159	Cv	100	0,170
Vlei's & Pans (<3%)	0	0,000	Very Permeable	10	0,005	Thick Bush & Plant	30	0,015
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Hilly (10% - 30%)	20	0,010	Semi - Permeable	40	0,080	Grass-lands	50	0,125
Steep Areas (>30%)	75	0,038	Impermeable	10	0,030	No Vegetation	0	0,000

Urban C2			
Use (%)	100	Classification	0,355
Lawns & Parks	50	eavy Soil, Flat - Steep (2% - 7%	0,105
City / Residential	50	Houses - Per Family	0,250
Business	0	Suburban	0,000
Streets	0	Streets	0,000

Time of Concentration (tc): 0,0926 hrs | 15,00 min | 0,25 hrs

1	2	5	10	25	50	100	1:? YEAR
77,193	95,036	125,103	154,020	202,749	249,614	307,311	mm/h

Run off Factors C:								
	Rural C1	0,379	0,379	0,379	0,379	0,379	0,379	0,379
	Urban C2	0,355	0,355	0,355	0,355	0,355	0,355	0,355
	Average	0,457	0,457	0,457	0,457	0,457	0,457	0,457
	Discharge (Q)	0,010	0,012	0,016	0,020	0,026	0,032	0,039 m³/s

Flow to Attenuate 0,011 m³/s
Volume to Attenuate 10 m³
Plan Area of Pond 10 m²
Depth of Pond 1,00 m

Outlet Slope 0,0125
Mannings Value (n) 0,010
owed discharge (Q) 0,024 m³/s
Number of Outlets 1

Outlet Diameter 153 mm

Sub Catchment 3

PRE DEVELOPMENT CALCULATIONS

Size of Catchment:
A = 1500 m²
0,15 Ha

Longest Watercourse:
L = 250 m
0,25 km

Average Slope:
S = 0,01681

Type of Water Flow: Watercourse

Closest Weather Station: Durban
Mean Annual Rainfall (mm): 1000

Overland Properties: Sparse Grass
r Value = 0,3

Rainfall Region: Inland

Area distribution:
Rural = 85%
Urban = 2%
Lakes = 13%

Rural C1								
Surface Slope (%)			Permeability (%)			Vegetation (%)		
Cs	100	0,271	Cp	100	0,159	Cv	100	0,170
Vlei's & Pans (<3%)	0	0,000	Very Permeable	10	0,005	Thick Bush & Plant	30	0,015
Flat Areas (3% - 10%)	5	0,006	Permeable	40	0,044	Light Bush & Farm-	20	0,030
Hilly (10% - 30%)	20	0,040	Semi - Permeable	40	0,080	Grass-lands	50	0,125
Steep Areas (>30%)	75	0,225	Impermeable	10	0,030	No Vegetation	0	0,000

Urban C2			
Use (%)	100	Classification	0,355
Lawns & Parks	50	eavy Soil, Flat - Steep (2% - 7%	0,105
City / Residential	50	Houses - Per Family	0,250
Business	0	Suburban	0,000
Streets	0	Streets	0,000

Time of Concentration (tc): 0,1100 hrs | 15,00 min | 0,25 hrs

1	2	5	10	25	50	100	1:? YEAR
77,193	95,036	125,103	154,020	202,749	249,614	307,311	mm/h

Run off Factors C:								
	Rural C1	0,600	0,600	0,600	0,600	0,600	0,600	0,600
	Urban C2	0,355	0,355	0,355	0,355	0,355	0,355	0,355
	Average	0,485	0,485	0,517	0,550	0,582	0,614	0,647
	Discharge (Q)	0,016	0,019	0,027	0,035	0,049	0,064	0,083 m³/s

POST DEVELOPMENT CALCULATIONS

Size of Catchment:
A = 1500 m²
0,15 Ha

Longest Watercourse:
L = 250 m
0,25 km

Average Slope:
S = 0,01681

Type of Water Flow: Watercourse

Closest Weather Station: Durban
Mean Annual Rainfall (mm): 1000

Overland Properties: sparse grass
r Value = 0,3

Rainfall Region: Inland

Area distribution:
Rural = 77%
Urban = 10%
Lakes = 13%

Rural C1								
Surface Slope (%)			Permeability (%)			Vegetation (%)		
Cs	100	0,050	Cp	100	0,159	Cv	100	0,170
Vlei's & Pans (<3%)	0	0,000	Very Permeable	10	0,005	Thick Bush & Plant	30	0,015
Flat Areas (3% - 10%)	5	0,003	Permeable	40	0,044	Light Bush & Farm-	20	0,030
Hilly (10% - 30%)	20	0,010	Semi - Permeable	40	0,080	Grass-lands	50	0,125
Steep Areas (>30%)	75	0,038	Impermeable	10	0,030	No Vegetation	0	0,000

