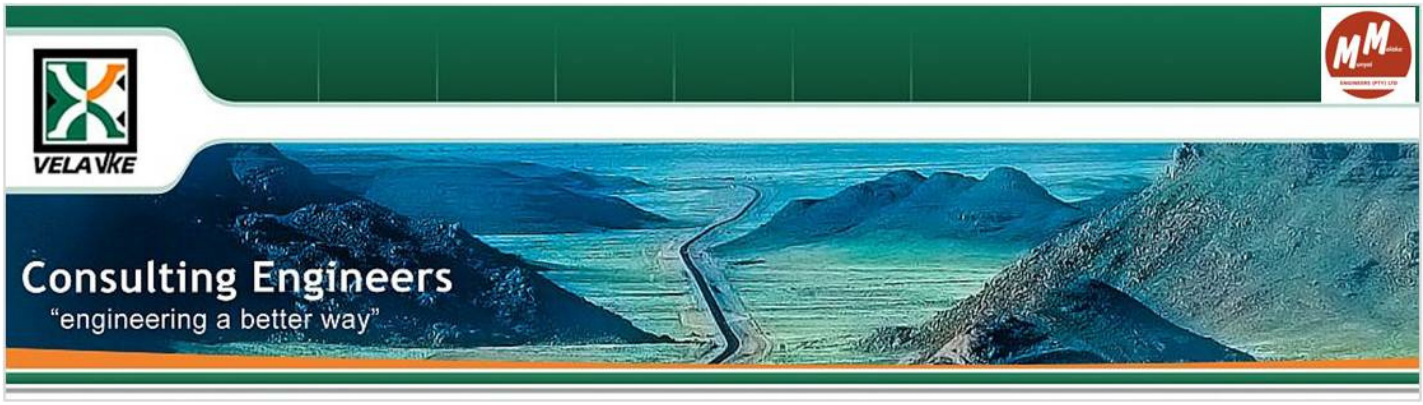

COMPENSATION FLATS

STORMWATER MANAGEMENT PLAN

Incorporating Policy, Regulations and Guidelines

Report No. : DR2011/16 – REVISION 0

APRIL 2012

Tongaat Hulett DEVELOPMENTS

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- DA894-COMP-HYD-01
- DA894-GEN-03-THD

1. INTRODUCTION

Tongaat Hulett Developments (THD) intends developing a 213 hectare Industrial and Business Park (known as "Compensation Flats") within the Kwadukuza (Ilembe District) Municipality.

The extent of the Compensation Flats development is shown on Drawing No DA894-GEN-03-THD. The western boundary of the site is approximately 600m to the west of and parallel with the existing R102. The eastern boundary lies 1km to the east of the existing R102. The site is bounded in the south by the common boundary between the eThekwini Municipality and the Kwadukuza Municipality while the northern boundary lies approximately 500m north of the existing MR387.

The development is situated on "Remainder of the Farm Pencarrow No 17860 and Portion 5 of the Farm Pencarrow No 17860".
The total area of the site is 300 ha, a large portion of which is under sugar cane. 87ha needs to be restored to a wetland state (shown in "open space / conservation"). The remaining 213ha will be developed in three categories i.e. Industrial (138ha), Office / Business Park (67ha) and Mixed Use (8ha).
Several notable features on the site are as follows –

- An existing network of reasonably well maintained cane-haul roads.
- Areas of forest approximately 16ha in extent.

2. IMPACT OF DEVELOPMENT ON EXISTING CATCHMENTS

The impacts of the proposed Compensation Flats 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.
Expected consequences of unmitigated development include an increase in hardened areas, reduced infiltration areas, loss of vegetation and reduced evapo-transpiration potential. There will be an overall increase in surface runoff, an increase in the speed of runoff and peak flow rates in the watercourses.

3. MITIGATION OF DEVELOPMENT CONSEQUENCES

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

- Improved wetland functionality and zero net-loss approach on wetland areas
- Protection of the natural watercourses to prevent pollution, erosion and retain runoff
- Promotion of subsoil infiltration where possible
- Provision of indigenous vegetation along watercourses and stabilisation of banks
- Provision of in-stream installations at selected sites to trap first-flush pollution and non-soluble trash and litter entering the stormwater system
- Attention to development of on-site use rainfall attenuation and provisions for reducing runoff by in-catchment and on-site evaporation and evapo-transpiration
- Local flood risk reduction by selection of appropriate design standards for culverts and stormwater attenuation facilities
- Implementation of adequate on-site and localised stormwater management practices
- Attenuation of flood peaks to predevelopment levels at the 2% (50-year) and the 10% (10-year) risk level
- Matching of new impermeable areas with sufficient flood attenuation and evaporation provisions
- Rehabilitation and upgrading of open spaces following conversion from sugarcane

These issues must be carried through the Stormwater Management Plan to the Parks & Landscaping plan.

