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REPUBLIC OF SOUTH AFRICA



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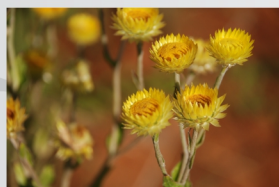
The uMkhomazi Water Project Phase 1: Module 1: Technical Feasibility Study: Raw Water

ENGINEERING FEASIBILITY DESIGN REPORT

WRITE-UP 1:
CLIMATOLOGICAL DATA FOR THE PROPOSED
SMITHFIELD DAM AND
LANGA BALANCING DAM

FINAL

MAY 2014



Project name: **The uMkhomazi Water Project Phase 1: Module 1: Technical Feasibility Study Raw Water**

Report Title: **Engineering feasibility design report**

Sub-report title: **Climatological data for the proposed Smithfield Dam and Langa Balancing Dam construction**

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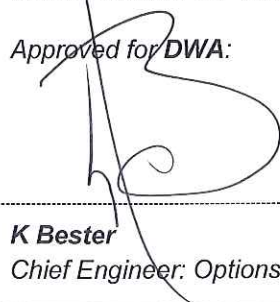
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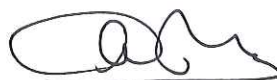
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PREAMBLE

In June 2014, two years after the commencement of the uMkhomazi Water Project Phase 1 Feasibility Study, a new Department of Water and Sanitation was formed by Cabinet, including the formerly known Department of Water Affairs.

In order to maintain consistent reporting, all reports emanating from Module 1 of the study will be published under the Department of Water Affairs name.

