DRAINAGE IMPACT ASSESSMENT GUIDELINE[1]

1.0 Background

As the effects of climate change are becoming more and more pronounced, many countries are experiencing extreme climatic events around the globe. According to the Fifth Assessment Report[2] of the Intergovernmental Panel on Climate Change (IPCC) released in 2013, there is consensus that a climate shift will alter the frequency, intensity and temporal and spatial variability of rainfall, cyclones and tropical storms. Owing to the worsening tendency, it is most likely that its adverse impacts would be among the most serious hurdles in the achievement of sustainable development goals for vulnerable countries like Mauritius. In fact, according to the World Risk Report of 2017[3], Mauritius is ranked as the 13th country with the highest disaster risk and ranked 7th on the list of countries most exposed to natural hazards.

Indeed, rainfall events associated with the first quarter of the year 2018 has brought to light some 150[4] cases of water accumulation and flooding around Mauritius as well as in Rodrigues. The Mauritius Meteorological Services, in its monthly reports of January to April 2018 confirmed that these events are partly attributed to the adverse effects of climate change resulting in an increase in the frequency of high intensity rainfall events occurring over a relatively short span of time.

Moreover, a recent assessment carried out by the Ministry of Social Security, National Solidarity and Environment and Sustainable Development in relation to main causes of flooding and based on inputs provided by various organisation (all relevant government and parastatal bodies) revealed that floodings/ water accumulations are occurring as a result of high intensity rainfall events and a combination of the following factors which are *inter alia*:

(i) changes brought by new development in term of sealing of ground and reduction in surface area for percolation and ground water infiltration;
(ii) encroachment on floodplains of watercourses reducing carrying capacity of natural drains;
(iii) construction along natural drainage paths, areas which are ex-backfilled wetlands and areas with high water table;
(iv) hindrances to the performance of drainage systems like obstructions, siltation and encroachment by services amongst others, and
(v) Construction in low-lying areas without adequate drainage provisions.

Resolving the issue of flooding in Mauritius has become a national priority. In this context**,** the Government has come up with a series of measures including the proposal to introduce a Drainage Impact Assessment (DIA) as part of the Environment Impact Assessment (EIA) report for Morcellement projects, in line with paragraph 146 of the National Budget Speech for the Financial Year 2018-2019 which stipulates that "***The granting of morcellement permit will be reviewed with a provision for a Drain Impact Assessment to be undertaken as part of the EIA report"***.

[1]**DISCLAIMER:THIS IS NOT A LEGAL DOCUMENT. IT IS MEANT TO SERVE AS A GUIDELINE FOR PROPONENTS, PROMOTERS AND CONSULTANTS. THE GOVERNMENT IS NOT RESPONSIBLE FOR, AND EXPRESSLY DISCLAIMS ALL LIABILITY FOR, DAMAGES OF ANY KIND ARISING OUT OF THE USE OR REFERENCE TO ANY INFORMATION CONTAINED IN THIS GUIDELINE.**

[2]Intergovernmental Panel on Climate Change (IPCC), 2013, Fifth Assessment Report.

[3] World Risk Report 2017 - Focus: Food Security. Alliance Development Works (BündnisEntwicklungHilft – Gemeinsamfür Menschen in Not e.V.) and the United Nations University Institute for Environment and Human Security (UNU-EHS).

[4]Source : National Disaster Risk Reduction and Management Centre, excluding Rodrigues.

2.0 What is a Drainage Impact Assessment?

A Drainage Impact Assessment (DIA) demonstrates the drainage issues associated to a development project and corresponding solutions to provide a suitable drainage system. A DIA will be particularly important to assess the negative impacts, if any, of proposed land developments on the existing drainage infrastructure.[5]

Major issues such as the flood risk associated with the development site, the possibility of the development leading to increased flood risk elsewhere and how surface and ground water from the site will be managed pre- and post-development in a sustainable way, will be dealt with in the DIA.[6] In addition, the maintenance aspects will also be addressed in the DIA.

3.0 Purpose of Drainage Impact Assessment Guideline

The purpose of this Guideline is to assist Proponents, Promoters and Consultants in the preparation of the DIA and to ensure that a holistic catchment-based approach is adopted in the process of evaluating the impacts of a new development.

This document may also be used as guidance for conducting drainage assessment for other projects.

4.0 Methodology used for the development of the Guideline

Information contained in this guideline has been compiled by the Land Drainage Authority based on inputs and comments received from the National Development Unit, the Ministry of Social Security, National Solidarity and Environment and Sustainable Development, the Local Authorities, the Water Resources Unit, the Ministry of Housing and Lands and other concerned stakeholders. References have also been made to existing guides on the preparation of a Drainage Impact Assessment for countries such as the United Kingdom, Scotland and Hong Kong. As regards drainage design considerations, these have been formulated on the basis of recommendations put forward in various design guidance notes developed for the United Kingdom in particular.