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 while supporting the proposed spatial development intensity levels and contributing positively 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 sufficient 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.
- Installations must be provided to contain pollution as close to source as possible and in a practical location for servicing by Department of Solid Wastes.

4. OBJECTIVES

This stormwater management plan for the Compensation Flats 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 conserve the flora and fauna of the natural environment
4. To protect and enhance water resources in the catchments from pollution and siltation
5. To protect and enhance the local and downstream water courses

5. MAJOR RISKS

5.1 Erosion

The general geology of the area consists of 4 main soil types as follows –

0,0m to 0,2->0,9m: Brown/dark brown, loose, **partly clayey SAND** – (Top Soil)

0,0m to 3,0m: Brown, loose, **fine grained SAND** – (Alluvium)
Occasionally the top soil horizon prior to the flood event occurs underlying the alluvial sands.

0,7m to >3,0m: Light grey, yellow and red to orange, firm/stiff, **partly very sandy, silty CLAY** – (Residual Vryheid)

The residual soils vary in sand content and the red to orange colour deriving from the haematite mineral (Fe_2O_3) is partly absent.

1,1m to >3,0m: Dark grey, weathered, soft rock **SILTSTONE/SHALE** – (Vryheid Formation)
(In the north eastern part Sandstone seem predominant in patches)

The topsoil and alluvial sands 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 them.

5.2 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 collectively in the watercourses and on individual sites if necessary. The design of the major stormwater system must address this issue as far as possible and must be designed such that the downstream post-development flood risks are no greater than the pre-development flood risks.
As a guide to the degree of runoff attenuation required, pre-development and post development 50-year flood estimates are given in the attached appendices.

6. STORMWATER MANAGEMENT PHILOSOPHY

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

The minor stormwater system consists of any measures provided to accommodate stormwater runoff within sites and road reserves and convey the runoff to the major stormwater system. These measures include gutters, 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 of more than 1 in 50 years. All elements of the built and natural environment must be able to withstand a 1 in 50 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 the Compensation Flats 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.
- Prevent pollution of water ways and water features by suspended solids and dissolved solids in stormwater discharges.
- Contain soil erosion, whether induced by wind or water forces, by constructing protective works to trap sediment at appropriate locations. This applies particularly during construction.
- Avoid situations where natural or artificial slopes may become saturated and unstable, both during and after the construction process.

7. STORMWATER MANAGEMENT POLICY

The following rules are to be observed by all developers, property owners, their professional teams, contractors and sub-contractors:

1. Designs for the buildings and site development in general must avoid concentration of stormwater runoff both spatially and in time and may be required to provide for on-site attenuation of stormwater runoff to limit peak flows to pre-development levels.
2. Detailed plans to control and prevent erosion by water must be agreed prior to the commencement of any works, including site clearance, on any portion of the site.
3. Removal of vegetation cover must be carried out with care and attention to the effect, whether temporary or long term, that this removal will have an erosion potential.
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 after building works have been completed, or have reached a stage where newly established ground cover is not at risk from the construction works.
6. On-site stormwater control systems, such as swales, berms, soil fences and detention ponds are to be constructed before any construction commences on the site. As construction progresses, the stormwater control measures are to be monitored and adjusted to ensure complete erosion and pollution control at all times.
7. Earthworks on sites are to be kept to a minimum. Where embankments have to be formed, stabilization and erosion control measures shall be implemented immediately.
8. Stormwater must not be allowed to pond in close proximity to existing building foundations.
9. Prior to any physical work proceeding on any site, stormwater control plans (SCPs) detailing the proposed stormwater control measures are to be formulated. 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.

8. MAJOR STORMWATER SYSTEMS

A plan indicating the sub-catchment delineation for this project is attached as an appendix with details and possible stormwater impacts indicated to advise the planning process and highlight critical areas for attention during the design phase.
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 areas
- 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
- 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.

