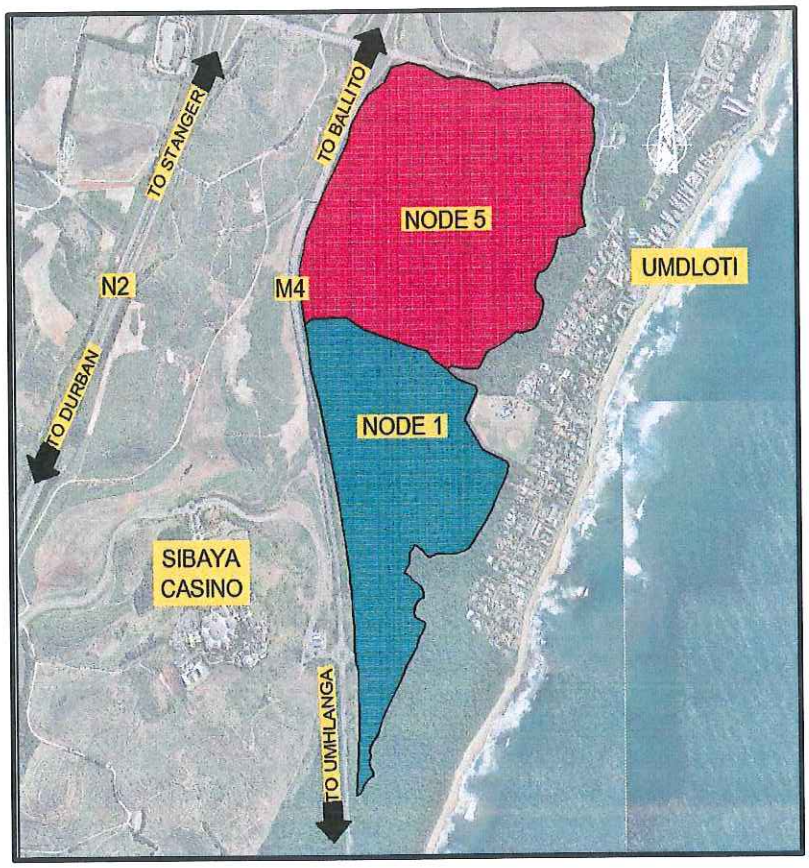
Tongaat Hulett Developments

The Proposed Sibaya Precinct - Nodes 1 & 5

Stormwater Management Plan



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1. TERMS OF REFERENCE

Hatch Goba (Pty) Ltd was appointed by Tongaat Hulett Developments (Pty) Ltd to undertake the preliminary design of civil engineering services i.e. roads; sewer, water and stormwater reticulation, for the proposed Nodes 1 & 5 of the Sibaya Precinct Development.

A Record of Decision (ROD), authorising the above mentioned development proposal was issued by the Kwa-Zulu Natal Department of Agriculture & Environmental Affairs (DAEA) on the 26th March 2009. In terms of this ROD, a detailed stormwater management plan was required for the proposed development and would also be required as supporting documentation to the application for a Water Use Licence as part of The National Water Act(Act no. 36 of 1998)

This report therefore is intended to satisfy the ROD Conditions of Authorisation, with respect to clause 9.28, and to provide supporting information to the application for obtaining a Water use Licence.

(An extract from the ROD for EIA 5809 is enclosed under Annexure A)

2. INTRODUCTION

The proposed Sibaya Precinct Development is located North of Umhlanga. This development has been subdivided into various phases referred to here as Nodes. It is important to note that the following report pertains to Nodes 1 & 5 of the Sibaya Precinct only, and it should be read in conjunction with the report entitled “Stormwater Management Plan For The Sibaya Precinct, version 2.0, dated 5 Nov 2007” prepared by VelaVKE Consulting Engineers (now known as SMEC South Africa).

This report will set forth details of the stormwater management plan for the proposed Nodes 1 & 5, and will serve to mitigate the adverse effects of the development on the downstream receiving waters and built environment of Umdloti’s residential developments. Effective and sustainable run-off control measures are presented in this report and these are to be administered both during the construction of the civil works and finally upon completion of all construction.

* *A copy of the above mentioned report prepared by VelaVKE Consulting Engineers is enclosed under Annexure A*

3. SITE DESCRIPTION

Nodes 1 & 5 of the proposed Sibaya Precinct are bound by the Hawaan Forest in the South, the M4 to its west, the M27 to the North and east by Umdloti's residential developments.

Node 1 which is located at the Southern Boundary of the site, comprises of a total area of approximately 61 hectares of land. This portion of the site, for the most part, is vegetated with large trees and thick bush being the predominant land cover. The remaining areas of the Node 1 portion of the site is overlain with Dune Sand and is sparsely grassed. (*Refer to dwg no. H115299/100/FIG1 enclosed under Annexure D which shows the extent and locality of Node1).*

Node 5 is located at the Northern Boundary of the site, and comprises of a total area of approximately 88.4 hectares of land. The majority of this portion of the site is supplanted by agriculture in the form of intensive monoculture sugar cane. The remaining smaller portions of Node 5 are densely vegetated with thick bush. (*Refer to dwg no. H115299/100/FIG1 enclosed under Annexure D which shows the extent and locality of Node5)*

Both Nodes 1 & 5 have been earmarked for an array of uses including mixed residential usage, multipurpose recreational use, aswell as commercial usage. The preliminary town planning for the proposed development is as reflected by drawing no. H115299/100/FIG4 enclosed under Annexure D.

* *The topography of the site is discussed in greater detail in sections 4 and 7 of this report*

4. GEOTECHNICAL CONDITIONS OF THE SITE

The geotechnical investigation was conducted by Thekwini GeoCivils cc. and their findings from this investigation is documented in the report entitled "*Report on the Geotechnical Investigation for the proposed Umdloti South Residential & Commercial Area*", dated July 2005.

The sites general topography comprises of gently sloping, densely vegetated hillsides(generally less than 1:10) in the southern half of the site and moderately sloping areas (± 1:5 to 1:10) in the northern half of the site. An exception to the above topography is in localised areas along the eastern portions of the site, here slopes steepen considerably, reaching gradients of 1:3 and in some areas as steep as 1:2. The northern hillside is supplanted by agriculture in the form of sugar cane and rises to a Trig High Point of 121 msl.

The majority of the site is overlain by Dune Sand forming on average a cover of between 2-3m. which has recently developed. This cover overlays clayey sand of the Berea Red formation and at further depths the existence of Sandstone of the Vryheid formation has been discovered.

The geohydrological condition of the site is for the most part permeable overlying the lesser permeable Berea Red. This soil strata is associated with infiltration and formation of seasonal perched water tables.

Exceptions to the above general condition of the site, occur in the following areas where clayey sand is exposed at the surface and hence ponding and runoff is experienced as opposed to infiltration:

- The North eastern and South Western portions of the site where the clayey Berea red sand is closer/at the surface
- The second area is the Northern valley line where Vryheid formation Sandstone and associated clayey Hillwash is closer/at the surface. A permanent seepage zone is encountered along this valley line.

Thekwini GeoCivils have also conducted percolation tests in various areas throughout the site and have identified areas that are adequate for disposal of stormwater via infiltrative methods. For further details reference is to be made to the above mentioned report which also includes more descriptive layout drawings and figures. The findings presented in their report have been used in proposing the stormwater management system described in section 6 of this report.

5. STORMWATER DESIGN STANDARDS AND GUIDELINES

5.1 Design Standards

The following general design standards are to be adopted when designing all stormwater infrastructure within the Sibaya Precinct Development:

5.1.1 Guidelines for Human Settlement Planning and Design

In general, the proposed stormwater management system will be designed in accordance with the Guidelines for Human Settlement Planning and Design, compiled by CSIR Building and Construction Technology & Department of Housing. In accordance with Section 6, Tables 6.1 and 6.2, the following design standards will be adopted:

Table 6.1: Design flood frequencies for major systems	
LAND USE	DESIGN FLOOD RECURRENCE INTERVAL
High Value Central Business District	**50**-100 years

Table 6.2: Design flood frequencies for minor systems	
LAND USE	DESIGN FLOOD RECURRENCE INTERVAL
High Value Central Business District	5-**10** years

The underlined values have been used in the design as these correlate with those prescribed in the eThekwini Municipality stormwater management policy.

5.1.2 eThekwini Municipality Stormwater Management Policy

The stormwater management policy is driven by the eThekwini Municipality Coastal, Stormwater and Catchment Management Department, in conjunction with the Environmental Management Department. The policy dictates that stormwater flows emanating from new developments may not exceed the flows prior to such development having taken place. To this end, the 1:10 and 1:50 storm recurrence intervals have been defined as the two control storms.

5.2 Design Philosophy

In accordance with the general design standards described in Section 5.1, the design philosophy adopted for the proposed Nodes 1 & 5 of the Sibaya Precinct development can best be described as follows:

- Stormwater runoff shall not be concentrated to an extent that would result in any damage to downstream receiving waters and/or built environment during storms with a recurrence interval not exceeding 1:100 years but may result in some damage during storms with a recurrence interval exceeding 1:100 years.
- The general level of internal stormwater management will require each property owner to provide their own attenuation system. It will be required that every property attenuate the 1:50 and 1:10 post development flows down to its original pre development state. As a result each property owner will therefore also be expected to submit their own individual stormwater management plans for councils approval.
- Given the up-market high density character of the proposed Sibaya Precinct development, the steep topography and high erodibility of the in-situ soils, it is deemed necessary to provide micro attenuation at source as mentioned above (1:10 & 1:50 post development reduced to 1:10 & 1:50 predevelopment respectively) using on-site attenuation tanks. The use of rainwater storage tanks is encouraged for the residential sites which can be used for washing and watering of gardens. The remaining portion of the stormwater volume (see eThekwini Municipality's guidelines) will then form part of the attenuation requirement. These on-site attenuation tanks are to be linked to a stormwater pipe drainage system that will discharge the flows directly into the internal piped reticulation system of the roads and eventually discharge into a multiple attenuation pond system. These pond systems are to be constructed in the open space/ general servitude.
- Roads will be designed to serve as a dual drainage system to safely convey the storm events exceeding 1:50 year recurrence interval to the engineered channels and swales.
- Predevelopment flows sustaining the green forest belt on the southern and eastern boundaries of the site are to be maintained so as to prevent starvation of this natural environment.

6. GUIDELINES FOR OWNERS AND DEVELOPERS

All sub-developments within the Sibaya Precinct will be required to control stormwater runoff in accordance with the stormwater management philosophy and policies of the eThekwini Municipality, as mentioned in the previous section. The following guidelines however are intended to assist developers, owners and their professional teams with the planning of site layouts, the design of the major and minor stormwater systems infrastructure and to ensure that the objectives of this Stormwater Management Plan are met during the planning, design, construction and operational phases of all developments. Furthermore, the guidelines prescribed hereafter shall be accepted and implemented as a rule.

6.1 STORMWATER RUNOFF CONTROL

Formal surface and underground stormwater systems are to be provided in the overall development for the acceptance of stormwater drainage from the individual sites, but it is important that the peak runoff rate from these sites do not exceed the hydraulic capacities of the elements in the major stormwater system. The following are general guidelines for stormwater control for each site within the confines of the Sibaya Precinct.

6.1.1 Buildings

a) Any building will inevitably result in some degree of flow concentration, or deflection of flow around the building. The developer/owner shall therefore ensure that the flow path of the stormwater on his site is adequately protected against erosion and is sufficiently roughened to retard stormwater flow to the same degree, or more, as that found in the natural pre-development state of the site.

b) Where the construction of a building causes a change in the natural flora of the site that might result in soil erosion, the risk of soil erosion by stormwater must be eliminated by the provision of approved artificial soil stabilisation devices, or alternative flora suited to the changed conditions on the site.

c) Where a piped stormwater system exists, an on-site stormwater drainage system should be connected to this external system. Any inlet to a piped system shall be fitted with a screen, or grating to prevent debris and refuse from entering the stormwater system. This must be done immediately on installation of the piped system.

d) No building works, earthworks, walls or fences may obstruct or encroach on a watercourse inside or outside the site without approved plans that do not compromise the objectives of the Stormwater Management Plan.

e) All Sites that are permitted full building coverage area, and have basement parking, will be required to attenuate its stormwater runoff at the first basement level or discharge directly into communal off site attenuation ponds. It is therefore a requirement that such sites be identified during the detailed Town Planning/Engineering stage, such that communal attenuation ponds may be sized accordingly.

6.1.2 Roof Drainage

a) Building designs must ensure that rainfall runoff from roofing and other areas, not subjected to excessive pollution, must be efficiently captured for re-use where possible for on-site irrigation and non-potable water uses.

b) Where ground conditions permit, rainwater runoff that is not stored and utilised on site must be connected to infiltration galleries or trenches designed to maximise groundwater recharge. Infiltration facilities must be large enough to contain at least the first hour of a minor storm's runoff without overflowing.

c) Infiltration trenches must be aligned along the contour on the downstream side of the property such that any spillage during major storms results in sheet overland flow.

d) Where a piped stormwater system has been provided to a property, surplus runoff should be connected to this system. Garden and other debris must be trapped on screens or gratings before entering the municipal or local development's stormwater system.

6.1.3 Parking Areas and Yards

a) Any external parking area, yard or other paved area must be designed to attenuate stormwater runoff from a major storm to an acceptable degree.

b) Any area described in (a) must discharge rainwater flowing over, or falling onto its surface, in a controlled manner either overland as sheet flow, or into a detention facility, or infiltration gallery suitably sized to accommodate minor storm runoff.

6.1.4 Driveways

a) Driveways shall not be constructed to deflect or channel runoff onto a roadway, or to concentrate runoff along a particular path that is not a natural water course, without prior consent.

b) Driveways and paths should be designed and constructed such that the rate of flow of stormwater across and along the driveway or path is not increased when compared with the pre-development state.

c) Where the driveway joins the road, the driveway must not obstruct the flow in any open channel, whether lined or unlined, found along the road verge.

6.1.5 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) 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

6.1.6 Stormwater Storage Facilities

a) The sufficiency and effectiveness of on-site micro attenuation to meet stormwater attenuation requirements within the minor and major stormwater systems is the responsibility of the property owner.

b) All attenuation/detention ponds/tanks shall be integrated with the landscape of the site.

c) All attenuation/detention ponds/tanks shall be maintained in good condition and shall not be permitted to become a health hazard or nuisance.

d) The eThekwini Municipality shall have the right to inspect any stormwater drainage control facility at any time and issue instructions for repair and maintenance works deemed to be necessary, which instructions must be carried out within the prescribed time period.

6.1.7 Subsurface Disposal of Stormwater

a) Any construction providing for the subsurface disposal of stormwater should be designed to ensure that such disposal does not cause slope instability, or areas of concentrated saturation or inundation.

b) Infiltration structures should be integrated into the terrain so as to be unobtrusive and in keeping with the natural surroundings.

6.1.8 Channels

a) Lined and unlined channels may be constructed to convey stormwater to a natural watercourse or wetland 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.

6.1.9 Energy Dissipaters

a) Measures should be taken to dissipate flow energy wherever concentrated stormwater flow is discharged down an embankment or erodible slope and the resulting supercritical flow poses a significant risk to the stability of the waterway.

b) Attenuation ponds 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.

6.1.10 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 the eThekwini Municipality or their appointed representatives.

6.2 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, wetlands and dams.

b) Regular monitoring of sites within the catchment should be undertaken by The eThekwini 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 eThekwini 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.

6.3 STORMWATER EROSION CONTROL

The eThekwini Municipality may, at its discretion, inspect the individual properties within the Sibaya Precinct 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.

b) Advise property owners of any repair, maintenance and improvement works required on the stormwater system control elements within their jurisdiction.

6.4 SAFETY

6.4.1 Innundation of Properties and Buildings

a) No new buildings are to be constructed below the 1:100 year flood line.

b) The 1:100 year flood line may not be altered by the development of the site, land-forming or other means, without the approval of The eThekwini Municipality, in case this interferes with the performance of existing stormwater management facilities.

c) All risk of inundation by flood water is carried by the owner of the property.

d) No flood water may be diverted or concentrated such that a risk of flooding or inundation of any property or building is created.

6.4.2 Structural Damage

a) The diversion or concentration of stormwater, whether on the surface or underground, must not increase the risk of structural damage to any development within The Sibaya Precinct.

b) The above includes the undermining of structures due to erosion of soil by stormwater.

7. PROPOSED STORMWATER MANAGEMENT SYSTEM

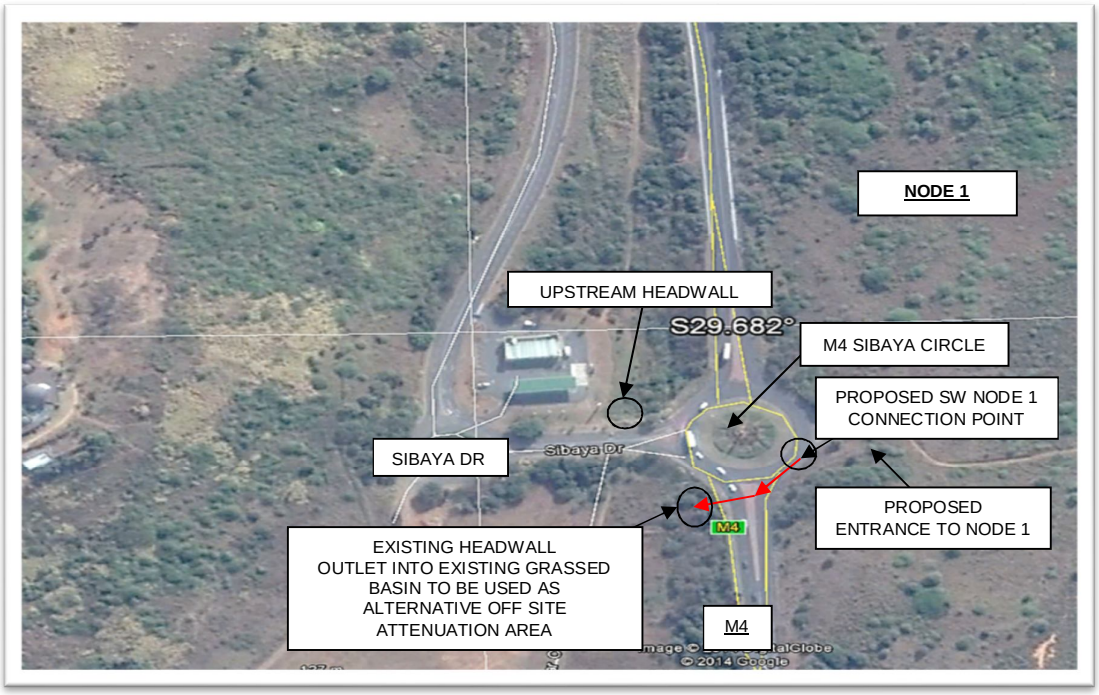
The following section should be read in conjunction with *dwg no. H115299/100/FIG2 and dwg no. H115299/100/FIG3*, enclosed under Annexure D. It should also be noted that the post development scenario only requires that provision be made for the runoff from the internal roads to be attenuated, as each property will attenuate its own stormwater runoff before discharging into the stormwater network of the internal roads.

7.1 Description of Node 1 System

- The overall Node 1 Catchment drains naturally in three directions ie. in a South Westerly direction - down towards the M4 Sibaya Traffic Circle, and in a Northern and North Easterly direction towards the open space/general servitude (shown on town planning layout) and green forest belt above Umdloti's residential area (*Refer to dwg no. H115299/107/FIG3 enclosed under Annexure D)*.

  In the post development scenario, very small portions of the road catchments are transferred between the directions mentioned – this is dictated by the preliminary vertical alignment of the internal roads and has been considered in the post development analysis. It is proposed that the internal road portion of Node 1 which drains towards the M4 be attenuated in a series of underground attenuation tanks before connecting into the existing pipe network which crosses the M4 and discharges into what appears to be a naturally infiltrative grassed basin area. These attenuation tanks will be constructed below the proposed internal traffic circles shown on the preliminary town planning layout, refer to dwg no. H115299/107/FIG3 enclosed under Annexure D.

  As an alternative to either reducing these tank sizes or to do away with them completely, the grassed basin area located South West of the M4 Sibaya Traffic Circle, may be used to construct an offsite attenuation pond for Node1. This alternative option will also make provision for additional attenuation to sites that have full building coverage area. Details with respect to the volume of stormwater discharged from such sites is to be investigated during detailed design stage.



Key plan aerial imagery showing existing stormwater(sw) reticulation, proposed connection point and entrance to Node 1.

The densely vegetated basin area mentioned previously, has over the years silted up. It will therefore require some maintenance/upgrading to reinstate its original condition so as to fulfil its intended design purpose or it may be converted to an offsite attenuation facility, based on the detailed Town Planning/Engineering specifications in terms of the site's building permissions.

That portion of Node 1 which drains towards the open space/general servitude will discharge directly into proposed attenuation ponds shown on the stormwater management plan layout drawing (*Refer to dwg no. H115299/100/FIG3 enclosed under Annexure D)*.

The portion of Node 1 which drains towards the Umdloti residential area will discharge into a proposed grassed swale on the sites eastern boundary located above the forest green belt. This swale will also be designed such that it bleeds predevelopment flows into the forest to prevent its starvation. The swale will finally drain into the attenuation pond located within the open space/general servitude (*Refer to dwg no. H115299/100/FIG7 enclosed under Annexure D)*.

7.2 Description of Node 5 System

- The overall Node 5 Catchment drains naturally from a localised high point in four directions ie. in a North Westerly direction - down towards the wetland adjacent to the M4/M27 interchange, in a Northern/ North Easterly direction towards the Umdloti forest green belt(portion north of the M27), in a South Easterly direction towards the forest green belt above Umdloti's residential area, and in a Southerly direction towards Node 1 and the open space/general servitude.As with Node 1's post development scenario, very small portions of the Node 5 road catchments are transferred between the directions mentioned – this is also dictated by the preliminary vertical alignment of the internal roads.

  It is proposed that the portion of Node 5 draining towards the M4/M27 interchange discharge into the existing wetland area shown on *dwg no. H115299/100/FIG3* via infiltration outlet structures. These structure will be specially designed to reduce the discharge flows and minimise the extent of erosion within the wetland by slowly dissipating flows into the ground via high capacity infiltrator chambers. (*Refer to dwg no. H115299/100/FIG3 enclosed under Annexure D for details)*

  The portion of Node 5 which drains in a Northern/North Easterly direction will discharge runoff from the internal roads directly into a proposed drop- down gabion channel or gabion weir revetment. This gabion structure will be located at the Northern boundary of the site, adjacent to the M27. The gabion structure, be it a revetment or channel, must be designed to minimise the extent of erosion and dissipate flows into the downstream wetland whilst allowing controlled infiltration/dissipation along its length. Erosion protection measures in the form reno mattresses and or dump rock may be considered at the discharge point. Details to be confirmed at detailed design stage.

  Those portions of Node 5 which drain in a Southern and South Easterly direction will discharge directly into the proposed attenuation ponds within the open space/general servitudes (*Refer to dwg no. H115299/100/FIG3 enclosed under Annexure D)*.

  * *It should be noted that details pertaining to all of the previous mentioned proposals are to be confirmed only during detailed design stage and the possibility of differing from these proposals as a result of future findings wrt managing runoff and discharging it, is likely. However it shall not differ to such an extent that it exacerbates the predevelopment scenario but it should still maintain the design philosophy that is in accordance with stormwater management.*

8. STORMWATER MANAGEMENT DURING INITIAL CONSTRUCTION PHASE

Due to the highly erodible nature of the Berea Red soils and other alluvial sands found within the site, certain precautionary measures should be taken once development is initiated. The following section prescribes some of the methods with respect to stormwater runoff control and pollution control, that are to be administered during the initial construction phase:

- Before commencing with construction the critical discharge points of the site are to be identified, checked and inspected for adequacy of receiving and conveying runoff.
- All critical points (eg. surrounding wetland areas and forest green belts) of the site that are prone to erosion, siltation and inundation, are to be identified before commencing with site clearance and bulk earthworks. Shade cloth fencing is to be erected along the sites perimeter and these critical areas. It should also be ensured that these fences have adequate anchorage.
- The erection of silt fences and the construction of temporary earth berms and cut off drains is extremely necessary during the construction of bulk earthworks. Silt fences are to be erected parallel to contours and along newly constructed embankments and platform edges. All silt fencing should also be securely anchored.
- All earthworks should be constructed in a systematic manner, working up natural slopes so as to allow the progressive installation of the stormwater reticulation system.
- Earthworks are also to be programmed such that the attenuation facilities and downstream runoff control measures are in place and operational during the early stages of construction
- The position of stockpiles is to be carefully selected. All stockpiles are to be covered with hessian or shade cloth and regularly watered during construction.
- The use of sand bags and the construction of sand bag cross walls is to be considered, especially in areas prone to erosion and when installing reticulation on embankments.
- Completed platforms are to be topsoiled and hydroseeded, and all completed embankments are to be planted with grass sods. This will limit the amount of erosion aswell as assist in dust pollution control.
- Only upon completion of construction and establishment of full vegetative cover, can silt fencing and sandbags then be removed.

The stormwater measures mentioned above should be maintained and monitored throughout the construction period. After every storm event, these measures should be inspected, de-silted, repaired and reinforced where necessary.

9. STORMWATER MODELING

9.1 Hydrological Modeling

All detailed stormwater modelling is to be undertaken using the Storm Module of Civil Designer Analysis and Design software, Version 13 (Build7), developed and distributed by Knowledge Base cc.

The runoff volumes presented in the sections to follow, was estimated using the Rational Method together with the guidelines prescribed in eThekwini's design manual: *Guidelines and policy for the design of stormwater drainage and stormwater management systems*. All catchment hydrograph's are calculated using the computed Tc and or prescribed min Tc value that is in accordance with the rational method and eThekwini guidelines mentioned above.

The scope of the stormwater modelling includes the following two modelling scenarios:

- Scenario 1: Predevelopment runoff
- Scenario 2: Post development runoff (Road areas to be attenuated only)

The areas under each Hydrograph is then computed to determine the required storage for the design return periods.

The 1:10; 1:50 and 1:100 year return periods have been identified as the critical design storm recurrence intervals.

Coordinates taken at the entrances of each node, used to determine the rainfall depth, are as follows:

NODE 1 ENTRANCE

Lat: **29** deg. **40** min

Long: **31** deg. **06** min

NODE 5 ENTRANCE

Lat: **29** deg. **39** min

Long: **31** deg. **06** min

The rainfall data used in the estimation of the design rainfall depth was derived from eThekwini municipality's AcruCons Report dated Nov 2002, available via:

http://www.durban.gov.za/City_Services/engineering%20unit/Coastal_Engineering_Stormwater_Catchment_Management/Engineering_Services_Records/Pages/Rainfall_Data.aspx

Table 8.1 : Rainfall depths for the various design return periods and storm duration of Node 1

DESIGN STORM DURATION (min)	RAINFALL DEPTH PER RETURN PERIOD (mm)			
	10	**20**	**50**	**100**
10	25.7	31.5	40.2	47.6
15	33.2	40.7	51.9	61.6
30	45.1	55.3	70.5	83.6
45	54	66.1	84.3	100
60	61.3	75	95.7	113.5

Table 8.2 : Rainfall depths for the various design return periods and storm duration of Node 5

DESIGN STORM DURATION (min)	RAINFALL DEPTH PER RETURN PERIOD (mm)			
	10	**20**	**50**	**100**
10	25.9	31.7	40.4	48
15	33.5	41	52.3	62
30	45.4	55.7	71	84.2
45	54.3	66.5	84.8	100.7
60	61.7	75.5	96.3	114.2

9.2 Scenario 1: Predevelopment Runoff

This portion of the report should be read in conjunction with *dwg no. H115299/100/FIG1* which is enclosed under annexures. The overall catchment area has been divided as per each Node.

Nodes 1 and 5 are then further subdivided into Catchments 1A, 1B, 1C, 1D, 1E, 1F and 5A, 5B, 5C, 5D, 5E, 5F, 5G.

9.2.1 Summary of Flows

A summary of the estimated predevelopment flows of Node 1 is included in Table 8.3 below and shown on *dwg no. H115299/100/FIG1.*

Table 8.1 : Node 1 Predevelopment Peak Flows (m^3/s)

	Storm Recurrence Interval		
Description	**1:10**	**1:50**	**1:100**
Catchment 1A	0.906	1.415	1.678
Catchment 1B	1.051	1.641	1.947
Catchment 1C	0.897	1.400	1.661
Catchment 1D	0.860	1.342	1.592
Catchment 1E	0.600	0.938	1.112
Catchment 1F	0.235	0.368	0.436

A summary of the estimated predevelopment flows of Node 5 is included in Table 8.4 below and shown on dwg no. H115299/100/FIG1

Table 8.4 : Node 5 Predevelopment Peak Flows (m^3/s)

	Storm Recurrence Interval		
Description	**1:10**	**1:50**	**1:100**
Catchment 5A	1.009	1.576	1.871
Catchment 5B	1.306	2.039	2.421
Catchment 5C	1.047	1.636	1.942
Catchment 5D	0.574	0.897	1.063
Catchment 5E	0.896	1.399	1.661
Catchment 5F	1.234	1.929	2.289
Catchment 5G	1.043	1.629	1.933

9.3 Scenario 2: Post development runoff

This portion of the report should be read in conjunction with *dwg no. H115299/100/FIG2* which is enclosed under annexures. As mentioned previously, the overall catchment area has been divided as per each Node.

Nodes 1 and 5 are then further subdivided into Catchments 1A, 1B, 1C, 1D, 1E, and 5A, 5B, 5C, 5F & 5G. A transfer of post development catchments occurs due to the vertical alignment of the internal roads and therefore these areas have been combined into the neighbouring sub-catchments. The proposed stormwater management system will be described in terms of a minor system and a major system and will be designed with the following criteria taken into account.

- ***Minor System***: The minor system will describe the collection system including road drainage i.e. pipes, controlled wetland outlet structures(Refer to *dwg no. H115299/100/FIG2 & FIG3*), underground attenuation tanks, manholes, kerb Inlets and side channels. Two benchmark return periods are identified in the design of this system. These being the 1:10 yr and 1:50 yr storm return periods.

- ***Major System***: The major system will convey flows for return periods in excess of the 1:50yr storm event. The system will comprise of the internal roads, swales, gabion channels and grassed emergency overland channels/depressions. (Refer to *dwg no. H115299/100/FIG2 & FIG 3*)

The internal stormwater management of the site will be reticulated via a piped stormwater network system. It should be noted that the attenuation structures sited on each property will provide micro attenuation at source. Therefore, flow emanating from each individual site will be attenuated. The on-site micro attenuation structures will be constructed by individual developers as part of the development of individual sites. These on-site micro attenuation structures will be linked to the internal stormwater pipe drainage system that will eventually discharge the flows into the proposed swales, engineered channels, attenuation ponds and wetland areas, as described in the previous section 6 of this report .

An effort will need to be made to design the pipe drainage system such that it diverts the maximum amount of runoff towards the proposed channels and ponds located in the open space/ general servitude where effective attenuation can be achieved.

The computed post development flows are for the internal road areas only as these are the only areas that will require macro attenuation. The calculated storage required are based on these flows only.

