KLEIN RIVER FLOOD LEVEL INVESTIGATION, HERMANUS

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1. INTRODUCTION

1.1 Background

Deca Consulting Engineers were appointed by Gregg Goddard Architect to assess the flood level of the Klein River Estuary with unbreached conditions (i.e. flooding of the river just before the mouth opens).

The purpose of the study was to investigate the maximum height of the water level in the estuary during the 1:50 and 1:100 year Recurrence Interval (RI) floods respectively before it breaches naturally or is artificially breached. The Alternative Rational and Unit Hydrograph methods were used to determine these peak flows. The catchment area and estuary were modelled using PCSWMM to determine the water levels for the respective storm events.

1.2 Available Information

The following information was available to DECA:

a) 1:10 000 Orthophoto Maps of the study area;

b) 5m Contour Maps of the study area from Surveys and Mapping;

c) Aerial photographs of the study area obtained via Google Earth;

d) Existing cadastral information of the study area;

e) Various breaching- and management reports, Klein River Estuary Forum;

f) Estuaries of the Cape, Report No. 40, Klein (CSW 16), CSIR;

g) Klein River Estuary (South Africa): 2D numerical modelling of estuary breaching by JS Beck and GR Basson, Depertment of Civil Engineering, University of Stellenbosch.

2. BREACHING OF RIVER MOUTH

According to the Mouth Management Plan for the Klein River Estuary (Klein River Estuary Forum), natural breaching water levels of 2.9 m to 3.1 m above MSL is preferred with no or minimal interference as breaches at these water levels result in the most effective scouring of sediment build-up.

The decision to artificially breach the mouth will be made by a sub-committee comprising of the Klein River Estuary Forum (KREF) Chairperson, the Overstrand Estuary Management Coordinator, the Overstrand Municipality's Environmental Manager and the Cape Nature: Overberg Business Unit Manager following consultation with at least two members of a team of specialists.

The minimum level at which artificial breaching may be considered is 2.6 m above MSL, although higher levels are preferred as indicated. Artificial breaching will not be considered to prevent the flooding of low lying private- or public properties or to flush polluted water out of the estuary.

For the purpose of this study, a minimum water level (berm height at the mouth) of 3.1 m above MSL was thus used.

3. PEAK STORMWATER RUNOFF

As mentioned, the 1:50 and 1:100 year RI storm event run-offs were required for the Klein River. KweziV3 Consulting Engineers completed a (basic) floodline analysis for Overstrand Municipality in 2008. This report identified a 1:50 year RI run-off of 620 m^3/s and a 1:100 year run-off of 740 m^3/s.

A few discrepancies were however identified in the KV3 report:

i) The report uses the Standard Design Flood Method to predict the stormwater run-off. This is a simplified method for primarily long, uniformly shaped catchments.

ii) The KV3 report adopts a Mean Annual Precipitation (MAP) of 500 mm per annum. Our analysis of rain gauges in and around the catchment indicates that the MAP should be in the region of 552 mm.

iii) The KV3 report uses a catchment area of 725 km^2, whereas other reports state larger catchment sizes. A catchment area of 863 km^2 was determined.

Based on the above, the Alternative Rational method and Unit Hydrograph method together with the PCSWMM model was used to determine the 1:50 and 1:100 year RI run-offs to compare to the findings of the KV3 report.

