Eskom	Standard	Technology

Title: **STANDARD FOR SUBSTATION FLOOD ANALYSIS DESIGN**

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Compiled by	Approved by	Authorized by
Zinhle Mkhize	**Andile Maneli**	**Subhas Maharaj**
Substation Civil Designer	**Middle Manager – Substation Civil Design**	**Senior Manager – Substation Engineering**
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Supported by SCOT/SC

Subhas Maharaj

SCOT/SC Chairperson

Date: 20/7/2022

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SCOT Study Committee Number/Name: **<Substations>**

Content

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1. Introduction

This procedure deals with the flood analysis design calculations in Transmission substation sites.

2. Supporting Clauses

2.1 Scope

2.1.1 Purpose

The standard for substation flood analysis presents clear and concise technical requirements, policies, and processes to enable design professionals to prepare designs and specifications necessary for development of flood analysis designs for Eskom substations. This document is not to be considered complete nor is it a substitute for the methods described in the SANRAL Drainage Manual, or other applicable laws. Should any conflicts arise between the information contained herein and the SANRAL Drainage Manual, the information contained within the SANRAL Drainage Manual shall govern.

2.1.2 Applicability

This document shall apply throughout Eskom Holdings Limited Divisions.

2.2 Normative/Informative References

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs.

2.2.1 Normative

[1] ISO 9001 Quality Management Systems.

[2] 240-53113685: Design Review Procedure

[3] 240-53114002: Engineering Change Procedure

[4] 240-48929482: Tender Evaluation Procedure

[5] 240-4332798: Engineering Policy

2.2.2 Informative

[6] SANS 1200 – Standards

[7] SANRAL Drainage Manual (2013). Pretoria; South Africa National Road Agency Ltd

[8] Chadwick, Andrew, John Morfett, and Martin Borthwick (2004). Hydraulics in Civil and Environmental Engineering. London: Spon

[9] John S Scott, A Dictionary of Civil Engineering. Penguin Reference Books

[10] TR102, P T Adamson, Southern African storm rainfall, DWA, 1981

[11] Haested Methods, Computer Applications in Hydraulic Engineering, 7th Ed, Bentley, 2007

[12] Schmidt, E.J. & Schulze, R.E. (1987) SCS-Based Design Run-off.

2.3 Definitions

2.3.1 General

Definition	Description
Catchment Area	A geographical area from which rainfall flows into a river, lake or reservoir.
Contract Documents	Documents prepared by the owner and project engineer for bidding and for awarding a project; can include bid forms, general conditions, special conditions, technical specifications, drawings, geotechnical data reports, and geotechnical baseline reports
Culvert	A covered channel or pipe for carrying stormwater below ground level, usually under a road or railway.
Manning's Formula	An equation for the value of coefficient c in the Chezy Formula, the factors of which are the hydraulic radius and a coefficient of roughness; an equation itself used to calculate flows in gravity channels and conduits.
Permit	The written authorization required pursuant to the Ordinances, rules and regulations of the Agency or applicable District, prior to the installation or construction of specific sewage works under specific conditions at specific locations, or the use of any public sewers.
Peak discharge	The maximum flow rate during the flood.
Runoff	That part of precipitation carried off from the area upon which it falls. Also, the rate of surface discharge of the above. That part of precipitation reaching a stream, drain or sewer.
Storm	A rainfall event.
Time of Concentration	The required time for a storm of a uniform area and temporal distribution to contribute to the run-off from the catchment.

2.3.2 Disclosure Classification

Controlled Disclosure: Controlled Disclosure to External Parties (either enforced by law, or discretionary).

2.4 Abbreviations

Abbreviation	Description
CMD	Construction Management Department
CoE	Eskom's Centre of Excellence
DEA	Department of Environmental Affairs
DWA	Department of Water Affairs
EDWL	Engineering Work Delivery Unit Manager
LPE	Lead Project Engineer
NWA	National Water Act
MAR	Mean Annual Rainfall
PDD	Project Development Department
PEM	Project Engineering Manager
SANRAL	South African National Roads Agency Limited
SANS	South African National Standards
TDAC	Technical Document Authorization Committee
TR	Technical Report

2.5 Roles and Responsibilities

2.5.1 The Role of a Centres of Excellence (CoE)

The role of the Engineering CoE is provided below:

- Apply its expertise, skill and processes to produce a high quality output of exceptional standards in line with the organizational requirement;
- Assist in providing project activities and man hours for project preplanning and
- Provide engineering resources to perform the engineering effort.