The uMkhomazi Water Project Phase 1

LIST OF REPORTS

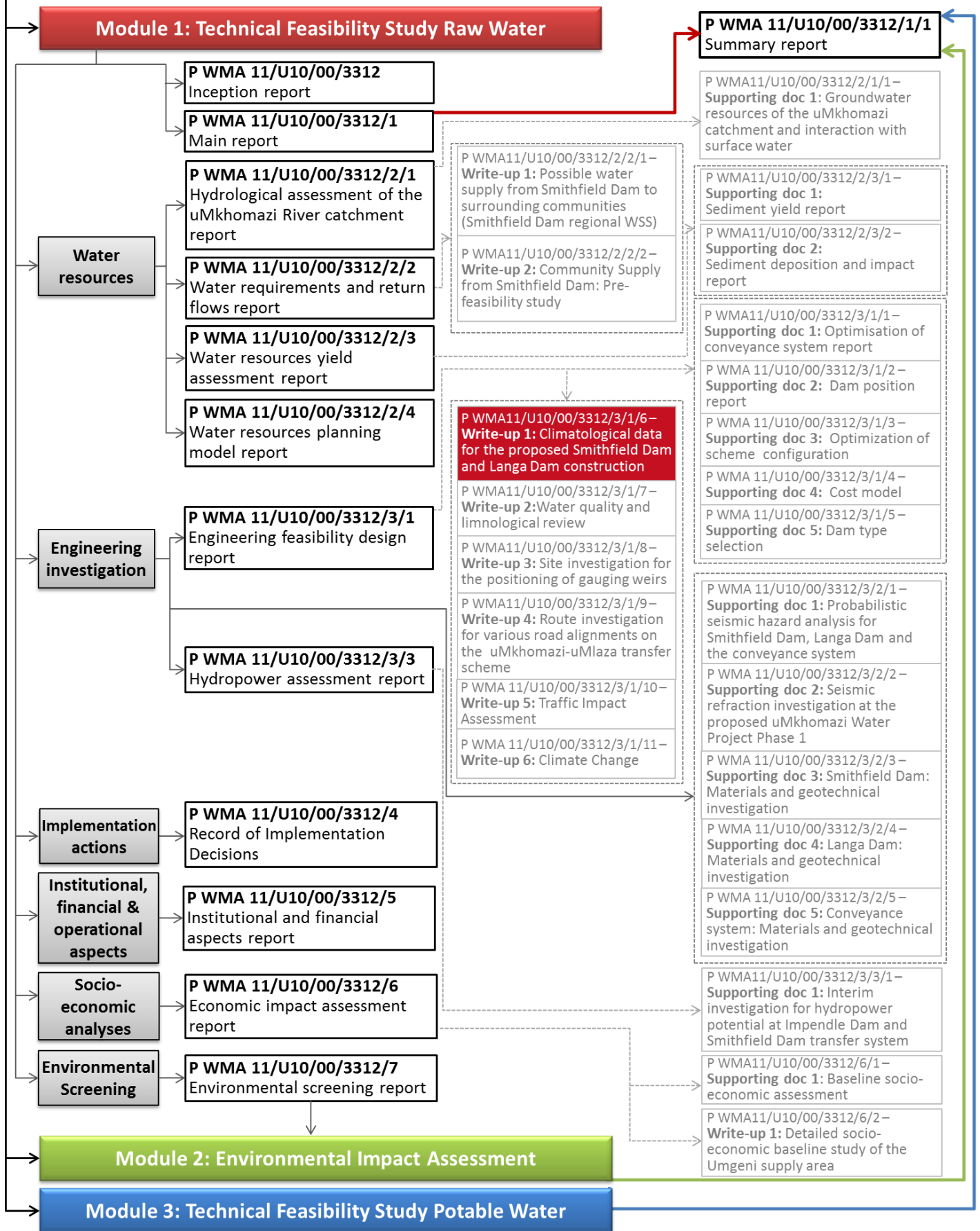


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1 INTRODUCTION

Climate is the pattern of variation in temperature, humidity, atmospheric pressure, wind, precipitation and other meteorological variables in a given region over long periods. Climate can be contrasted to **weather**, which is the present condition of these variables over shorter periods.

It is vital to provide reasonable predictions of the expected climate at a specific site **prior to construction**, as inclement weather conditions might have a significant impact on the execution of work on site and need to be planned for by the contractor. It is expected that Phase 1 of the uMkhomazi Water Project (uMWP1) will be implemented shortly after completion of the current Feasibility Study. Therefore, very little time, if any, will be available to gather detailed climatological information for both the proposed Smithfield Dam and Langa Balancing Dam construction sites. Hence, it was requested that the gathering of climatological information should be undertaken as part of the current study.

Adverse weather can take many forms, namely:

- ◆ Precipitation in the form of rain, snow, hail or ice.
- ◆ High or low evaporation rates.
- ◆ High or low temperature conditions.
- ◆ High wind speeds.
- ◆ High or low humidity.

As such, the objective of this report is to describe the climatology at the proposed Smithfield Dam and Langa Balancing Dam construction sites. For this purpose variables that are readily available and give a broad perspective of the expected climatological conditions at the sites were considered, namely (i) **rainfall**; (ii) **evaporation**; and (iii) **temperature**. These are discussed in the following sections of this report.

2 RAINFALL

Daily and monthly rainfall data in the vicinity of the proposed construction sites were obtained from the *Water Research Commission (WRC) Daily Rainfall Database* (Lynch, SD, 2003). It is acknowledged that a major drawback of using this data set is that it has not been recently updated and contains data up to December 2001 only. However, it was accepted that this region's rainfall can adequately be described if the record length exceeds 15 years of recorded data and use of the WRC data set was therefore considered to be acceptable.

The factors considered in the selection of a representative rainfall gauging station for the Smithfield Dam and Langa Balancing Dam sites, respectively, were as follows:

- ◆ Location (distance from the site in question).
- ◆ Length and reliability of the data set.
- ◆ Topography.
- ◆ Rainfall isohyets.

Based on the above considerations, a number of rainfall gauging stations were discarded, including all stations with a record length of less than 15 years. Details of the remaining stations are shown in **Table 2.1**.

Table 2.1: Rainfall gauging stations located in the vicinity of the proposed Smithfield Dam and Langa Balancing Dam sites

SAWS No.	Name	Location			Record period		
		Quaternary catchment	Lat. (°S)	Long. (°E)	Start	End	Length (years)
Proposed Impendle Dam (quaternary catchment U10E)							
0238442W	Sarnia – BOS	U10F	-29° 52'	29° 45'	1956	2008	53
0238682A	Inglenook, Donny Brook	U10H	-29° 52'	29° 53'	1956	1987	32
0238468W	Bulwer – TNK	U10F	-29° 49'	29° 46'	1919	2008	90
0239138W	Whitson	U10H	-29° 48'	30° 05'	1930	1973	44
Proposed Langa Balancing Dam (quaternary catchment U60A)							
0239585W	Baynesfield Estate	U60B	-29° 46'	30° 20'	1926	2008	83

The location of the above rainfall gauging stations, together with the rainfall isohyets for the proposed Smithfield Dam and Langa Balancing Dam sites are shown in **Figure 1** and **Figure 2**, respectively, in **Appendix A**. **Figure 3** and **Figure 4** provide summaries of the mean annual precipitation (MAP) and elevation of each station.