9. CRITICAL ASPECTS

1. Stormwater drainage is a crucial aspect in the development of the Compensation Flats and will require careful planning, designing and managing.
2. The stormwater detention ponds should be designed for the 50-year storm event and should be located at appropriately selected sites. Site selection must take account of the necessary geotechnical, environmental and topographical conditions, including wetland conservation.
3. 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.
4. In the flatter areas (a large portion of the site) 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.
5. 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.
6. 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.
7. While the stormwater management objective of the development should be to minimize the concentration of stormwater and attenuate flows as much as possible, roads and driveways cut into steeper slopes will cause storm runoff to be channeled 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.
8. 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 formalized 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%.
9. The proposed development should not adversely impact on the environments of the development node and surrounding areas in terms of erosion and sediment deposition, but the frequency of flooding and the total runoff volume will increase unless adequate provision can be made to maintain the current natural rate of stormwater retention and infiltration in the sub-catchments.

10. 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.
11. Detailed hydraulic analysis will be required during the design stage to assess storm runoff and flood levels at specific locations, such as bridges, road culverts and where properties are affected by the 100-year flood. It is important to note that although a structure may be designed for a return period less than 1 in 100 years, the design analysis must still assess the consequences resulting from a 100-year storm event.
12. 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.
13. 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.
14. 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.
15. Overland flow may be encouraged where possible, but should be avoided in the specific areas identified. These are typically where roads 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.
16. Steeper watercourses will require protection from erosion through the use of appropriate channel lining, detention dams, or controlled drops to dissipate flow energy.
17. All natural and unlined channels should be inspected for adequate binding of soil by sustainable ground cover. Stone pitching should be used to reinforce channel inverts on steep slopes. Existing wetlands and stormwater detention areas should be protected from encroachment by the development.

10. GUIDELINES FOR OWNERS AND DEVELOPERS

All sub-developments within Compensation Flats will be required to control stormwater runoff in accordance with the stormwater management philosophy and policies of the Kwadukuza / ILembe and eThekwini Municipalities.
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.

10.1 STORMWATER RUNOFF CONTROL

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

10.1.1 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.

10.1.2 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.

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.

10.1.3 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.

10.1.4 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.

10.1.5 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) Inlet structures at culverts must be designed to ensure that the capacity of the culvert does not exceed the pre-development stormwater flow at that point and detention storage should be provided on the road and/or upstream of the stormwater culvert.

d) Outlet structures at a road culvert or a natural watercourse must be designed to dissipate flow energy and any unlined downstream channel must be adequately protected against soil erosion.

10.1.6 Stormwater Storage Facilities

a) The sufficiency and effectiveness of on-site detention 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.

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

d) The Kwadukuza / Ilembe 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.

10.1.7 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.

10.1.8 Channels

a) Lined and unlined channels may be constructed to convey stormwater to a natural watercourse where deemed necessary and unavoidable.

b) Channels must be constructed with rough artificial surfaces, or lined with suitable, hardy vegetation, to be non-erodible and to provide maximum possible energy dissipation to the flow.

10.1.9 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 dams should be provided at the head of the energy dissipating structure if possible.

c) A means of dissipating energy must be provided at the outfall of any drop structure to ensure stormwater flow is returned to a safe sub-critical state, or to disperse the flow.

10.1.10 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 Kwadukuza / Ilembe Municipality or their appointed representatives.

10.2 STORMWATER POLLUTION CONTROL

a) All property owners and developers shall ensure that no materials, fluids or substances are allowed to enter the stormwater system that could have a detrimental effect on the flora, fauna and aquatic life in the water courses, wetlands and dams.

b) Regular monitoring of sites within the catchment should be undertaken by Kwadukuza / Ilembe 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 Kwadukuza / Ilembe and eThekwini Municipalities and shall take measures to ensure spillages of the substance(s) can be adequately contained to prevent contamination of the water resources within the development area.

d) No stormwater, wash water, or waste water may be directed towards any permanent water body or wetland without the installation of a suitable filtration system to prevent pollution, including silt, from entering such water body.

10.3 STORMWATER EROSION CONTROL

The Kwadukuza / ILembe Municipality may, at its discretion, inspect the individual properties within the Compensation Flats 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.

10.4 SAFETY

10.4.1 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 Kwadukuza / Ilembe 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.

10.4.2 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 Compensation Flats.