2.5.2 The Engineering Design Work Lead

The EDWL has the following reporting lines:

- Accountable for the strategy and all design related activities to the Plant Engineering General Manager. The Centre of Excellence Engineering Manager will prepare, review, assess and score the performance contract of the EDWL.
- The EDWL is appointed by the Engineering Work Delivery Unit Manager in conjunction with the relevant Centres of Engineering Excellence and Authorised by the Plant Engineering General Manager (GM).
- Reports to the Project Engineering Practitioner for technical delivery achieved to baseline scope, schedule and cost.

2.5.3 The Project Engineering Manager

The Project Engineering Manager (PEM) has the following reporting lines:

- Accountable for the schedule, scope and cost of engineering activities. The Project Engineering Area/Portfolio Senior Manager will also prepare, review, assess and score the performance contract of the PEM.
- The PEM is appointed by the Project Engineering Senior Manager and Authorised by the Project Engineering General Manager (GM).
- Reports to the PDD or CMD Manager for engineering delivery achieved to baseline scope, schedule and cost.

2.5.4 The Project Engineering Controls

The Project Engineering Controls should know the functionality and requirements associated with developing a proper basis of estimate, Cost breakdown structure, level II scheduling, direct and indirect costing, Parametric and factoring approaches. Must be able to produce and communicate the methodology used to arrive at the man hours and costs associated with the estimates. The candidates must have knowledge and hands-on experience with Cost Breakdown Systems (CBS), cost reporting, trend/change management, budget control, forecasting (multiple methods).

2.5.5 The Lead Discipline Engineer

The LDE has the following reporting lines:

- Accountable for all design related activities to the Centre of Excellence Engineering Manager. The Centre of Excellence Engineering Manager will also prepare, review, assess and score the performance contract of the LDE.
- Reports to the Engineering Design Work Lead (EDWL) for day to day activities, service delivery and logistics. However leave requests will be addressed with the Centre of Excellence Engineering Manager.

2.6 Process for monitoring

Monitoring and maintenance of the culverts is to be done by the owner of the substation.

2.7 Related/Supporting Documents

None

3. Flood Analysis for Substations standard

3.1 Design standards for flood analysis

3.1.1 Objective

The objective for this specification is to ensure all flood analysis calculations are approached and designed according to South African codes and Legislation. This will also standardise all flood peak calculations and designs for Eskom substations.

The design activity is concerned with calculating flood peaks and risks for hydraulic structures and specified flood return periods. No flood analysis studies will be necessary if the pre-selected site is not located in close proximity to a natural stream or river.

3.1.2 Codes and Legislation

The following policies, codes and legislation are used during any flood analysis design (see 1) and should be considered as it impacts design flood peaks planning.

Table 1: Codes and legislation needed for flood analysis designs

Description	Policy, Code and Legislation
Constitution of the Republic of South Africa	Act No 108 of 1996
National Water Act (NWA)	Act No 36 of 1998
Environmental Conservation Act	Act No 73 of 1989
National Roads Act	Act No 54 of 1971
Conservation of Agricultural Resources	Act No 43 of 1983
SANRAL Drainage Manual 6th Edition	ISBN 978-0-620-55428-2

3.1.3 Design Process

The flood analysis for substations specification will discuss the process to follow when calculating flood peaks and sizing culverts. 1 illustrates the process to follow when performing a flood analysis.