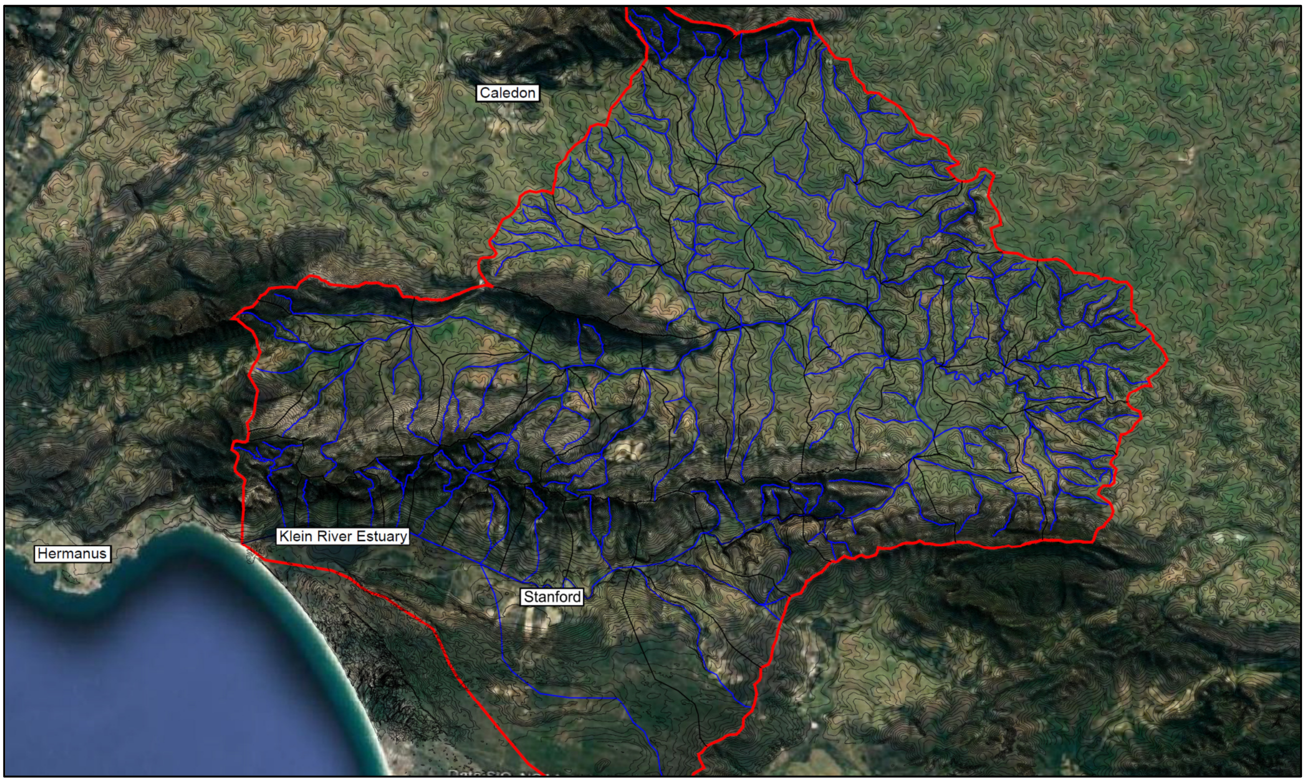
3.1 Hydrology

3.1.1 Characteristics of Catchment Area

The characteristics of the catchment area are as follows:

Catchment Area	:	862.87 km^2
Longest length	:	77.21 km
Height Difference	:	1140 m
Average Gradient of stream	:	0.270 m/m

Figure 1: Catchment Area of the Klein River



3.1.2 Climate

The study area is situated in the winter rainfall region of the Western Cape. No extreme rainfall intensities occur. A representative mean annual rainfall (MAP) of **552 mm** has been determined from a number of weather stations in the catchment area.

3.1.3 Storm Rainfall

The "Design Rainfall Estimation in South Africa" computer program which accompanies the Water Research Commission Report titled "Design Rainfall and Flood Estimation in South Africa" by JC Smithers and RE Schiltze, was used to complete a rainfall station search and to obtain storm rainfall depth data.

A summary of the rainfall station search and related storm rainfall data is given in the ***Table 1***.

Table 1 – Rainfall records from nearby weather stations

Location	**Station Name**	**Stanford (SKL)**	**Hermanus (Mun)**	**Caledon (POL)**	**Accepted**
	SAWA Station No.	0006836_W	0006415_W	0006733_W	
	Latitude	34˚26'	34˚25'	34˚13'	
	Longitude	19˚27'	19˚14'	19˚25'	
	Mean annual Precipitation (mm)	558	626	473	552
	Length of Record (years)	71	64	93	
			1 Day Storm Rainfall Depths		
Return Period	**1 in 50 year**	98.6	123.6	107.0	109.7
	1 in 100 year	115.1	144.3	124.9	128.1

3.1.4 Calculations

The peak flow stormwater runoff for the Klein River for the various RI storm events were calculated with the Alternative Rational, Unit Hydrograph and PCSWMM (South African SCS 24h Type 1 design storm) with the results summarised in ***Table 2***.

Table 2: Peak flow stormwater runoff

RI Runoff	Alt Rational	Unit Hydrograph	PCSWMM
1:50 Year	705.3 m^3/s	Peak flow too low	717.8 m^3/s
1:100 Year	913.8 m^3/s	Peak flow too low	907.0 m^3/s

As suspected, the results of the methods used indicated more conservative (higher) peak flow runoffs than the KV3 report. These results were subsequently applied in the compilation of the model to determine the estimated flood levels.

4. ESTUARY FLOOD LEVEL

4.1 Model

The Klein River Estuary was modelled in PCSWMM as mentioned. A detailed survey of the estuary was not carried out / available and contour maps of the area obtained from Surveys and Mapping as well as bathymetry information of the estuary obtained from Estuaries of the Cape (CSIR Research Report 439) was used to create a contour map of the estuary. ***Figure 2*** indicates the contour map used in the model.

Figure 2: Contour Map of the Klein River Estuary

The resulting contour map was used to create a storage unit representing the estuary in the PCSWMM model, based on a depth to area storage curve. An overflow or outfall was created for the storage unit based on the natural berm formed at the mouth of the river at a height of 3.1 m above MSL. The outflow width over the berm was limited to 75 m. This width was based on the natural breaching stream width (2.8 m above MSL) as simulated in a 2D numerical modelling study of the estuary. *(Klein River Estuary (South Africa): 2D numerical modelling of estuary breaching by JS Beck and GR Basson, Department of Civil Engineering, University of Stellenbosch.)* This can be seen as a conservative width (limiting outflow will cause higher levels in the estuary) as higher water levels in the estuary results in wider breaching widths.

4.2 Analysis and Results

The storage unit was programmed to have an initial depth of 3.1 m above MSL, i.e. the maximum estuary water level before the storm events. The analysis was subsequently carried out with the 1:50 and 1:100 year RI storm events as indicated in ***Table 2*** to determine the rise in water level in the estuary with the berm or outflow still in place at 3.1 m above MSL. ***Table 3*** summarises the results of the analysis for the different RI storm events.

Table 3: Storage Unit Flooding Results

RI Runoff	Initial Level (above MSL)	Avg Level (above MSL)	Max. Level (above MSL)	Max. Total Inflow (m^3/s)	Total Inflow (ML)
1:50 Year	3.10	3.24	3.39	717.80	77 082.53
1:100 Year	3.10	3.35	3.44	907.04	83 562.91

As seen from ***Table 3***, the maximum water level of the estuary with the 1:100 year RI storm event and berm intact is 3.44 m above MSL. It is however expected that this water level will not likely be reached. It is not expected that the natural berm at the river mouth will stay intact at water levels higher than 3.1 m above MSL, after which the water level in the estuary will drop significantly.

5. CONCLUSION

From the above, the following can be concluded:

- That the maximum water level of the estuary during the 1:50 year RI storm event and berm intact is 3.39 m above MSL;

- That the maximum water level of the estuary during the 1:100 year RI storm event and berm intact is 3.44 m above MSL;

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