Urban C2			
Use (%)	100	Classification	0,355
Lawns & Parks	50	eavy Soil, Flat - Steep (2% - 7%	0,105
City / Residential	50	Houses - Per Family	0,250
Business	0	Suburban	0,000
Streets	0	Streets	0,000

Time of Concentration (tc): 0,1100 hrs | 15,00 min | 0,25 hrs

1	2	5	10	25	50	100	1:? YEAR
77,193	95,036	125,103	154,020	202,749	249,614	307,311	mm/h

Run off Factors C:								
	Rural C1	0,379	0,379	0,379	0,379	0,379	0,379	0,379
	Urban C2	0,355	0,355	0,355	0,355	0,355	0,355	0,355
	Average	0,457	0,457	0,457	0,457	0,457	0,457	0,457
	Discharge (Q)	0,015	0,018	0,024	0,029	0,039	0,048	0,059 m³/s

Flow to Attenuate 0,016 m³/s
Outlet Slope 0,0125
Outlet Diameter 179 mm

Volume to Attenuate 15 m³
Mannings Value (n) 0,010

Plan Area of Pond 15 m²
owed discharge (Q) 0,035 m³/s

Depth of Pond 1,00 m
Number of Outlets 1

Sub Catchment 4

PRE DEVELOPMENT CALCULATIONS

Size of Catchment:
A = 1000 m²
0,10 Ha

Longest Watercourse:
L = 200 m
0,20 km

Average Slope:
S = 0,01681

Type of Water Flow: Watercourse

Closest Weather Station: Durban

Mean Annual Rainfall (mm): 1000

Overland Properties: Sparse Grass

r Value = 0,3

Rainfall Region: Inland

Area distribution:
Rural = 85%
Urban = 2%
Lakes = 13%

Rural C1								
Surface Slope (%)			Permeability (%)			Vegetation (%)		
Cs	100	0,271	Cp	100	0,159	Cv	100	0,170
Vlei's & Pans (<3%)	0	0,000	Very Permeable	10	0,005	Thick Bush & Plant	30	0,015
Flat Areas (3% - 10%)	5	0,006	Permeable	40	0,044	Light Bush & Farm-	20	0,030
Hilly (10% - 30%)	20	0,040	Semi - Permeable	40	0,080	Grass-lands	50	0,125
Steep Areas (>30%)	75	0,225	Impermeable	10	0,030	No Vegetation	0	0,000

Urban C2			
Use (%)	100	Classification	0,355
Lawns & Parks	50	eavy Soil, Flat - Steep (2% - 7%	0,105
City / Residential	50	Houses - Per Family	0,250
Business	0	Suburban	0,000
Streets	0	Streets	0,000

Time of Concentration (tc): 0,0926 hrs | 15,00 min | 0,25 hrs

1	2	5	10	25	50	100	1:? YEAR
77,193	95,036	125,103	154,020	202,749	249,614	307,311	mm/h

Run off Factors C:								
	Rural C1	0,600	0,600	0,600	0,600	0,600	0,600	0,600
	Urban C2	0,355	0,355	0,355	0,355	0,355	0,355	0,355
	Average	0,485	0,485	0,517	0,550	0,582	0,614	0,647
	Discharge (Q)	0,010	0,013	0,018	0,024	0,033	0,043	0,055 m³/s

POST DEVELOPMENT CALCULATIONS

Size of Catchment:
A = 1000 m²
0,10 Ha

Longest Watercourse:
L = 200 m
0,20 km

Average Slope:
S = 0,01681

Type of Water Flow: Watercourse

Closest Weather Station: Durban

Mean Annual Rainfall (mm): 1000

Overland Properties: sparse grass

r Value = 0,3

Rainfall Region: Inland

Area distribution:
Rural = 77%
Urban = 10%
Lakes = 13%

Rural C1								
Surface Slope (%)			Permeability (%)			Vegetation (%)		
Cs	100	0,050	Cp	100	0,159	Cv	100	0,170
Vlei's & Pans (<3%)	0	0,000	Very Permeable	10	0,005	Thick Bush & Plant	30	0,015
Flat Areas (3% - 10%)	5	0,003	Permeable	40	0,044	Light Bush & Farm-	20	0,030
Hilly (10% - 30%)	20	0,010	Semi - Permeable	40	0,080	Grass-lands	50	0,125
Steep Areas (>30%)	75	0,038	Impermeable	10	0,030	No Vegetation	0	0,000