9.3.1 Summary of Flows

A summary of the estimated post development flows of Node 1 is included in Table 8.5 below and shown on *dwg no. H115299/100/FIG2.*

Table 8.5 : Node 1 Post Development Peak Flows (m^3/s)

	Storm Recurrence Interval		
Description	**1:10**	**1:50**	**1:100**
Catchment 1A	0.769	1.203	1.424
Catchment 1B	0.972	1.520	1.800
Catchment 1C	0.339	0.530	0.627
Catchment 1D	0.863	1.350	1.599
Catchment 1E	0.349	0.547	0.647

A summary of the estimated post development flows of Node 5 is included in Table 8.6 below and shown on dwg no. H115299/100/FIG2

Table 8.6 : Node 5 Post Development Peak Flows (m^3/s)

	Storm Recurrence Interval		
Description	**1:10**	**1:50**	**1:100**
Catchment 5A	0.665	1.038	1.233
Catchment 5B	1.553	2.422	2.878
Catchment 5C	0.739	1.152	1.369
Catchment 5F	0.401	0.626	0.744
Catchment 5G	1.034	1.613	1.916

9.4 Attenuation of Flow

9.4.1 Required Storage

This portion of the report should be read in conjunction with dwg nos. H115299/100/FIG2 and FIG3 which is enclosed under annexures of this report. As described in Section 6, attenuation ponds are proposed within the open space/general servitude where attenuation to predevelopment levels will be achieved before discharging. These attenuation facilities will be of similar design with multi-level outlet structures consisting of pipes and weirs to hold run-off before releasing at predetermined levels thereby reducing the peak run-off being discharged into wetlands and forest green belts (refer to dwg no. H115299/100/FIG6 for details of attenuation ponds).

A summary of the required storage for attenuation of post development flows down to pre development for Node 1 is included in Table 8.7 below and shown on *dwg no. H115299/100/FIG2.*

Table 8.7 : Node 1 Storage Capacity Required (m^3)

	Required Storage		
Description	**1:10**	**1:50**	**1:100**
Catchment 1A	461	722	855
Catchment 1B	583	912	1080
Catchment 1C	203	318	376
Catchment 1D	518	810	959
Catchment 1E	210	328	388

A summary of the required storage for attenuation of post development flows down to pre development for Node 5 is included in Table 8.8 below and shown on *dwg no. H115299/100/FIG2.*

Table 8.8: Node 5 Storage Capacity Required (m^3)

	Required Storage		
Description	**1:10**	**1:50**	**1:100**
Catchment 5A	399	623	740
Catchment 5B	932	1453	1727
Catchment 5C	443	691	821
Catchment 5F	241	376	446
Catchment 5G	620	968	1150

10. CONCLUSION

The design standards presented in this report for the proposed stormwater management system of Nodes 1 & 5 of the Sibaya Precinct, are to be strictly adhered to.

The composite system proposed, as described under section 6 of this report, to attenuate the post development peak runoff from the 1:10 and 1:50 year storm recurrence intervals down to the sites original predevelopment levels, is to be designed to these standards and using the guidelines prescribed within this report.

In this report it has been clearly stated that each property is to develop its own stormwater management plan and as a requirement will need to provide on-site micro attenuation structures to attenuate its 1:50 post flows down to the original 1:50 pre flow. Only then may these structures be linked to the piped stormwater network installed within the road verges and eventually leading into the proposed multiple attenuation pond systems, grassed swales and engineered channels.

The proposed multiple attenuation pond systems will serve to attenuate the additional flows from the internal roads of the development, and attenuate the consequent increase in flow volume concentrated at points of discharge into the surrounding wetlands and forest green belt areas. These proposed systems will provide flood relief up to the 1:100 year recurrence interval storm.

It is to be concluded that this report outlines the proposed developments impact on existing catchments together with the associated major risks such as erosion and flooding. Through strict adherence to the proposed stormwater management plan, the potential adverse effects of stormwater runoff resulting from the proposed development on the surrounding environment, can be successfully mitigated.

ANNEXURE A:

- *Extract from KZN Department of Agriculture and Environmental Affairs Record of Decision for EIA/5809*
- *Stormwater Management Plan For The Sibaya Precinct, version 2.0, dated 5 Nov 2007" prepared by VelaVKE Consulting Engineers*

KZN AGRICULTURE AND ENVIRONMENTAL AFFAIRS

uMnyango: weZolimo neZemvelo ISIFUNDAZWE SAKWAZULU-NATALI

Directorate: Environmental Services: South Region
Private Bag X6005, Hilton 3245

Tel: 033 – 3438 428
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FAX TO/FAKS AAN/ISIKHANHLAMEZI SIYAKU:

Mr Rory Wilkinson	086 - 681 9207
Mr Guy Betler	086 - 6141572
Amafa – Weziwe	033 – 342 6097
Dominic	033 - 8451499

FAX NO/FAKS NO/INOMBOLO YESIKHAHHLAEZI:

DATE/DATUM/USUKU: 26/03/09

TIME / TYD / ISIKHATHI:

ATTENTION/AANDAG/IYA KU: Please find attached Environ. Authoriz.

Name of sender / Naam van sender / Umthumelo Ngu:
M. Padayachee

Sender's Ref. / Sender se verw. / Yesikha alamazi sika:

EIA/5809

Sender's Details:

Fax No: 033 – 343 8470
Inombolo:

Tel No: 033 – 343 8428
Inombolo:

Cell No:
Inombolo:

KZN Agriculture and Environmental Affairs

uMnyango:
weZolimo neZemvelo
ISIFUNDAZWE SAKWAZULU-NATALI

Chief Directorate/ Directorate:
Environmental Management
Address:
Private Bag X6005
Hilton
3245
Enquiries: Ms S.J. Allan

Tel: 033 - 343 8300
Fax: 033 - 343 8470
Ref: EIA/5809

Date: 26/03/2009

Tongaat Hulett Developments (Pty) Ltd (THDEV, formerly known as Morelands)
P O Box 22319
Glenashley
4022

Attention : Mr. Rory Wilkinson
Tel : 031 560 1900
Fax : 086 681 9207

cc. Mr. Guy Butler/Ms. Debbie Donkin, GAEA Projects, Fax: 086 614 1572

Re: Authorisation and Record of Decision

The KwaZulu-Natal Department of Agriculture and Environmental Affairs hereby authorises, by virtue of powers delegated by the National Minister of Environmental Affairs and Tourism and in terms of Section 22 of the Environment Conservation Act, Act No. 73 of 1989,

the development of Nodes 1 and 5 of the Sibaya Precinct between Umdloti and Umhlanga Rocks, within the eThekwini Municipality, as described in the attached Record of Decision.

This authorisation is subject to the conditions contained in the attached Record of Decision.

Validity:

The following validity periods shall apply:

1. The duration of authorisation to commence with this project is **48 (forty-eight) months** from the date of issue of this Record of Decision.
2. If this project has not commenced within this period this authorisation is deemed to have lapsed and is no longer valid.
3. Conditions pertaining to the operation of the development remain valid for the lifetime of the development.

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Appeal:

In accordance with the provisions of subregulation 62(1) of the EIA Regulations, 2006, a notice of intention to appeal must be lodged with **Mr. M.E Mthlmkhulu, the MEC for the KwaZulu-Natal Department of Agriculture and Environmental Affairs,** on the form attached within **10 calendar days** of receipt of this decision by means of the following methods:

POSTAL:
Private Bag X9059
PIETERMARITZBURG
3200

PHYSICAL:
No. 1 Cedara
Executive Building
Cedara College
PIETERMARITZBURG
3201

SATELLITE OFFICE

POSTAL:
PO Box 2132
DURBAN
4000

PHYSICAL:
8th Floor, Truro House
17 Margaret Mncadi Blvd (Victoria Embankment)
Durban
4001

TEL: 033 343 8240
FAX: 033 343 8255

Before lodging the notice of intention to appeal, a copy of the notice of intention to appeal must be served by the appellant on all registered interested and affected parties, as well as a notice indicating where, and for what period the appeal submission will be available for inspection.

Yours faithfully

for : **Acting Head of Department**
SJ ALLAN
26/03/2009

26/03/09

KZN Agriculture and Environmental Affairs

Mnyango:
eZolimo neZemvelo
SIFUNDAZWE SAKWAZULU-NATALI

Directorate: Environmental Management

Enquiries: Mrs S.J Allan

Reference No: EIA/5809

Private Bag X 6005
Hilton
3245

Tel: 033 343 8330
Fax: 033 343 8470
Date: 26/03/2009

RECORD OF DECISION

Herewith the Record of Decision in terms of regulation 10 of Government Notice No. R. 1183 of 05 September 1997 (as amended) and section 22(3) of the Environment Conservation Act, (Act No. 73 of 1989) with regard to the undertaking of the activity described below. This Record of Decision must be made available by the applicant or appointed consultant to interested and affected parties on request.

1. Description of the Activity

Background

The applicant, Tongaat Hulett Developments (Pty) Ltd (THDEV, formerly known as Morelands) proposes the development of the Sibaya Precinct (Nodes 1 and 5 only) on Rem of Portion 42 of Lot 31 No. 1560 and Rem of Portion 615 of the Farm Cottonlands No. 1575.

The Sibaya Precinct (in its entirety) includes the land surrounding the Sibaya Casino, and is located between the N2 in the west and the Indian Ocean in the east, between the Hawaan Forest in the south and the Main Road (MR 96) into Umdloti in the north. Kindly refer to Appendix 1, confirming the locality of the site.

The Sibaya Precinct has been divided into 5 development nodes (as depicted in Appendix 2 attached). Node 1 comprises the development area to the east of the M4 above the southern portion of Umdloti, whilst Node 2 comprises the area south and south west of the Sibaya Casino. Node 3 comprises the area to the east of Node 2 and bordered by Forest 31 in the east. Node 4 comprises the north western section of the Precinct bordered by the MR 96 in the north, the N2 in the west, the M4 in the east and the Sibaya Casino in the south. Node 5 comprises the hill behind Umdloti, and constitutes the north east corner of the Precinct.

For the purposes of this authorisation, the applicant seeks authorisation for Nodes 1 and 5 only. Nodes 1 and 5, approximately 125Ha (nett) in extent, are key components of the Sibaya Precinct which is being planned on 850 hectares.

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Details of Activity
The development of nodes 1 and 5, subject to such approvals by the eThekwini Municipality as may be necessary, include the following (as depicted in Appendices 2 and 3 attached):

Phase 1 - Node 1		**Phase 2 - Node 5**	
No. of Units	1140	No. of Units	1185 units
Hotel Rooms	130	Hotel Rooms	490
Commercial	65 800m²	Commercial	37 900m²
Roads • Access provision from M4 at Sibaya Casino circle. **Sewer** • Temporary pump station at bottom of Node 1 + temporary rising main to new Gravity Trunk running from top of Node 1, across M4, below Sibaya Casino and linking to the Sibaya Trunk. • The pump station will be removed and relocated once Node 5 is developed and the rising main converted into a gravity trunk. **Electricity and Water** No bulks required, only reticulation within Node 1		**Roads** • New signalised access off M27 and link to M4 Sibaya Casino circle; • Upgrade of M27 to 4 lanes and turning lanes. **Sewer** • Temporary pump station relocated to adjacent to Umdloti access road and new rising main (south-west direction) across the M4 through Node 4 and gravity main running parallel to N2 linking into Sibaya Trunk, and • the long-term ultimate solution will be a gravity trunk that runs northwards eventually to a new treatment works on the Mdloti River. **Electricity and Water** No bulks required, only reticulation within Node 5	

The concept for Nodes 1 and 5 is to create an "urban centre", at an appropriate density and scale, which maximizes the physical attributes and creates opportunities for a wide mix of uses, including residential apartments, resort hotels, commercial and leisure and recreational activities.

From a height perspective, the development proposal is based upon a gradation of heights from the lower slopes to the hilltops with 2 Storey heights on the lower slopes extending to 4-6 Storeys on the hilltops with single iconic/landmark buildings (up to a maximum of 15 Storeys) in each node.

This project is described under items 1©, 1(n), 2© and 7 in Schedule 1 of Government Notice No. R. 1182 of 05 September 1997 (as amended), which state:

"1c(ii) temporary storage of diesel".

"1(d) The construction or upgrading of roads".

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"1(m) The construction, erection or upgrading of private resorts and associated infrastructure".

"1(n) The construction, erection or upgrading of sewage treatment plants and associated infrastructure".

"2c The change of land use from agriculture or undetermined use to any other land use".

"7 The reclamation of land, including wetlands, below the high-water mark of the sea, and inland waters".

"10 The development of virgin ground".

Note: Review and evaluation of this application for environmental authorization by the Department has also considered activities listed in terms of the 2006 EIA Regulations promulgated under section 24 of the National Environmental Management Act, 1998.

2. Location

Province	:	KwaZulu-Natal
Magisterial District	:	eThekwini
Name of Property	:	Rem of Portion 42 of Lot 31 No. 1560 and Rem of Portion 615 of the Farm Cottonlands No. 1575.
Footprint of development:		125 ha

3. Applicant

Name	:	Tongaat Hulett Developments (Pty) Ltd (THDEV, formerly known as Morelands)
Address	:	P O Box 22319 Glenashley 4022
Contact person	:	Mr. Rory Wilkinson
Tel	:	(031) 560 1900
Fax	:	086 681 9207
Cell phone	:	083 278 4299
E-mail	:	Rory.Wilkinson@thdev.co.za

4. Consultant

Name	:	GAEA Projects
Address	:	PO Box 30258 Mayville 4058

26/03/09

Contact person	:	Mr. Guy Butler/Ms. Debbie Donkin
Tel	:	031 566 3817
Fax	:	086 614 1572
Cell	:	083 556 4087
E-mail	:	debbiedonkin@iafrica.com

5. Site visit

Date	Persons Present	Organization
14 May 2007	Mr. Malcolm Moses	DAEA
	Ms. Vanessa Maclou	DAEA
	Mr. Guy Butler	GAEA Projects
	Mr. Rory Wilkinson	THDEV
	Mr. John Cook	THDEV

6. Documentation assessed:

Date	Description
04 March 2005	Submission: Application for authorisation
10 March 2005	Acknowledgement of application by DAEA
July 2005	Amended Plan Of Study for Scoping
November 2006	Draft Plan of Study (POS) for EIA
December 2005	Addendum Scoping Report
08 December 2006	Final Scoping Report and Final POS for EIA
13 April 2007	Draft Environmental Impact Report
11 June 2008	Final Environmental Impact Report
08 September 2008	Final Framework Plan and the Services Plan for Sibaya
13 October 2008	eThekwini Municipality comments
various	Numerous other correspondences from other authorities, Interested & Affected Parties, THDev, and this Department

7. Decision

Authorisation is granted by the KwaZulu-Natal Department of Agriculture & Environmental Affairs in terms of the provisions of section 22(3) of the Environment Conservation Act, (Act No. 73 of 1989) to develop Nodes 1 and 5 of the Sibaya Precinct on Rem of Portion 42 of Lot 31 No. 1560 and Rem of Portion 615 of the Farm Cottonlands No. 1575 as described in section 1 of this Record of Decision (ROD) and subject to the conditions stipulated in Section 9 of this ROD.

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8. Key Decision Factors

8.1 Need and Desirability

a) The Sibaya Precinct is strategically located along KZN's north coast within the province's Primary Corridor only 5 minutes from the new King Shaka International Airport and the Dube Trade Port and in the middle of two of Durban's major tourism nodes namely; Umhlanga and Umdloti. Irrespective of the current economic slide, the strategic location of the site warrants the need for the development.

b) The Sibaya Casino and Entertainment World is well established and located at the heart of the Sibaya Precinct midway between the N2 and M4 which provides good accessibility from both roads. In addition, a significant amount of infrastructure has already been invested with the development of the casino including new bulk water, electricity and sewer systems as well as two accesses off regional routes.

c) The physical attributes of the land includes easy accessibility, high visibility, prime sea views and the interface with a unique natural environment that includes river, estuary, wetlands and coastal forests.

d) The ecological potential is therefore equally significant but whilst the natural environment exists and its importance acknowledged, unless there is associated development, the potential and opportunity to conserve and manage this ecological asset is extremely difficult and limited.

e) These natural habitats are constantly under threat from a variety of illegal activities such as dumping, poaching and illegal settlement (to name a few). Therefore there is a need to implement formal viable and sustainable management interventions that will result in the conservation and appropriate utilization of these resources. The development of the Sibaya Precinct, of which the natural habitat is an integral component, will enable this to occur.

8.2 Public Participation

a) An Application Form was lodged in February 2005 with the Department.

b) Advertisements were placed in the following newspapers, to inform all interested and affected parties (I&APs) of the proposed development:
- The Mercury on 02 March 2005;
- The North Glen News on 11 March 2005; and
- The Isolezwe on 1 March 2005.

c) In response to the adverts and notification of a pre-identified list of I&APs, a public meeting was held on 17 March 2005 at the Sharks Board located in Umhlanga Rocks. All issues were tabled.

d) A new vision/alternative development concept which resulted in an amendment to the Plan of Study for Scoping.

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e) Another public meeting was held on 07 June 2006 at the Sharks Board, informing I&APs of the latest developments of the application.

f) A Draft Scoping Report was available to I&APs for comment at the end of August 2006, with the Final Scoping Report submitted to the Department on 8 December 2006.

g) The Plan of Study for EIA was also submitted to DAEA on 8 December 2006 with the Terms of Reference for the specialist studies and circulated to key stakeholders and I&APs in January 2007.

h) A public meeting was held on 8 February 2007 at the Sharks Board, Umhlanga Rocks Drive, Umhlanga Rocks, in order to present the findings of the specialist studies.

i) The draft environmental impact report (EIR) was compiled and distributed to key stakeholders and I&APs for comment on 20 June 2007.

j) Correspondences were received on the first draft EIR and these were subsequently responded to. As a result of the response, revisions were made to the proposed development.

k) In essence, the draft Environmental Impact Report (EIR) for EIA/5809, the Sibaya Precinct, circulated in June 2007, recommended that the development of the Sibaya Precinct should be allowed to proceed based on the revised alternative development concept and framework plan (for Nodes 1 and 5). A number of recommendations were provided to ensure the sustainability of the development and the protection of the sensitive ecosystems forming part of the Precinct.

l) A revised draft EIR (second draft) was distributed for comment in February 2008 that dealt with the above issues as well as a number of additional issues including the implementation of a conservation servitude over the forest portions of the Sibaya Precinct. These changes resulted in changes to the draft EIR and therefore resulted in the need to re-circulate the report prior to final submission for the Department's consideration.

m) Comments were also received on the second draft EIR. The primary comments relating to the second draft EIR related to the uncertainties with regards to the sewering of Nodes 2, 3 and 4, the M4 realignment proposed by the eThekwini Municipality, the extent and detail of the conservation servitude, assessment of sewer pump stations, stormwater attenuation details, wetland buffer and intrusions, traffic detail as well as the phasing of the development.

n) Following receipt of the comments, further engagement with the eThekwini Municipality took place and a number of specialist reports were updated which resulted in the final EIR.

o) This final EIR includes the Final Development Concept and Development Framework including a proposal for a conservation servitude to be registered over the entire Conservation Trust area which includes the Mhlanga

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Forest, Forest 31, Hawaan Forest and the Ohlanga River and associated wetlands.

p) Any future activities in the conservation servitude area would depend on the terms of the servitude, but in any event would only take place in those portions that are already degraded, and would be of a low impact. The registration of the conservation servitude implies that any future activities proposed therein will be the subject to a separate EIA. A condition to this effect has been included in the conditions of authorisation herewith.

q) Additional specific engagement subsequently occurred with the eThekwini Municipality in regard to the development proposal and their concerns. This engagement, together with the concerns and comments from other I&APs has resulted in a Final Development Framework Plan and recommendation for the approval of Nodes 1 and 5 only at this time.

r) In general, during the EIA process, numerous I&APs raised their concerns on the proposed development. This included key I&APs such as the Umdloti Rate Payers Association, WESSA, the eThekwini Municipality and EKZNW. Their key concerns related to:
- Storm water and associated impacts;
- "Back of Beach" impacts;
- The noise impacts associated with the King Shaka International Airport;
- Traffic Impacts;
- Visual Impacts;
- Impacts associated with bulk infrastructure;
- Issues relating to security in general;
- and the management of the conservation area.

s) This authorisation is strictly for the development of Nodes 1 and 5. Whilst the final approval for Nodes 2, 3 and 4 has been excluded in this decision, the Department notes that an overall Development Framework plan that includes all nodes was included in the Final EIR report to ensure that the potential cumulative effect of the development is assessed to an extent that the Department is able to reach an informed decision on Nodes 1 and 5 only.

t) Nodes 2, 3 and 4 were excluded from the decision as there were numerous issues related to those nodes that could not be adequately addressed at the time of preparation of the final EIR, and in all likelihood would take considerable time to resolve. Development of Nodes 2, 3 and 4 will, therefore, be subject to separate EIA processes with the existing Development Framework Plan used as a decision support tool to assess the development of Nodes 2, 3 and 4 when the respective application/s are submitted to the Department for assessment/consideration.

8.3 Motivation for Nodes 1 and 5

a) Nodes 1 and 5 are located between the existing Sibaya Casino and the village of Umdloti and can be seen as an extension to Umdloti whilst creating a link to the Sibaya Casino.

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b) The development of Nodes 1 and 5 will enable the constrained village of Umdloti to be enhanced and expanded in an appropriate area, and in a manner that can accommodate the increased traffic and commercial demand.

c) The development of Node 5 will specifically include recreational facilities and activities that aim to create a 'back of beach' and 'beach alternative' attraction that not only takes pressure off the beach but enables a broader and more inclusive tourist and resident attraction.

d) The applicant avers that the physical attributes of Nodes 1 and 5 are spectacular and is considered as prime real estate land with two 'hilltops' that provide for incredible views as well as an area between the two hilltops that lends itself to a potential community oriented leisure and recreational space.

e) In addition, a significant amount of infrastructure has already been invested with the development of the casino including new bulk water, electricity and sewer systems as well as two accesses off regional routes thereby prompting the development of Nodes 1 and 5 only.

8.4 Future Iconic Identity

a) The vision of the Precinct is to create a complex, resort-residential focused development which integrates the urban environment with the natural environment in a manner that not only enables an efficient, compact urban form but also the sustainable conservation and management of the unique environment for the benefit of the greater community.

b) A concept of clustered hilltops will be used to achieve these objectives which will result in intensive urban environments which aim to generate diverse opportunities by creating thresholds to support a wider range of activities. This concept will therefore result in a reduction of the overall physical footprint of the development, thereby enabling a most intense urban hilltop environment whilst simultaneously enabling a very generous and functioning open space system.

8.5 Shadow and Visual Impact

a) One of the key issues raised by I&AP's related to visual impacts as a result of the development. In response to this issue a Visual Impact Assessment (VIA) was undertaken by SRK Consulting dated March 2007.

b) The findings of the study can be summarised as follows:
- The people that would be most affected by the development, from a visual perspective, would be residents of Umdloti traveling in and out of the area and people traveling on the M4.
- The buildings, including iconic structures will be marginally visible from certain areas in Umdloti such as the turning circle and the southern beach.
- Some structures comprising the Precinct would be visible on the skyline from Umhlanga.

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- Based on the current development plan and a brief assessment, shadows will not reach any residential houses in Umdloti or the forest buffer strip between Umdloti and the proposed precinct.
- The visual exposure is further than 3km, however, the visibility from residential areas is reduced by the undulating topography of the area as well as natural features such as the forests and dunes.
- Visual absorption will be provided by the development as it will be following the natural topography and become less dense to the lower areas i.e. become absorbed by the surrounding vegetation. Hilltop development ensures flowing green corridors, which enhance the natural features of the development.
- Most residents or "receptors" will be screened from the visual impact of the proposed Precinct or will only experience transient visual impacts.
- Although not analysed specifically, the cumulative visual impact of the Precinct is likely to contribute further to the new character of the Umhlanga-Ballito area.
- The visual impact at the site is regarded as being acceptable within the context of other development such as the King Shaka International Airport and Dube Trade Port in the area.

c) Based on the findings of the VIA, the Department acknowledges that there would be negative impacts associated with the development in terms of densely developed hilltops and intrusion into the skyline. However, to ensure the conservation of biodiversity on site, the concept of clustered hilltops cannot be avoided.

d) Mitigation by means of an architectural code/design, an urban development layout and a landscape strategy (intensive landscaping/screening) as prepared by Geoff Nichols and the Landscape Studio will be implemented to enhance the visual character, quality and sense of place of the area.

8.6 Traffic Impact Assessment

a) A Traffic Impact Assessment (TIA) specifically for Nodes 1 and 5 was undertaken by David McFarlane and Associates, dated May 2008 (Revision3). The TIA confirmed that the proposed land uses for the Sibaya Precinct have taken cognisance of both the environmentally sensitive areas within the precinct and have balanced and positioned the larger traffic generators to minimise the need for high capacity road infrastructure. This has resulted in a reduction in traffic generation for the area as compared to the potential from such a large land area.

b) The development is in an area that is currently very underdeveloped, but this is expected to change radically in the near future with the new King Shaka International Airport / Dube Trade Port and other potential developments in the region that are likely to follow.

c) For Nodes 1 and 5 in isolation, the upgrading of the M27 from west of the N2 to the access point into the development off the M27 to the west of the M4 will be required to the same layout as is required for the full Sibaya development.

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8.5 Biodiversity/Ecological impacts

An Ecological Assessment for the Sibaya Precinct was undertaken by Strategic Environmental Focus (SEF) Pty Ltd, dated June 2005. The study confirmed that the site consisted of assemblages similar to proper coastal dune forest, coastal scrub and secondary grassland. In addition, wetland associated vegetation is also found on site.

As part of the EIA process all biophysical impacts were fully assessed and all sensitive environments were identified, with an appropriate buffer assigned to ensure adequate protection is afforded to the environment to maintain or enhance its functionality.

- **Impacts on the Mhlanga Estuary**

In a formal statement (undated) regarding the impacts of the proposed Sibaya Node development on the Mhlanga estuary, Mr. Kevin Weerts concluded that *"the successful implementation of the stormwater management plan would successfully mitigate against any impact of surface water runoff from the development impacting on the estuary".* This matter has been addressed in the Conditions of Authorisation.

- **Wetlands**

The wetlands on site have been delineated and a functional was undertaken by Land Resources Institute, dated May 2008. The assessment confirmed that a total of **fourteen (14)** hydrogeomorphic units were identified within the project area. The proposed development layout further confirmed that all fourteen hydrogeomorphic units will be maintained as potentially functioning entities within the post development landscape. Net gain will be achieved as a result of the implementation of a Wetland Rehabilitation Plan and the ongoing management of the wetlands.

- **Forests**

The applicant has agreed to the imposition of a Conservation Servitude in favour of the eThekwini Municipality (Municipality) over the entire Conservation Trust area. The primary intent of the conservation servitude is to ensure the protection of the environmental qualities of the properties for the sustained supply of environmental goods and services to the city as a whole.

The Mhlanga Forest (and remainder of the Conservation Trust area) will be protected through the registration of a conservation servitude which will allow for the formal protection of the Trust area while still allowing for limited, low impact activities to be undertaken (subject to the necessary approvals). Any future activities in the conservation servitude area would depend on the terms/provisions of the servitude, but in any event would only take place in those portions of the servitude area that are already degraded and would have a low impact.

The ownership of the properties will not be affected. The Hawaan Conservation Trust will however be the body responsible for the formal management, conservation and maintenance of the Conservation Trust area including the Servitude Area. This will be done by way of a Conservation Management Plan that will be approved by the eThekwini Municipality and Ezemvelo KZN Wildlife.

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It is noted that the conservation servitude area includes natural coastal forests, estuary and wetlands and that each component will be subject to different requirements and management options. The conservation servitude therefore provides an additional level of protection for the core conservation area and hence the required degree of comfort for the Municipality.

In terms of the forest and estuary components of the conservation servitude area, the primary use and activities that will be permitted will include passive environmental activities such as walking, bird watching, botanising, and picnicking, provided that this does not have a negative impact on the servitude area and its primary purpose of environmental protection.

In terms of the wetland components of the conservation servitude area, the primary use and activities that will be permitted will include passive environmental activities such as walking, cycling, horse riding, bird watching, and botanising, provided that this does not have a negative impact on the servitude area and its primary purpose of environmental protection.

Funding for the Trust will be raised via the Sibaya Management Association levies and contributions by the other Trustees on an agreed Business Plan basis as well as any other future activity that could provide an income stream. THDEV will be responsible for providing the initial capital requirements for the establishment of the Trust and will, once approval has been received for the Sibaya Precinct development as proposed, formalise the establishment of the Trust.

8.6 Bulk Infrastructure

It is noted that development proposals such as the Sibaya Precinct rely heavily upon the Local Authority to provide the bulk infrastructural requirements for the ultimate development and hence it is not possible to deal with the ultimate infrastructural requirements. It is therefore necessary to focus upon a phased approach in order to ensure that available infrastructural capacities are not exceeded and in that way sustainably implemented.

a) From an infrastructural perspective it is noted that there is road, bulk electricity and water infrastructure in place to service at least a vast portion of the development with a new water reservoir required to accommodate the full, ultimate development.

b) From a wastewater perspective, more than half of Node 1 is situated within the Ohlanga catchment, with the remainder of Node 1 and Node 5 located in the Mdloti catchment. In terms of the portions in the Mdloti catchment, the natural solution would be to service these to the existing Mdloti wastewater treatment works (limited capacity), or to a new treatment works on the Mdloti River. These options are not possible in the short-term and consequently alternative solutions were sought.

c) There is however a relatively easy solution that can deal with the interim period until a new works on the Mdloti River is commissioned. A new temporary pump station can be constructed in the short term between Nodes 1 and 5 and, should the new works still not have materialized, the pump station could be relocated to just below Node 5 to deal with both nodes.

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d) In their letter dated 08 May 2008, VelaVKE Engineers confirmed that the Sibaya sewerage pump station has sufficient capacity to accommodate the sewage contributions from the Sibaya Casino in addition to that of Nodes 1 and 5.

e) It is anticipated that construction and operational activities could potentially result in negative impacts on the receiving environment through uncontrolled runoff from storm or rain events. As a result, a Stormwater Management Plan for both the construction and operational phases of the development has been drafted and will be submitted to the eThekwini Municipality: Coastal and Drainage Division and the Department of Water Affairs and Forestry for their approval. Construction will only commence once the Stormwater Management Plan has been approved by the aforementioned authorities.

f) The Sibaya Precinct is to be developed on a phased basis in order to ensure both market and infrastructural sustainability. With a development of the size and nature of Sibaya Precinct it is not possible to finalise the exact timing and detail for the entire development specifically as it will be constructed and implemented over more than 10 years. The benefit of assessing the entire development has however enabled a complete and thorough understanding of all the impacts and implications of the ultimate development, specifically from an infrastructural perspective.

8.7 Alternatives

Prior to the finalization of the layout presented in Appendix 2, a number of other alternatives were identified by I&APs during the public participation process as well as by the applicant's professional team.

The initial/ original development framework (dated 2004, Figure 11 of the Scoping Report) proposed raised many concerns relating to the layout, the land uses and the need for more connected "green" corridors leading to a less fragmented ecological environment. Following the Scoping Process which was initiated in February 2005, and as a result of the concerns and issues raised, THDEV took a decision to review the initial concept plan through a 'charrette' process and to produce a new vision and development framework which was more appropriate and sympathetic to the site and the concerns raised (December 2005).