5.0 Projects subject to a Drainage Impact Assessment

In line with the budgetary measure announced for the Financial Year 2018-2019, a full-fledged Drainage Impact Assessment (DIA) shall be submitted as part of the Environment Impact Assessment (EIA) report for Morcellement projects and other major land developments.

Accordingly, the DIA component will be incorporated as an Annex under Section 4.7 ‘Mitigation Measures’ of the “Proponent’s Guide to Environment Impact Assessment” available on the website of the Ministry of Social Security, National Solidarity and Environment and Sustainable Development.

[5] Flood Risk Assessment and Drainage Impact Assessment: Planning Guidance for Developers, May 2011, Development and Regeneration Services, Glasgow City Council, Scotland,<https://www.glasgow.gov.uk/CHttpHandler.ashx?id=6179&p=0>

[6] Flood Risk and Drainage Impact Assessment for new developments Technical Guidance, Moray Council, Scotland, <http://www.moray.gov.uk/downloads/file117329.pdf>

6.0 Contents of a Drainage Impact Assessment Report

In addition to the requirements as laid down in the EIA guidelines for Morcellement Projects, the DIA shall include the following:

6.1 Preliminaries

(i) A comprehensive site plan of appropriate scale[7] certified by a Sworn Land Surveyor and showing existing drainage infrastructure, natural watercourses and/or drains and water bodies, including wetlands and also longitudinal[8]and cross-sectional drawings of the watercourses and drains indicating peak water level, where applicable, for the development site and surrounding regions;

(ii) A contour plan of appropriate scale[7] certified by a Sworn Land Surveyor, for the development site and surrounding regions;

(iii) A map of appropriate scale[7] showing the delimitation and area of the overall catchment of the project site including the upstream catchment that is likely to affect the project site and the downstream catchment that is likely to be affected by the new development;

(iv) Project site's vulnerability to flooding based on records (testimonies from local residents and/or information gathered from the media, amongst others) of past flooding which occurred within or adjacent to the project site[9];

(v) A full Geotechnical Investigation report may be requested by concerned stakeholders in cases of areas prone to or suspected to be prone to flooding, landslide or other hazards such as rockfall as well as in case of cavernous areas.

In the preparation of the above, the Proponent may consult the Ministry of Housing and Lands, the Ministry of Public Infrastructure and Land Transport (Geo-Technical Unit), the Water Resources Unit, the Local Authorities, the National Disaster Risk Reduction and Management Centre and other relevant authorities.

6.2 Drainage Design Considerations[10]

(i) Details on the derivation of all design parameters used with supporting documentation including codes of practice and reference materials used, assumptions made and limitations;

[7]Based on the extent of the Development, concerned Authorities may request the Proponent to submit a plan of the required scale.

[8] With respect to river bed as well as water levels for mean and peak flow conditions

[9]Application of the Drainage Impact Assessment process to private sector projects, September 2010, Drainage Services Department, Hong Kong, <https://www.dsd.gov.hk/EN/Files/Technical_Manual/dsd_guideline/Advise_Note_1.pdf>

[10]Woods Ballard, B., Wilson, S., Udale-Clarke, H., Illman, S., Scott, T., Ashley, R. and Kellagher, R., 2015. The SuDS Manual (C753). *CIRIA, London, UK*, <http://www.scotsnet.org.uk/documents/NRDG/CIRIA-report-C753-the-SuDS-manual-v6.pdf>

Note:

a. Recommended Return Periods:

S.N	Infrastructure	Minimum Rainfall Return Period[11] (years)
1.	Drains	25
2.	Discharge into watercourses (including Feeders, Rivulets, Rivers)	50
3.	Culverts	50
4.	Bridges	100

Depending on the region under consideration and its vulnerability to flooding, the concerned Local Authority may request for an increase in return period.

b. Details on source and limitation of Intensity Duration Frequency (IDF) curve and rainfall data used in the design and method used for determining the time of concentration to be included in submission;

c. Details on methodology adopted to determine the run-off coefficients need to be specified, taking into consideration changes inland use, soil saturation and extreme rainfall events, inter alia.

There are various studies that have been carried out to establish run-off coefficients and different methodologies exist for the determination of run-off coefficients. Two such studies are illustrated below.