Urban C2			
Use (%)	100	Classification	0,355
Lawns & Parks	50	eavy Soil, Flat - Steep (2% - 7%	0,105
City / Residential	50	Houses - Per Family	0,250
Business	0	Suburban	0,000
Streets	0	Streets	0,000

Time of Concentration (tc): 0,0926 hrs | 15,00 min | 0,25 hrs

1	2	5	10	25	50	100	1:? YEAR
77,193	95,036	125,103	154,020	202,749	249,614	307,311	mm/h

Run off Factors C:								
	Rural C1	0,379	0,379	0,379	0,379	0,379	0,379	0,379
	Urban C2	0,355	0,355	0,355	0,355	0,355	0,355	0,355
	Average	0,457	0,457	0,457	0,457	0,457	0,457	0,457
	Discharge (Q)	0,010	0,012	0,016	0,020	0,026	0,032	0,039 m³/s

Flow to Attenuate 0,011 m³/s

Outlet Slope 0,0125

Outlet Diameter 153 mm

Volume to Attenuate 10 m³

Mannings Value (n) 0,010

Plan Area of Pond 10 m²

owed discharge (Q) 0,024 m³/s

Depth of Pond 1,00 m

Number of Outlets 1

Sub Catchment 5

PRE DEVELOPMENT CALCULATIONS

Size of Catchment:
A = 2000 m²
0,20 Ha

Longest Watercourse:
L = 200 m
0,20 km

Average Slope:
S = 0,01681

Type of Water Flow: Watercourse

Closest Weather Station: Durban

Mean Annual Rainfall (mm): 1000

Overland Properties: Sparse Grass

r Value = 0,3

Rainfall Region: Inland

Area distribution:
Rural = 85%
Urban = 2%
Lakes = 13%

Rural C1								
Surface Slope (%)			Permeability (%)			Vegetation (%)		
Cs	100	0,271	Cp	100	0,159	Cv	100	0,170
Vlei's & Pans (<3%)	0	0,000	Very Permeable	10	0,005	Thick Bush & Plant	30	0,015
Flat Areas (3% - 10%)	5	0,006	Permeable	40	0,044	Light Bush & Farm-	20	0,030
Hilly (10% - 30%)	20	0,040	Semi - Permeable	40	0,080	Grass-lands	50	0,125
Steep Areas (>30%)	75	0,225	Impermeable	10	0,030	No Vegetation	0	0,000

Urban C2			
Use (%)	100	Classification	0,355
Lawns & Parks	50	eavy Soil, Flat - Steep (2% - 7%	0,105
City / Residential	50	Houses - Per Family	0,250
Business	0	Suburban	0,000
Streets	0	Streets	0,000

Time of Concentration (tc): 0,0926 hrs | 15,00 min | 0,25 hrs

1	2	5	10	25	50	100	1:? YEAR
77,193	95,036	125,103	154,020	202,749	249,614	307,311	mm/h

Run off Factors C:								
	Rural C1	0,600	0,600	0,600	0,600	0,600	0,600	0,600
	Urban C2	0,355	0,355	0,355	0,355	0,355	0,355	0,355
	Average	0,485	0,485	0,517	0,550	0,582	0,614	0,647
	Discharge (Q)	0,021	0,026	0,036	0,047	0,066	0,085	0,110 m³/s

POST DEVELOPMENT CALCULATIONS

Size of Catchment:
A = 2000 m²
0,20 Ha

Longest Watercourse:
L = 200 m
0,20 km

Average Slope:
S = 0,01681

Type of Water Flow: Watercourse

Closest Weather Station: Durban

Mean Annual Rainfall (mm): 1000

Overland Properties: sparse grass

r Value = 0,3

Rainfall Region: Inland

Area distribution:
Rural = 77%
Urban = 10%
Lakes = 13%

Rural C1								
Surface Slope (%)			Permeability (%)			Vegetation (%)		
Cs	100	0,050	Cp	100	0,159	Cv	100	0,170
Vlei's & Pans (<3%)	0	0,000	Very Permeable	10	0,005	Thick Bush & Plant	30	0,015
Flat Areas (3% - 10%)	5	0,003	Permeable	40	0,044	Light Bush & Farm-	20	0,030
Hilly (10% - 30%)	20	0,010	Semi - Permeable	40	0,080	Grass-lands	50	0,125
Steep Areas (>30%)	75	0,038	Impermeable	10	0,030	No Vegetation	0	0,000

Urban C2			
Use (%)	100	Classification	0,355
Lawns & Parks	50	eavy Soil, Flat - Steep (2% - 7%	0,105
City / Residential	50	Houses - Per Family	0,250
Business	0	Suburban	0,000
Streets	0	Streets	0,000