As with the original concept and framework, the alternative development concept and framework was also subject to a public participation process. Upon review of, and comment on, the draft EIR by key stakeholders and I&APs, THDEV decided to withdraw the following components from this application:

- beach groyne;
- dune boardwalk;
- niche spa / resort for the Mhlanga Forest;
- aerial gondola;
- funicular;
- canopy boardwalks; and
- river boardwalks

The process followed thus looked at the withdrawal of activities, the addition of a conservation servitude over the forest components and an alternative framework and

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concept plan which considered issues and concerns comprehensively. Section 7 of the Final EIR provides a more detailed analysis of alternatives considered.

8.8 Densities and Height

Various I&APs have made reference to the density of the development proposal. Iyer Rothaug Collaborative was tasked at looking at the issues of density and height.

The report indicates that a key driver for the Sibaya Precinct is the clustering of development on certain hilltops to reduce the overall physical footprint to enable a more urban hilltop development, which is played against a more generous open space system. Further, the report concluded the following:

- Clustering of development on hilltops together with limited, appropriately located landmarks, will create a more legible visually stimulating and diverse environment, as opposed to the perpetual sameness of suburbia.
- Higher densities encourage greater efficiencies in terms of infrastructure and provide an important basis to sustain a diverse offering in terms of services, facilities and economic activity.
- Compact and clustered development also reduces the spatial footprint and therefore, if properly managed, reduces the impact on the environment.

From a height perspective, the development proposal is based upon a gradation of heights from the lower slopes to the hilltops with 2 Storey heights on the lower slopes extending to 4-6 Storeys on the hilltops with single iconic/landmark buildings up to a maximum of 15 Storeys in each node. The Iyer Rothaug report provides an indication of the implications of the height proposals as does the visual impact assessment. In essence the impacts associated with visual impacts and that of heights and densities is of low significance with the protection of the biophysical environment in mind.

9. Conditions of authorisation
Standard Conditions

9.1 This authorisation refers only to the activity as specified and described in Section 1. Any substantial changes to, or deviations from, the project description set out in this authorisation must be approved in writing by this Department before such changes or deviations may be effected.

9.2 In assessing whether to grant such approval or not, this Department may request such information as it deems necessary to evaluate the significance and impacts of such changes or deviations and it may be necessary for the holder of the authorisation to apply for further authorisation in terms of the NEMA EIA Regulations, 2006.

9.3 **Tongaat Hulett Developments (Pty) Ltd** is responsible for compliance with the provisions for *Duty of care and remediation of environmental damage* in accordance with section 28 of the National Environmental Management Act, Act 107 of 1998 and its obligations regarding the control of emergency incidents in terms of section 30 of this Act. Accordingly, this Department must immediately be notified of an incident as defined in subsection 30(1)(a) of the National Environmental Management Act (Act 107 of 1998).

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9.4 The holder of the authorisation shall be responsible for ensuring compliance with the conditions by any person acting on his or her behalf, including but not limited to, an agent, contractor, sub-contractor, employee or person rendering a service to the holder of the authorisation.

9.5 In all relevant contracts entered into by the applicant, the contractor(s) shall be compelled to comply with the terms of authorisation. In the event of non-compliance by any contractor implicated in this activity, the applicant and/or his successor/s in title will be held liable.

9.6 This Department retains the right to inspect the proposed project during both construction and operational phases.

9.7 **Tongaat Hulett Developments (Pty) Ltd** must inform all registered interested and affected parties of this Record of Decision within **7 calendar days** of its receipt by letter, facsimile or e-mail and explain their right to appeal utilizing the provisions of the 2006 EIA Regulations.

9.8 This Department reserves its right to review any condition contained in this authorisation, and if deemed necessary, delete or amend such condition, or at its discretion, determine new conditions, in such a manner that it is lawful, reasonable and procedurally fair.

9.9 Records relating to the compliance/non-compliance with the conditions of authorisation must be kept in good order. Such records shall be made available to this Department within seven (7) calendar days of receipt of a written request by this Department for such records.

9.10 Failure to comply with the conditions of this authorisation will be dealt with in terms of the relevant sections of the Environment Conservation Act (No. 73 of 1989) as amended, the National Environmental Management Act (Act No. 107 of 1998) and any other appropriate legal legislation.

9.11 This Department must be notified within thirty (30) days thereof, of any change of ownership and/or project manager of the entire property. Conditions imposed in this Record of Decision must be made known to the new owner/s and/or developer/s and are binding on the new owner/s and or developer/s.

Specific Conditions

9.13 The development must comply substantially with that depicted in the Final Development Concept Framework (for Nodes 1 and 5 only), as attached as Appendix 2 and the Services Layout attached as Appendix 3.

9.14 The final development numbers in each Node to be as per **Table 1** of this authorisation but with formal allowance being provided for flexibility and adjustments to numbers, subject to approval by the eThekwini Municipality provided no additional impacts on infrastructure and services.

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9.15 Further to the above, the Services Plan for Nodes 1 and 5 must comply substantially to that depicted in the Plan as attached as Appendix 3 herewith.

9.16 An Environmental Management Plan (EMP) for the construction and operational phases of the development must be drawn up and submitted to this Department and approved **prior** to construction (including site preparation) commencing. This EMP must:

a) incorporate the conditions of authorisation given in this Record of Decision;
b) include the recommendations and mitigation measures provided in the specialist studies;
c) be included in all contract documentation for the construction phase of the development;
d) specify the persons responsible for ensuring that the individual conditions are carried out as stated in the EMP;
e) specify the working hours for the construction phase of the project;
f) include the location of construction camp/s and specify how these will be decommissioned and rehabilitated;
g) be drawn up by the appointed environmental consultant for the individual nodes to be developed as part of the Precinct. The EMP must be submitted to the Department, the eThekwini Municipality: Environmental Management Department and EKZNW for approval prior to the commencement of construction;
h) be implemented by the applicant during the construction and operational phases of the development; and
i) be submitted to the eThekwini Municipality: Environmental Management Department for comment. Any comments are to be provided to this Department prior to approval being given by this Department.

9.17 In addition to Condition 9.16 above:

a) Developers of hotels, resorts and/or multiple residential developments must appoint their own Environmental Control Officers (ECO) who together with DAEA and eThekwini Municipality will be responsible for monitoring and auditing construction in accordance with the EMP for the specific Precinct.
b) In terms of condition 9.16 (d) above, the node specific EMP must be clear in this regard. Should there be any uncertainties regarding roles and responsibilities, THDEV will be held responsible for any non-compliance to the conditions of authorisation.

9.18 Details of the ECO/s must be communicated to this Department upon appointment of the ECO/s.

9.19 The ECO/s must on a weekly basis monitor project compliance with conditions of this Record of Decision, environmental legislation and the EMP. Details regarding the frequency of site visits and responsibilities of the ECO/s must be included in the EMP.

9.20 Monthly audit reports for the construction phase of the development must be submitted to this Department. The details for the submission of the audit reports are as follows:

Assistant Manager: Compliance, Monitoring and Enforcement

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Private Bag X006
Bishopsgate
4008

9.21 In terms of Monitoring, Recording and reporting to the Department, the development must be audited on an annual basis during the operational phase (i.e. post-construction phase) to measure compliance and the effectiveness of mitigation measures in the EMP. The audits must be done by an independent environmental auditor and the audit reports must be submitted to this Department at the address provided above.

9.22 THDEV as the applicant are responsible for adherence to the conditions laid out in the Record of Decision (RoD) until such time as the land is transferred to developers and/or private purchasers. The RoD will then become binding on the new landowner whom shall assume direct and full responsibility for adherence to the conditions of the RoD and monitoring thereof according to the RoD and EMP to the extent relevant.

It is the responsibility of the applicant to ensure that the new landowner is made aware of the conditions of this authorisation prior to the signing of the necessary sale purchase agreements as well as the legal implications of contravening Conditions of this Authorisation applicable to them.

9.23 Ecological corridors are to be established, vegetated and maintained according to the approved development concept framework and the landscaping and rehabilitation plans with the involvement of Ezemvelo KZN Wildlife and the eThekwini Municipality: Environmental Management Department.

9.24 A Conservation Servitude in favour of the eThekwini Municipality must be registered over the Conservation Trust area, as depicted on the drawing prepared by IYER Urban Design Studio, ref 12/12/ver.03, dated 13 May 2008.

9.25 Regarding the management of the Conservation Servitude, the following conditions must be complied with:

a) THDEV must establish a Conservation Management Trust for the Sibaya Conservation Trust Area (as per plan ref 12/12/ver.03) within 1 year of the date of the first transfer in the Sibaya Precinct from THDEV to a third party.
b) THDEV must ensure that a Conservation Management Plan (CMP) is prepared for the Conservation Trust Area. This plan must be prepared and approved by the eThekwini Municipality and Ezemvelo KZN Wildlife and must include the financial sustainability of the operation of the Trust and is to be in place prior to the establishment of the Trust.
c) THDEV must provide seed capital to enable the establishment of the Trust with a suitable window period for management of the Trust.
d) The CMP must detail all required activities over a phased period and provide details of associated costs, sources of funding and responsible parties for implementation of the plan. It must also indicate an "upfront payment" amount to be provided by THDEV.
e) At every sale within Sibaya (within Nodes 1-5), provision must be made for an appropriate conservation levy to be paid to the Trust on a monthly basis that will be utilised for the ongoing operation of the Trust. This amount must be determined when the CMP is developed and must be noted in the CMP.

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f) THDEV must assume responsibility for the management of the Conservation Trust area should the Trust fail.

9.26 The relevant departments of the eThekwini Municipality must approve all finalised infrastructural service layouts and plans for sewer, water and electricity.

9.27 All proposed road upgrades and new road works must be approved in writing by the relevant transport authority (i.e. the Department of Transport, eThekwini Transport Authority and/or SANRAL) prior to commencement of the proposed works.

9.28 The following conditions apply to stormwater management on the site:

a) Stormwater must be disposed of without causing soil saturation, erosion and sloughing.
b) A stormwater management plan (SMP) must be approved by the Department of Water Affairs and Forestry (DWAF) and the eThekwini Municipality **prior** to the commencement of construction.
c) The SMP must be implemented during both the construction and operational phases of the development of the Sibaya Precinct.
a) The SMP must be considered as an active document and is to be updated as and when required.
b) Where necessary, site-specific specifications must be included with the SMP. These specifications must be approved by the relevant authorities.
c) Stormwater management must take cognisance of the wetlands on site and must not lead to a decrease in the functionality thereof.
d) Stormwater management must take cognisance of the Ohlanga River and estuary, with post-development run-off into the estuary maintained at pre-development levels.
e) Within the jurisdiction of a site specifically and the Sibaya Precinct precincts in general, the proponent and his professional team, including the contractor, shall be responsible for ensuring that the requirements of this Stormwater Management Plan are met.
f) The proponent and his professional team shall be responsible for the performance of all stormwater control measures implemented on a site under their jurisdiction and the impact such works may have on downstream property within the Sibaya Precinct nodes.
g) Approval of any plan or document, whether verbally or in writing, by the eThekwini Municipality shall not be construed as absolving the owner or the professional team of this responsibility.

9.29 As proposed by THDEV, the Sibaya Management Association (a Section 21 Company) must be formed to manage development of the Sibaya Precinct.

9.30 The Sibaya Management Association must have an Operational Management Plan (OEMP) which details how potential impacts will be mitigated should they arise.

9.31 All development must adhere to the Architectural guidelines for the Sibaya Precinct. All architectural designs must be approved by the Design Review Committee (formed by the Boards of the Sibaya Management Association) prior to the submission of building plans to the eThekwini Municipality for approval and the commencement of construction.

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9.32 The landscape and rehabilitation plan must be included with the EMP as a legally binding document with which all developers, their contractors and the Management Associations must comply. Site-specific modifications to the landscape plan must be approved by the eThekwini Municipality and any other relevant authority prior to implementation.

9.33 Alien vegetation removal and control must form part of the construction and operational phase EMPs. This program not only relates to the removal of alien species but also to the rehabilitation and ongoing management of the area thereafter.

9.34 Rigorous planting of locally appropriate indigenous trees and vegetation along the M4 to screen the development must be undertaken during the development stage of the project.

9.35 A security management plan based on the principles noted in the Final EIR must be implemented during both the construction and operational phases of the development.

9.36 The Security detail for the forest edge dated 3rd September 2008 must be implemented.

9.37 All archaeological sites identified within the Sibaya Precinct must be treated according to the recommendations in the archaeological study produced by the Natal Museum (4 June 1997).

9.38 Developers/contractors must be sensitive to the occurrence of Heritage Resources in the area. If such a site is located during construction, Amafa must be contacted immediately and construction discontinued until resumption is authorized by Amafa.

9.39 Iconic buildings (such as the 15 Storey buildings) are to be limited to single buildings on the hilltops wiithin each node, subject to approval of the eThekwini Municipality via the rezoning and Precinct plan processes.

9.40 The following conditions are applicable from a Visual Impact Assessment perspective and must be adhered to:

a) As much of the natural vegetation as possible is to be retained and nursey area/s to be provided for such material.
b) All berms and soil stockpiles must be vegetated immediately to reduce both visual impact and wind and water erosion.
c) A canopy cover must be established along the M4 to reduce the immediate visual impact of the Precinct and to keep the vista consistent with that when traveling next to the Mhlanga Forest and Forest 31.
d) The building colours shall be kept earthy and natural and be consistent with the architectural recommendations.
e) Anti-glare materials shall be used for buildings adjacent to the M27, M4 and N2.
f) Litter and dust management measures must be in place at all times;
g) Fires shall not be allowed on-site and burning of waste on site is prohibited.
h) The entire site is to be kept neat and tidy at all times.

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i) Except for the required aviation lighting, outdoor lighting is to be focused towards the landscaping to detract the focus from the building structures;
j) Where unavoidable, outdoor lighting must be as unobtrusive as possible. Reflectors must be used to avoid light spillage and low level lighting shall be used for footpaths and parking areas;
k) External signage must be kept to a minimum and where possible attached to structures to avoid free-standing signs in the landscape.
l) It is the responsibility of the proponent to ensure that no shadows reach the residential areas of Umdloti should the building types, layout or heights change.

9.41 The following conditions apply to the management of wetlands on site:
a) The wetlands within the development site must be rehabilitated to restore the integrity of the hydrological and vegetative components of the systems by means of deactivation of the drainage network and the removal of sugar cane and alien invasive vegetation. Further, the recommendations provided by the wetland specialist and that of the landscape plan must be implemented in order to improve wetland functionality.
b) There must be no development within the drainage lines, wetland areas or within the minimum delineated buffer zones other than the placement of bulk infrastructure or associated infrastructure where no alternatives exist, and such structures for the enhancement of passive recreational use of these areas as may be provided in the Conservation Management Plan.
c) All wetlands within the site must be rehabilitated according to the wetland specialist and landscape plan in order to improve their functioning.
d) The wetlands and their associated buffers as well as the open space/conservation servitude areas must be clearly marked and cordoned off by the land surveyor with assistance from the relevant specialist prior to the commencement of construction. These are to be no-go areas for the entire construction team, except for the installation of services or amenites referred to in (b) above where necessary and for rehabilitation purposes.
e) Wetland and buffer zone management must be detailed in both the construction EMP as well as the Operational EMP.
f) The stormwater structures within wetlands must be designed as 'dry ponds' in order to reduce the loss of wetland habitat upstream associated with flooding.
g) The wetlands shall be protected through the adoption of a 20m buffer zone across the majority of the site as indicated by the wetland specialist.

9.42 The following conditions are applicable for road crossings of wetlands, drainage lines, streams or rivers:
a) These crossings must be as narrow as feasibly possible to reduce the area of vegetation requiring removal.
b) Pipe crossings for reticulation purposes (typically water and sewer) and other services such as communication and electrical must be ducted and designed within or attached to a required structure;
c) All crossings are to be designed in order to ensure that they account for diffuse flow in areas associated with the flow characteristics of the rehabilitated tributaries;
d) The crossing must be designed and assessed in consultation with an appropriate environmental expert to ensure that the functioning of the effected system is improved.

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e) The relevant permit for the crossings must be obtained from the Department of Water Affairs and Forestry prior to the commencement of construction for such crossings.

9.43 Where development abuts a forest (Hawaan, Mhlanga, Forest 31), buffer zones of 40m must be established from the edge of the forest, which is defined as the drip-line of the trees. These buffer zones are to be maintained and the first 20m of these buffers are strictly areas of no development. The development of passive recreational activities such as cycling, anti-walking tracks and the placement of bulk infrastructure where no other alternative exists will be permissible in the second 20m section. In addition, this second 20m section is also to be used for the necessary security measures/installation.

9.44 The existing dirt road that runs along the Ohlanga River, must be maintained as a grassed road and not used by the general public. Further, the existing prism of the dirt road may not increase.

9.45 The road (within Unit D) proposed on the eastern side of the system must be aligned such that cut/fill operations do not encroach further than the existing road footprint with the lower reaches of this road being retained for management and recreational purposes and maintained as a grass track.

9.46 The road (within Unit G) on the south-eastern side of the system must be maintained for management and recreational purposes and maintained as a grass track rather than bare soil/quarry material.

9.47 The road (within Unit K) proposed on the eastern side of the system must be aligned to ensure that cut/fill operations do not encroach further than the existing road footprint.

9.48 The road (within Unit M) proposed on the eastern side of the system must be aligned to ensure that cut/fill operations do not encroach further than the existing road.

9.49 The Recommendations from the Hydrological Plan for stormwater planning must be adhered to.

9.50 The following conditions apply to noise, dust and blasting.

a) Vehicles transporting sand or finer grained materials are to have covered loads to prevent dangers/nuisance to other road users (dust, falling sand/rocks).
b) Speed limits must be implemented in all areas of the site and adhered to.
c) Dust must be suppressed during dry periods by the regular application of water or a biodegradable soil stabilisation agent. Water (of suitable quality) used for this purpose must be used in quantities that will not result in runoff and erosion, or muddied areas.
d) Vehicle and plant tyres are to be washed prior to leaving the site, and prohibited from transporting excess mud onto roads.
e) Routes for temporary access and haul roads are to be located within the approved demarcated areas and vehicle movement is to be confined to these roads, unless otherwise approved by the project team.
f) Soil shall be exposed for the minimum time possible once cleared, such that

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the timing of clearance is coordinated with the onset of construction. This will prevent wind and water erosion.

g) Construction activities in the vicinity of schools and other sensitive areas are to be scheduled during school holidays when road usage is reduced.
h) All stockpiles are to be covered if the stockpile is to be exposed for an extended period of time.
i) Blast events are to be controlled as required by the relevant legislation, and undertaken by a professional team. Blast mats are to be used to reduce fly-rock and subsequent dust in sections of the pipeline route that are in close proximity to other land uses.

9.51 **Nodes 1 & 5**

a) The development of Node 1 is hereby allowed to proceed based on the layout plan attached herewith, subject to the necessary planning approvals from the eThekwini Municipality.
b) The development of Node 5 hereby allowed to proceed based on the layout plan attached herewith, subject to the necessary planning approvals from the eThekwini Municipality.
c) Any material changes to the detailed layout plans of Nodes 1 & 5 must be submitted to DAEA, the eThekwini Municipality, Ezemvelo KZN Wildlife and DWAF for their approval, prior to implementation of the amendments.
d) Nodes 1 and 5 shall, in the short term, be sewered to the Ohlanga catchment and specifically to the Phoenix Treatment Works as recommended in the Sewer report. When a new wastewater treatment works is provided in the Umdloti catchment, these nodes will be sewered to this new works. The mitigation measures included in the EIR shall be adhered to.
e) The occupation of development phases within Nodes 1 and 5 will be subject to the approval of the respective eThekwini Municipality servicing departments depending upon available service and infrastructural capacities for each phase.
f) The stormwater attenuation details shall be as per Appendix 25 of the EIR.

9.52 The following conditions apply to the establishment of a shuttle service between the Sibaya Precinct (specifically Node 5) and Umdloti beach:

a) A shuttle service between the Sibaya Precinct (specifically Node 5) and Umdloti beach must be established in order to reduce the impacts on the roads and limited facilities and infrastructure within Umdloti.
b) The number and frequency of trips of this shuttle service will depend on the demand as the Sibaya Precinct develops.
c) The drop off, collection points and operation of the service must be established in consultation with the Umdloti Ratepayers Association and the eThekwini Municipality.
d) Should an alternate means of moving people between the Sibaya Precinct and Umdloti beach, the shuttle service may fall away, provided the alternate means is agreed upon by both the Umdloti Ratepayers Association and the eThekwini Municipality.

9.53 In addition to condition 9.53 above, the establishment of pedestrian routes and possible pedestrian crossings from the Sibaya Precinct (specifically Nodes 5) to Umdloti beach and surrounding areas must be approved by the eThekwini Municipality prior to its implementation.

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9.54 The Developer must commit to a programme, which provides for the required connecting sewer to be completed by July 2011 (i.e. the EIA must be undertaken and approval sought for this installation).

9.55 The development of Nodes 2, 3 & 4 are subject to detailed Environmental Impact Assessment.

9.56 Any future significant environmental issues that arise during the lifetime of the proposed project must be incorporated in an updated Environmental Management Plan that is to be forwarded to this Department for approval.

9.57 Measures must be implemented such that erosion is minimised during and after construction. Suitable erosion control measures must be implemented in sensitive areas such as near water supply points and edges of slopes. These measures may include:

a) The suitable use of sand bags or Hessian sheets.
b) The prompt rehabilitation of exposed soil areas with indigenous vegetation to ensure that soil is protected from the elements.
c) The removal of vegetation, only as it becomes necessary for work to proceed.
d) Prevent the unnecessary removal of vegetation especially on steep areas.

9.58 The infrastructural service layouts and plans for sewer, water and electricity are to be approved by the eThekwini Municipality prior to the commencement of construction.

9.59 All construction related work, including the storage of construction materials must take place within the construction camp/s which will be clearly demarcated. No storage of material will be permitted outside these areas unless agreed upon by the Environmental Control Officer, Engineer and this department.

9.60 Construction workers must be briefed on the sensitivity of the natural environment where this is applicable.

9.61 Should the temporary aboveground storage of fuel be required during any phase of the development, the following will apply:

a) Relevant environmental legislation must be adhered to.
b) The aboveground storage tank must comply with relevant SANS Codes of Practice and local authority bylaws.
c) The aboveground storage tank must be fitted with an overfill protection device.
d) The tank must be located on an impervious surface and must be enclosed by a completely sealed bund wall, which must be able to contain 110% of the maximum volumes stored in the tank.
e) The tank and products lines must be pressure tested prior to commissioning.
f) The condition of the bund wall, tank and associated piping must be inspected on a regularly basis and be maintained accordingly.
g) A procedure for decommissioning of the tanks must be included in the EMP.
h) Spillages occurring at the dispensing area must be contained and cleaned up. Any water containing waste generated as a result of the spillage and associated clean up must be disposed of correctly and safely. Care must be

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taken not to allow any discharge into the storm-water system, sewer system or the environment.

i) A spill contingency plan must be drawn-up and adhered to.

9.62 All significant spills must be reported to DWAF as well as the Environmental Section of the eThekwini Municipality.

9.63 All the necessary precautions shall be taken to prevent contamination of soil and water by fuel, oil and cement products during the construction phase.

9.64 A spill contingency plan is to be drawn up, in consultation with the Department of Water Affairs and Forestry (DWAF), and implemented. This plan must be completed before commencement of construction.

9.65 At the first sign of a leak, appropriate steps must be taken by the applicant to stop the leak and remediate any contamination. In the event of a spill exceeding 10 litres, this Department must be contacted immediately.

9.66 Any complaint from the public and interested and affected parties regarding this project must be attended by the holder of this authorisation as soon as possible to the satisfaction of the parties concerned.

9.67 All rubble and waste must be removed from the site and disposed of at a waste disposal site licensed in terms of section 20 of the Environment Conservation Act, (ECA) No. 73 of 1989. The contractor responsible for the removal of the rubble must supply the applicant with a certificate indicating safe disposal site. Within 14 days of its issue, a copy of the safe disposal certificates must be forwarded to:

The Assistant Manager: Compliance, Monitoring and Enforcement Component
Private Bag X006
Bishopsgate
4008

10. Validity Period

10.1 The duration of authorisation to commence with this project is **48 (forty-eight) months** from the date of issue of this Record of Decision.

10.2 If this project has not commenced within this period this authorisation is deemed to have lapsed and is no longer valid unless a written application for amendment is received at least 60 days prior to the expiry of this authorization.

10.3 Conditions pertaining to the operation of the development remain valid for the lifetime of the development.

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11. Appeal

In accordance with the provisions of subregulation 62(1) of the EIA Regulations, 2006, a notice of intention to appeal must be lodged with **Mr. M.E Mthimkhulu, the MEC for the KwaZulu-Natal Department of Agriculture and Environmental Affairs,** on the form attached within **10 calendar days** of receipt of this decision by means of the following methods:

POSTAL:
Private Bag X9059
PIETERMARITZBURG
3200

PHYSICAL:
No. 1 Cedara
Executive Building
Cedara College
PIETERMARITZBURG
3201

SATELLITE OFFICE

POSTAL:
PO Box 2132
DURBAN
4001

PHYSICAL:
8th Floor, Truro House
17 Margaret Mncadi Blvd (Victoria Embankment)

TEL: 033 343 8240
FAX: 033 343 8255

Before lodging the notice of intention to appeal, a copy of the notice of intention to appeal must be served by the appellant on all registered interested and affected parties, as well as a notice indicating where, and for what period the appeal submission will be available for inspection.

12. Authorizing Officer
Comments:

.....

.....

for: **Acting Head of Department:**
Department of Agriculture and Environmental Affairs

26/03/2009
Date

Date stamp

26/03/09

Appendix 1: Locality Map

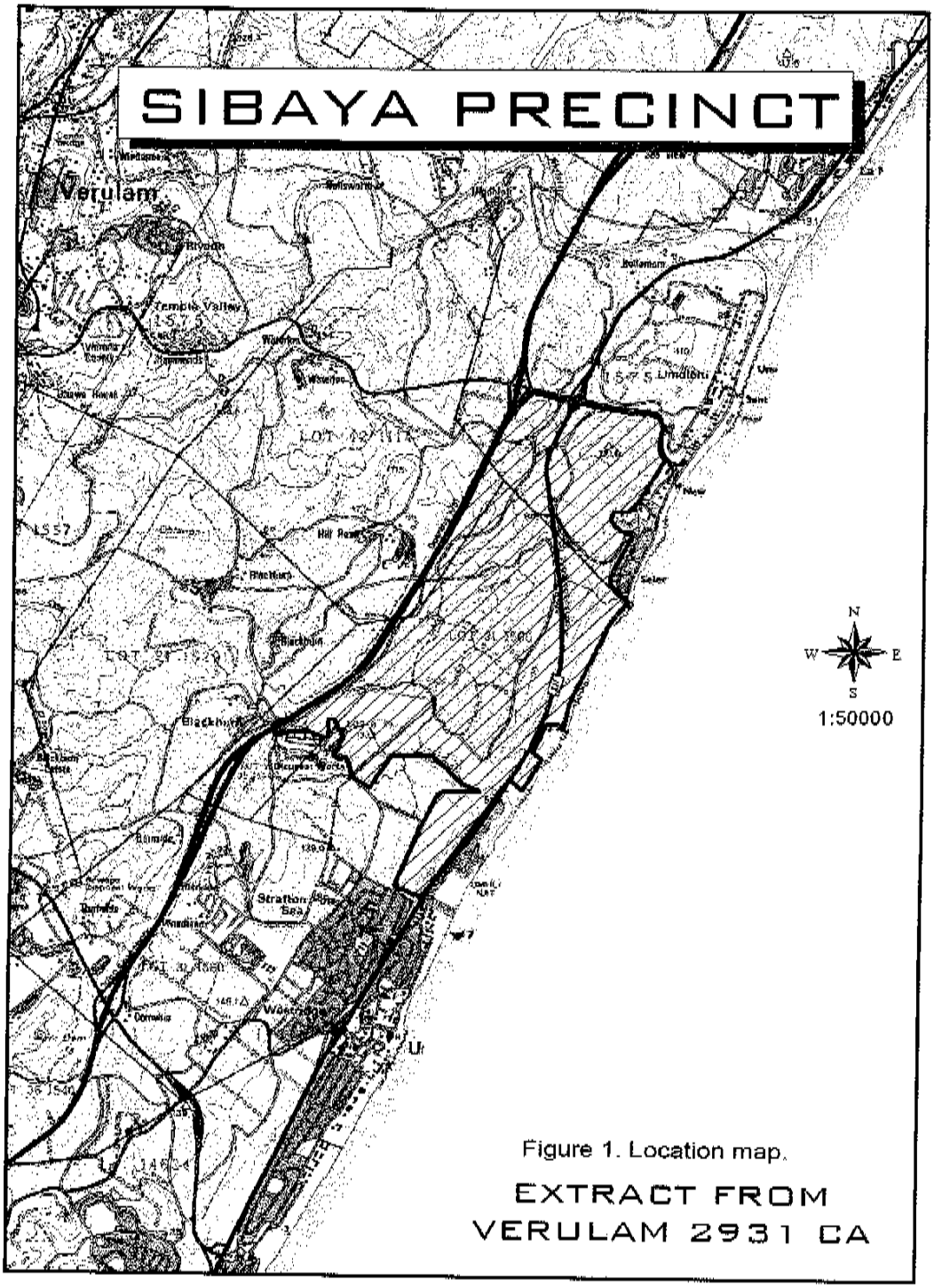
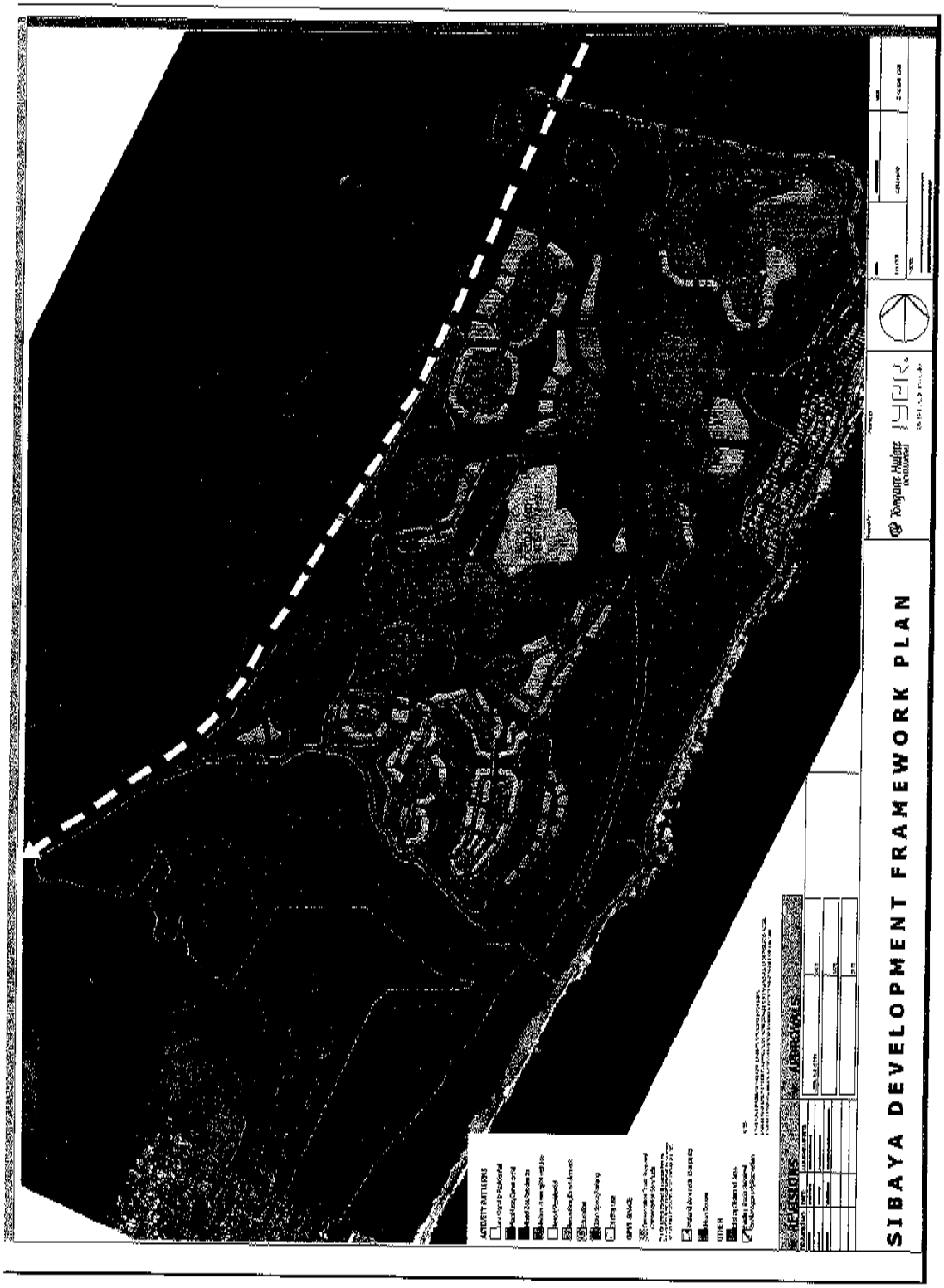


Figure 1. Location map.