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

11. STORMWATER PLAN IMPLEMENTATION PROCEDURES

The following procedures are to be followed by owners, developers, appointed agents, professional teams and contractors:

1. Application for Permission to Build

   A copy of the Stormwater Management Plan shall be obtained from the Kwadukuza / Ilembe Municipality.

2. Site Survey and Investigations

   Anyone involved in site survey and investigation work shall be familiar with the contents of the Stormwater Management Plan.

3. Design Stage

   The professional team shall take into account the stormwater management requirements contained in this document and shall clearly indicate on all plans and in any contract document where and how measures have been provided in the design to ensure the stormwater management requirements are implemented. Approval from the Kwadukuza / Ilembe 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 Compensation Flats 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 Kwadukuza / Ilembe 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 Kwadukuza / Ilembe Municipality.

6. Occupation Period

   During occupation of any property, Kwadukuza / Ilembe 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 Kwadukuza / Ilembe Municipality.

12. COMPLIANCE WITH STORMWATER MANAGEMENT POLICY

1. Within the jurisdiction of a site specifically and the Compensation Flats 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 and beyond the Compensation Flats.

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

13. HYDROLOGY

13.1 Catchment Characteristics

(Refer to DA894-COMP-HYD-01 attached)

Using topographical survey supplied by Mark Gibbs Surveys, the project area was delineated into 8 stormwater sub-catchments. The characteristics of these are tabled below:

Catchment	Area (ha)	Existing Land Use	Primary Proposed Land Use	Predominant Slope
CFSWCA01	64.6867	Cultivated / Forest	Light Industrial	< 3%
CFSWCA02	24.1877	Cultivated / Forest	Open Space	3 – 10%
CFSWCA03	19.4241	Cultivated	Light Industrial	3 – 10%
CFSWCA04	81.7984	Cultivated	Business Park	< 3%
CFSWCA05	29.3207	Cultivated	General Industrial	< 3%
CFSWCA06	45.2888	Cultivated	General Industrial	3 – 10%
CFSWCA07	18.5074	Cultivated	General Industrial	< 3 %
CFSWCA08	36.1672	Cultivated	General Industrial	< 3%

13.2 Rational Method

(Refer to Appendices B to C attached)

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

Rainfall data obtained from eThekwini Municipality for the 1 in 10 and 1 in 50 year return periods was used in these calculations. Following the delineation of the project area into sub-catchments, the primary drainage lines were identified and analyzed to determine the time of concentration (Tc) of each sub-catchment. The Tc's were then used to select appropriate storm durations from the rainfall data available.

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

A slope analysis of the topographic survey supplied by Mark Gibbs Surveys was undertaken and used to determine the range of pre-development slopes in each sub-catchment. These are summarized in Appendix B.

The permeability of the soil is assumed to be semi-permeable which is supported by the Geotechnical Report undertaken by TGC Engineers. The vegetal cover is predominantly sugar cane with a portion of dense forest in catchments 1 and 2.

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

13.3 Analysis of Results

(Refer to Appendix A attached)

Appendix A summarizes the results of the preliminary Rational Method calculations for the development. It is evident from these results that one of the negative impacts of the development is a substantial increase in the peak stormwater runoff flows for both the 1 in 10 and 1 in 50 year return periods.

The increase in peak runoff will primarily be mitigated by the introduction of stormwater attenuation devices as part of the stormwater network. These devices will either be dual purpose elements e.g. parking lots, underground stormwater tanks or attenuation dams. An estimate of the attenuation volumes required has been included in appendix A. This estimate is based on a rate of $1m^3$ per $40m^2$ of hardened area.

The attenuation measures selected will be required to reduce the post-development peak runoffs for the 1 in 10 and 1 in 50 year storms to pre-development levels. With this in mind, it is recommended that the hydraulic characteristics of the stormwater network is analyzed (using EPASWMM or similar software) during the detail design phase of the project. This analysis will accurately determine the attenuation volumes required and the outlet configuration required to reduce the peak outflows to pre-development levels.

14. REFERENCES

1 Geotechnical Investigation of the Proposed Hamlyn Estate Development Phase 1 & 2: March 2009, Drennan, Maud & Partners.