Time of Concentration (tc): 0,0926 hrs | 15,00 min | 0,25 hrs

1	2	5	10	25	50	100	1:? YEAR
77,193	95,036	125,103	154,020	202,749	249,614	307,311	mm/h

Run off Factors C:								
	Rural C1	0,379	0,379	0,379	0,379	0,379	0,379	0,379
	Urban C2	0,355	0,355	0,355	0,355	0,355	0,355	0,355
	Average	0,457	0,457	0,457	0,457	0,457	0,457	0,457
	Discharge (Q)	0,020	0,024	0,032	0,039	0,052	0,063	0,078 m³/s

Flow to Attenuate 0,022 m³/s

Outlet Slope 0,0125

Outlet Diameter 199 mm

Volume to Attenuate 20 m³

Mannings Value (n) 0,010

Plan Area of Pond 20 m²

owed discharge (Q) 0,047 m³/s

Depth of Pond 1,00 m

Number of Outlets 1

Sub Catchment 6

PRE DEVELOPMENT CALCULATIONS

Size of Catchment:
A = 1800 m²
0,18 Ha

Longest Watercourse:
L = 300 m
0,30 km

Average Slope:
S = 0,01681

Type of Water Flow: Watercourse

Closest Weather Station: Durban

Mean Annual Rainfall (mm): 1000

Overland Properties: Sparse Grass

r Value = 0,3

Rainfall Region: Inland

Area distribution:
Rural = 85%
Urban = 2%
Lakes = 13%

Rural C1								
Surface Slope (%)			Permeability (%)			Vegetation (%)		
Cs	100	0,271	Cp	100	0,159	Cv	100	0,170
Vlei's & Pans (<3%)	0	0,000	Very Permeable	10	0,005	Thick Bush & Plant	30	0,015
Flat Areas (3% - 10%)	5	0,006	Permeable	40	0,044	Light Bush & Farm-	20	0,030
Hilly (10% - 30%)	20	0,040	Semi - Permeable	40	0,080	Grass-lands	50	0,125
Steep Areas (>30%)	75	0,225	Impermeable	10	0,030	No Vegetation	0	0,000

Urban C2			
Use (%)	100	Classification	0,355
Lawns & Parks	50	eavy Soil, Flat - Steep (2% - 7%	0,105
City / Residential	50	Houses - Per Family	0,250
Business	0	Suburban	0,000
Streets	0	Streets	0,000

Time of Concentration (tc): 0,1266 hrs | 15,00 min | 0,25 hrs

1	2	5	10	25	50	100	1:? YEAR
77,193	95,036	125,103	154,020	202,749	249,614	307,311	mm/h

Run off Factors C:								
	Rural C1	0,600	0,600	0,600	0,600	0,600	0,600	0,600
	Urban C2	0,355	0,355	0,355	0,355	0,355	0,355	0,355
	Average	0,485	0,485	0,517	0,550	0,582	0,614	0,647
	Discharge (Q)	0,019	0,023	0,032	0,042	0,059	0,077	0,099 m³/s

POST DEVELOPMENT CALCULATIONS

Size of Catchment:
A = 1800 m²
0,18 Ha

Longest Watercourse:
L = 300 m
0,30 km

Average Slope:
S = 0,01681

Type of Water Flow: Watercourse

Closest Weather Station: Durban

Mean Annual Rainfall (mm): 1000

Overland Properties: sparse grass

r Value = 0,3

Rainfall Region: Inland

Area distribution:
Rural = 77%
Urban = 10%
Lakes = 13%

Rural C1								
Surface Slope (%)			Permeability (%)			Vegetation (%)		
Cs	100	0,050	Cp	100	0,159	Cv	100	0,170
Vlei's & Pans (<3%)	0	0,000	Very Permeable	10	0,005	Thick Bush & Plant	30	0,015
Flat Areas (3% - 10%)	5	0,003	Permeable	40	0,044	Light Bush & Farm-	20	0,030
Hilly (10% - 30%)	20	0,010	Semi - Permeable	40	0,080	Grass-lands	50	0,125
Steep Areas (>30%)	75	0,038	Impermeable	10	0,030	No Vegetation	0	0,000

Urban C2			
Use (%)	100	Classification	0,355
Lawns & Parks	50	eavy Soil, Flat - Steep (2% - 7%	0,105
City / Residential	50	Houses - Per Family	0,250
Business	0	Suburban	0,000
Streets	0	Streets	0,000

Time of Concentration (tc): 0,1266 hrs | 15,00 min | 0,25 hrs

1	2	5	10	25	50	100	1:? YEAR
77,193	95,036	125,103	154,020	202,749	249,614	307,311	mm/h