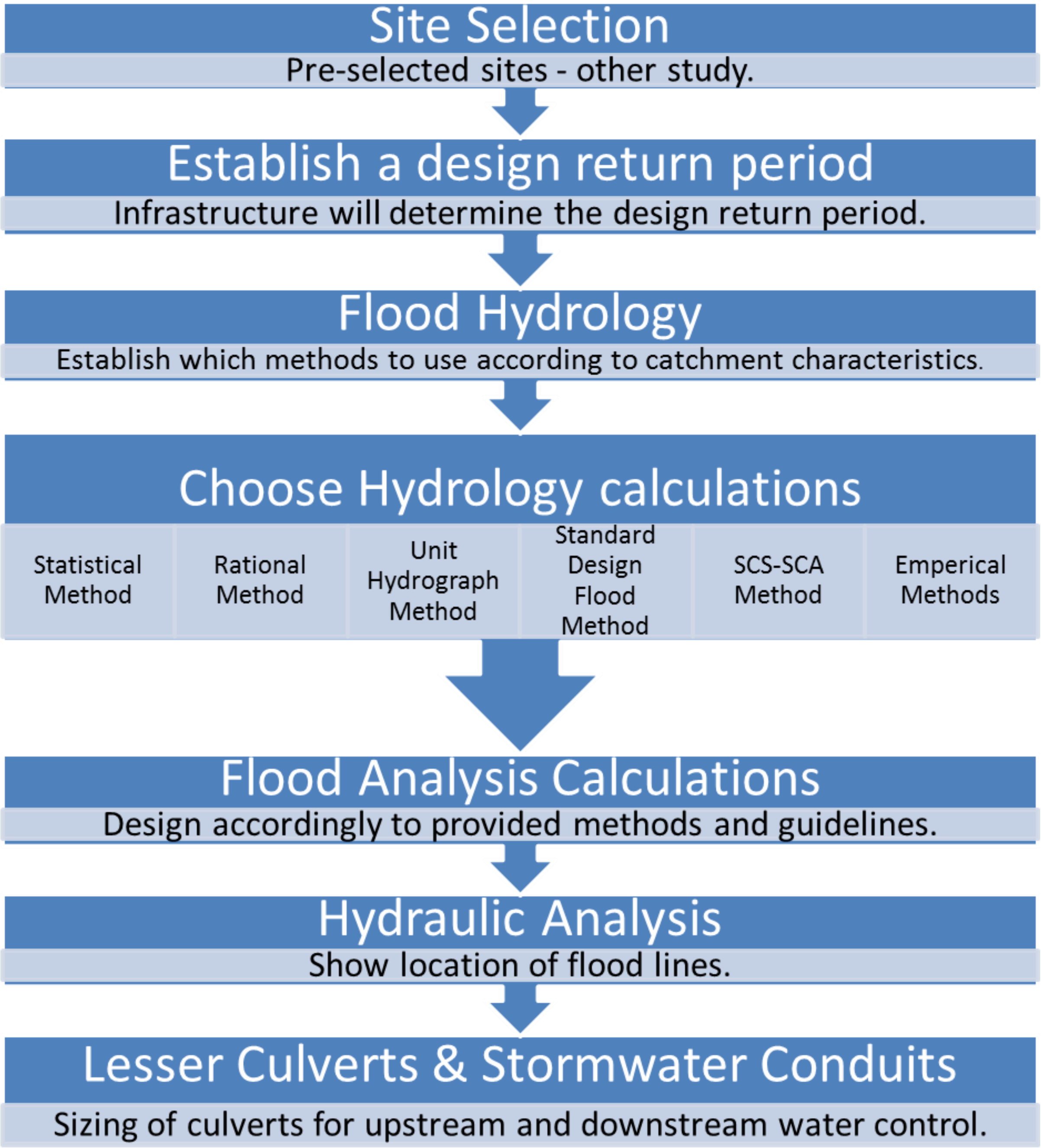

Figure 1: Design process flow diagram for flood analysis

3.1.3.1 Site Selection

At least three potential sites will be pre-selected in a site selection study. When one or more of these sites are located in close proximity to a water source, natural stream or river it will require a flood analysis study.

3.1.3.2 Design Period

Risks of floods are measured according to likelihood and consequences. The Department of Environmental Affairs dictates that the design flood recurrence interval will be chosen as 100 years. This will enable a flood peak calculation design to accommodate the worst case scenario due to the high value of the infrastructure. This will also enable minimum loss of service.

3.1.3.3 Catchment Hydrology

When performing a flood analysis design, the study will include rainfall, flow and flood hydrology studies. There are a few methods available to design the flood peaks. These methods have been developed for certain regions and flood events. 2 lists the methods, input data required and maximum catchment areas needed to design the flood peaks. The SANRAL Drainage Manual should be used to calculate the flood peaks as all the methods are described in full detail.