3 Compensation Flats – Engineering Services Report Revision 3, June 2011, Vela VKE Consulting Engineers (Pty) Ltd.

APPENDIX A

Rational Method Calculations for a 1 in 10 and 1 in 50 year return period

COMPENSATION FLATS - RATIONAL METHOD CALCULATIONS

1:10 YEAR RP

	PRE DEVELOPMENT						POST DEVELOPMENT					
Catchment	C	I (mm/hr)	A (ha)	Q (m3/s)	Tc (min.)	Volume (m3)	C	I (mm/hr)	A (ha)	Q (m3/s)	Tc (min.)	Volume (m3)
CFSWCA01	0.24	59	64.6867	**2.602**	65	15232	0.63	137.60	64.6867	15.607	15	21069
CFSWCA02	0.26	85	24.1877	**1.490**	36	4764	0.50	137.60	24.1877	4.604	15	6215
CFSWCA03	0.27	86	19.4241	**1.268**	35	3962	0.59	137.60	19.4241	4.391	15	5928
CFSWCA04	0.25	69	81.7984	**3.974**	50	17816	0.56	137.60	81.7984	17.431	15	23532
CFSWCA05	0.25	58	29.3207	**1.170**	69	7242	0.65	137.60	29.3207	7.294	15	9847
CFSWCA06	0.27	60	45.2888	**2.007**	64	11503	0.64	137.60	45.2888	11.124	15	15017
CFSWCA07	0.26	67	18.5074	**0.887**	52	4172	0.70	137.60	18.5074	4.952	15	6685
CFSWCA08	0.26	75	36.1672	**1.929**	44	7567	0.63	137.60	36.1672	8.654	15	11682

1:50 YEAR RP

	PRE DEVELOPMENT						POST DEVELOPMENT						Estimated SW Attenuation Req.
Catchment	C	I (mm/hr)	A (ha)	Q (m3/s)	Tc (min.)	Volume (m3)	C	I (mm/hr)	A (ha)	Q (m3/s)	Tc (min.)	Volume (m3)	Volume (m3)
CFSWCA01	0.34	93	64.6867	**5.621**	65	32913	0.63	215.20	64.6867	24.408	15	32951	9000
CFSWCA02	0.36	133	24.1877	**3.221**	36	10299	0.50	215.20	24.1877	7.200	15	9720	1200
CFSWCA03	0.38	135	19.4241	**2.740**	35	8566	0.59	215.20	19.4241	6.867	15	9270	2000
CFSWCA04	0.35	108	81.7984	**8.588**	50	38506	0.56	215.20	81.7984	27.262	15	36803	8900
CFSWCA05	0.34	90	29.3207	**2.528**	69	15647	0.65	215.20	29.3207	11.408	15	15401	3800
CFSWCA06	0.37	94	45.2888	**4.336**	64	24855	0.64	215.20	45.2888	17.397	15	23486	5300
CFSWCA07	0.36	105	18.5074	**1.917**	52	9016	0.70	215.20	18.5074	7.744	15	10455	2800
CFSWCA08	0.36	117	36.1672	**4.170**	44	16356	0.63	215.20	36.1672	13.534	15	18271	3900

APPENDIX A

APPENDIX B

DETERMINATION OF C FACTORS

COMPENSATION FLATS: CALCULATION OF RUNOFF COEFFICIENTS USING DWA METHOD

					PRE / RURAL Runoff Coefficient											Post Development Runoff Coefficient						
					Steepness Cs					Permeability Cp		Vegetal Cv			Ct							
Sub-catchments	Proportional C-factor		Total Subcatchment Area	% Rural	<3%	3-10%	10-30%	>30%	Cs	Semi (most soils)	Cp	Cult land, sparse bush	Dense Bush / Forest	Cv	Cs + Cp + Cv = Ct	C-factor	Business Park	General Industrial	Light Industrial	Mixed Use	Roadways	Open Space
					0.05	0.11	0.20	0.30		0.20		0.15	0.05				0.6	0.7	0.65	0.6	0.95	
	1:50 RP	1:10 RP		%	Area (m2)												Area (m2)					
CFSWCA01	**0.34**	**0.24**	646867	100%	471605	170640	4032	540	0.07	646867	0.20	574191	72676	0.14	0.41	**0.63**	137224		315173	30506	66944	96663
CFSWCA02	**0.36**	**0.26**	241877	100%	60544	145128	34454	1610	0.11	241877	0.20	180945	60933	0.12	0.43	**0.50**	34962		33406		5076	168128
CFSWCA03	**0.38**	**0.27**	194241	100%	51733	124447	17453	599	0.10	194241	0.20	194241	0	0.15	0.45	**0.59**			91530	10338	16561	73880
CFSWCA04	**0.35**	**0.25**	817984	100%	514503	296815	5470	254	0.07	817984	0.20	817984	0	0.15	0.42	**0.56**	544710				28268	242134
CFSWCA05	**0.34**	**0.25**	293207	100%	226222	65404	1494	46	0.06	293207	0.20	293207	0	0.15	0.41	**0.65**		206438		30501	8867	47341
CFSWCA06	**0.37**	**0.27**	452888	100%	147888	296665	8283	52	0.09	452888	0.20	452888	0	0.15	0.44	**0.64**		326735		8455	10569	106775
CFSWCA07	**0.36**	**0.26**	185074	100%	99684	82067	2712	161	0.08	185074	0.20	185074	0	0.15	0.43	**0.70**		185068				
CFSWCA08	**0.36**	**0.26**	361672	100%	219172	124447	17453	599	0.08	361672	0.20	361672	0	0.15	0.43	**0.63**		237821			13300	110416