EXTRACT FROM
VERULAM 2931 CA

26/03/09

Appendix 2: Sibaya Development Framework Plan (Applicable for Nodes 1 and 5 only)



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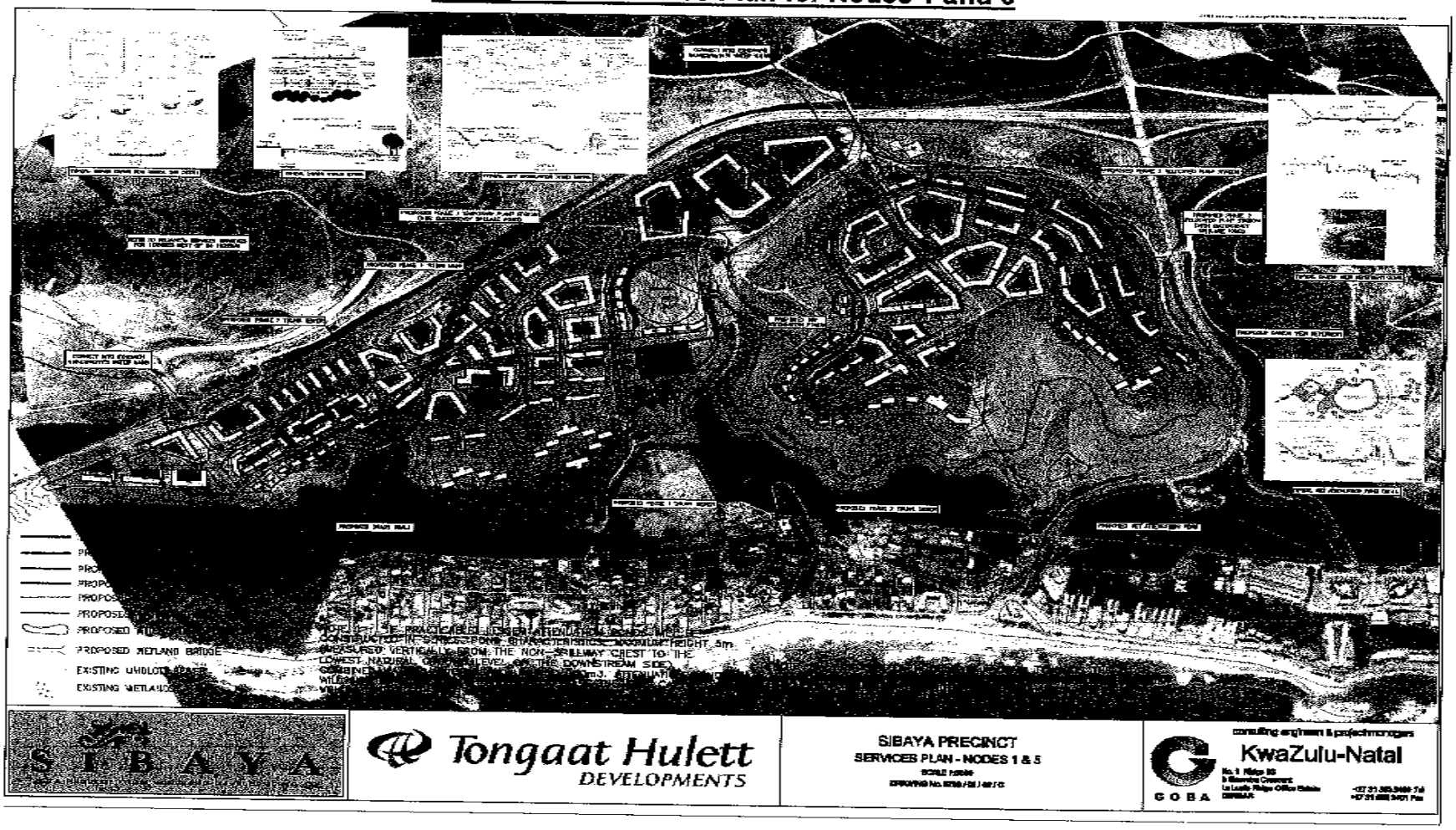
Appendix 3: Services Plan for Nodes 1 and 5



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KZN Agriculture and Environmental Affairs
Mnyango: eZolimo neZemvelo
SIFUNDAZWE SAKWAZULU-NATALI

Notice of intention to appeal to the KwaZulu-Natal MEC for Agriculture and Environmental Affairs

Notice in accordance with the requirements of the Environmental Impact Assessment Regulations, 2006

Kindly note that:

1. It is the responsibility of the appellant to ascertain whether subsequent versions of the form have been published or produced by the competent authority.
2. This notice must be hand delivered or posted to the office of the KwaZulu-Natal MEC for Agriculture and Environmental Affairs **within 10 days** after the notification of a decision. No faxed or e-mailed notices will be accepted.
3. If the appellant is the applicant, the appellant must, in accordance with the requirements of sub-regulation 62(2) of the Environmental Impact Assessment (EIA) Regulations 2006 serve this notice on each person and organ of state which was a registered interested and affected party. If the appellant is not the applicant, the appellant must, in accordance with the requirements of sub-regulation 62(3) of the EIA Regulations 2006 serve a copy of this notice on the applicant.
4. The appellant must submit an appeal to the office of the KwaZulu-Natal MEC for Agriculture and Environmental Affairs on the prescribed form (obtainable from the Department) **within 30 days** of the lodging of this notice.

DETAILS OF THE KWAZULU-NATAL MEC FOR AGRICULTURE AND ENVIRONMENTAL AFFAIRS:

This notice must be posted or delivered to:

The KwaZulu-Natal MEC for Agriculture and Environmental Affairs

8th Floor, Truro House
17 Victoria Embankment
Durban
PO Box 2132
DURBAN, 4000

OR

No 1 Cedara
Executive Building
HILTON
Private Bag X9069
Pietermaritzburg, 3200

1. DETAILS OF PROJECT

EIA Reference No:	
Project description:	

2. AVAILABILITY OF APPEAL SUBMISSION FOR INSPECTION

Where the appeal submission will be available for inspection:	
Period that the appeal submission will be available for inspection:	**From:**
	To:

3. BRIEF DETAILS OF THE GROUND/S OF APPEAL

1.
2.
3.
4.

4. DISCLOSURE OF APPELLANT'S INTEREST IN THE PROPOSED PROJECT

(For official use only)

EIA Reference Number:	
Date Received:	

5. DETAILS OF PARTIES ON WHOM THIS NOTICE HAS BEEN SERVED

Name	Contact details

6. DETAILS OF APPELLANT

Is the appellant the applicant for this project?	YES	NO

Full names of Appellant

Address

Telephone number **Fax number**

Cellphone number **E-mail details**

Signature of appellant

Date

KZN Agriculture and Environmental Affairs
Mnyango: eZolimo neZemvelo
SIFUNDAZWE SAKWAZULU-NATALI

Appeal to the KwaZulu-Natal MEC for Agriculture and Environmental Affairs

Appeal in terms of the provisions of section 43 of the National Environmental Management Act, Act 107 of 1998, (as amended) and the Environmental Impact Assessment Regulations, 2006

Kindly note that:

1. This form complies with the requirements of sub-regulation 63(2)(a) of the Environmental Impact Assessment Regulations, 2006.
2. It is the responsibility of the appellant to ascertain whether subsequent versions of the form have been published or produced by the competent authority.
3. Appeals must be hand delivered or posted to the office of the KwaZulu-Natal MEC for Agriculture and Environmental Affairs **within 30 days** of the lodging of a Notice of Intention to Appeal. No faxed or e-mailed appeals will be accepted.
4. Responding statements may be submitted to the office of the KwaZulu-Natal MEC for Agriculture and Environmental Affairs **within 30 days** of the lodging of this appeal.

DETAILS OF THE KWAZULU-NATAL MEC FOR AGRICULTURE AND ENVIRONMENTAL AFFAIRS:

This appeal must be posted or delivered to:

The KwaZulu-Natal MEC for Agriculture and Environmental Affairs

8TH Floor, Truro House
17 Victoria Embankment
Durban
PO Box 2132
DURBAN, 4000

OR

No 1 Cedara
Executive Building
HILTON
Private Bag X9059
PIETERMARITZBURG, 3200

(For official use only)

EIA Reference Number:	
Date Received:	

STORMWATER MANAGEMENT PLAN

FOR THE

SIBAYA PRECINCT

Incorporating Policy, Regulations and Guidelines

Version 2.0

5 NOVEMBER 2007

Prepared by

VelaVKE Consulting Engineers (Pty) Ltd
21 West Riding Row
Sherwood, 4091

For

Tongaat Hulett Developments (Pty) Ltd
P O Box 22319
Glen Ashley, 4300

Report No DR2007/14

TABLE OF CONTENTS

STORMWATER MANAGEMENT PLAN

FOR THE

SIBAYA PRECINCT

1. INTRODUCTION

The proposed Sibaya Precinct is bounded by the Hawaan Forest in the South, the N2 freeway in the west, Main Road 96 to the North and the coastal developments of Umdloti to the East. Central to the Node is the existing Sibaya Casino, which is located at the highest point on the watershed.

Most of the sub-catchments in the development area drain southwards to the Ohlanga River, but roughly one third of the area drains eastwards through existing developments in Umdloti. A small part of the area drains under the N2 and MR96 to the Umdloti River. Parts of the south-draining catchments, that incorporate the N2 drainage system, lie to the west of the N2.

This stormwater management plan applies to all new developments within the Sibaya Precinct and covers the impacts that developments may have on neighbouring catchments that must receive runoff from the Sibaya developments as well as the impact of stormwater that must be received from neighbouring catchments.

The user should refer to the various specialist reports for more details on the impacts that development will have on the affected catchments and possible means for mitigating these impacts. In particular the “Hydrological Investigation Report” by Sagen Projects and the “Current & Post-Development Wetland Assessment Report using Ecoservices” by LRI contain detailed assessments and recommendations for mitigating the development effects.

2. MITIGATION OF DEVELOPMENT CONSEQUENCES

The impacts of the Sibaya Precinct development on the environments in the affected catchments will range from negative to positive depending on the degree of planning and design and methods of implementation that contribute to the mitigation of the naturally negative impacts of development.

One consequence of unmitigated development that leads to increased hardened areas, reduced infiltration, loss of vegetation and reduced evapotranspiration, would be an average increase in surface runoff from the Sibaya Precinct area equivalent to 98 mm per annum.

In the Ohlanga River Catchment, the mean annual runoff (MAR) of the catchment is about 160mm/year, or 36.4 Ml/day from 83.1 square kilometres of catchment. The Sibaya Precinct covers 4.8 square kilometres in this catchment and has a current MAR of 169mm/year. Unmitigated development would increase this to 279 mm/year leading to 1.44 Ml/day in additional normal and flood runoff.

The Sibaya development will result in the importation of approximately 5.5 Ml/day of alien water through the potable water supply, which will contribute a further 4.75 Ml/day of sewage flows into the Ohlanga catchment. Any irrigation off the potable water supply would add further to the net catchment runoff.

The Ohlanga River estuary already receives excess flow in the form of wastewater discharges from two sewerage treatment works and it is important therefore that adequate measures are taken to mitigate these impacts.

The specialist studies have shown that mitigation of the potentially negative effects of the proposed development can be successfully mitigated through the implementation of the policy, regulations and guidelines contained in this Stormwater Management Plan, as well as the specific recommendations given in the specialist reports.

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

- Improved wetland functionality
- Adoption of a zero net-loss approach on wetland areas
- Rehabilitation of the natural watercourses to prevent erosion and retain runoff
- Promotion of subsoil infiltration at every opportunity
- Provision of vegetation and stabilisation of all slopes
- Increased functionality of land use to encourage evaporation and evopo-transpiration
- Flood risk assessment
- Acknowledgement of flood risk versus environmental potential in assigning land-uses
- Attenuation of flood peaks to predevelopment levels or less
- No impermeable areas without sufficient flood attenuation and evaporation potential
- Rehabilitation of the development area following conversion from sugarcane

These issues must be carried through the Stormwater Management Plan to the Landscaping plan, particularly in addressing the land rehabilitation issues.

The Stormwater Management Plan described below lists many practical on-site controls to address these fundamentals issues. However, this does not exclude any technology that can be shown to be effective in controlling runoff, supporting One-Planet-Living principles and generally making a positive contribution to the environment.

To fully mitigate the negative impacts of development:

- 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 both storm runoff and treated wastewater.
- The potential increase in flood peaks must be mitigated to at least predevelopment levels by the provision of adequate stormwater detention facilities at micro and macro levels.
- The potential increase in flood volumes must be mitigated where possible by subsoil infiltration, retention of runoff in on-site facilities for irrigation use and unsaturated wetland areas where evaporation and infiltration can help to reduce flood runoff rates.

3. OBJECTIVES

This stormwater management plan for the Sibaya Precinct has the following objectives:

1. To protect all life and property from damage by stormwater and floods
2. To prevent erosion of soil by wind and water
3. To improve the quality of life of the Sibaya Precinct and the affected downstream communities of Umdloti
4. To conserve the flora and fauna of the natural environment
5. To protect and enhance water resources in the catchments from pollution and siltation
6. To protect and enhance the local and downstream water courses and their eco-systems, in particular the Ohlanga River Estuary.

4. MAJOR RISKS

4.1. Erosion

The Berea Red soils and other alluvial sands found in the area vary from cohesive to non-cohesive, but are generally highly erodible and pose a constant and significant threat to the stability of the natural landforms. On the steeper slopes, erosion can take place extremely quickly once initiated, resulting in dongas and undermining structures. The damage to the watercourse will seriously impact not only on the site of the erosion but could damage neighbouring properties and any dams and wetlands located in the downstream valleys where the eroded sediment will be deposited. The cost of correcting the damages will be substantially more than the precautions required to avoid the damages.

4.2. 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 by the development either collectively and/or individually. The design of the major stormwater system must address this issue as far as possible, but it is important to note that each individual development and its associated infrastructure must be designed such that the downstream post-development flood risks are no greater that the pre-development flood risks.

This is particularly relevant in the case of developments that drain eastwards through the stormwater system infrastructure of Umdloti. A detailed analysis of the stormwater systems in the east-draining sub-catchments will be required to determine where stormwater attenuation measures can be implemented to meet the above conditions.

The analysis should also advise the degree to which individual developments will have to provide on-site attenuation to ensure that post-development runoff at the boundary with Umdloti developments remains the same, or is less than the pre-development runoff.

As a guide to the degree of runoff attenuation required, pre-development and post development 100-year event peak flood estimates for the individual catchments are given in the report entitled “Sibaya Development Node: Preliminary Assessment for Stormwater Catchment Management Plan Revision 1.0“ dated 5/11/07

5. STORMWATER MANAGEMENT PHILOSOPHY

The major stormwater system consists of all natural water ways, including springs, streams, rivers, wetlands and dams. It includes detention and retention dams and other devices constructed to control stormwater. Roadways and their associated drainage structures are 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, conduits, berms, channels, road verges, small watercourses and infiltration constructions.

Stormwater runoff should not be concentrated to an extent that would result in any damage to the environment during storms with a probability frequency more than 1 in 10 years and would result in only minor, repairable damage in storms with a probability frequency more than 1 in 50 years. All elements of the built and natural environment must be able to withstand a 1 in 100 year storm event without significant consequential loss and risk to property and life.

Note that a “storm frequency” equates to a “probability of occurrence” of a storm event that should be used to assess the annual budget or insurance provision for remedial works, should the event occur.

In all catchments, the water courses and built stormwater infrastructure must be maintained in a clean state, free of any rubbish, debris and matter likely to pose any pollution threat to the lower reaches of the water courses.

The Stormwater Management Philosophy for Sibaya Precinct encourages 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.
- Reduce stormwater flows as much as possible by the effective use of attenuating devices.
- 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 theme for the area.
- 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.

6. 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 with 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 on erosion potential.

4. Precautions shall be taken at all times on building sites to contain soil erosion and prevent any eroded material from being removed from the site.

5. Landscaping and re-vegetation of areas not occupied by buildings or paving shall be programmed to proceed immediately 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. Earthworks on sites are to be kept to a minimum. Where embankments have to be formed, stabilisation and erosion control measures shall be implemented immediately.

8. Stormwater must not be allowed to pond in close proximity to existing building foundations.

9. Prior to any physical work proceeding on any site, stormwater control plans (SCPs) detailing the proposed stormwater control measures are to be submitted to the Design Review Committee of Tongaat Hulett Developments, or their appointed representative. No work is to be undertaken without an approved SCP.

10. Stormwater Control Plans must describe what control measures are to be implemented before and during the construction period, as well as the final stormwater control measures required for the site on completion of site development. Plans must indicate who is responsible for the design of the control measures and who is, or will be, designated as the responsible person on site during each stage of the implementation of the control measures.

11. Stormwater Control Plans must show that all the provisions, regulations and guidelines contained in this document have been taken into account.

12. In the event of a failure to adequately implement the approved stormwater control plan, the owner/developer shall be responsible for making good all consequential environmental damage at his own cost. Owner/developers are therefore advised to ensure that all members of their professional teams and their contractors are competent to undertake the development work and are adequately insured.

7. MAJOR STORMWATER SYSTEMS

A plan of the sub-catchments is given in Figure 1, with details and possible stormwater impacts given for each sub-catchment in Appendix A to advise the planning process and highlight critical areas for attention during design.

In due course, the stormwater systems in each drainage basin will need to be identified and analysed to determine the requirements for new stormwater infrastructure to meet the objectives of this stormwater management plan. The results 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:

- Allowable ranges for the percentage impervious for commercial and residential areas site
- Average depression storage values for pervious and impervious areas
- Initial and final infiltration rates and the appropriate Horton's decay constant
- Geotechnical data on infiltration rates for infiltration galleries
- Equivalent Rational Method coefficients and unit area runoffs for developments on the small sites

It is important that all building designs provide for maximum on-site stormwater attenuation and that the developers instruct their professional teams accordingly. It is important that level and near-level areas, such as building roofs and parking areas, are used to best advantage to attenuate storm runoff.

8. CRITICAL ASPECTS

1. Preliminary assessment reports have highlighted the vulnerability and susceptibility of existing developments in Umdloti to the effects of stormwater runoff generated upstream by the proposed Sibaya Precinct. Stormwater drainage is hence a crucial aspect in the development of the Sibaya Precinct and will require careful planning, designing and managing.
2. The existing stormwater reticulation through Umdloti, particularly in the two primary watercourses, appears inadequate to handle the present upstream flows, which represent the pre-development flows from the Sibaya Precinct. Taking into account sensitive social and environmental considerations, upgrading of the existing stormwater systems and the provision of stormwater attenuation measures on a macro and micro scale should be included in development plans as far as possible.
3. The stormwater detention ponds should be designed for the 100-year storm event and should be located at appropriately selected sited in the primary watercourses. Site selection must take account of the necessary geotechnical, environmental and topographical conditions, including wetland conservation.
4. In addition to macro stormwater measures, micro-stormwater measures should be implemented on individual sites. The form of this attenuation will be dependant on a number of factors such as topography (natural and artificial slopes), the zoning of the site and soil conditions present. It is envisaged that in the steeper regions on-site attenuation tanks will be the most suitable form of attenuation with outlets to the municipal pipe network, where provided, or appropriate flow spreaders.
5. In the less steep areas where soil conditions are favourable, infiltration measures will be the preferred form of on-site stormwater control and disposal. In certain instances infiltration devices may need to be supplemented with attenuation tanks with outlets to the municipal pipe network.
6. A limited stormwater pipe network should be provided for stormwater reticulation to safely convey minor stormwater runoff from properties and roads to and between the attenuation facilities. Hydraulic analysis is required to determine where existing elements of the major stormwater system are inadequate and how the problems can best be addressed.
7. To ensure that water quality is not compromised, silt and trash traps will need to be provided within the system. Where conditions permit, open ditches, drains and channels should be used instead of pipes. 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 and reinforced concrete linings.
8. While the stormwater management objective of the development should be to minimise 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, or an energy-dissipating device.
9. 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. Certain sub-catchment boundaries will be defined by proposed roadways that are likely to concentrate stormwater runoff in a formalised system. Within the development area, stormwater servitudes of adequate width will be required over properties straddling a natural watercourse, or where runoff is diverted for a specific reason. Lined conduits, either open channels or pipes, with outfall energy dissipaters must be provided wherever there is an assessed risk of erosion on slopes steeper than 2%.
10. The proposed developments 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.

11. 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.
12. 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 the100-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.
13. For sub-catchments flowing into the development area, potential future development in these sub-catchments should be considered and any requirements for stormwater detention should be identified. Similarly, for sub-catchments flowing out of the development area the impact on the downstream watercourse must be considered and measures taken to ensure any upstream development does not result in an increased flood damage risk downstream.
14. Sites within the proposed development that bound on stormwater detention areas, near road crossings, watercourse confluences and water features could be subject to flooding. In these situations no development should take place below the outfall levels of water detention areas, plus an appropriate freeboard allowance.
15. 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.
16. Overland flow may be encouraged where possible, but should be avoided in the specific areas identified. These are typically where roads on steep slopes will capture and concentrate cross flows at the local low points in the roads. Plans must take into account probable impact of flow from these points of concentration on the downstream environment.
17. Steep watercourses will require protection from erosion through the use of appropriate channel lining, detention dams, or controlled drops to dissipate flow energy.
18. 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.

9. GUIDELINES FOR OWNERS AND DEVELOPERS

All developments within the Sibaya Precinct will be required to control stormwater runoff in accordance with the stormwater management philosophy and policies of Tongaat Hulett Developments and the Ethekwini Metro Municipality.

The following guidelines are intended to assist developers, owners and their professional teams with the planning of site layouts, the design of the major and minor stormwater systems infrastructure and to ensure that the objectives of this Stormwater Management Plan are met during the planning, design, construction and operational phases of all developments.

Where prescriptive wording is adopted, the guideline shall be accepted and implemented as a rule.

9.1. STORMWATER RUNOFF CONTROL

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

Buildings

a) Any building will inevitably result in some degree of flow concentration, or deflection of flow around the building.

b) The developer/owner shall ensure that the flow path of the stormwater on his site is adequately protected against erosion and is sufficiently roughened to retard stormwater flow to the same degree, or more, as that found in the natural pre-development state of the site.

c) Where the construction of a building causes a change in the natural flora of the site that might result in soil erosion, the risk of soil erosion by stormwater must be eliminated by the provision of approved artificial soil stabilisation devices, or alternative flora suited to the changed conditions on the site.

d) Where a piped stormwater system exists, an on-site stormwater drainage system should be connected to this external system. Any inlet to a piped system shall be fitted with a screen, or grating to prevent debris and refuse from entering the stormwater system. This must be done immediately on installation of the piped system.

e) No building works, earthworks, walls or fences may obstruct or encroach on a watercourse inside or outside the site without approved plans that do not compromise the objectives of the Stormwater Management Plan.

Roof Drainage

a) Building designs must adopt the One-Planet-Living-10 principles and rainfall runoff from roofing and other areas, not subjected to excessive pollution, must be efficiently captured for re-use where possible for on-site irrigation and non potable water uses.

b) Where ground conditions permit, rainwater runoff that is not stored and utilised on site must be connected to infiltration galleries or trenches designed to maximise groundwater recharge. Infiltration facilities must be large enough to contain at least the first hour of a minor storm's runoff without overflowing.

b) Infiltration trenches must be aligned along the contour on the downstream side of the property such that any spillage during major storms results in sheet overland flow.

c) Where a piped stormwater system has been provided to a property, surplus runoff should be connected to this system. Garden and other debris must be trapped on screens or gratings before entering the municipal or local development's stormwater system.

Swimming Pools

a) Unless municipal by-laws provide otherwise, back-wash from swimming pools must be discharged into a suitable soak-away or similar approved structure to ensure the flow is not concentrated without adequate attenuation.

Parking Areas and Yards

a) Any external parking area, yard or other paved area must be designed to attenuate stormwater runoff from a major storm to an acceptable degree.

b) Any area described in (a) must discharge rainwater flowing over, or falling onto its surface, in a controlled manner either overland as sheet flow, or into a detention facility, or infiltration gallery suitably sized to accommodate minor storm runoff.

Driveways

a) Driveways shall not be constructed to deflect or channel runoff onto a roadway, or to concentrate runoff along a particular path that is not a natural water course, without prior consent.

b) Driveways and paths should be designed and constructed such that the rate of flow of stormwater across and along the driveway or path is not increased when compared with the pre-development state.

c) Where the driveway joins the road, the driveway must not obstruct the flow in any open channel, whether line or unlined, found along the road verge.

Private 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.

Stormwater Storage Facilities

a) The sufficiency and effectiveness of on-site detention and retention storage to meet stormwater attenuation requirements within the minor and major stormwater systems is the responsibility of the property owner.

b) Any detention pond shall be integrated with the landscape on the site and maintained in good condition.

c) Retention ponds shall be maintained in good condition and shall not be permitted to become a health hazard or nuisance.

d) Tongaat Hulett Developments, or the eThekwini Municipality, shall have the right to inspect any stormwater drainage control facility at any time and issue instructions for repair and maintenance works deemed to be necessary, which instructions must be carried out within the prescribed time period.

Subsurface Disposal of Stormwater

a) Any construction providing for the subsurface disposal of stormwater should be designed to ensure that such disposal does not cause slope instability, or areas of concentrated saturation or inundation.

b) Infiltration structures should be integrated into the terrain so as to be unobtrusive and in keeping with the natural surroundings.

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.

Energy Dissipators

a) Measures should be taken to dissipate flow energy wherever concentrated stormwater flow is discharged down an embankment or erodible slope and the resulting supercritical flow poses a significant risk to the stability of the waterway.

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.

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 Tongaat Hulett Developments, or the eThekwini Municipality, or their appointed representatives.

9.2. 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, wetlands and dams.

b) Regular monitoring of sites within the catchments should be undertaken by Tongaat Hulett Developments, the eThekwini 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 eThekwini 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 and particularly the Ohlanga River Estuary.

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.

9.3. STORMWATER EROSION CONTROL

Tongaat Hulett Developments or the eThekwini Municipality may, at its discretion, inspect the individual properties within in the Sibaya Node precincts 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.

b) advise property owners of any repair, maintenance and improvement works required on the stormwater system control elements within their jurisdiction.

9.4. SAFETY

Inundation of Property and Buildings

a) No new buildings are to be constructed below the 1:100 year flood line.

b) The 1:100 year flood line may not be altered by the development of the site, land-forming or other means, without the approval of Tongaat Hulett Developments and/or the eThekwini Municipality, in case this interferes with the performance of existing stormwater management facilities.

c) All risk of inundation by flood water is carried by the owner of the property.

d) No flood water may be diverted or concentrated such that a risk of flooding or inundation of any property or building is created.

Structural Damage

a) The diversion or concentration of stormwater, whether on the surface or underground, must not increase the risk of structural damage to any development within the Sibaya Precinct.

b) The above includes the undermining of structures due to erosion of soil by stormwater.

10. 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 Tongaat Hulett Developments.

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 eThekwini 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 Sibaya Precinct precincts 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. The designated responsible person on site, as indicated in the stormwater control plan (usually the contractor) shall ensure that no construction work takes place before the stormwater control measures are in place.

5. Certificate of Occupation

On completion of the works, the eThekwini 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 occupation by the eThekwini Municipality.

6. Occupation Period

During occupation of any property, Tongaat Hulett Developments or the eThekwini Municipality may undertake periodic inspections, to ensure the stormwater management policy is being correctly implemented, and may serve notice on occupants to undertake remedial work, which is deemed necessary in the opinion of Tongaat Hulett Developments and/or the eThekwini Municipality.

11. COMPLIANCE WITH STORMWATER MANAGEMENT POLICY

1. Within the jurisdiction of a site specifically and the Sibaya Precinct precincts in general, the owner and his professional team, including the contractor, shall be responsible for ensuring that the requirements of this Stormwater Management Plan are met.

2. The owner and his professional team shall be responsible for the performance of all stormwater control measures implemented on a site under their jurisdiction and the impact such works may have on downstream property within the Sibaya Umdloti Development precincts.

3. Approval of any plan or document, whether verbally or in writing, by the eThekwini Municipality shall not be construed as absolving the owner or the professional team of this responsibility.

12. References

1 "Sibaya Development Node – Preliminary Assessment for Stormwater Catchment Management Plan", 5 November 2007, VelaVKE Consulting Engineers (Pty) Ltd..

2 "Preliminary Assessment of the Stormwater Catchment for the Umdloti South Development", 13 July 2006, Goba Moahloli Keeve Steyn (Pty) Ltd.

3 "Sibaya Umdloti Development Node - East of MR 398 (M4): Summary of Bulk Civil Services", 10 May 2006, Goba (Pty) Ltd.

4 "Hydrological Investigation Report", March 2007, Sagen Projects

5 "Current & Post-Development Wetland Assessment Report using Ecoservices", March 2007, LRI

13. Figures

Figure 1 Plan of the catchments affected by Sibaya Precincts

Issued by:

Tongaat Hulett Developments (Pty) Ltd.

Date: . . . . . .

INSERT FIGURE 1 HERE

No	Date	Description	By

AMENDMENTS

Client

Moreland

1001 UMHLANGA ROCKS DRIVE
LA LUCIA
4051

TEL. : (031) 522244
FAX. : (031) 525332

P.O. BOX 22319
GLENASHLEY
4022

Project title

SIBAYA CASINO & MOUNT EDGECOMBE NORTH

Drawing title

SIBAYA STORMWATER CATCHMENT PLAN

VELAVKE
CONSULTING ENGINEERS
VKE Centre, 21 West Riding Row, Sherwood, Durban
P O Box 37067, Overport 4067, South Africa
Tel +27(0)31 240-7300 Fax +27(0)31 209-4514
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Signature ______________ Date ________

Scale 1:5000	Name	Date	Signature
Designed			
Checked			
Verified			
Drawn			
Checked			

Drawing No. DH835–SMC–01 | Sht 1 Of 1

Appendix A: Sub-Catchment Stormwater Details

Table of Contents

Catchments Located East of MR 4

The relevant sub-catchments are A to E shown in Figure 1. The approximate sizes of the catchments are tabulated below.