Table 2: Application and limitations of flood peak calculation methods (SANRAL Drainage Manual, 2013)

Method	Input Data	Recommended maximum area (km^2)	Return period of flood that could be determined (years)
Statistical Method	Historical flood peak records are used	No limitation (large areas)	2-200 (depending on the record length)
Rational Method	Catchment area, watercourse length, average slope, catchment characteristics, rainfall intensity	< 15	2-200, PMF
Alternative Rational Method		No limitation	
Unit Hydrograph Method	Design rainfall, catchment area, watercourse length, length of catchment centroid, MAP, veld type and synthetic regional unit hydrograph	15 to 5000	2-100, PMF
Standard Design Flood Methods (SDF)	Catchment area, watercourse length, slope and SDF basin number	No limitations	2-200
Empirical Methods	Catchment area, watercourse length, distance to catchment centroid, MAP	No limitations (larger areas)	10-100, RMF

3.1.3.4 Flood Peak Calculations

The flood peaks can be calculated step by step using Appendix 3C of the SANRAL Drainage Manual. The Design Rainfall and Flood estimation in South Africa (TR 102) must be used in conjunction with the SDF Method. The input data available will normally dictate which method of calculations to be used. The Rational and Alternative Rational methods are normally the preferred method of calculations for substation designs. The calculation sheets for both these methods can be found in Appendix B. The factors required within the calculation process will be explained within this chapter.

3.1.3.4.1 Catchment Size

Topographical maps (1:50 000) are generally used to determine the size of a specific catchment area. For smaller catchment areas, the contour levels on a 1:50 000 map will not be sufficiently accurate, so a 1:10 000 map will be preferred. Google Earth and a Site Survey will also assist in easing the task. The measurement of the catchment size can be assisted by using a measuring tool on a computer drawing program (Microstation).

3.1.3.4.2 Longest Watercourse

The longest natural water stream or river can be measured by using the 1:50 000 topographical maps or the measuring tool on Google Earth, as soon as the catchment size has been determined.

3.1.3.4.3 Average slope

The US Geological Survey's 1085 method is the preferred method to determine the slope of the longest watercourse within the catchment. The following formula will be used to determine the slope:

$$S_{av} = \frac{H_{0.85L} - H_{0.10L}}{(1000)(0.75L)}$$

where: S_{av} = average slope (m/m)

$H_{0.10L}$ = elevation height at 10% length of the watercourse (m)

$H_{0.85L}$ = elevation height at 85% length of the watercourse (m)

L = length of watercourse (km)

3.1.3.4.4 Run-off Coefficient

As stated in chapter 3 in the SANRAL Drainage Manual the run-off coefficient is an integrated value that characterises the factors influencing the rainfall-run-off relationship. It returns the storm rainfall contributing to the peak flood run-off at the catchment outlet. The determination of the C value is not very theoretical and it is very subjective and engineering experience plays a role in the successful application of the method.

A table of recommended C-values can be found in chapter 3 of the SANRAL Drainage Manual. The main factors affecting the C-value in rural areas will be the slope of the catchment, soil permeability, vegetation, MAR and the return period (use 1:100). There are classification guidelines in the Drainage Manual that can be used to determine the permeability, where information from the Geotechnical report or soil maps can be used in the determination process. The Drainage Manual also provides reduction factors in this same chapter that should be applied to areas where Dolomite can be found. The vegetation in the area should be inspected on site to make an accurate determination of the C-value correlating to vegetation. Chapter 3 in the SANRAL Drainage Manual gives a step by step explanation on determining all the above mentioned factors.

3.1.3.4.5 Mean Annual Rainfall (MAR)

The SDF method requires using the TR102 data measured at several different weather stations throughout the country. The Drainage Manual suggests that 2 be used to determine the MAR for a specific area. The Interactive South African Rain Atlas available at: http://134.76.173.220/rainfall/index.html is a good database of information that can be used. The SCS-Based Design run-off Appendices also includes weather station data.

