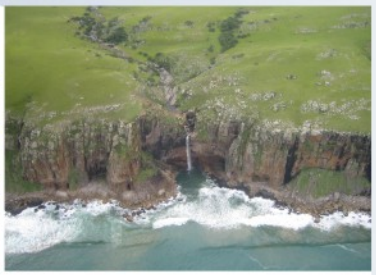
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DWA REPORT NO: P WMA 12/T60/00/3711

Feasibility Study for Augmentation of the Lusikisiki Regional Water Supply Scheme (WP 10317)






WATER RESOURCES ASSESSMENT

FEBRUARY 2014

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CONSULTANTS

AECOM (BKS) in association with AGES, KARIWA, Scherman Colloty & Associates and Urban-Econ.*

Approved for ***Consultants:***

HS Pieterse
HS Pieterse
Deputy Study Leader

JD Rossouw
JD Rossouw
Study Leader

DEPARTMENT OF WATER AFFAIRS (DWA)

Directorate: Options Analysis

Approved for DWA:

M Mugumo
M Mugumo
Chief Engineer: Options Analysis (South)

LS Mabuda
LS Mabuda
Chief Director: Integrated Water Resource Planning

* *BKS (Pty) Ltd was acquired by AECOM Technology Corporation on 1 November 2012*

LIST OF STUDY REPORTS

This report forms part of the series of reports, prepared for the Feasibility Study for Augmentation of the Lusikisiki Regional Water Supply Scheme. *All reports for the Study are listed below.*

Report Name	DWA Report Number
Water Resources Assessment	***P WMA 12/T60/00/3711***
Assessment of Augmentation from Groundwater	P WMA 12/T60/00/3811
Intermediate Reserve Determination	P WMA 12/T60/00/3911
Legal, Institutional and Financial Arrangements	P WMA 12/T60/00/4011
Domestic Water Requirements	P WMA 12/T60/00/4111
Irrigation Potential Assessment	P WMA 12/T60/00/4211
Water Distribution Infrastructure	P WMA 12/T60/00/4311
Materials and Geotechnical Investigations	P WMA 12/T60/00/4411
Zalu Dam Feasibility Design	P WMA 12/T60/00/4511
Regional Economics	P WMA 12/T60/00/4611
Environmental Screening	P WMA 12/T60/00/4711
Record of Implementation Decisions	P WMA 12/T60/00/4811
Main Study Report	P WMA 12/T60/00/4911

This report is to be referred to in bibliographies as:

Department of Water Affairs, 2011. FEASIBILITY STUDY FOR AUGMENTATION OF THE LUSIKISIKI REGIONAL WATER SUPPLY SCHEME: WATER RESOURCES ASSESSMENT, P WMA 12/T60/00/3711

Prepared by:

AECOM

AECOM SA

In association with:

AGES

KARIWA

Schlemmer Cellatly and Associates cc

URBAN-ECON Development Economists

Executive summary

This report deals with the water resources of the Msikaba River catchment, and addresses:

- *an update of the meteorological and hydrological data of the Msikaba River for the hydrological years 1920 to 2007. The Msikaba River comprises of the quaternary catchments T10E, T10F and T10G;*
- *an assessment of the sediment yield of the proposed Zalu Dam catchment;*
- *the yield analyses of the proposed Zalu Dam for various development scenarios; and*
- *development scenarios for analysing the ecological consequences of development.*

HYDROLOGICAL ASSESSMENT

RAINFALL

The mean annual rainfall (MAP) in the Msikaba River catchment decreases from 1 500 mm at the coast to 800 mm inland at the headwaters of the Msikaba River.

EVAPORATION

There are no observed DWA evaporation records in this catchment. According to the WR2005-study, the Msikaba River catchment is situated in the WR2005-evaporation Zone 30C with a S-pan mean annual evaporation (MAE) of 1 151 mm/a.

LAND USE DATA

Land use throughout much of the area consists of small-scale, or subsistence agriculture comprising cultivation of cash crops (predominantly maize and vegetables) and a variety of livestock. Afforestation, invasive alien plants (IAPs), irrigation and domestic water use are considered to be the main water users in the Msikaba River catchment.

FLOW DATA

The Msikaba River catchment constitutes three quaternary catchments, T60E, T60F and T60G. The natural and present day MAR generated for the hydrological years 1920 to 2007 for the Msikaba and the Xura rivers are given in ***Table i****.* ***Table ii*** *provides a breakdown of the quinaries of T60F which represents the Xura River (T60F1, T60F2 and T60F3) plus approximately 20% of T60F (T60F4) which flows directly into the Msikaba River.*

Table i: Natural and present day MAR for the Msikaba River quaternary catchments

Quaternary catchment	Catchment area (km²)	Natural MAR (million m³)	Present day MAR (million m³)
T60E	198.0	29.5	29.0
T60F	463.9	85.8	84.1
T60G	360.0	105.7	105.7
Total T60E,T60F & T60G	**1 021.9**	**221.0**	**218.8**

Table ii: Natural and present day MAR for the T60F quinary catchments

Quaternary catchment	Description	Catchment area (km²)	Natural MAR (million m³)
T60F1	Xura River upstream of the proposed Zalu Dam	71.4	13.2
T60F2	Xura River downstream of the proposed Zalu Dam to T6H004	21.6	4.0
T60F3	Xura River downstream of T6H004 to confluence with the Msikaba River	271.1	50.2
T60F4	Remainder of T60F with flow directly to the Msikaba River	100.0	18.5
Total T60F		**463.9**	**85.8**