Table 2.2 provides a comparison of the number of days in a month with rainfall greater than 10 mm for rainfall gauging stations in question, calculated over the common period of 1 January 1958 to 31 December 1972.

Table 2.2: Number of days in month with rainfall greater than 10 mm

SAWS No.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Proposed Impendle Dam site (quaternary catchment U10F)													
0238442W	4.7	4.2	4.3	2.1	0.7	0.3	0.5	0.8	0.9	1.8	4.1	4.3	28.5
0238682A	3.9	4.1	3.8	1.5	0.9	0.5	0.6	0.9	1.0	2.3	3.5	3.8	26.8
0238468W	5.8	4.7	4.4	2.4	0.9	0.4	0.6	1.0	1.4	2.5	4.0	5.4	33.5
0239138W	4.4	3.2	4.1	1.7	0.9	0.7	0.6	0.7	1.3	2.5	3.4	3.5	27.1
Proposed Langa Balancing Dam site (quaternary catchment U60B)													
0239585W	3.3	2.7	3.6	1.4	0.9	0.2	0.5	0.9	1.0	1.6	3.0	2.9	21.9

Note: Calculated over a common period of 1 January 1958 to 31 December 1972.

Based on the considerations discussed above, the following rainfall gauging stations were selected to be most representative of the long-term rainfall characteristics of the proposed dam sites:

- ◆ Proposed Smithfield Dam site: *0238682A* (Inglenook, Donny Brook).
- ◆ Proposed Langa Balancing Dam site: *0239585W* (Baynesfield Estate).

The rainfall statistics for these stations, calculated over the full available record period, are provided in **Table 2.3** and **Table 2.4** respectively.

Table 2.3: Adopted rainfall statistics for the proposed Smithfield Dam site (based on rainfall gauging station 0238682A)

Month	Average monthly rainfall (mm)	Number of days with rainfall > 10 mm
January	138	4.6
February	109	3.7
March	107	3.6
April	50	1.7
May	23	0.5
June	13	0.3
July	12	0.4
Augustus	26	0.9
September	43	1.5
October	69	2.6
November	107	3.9
December	112	3.9
Total / average:	809	27.5

Note: Calculated over the full available record period of January 1957 to December 1988.

Table 2.4: Adopted rainfall statistics for the proposed Langa Balancing Dam site (based on rainfall gauging station 0239585W)

Month	Average monthly rainfall (mm)	Number of days with rainfall > 10 mm
January	121	3.4
February	106	3.0
March	102	3.1
April	51	1.5
May	25	0.7
June	15	0.4
July	15	0.4
Augustus	25	0.7
September	48	1.2
October	79	2.0
November	108	3.1
December	117	3.3
Total / average:	812	22.7

Note: Calculated over the full available record period of January 1928 to December 2001.

The results shown above compare well with those from climate station No. 02388066 at Emerald Dale as discussed later in **Section 4**.

Finally, it should be noted that the rainfall statistics shown above differ slightly from the point rainfall data presented in the study report *Hydrological Assessment of the uMkhomazi River Catchment* (AECOM, AGES, MMA & Urban-Econ, 2014) for the proposed Smithfield Dam. The reason for this is that the latter was developed for the purpose of modelling the impacts of rainfall over the entire impounded area of the dam (as opposed to the site at which the dam wall will be constructed) and therefore considered data from a number of selected rainfall gauging stations in the area.

3 EVAPORATION

Since no evaporation stations are located within the study area, mean annual Symons-pan (S-pan) evaporation and monthly distribution patterns were sourced from the *Water Resources of South Africa, 2005 (WR2005)* study (WRC, 2008). These are summarised **Table 3.1** and further details are provided in the study report *Hydrological Assessment of the uMkhomazi River Catchment* (AECOM, AGES, MMA & Urban-Econ, 2014).