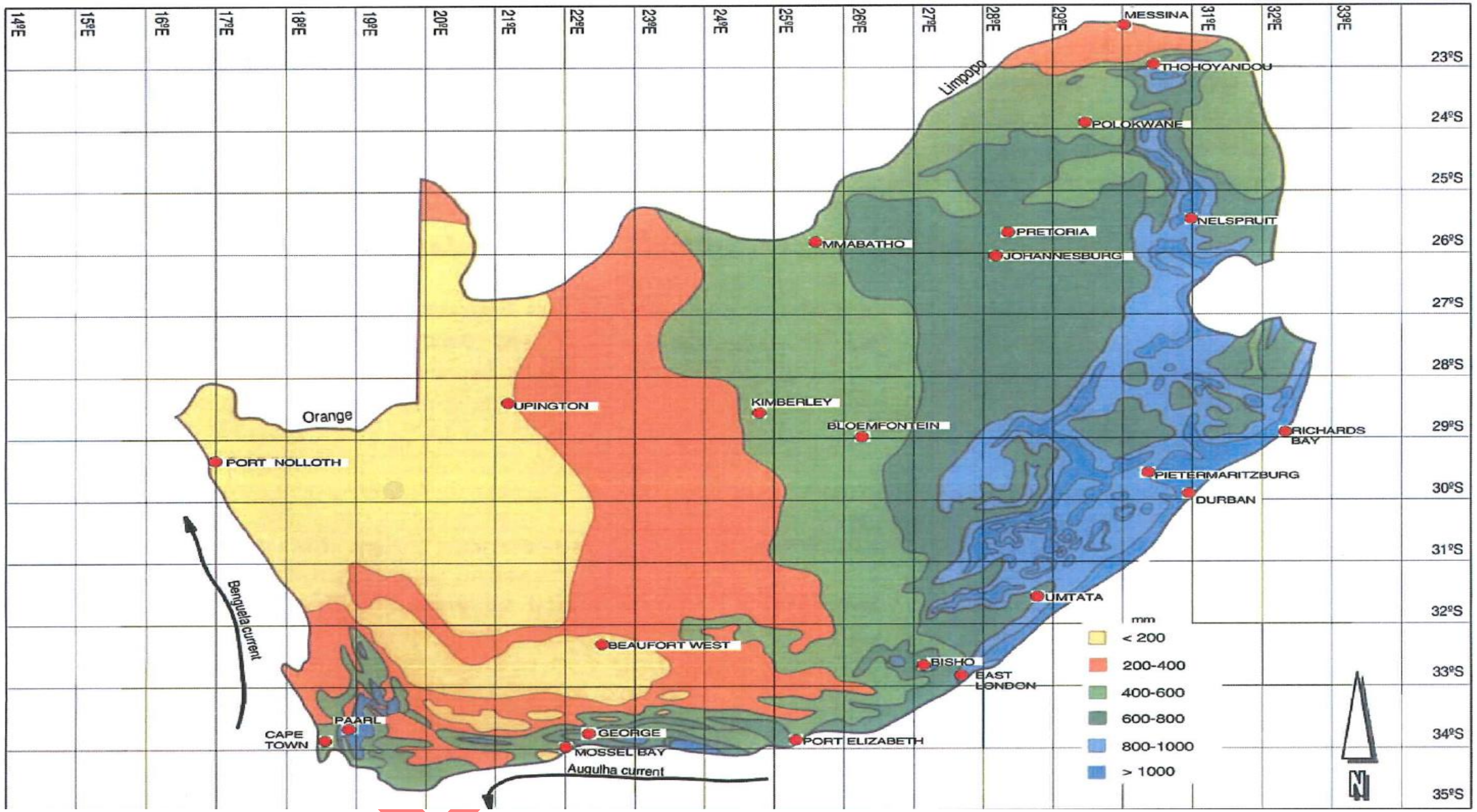

Figure 2: Average annual rainfall in South Africa

3.1.3.4.6 Time of Concentration

The time of concentration is defined as the time required for a storm of uniform area to contribute to the run-off from a catchment. The following empirical formula, as developed by the US Soil Conservation Services, is used to determine the time of concentration of the catchment area for a defined watercourse:

$Tc = (0.87L^2/1000S_{av})^{0.385}$

where: T_c = time of concentration (hours)

L = length of watercourse (km)

S_{av} = average slope (m/m)

If the flow within the catchment area cannot be classified within a natural stream or defined watercourse, the Drainage Manual also has the Kerby Formula that can be used for overland flow for fairly even slopes.

3.1.3.4.7 Point Rainfall

Table 3C.6 in the Drainage Manual provides selection criteria based on the Time of Concentration with a corresponding calculation method to determine the Point Rainfall. It ranges between using the Modified Hershfield equation and using point rainfall data from the TR102 documents. Figure 3.6 in the Manual can also be used to determine the point rainfall by performing linear interpolation and using the Time of Concentration, MAR and return period. The point intensity can be determined by dividing the point rainfall with the time of concentration.