Run off Factors C:								
	Rural C1	0,379	0,379	0,379	0,379	0,379	0,379	0,379
	Urban C2	0,355	0,355	0,355	0,355	0,355	0,355	0,355
	Average	0,457	0,457	0,457	0,457	0,457	0,457	0,457
	Discharge (Q)	0,018	0,022	0,029	0,035	0,046	0,057	0,070 m³/s

Flow to Attenuate 0,020 m³/s

Volume to Attenuate 18 m³

Plan Area of Pond 18 m²

Depth of Pond 1,00 m

Outlet Slope 0,0125

Mannings Value (n) 0,010

owed discharge (Q) 0,042 m³/s

Number of Outlets 1

Outlet Diameter 191 mm

Sub Catchment 7

PRE DEVELOPMENT CALCULATIONS

Size of Catchment:
A = 600 m²
0,06 Ha

Longest Watercourse:
L = 250 m
0,25 km

Average Slope:
S = 0,01681

Area distribution:
Rural = 85%
Urban = 2%
Lakes = 13%

Type of Water Flow: Watercourse

Closest Weather Station: Durban
Mean Annual Rainfall (mm): 1000

Overland Properties: Sparse Grass
r Value = 0,3

Rainfall Region: Inland

Rural C1								
Surface Slope (%)			Permeability (%)			Vegetation (%)		
Cs	100	0,271	Cp	100	0,159	Cv	100	0,170
Vlei's & Pans (<3%)	0	0,000	Very Permeable	10	0,005	Thick Bush & Plant	30	0,015
Flat Areas (3% - 10%)	5	0,006	Permeable	40	0,044	Light Bush & Farm-	20	0,030
Hilly (10% - 30%)	20	0,040	Semi - Permeable	40	0,080	Grass-lands	50	0,125
Steep Areas (>30%)	75	0,225	Impermeable	10	0,030	No Vegetation	0	0,000

Urban C2			
Use (%)	100	Classification	0,355
Lawns & Parks	50	eavy Soil, Flat - Steep (2% - 7%	0,105
City / Residential	50	Houses - Per Family	0,250
Business	0	Suburban	0,000
Streets	0	Streets	0,000

Time of Concentration (tc): 0,1100 hrs | 15,00 min | 0,25 hrs

1	2	5	10	25	50	100	1:? YEAR
77,193	95,036	125,103	154,020	202,749	249,614	307,311	mm/h

Run off Factors C:								
	Rural C1	0,600	0,600	0,600	0,600	0,600	0,600	0,600
	Urban C2	0,355	0,355	0,355	0,355	0,355	0,355	0,355
	Average	0,485	0,485	0,517	0,550	0,582	0,614	0,647
	Discharge (Q)	0,006	0,008	0,011	0,014	0,020	0,026	0,033 m³/s

POST DEVELOPMENT CALCULATIONS

Size of Catchment:
A = 600 m²
0,06 Ha

Longest Watercourse:
L = 250 m
0,25 km

Average Slope:
S = 0,01681

Area distribution:
Rural = 77%
Urban = 10%
Lakes = 13%

Type of Water Flow: Watercourse

Closest Weather Station: Durban
Mean Annual Rainfall (mm): 1000

Overland Properties: sparse grass
r Value = 0,3

Rainfall Region: Inland

Rural C1								
Surface Slope (%)			Permeability (%)			Vegetation (%)		
Cs	100	0,050	Cp	100	0,159	Cv	100	0,170
Vlei's & Pans (<3%)	0	0,000	Very Permeable	10	0,005	Thick Bush & Plant	30	0,015
Flat Areas (3% - 10%)	5	0,003	Permeable	40	0,044	Light Bush & Farm-	20	0,030
Hilly (10% - 30%)	20	0,010	Semi - Permeable	40	0,080	Grass-lands	50	0,125
Steep Areas (>30%)	75	0,038	Impermeable	10	0,030	No Vegetation	0	0,000

Urban C2			
Use (%)	100	Classification	0,355
Lawns & Parks	50	eavy Soil, Flat - Steep (2% - 7%	0,105
City / Residential	50	Houses - Per Family	0,250
Business	0	Suburban	0,000
Streets	0	Streets	0,000

Time of Concentration (tc): 0,1100 hrs | 15,00 min | 0,25 hrs

1	2	5	10	25	50	100	1:? YEAR
77,193	95,036	125,103	154,020	202,749	249,614	307,311	mm/h