Catchment	Overall Size	Portion Within Proposed Development
A	28.91 ha	16.90 ha
B	11.26 ha	6.67 ha
C	4.9ha	0.81 ha
D	87.67ha	83.16 ha
E	177.76 ha	80.43 ha

Catchment A

The proposed Hotel/Lodge site falls into this catchment. A limited piped stormwater system is present along the existing roads below the site, but has been implemented on an ad-hoc basis. The pipes are small diameter with a number of discharge points onto the beach.

The strip of coastal bush and trees performs an important role in retarding the stormwater runoff from the cultivated lands. The proposed town planning scheme has taken into account this strip of coastal forest.

Subject to the findings of the geotechnical investigation, it is important that on-site stormwater infiltration measures be implemented on the Hotel/Lodge site. The on-site stormwater measures will most likely need to be supplemented by a piped system discharging to existing stormwater drainage along the roads and which may need upgrading.

Catchments B & C

The existing army base occupies most of this area and the small portion that does drain onto the site could most likely be re-routed into the adjacent catchments.

Catchment D

This is a significant catchment with some 83.16ha of the development falling into this catchment which stretches from Umdloti to some 250m west of the M4.

In the existing cultivated lands the watercourse is relatively well defined however it tends to disappear as it enters the band of coastal bush at the interface with Umdloti. The watercourse is extremely overgrown and the stormwater appears to be piped from the property above the road (the existing ski-boat club site) to an outlet on the beach next to the sewer pump station.

The proposed town planning takes into account the existing watercourse, but some refinement may be required depending on the extent of the seepage zones that will

be determined from the geotechnical investigation and floodline analysis. More accurate contours along the watercourse are required for the analysis.

The proposed link road between the M4/Sibaya Casino traffic circle and the Main Access Road (MR96) to Umdloti can be used for stormwater attenuation where it crosses the watercourse. To maximize the amount of stormwater attenuation in the open spaces the level of the adjacent residential properties will need to be raised.

Downstream of the link road the watercourse is steeper and channel protection will be required. A depressed area on the western fringe of the coastal forest requires investigation to ascertain the extent of attenuation that can be provided in this area immediately above the boundary with Umdloti.

Although stormwater attenuation in the open spaces is provided in the town planning layout, on-site stormwater control and disposal methods should still be implemented on the individual properties. The stormwater protection measures of the watercourse through the coastal forest must take particular cognisance of the Environmental Impact assessment.

Existing stormwater servitudes over the properties along the main watercourse need to be verified.

Catchment E

Catchment E is some 178 hectare in extent. It stretches up to the N2 in the West and is bisected by the Main Road (MR96) to Umdloti. The proposed Development comprises some 80 hectares of this catchment.

An open drainage channel, portions of which are protected with gabions runs along the Main Road (MR96) to Umdloti. The open channel starts at the farm access intersection East of the M4 interchange where it picks up stormwater runoff from the Northern and Southern side of the Main Road. This open drain, which is very overgrown with vegetation, runs along the northern side of the Main Road to just before the intersection with Bellamont Road, at which point it is piped to the southern side of the road where it continues as an open channel before being piped under the traffic circle to the stormwater outlet on the beach.

At the entrance to Umdloti a number of pipe culverts have been provided across the open channel for the property accesses off the Main Road. Preliminary calculations show that the capacity of the system is very limited in terms of the size of the catchment that drains into this watercourse. A detailed survey will be required to assess the capacity of the drainage system and to determine the measures required to accommodate the additional runoff from the proposed development.

Catchments Located West of MR 4

Catchments west of MR4 have identification numbers from 1 to 16. Where the development area bisects a catchments, the sub-areas inside and outside the development area are identified by “a” or “b” suffixes.

Catchment 1a

Catchment 1a is 26 ha in extent and drains the North-East quarter of the Sibaya Casino complex, before flowing southwards into Catchment 2a through a culvert under the access road to the casino and commercial area. Runoff from Catchment 1b flows through a culvert under the M4 to join the Catchment 1a water course above the culvert linking to Catchment 2a. The casino site has an attenuation dam on its boundary.

The catchment is relatively steep and the main concern will be erosion during development. Risk of flooding should be considered for developments near the watercourse in the commercial areas.

Catchment 2a

The catchment is 93 ha in extent and the main watercourse draining southwards to the Ohlanga River floodplain picks up runoff from relatively steep slopes east and west. The eastern slopes and the watercourse fall into the conservation zone. Development of entertainment and residential areas on the western slopes could significantly increase storm runoff and protection against erosion is recommended for all steep valley lines.

Proposed road alignments will impact on the direction and concentration of runoff in this catchment. Detention storage and energy dissipation along the main watercourse should be provided.

Runoff from the 4 ha Catchment 2b located outside the development node enters the main watercourse at the circle on the M4.

Catchment 3

Catchment 3 is 35 ha in extent and drains south into the flood plain of the Ohlanga River. It has steep sides to both the east and west. Development on the watershed above this catchment should be carefully planed to avoid, or minimise, concentrated runoff down the steep slopes. There is a high potential for erosion damage in this catchment.

Catchment 4

Catchment 4 is a very steep 7 ha catchment draining to the Ohlanga River flood plain. The same comments given for Catchment 3 apply with respect to development in this catchment. Extreme care will be required to deal with any concentrated runoff. Special care will be required to prevent or control erosion during and after construction.

Catchment 5

The Catchment 5 catchment drains from the north-east to the south-west. The sides are generally steep. The valley curves from a southerly direction to a westerly direction and displays sections that are relatively flat, which could be used for stormwater attenuation. The impact on storm runoff of the proposed road(s) through the catchment should be assessed in relation to potential flow attenuation sites.

The lower sections of the watercourse are steep and may require special attention to prevent erosion due to increased runoff volumes. Protective vegetation must be retained at all times. Catchment 5 drains into Catchment 7 where there appears to be a wetland area within the defined conservation space.

Catchment 6

Catchment 6 drains into the most westerly portion of Catchment 7 where a proposed major road crosses the valley. The catchment has relatively steep sides and contains a main lower valley and two side valleys. The main valley is relatively flat and receives runoff from Catchment 10. A proposed road follows the water course to a tee junction at the catchment boundary with Catchment 7. This road may assist in creating upstream flood attenuation areas in the conservation zones. This would affect the road and culvert designs, in particular at the boundary interface with Catchment 7 (see below).

Catchment 7

Catchment 7 is steep-sided, except for the valley bounding on the Ohlanga River floodplain. Upstream catchments draining into Catchment 7 are Catchment 5 and Catchment 6. In the vicinity of the Ohlanga floodplain, development should take note of the 100 year flood line and encroachment onto the flood plain where permitted by the EIA should be limited.

The steep fall in the stream bed below the road tee junction at the catchment boundary with Catchment 6 is a potential area of concern. Further investigation of the valley is required to determine the erodibility and general stability of this section of the water course. The impact of the road on stormwater drainage and flood attenuation at the junction should be assessed and upstream attenuation storage provided in the main valley of Catchment 6.

Catchment 8

The Catchment 8 catchment is small, has no watercourse and drains onto the Ohlanga River flood plain to the South. The slopes are steep and special precautions will be required to prevent erosion and concentration of stormwater by any development.

Catchment 9a & Catchment 9b

Catchment 9a is east of the N2 within the development node and Catchment 9b is west of the N2. Runoff in both catchments is controlled by the existing N2 freeway drainage system There is little potential for flood attenuation, other than that already provided by the freeway drainage system, and the main concern will be the conveyance of storm runoff down steep slopes and the control of erosion during and after development.

The status of the watercourse and the capacity of culverts under the N2 and elsewhere along the watercourse may require evaluation to determine if any protective measures are required.

Catchment 10a & Catchment 10b

Catchment 10a is east of the N2 within the development node and Catchment 10b is outside to the west of the N2 freeway. Most of Catchment 10a is steep, except along the main watercourse that runs south parallel to the N2. The main watercourse receives flow from Catchment 11a and Catchment 10b.

A proposed road located through Catchment 10a will impact on storm runoff distribution, in particular a small dam in the middle of the catchment. This interface will require careful analysis. The impact of the proposed internal roads on storm runoff should be covered in the stormwater management plan.

Catchment 10b is outside the development node and is zoned for business developments, while Catchment 10a is zoned entertainment, residential and commercial. Consideration should be given to flood attenuation on the west of the N2, as well as any water quality controls that could be introduced to protect the water quality in the main watercourse.

Catchment 11a & Catchment 11b

Catchment 11a receives runoff under the N2 from Catchment 11b and discharges the combined runoff into the main watercourse of Catchment 10a. The steep west-facing slopes pose a risk of erosion similar to the other catchments. Attenuation and water quality controls should be applied in Catchment 11b on the western side of the N2.

Catchment 12

Catchment 12 is located in the Northwest of the development node. Slopes are relatively gentle slopes compared to elsewhere and runoff flows west under the N2. No specific stormwater related issues are identified.

Catchment 13

Catchment 13 faces the uMdloti/N2 interchange. It is relatively steep and has no watercourse. Runoff from development on the watershed to the N2 freeway drainage system will require careful control to avoid erosion of the steep slopes.

Catchment 14a & Catchment 14b (upper parts of catchment E)

Runoff from Catchment 14a west of the M4 into Catchment 14b east of the M4 is controlled by the drainage system of the M4. The catchment is relatively small and its development should have minimum impact on the larger downstream catchments. An assessment should be made and, if required, flow controls could be put in place where the watercourse crosses under the M4.

Catchment 15a & Catchment 15b (upper parts of catchment D)

Catchment 15a drains to a proposed traffic circle on the M4 before crossing under the road into the top of Catchment 15b. Both are part of Catchment D. The catchment slopes are relatively mild, but with the anticipated development on the east-facing slopes, provision should be made for the additional runoff to be attenuated on the western side of the traffic circle. This will minimise the impact on Catchment 15b, where any space for stormwater attenuation will be required to address the problems that additional runoff from developments could cause lower down in Catchment D.

Catchment 16

Catchment 16 is a long narrow strip of vegetated land draining from the watershed to the M4. The road drainage system should be adequate to accommodate existing runoff from this catchment, but any proposed developments on the ridge should be assessed to determine the best way to handle additional runoff. It is possible that the ridge is sufficiently permeable that all runoff could be disposed of by infiltration.

Revision 1.0

6 April 2007

ANNEXURE B:

Pre Development Analysis

Sibaya Precinct Node 1 - Catchment A Pre Development Flows

Step 1 - Identify the following properties of your catchment and fill in the shaded cells

1 Catchment Area	**128946**	**m²**
2 Longest Water Course	**639**	**m**
3 Slope of Longest Water Course	**5.48%**	

Step 2 - Time of Concentration

1 Compute the roughness coeffeicent (r) of the site

Type of Surface	r factor	Area	% Area
Smooth Paving	0.02	0	0%
Clean Soil	0.10	0	0%
Sparse Grass	0.30	12895	10%
Moderate Grass	0.40	25789	20%
Thick Bush/Grass	0.80	90262	70%
		100%	

Comment: O.K.

Representative *r* Factor **0.67**

2 Compute the Time of Concentration (Tc) of the site

r =	0.67
L =	639
S =	0.055

Comment: Not O.K. L>200m

$$T_c = 36 \cdot \left(r \cdot \frac{L}{1000} \cdot \frac{1}{S^{0.5}} \right)^{0.467}$$

Computed Tc = **48.02 minutes**
Min. Allowed Tc = **15.00 minutes**

Therefore Tc = **48.02 minutes** *Comment: Use calculated value*

Step 3 - Obtain the Design Rainfall Depth & Intensity

1 Design Rainfall Depth (Smithers & Schulze)

		Return Period			
		10	**20**	**50**	**100**
15		*33.2*	*40.7*	*51.9*	*61.6*
30		*45.1*	*55.3*	*70.5*	*83.6*
45		*54.0*	*66.1*	*84.3*	*100.0*
48.02		***55.47***	***67.89***	***86.59***	***102.72***
60		*61.3*	*75.0*	*95.7*	*113.5*

2 Intensity of storm

Intensity 1:10	**69**	**mm/hr**
Intensity 1:50	**108**	**mm/hr**
Intensity 1:100	**128**	**mm/hr**

$$i = D / T_c$$

Step 4 - Calculation of the Runoff Coefficient

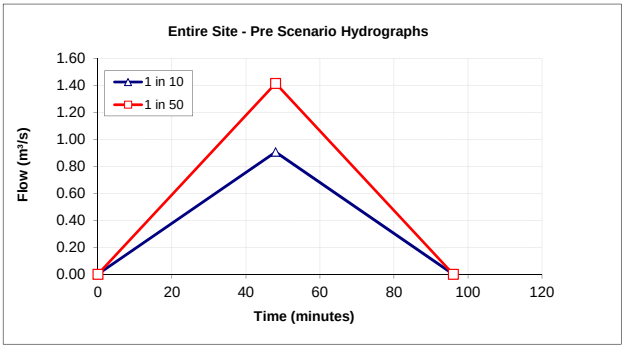
Steepness / Slope (Cs)	***Area***			
< 3%	0	0%	0.05	
3 to 10%	128946	100%	0.11	
10 to 30%	0	0%	0.20	
> 30%	0	0%	0.30	0.110
Permability (Cp)				
Very Perm (Dunes)	12895	10%	0.05	
Perm (light soils)	25789	20%	0.10	
Semi (most soils)	90262	70%	0.20	
Imperm (rock, paving)	0	0%	0.30	0.165
Vegetative Growth (Cv)				
Dense bush, forest	90262	70%	0.05	
Cult land, sparse bush	25789	20%	0.15	
Grassland	12895	10%	0.25	
Bare Surface	0	0%	0.30	0.090

Representative Coefficient **0.37**

Step 5 - Determine the Design Q Value

1 Flood Peak (Q) - 1 in 10 years	**0.906**	**m³/s**
2 Flood Peak (Q) - 1 in 50 years	**1.415**	**m³/s**
3 Flood Peak (Q) - 1 in 100 years	**1.678**	**m³/s**

	1 in 10	**1 in 50**	**1 in 100**
Time	**Q (m³/s)**	**Q (m³/s)**	**Q (m³/s)**
0	0.00	0.00	0.00
48	0.906	1.415	1.678
96	0.00	0.00	0.00
Volume =	2611	4076	4834



Sibaya Precinct Node 1 - Catchment B Pre Development Flows

Step 1 - Identify the following properties of your catchment and fill in the shaded cells

1 Catchment Area	**148697**	**m²**
2 Longest Water Course	**657**	**m**
3 Slope of Longest Water Course	**6.85%**	

Step 2 - Time of Concentration

1 Compute the roughness coeffeicent (r) of the site

Type of Surface	r factor	Area	% Area
Smooth Paving	0.02	0	0%
Clean Soil	0.10	0	0%
Sparse Grass	0.30	7435	5%
Moderate Grass	0.40	29739	20%
Thick Bush/Grass	0.80	111523	75%
			100%

Comment: O.K.

Representative *r* Factor **0.70**

2 Compute the Time of Concentration (Tc) of the site

r =	0.70
L =	657
S =	0.069

Comment: Not O.K. L>200m

$$T_c = 36 \cdot \left(r \cdot \frac{L}{1000} \cdot \frac{1}{S^{0.5}} \right)^{0.467}$$

Computed Tc = **46.97 minutes**
Min. Allowed Tc = **15.00 minutes**

Therefore Tc = **46.97 minutes** *Comment: Use calculated value*

Step 3 - Obtain the Design Rainfall Depth & Intensity

1 Design Rainfall Depth (Smithers & Schulze)

		Return Period			
		10	**20**	**50**	**100**
15		*33.2*	*40.7*	*51.9*	*61.6*
30		*45.1*	*55.3*	*70.5*	*83.6*
45		*54.0*	*66.1*	*84.3*	*100.0*
46.97		***54.96***	***67.27***	***85.80***	***101.78***
60		*61.3*	*75.0*	*95.7*	*113.5*

2 Intensity of storm

Intensity 1:10	**70**	**mm/hr**
Intensity 1:50	**110**	**mm/hr**
Intensity 1:100	**130**	**mm/hr**

$$i = D / T_c$$

Step 4 - Calculation of the Runoff Coefficient

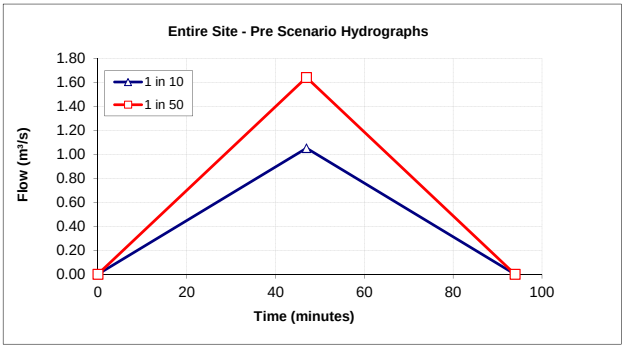
Steepness / Slope (Cs)	***Area***			
< 3%	0	0%	0.05	
3 to 10%	148697	100%	0.11	
10 to 30%	0	0%	0.20	
> 30%	0	0%	0.30	0.110
Permability (Cp)				
Very Perm (Dunes)	7435	5%	0.05	
Perm (light soils)	29739	20%	0.10	
Semi (most soils)	111523	75%	0.20	
Imperm (rock, paving)	0	0%	0.30	0.173
Vegetative Growth (Cv)				
Dense bush, forest	111523	75%	0.05	
Cult land, sparse bush	29739	20%	0.15	
Grassland	7435	5%	0.25	
Bare Surface	0	0%	0.30	0.080

Representative Coefficient **0.36**

Step 5 - Determine the Design Q Value

1 Flood Peak (Q) - 1 in 10 years	**1.051**	**m³/s**
2 Flood Peak (Q) - 1 in 50 years	**1.641**	**m³/s**
3 Flood Peak (Q) - 1 in 100 years	**1.947**	**m³/s**

	1 in 10	**1 in 50**	**1 in 100**
Time	**Q (m³/s)**	**Q (m³/s)**	**Q (m³/s)**
0	0.00	0.00	0.00
47	1.051	1.641	1.947
94	0.00	0.00	0.00
Volume =	2962	4625	5486



Sibaya Precinct Node 1 - Catchment C Pre Development Flows

Step 1 - Identify the following properties of your catchment and fill in the shaded cells

1 Catchment Area	**117497**	**m²**
2 Longest Water Course	**476**	**m**
3 Slope of Longest Water Course	**6.51%**	

Step 2 - Time of Concentration

1 Compute the roughness coeffeicent (r) of the site

Type of Surface	r factor	Area	% Area
Smooth Paving	0.02	0	0%
Clean Soil	0.10	0	0%
Sparse Grass	0.30	11750	10%
Moderate Grass	0.40	11750	10%
Thick Bush/Grass	0.80	93998	80%
		100%	

Comment: O.K.

Representative *r* Factor **0.71**

2 Compute the Time of Concentration (Tc) of the site

r =	0.71
L =	476
S =	0.065

Comment: Not O.K. L>200m

$$T_c = 36 \cdot \left(r \cdot \frac{L}{1000} \cdot \frac{1}{S^{0.5}} \right)^{0.467}$$

Computed Tc = **41.30 minutes**
Min. Allowed Tc = **15.00 minutes**

Therefore Tc = **41.30 minutes** *Comment: Use calculated value*

Step 3 - Obtain the Design Rainfall Depth & Intensity

1 Design Rainfall Depth (Smithers & Schulze)

		Return Period			
		10	**20**	**50**	**100**
15		*33.2*	*40.7*	*51.9*	*61.6*
30		*45.1*	*55.3*	*70.5*	*83.6*
41.30		***51.81***	***63.44***	***80.90***	***95.96***
45		*54.0*	*66.1*	*84.3*	*100.0*
60		*61.3*	*75.0*	*95.7*	*113.5*

2 Intensity of storm

Intensity 1:10	**75**	**mm/hr**
Intensity 1:50	**118**	**mm/hr**
Intensity 1:100	**139**	**mm/hr**

$$i = D / T_c$$

Step 4 - Calculation of the Runoff Coefficient

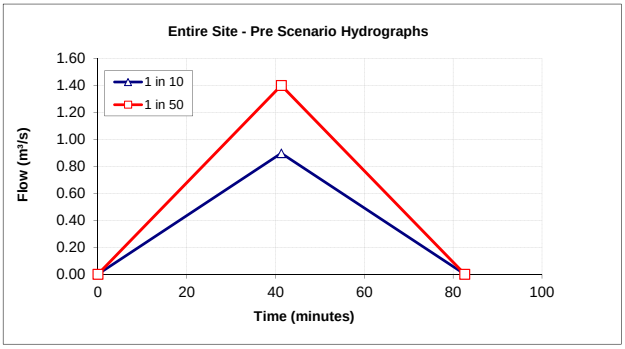
Steepness / Slope (Cs)	***Area***			
< 3%	0	0%	0.05	
3 to 10%	117497	100%	0.11	
10 to 30%	0	0%	0.20	
> 30%	0	0%	0.30	0.110
Permability (Cp)				
Very Perm (Dunes)	11750	10%	0.05	
Perm (light soils)	11750	10%	0.10	
Semi (most soils)	93998	80%	0.20	
Imperm (rock, paving)	0	0%	0.30	0.175
Vegetative Growth (Cv)				
Dense bush, forest	93998	80%	0.05	
Cult land, sparse bush	11750	10%	0.15	
Grassland	11750	10%	0.25	
Bare Surface	0	0%	0.30	0.080

Representative Coefficient **0.37**

Step 5 - Determine the Design Q Value

1 Flood Peak (Q) - 1 in 10 years	**0.897**	**m³/s**
2 Flood Peak (Q) - 1 in 50 years	**1.400**	**m³/s**
3 Flood Peak (Q) - 1 in 50 years	**1.661**	**m³/s**

	1 in 10	**1 in 50**	**1 in 100**
Time	**Q (m³/s)**	**Q (m³/s)**	**Q (m³/s)**
0	0.00	0.00	0.00
41	0.897	1.400	1.661
83	0.00	0.00	0.00
Volume =	2222	3469	4115



Sibaya Precinct Node 1 - Catchment D Pre Development Flows

Step 1 - Identify the following properties of your catchment and fill in the shaded cells

1 Catchment Area	**124632**	**m²**
2 Longest Water Course	**607**	**m**
3 Slope of Longest Water Course	**4.61%**	

Step 2 - Time of Concentration

1 Compute the roughness coeffeicent (r) of the site

Type of Surface	r factor	Area	% Area
Smooth Paving	0.02	0	0%
Clean Soil	0.10	0	0%
Sparse Grass	0.30	6232	5%
Moderate Grass	0.40	31158	25%
Thick Bush/Grass	0.80	87242	70%
			100%

Comment: O.K.

Representative *r* Factor **0.68**

2 Compute the Time of Concentration (Tc) of the site

r =	0.68
L =	607
S =	0.046

Comment: Not O.K. L>200m

$$T_c = 36 \cdot \left(r \cdot \frac{L}{1000} \cdot \frac{1}{S^{0.5}} \right)^{0.467}$$

Computed Tc = **48.98 minutes**
Min. Allowed Tc = **15.00 minutes**

Therefore Tc = **48.98 minutes** *Comment: Use calculated value*

Step 3 - Obtain the Design Rainfall Depth & Intensity

1 Design Rainfall Depth (Smithers & Schulze)

		Return Period			
		10	**20**	**50**	**100**
15		*33.2*	*40.7*	*51.9*	*61.6*
30		*45.1*	*55.3*	*70.5*	*83.6*
45		*54.0*	*66.1*	*84.3*	*100.0*
48.98		***55.94***	***68.46***	***87.33***	***103.58***
60		*61.3*	*75.0*	*95.7*	*113.5*

2 Intensity of storm

Intensity 1:10	**69**	**mm/hr**
Intensity 1:50	**107**	**mm/hr**
Intensity 1:100	**127**	**mm/hr**

$$i = D / T_c$$

Step 4 - Calculation of the Runoff Coefficient

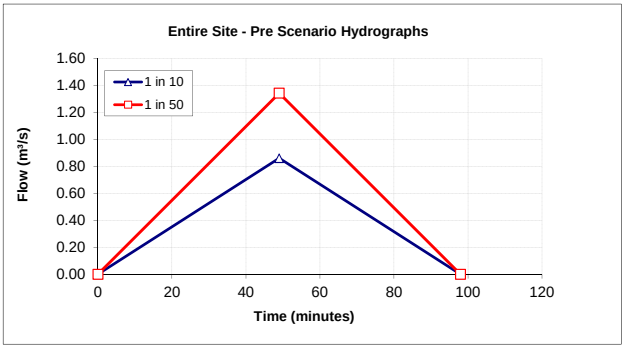
Steepness / Slope (Cs)	***Area***			
< 3%	0	0%	0.05	
3 to 10%	124632	100%	0.11	
10 to 30%	0	0%	0.20	
> 30%	0	0%	0.30	0.110
Permability (Cp)				
Very Perm (Dunes)	6232	5%	0.05	
Perm (light soils)	31158	25%	0.10	
Semi (most soils)	87242	70%	0.20	
Imperm (rock, paving)	0	0%	0.30	0.168
Vegetative Growth (Cv)				
Dense bush, forest	87242	70%	0.05	
Cult land, sparse bush	31158	25%	0.15	
Grassland	6232	5%	0.25	
Bare Surface	0	0%	0.30	0.085

Representative Coefficient **0.36**

Step 5 - Determine the Design Q Value

1 Flood Peak (Q) - 1 in 10 years	**0.860**	**m³/s**
2 Flood Peak (Q) - 1 in 50 years	**1.342**	**m³/s**
3 Flood Peak (Q) - 1 in 100 years	**1.592**	**m³/s**

	1 in 10	**1 in 50**	**1 in 100**
Time	**Q (m³/s)**	**Q (m³/s)**	**Q (m³/s)**
0	0.00	0.00	0.00
49	0.860	1.342	1.592
98	0.00	0.00	0.00
Volume =	2527	3945	4680



Sibaya Precinct Node 1 - Catchment E Pre Development Flows

Step 1 - Identify the following properties of your catchment and fill in the shaded cells

1 Catchment Area	**64299**	**m²**
2 Longest Water Course	**290**	**m**
3 Slope of Longest Water Course	**3.45%**	

Step 2 - Time of Concentration

1 Compute the roughness coeffeicent (r) of the site

Type of Surface	r factor	Area	% Area
Smooth Paving	0.02	0	0%
Clean Soil	0.10	0	0%
Sparse Grass	0.30	25720	40%
Moderate Grass	0.40	22505	35%
Thick Bush/Grass	0.80	16075	25%
		100%	

Comment: O.K.

Representative *r* Factor 0.46

2 Compute the Time of Concentration (Tc) of the site

r =	0.46
L =	290
S =	0.035

Comment: Not O.K. L>200m

$$T_c = 36 \cdot \left(r \cdot \frac{L}{1000} \cdot \frac{1}{S^{0.5}} \right)^{0.467}$$

Computed Tc = 31.03 minutes
Min. Allowed Tc = 15.00 minutes

Therefore Tc = 31.03 minutes *Comment: Use calculated value*

Step 3 - Obtain the Design Rainfall Depth & Intensity

1 Design Rainfall Depth (Smithers & Schulze)

	Return Period			
	10	**20**	**50**	**100**
15	*33.2*	*40.7*	*51.9*	*61.6*
30	*45.1*	*55.3*	*70.5*	*83.6*
31.03	***45.71***	***56.04***	***71.45***	***84.73***
45	*54.0*	*66.1*	*84.3*	*100.0*
60	*61.3*	*75.0*	*95.7*	*113.5*

2 Intensity of storm

Intensity 1:10	**88 mm/hr**
Intensity 1:50	**138 mm/hr**
Intensity 1:100	**164 mm/hr**

$$i = D / T_c$$

Step 4 - Calculation of the Runoff Coefficient

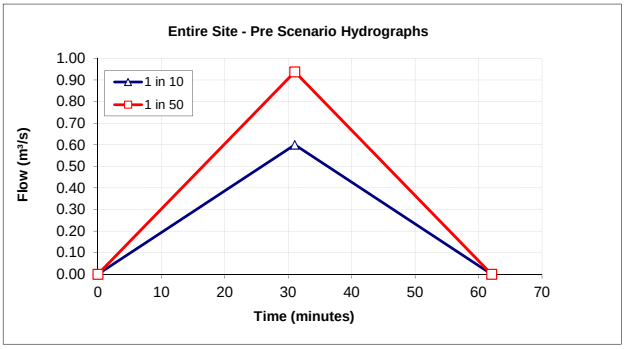
Steepness / Slope (Cs)	***Area***			
< 3%	0	0%	0.05	
3 to 10%	64299	100%	0.11	
10 to 30%	0	0%	0.20	
> 30%	0	0%	0.30	0.110
Permability (Cp)				
Very Perm (Dunes)	25720	40%	0.05	
Perm (light soils)	22505	35%	0.10	
Semi (most soils)	16075	25%	0.20	
Imperm (rock, paving)	0	0%	0.30	0.105
Vegetative Growth (Cv)				
Dense bush, forest	16075	25%	0.05	
Cult land, sparse bush	22505	35%	0.15	
Grassland	25720	40%	0.25	
Bare Surface	0	0%	0.30	0.165

Representative Coefficient 0.38

Step 5 - Determine the Design Q Value

1 Flood Peak (Q) - 1 in 10 years	**0.600 m³/s**
2 Flood Peak (Q) - 1 in 50 years	**0.938 m³/s**
3 Flood Peak (Q) - 1 in 100 years	**1.112 m³/s**

	1 in 10	1 in 50	1 in 100
Time	**Q (m³/s)**	**Q (m³/s)**	**Q (m³/s)**
0	0.00	0.00	0.00
31	0.600	0.938	1.112
62	0.00	0.00	0.00
Volume =	1117	1746	2070



Sibaya Precinct Node 1 - Catchment F Pre Development Flows

Step 1 - Identify the following properties of your catchment and fill in the shaded cells

1 Catchment Area	**26428**	**m²**
2 Longest Water Course	**261**	**m**
3 Slope of Longest Water Course	**4.68%**	

Step 2 - Time of Concentration

1 Compute the roughness coeffeicent (r) of the site

Type of Surface	r factor	Area	% Area
Smooth Paving	0.02	0	0%
Clean Soil	0.10	0	0%
Sparse Grass	0.30	3964	15%
Moderate Grass	0.40	6607	25%
Thick Bush/Grass	0.80	15857	60%
			100%

Comment: O.K.