3.1.3.4.8 Average Intensity

The average storm intensity is determined by calculating an area reduction factor (based on the time of concentration) and multiplying it with the point rainfall, as shown in chapter 3 in the Drainage Manual.

Peak Flow

Finally the peak flow for each of the required return periods (1:100) can be calculated using this linear relationship:

$$Q_T = \frac{C_T I_T A}{3.6}$$

where: Q_T = peak flow rate for T-year return period (m^3/s)

C_T = combined run-off coefficient for T-year return period

I_T = average rainfall intensity over catchment for T (mm/h)

A = effective area of catchment (km^2)

3.6 = conversion factor

A flood analysis design report must also be provided that shows all assumptions, simulated scenarios and chosen approaches. The report must also reference the specific calculation methods chosen. Ideally, more than one calculation method can be applied.

3.1.3.5 Hydraulic analysis

Hydraulic analysis can be performed by approaching the problem as an open system channel and using Manning's hydraulic equation to determine the location of the flood lines. This will only be a necessity if the natural stream or river is in very close proximity to the proposed site and a survey must be available of the river basin.

Manning's Equation:

$$Q = \frac{1 . A^{5/3} . S_0^{1/2}}{n \quad P^{2/3}}$$

where: n = Manning's roughness coefficient (used as 0.03)

A = Cross-sectional Area of flow (m^2)

P = Wetted Perimeter (m)

S_0 = Slope of river (m/m)

Q = Flow capacity (m^3/s)

The flow capacity is calculated by using any method mentioned in the Drainage Manual. The cross-sectional area and wetted perimeter can be obtained from sections taken from the survey done through the river basin. The more sections used in calculations, the more accurately the flood lines can be depicted on a drawing.

3.1.3.6 Lesser Culverts & Stormwater Conduits

All natural streams and/or water courses, mostly crossed by substation access roads, will require stormwater pipes or lesser culverts to ensure that the natural water path remains undisturbed. Upstream and downstream control volumes will be taken into consideration when sizing these structures. Chapter 7 in the SANRAL Drainage Manual provides a systematic process that can be followed to design and size lesser culverts and stormwater conduits. If needed, chapter 8 includes information regarding bridges and major culverts.

3.1.4 Design Computations and Report

A design report shall be prepared containing the following information as a minimum:

a) The results of site selection study;

b) A geotechnical summary of soil conditions (if available);

c) Short outline of the design methods applied and chosen methods;

d) All calculation results and

e) Recommendation on preferred sites that will be safe in terms of flooding.

If possible, more than one method must be used to calculate the flood peaks.

4. Authorisation

This document has been seen and accepted by:

Name and surname	Designation
NP Tlhatlhetji	Senior Manager Substations Engineering
DJC Senekal	Senior Technologist Substations Engineering

5. Revisions

Date	Rev	Compiler	Remarks
July 2022	Final	Zinhle Mkhize	No Revision Required

6. Development team

The following people were involved in the development of this document:

- Christine Schutte
- Zinhle Mkhize

7. Acknowledgements

Not applicable.

Annex A –

WEB2P

RATIONAL METHOD

Description of catchment			
River detail			
Calculated by		**Date**	

Physical characteristics

Size of catchment (A)		km²	Rainfall region		
Longest watercourse (L)		km	**Area distribution factors**		
Average slope (S_{av})		m/m	Rural (α)	Urban (β)	Lakes (γ)
Dolomite area ($D_{\%}$)		%			
Mean annual rainfall (MAR)⓪#		mm			

Rural①				**Urban②**			
Surface slope	**%**	**Factor**	**C_s**	**Description**	**%**	**Factor**	**C_2**
Vleis and pans				**Lawns**			
Flat areas				Sandy, flat (<2%)			
Hilly				Sandy, steep (>7%)			
Steep areas				Heavy soil, flat (<2%)			
Total	100	-		Heavy soil, steep (>7%)			
Permeability	**%**	**Factor**	**C_p**	**Residential areas**			
Very permeable				Houses			
Permeable				Flats			
Semi-permeable				**Industry**			
Impermeable				Light industry			
Total	100	-		Heavy industry			
Vegetation	**%**	**Factor**	**C_v**	**Business**			
Thick bush and plantation				City centre			
Light bush and farm-lands				Suburban			
Grasslands				Streets			
No vegetation				Maximum flood			
Total	100	-		Total (C_2)	100	-	