Run off Factors C:								
	Rural C1	0,379	0,379	0,379	0,379	0,379	0,379	0,379
	Urban C2	0,355	0,355	0,355	0,355	0,355	0,355	0,355
	Average	0,457	0,457	0,457	0,457	0,457	0,457	0,457
	Discharge (Q)	0,006	0,007	0,010	0,012	0,015	0,019	0,023 m³/s

Flow to Attenuate 0,007 m³/s
Volume to Attenuate 6 m³
Plan Area of Pond 6 m²
Depth of Pond 1,00 m

Outlet Slope 0,0125
Mannings Value (n) 0,010
owed discharge (Q) 0,014 m³/s
Number of Outlets 1

Outlet Diameter 127 mm

Sub Catchment 8

PRE DEVELOPMENT CALCULATIONS

Size of Catchment:
A = 700 m²
0,07 Ha

Longest Watercourse:
L = 350 m
0,35 km

Average Slope:
S = 0,01681

Type of Water Flow: Watercourse

Closest Weather Station: Durban

Mean Annual Rainfall (mm): 1000

Overland Properties: Sparse Grass

r Value = 0,3

Rainfall Region: Inland

Area distribution:

Rural =	85%
Urban =	2%
Lakes =	13%

Rural C1

Surface Slope (%)			Permeability (%)			Vegetation (%)		
Cs	100	0,271	Cp	100	0,159	Cv	100	0,170
Vlei's & Pans (<3%)	0	0,000	Very Permeable	10	0,005	Thick Bush & Plant	30	0,015
Flat Areas (3% - 10%)	5	0,006	Permeable	40	0,044	Light Bush & Farm-	20	0,030
Hilly (10% - 30%)	20	0,040	Semi - Permeable	40	0,080	Grass-lands	50	0,125
Steep Areas (>30%)	75	0,225	Impermeable	10	0,030	No Vegetation	0	0,000

Urban C2

Use (%)	100	Classification	0,355
Lawns & Parks	50	eavy Soil, Flat - Steep (2% - 7%	0,105
City / Residential	50	Houses - Per Family	0,250
Business	0	Suburban	0,000
Streets	0	Streets	0,000

Time of Concentration (tc) 0,1425 hrs | 15,00 min | 0,25 hrs

1	2	5	10	25	50	100	1:? YEAR
77,193	95,036	125,103	154,020	202,749	249,614	307,311	mm/h

Run off Factors C:								
	Rural C1	0,600	0,600	0,600	0,600	0,600	0,600	0,600
	Urban C2	0,355	0,355	0,355	0,355	0,355	0,355	0,355
	Average	0,485	0,485	0,517	0,550	0,582	0,614	0,647
	Discharge (Q)	0,007	0,009	0,013	0,016	0,023	0,030	0,039 m³/s

POST DEVELOPMENT CALCULATIONS

Size of Catchment:
A = 700 m²
0,07 Ha

Longest Watercourse:
L = 350 m
0,35 km

Average Slope:
S = 0,01681

Type of Water Flow: Watercourse

Closest Weather Station: Durban

Mean Annual Rainfall (mm): 1000

Overland Properties: sparse grass

r Value = 0,3

Rainfall Region: Inland

Area distribution:

Rural =	77%
Urban =	10%
Lakes =	13%

Rural C1

Surface Slope (%)			Permeability (%)			Vegetation (%)		
Cs	100	0,050	Cp	100	0,159	Cv	100	0,170
Vlei's & Pans (<3%)	0	0,000	Very Permeable	10	0,005	Thick Bush & Plant	30	0,015
Flat Areas (3% - 10%)	5	0,003	Permeable	40	0,044	Light Bush & Farm-	20	0,030
Hilly (10% - 30%)	20	0,010	Semi - Permeable	40	0,080	Grass-lands	50	0,125
Steep Areas (>30%)	75	0,038	Impermeable	10	0,030	No Vegetation	0	0,000

Urban C2

Use (%)	100	Classification	0,355
Lawns & Parks	50	eavy Soil, Flat - Steep (2% - 7%	0,105
City / Residential	50	Houses - Per Family	0,250
Business	0	Suburban	0,000
Streets	0	Streets	0,000

Time of Concentration (tc) 0,1425 hrs | 15,00 min | 0,25 hrs

1	2	5	10	25	50	100	1:? YEAR
77,193	95,036	125,103	154,020	202,749	249,614	307,311	mm/h

Run off Factors C:								
	Rural C1	0,379	0,379	0,379	0,379	0,379	0,379	0,379
	Urban C2	0,355	0,355	0,355	0,355	0,355	0,355	0,355
	Average	0,457	0,457	0,457	0,457	0,457	0,457	0,457
	Discharge (Q)	0,007	0,008	0,011	0,014	0,018	0,022	0,027 m³/s