Representative *r* Factor **0.63**

2 Compute the Time of Concentration (Tc) of the site

r =	0.63
L =	261
S =	0.047

Comment: Not O.K. L>200m

$$T_c = 36 \cdot \left(r \cdot \frac{L}{1000} \cdot \frac{1}{S^{0.5}} \right)^{0.467}$$

Computed Tc = **31.75 minutes**
Min. Allowed Tc = **15.00 minutes**

Therefore Tc = **31.75 minutes** *Comment: Use calculated value*

Step 3 - Obtain the Design Rainfall Depth & Intensity

1 Design Rainfall Depth (Smithers & Schulze)

	Return Period			
	10	**20**	**50**	**100**
15	*33.2*	*40.7*	*51.9*	*61.6*
30	*45.1*	*55.3*	*70.5*	*83.6*
31.75	***46.14***	***56.56***	***72.11***	***85.51***
45	*54.0*	*66.1*	*84.3*	*100.0*
60	*61.3*	*75.0*	*95.7*	*113.5*

2 Intensity of storm

Intensity 1:10	**87**	**mm/hr**
Intensity 1:50	**136**	**mm/hr**
Intensity 1:100	**162**	**mm/hr**

$$i = D / T_c$$

Step 4 - Calculation of the Runoff Coefficient

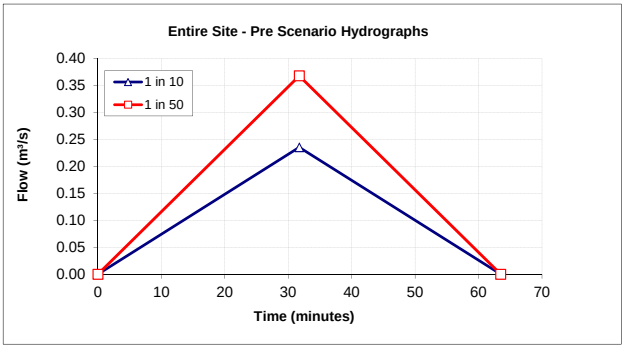
Steepness / Slope (Cs)	***Area***			
< 3%	0	0%	0.05	
3 to 10%	26428	100%	0.11	
10 to 30%	0	0%	0.20	
> 30%	0	0%	0.30	0.110
Permability (Cp)				
Very Perm (Dunes)	3964	15%	0.05	
Perm (light soils)	6607	25%	0.10	
Semi (most soils)	15857	60%	0.20	
Imperm (rock, paving)	0	0%	0.30	0.153
Vegetative Growth (Cv)				
Dense bush, forest	15857	60%	0.05	
Cult land, sparse bush	6607	25%	0.15	
Grassland	3964	15%	0.25	
Bare Surface	0	0%	0.30	0.105

Representative Coefficient **0.37**

Step 5 - Determine the Design Q Value

1 Flood Peak (Q) - 1 in 10 years	**0.235**	**m³/s**
2 Flood Peak (Q) - 1 in 50 years	**0.368**	**m³/s**
3 Flood Peak (Q) - 1 in 100 years	**0.436**	**m³/s**

	1 in 10	1 in 50	1 in 100
Time	**Q (m³/s)**	**Q (m³/s)**	**Q (m³/s)**
0	0.00	0.00	0.00
32	0.235	0.368	0.436
63	0.00	0.00	0.00
Volume =	448	700	831



Sibaya Precinct Node 5 - Catchment A Pre Development Flows

Step 1 - Identify the following properties of your catchment and fill in the shaded cells

1 Catchment Area	**145785**	**m²**
2 Longest Water Course	**477**	**m**
3 Slope of Longest Water Course	**3.14%**	

Step 2 - Time of Concentration

1 Compute the roughness coeffeicent (r) of the site

Type of Surface	r factor	Area	% Area
Smooth Paving	0.02	0	0%
Clean Soil	0.10	0	0%
Sparse Grass	0.30	7289	5%
Moderate Grass	0.40	21868	15%
Thick Bush/Grass	0.80	116628	80%
			100%

Comment: O.K.

Representative *r* Factor **0.72**

2 Compute the Time of Concentration (Tc) of the site

r =	0.72
L =	477
S =	0.031

Comment: Not O.K. L>200m

$$T_c = 36 \cdot \left(r \cdot \frac{L}{1000} \cdot \frac{1}{S^{0.5}} \right)^{0.467}$$

Computed Tc = **49.18 minutes**
Min. Allowed Tc = **15.00 minutes**

Therefore Tc = **49.18 minutes** Comment: Use calculated value

Step 3 - Obtain the Design Rainfall Depth & Intensity

1 Design Rainfall Depth (Smithers & Schulze)

	Return Period			
	10	**20**	**50**	**100**
15	*33.5*	*41.0*	*52.3*	*62.0*
30	*45.4*	*55.7*	*71.0*	*84.2*
45	*54.3*	*66.5*	*84.8*	*100.7*
49.18	***56.36***	***69.01***	***88.00***	***104.46***
60	*61.7*	*75.5*	*96.3*	*114.2*

2 Intensity of storm

Intensity 1:10	**69 mm/hr**
Intensity 1:50	**107 mm/hr**
Intensity 1:100	**127 mm/hr**

$$i = D / T_c$$

Step 4 - Calculation of the Runoff Coefficient

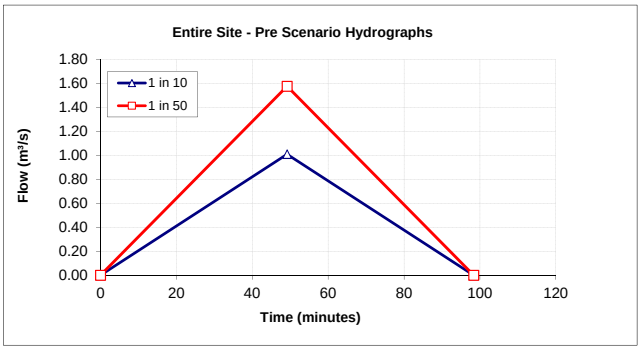
Steepness / Slope (Cs)	***Area***			
< 3%	0	0%	0.05	
3 to 10%	145785	100%	0.11	
10 to 30%	0	0%	0.20	
> 30%	0	0%	0.30	0.110
Permability (Cp)				
Very Perm (Dunes)	7289	5%	0.05	
Perm (light soils)	21868	15%	0.10	
Semi (most soils)	116628	80%	0.20	
Imperm (rock, paving)	0	0%	0.30	0.178
Vegetative Growth (Cv)				
Dense bush, forest	116628	80%	0.05	
Cult land, sparse bush	21868	15%	0.15	
Grassland	7289	5%	0.25	
Bare Surface	0	0%	0.30	0.075

Representative Coefficient **0.36**

Step 5 - Determine the Design Q Value

1 Flood Peak (Q) - 1 in 10 years	**1.009**	**m³/s**
2 Flood Peak (Q) - 1 in 50 years	**1.576**	**m³/s**
3 Flood Peak (Q) - 1 in 100 years	**1.871**	**m³/s**

	1 in 10	1 in 50	1 in 100
Time	**Q (m³/s)**	**Q (m³/s)**	**Q (m³/s)**
0	0.00	0.00	0.00
49	1.009	1.576	1.871
98	0.00	0.00	0.00
Volume (m³)	2979	4651	5520



Sibaya Precinct Node 5 - Catchment B Pre Development Flows

Step 1 - Identify the following properties of your catchment and fill in the shaded cells

1 Catchment Area	**184902**	**m²**
2 Longest Water Course	**608**	**m**
3 Slope of Longest Water Course	**7.40%**	

Step 2 - Time of Concentration

1 Compute the roughness coeffeicent (r) of the site

Type of Surface	r factor	Area	% Area
Smooth Paving	0.02	0	0%
Clean Soil	0.10	0	0%
Sparse Grass	0.30	0	0%
Moderate Grass	0.40	9245	5%
Thick Bush/Grass	0.80	175657	95%
			100%

Comment: O.K.

Representative *r* Factor **0.78**

2 Compute the Time of Concentration (Tc) of the site

r =	0.78
L =	608
S =	0.074

Comment: Not O.K. L>200m

$$T_c = 36 \cdot \left(r \cdot \frac{L}{1000} \cdot \frac{1}{S^{0.5}} \right)^{0.467}$$

Computed Tc = **46.96 minutes**
Min. Allowed Tc = **15.00 minutes**

Therefore Tc = **46.96 minutes** Comment: Use calculated value

Step 3 - Obtain the Design Rainfall Depth & Intensity

1 Design Rainfall Depth (Smithers & Schulze)

		Return Period			
		10	20	50	100
15		*33.5*	*41.0*	*52.3*	*62.0*
30		*45.4*	*55.7*	*71.0*	*84.2*
45		*54.3*	*66.5*	*84.8*	*100.7*
46.96		***55.27***	***67.67***	***86.30***	***102.46***
60		*61.7*	*75.5*	*96.3*	*114.2*

2 Intensity of storm

Intensity 1:10	**71 mm/hr**
Intensity 1:50	**110 mm/hr**
Intensity 1:100	**131 mm/hr**

$$i = D / T_c$$

Step 4 - Calculation of the Runoff Coefficient

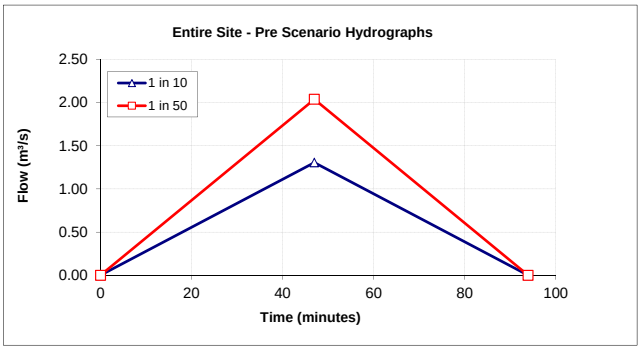
Steepness / Slope (Cs)	***Area***			
< 3%	0	0%	0.05	
3 to 10%	184902	100%	0.11	
10 to 30%	0	0%	0.20	
> 30%	0	0%	0.30	0.110
Permability (Cp)				
Very Perm (Dunes)	0	0%	0.05	
Perm (light soils)	9245	5%	0.10	
Semi (most soils)	175657	95%	0.20	
Imperm (rock, paving)	0	0%	0.30	0.195
Vegetative Growth (Cv)				
Dense bush, forest	175657	95%	0.05	
Cult land, sparse bush	9245	5%	0.15	
Grassland	0	0%	0.25	
Bare Surface	0	0%	0.30	0.055

Representative Coefficient **0.36**

Step 5 - Determine the Design Q Value

1 Flood Peak (Q) - 1 in 10 years	**1.306**	**m³/s**
2 Flood Peak (Q) - 1 in 50 years	**2.039**	**m³/s**
3 Flood Peak (Q) - 1 in 100 years	**2.421**	**m³/s**

	1 in 10	1 in 50	1 in 100
Time	Q (m³/s)	Q (m³/s)	Q (m³/s)
0	0.00	0.00	0.00
47	1.306	2.039	2.421
94	0.00	0.00	0.00
Volume (m³)	3679	5745	6820



Sibaya Precinct Node 5 - Catchment C Pre Development Flows

Step 1 - Identify the following properties of your catchment and fill in the shaded cells

1 Catchment Area	**115022**	**m²**
2 Longest Water Course	**499**	**m**
3 Slope of Longest Water Course	**13.03%**	

Step 2 - Time of Concentration

1 Compute the roughness coeffeicent (r) of the site

Type of Surface	r factor	Area	% Area
Smooth Paving	0.02	0	0%
Clean Soil	0.10	0	0%
Sparse Grass	0.30	5751	5%
Moderate Grass	0.40	5751	5%
Thick Bush/Grass	0.80	103520	90%
			100%

Comment: O.K.

Representative *r* Factor **0.76**

2 Compute the Time of Concentration (Tc) of the site

r =	0.76
L =	499
S =	0.130

Comment: Not O.K. L>200m

$$T_c = 36 \cdot \left(r \cdot \frac{L}{1000} \cdot \frac{1}{S^{0.5}} \right)^{0.467}$$

Computed Tc = **36.95 minutes**
Min. Allowed Tc = **15.00 minutes**

Therefore Tc = **36.95 minutes** Comment: Use calculated value

Step 3 - Obtain the Design Rainfall Depth & Intensity

1 Design Rainfall Depth (Smithers & Schulze)

	Return Period			
	10	20	50	100
15	*33.5*	*41.0*	*52.3*	*62.0*
30	*45.4*	*55.7*	*71.0*	*84.2*
36.95	***49.5***	***60.7***	***77.4***	***91.8***
45.00	*54.30*	*66.50*	*84.80*	*100.70*
60	*61.7*	*75.5*	*96.3*	*114.2*

2 Intensity of storm

Intensity 1:10	**80 mm/hr**
Intensity 1:50	**126 mm/hr**
Intensity 1:100	**149 mm/hr**

$$i = D / T_c$$

Step 4 - Calculation of the Runoff Coefficient

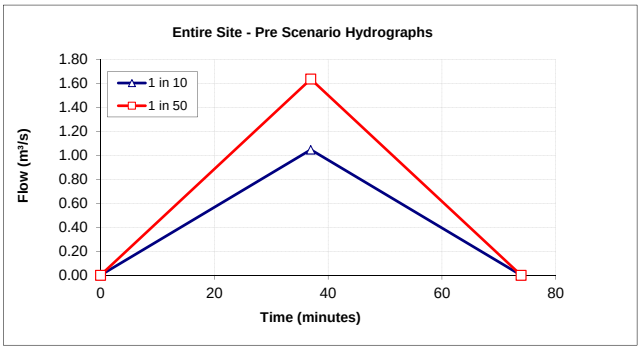
Steepness / Slope (Cs)	***Area***			
< 3%	0	0%	0.05	
3 to 10%	57511	50%	0.11	
10 to 30%	57511	50%	0.20	
> 30%	0	0%	0.30	0.155
Permability (Cp)				
Very Perm (Dunes)	5751	5%	0.05	
Perm (light soils)	5751	5%	0.10	
Semi (most soils)	103520	90%	0.20	
Imperm (rock, paving)	0	0%	0.30	0.188
Vegetative Growth (Cv)				
Dense bush, forest	103520	90%	0.05	
Cult land, sparse bush	5751	5%	0.15	
Grassland	5751	5%	0.25	
Bare Surface	0	0%	0.30	0.065

Representative Coefficient **0.41**

Step 5 - Determine the Design Q Value

1 Flood Peak (Q) - 1 in 10 years	**1.047**	**m³/s**
2 Flood Peak (Q) - 1 in 50 years	**1.636**	**m³/s**
3 Flood Peak (Q) - 1 in 100 years	**1.942**	**m³/s**

	1 in 10	1 in 50	1 in 100
Time	Q (m³/s)	Q (m³/s)	Q (m³/s)
0	0.00	0.00	0.00
37	1.047	1.636	1.942
74	0.00	0.00	0.00
Volume (m^3)	2321	3628	4305



Sibaya Precinct Node 5 - Catchment D Pre Development Flows

Step 1 - Identify the following properties of your catchment and fill in the shaded cells

1 Catchment Area	**43703**	**m²**
2 Longest Water Course	**241**	**m**
3 Slope of Longest Water Course	**24.07%**	

Step 2 - Time of Concentration

1 Compute the roughness coeffeicent (r) of the site

Type of Surface	r factor	Area	% Area
Smooth Paving	0.02	0	0%
Clean Soil	0.10	0	0%
Sparse Grass	0.30	2185	5%
Moderate Grass	0.40	2185	5%
Thick Bush/Grass	0.80	39333	90%
			100%

Comment: O.K.

Representative *r* Factor **0.76**

2 Compute the Time of Concentration (Tc) of the site

r =	0.76
L =	241
S =	0.241

Comment: Not O.K. L>200m

$$T_c = 36 \cdot \left(r \cdot \frac{L}{1000} \cdot \frac{1}{S^{0.5}} \right)^{0.467}$$

Computed Tc = **22.79 minutes**
Min. Allowed Tc = **15.00 minutes**

Therefore Tc = **22.79 minutes** Comment: Use calculated value

Step 3 - Obtain the Design Rainfall Depth & Intensity

1 Design Rainfall Depth (Smithers & Schulze)

	Return Period			
	10	**20**	**50**	**100**
15	*33.5*	*41.0*	*52.3*	*62.0*
22.79	***39.7***	***48.6***	***62.0***	***73.5***
30	*45.4*	*55.7*	*71.0*	*84.2*
45.00	*54.30*	*66.50*	*84.80*	*100.70*
60	*61.7*	*75.5*	*96.3*	*114.2*

2 Intensity of storm

Intensity 1:10	**104 mm/hr**
Intensity 1:50	**163 mm/hr**
Intensity 1:100	**194 mm/hr**

$$i = D / T_c$$

Step 4 - Calculation of the Runoff Coefficient

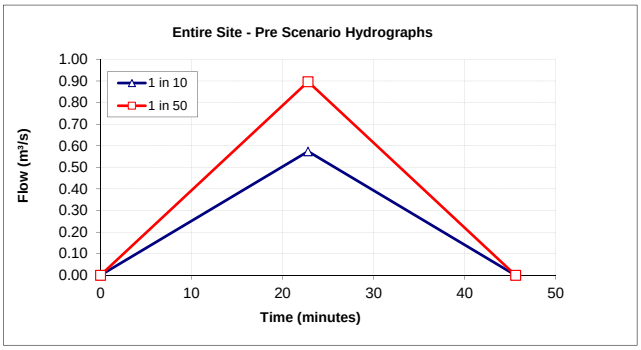
Steepness / Slope (Cs)	***Area***			
< 3%	0	0%	0.05	
3 to 10%	0	0%	0.11	
10 to 30%	43703	100%	0.20	
> 30%	0	0%	0.30	0.200
Permability (Cp)				
Very Perm (Dunes)	2185	5%	0.05	
Perm (light soils)	2185	5%	0.10	
Semi (most soils)	39333	90%	0.20	
Imperm (rock, paving)	0	0%	0.30	0.188
Vegetative Growth (Cv)				
Dense bush, forest	39333	90%	0.05	
Cult land, sparse bush	2185	5%	0.15	
Grassland	2185	5%	0.25	
Bare Surface	0	0%	0.30	0.065

Representative Coefficient **0.45**

Step 5 - Determine the Design Q Value

1 Flood Peak (Q) - 1 in 10 years	**0.574**	**m³/s**
2 Flood Peak (Q) - 1 in 50 years	**0.897**	**m³/s**
3 Flood Peak (Q) - 1 in 100 years	**1.063**	**m³/s**

	1 in 10	1 in 50	1 in 100
Time	**Q (m³/s)**	**Q (m³/s)**	**Q (m³/s)**
0	0.00	0.00	0.00
23	0.574	0.897	1.063
46	0.00	0.00	0.00
Volume (m^3)	785	1226	1454



Sibaya Precinct Node 5 - Catchment E Pre Development Flows

Step 1 - Identify the following properties of your catchment and fill in the shaded cells

1 Catchment Area	**99736**	**m²**
2 Longest Water Course	**542**	**m**
3 Slope of Longest Water Course	**13.84%**	

Step 2 - Time of Concentration

1 Compute the roughness coeffeicent (r) of the site

Type of Surface	r factor	Area	% Area
Smooth Paving	0.02	0	0%
Clean Soil	0.10	0	0%
Sparse Grass	0.30	4987	5%
Moderate Grass	0.40	4987	5%
Thick Bush/Grass	0.80	89762	90%
			100%

Comment: O.K.

Representative *r* Factor **0.76**

2 Compute the Time of Concentration (Tc) of the site

r =	0.76
L =	542
S =	0.138

Comment: Not O.K. L>200m

$$T_c = 36 \cdot \left(r \cdot \frac{L}{1000} \cdot \frac{1}{S^{0.5}} \right)^{0.467}$$

Computed Tc = **37.87 minutes**
Min. Allowed Tc = **15.00 minutes**

Therefore Tc = **37.87 minutes** *Comment: Use calculated value*

Step 3 - Obtain the Design Rainfall Depth & Intensity

1 Design Rainfall Depth (Smithers & Schulze)

	Return Period			
	10	**20**	**50**	**100**
15	*33.5*	*41.0*	*52.3*	*62.0*
30	*45.4*	*55.7*	*71.0*	*84.2*
37.87	***50.1***	***61.4***	***78.2***	***92.9***
45.00	*54.30*	*66.50*	*84.80*	*100.70*
60	*61.7*	*75.5*	*96.3*	*114.2*

2 Intensity of storm

Intensity 1:10	**79 mm/hr**
Intensity 1:50	**124 mm/hr**
Intensity 1:100	**147 mm/hr**

$$i = D / T_c$$

Step 4 - Calculation of the Runoff Coefficient

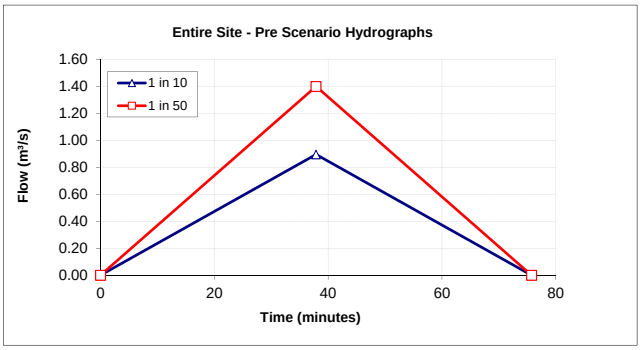
Steepness / Slope (Cs)	***Area***			
< 3%	0	0%	0.05	
3 to 10%	49868	50%	0.11	
10 to 30%	49868	50%	0.20	
> 30%	0	0%	0.30	0.155
Permability (Cp)				
Very Perm (Dunes)	4987	5%	0.05	
Perm (light soils)	4987	5%	0.10	
Semi (most soils)	89762	90%	0.20	
Imperm (rock, paving)	0	0%	0.30	0.188
Vegetative Growth (Cv)				
Dense bush, forest	89762	90%	0.05	
Cult land, sparse bush	4987	5%	0.15	
Grassland	4987	5%	0.25	
Bare Surface	0	0%	0.30	0.065

Representative Coefficient **0.41**

Step 5 - Determine the Design Q Value

1 Flood Peak (Q) - 1 in 10 years	**0.896**	**m³/s**
2 Flood Peak (Q) - 1 in 50 years	**1.399**	**m³/s**
3 Flood Peak (Q) - 1 in 100 years	**1.661**	**m³/s**

	1 in 10	1 in 50	1 in 100
Time	**Q (m³/s)**	**Q (m³/s)**	**Q (m³/s)**
0	0.00	0.00	0.00
38	0.896	1.399	1.661
76	0.00	0.00	0.00
Volume (m³)	2035	3180	3774



Sibaya Precinct Node 5 - Catchment F Pre Development Flows

Step 1 - Identify the following properties of your catchment and fill in the shaded cells

1 Catchment Area	**136361**	**m²**
2 Longest Water Course	**464**	**m**
3 Slope of Longest Water Course	**10.78%**	

Step 2 - Time of Concentration

1 Compute the roughness coeffeicent (r) of the site

Type of Surface	r factor	Area	% Area
Smooth Paving	0.02	0	0%
Clean Soil	0.10	0	0%
Sparse Grass	0.30	6818	5%
Moderate Grass	0.40	6818	5%
Thick Bush/Grass	0.80	122725	90%
			100%

Comment: O.K.

Representative *r* Factor **0.76**

2 Compute the Time of Concentration (Tc) of the site

r =	0.76
L =	464
S =	0.108

Comment: Not O.K. L>200m

$$T_c = 36 \cdot \left(r \cdot \frac{L}{1000} \cdot \frac{1}{S^{0.5}} \right)^{0.467}$$

Computed Tc = **37.34 minutes**
Min. Allowed Tc = **15.00 minutes**

Therefore Tc = **37.34 minutes** *Comment: Use calculated value*

Step 3 - Obtain the Design Rainfall Depth & Intensity

1 Design Rainfall Depth (Smithers & Schulze)

	Return Period			
	10	**20**	**50**	**100**
15	*33.5*	*41.0*	*52.3*	*62.0*
30	*45.4*	*55.7*	*71.0*	*84.2*
37.34	***49.8***	***61.0***	***77.7***	***92.3***
45.00	*54.30*	*66.50*	*84.80*	*100.70*
60	*61.7*	*75.5*	*96.3*	*114.2*

2 Intensity of storm

Intensity 1:10	**80 mm/hr**
Intensity 1:50	**125 mm/hr**
Intensity 1:100	**148 mm/hr**

$$i = D / T_c$$

Step 4 - Calculation of the Runoff Coefficient

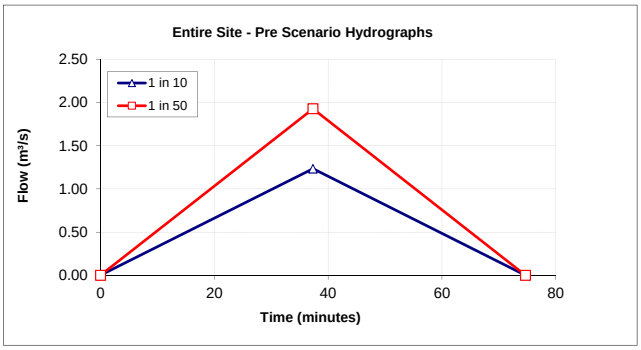
Steepness / Slope (Cs)	***Area***			
< 3%	0	0%	0.05	
3 to 10%	68181	50%	0.11	
10 to 30%	68181	50%	0.20	
> 30%	0	0%	0.30	0.155
Permability (Cp)				
Very Perm (Dunes)	6818	5%	0.05	
Perm (light soils)	6818	5%	0.10	
Semi (most soils)	122725	90%	0.20	
Imperm (rock, paving)	0	0%	0.30	0.188
Vegetative Growth (Cv)				
Dense bush, forest	122725	90%	0.05	
Cult land, sparse bush	6818	5%	0.15	
Grassland	6818	5%	0.25	
Bare Surface	0	0%	0.30	0.065

Representative Coefficient **0.41**

Step 5 - Determine the Design Q Value

1 Flood Peak (Q) - 1 in 10 years	**1.234**	**m³/s**
2 Flood Peak (Q) - 1 in 50 years	**1.929**	**m³/s**
3 Flood Peak (Q) - 1 in 100 years	**2.289**	**m³/s**

	1 in 10	1 in 50	1 in 100
Time	**Q (m³/s)**	**Q (m³/s)**	**Q (m³/s)**
0	0.00	0.00	0.00
37	1.234	1.929	2.289
75	0.00	0.00	0.00
Volume (m^3)	2765	4320	5127



Sibaya Precinct Node 5 - Catchment G Pre Development Flows

Step 1 - Identify the following properties of your catchment and fill in the shaded cells

1 Catchment Area	**157591**	**m²**
2 Longest Water Course	**819**	**m**
3 Slope of Longest Water Course	**7.33%**	

Step 2 - Time of Concentration

1 Compute the roughness coeffeicent (r) of the site

Type of Surface	r factor	Area	% Area
Smooth Paving	0.02	0	0%
Clean Soil	0.10	0	0%
Sparse Grass	0.30	7880	5%
Moderate Grass	0.40	7880	5%
Thick Bush/Grass	0.80	141832	90%
			100%

Comment: O.K.

Representative *r* Factor **0.76**

2 Compute the Time of Concentration (Tc) of the site

r =	0.76
L =	819
S =	0.073

Comment: Not O.K. L>200m

$$T_c = 36 \cdot \left(r \cdot \frac{L}{1000} \cdot \frac{1}{S^{0.5}} \right)^{0.467}$$

Computed Tc = **53.27 minutes**
Min. Allowed Tc = **15.00 minutes**

Therefore Tc = **53.27 minutes** Comment: Use calculated value

Step 3 - Obtain the Design Rainfall Depth & Intensity

1 Design Rainfall Depth (Smithers & Schulze)

	Return Period			
	10	**20**	**50**	**100**
15	*33.5*	*41.0*	*52.3*	*62.0*
30	*45.4*	*55.7*	*71.0*	*84.2*
45.00	*54.3*	*66.5*	*84.8*	*100.7*
53.27	***58.38***	***71.46***	***91.14***	***108.14***
60	*61.7*	*75.5*	*96.3*	*114.2*

2 Intensity of storm

Intensity 1:10	**66 mm/hr**
Intensity 1:50	**103 mm/hr**
Intensity 1:100	**122 mm/hr**

$$i = D / T_c$$

Step 4 - Calculation of the Runoff Coefficient

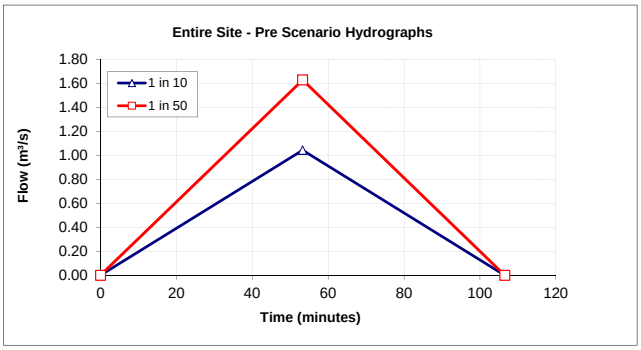
Steepness / Slope (Cs)	***Area***			
< 3%	0	0%	0.05	
3 to 10%	157591	100%	0.11	
10 to 30%	0	0%	0.20	
> 30%	0	0%	0.30	0.110
Permability (Cp)				
Very Perm (Dunes)	7880	5%	0.05	
Perm (light soils)	7880	5%	0.10	
Semi (most soils)	141832	90%	0.20	
Imperm (rock, paving)	0	0%	0.30	0.188
Vegetative Growth (Cv)				
Dense bush, forest	141832	90%	0.05	
Cult land, sparse bush	7880	5%	0.15	
Grassland	7880	5%	0.25	
Bare Surface	0	0%	0.30	0.065

Representative Coefficient **0.36**

Step 5 - Determine the Design Q Value

1 Flood Peak (Q) - 1 in 10 years	**1.043**	**m³/s**
2 Flood Peak (Q) - 1 in 50 years	**1.629**	**m³/s**
3 Flood Peak (Q) - 1 in 100 years	**1.933**	**m³/s**

	1 in 10	1 in 50	1 in 100
Time	**Q (m³/s)**	**Q (m³/s)**	**Q (m³/s)**
0	0.00	0.00	0.00
53	1.043	1.629	1.933
107	0.00	0.00	0.00
Volume (m^3)	3335	5206	6178



ANNEXURE C

Post Development Analysis

Sibaya Precinct Node 1 - Catchment A Post Development Flows

Step 1 - Identify the following properties of your catchment and fill in the shaded cells

1 Catchment Area	**19948**	**m²**
2 Longest Water Course	**486**	**m**
3 Slope of Longest Water Course	**6.58%**	

Step 2 - Time of Concentration

1 Compute the roughness coeffeicent (r) of the site

Type of Surface	r factor	Area	% Area
Smooth Paving	0.02	19948	100%
Clean Soil	0.10	0	0%
Sparse Grass	0.30	0	0%
Moderate Grass	0.40	0	0%
Thick Bush/Grass	0.80		0%
			100%

Comment: O.K.