Time of concentration (T_C)		Notes:
Overland flow③	Defined watercourse	
$T_C = 0{,}604\left(\frac{rL}{\sqrt{S_{av}}}\right)^{0{,}467}$	$T_C = \left(\frac{0{,}87L^2}{1000S_{av}}\right)^{0{,}385}$	
hours	hours	

Run-off coefficient

Return period (years), T	**2**	**5**	**10**	**20**	**50**	**100**	**Max**
Run-off coefficient, C_1 ($C_1 = C_S + C_P + C_V$)							
Adjusted for dolomitic areas, C_{1D} ($= C_1(1 - D_{\%}) + C_1 D_{\%}(\sum(D_{factor} \times C_{S\%}))$)④							
Adjustment factor for initial saturation, F_t⑤							
Adjusted run-off coefficient, C_{1T} ($= C_{1D} \times F_t$)							
Combined run-off coefficient C_T ($= \alpha C_{1T} + \beta C_2 + \gamma C_3$)							

Rainfall

Return period (years), T	**2**	**5**	**10**	**20**	**50**	**100**	**Max**
Point rainfall (mm), P_T⑥							
Point intensity (mm/hour), P_{IT} ($= P_T/T_C$)							
Area reduction factor (%), ARF_T⑦							
Average intensity (mm/hour), I_T ($= P_{IT} \times ARF_T$)							
Return period (years), T	**2**	**5**	**10**	**20**	**50**	**100**	**Max**
Peak flow (m³/s), $Q_T = \frac{C_T I_T A}{3{,}6}$							

Note: # Reference to the appropriate figures and tables is made in the legend table of this method.

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RATIONAL METHOD

LEGEND TABLE Rational method	
ID	**Reference**
⓪	Figure 3.7
①	Table 3C.1
②	Table 3C.2
③	Table 3C.3
④	Table 3C.4
⑤	Table 3C.5
⑥	Figure 3.6
⑦	Figure 3.20 or 3.21

Table 3C.1

Rural (C_1)

Component	Classification	Mean annual rainfall (mm)		
		600	**600 - 900**	**900**
Surface slope (C_S)	Vleis and pans (<3%)	0,01	0,03	0,05
	Flat areas (3 to 10%)	0,06	0,08	0,11
	Hilly (10 to 30%)	0,12	0,16	0,20
	Steep areas (>30%)	0,22	0,26	0,30
Permeability (C_P)	Very permeable	0,03	0,04	0,05
	Permeable	0,06	0,08	0,10
	Semi-permeable	0,12	0,16	0,20
	Impermeable	0,21	0,26	0,30
Vegetation (C_V)	Thick bush and plantation	0,03	0,04	0,05
	Light bush and farm-lands	0,07	0,11	0,15
	Grasslands	0,17	0,21	0,25
	No vegetation	0,26	0,28	0,30

Table 3C.2

Urban (C_2)

Use	Factor
Lawns	
Sandy, flat (< 2%)	0,05 - 0,10
Sandy, steep (>7%)	0,15 - 0,20
Heavy soil, flat (< 2%)	0,13 - 0,17
Heavy soil, steep (>7%)	0,25 - 0,35
Residential areas	
Houses	0,30 - 0,50
Flats	0,50 - 0,70
Industry	
Light industry	0,50 - 0,80
Heavy industry	0,60 - 0,90
Business	
City centre	0,70 - 0,95
Suburban	0,50 - 0,70
Streets	0,70 - 0,95
Maximum flood	1,00

Table 3C.3

Surface description	Recommended value of r
Paved areas	0,02
Clean compacted soil, no stones	0,1
Sparse grass over fairly rough surface	0,3
Medium grass cover	0,4
Thick grass cover	0,8

Table 3C.4

Adjustment factor to C_s

Surface slope classification	D_{factor}
Steep areas (slopes >30%)	0,50
Hilly (10 to 30%)	0,35
Flat areas (3 to 10%)	0,20
Vleis and pans (slopes <3%)	0,10

Table 3C.5

Return period (years)	2	5	10	20	50	100
Adjustment factor (F_t) for steep and impermeable catchments	0,75	0,80	0,85	0,90	0,95	1,00
Adjustment factor (F_t) for flat and permeable catchments	0,50	0,55	0,60	0,67	0,83	1,00