Table 3.1: Adopted evaporation statistics for the proposed Smithfield Dam and Langa Balancing Dam sites

Month	S-pan evaporation (mm) at indicated site (associated quaternary catchment)	
	Proposed Impendle Dam (U10F)	Proposed Langa Balancing Dam (U60B)
January	123	113
February	124	116
March	147	127
April	139	126
May	122	112
June	125	111
July	94	91
Augustus	78	77
September	67	67
October	75	72
November	96	87
December	109	102
Totals:	1 300	1 200

Note: From WR2005 (WRC, 2008)

4 TEMPERATURE

The publication *Climate of South Africa WB 42 Climate Statistics* (SAWS, n.d.) was consulted for statistics on temperature. Since there are relatively few climate stations in South Africa, a single station was selected and assumed to be representative of the climate at both the proposed dam sites. The station in question is No. 02388066 at Emerald Dale (Lat. 29° 56' S; Long. 29° 57' E) and provides data over the period 1961 to 1990.

At the Emerald Dale station the highest maximum temperature of 38.5°C was recorded during January 1974 and the lowest minimum of -5°C in July 1974. Furthermore, mild to warm temperatures are experienced during summer, while winters are characterised as being cold with frost occurring regularly. Climate statistics for the Emerald Dale station are summarised in **Table 4.1**.

Table 4.1: Climate statistics for station No. 02388066 at Emerald Dale

Month	Monthly rainfall (mm)	Number of days with rainfall > 10 mm	Number of days with minimum air temp. less than 0°C	Number of days with snow lying at 08:00 CAT	Number of days with fog
January	135	3.9	0.0	0.0	7.2
February	117	3.4	0.0	0.0	5.1
March	129	4.1	0.0	0.0	4.8
April	50	1.9	0.1	0.0	3.2
May	23	0.7	0.5	0.0	3.2
June	15	0.4	4.7	0.4	1.2
July	14	0.5	3.8	0.2	1.5
Augustus	29	0.8	2.0	0.2	2.4
September	57	1.4	0.6	0.0	4.2
October	74	2.0	0.0	0.4	6.5
November	108	3.2	0.0	0.0	7.5
December	109	3.1	0.0	0.0	6.6
Total / average:	860	25.4	11.7	1.2	53.4

Note: From (SAWS, n.d.)

5 CONCLUSIONS AND RECOMMENDATIONS

Based on the assessment of available climatological data as discussed in the preceding sections of this report, it is concluded that the climatic conditions at the proposed Smithfield Dam and Langa Balancing Dam sites can reasonably be summarised as shown in **Table 5.1**.

Table 5.1: Summary of climatology for the proposed Smithfield Dam and Langa Balancing Dam sites

MAP (mm)	Number of days with rainfall > 10 mm	MAE (mm)	Number of days with minimum air temp. less than 0°C
Proposed Smithfield Dam site			
809 ⁽¹⁾	28 ⁽¹⁾	1 300 ⁽³⁾	12 ⁽⁵⁾
Proposed Langa Balancing Dam site			
812 ⁽²⁾	23 ⁽²⁾	1 200 ⁽⁴⁾	12 ⁽⁵⁾

Note: (1) Based on observed data for rainfall gauging station 0238682A, calculated over the available record period of January 1957 to December 1988.

(2) Based on observed data for rainfall gauging station 0239585W, calculated over the available record period of January 1928 to December 2001.

(3) From WR2005 for quaternary catchment U10F (WRC, 2008).

(4) From WR2005 for quaternary catchment U60B (WRC, 2008).

(5) From observed data for climate station No. 02388066 at Emerald Dale (SAWS, n.d.).

Finally, it is recommended that the information summarised above is used for construction planning purposes at the proposed dam sites in question.

6 REFERENCES

AECOM, AGES, MMA & Urban-Econ, 2014. *The uMkhomazi Water Project Phase 1: Module 1: Technical Feasibility Study: Raw Water; P WMA 11/U10/00/3312/2/1 - Hydrological Assessment of the uMkhomazi River Catchment*, Pretoria, South Africa: Department of Water Affairs (DWA).