Flow to Attenuate 0,008 m³/s

Outlet Slope 0,0125

Outlet Diameter 134 mm

Volume to Attenuate 7 m³

Mannings Value (n) 0,010

Plan Area of Pond 7 m²

owed discharge (Q) 0,016 m³/s

Depth of Pond 1,00 m

Number of Outlets 1

Sub Catchment 9

PRE DEVELOPMENT CALCULATIONS

Size of Catchment:
A = 400 m²
0,04 Ha

Longest Watercourse:
L = 150 m
0,15 km

Average Slope:
S = 0,01681

Type of Water Flow: Watercourse

Closest Weather Station: Durban

Mean Annual Rainfall (mm): 1000

Overland Properties: Sparse Grass

r Value = 0,3

Rainfall Region: Inland

Area distribution:
Rural = 85%
Urban = 2%
Lakes = 13%

Rural C1								
Surface Slope (%)			Permeability (%)			Vegetation (%)		
Cs	100	0,271	Cp	100	0,159	Cv	100	0,170
Vlei's & Pans (<3%)	0	0,000	Very Permeable	10	0,005	Thick Bush & Plant	30	0,015
Flat Areas (3% - 10%)	5	0,006	Permeable	40	0,044	Light Bush & Farm-	20	0,030
Hilly (10% - 30%)	20	0,040	Semi - Permeable	40	0,080	Grass-lands	50	0,125
Steep Areas (>30%)	75	0,225	Impermeable	10	0,030	No Vegetation	0	0,000

Urban C2			
Use (%)	100	Classification	0,355
Lawns & Parks	50	eavy Soil, Flat - Steep (2% - 7%	0,105
City / Residential	50	Houses - Per Family	0,250
Business	0	Suburban	0,000
Streets	0	Streets	0,000

Time of Concentration (tc) 0,0742 hrs | 15,00 min | 0,25 hrs

1	2	5	10	25	50	100	1:? YEAR
77,193	95,036	125,103	154,020	202,749	249,614	307,311	mm/h

Run off Factors C:								
	Rural C1	0,600	0,600	0,600	0,600	0,600	0,600	0,600
	Urban C2	0,355	0,355	0,355	0,355	0,355	0,355	0,355
	Average	0,485	0,485	0,517	0,550	0,582	0,614	0,647
	Discharge (Q)	0,004	0,005	0,007	0,009	0,013	0,017	0,022 m³/s

POST DEVELOPMENT CALCULATIONS

Size of Catchment:
A = 400 m²
0,04 Ha

Longest Watercourse:
L = 150 m
0,15 km

Average Slope:
S = 0,01681

Type of Water Flow: Watercourse

Closest Weather Station: Durban

Mean Annual Rainfall (mm): 1000

Overland Properties: sparse grass

r Value = 0,3

Rainfall Region: Inland

Area distribution:
Rural = 77%
Urban = 10%
Lakes = 13%

Rural C1								
Surface Slope (%)			Permeability (%)			Vegetation (%)		
Cs	100	0,050	Cp	100	0,159	Cv	100	0,170
Vlei's & Pans (<3%)	0	0,000	Very Permeable	10	0,005	Thick Bush & Plant	30	0,015
Flat Areas (3% - 10%)	5	0,003	Permeable	40	0,044	Light Bush & Farm-	20	0,030
Hilly (10% - 30%)	20	0,010	Semi - Permeable	40	0,080	Grass-lands	50	0,125
Steep Areas (>30%)	75	0,038	Impermeable	10	0,030	No Vegetation	0	0,000

Urban C2			
Use (%)	100	Classification	0,355
Lawns & Parks	50	eavy Soil, Flat - Steep (2% - 7%	0,105
City / Residential	50	Houses - Per Family	0,250
Business	0	Suburban	0,000
Streets	0	Streets	0,000

Time of Concentration (tc) 0,0742 hrs | 15,00 min | 0,25 hrs

1	2	5	10	25	50	100	1:? YEAR
77,193	95,036	125,103	154,020	202,749	249,614	307,311	mm/h

Run off Factors C:								
	Rural C1	0,379	0,379	0,379	0,379	0,379	0,379	0,379
	Urban C2	0,355	0,355	0,355	0,355	0,355	0,355	0,355
	Average	0,457	0,457	0,457	0,457	0,457	0,457	0,457
	Discharge (Q)	0,004	0,005	0,006	0,008	0,010	0,013	0,016 m³/s