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ALTERNATIVE RATIONAL METHOD

Description of catchment			
River detail			
Calculated by		**Date**	

Physical characteristics						
Size of catchment (A)		km²	Days of thunder per year (R)②		days/year	
Longest watercourse (L)		km	Weather Service station⑩			
Average slope (S_{av})		m/m	Weather Service number⑩			
Dolomite area ($D_{\%}$)		%	**Area distribution factors**			
Mean annual rainfall (MAR)⓪#		mm	Rural (α)	Urban (β)	Lakes (γ)	
2-year return period rainfall (M) ①		mm				

Rural③				**Urban④**			
Surface slope	**%**	**Factor**	**C_s**	**Description**	**%**	**Factor**	**C_2**
Vleis and pans				**Lawns**			
Flat areas				Sandy, flat (<2%)			
Hilly				Sandy, steep (>7%)			
Steep areas				Heavy soil, flat (<2%)			
Total	100	-		Heavy soil, steep (>7%)			
Permeability	**%**	**Factor**	**C_p**	**Residential areas**			
Very permeable				Houses			
Permeable				Flats			
Semi-permeable				**Industry**			
Impermeable				Light industry			
Total	100	-		Heavy industry			
Vegetation	**%**	**Factor**	**C_v**	**Business**			
Thick bush and plantation				City centre			
Light bush and farm-lands				Suburban			
Grasslands				Streets			
No vegetation				Maximum flood			
Total	100	-		Total (C_2)	100	-	

Time of concentration (T_C)		Notes:
Overland flow⑤	Defined watercourse	
$T_C = 0{,}604\left(\frac{rL}{\sqrt{S_{av}}}\right)^{0{,}467}$	$T_C = \left(\frac{0{,}87L^2}{1000S_{av}}\right)^{0{,}385}$	
hours	hours	

Run-off coefficient							
Return period (years), T	**2**	**5**	**10**	**20**	**50**	**100**	**Max**
Run-off coefficient, C_1 ($C_1 = C_S + C_P + C_V$)							
Adjusted for dolomitic areas, C_{1D} ($= C_1(1 - D_{\%}) + C_1D_{\%}(\sum(D_{factor} \times C_{S\%}))$)⑥							
Adjustment factor for initial saturation, F_t⑦							
Adjusted run-off coefficient, C_{1T} ($= C_{1D} \times F_t$)							
Combined run-off coefficient C_T ($= \alpha C_{1T} + \beta C_2 + \gamma C_3$)							

Rainfall							
Return period (years), T	**2**	**5**	**10**	**20**	**50**	**100**	**Max**
Point rainfall (mm), P_T⑧							
Point intensity (mm/hour), P_{iT} ($= P_T/T_C$)							
Area reduction factor (%), ARF_T⑨							
Average intensity (mm/hour), I_T ($= P_{iT} \times ARF_T$)							
Peak flow (m³/s) $Q_T = \frac{C_T I_T A}{3{,}6}$							

Note: # Reference to the appropriate figures and tables is made in the legend table of this method.

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THE SOUTH AFRICAN NATIONAL ROADS AGENCY WEB2P

ALTERNATIVE RATIONAL METHOD

n-day rainfall data							
Weather Service station							
Weather Service station number							
Mean annual precipitation (MAP)					mm		
Coordinates				&			
Duration (days)	**Return period (years), T**						
	2	**5**	**10**	**20**	**50**	**100**	**200**
1 day							
2 days							
3 days							
7 days							

Table 3C.6	
Selection criteria	**Calculation method**
$T_C < 6$ hours	Modified Hershfield equation $P_{t,T} = 1{,}13(0{,}41 + 0{,}64\ln T)(-0{,}11 + 0{,}27\ln t)(0{,}79M^{0{,}69}R^{0{,}20})$
6 hours $\leq T_C <$ 24 hours	Linear interpolation between calculated modified Hershfield equation point rainfall and 1-day point rainfall from TR102
$T_C \geq$ 24 hours	Linear interpolation between n-day point rainfall values from TR102

LEGEND TABLE Alternative Rational method	
ID	**Reference**
⓪	Figure 3.7
①	TR102 (3.15) or other
②	Figure 3.12 (3.28)
③	Table 3C.1
④	Table 3C.2
⑤	Table 3C.3
⑥	Table 3C.4
⑦	Table 3C.5
⑧	Table 3C.6
⑨	Figure 3.14
⑩	Figure 3.13, TR102 (3.15) or other

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