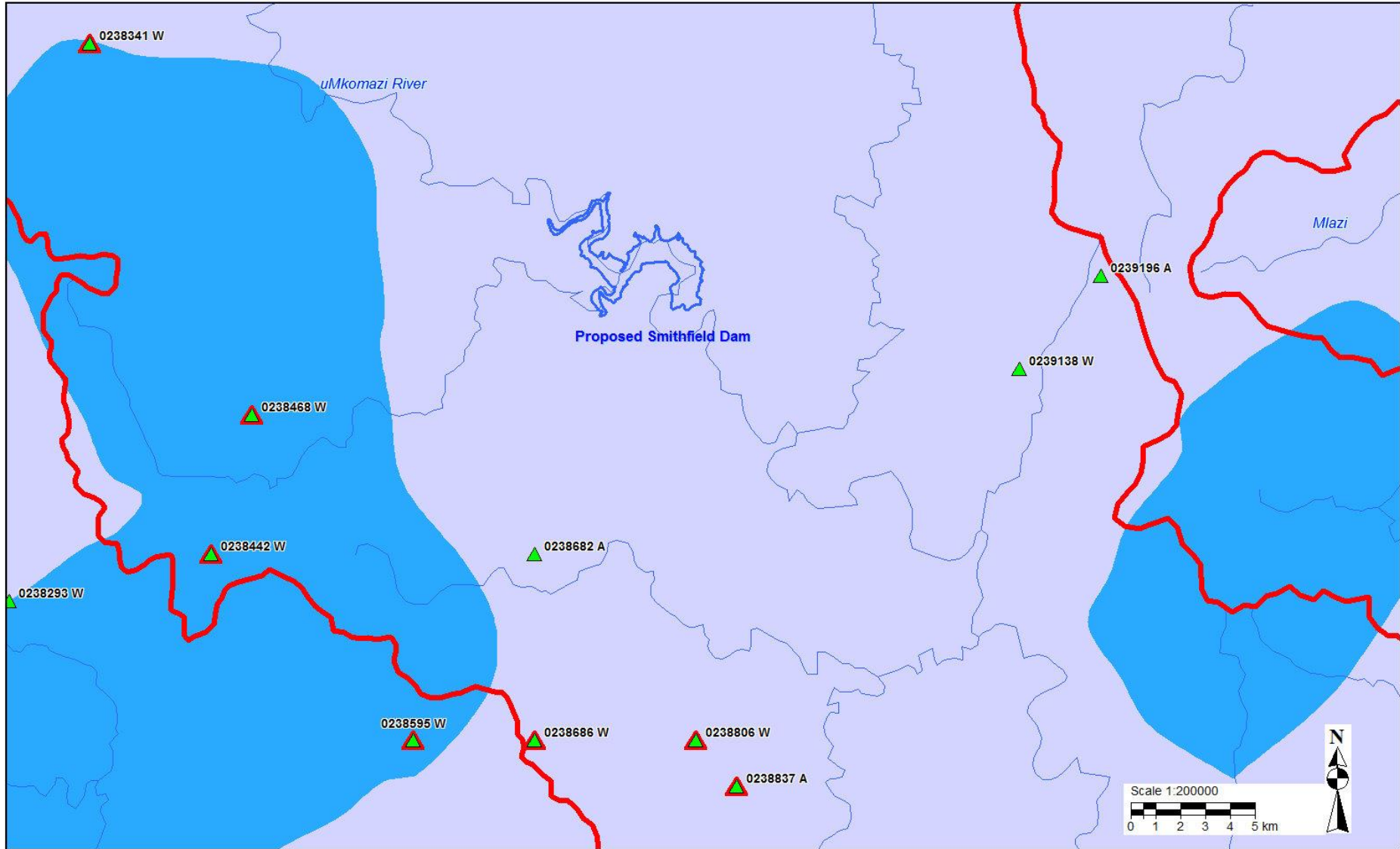
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Appendix A

Figures



**uMkhomazi Water Project Phase 1: Module 1:
Technical Feasibility Study: Raw Water (eMWP1-1/RW)
Rainfall gauging stations in the vicinity
of the proposed Smithfield Dam site**

Legend	
uMkhomazi & Upper uMlaza Catchments	Used for Catchment Rainfall
Proposed Dams	Used for Patching
Existing Dams	800
Rivers	1000
MAP	

FIGURE 1	
Drawn:	LC Gallagher
Checked:	E van Niekerk
Approved:	2013-12-11
Date:	eMkhomazi map
Map Ref:	Rainfall gauging_Smithfield Dam
View Ref:	J01763



**uMkhomazi Water Project Phase 1: Module 1:
Technical Feasibility Study: Raw Water (eMWP1-1/RW)
Rainfall gauging stations in the vicinity of the
proposed Langa Balancing Dam site**

Legend	
uMkhomazi & Upper uMlaza Catchments	Used for Catchment Rainfall
Proposed Dams	Used for Patching
Existing Dams	MAP
Rivers	800
	1000

FIGURE 2	
Drawn:	LC Gallagher
Checked:	E van Niekerk
Approved:	2013-12-11
Date:	eMkhomazi map
Map Ref:	Rainfall_Langa
View Ref:	J01763