Flow to Attenuate 0,004 m³/s

Outlet Slope 0,0125

Outlet Diameter 109 mm

Volume to Attenuate 4 m³

Mannings Value (n) 0,010

Plan Area of Pond 4 m²

owed discharge (Q) 0,009 m³/s

Depth of Pond 1,00 m

Number of Outlets 1

Sub Catchment 10

PRE DEVELOPMENT CALCULATIONS

Size of Catchment:
A = 2000 m²
0,20 Ha

Longest Watercourse:
L = 200 m
0,20 km

Average Slope:
S = 0,01681

Type of Water Flow: Watercourse

Closest Weather Station: Durban

Mean Annual Rainfall (mm): 1000

Overland Properties: Sparse Grass

r Value = 0,3

Rainfall Region: Inland

Area distribution:
Rural = 85%
Urban = 2%
Lakes = 13%

Rural C1								
Surface Slope (%)			Permeability (%)			Vegetation (%)		
Cs	100	0,271	Cp	100	0,159	Cv	100	0,170
Vlei's & Pans (<3%)	0	0,000	Very Permeable	10	0,005	Thick Bush & Plant	30	0,015
Flat Areas (3% - 10%)	5	0,006	Permeable	40	0,044	Light Bush & Farm-	20	0,030
Hilly (10% - 30%)	20	0,040	Semi - Permeable	40	0,080	Grass-lands	50	0,125
Steep Areas (>30%)	75	0,225	Impermeable	10	0,030	No Vegetation	0	0,000

Urban C2			
Use (%)	100	Classification	0,355
Lawns & Parks	50	eavy Soil, Flat - Steep (2% - 7%	0,105
City / Residential	50	Houses - Per Family	0,250
Business	0	Suburban	0,000
Streets	0	Streets	0,000

Time of Concentration (tc): 0,0926 hrs | 15,00 min | 0,25 hrs

1	2	5	10	25	50	100	1:? YEAR
77,193	95,036	125,103	154,020	202,749	249,614	307,311	mm/h

Run off Factors C:								
	Rural C1	0,600	0,600	0,600	0,600	0,600	0,600	0,600
	Urban C2	0,355	0,355	0,355	0,355	0,355	0,355	0,355
	Average	0,485	0,485	0,517	0,550	0,582	0,614	0,647
Discharge (Q)		0,021	0,026	0,036	0,047	0,066	0,085	0,110 m³/s

POST DEVELOPMENT CALCULATIONS

Size of Catchment:
A = 2000 m²
0,20 Ha

Longest Watercourse:
L = 200 m
0,20 km

Average Slope:
S = 0,01681

Type of Water Flow: Watercourse

Closest Weather Station: Durban

Mean Annual Rainfall (mm): 1000

Overland Properties: sparse grass

r Value = 0,3

Rainfall Region: Inland

Area distribution:
Rural = 77%
Urban = 10%
Lakes = 13%

Rural C1								
Surface Slope (%)			Permeability (%)			Vegetation (%)		
Cs	100	0,050	Cp	100	0,159	Cv	100	0,170
Vlei's & Pans (<3%)	0	0,000	Very Permeable	10	0,005	Thick Bush & Plant	30	0,015
Flat Areas (3% - 10%)	5	0,003	Permeable	40	0,044	Light Bush & Farm-	20	0,030
Hilly (10% - 30%)	20	0,010	Semi - Permeable	40	0,080	Grass-lands	50	0,125
Steep Areas (>30%)	75	0,038	Impermeable	10	0,030	No Vegetation	0	0,000

Urban C2			
Use (%)	100	Classification	0,355
Lawns & Parks	50	eavy Soil, Flat - Steep (2% - 7%	0,105
City / Residential	50	Houses - Per Family	0,250
Business	0	Suburban	0,000
Streets	0	Streets	0,000

Time of Concentration (tc): 0,0926 hrs | 15,00 min | 0,25 hrs

1	2	5	10	25	50	100	1:? YEAR
77,193	95,036	125,103	154,020	202,749	249,614	307,311	mm/h

Run off Factors C:								
	Rural C1	0,379	0,379	0,379	0,379	0,379	0,379	0,379
	Urban C2	0,355	0,355	0,355	0,355	0,355	0,355	0,355
	Average	0,457	0,457	0,457	0,457	0,457	0,457	0,457
Discharge (Q)		0,020	0,024	0,032	0,039	0,052	0,063	0,078 m³/s

Flow to Attenuate 0,022 m³/s

Volume to Attenuate 20 m³

Plan Area of Pond 20 m²

Depth of Pond 1,00 m

Outlet Slope 0,0125

Mannings Value (n) 0,010

owed discharge (Q) 0,047 m³/s

Number of Outlets 1

Outlet Diameter 199 mm