1) David B. Thompson, an American Civil Engineer and surface water hydrologist developeda Paperfor the Civil Engineering Department of the Texas Tech University on the Rational Method[12], a very popular method to calculate the peak discharge for small catchment areas. The table below is an extract from the Paper with some recommended range of values for the run-off coefficient based on the American Society of Civil Engineers (ASCE) manual of practice:

General runoff coefficients for the Rational Method

Description	Runoff Coefficient
Business	
Downtown Areas	0.70 - 0.95
Neighbourhood Areas	0.50 - 0.70
Residential	
Single-Family	0.30-0.50
Multi-family detached	0.40-0.50
Multi-family attached	0.60–0.75
Residential Suburban	0.25-0.40
Apartments	0.50-0.70

[11]Higher return periods are recommended for regions with known vulnerabilities to flooding.

[12]Thompson David B. 2006, The Rational Method, Civil Engineering Department, Texas Tech University, <http://drdbthompson.net/writings/rational.pdf>

Parks, cemeteries	0.10-0.25
Playgrounds	0.20-0.35
Railroad yards	0.20-0.40
Unimproved areas	0.10-0.30
Drives and Walks	0.75-0.85
Roofs	0.75-0.95
Streets	
Asphalt	0.70-0.95
Concrete	0.80-0.95
Brick	0.70-0.85
Lawns; sandy soils	
Flat, 2 % slopes	0.05-0.10
Average, 2 %-7% slopes	0.10-0.15
Steep,, 7 slopes	0.15-0.20
Lawns; heavy soils	
Flat, 2 % slopes	0.13-0.17
Average, 2 % -7% slopes	0.18-0.22
Steep, 7% slopes	0.25-0.35

2) On the other hand, in his paper "Drain Design for Dry feet[13]" published in the Journal of the Institution of Engineers Mauritius, Associate Professor V. Proag recommended the value 1 for the run-off coefficient in tropical countries like Mauritius.

High intensity rainfall events are becoming more and more frequent and as a consequence, areas which were not necessarily considered to be flood prone in the past, are being flooded over a short span of time. In fact, rapid soil saturation is being observed. A few examples of such regions are Rivière du Rempart village, Baie du Tombeau and a few localities in Port Louis (Les Casernes area, surroundings of La Poudrière Street, inter alia), where high intensity rainfall events over a very short span of time are causing existing drains to be overflowed and the regions to be flooded.

Considering the above, choice of small values for the run-off coefficient will have to be appropriatelyjustified.

(ii) Supporting calculations accompanied by drawings, to assess the impact of run off from the catchment upstream of the project site and the need for any cut-off drain;

(iii) Pre-development assessment of the impact of surface run-off from the catchment upstream of the project site up to the proposed outlet downstream of the site, supported by calculations and drawings;

(iv) Supporting calculations accompanied by drawings, to assess the adequacy of the proposed drainage system within the project site;

[13]Proag V. 2013, Drain Design For Dry Feet. The Journal of The Institution of Engineers Mauritius, University of Mauritius, <http://www.iemauritius.com/upload/files/drain_design_(proag).pdf>

(v) Supporting calculations accompanied by drawings, to assess the adequacy of the proposed discharge point and existing drainage system downstream of the project site up to the final outlet. In this respect, appropriate drainage works including any upgrading works and offsite works required need to be undertaken at the Promoter's cost. Survey of existing canals/drainage system shall also be included.

(vi) Design for drainage exceedance showing ground conveyance, flood pathways and flood routing to appropriate areas to allow runoff from extreme rainfall events to drain from the project site effectively.[14]

(vii) The concerned authorities may request the Proponents to submit any other information related to land drainage issues in addition to the above for verification and assessment purposes.

6.3 Maintenance of Drainage Infrastructure

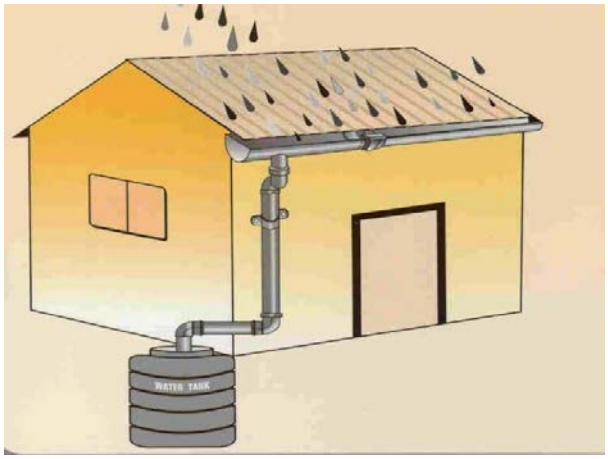
Proposed drainage network shall be designed to be maintenance-friendly and shall, where practicable, make use of structures such as filters and silt traps within the drainage system for the removal of debris and deposits from surface run-off.