APPENDIX B

APPENDIX C

DETERMINATION OF TIME OF CONCENTRATION

COMPENSATION FLATS

Time of Concentration Calculations

			Subcatchments							
			CFSWCA01	CFSWCA02	CFSWCA03	CFSWCA04	CFSWCA05	CFSWCA06	CFSWCA07	CFSWCA08
Pre-development	Overland Flow	r factor	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
		L (m)	150	150	150	150	150	150	150	150
		Z_1	86.8	79.9	71.5	83.7	70.2	70.2	69.6	63.0
		Z_2	84.9	74.8	66.8	79.6	69.8	69.7	68.4	60.0
		Slope (m/m)	0.012	0.034	0.032	0.028	0.002	0.003	0.008	0.020
		Tc_{OF} (min.)	37	29	30	31	56	52	41	33
	Stream Flow	L (m)	1021	279	235	943	579	669	531	453
		Z_1	86.8	69.6	63.2	73.4	67.9	68.8	67.4	56.0
		Z_2	79.9	62.4	55.1	58.8	59.5	52.2	56.5	48.0
		Slope (m/m)	0.01	0.03	0.03	0.02	0.01	0.02	0.02	0.02
		Tc_{SF} (min.)	28	6	5	19	13	12	11	10
		Tc_{TOTAL} (min.)	**65**	**36**	**35**	**50**	**69**	**64**	**52**	**44**
	10 YR RP	Rainfall Depth 10 YR RP	64	50	50	57	66	64	58	54
		Intensity (mm/hr)	59	85	86	69	58	60	67	75
	50 YR RP	Rainfall Depth 50 YR RP	101	79	78	89	103	100	91	85
		Intensity (mm/hr)	93	133	135	108	90	94	105	117
Post Development		Tc (min.)	**15**	**15**	**15**	**15**	**15**	**15**	**15**	**15**
	10 YR RP	Rainfall Depth 10 YR RP	34.4	34.4	34.4	34.4	34.4	34.4	34.4	34.4
		Intensity (mm/hr)	138	138	138	138	138	138	138	138
	50 YR RP	Rainfall Depth 50 YR RP	53.8	53.8	53.8	53.8	53.8	53.8	53.8	53.8
		Intensity (mm/hr)	215	215	215	215	215	215	215	215

APPENDIX C

APPENDIX D

DRAWINGS

- DA894-GEN-03-THD
- DA894-COMP-HYD-01

LEGEND

- GENERAL INDUSTRIAL : 90.5299 Ha
- SERVICE INDUSTRIAL / LIGHT INDUSTRIAL : 47.4740 Ha
- OFFICE PARK / BUSINESS PARK : 67.2593 Ha
- OPEN SPACE : 87.4257 Ha
- MIXED USE : 7.9813Ha

Dudley Pringle Dam
Tongaat
Tongaat Central WWTW
Existing Railway Line
Monument
Compensation Flats
R102
MR387
Existing Railway Line
MR445
RICHARDS BAY
Proposed future N2 link
N2 Freeway
DURBAN
Frasers Treatment Works
Avondale Reservoir
Zimbali
Ballito