Representative *r* Factor **0.02**

2 Compute the Time of Concentration (Tc) of the site

r =	0.02
L =	486.244
S =	0.066

Comment: Not O.K. L>200m

$$T_c = 36 \cdot \left(r \cdot \frac{L}{1000} \cdot \frac{1}{S^{0.5}} \right)^{0.467}$$

Computed Tc = **7.81 minutes**

Min. Allowed Tc = **10.00 minutes**

Therefore Tc = **10.0 minutes**

Comment: Use prescibed minimum Tc Value

Step 3 - Obtain the Design Rainfall Depth & Intensity

1 Design Rainfall Depth (Smithers & Schulze)

	Return Period					
	2	5	10	20	50	100
10			**25.7**		**40.2**	**47.6**
15			33.2		51.9	61.6
30			45.1		70.5	83.6
45			54.0		84.3	100

2 Intensity of storm

Intensity 1:10	**154 mm/hr**
Intensity 1:50	**241 mm/hr**
Intensity 1:100	**286 mm/hr**

$$i = D / T_c$$

Step 4 - Calculation of the Runoff Coefficient

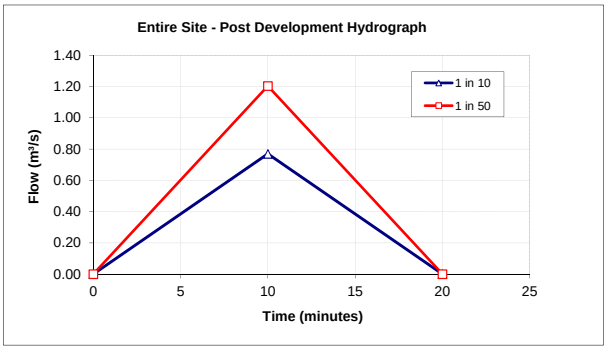
Runoff Coefficient Urban	*Coefficient*	*Area*	*% Area*
Lawn Sandy<2%	0.08	0	0%
Lawn Sandy>7%	0.18	0	0%
Lawn Heavy<2%	0.15	0	0%
Lawn Heavy>7%	0.30	0	0%
Residential Single	0.40	0	0%
Flat/dense townships	0.60	0	0%
Industry, light	0.65	0	0%
Industry, heavy	0.70	0	0%
Business Local	0.60	0	0%
Business CBD	0.85	0	0%
Streets / Roof	0.90	19948	100%
			100%

Representative *c* Factor **0.90**

Step 5 - Determine the Design Q Value

1 Flood Peak (Q) - 1 in 10 years	**0.769 m³/s**
2 Flood Peak (Q) - 1 in 50 years	**1.203 m³/s**
3 Flood Peak (Q) - 1 in 100 years	**1.424 m³/s**

	1 in 10	1 in 50	1 in 100
Time	Q (m³/s)	Q (m³/s)	Q (m³/s)
0	0.00	0.00	0.00
10	0.769	1.203	1.424
20	0.00	0.00	0.00
Volume =	461	722	855



Sibaya Precinct Node 1 - Catchment B Post Development Flows

Step 1 - Identify the following properties of your catchment and fill in the shaded cells

1 Catchment Area	**25211**	**m²**
2 Longest Water Course	**530**	**m**
3 Slope of Longest Water Course	**4.02%**	

Step 2 - Time of Concentration

1 Compute the roughness coeffeicent (r) of the site

Type of Surface	r factor	Area	% Area
Smooth Paving	0.02	25211	100%
Clean Soil	0.10	0	0%
Sparse Grass	0.30	0	0%
Moderate Grass	0.40	0	0%
Thick Bush/Grass	0.80		0%
			100%

Comment: O.K.

Representative *r* Factor **0.02**

2 Compute the Time of Concentration (Tc) of the site

r =	0.02
L =	530.305
S =	0.040

Comment: Not O.K. L>200m

$$T_c = 36 \cdot \left(r \cdot \frac{L}{1000} \cdot \frac{1}{S^{0.5}} \right)^{0.467}$$

Computed Tc = **9.12 minutes**
Min. Allowed Tc = **10.00 minutes**

Therefore Tc = **10.0 minutes**

Comment: Use prescibed minimum Tc Value

Step 3 - Obtain the Design Rainfall Depth & Intensity

1 Design Rainfall Depth (Smithers & Schulze)

	Return Period					
	2	5	10	20	50	100
10			**25.7**		**40.2**	**47.6**
15			33.2		51.9	61.6
30			45.1		70.5	83.6
45			54.0		84.3	100

2 Intensity of storm

Intensity 1:10	**154**	**mm/hr**
Intensity 1:50	**241**	**mm/hr**
Intensity 1:100	**286**	**mm/hr**

$$i = D / T_c$$

Step 4 - Calculation of the Runoff Coefficient

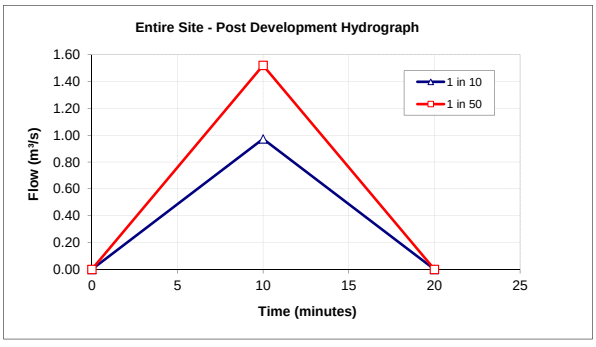
Runoff Coefficient Urban	*Coefficient*	*Area*	*% Area*
Lawn Sandy<2%	0.08	0	0%
Lawn Sandy>7%	0.18	0	0%
Lawn Heavy<2%	0.15	0	0%
Lawn Heavy>7%	0.30	0	0%
Residential Single	0.40	0	0%
Flat/dense townships	0.60	0	0%
Industry, light	0.65	0	0%
Industry, heavy	0.70	0	0%
Business Local	0.60	0	0%
Business CBD	0.85	0	0%
Streets / Roof	0.90	25211	100%
			100%

Representative *c* Factor **0.90**

Step 5 - Determine the Design Q Value

1 Flood Peak (Q) - 1 in 10 years	**0.972**	**m³/s**
2 Flood Peak (Q) - 1 in 50 years	**1.520**	**m³/s**
3 Flood Peak (Q) - 1 in 100 years	**1.800**	**m³/s**

	1 in 10	1 in 50	1 in 100
Time	Q (m³/s)	Q (m³/s)	Q (m³/s)
0	0.00	0.00	0.00
10	0.972	1.520	1.800
20	0.00	0.00	0.00
Volume =	583	912	1080



Sibaya Precinct Node 1 - Catchment C Post Development Flows

Step 1 - Identify the following properties of your catchment and fill in the shaded cells

1 Catchment Area	**8785**	**m²**
2 Longest Water Course	**291**	**m**
3 Slope of Longest Water Course	**2.52%**	

Step 2 - Time of Concentration

1 Compute the roughness coeffeicent (r) of the site

Type of Surface	r factor	Area	% Area
Smooth Paving	0.02	**8785**	100%
Clean Soil	0.10	**0**	0%
Sparse Grass	0.30	**0**	0%
Moderate Grass	0.40	**0**	0%
Thick Bush/Grass	0.80		0%
			100%

Comment: O.K.

Representative *r* Factor **0.02**

2 Compute the Time of Concentration (Tc) of the site

r =	0.02
L =	291.066
S =	0.025

Comment: Not O.K. L>200m

$$T_c = 36 \cdot \left(r \cdot \frac{L}{1000} \cdot \frac{1}{S^{0.5}} \right)^{0.467}$$

Computed Tc = **7.69 minutes**
Min. Allowed Tc = **10.00 minutes**

Therefore Tc = **10.0 minutes**

Comment: Use prescibed minimum Tc Value

Step 3 - Obtain the Design Rainfall Depth & Intensity

1 Design Rainfall Depth (Smithers & Schulze)

	Return Period					
	2	**5**	**10**	**20**	**50**	**100**
10			**25.7**		**40.2**	**47.6**
15			33.2		51.9	61.6
30			45.1		70.5	83.6
45			54.0		84.3	100

2 Intensity of storm

Intensity 1:10	**154**	**mm/hr**
Intensity 1:50	**241**	**mm/hr**
Intensity 1:100	**286**	**mm/hr**

$$i = D / T_c$$

Step 4 - Calculation of the Runoff Coefficient

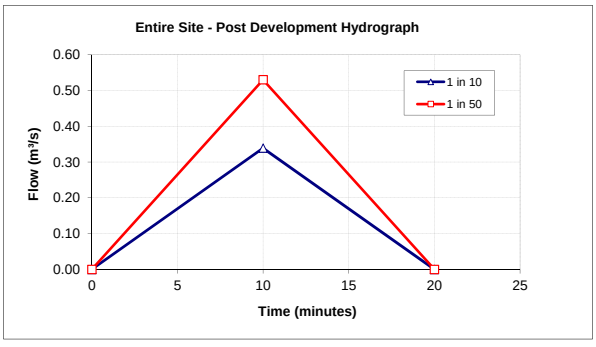
Runoff Coefficient Urban	***Coefficient***	***Area***	***% Area***
Lawn Sandy<2%	0.08	0	0%
Lawn Sandy>7%	0.18	0	0%
Lawn Heavy<2%	0.15	0	0%
Lawn Heavy>7%	0.30	0	0%
Residential Single	0.40	0	0%
Flat/dense townships	0.60	0	0%
Industry, light	0.65	0	0%
Industry, heavy	0.70	0	0%
Business Local	0.60	0	0%
Business CBD	0.85	0	0%
Streets / Roof	0.90	8785	100%
			100%

Representative *c* Factor **0.90**

Step 5 - Determine the Design Q Value

1 Flood Peak (Q) - 1 in 10 years	**0.339**	**m³/s**
2 Flood Peak (Q) - 1 in 50 years	**0.530**	**m³/s**
3 Flood Peak (Q) - 1 in 100 years	**0.627**	**m³/s**

	1 in 10	**1 in 50**	**1 in 100**
Time	**Q (m³/s)**	**Q (m³/s)**	**Q (m³/s)**
0	0.00	0.00	0.00
10	0.339	0.530	0.627
20	0.00	0.00	0.00
Volume =	203	318	376



Sibaya Precinct Node 1 - Catchment D Post Development Flows

Step 1 - Identify the following properties of your catchment and fill in the shaded cells

1 Catchment Area	22390	m²
2 Longest Water Course	469	m
3 Slope of Longest Water Course	6.54%	

Step 2 - Time of Concentration

1 Compute the roughness coeffeicent (r) of the site

Type of Surface	r factor	Area	% Area
Smooth Paving	0.02	22390	100%
Clean Soil	0.10	0	0%
Sparse Grass	0.30	0	0%
Moderate Grass	0.40	0	0%
Thick Bush/Grass	0.80		0%
			100%

Comment: O.K.

Representative *r* Factor 0.02

2 Compute the Time of Concentration (Tc) of the site

r =	0.02
L =	468.724
S =	0.065

Comment: Not O.K. L>200m

$$T_c = 36 \cdot \left(r \cdot \frac{L}{1000} \cdot \frac{1}{S^{0.5}} \right)^{0.467}$$

Computed Tc = 7.69 minutes
Min. Allowed Tc = 10.00 minutes

Therefore Tc = 10.0 minutes

Comment: Use prescibed minimum Tc Value

Step 3 - Obtain the Design Rainfall Depth & Intensity

1 Design Rainfall Depth (Smithers & Schulze)

	Return Period					
	2	5	10	20	50	100
10			25.7		40.2	47.6
15			33.2		51.9	61.6
30			45.1		70.5	83.6
45			54.0		84.3	100

2 Intensity of storm

Intensity 1:10	154	mm/hr
Intensity 1:50	241	mm/hr
Intensity 1:100	286	mm/hr

$$i = D / T_c$$

Step 4 - Calculation of the Runoff Coefficient

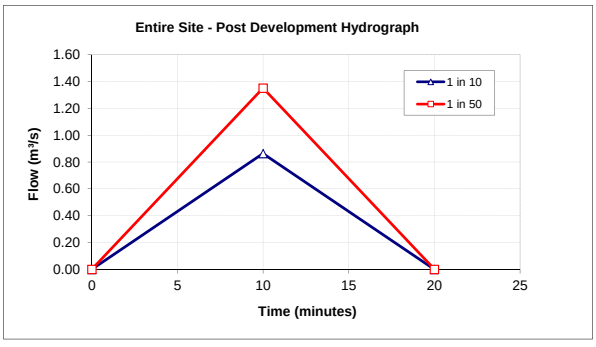
Runoff Coefficient Urban	*Coefficient*	*Area*	*% Area*
Lawn Sandy<2%	0.08	0	0%
Lawn Sandy>7%	0.18	0	0%
Lawn Heavy<2%	0.15	0	0%
Lawn Heavy>7%	0.30	0	0%
Residential Single	0.40	0	0%
Flat/dense townships	0.60	0	0%
Industry, light	0.65	0	0%
Industry, heavy	0.70	0	0%
Business Local	0.60	0	0%
Business CBD	0.85	0	0%
Streets / Roof	0.90	22390	100%
			100%

Representative *c* Factor 0.90

Step 5 - Determine the Design Q Value

1 Flood Peak (Q) - 1 in 10 years	0.863	m³/s
2 Flood Peak (Q) - 1 in 50 years	1.350	m³/s
3 Flood Peak (Q) - 1 in 100 years	1.599	m³/s

	1 in 10	1 in 50	1 in 100
Time	Q (m³/s)	Q (m³/s)	Q (m³/s)
0	0.00	0.00	0.00
10	0.863	1.350	1.599
20	0.00	0.00	0.00
Volume =	518	810	959



Sibaya Precinct Node 1 - Catchment E Post Development Flows

Step 1 - Identify the following properties of your catchment and fill in the shaded cells

1 Catchment Area	**9065**	**m²**
2 Longest Water Course	**308**	**m**
3 Slope of Longest Water Course	**2.17%**	

Step 2 - Time of Concentration

1 Compute the roughness coeffeicent (r) of the site

Type of Surface	r factor	Area	% Area
Smooth Paving	0.02	9065	100%
Clean Soil	0.10	0	0%
Sparse Grass	0.30	0	0%
Moderate Grass	0.40	0	0%
Thick Bush/Grass	0.80		0%
			100%

Comment: O.K.

Representative *r* Factor **0.02**

2 Compute the Time of Concentration (Tc) of the site

r =	0.02
L =	307.727
S =	0.022

Comment: Not O.K. L>200m

$$T_c = 36 \cdot \left(r \cdot \frac{L}{1000} \cdot \frac{1}{S^{0.5}} \right)^{0.467}$$

Computed Tc = **8.17 minutes**
Min. Allowed Tc = **10.00 minutes**

Therefore Tc = **10.0 minutes**

Comment: Use prescibed minimum Tc Value

Step 3 - Obtain the Design Rainfall Depth & Intensity

1 Design Rainfall Depth (Smithers & Schulze)

	Return Period					
	2	5	10	20	50	100
10			**25.7**		**40.2**	**47.6**
15			33.2		51.9	61.6
30			45.1		70.5	83.6
45			54.0		84.3	100

2 Intensity of storm

Intensity 1:10	**154**	**mm/hr**
Intensity 1:50	**241**	**mm/hr**
Intensity 1:100	**286**	**mm/hr**

$$i = D / T_c$$

Step 4 - Calculation of the Runoff Coefficient

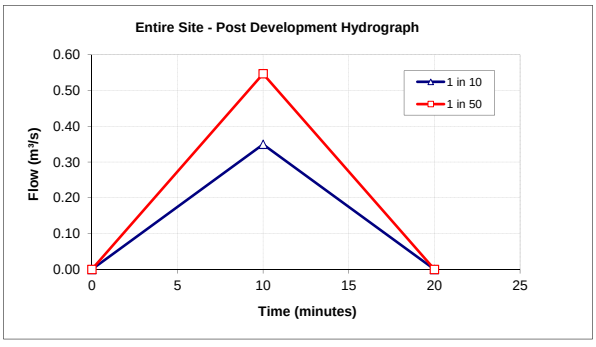
Runoff Coefficient Urban	*Coefficient*	*Area*	*% Area*
Lawn Sandy<2%	0.08	0	0%
Lawn Sandy>7%	0.18	0	0%
Lawn Heavy<2%	0.15	0	0%
Lawn Heavy>7%	0.30	0	0%
Residential Single	0.40	0	0%
Flat/dense townships	0.60	0	0%
Industry, light	0.65	0	0%
Industry, heavy	0.70	0	0%
Business Local	0.60	0	0%
Business CBD	0.85	0	0%
Streets / Roof	0.90	9065	100%
			100%

Representative *c* Factor **0.90**

Step 5 - Determine the Design Q Value

1 Flood Peak (Q) - 1 in 10 years	**0.349**	**m³/s**
2 Flood Peak (Q) - 1 in 50 years	**0.547**	**m³/s**
3 Flood Peak (Q) - 1 in 100 years	**0.647**	**m³/s**

	1 in 10	1 in 50	1 in 100
Time	Q (m³/s)	Q (m³/s)	Q (m³/s)
0	0.00	0.00	0.00
10	0.349	0.547	0.647
20	0.00	0.00	0.00
Volume =	210	328	388



Sibaya Precinct Node 5 - Catchment A Post Development Flows

Step 1 - Identify the following properties of your catchment and fill in the shaded cells

1 Catchment Area	**17124**	**m²**
2 Longest Water Course	**333**	**m**
3 Slope of Longest Water Course	**8.61%**	

Step 2 - Time of Concentration

1 Compute the roughness coeffeicent (r) of the site

Type of Surface	r factor	Area	% Area
Smooth Paving	0.02	17124	100%
Clean Soil	0.10	0	0%
Sparse Grass	0.30	0	0%
Moderate Grass	0.40	0	0%
Thick Bush/Grass	0.80		0%
			100%

Comment: O.K.

Representative *r* Factor **0.02**

2 Compute the Time of Concentration (Tc) of the site

r =	0.02
L =	332.842
S =	0.086

Comment: Not O.K. L>200m

$$T_c = 36 \cdot \left(r \cdot \frac{L}{1000} \cdot \frac{1}{S^{0.5}} \right)^{0.467}$$

Computed Tc = **6.14 minutes**

Min. Allowed Tc = **10.00 minutes**

Therefore Tc = **10.0 minutes**

Comment: Use prescibed minimum Tc Value

Step 3 - Obtain the Design Rainfall Depth & Intensity

1 Design Rainfall Depth (Smithers & Schulze)

	Return Period			
	10	20	50	100
10	*25.9*		*40.4*	*48.0*
15	*33.5*	*41.0*	*52.3*	*62.0*
30	*45.4*	*55.7*	*71.0*	*84.2*
45	*54.3*	*66.5*	*84.8*	*100.7*

2 Intensity of storm

Intensity 1:10	**155**	**mm/hr**
Intensity 1:50	**242**	**mm/hr**
Intensity 1:100	**288**	**mm/hr**

$$i = D / T_c$$

Step 4 - Calculation of the Runoff Coefficient

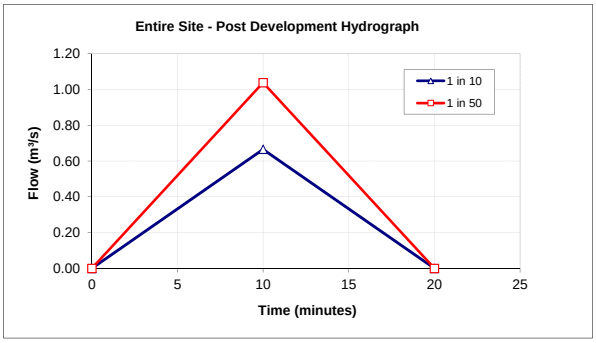
Runoff Coefficient Urban	*Coefficient*	*Area*	*% Area*
Lawn Sandy<2%	0.08	0	0%
Lawn Sandy>7%	0.18	0	0%
Lawn Heavy<2%	0.15	0	0%
Lawn Heavy>7%	0.30	0	0%
Residential Single	0.40	0	0%
Flat/dense townships	0.60	0	0%
Industry, light	0.65	0	0%
Industry, heavy	0.70	0	0%
Business Local	0.60	0	0%
Business CBD	0.85	0	0%
Streets / Roof	0.90	17124	100%
			100%

Representative *c* Factor **0.90**

Step 5 - Determine the Design Q Value

1 Flood Peak (Q) - 1 in 10 years	**0.665 m³/s**
2 Flood Peak (Q) - 1 in 50 years	**1.038 m³/s**
3 Flood Peak (Q) - 1 in 100 years	**1.233 m³/s**

	1 in 10	1 in 50	1 in 100
Time	Q (m³/s)	Q (m³/s)	Q (m³/s)
0	0.00	0.00	0.00
10	0.665	1.038	1.233
20	0.00	0.00	0.00
Volume =	399	623	740



Sibaya Precinct Node 5 - Catchment B Post Development Flows

Step 1 - Identify the following properties of your catchment and fill in the shaded cells

1 Catchment Area	**39971**	**m²**
2 Longest Water Course	**464**	**m**
3 Slope of Longest Water Course	**5.17%**	

Step 2 - Time of Concentration

1 Compute the roughness coeffeicent (r) of the site

Type of Surface	r factor	Area	% Area
Smooth Paving	0.02	39971	100%
Clean Soil	0.10	0	0%
Sparse Grass	0.30	0	0%
Moderate Grass	0.40	0	0%
Thick Bush/Grass	0.80		0%
			100%

Comment: O.K.

Representative *r* Factor **0.02**

2 Compute the Time of Concentration (Tc) of the site

r =	0.02
L =	464.142
S =	0.052

Comment: Not O.K. L>200m

$$T_c = 36 \cdot \left(r \cdot \frac{L}{1000} \cdot \frac{1}{S^{0.5}} \right)^{0.467}$$

Computed Tc = **8.08 minutes**
Min. Allowed Tc = **10.00 minutes**

Therefore Tc = **10.0 minutes**

Comment: Use prescibed minimum Tc Value

Step 3 - Obtain the Design Rainfall Depth & Intensity

1 Design Rainfall Depth (Smithers & Schulze)

	Return Period			
	10	**20**	**50**	**100**
10	*25.9*		*40.4*	*48.0*
15	*33.5*	*41.0*	*52.3*	*62.0*
30	*45.4*	*55.7*	*71.0*	*84.2*
45	*54.3*	*66.5*	*84.8*	*100.7*

2 Intensity of storm

Intensity 1:10	**155**	**mm/hr**
Intensity 1:50	**242**	**mm/hr**
Intensity 1:100	**288**	**mm/hr**

$$i = D / T_c$$

Step 4 - Calculation of the Runoff Coefficient

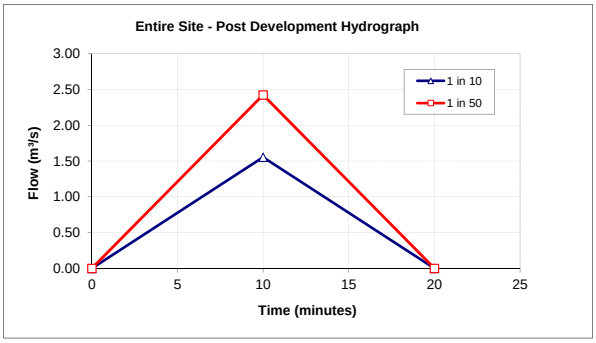
Runoff Coefficient Urban	*Coefficient*	*Area*	*% Area*
Lawn Sandy<2%	0.08	0	0%
Lawn Sandy>7%	0.18	0	0%
Lawn Heavy<2%	0.15	0	0%
Lawn Heavy>7%	0.30	0	0%
Residential Single	0.40	0	0%
Flat/dense townships	0.60	0	0%
Industry, light	0.65	0	0%
Industry, heavy	0.70	0	0%
Business Local	0.60	0	0%
Business CBD	0.85	0	0%
Streets / Roof	0.90	39971	100%
			100%

Representative *c* Factor **0.90**

Step 5 - Determine the Design Q Value

1 Flood Peak (Q) - 1 in 10 years	**1.553**	**m³/s**
2 Flood Peak (Q) - 1 in 50 years	**2.422**	**m³/s**
3 Flood Peak (Q) - 1 in 100 years	**2.878**	**m³/s**

	1 in 10	1 in 50	1 in 100
Time	**Q (m³/s)**	**Q (m³/s)**	**Q (m³/s)**
0	0.00	0.00	0.00
10	1.553	2.422	2.878
20	0.00	0.00	0.00
Volume =	932	1453	1727



Sibaya Precinct Node 5 - Catchment C Post Development Flows

Step 1 - Identify the following properties of your catchment and fill in the shaded cells

1 Catchment Area	**19015**	**m²**
2 Longest Water Course	**370**	**m**
3 Slope of Longest Water Course	**12.66%**	

Step 2 - Time of Concentration

1 Compute the roughness coeffeicent (r) of the site

Type of Surface	r factor	Area	% Area
Smooth Paving	0.02	19015	100%
Clean Soil	0.10	0	0%
Sparse Grass	0.30	0	0%
Moderate Grass	0.40	0	0%
Thick Bush/Grass	0.80		0%
			100%

Comment: O.K.

Representative *r* Factor **0.02**

2 Compute the Time of Concentration (Tc) of the site

r =	0.02
L =	369.685
S =	0.127

Comment: Not O.K. L>200m

$$T_c = 36 \cdot \left(r \cdot \frac{L}{1000} \cdot \frac{1}{S^{0.5}} \right)^{0.467}$$

Computed Tc = **5.90 minutes**
Min. Allowed Tc = **10.00 minutes**

Therefore Tc = **10.0 minutes**

Comment: Use prescibed minimum Tc Value

Step 3 - Obtain the Design Rainfall Depth & Intensity

1 Design Rainfall Depth (Smithers & Schulze)

	Return Period			
	10	**20**	**50**	**100**
10	***25.9***		***40.4***	***48.0***
15	*33.5*	*41.0*	*52.3*	*62.0*
30	*45.4*	*55.7*	*71.0*	*84.2*
45	*54.3*	*66.5*	*84.8*	*100.7*

2 Intensity of storm

Intensity 1:10	**155**	**mm/hr**
Intensity 1:50	**242**	**mm/hr**
Intensity 1:100	**288**	**mm/hr**

$$i = D / T_c$$

Step 4 - Calculation of the Runoff Coefficient

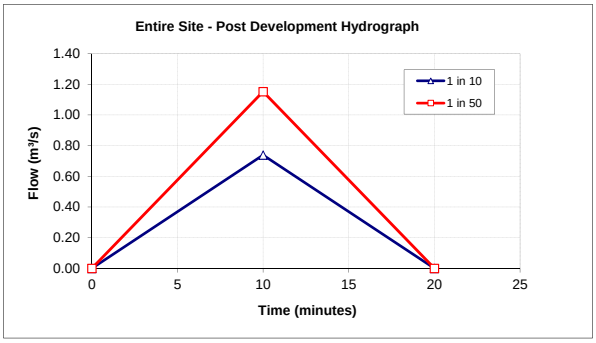
Runoff Coefficient Urban	***Coefficient***	***Area***	***% Area***
Lawn Sandy<2%	0.08	0	0%
Lawn Sandy>7%	0.18	0	0%
Lawn Heavy<2%	0.15	0	0%
Lawn Heavy>7%	0.30	0	0%
Residential Single	0.40	0	0%
Flat/dense townships	0.60	0	0%
Industry, light	0.65	0	0%
Industry, heavy	0.70	0	0%
Business Local	0.60	0	0%
Business CBD	0.85	0	0%
Streets / Roof	0.90	19015	100%
			100%

Representative *c* Factor **0.90**

Step 5 - Determine the Design Q Value

1 Flood Peak (Q) - 1 in 10 years	**0.739 m³/s**
2 Flood Peak (Q) - 1 in 50 years	**1.152 m³/s**
3 Flood Peak (Q) - 1 in 100 years	**1.369 m³/s**

	1 in 10	1 in 50	1 in 100
Time	**Q (m³/s)**	**Q (m³/s)**	**Q (m³/s)**
0	0.00	0.00	0.00
10	0.739	1.152	1.369
20	0.00	0.00	0.00
Volume =	443	691	821



Sibaya Precinct Node 5 - Catchment F Post Development Flows

Step 1 - Identify the following properties of your catchment and fill in the shaded cells

1 Catchment Area	**10330**	**m²**
2 Longest Water Course	**341**	**m**
3 Slope of Longest Water Course	**7.43%**	

Step 2 - Time of Concentration

1 Compute the roughness coeffeicent (r) of the site

Type of Surface	r factor	Area	% Area
Smooth Paving	0.02	10330	100%
Clean Soil	0.10	0	0%
Sparse Grass	0.30	0	0%
Moderate Grass	0.40	0	0%
Thick Bush/Grass	0.80		0%
			100%

Comment: O.K.

Representative *r* Factor **0.02**

2 Compute the Time of Concentration (Tc) of the site

r =	0.02
L =	341.172
S =	0.074

Comment: Not O.K. L>200m

$$T_c = 36 \cdot \left(r \cdot \frac{L}{1000} \cdot \frac{1}{S^{0.5}} \right)^{0.467}$$

Computed Tc = **6.43 minutes**
Min. Allowed Tc = **10.00 minutes**

Therefore Tc = **10.0 minutes**

Comment: Use prescibed minimum Tc Value

Step 3 - Obtain the Design Rainfall Depth & Intensity

1 Design Rainfall Depth (Smithers & Schulze)

	Return Period			
	10	20	50	100
10	*25.9*		*40.4*	*48.0*
15	*33.5*	*41.0*	*52.3*	*62.0*
30	*45.4*	*55.7*	*71.0*	*84.2*
45	*54.3*	*66.5*	*84.8*	*100.7*

2 Intensity of storm

Intensity 1:10	**155**	**mm/hr**
Intensity 1:50	**242**	**mm/hr**
Intensity 1:100	**288**	**mm/hr**

$$i = D / T_c$$

Step 4 - Calculation of the Runoff Coefficient

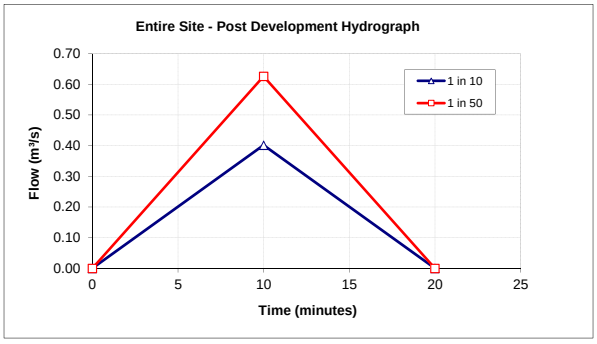
Runoff Coefficient Urban	*Coefficient*	*Area*	*% Area*
Lawn Sandy<2%	0.08	0	0%
Lawn Sandy>7%	0.18	0	0%
Lawn Heavy<2%	0.15	0	0%
Lawn Heavy>7%	0.30	0	0%
Residential Single	0.40	0	0%
Flat/dense townships	0.60	0	0%
Industry, light	0.65	0	0%
Industry, heavy	0.70	0	0%
Business Local	0.60	0	0%
Business CBD	0.85	0	0%
Streets / Roof	0.90	10330	100%
			100%

Representative *c* Factor **0.90**

Step 5 - Determine the Design Q Value

1 Flood Peak (Q) - 1 in 10 years	**0.401**	**m³/s**
2 Flood Peak (Q) - 1 in 50 years	**0.626**	**m³/s**
3 Flood Peak (Q) - 1 in 100 years	**0.744**	**m³/s**

	1 in 10	1 in 50	1 in 100
Time	Q (m³/s)	Q (m³/s)	Q (m³/s)
0	0.00	0.00	0.00
10	0.401	0.626	0.744
20	0.00	0.00	0.00
Volume =	241	376	446



Sibaya Precinct Node 5 - Catchment G Post Development Flows

Step 1 - Identify the following properties of your catchment and fill in the shaded cells

1 Catchment Area	**26615**	**m²**
2 Longest Water Course	**412**	**m**
3 Slope of Longest Water Course	**9.21%**	

Step 2 - Time of Concentration

1 Compute the roughness coeffeicent (r) of the site

Type of Surface	r factor	Area	% Area
Smooth Paving	0.02	**26615**	100%
Clean Soil	0.10	**0**	0%
Sparse Grass	0.30	**0**	0%
Moderate Grass	0.40	**0**	0%
Thick Bush/Grass	0.80		0%
			100%

Comment: O.K.