Modalities for vesting of the new drainage infrastructures to the concerned authorities shall also be detailed The Proponent shall consult the Local Authority concerned for a Maintenance Agreement in respect of the new drainage infrastructures prior to vesting to the latter.

[14] Balmforth, D., 2006.*Designing for exceedance in urban drainage: good practice*. London: CIRIA, <http://observatoriaigua.uib.es/repositori/suds_ciria_12.pdf>

6.4 Examples of Sustainable Drainage Practices to mitigate flooding

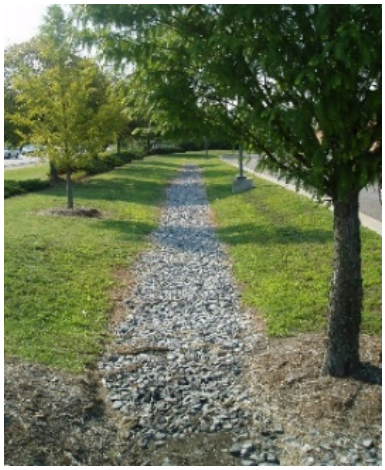
Adoption of sustainable urban drainage practices as attenuation measures are encouraged. The implementation of rainwater harvesting facilitiesand the provision for permeable surfaces such as pervious pavements, green spaces, green roofs, soakaways, infiltration trenches and swales, amongst others are recommended[15], where appropriate.

Good Practices	DOs (√)	DONTs (X)
Green Roofs/ Green Spaces[16]	 	
Rain water Harvesting[17]		 

[15]A simple guide to Sustainable Drainage Systems for housing, July 2010, NHBC Foundation, United Kingdom, <http://geosmartinfo.co.uk/wp-content/uploads/LA-Guidance-SuDS/England/NHBC_An-introduction-to-Sustainable-Drainage-Systems.pdf>

[16]What is a "Green Roof" and are they helpful to the environment?, Soil Science, Society of America, accessed 27 September 2018,<https://soilsmatter.wordpress.com/2018/05/01/what-is-a-green-roof-and-are-they-helpful-to-the-environment>, New urban development bill threatens green spaces in Bangalore, 99acres, India's No.1 Property Portal, accessed 18 October 2018, <https://www.99acres.com/articles/new-urban-development-bill-threatens-green-spaces-in-bangalore-nid.html>and Help Us Save the Old South Philly Tree on South 2 Street,Saveold2sttree.org,United States of America, accessed 27 September 2018, <http://www.saveold2sttree.org/tree-and-green-space-haters-in-philly>

[17]Rainwater harvesting from rooftops, ClimateTechWiki, A clean Technology Platform, accessed 27 September 2018, <http://www.climatetechwiki.org/content/rainwater-harvesting-rooftops>, Building a Rain Barrel, City of Dubuque, Mississippi, accessed 27 September 2018, <https://www.cityofdubuque.org/1192/Rain-Barrel>and GoWatertown.net, news from Watertown in South Dakota, accessed 27 September 2018, <https://www.gowatertown.net/2018/02/10/cape-town-welcomes-much-needed-rain-but-day-zero-still-looms/>

Good Practices	DOs (√)	DONTs (X)
Infiltration trenches/Swales[18]	 	 

7.0 IMPORTANT NOTE

(i) The DIA report should be signed by a Registered Professional Civil Engineer from the Council of Engineers of Mauritius.

(ii) The above list of requirements is by no means exhaustive and should be complemented with the provisions under other relevant Acts and regulations. Additional information may also be requested by concerned stakeholders.

(iii) This is the first version of the DIA Guideline, prepared by the Land Drainage Authority and the Ministry of Social Security, National Solidarity and Environment and Sustainable Development in consultation with the National Development Unit, the Ministry of Housing and Lands, the Ministry of Public Infrastructure and Land Transport, the National Disaster Risk Reduction and Management Centre, the Local Authorities, the Road Development Authority and the Water Resources Unit. The concerned authorities may revise the Guideline should the need arise.

[18] ChesapeakStormwater Network, accessed 27 September 2018, <https://chesapeakestormwater.net/tag/infiltration/>,Despreraonic.info, accessed 27 September 2018,<http://despreraonic.info/swales-drainage/>, Concrete Drainage Swale, Enterprise Commercial Paving, Houston, accessed 30 October 2018, <https://www.ecpaving.com/project/concrete-drainage-swale>,Source: National Disaster Risk Reduction and Management Centre.