VELAVKE

COMPENSATION FLATS

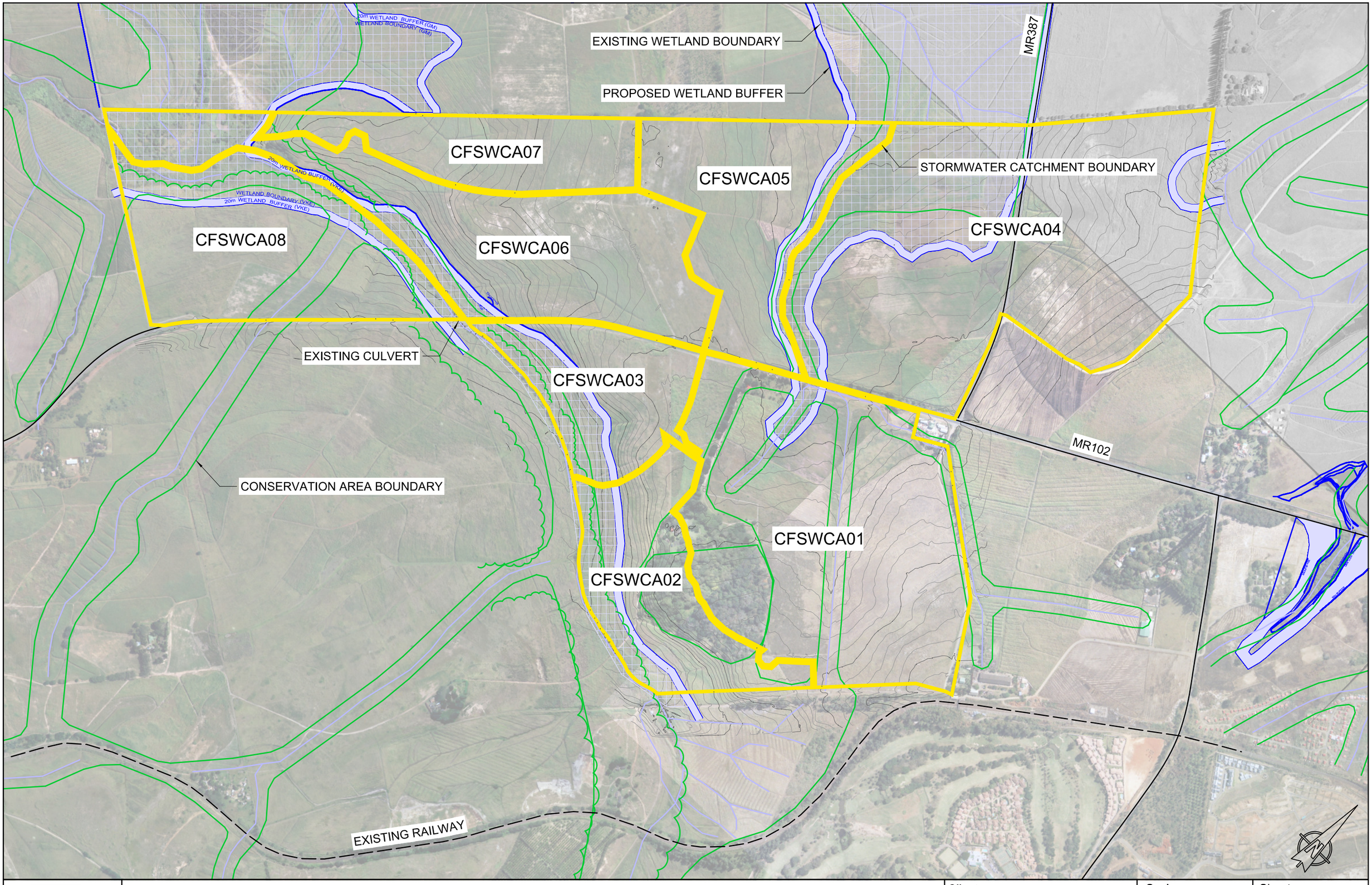
LOCALITY PLAN

Client: Tongaat Hulett DEVELOPMENTS

Scale: 1:30 000

Sheet: 1

Drawing No: DA894-GEN-03-THD



COMPENSATION FLATS

GENERAL LAYOUT - HYDROLOGY

VELAVKE

Client: Tongaat Hulett DEVELOPMENTS

Scale	Sheet
1:10000 (A3)	1

Drawing No: DA894-COMP-HYD-01