Representative *r* Factor **0.02**

2 Compute the Time of Concentration (Tc) of the site

r =	0.02
L =	412.402
S =	0.092

Comment: Not O.K. L>200m

$$T_c = 36 \cdot \left(r \cdot \frac{L}{1000} \cdot \frac{1}{S^{0.5}} \right)^{0.467}$$

Computed Tc = **6.68 minutes**
Min. Allowed Tc = **10.00 minutes**

Therefore Tc = **10.0 minutes**

Comment: Use prescibed minimum Tc Value

Step 3 - Obtain the Design Rainfall Depth & Intensity

1 Design Rainfall Depth (Smithers & Schulze)

	Return Period			
	10	**20**	**50**	**100**
10	***25.9***		***40.4***	***48.0***
15	*33.5*	*41.0*	*52.3*	*62.0*
30	*45.4*	*55.7*	*71.0*	*84.2*
45	*54.3*	*66.5*	*84.8*	*100.7*

2 Intensity of storm

Intensity 1:10	**155**	**mm/hr**
Intensity 1:50	**242**	**mm/hr**
Intensity 1:100	**288**	**mm/hr**

$$i = D / T_c$$

Step 4 - Calculation of the Runoff Coefficient

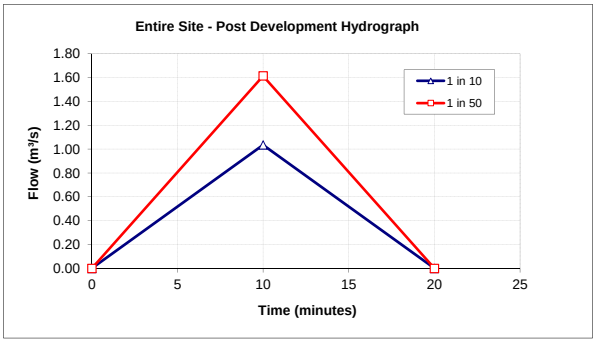
Runoff Coefficient Urban	***Coefficient***	***Area***	***% Area***
Lawn Sandy<2%	0.08	0	0%
Lawn Sandy>7%	0.18	0	0%
Lawn Heavy<2%	0.15	0	0%
Lawn Heavy>7%	0.30	0	0%
Residential Single	0.40	0	0%
Flat/dense townships	0.60	0	0%
Industry, light	0.65	0	0%
Industry, heavy	0.70	0	0%
Business Local	0.60	0	0%
Business CBD	0.85	0	0%
Streets / Roof	0.90	26615	100%
			100%

Representative *c* Factor **0.90**

Step 5 - Determine the Design Q Value

1 Flood Peak (Q) - 1 in 10 years	**1.034**	**m³/s**
2 Flood Peak (Q) - 1 in 50 years	**1.613**	**m³/s**
3 Flood Peak (Q) - 1 in 100 years	**1.916**	**m³/s**

	1 in 10	1 in 50	1 in 100
Time	**Q (m³/s)**	**Q (m³/s)**	**Q (m³/s)**
0	0.00	0.00	0.00
10	1.034	1.613	1.916
20	0.00	0.00	0.00
Volume =	620	968	1150



ANNEXURE D
FIGURE DRAWINGS

Figure 1 : Stormwater Predevelopment scenario (H115299/100/FIG1)

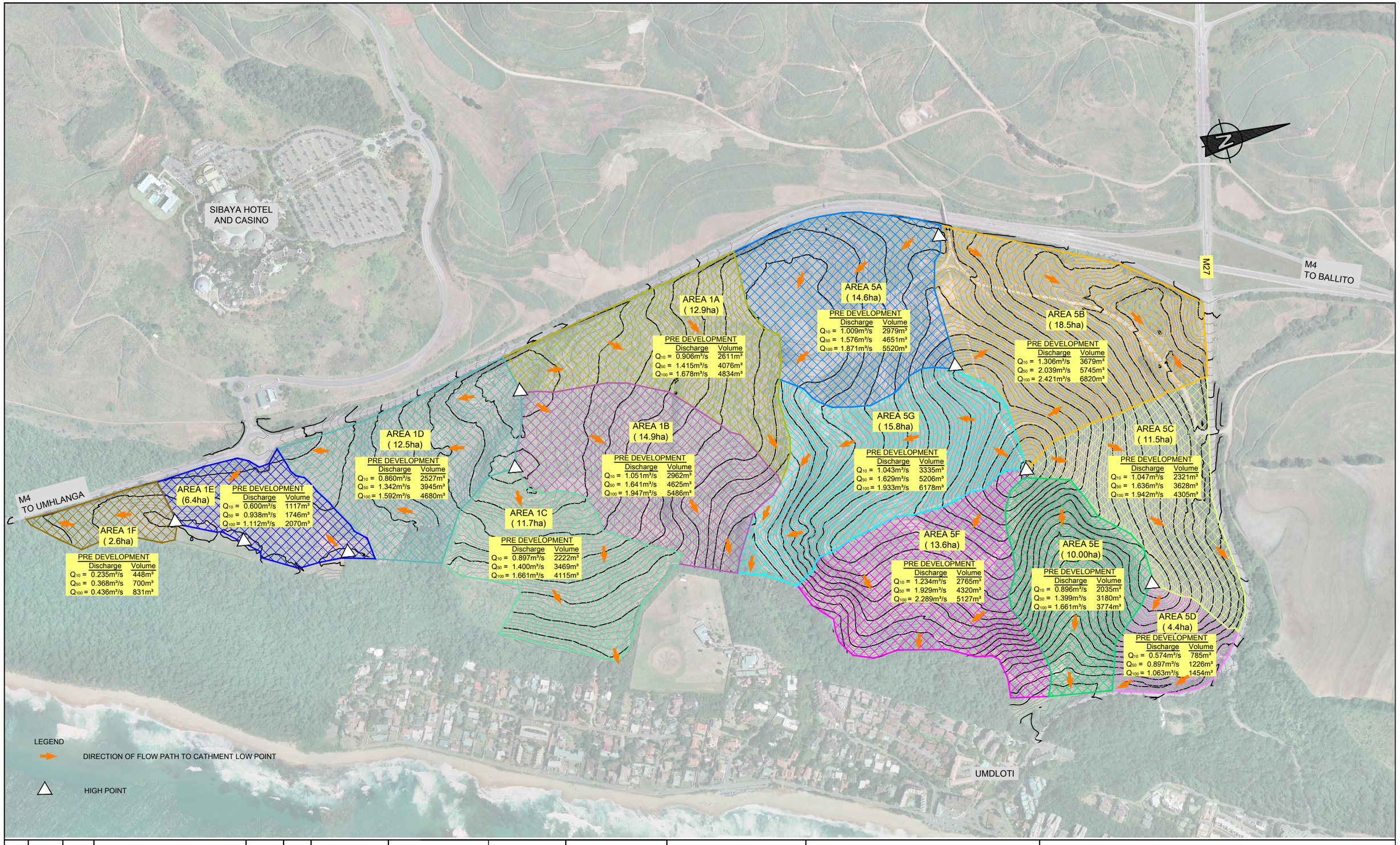
Figure 2 : Stormwater Post development scenario (H115299/100/FIG2)

Figure 3 : Proposed Stormwater Development Plan (H115299/100/FIG3)

Figure 4 : Town Planning Layout Preliminary Overall Layout (H115299/100/FIG4)

Figure 5 : Stormwater Wetland Outlet Structure (H115299/100/FIG5)

Figure 6 : Stormwater Structures Details (H115299/100/FIG6)



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DRG. FILE NAME:		CLIENT:	TONGAAT HULETT

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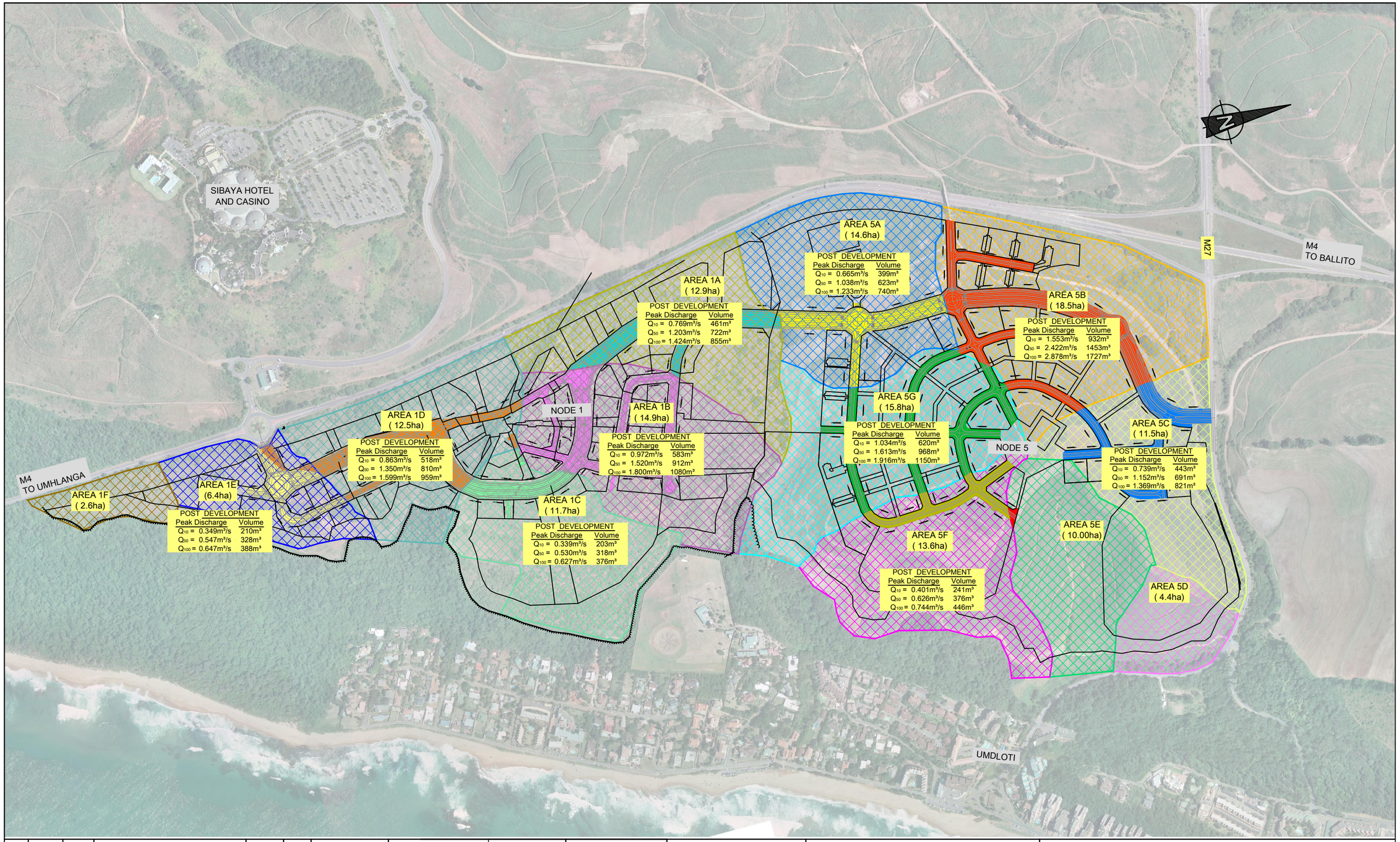
SIBAYA PRECINCT

STORMWATER PRE DEVELOPMENT SCENARIO

A3

DRG No: H115299/100/ FIG 1

REV.No. A



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DRG. FILE NAME:	****/**/**	CLIENT:	TONGAAT HULETT

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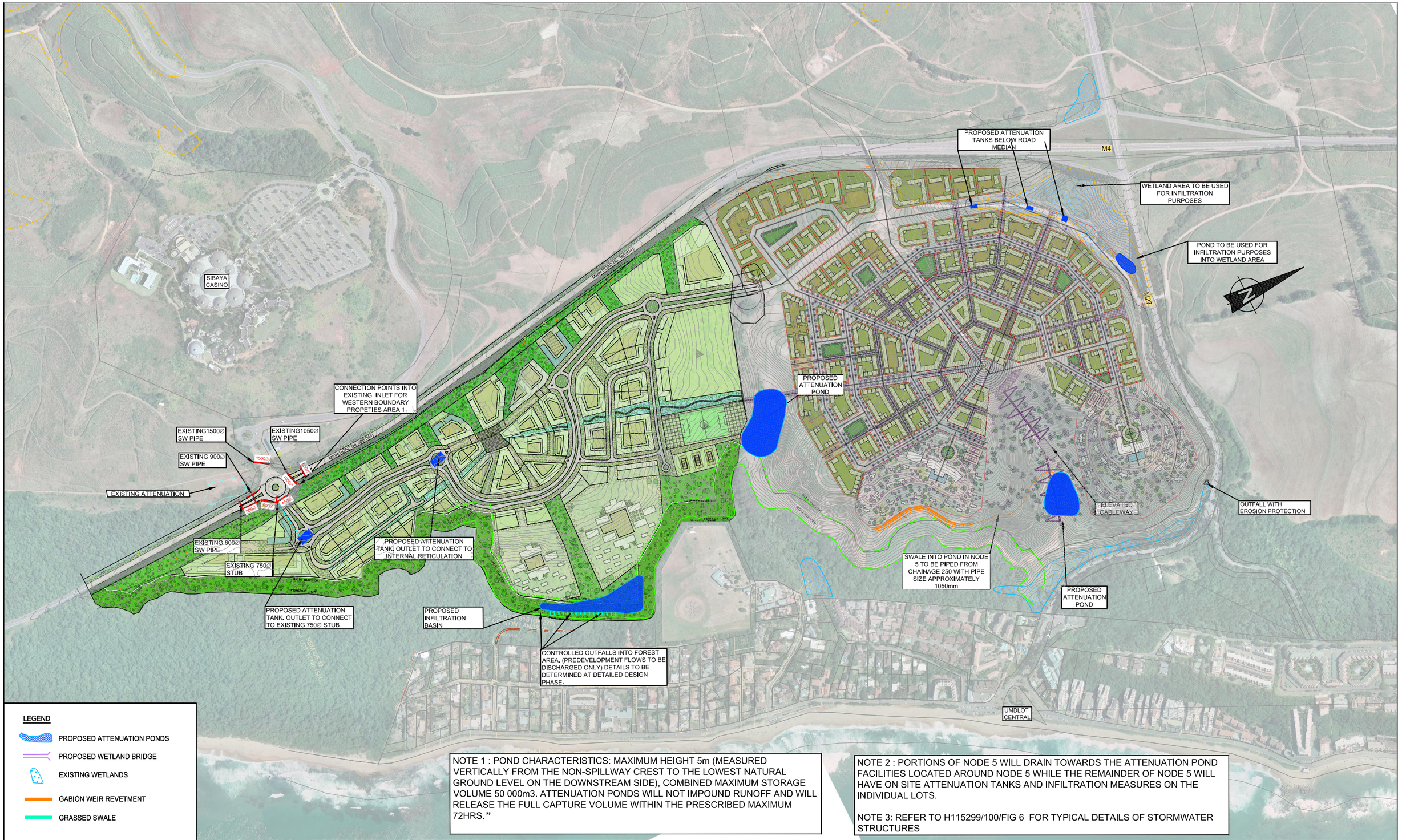
STORMWATER POST DEVELOPMENT SCENARIO

SHEET * OF *

A3

DRG No: H115299/100/FIG 2

REV.No. A



NOTE 1 : POND CHARACTERISTICS: MAXIMUM HEIGHT 5m (MEASURED VERTICALLY FROM THE NON-SPILLWAY CREST TO THE LOWEST NATURAL GROUND LEVEL ON THE DOWNSTREAM SIDE), COMBINED MAXIMUM STORAGE VOLUME 50 000m3. ATTENUATION PONDS WILL NOT IMPOUND RUNOFF AND WILL RELEASE THE FULL CAPTURE VOLUME WITHIN THE PRESCRIBED MAXIMUM 72HRS."

NOTE 2 : PORTIONS OF NODE 5 WILL DRAIN TOWARDS THE ATTENUATION POND FACILITIES LOCATED AROUND NODE 5 WHILE THE REMAINDER OF NODE 5 WILL HAVE ON SITE ATTENUATION TANKS AND INFILTRATION MEASURES ON THE INDIVIDUAL LOTS.

NOTE 3: REFER TO H115299/100/FIG 6 FOR TYPICAL DETAILS OF STORMWATER STRUCTURES

REV.	DATE	DRAWN	DESCRIPTION	CHECKED	APPR'D
B	10/2015		UPDATED STORMWATER FACILITIES		
A	12/2014		PRELIMINARY REPORT		

SCALE:	1 : 8000	DESIGNED:	V.NAIDOO
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0 50 100

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SIBAYA PRECINCT

PROPOSED STORMWATER DEVELOPMENT PLAN

SHEET 1 OF 2

A3

DRG No: H115299/100/ FIG. 3

REV.No. B

REV.	DATE	DRAWN	DESCRIPTION	CHECKED	APPR'D
B			PONDS ADDED		
A	**://:**	INI	DESCRIPTION		

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DRAWN:	E. ROY / V.NAIDOO	DISCIPLINE:	P.D.G.
CHECKED:	S.SEWPARSAD	PROJECT LEADER:	M.WEEDON
DRG. FILE NAME:	****/**/**	CLIENT:	TONGAAT HULETT

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SIBAYA PRECINCT

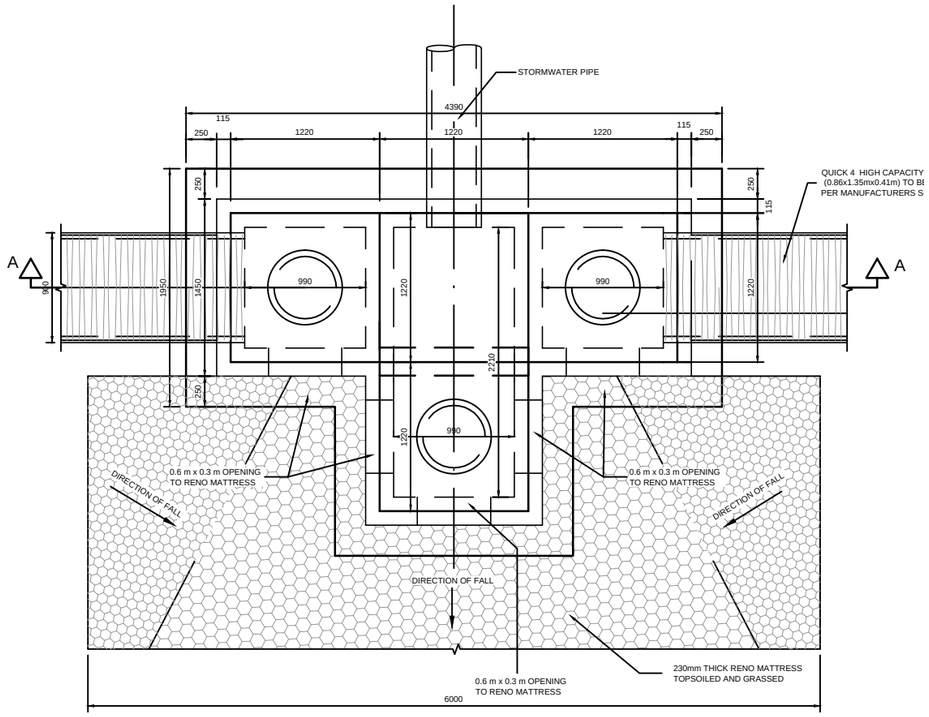
TOWN PLANNING LAYOUT
PRELIMINARY OVERALL LAYOUT
AREAS 1 TO 5

SHEET * OF *

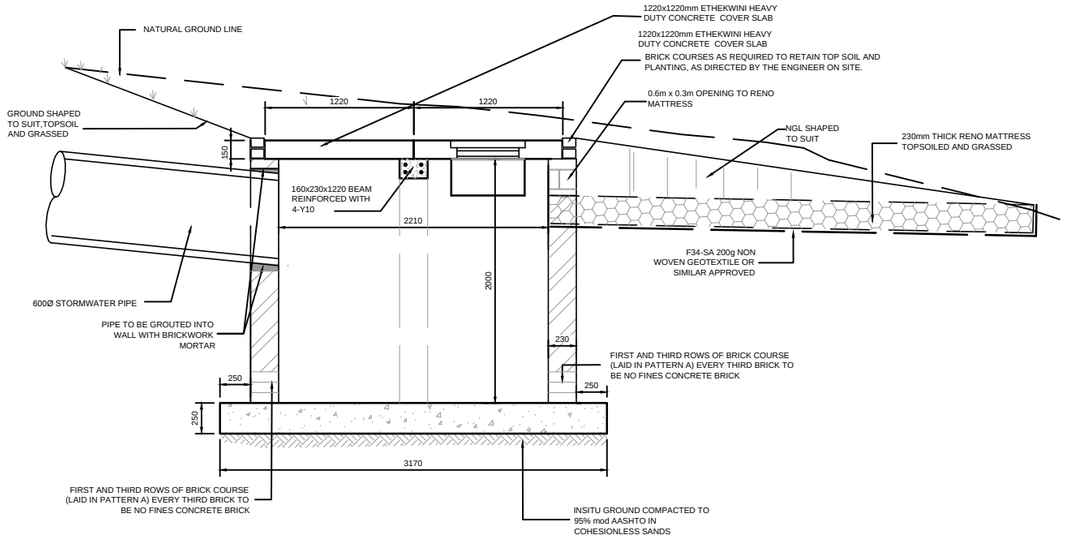
A3

DRG No: H115299/100/FIG. 4

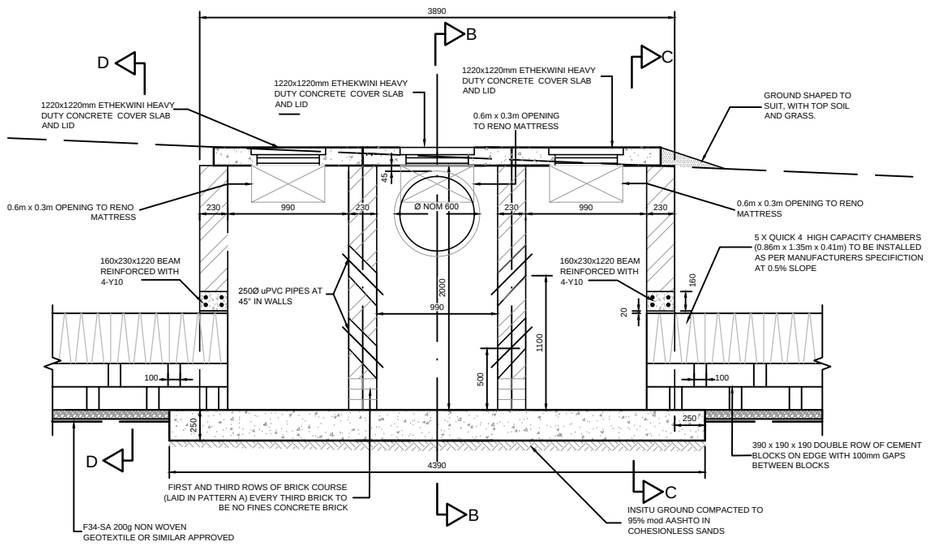
REV.No. B



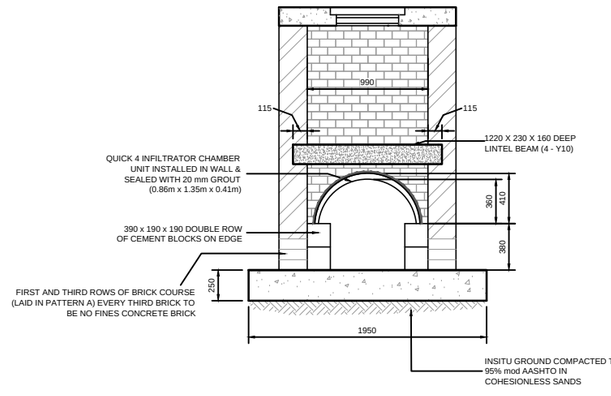
HEADWALL OUTLET MANHOLE
LAYOUT PLAN



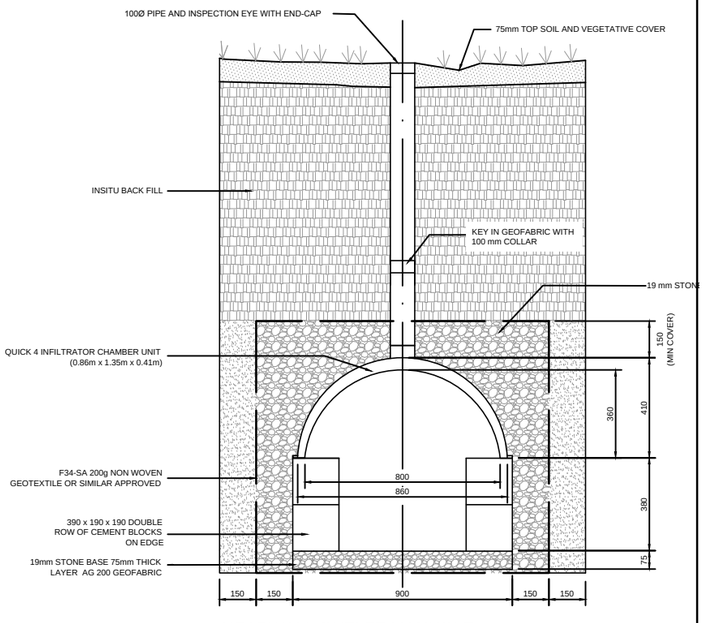
HEADWALL OUTLET
MANHOLE (SECTION B-B)



HEADWALL OUTLET MANHOLE
(SECTION A-A)



HEADWALL OUTLET MANHOLE
SECTION C-C



HEADWALL OUTLET MANHOLE
SECTION D-D

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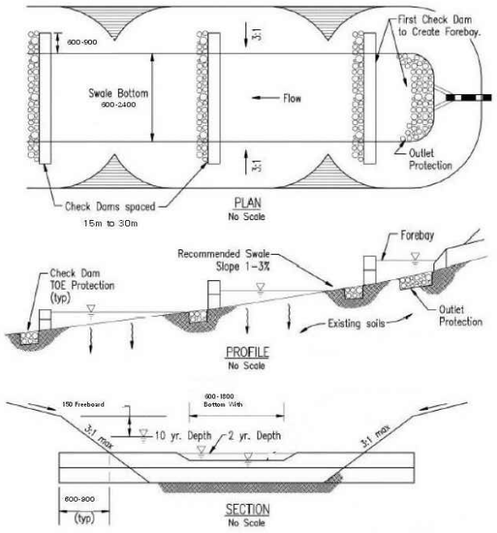
SIBAYA PRECINCT

STORMWATER WETLAND OUTLET STRUCTURE

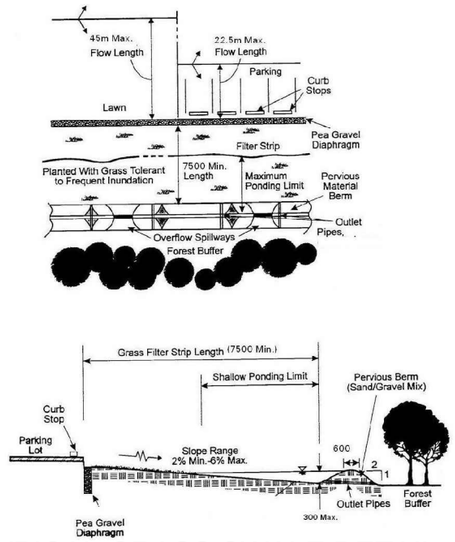
A3

DRG No: H115299/100/ FIG. 5

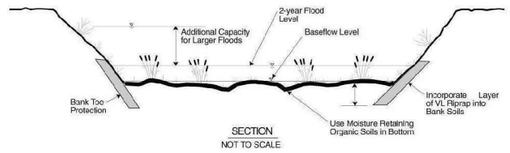
REV.No. A

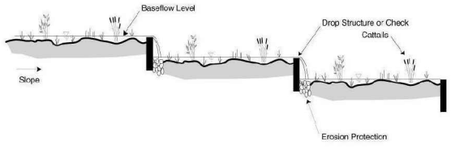


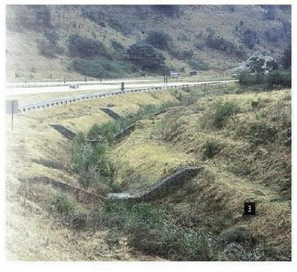
TYPICAL GRASS SWALE WITH CHECK DAM DETAIL



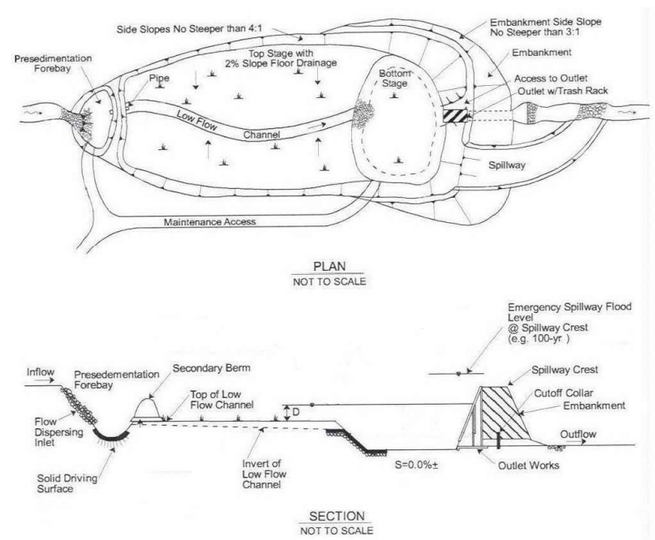
TYPICAL GRASS SWALE DETAIL



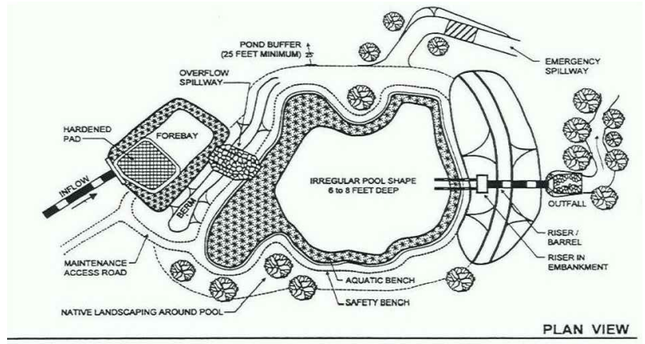




TYPICAL GABION WEIR REVETMENT DETAIL



TYPICAL DRY ATTENUATION POND DETAIL



TYPICAL WET ATTENUATION POND DETAIL

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SIBAYA PRECINCT

STORMWATER STRUCTURES DETAILS

SHEET 2 OF 2

A3

DRG No: H115299/100/ FIG. 6

REV.No. A