RESERVOIR SEDIMENTATION

*The expected retained sediment volumes for a 1 x MAR dam are given in **Table iii** below. The 80% confidence level for 50 year sedimentation which relates to 2.52 million m³ was adopted for yield analyses of the proposed Zalu Dam.*

Table iii: Future retained sediment volume in Zalu Dam

Confidence level	Catchment sediment yield (t/km²/a)	Sediment yield (million t/a)	Estimated future sediment volume (million m³)				
			Sedimentation period (years)				
			10	20	30	40	50
65%	747.5	0.052	0.762	1.265	1.56	1.77	1.93
80%	975.0	0.068	0.995	1.65	2.04	2.31	2.52
90%	1235.0	0.086	1.257	2.087	2.57	2.92	3.19
95%	1527.5	0.107	1.564	2.597	3.20	3.63	3.96

YIELD ANALYSIS

OVERVIEW

Scenario analyses using the WRYM were carried out to ascertain:

- *the required Zalu Dam size for the expected 2040 domestic water requirements and possible irrigation development; and*
- *impact of the low flow EWR on the yield of Zalu Dam.*

The results from the scenario analyses listed above were used to develop flow regimes for various development scenarios to assist the Ecologists to study the consequences of various development scenarios, and are described in ***Appendix K****.*

EWR

The recommended ecological category (REC) of an A/B ecological water requirement (EWR) at EWR1 downstream of the proposed Zalu Dam for the Xura River, as determined by the Intermediate Reserve Determination study, was used for analyses. Unlike the traditional approach to yield analyses, it was not necessary to explicitly release floods and freshets to satisfy the EWR. Compliance with the EWR was tested through scenario modelling at various reaches in the Xura River, and is addressed in the discussion of Ecological Consequences in the Intermediate Reserve Determination Report.

LOCATION OF WATER ABSTRACTION

Two locations of abstraction points for domestic water were considered for the purpose of the yield analyses and are listed below:

- *all domestic water abstracted at the proposed Zalu Dam; and*
- *all domestic abstractions released to the river and abstracted at the weir T6H004 downstream of EWR1.*

Because the estimated water requirements for domestic use in 2040 exceed the low flow EWR at EWR1, this became the main driver for the minimum size that could be recommended for the proposed Zalu Dam and for determining the most beneficial point for abstracting water for domestic use. In these conditions, ie developing a dam at the Zalu site ***for the single purpose*** *of making reliable water supplies available for domestic use in the immediate vicinity of Lusikisiki,*

while always meeting the EWR in the Xura River, no low flow EWR releases are necessary if water is released from the dam directly into the river for abstraction downstream of the EWR1 site. The ecological impact of the proposed Zalu Dam on the high flow EWR and remainder of the Xura River downstream of EWR1 is discussed in detail in the Intermediate Reserve Determination Report.

For other development scenarios such as also providing water from the proposed dam for new irrigation development and for domestic water use in an area of supply much larger than is considered in the base case above, a larger dam will be required but proposed means for best satisfying the EWR are as described above.

RESULTS OF THE YIELD ANALYSIS OF THE PROPOSED ZALU DAM

The historic firm yield (HFY) and 1:100 year stochastic yield of a 7.6 million m³ capacity Zalu Dam, i.e. 60% MAR and FSL at 612 masl, and with abstractions at the weir T6H004, is 6.0 million m^3/a and 6.95 million m^3/a respectively. This yield will be sufficient to supply the estimated future water requirement at 2040, i.e. 6.9 million m^3/a. This option is recommended as the required size of Zalu Dam for future analyses for meeting the 2040 demands.

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APPENDIX K **ECOLOGICAL ANALYSES**

APPENDIX L **CD WITH HYDRO-METEOROLOGICAL AND WRYM DATA**

List of abbreviations

A_e	effective catchment area
$A_{H,M,L}$	areas consisting of soils with high, medium and low sediment yield potential
A_T	total catchment area
AEC	alternative ecological category
BKS	BKS (Pty) Ltd
D: NWRP	Directorate: National Water Resource Planning
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
E_{IW}	weighted erosion hazard class
EPBS	Eastern Pondoland Basin Study
$F_{H,M,L}$	high, medium and low yield potential factor
EWR	Ecological Water Requirements
FSA	full supply area
FSC	full supply capacity
IAP	invasive alien plants
LRWSS	Lusikisiki Regional Water Supply Scheme
MAE	mean annual evaporation
masl	meters above sea level
MAP	mean annual precipitation
MAR	mean annual runoff
N/A	not applicable
nMAR	natural MAR
PES	present ecological status
REC	recommended ecological class
PSP	Professional service provider
Q_S	sediment load
Q_T	flood with recurrence interval of 1 in T years
REC	recommended ecological category
RMF	regional maximum flood
R_{nd}	river network density
RSA	Republic of South Africa
SAWS	South African Weather Service
S_o	average river slope
SUH	synthetic unit hydrograph

T20A	quaternary catchment
V_T	reservoir volume after T years
V_W	original reservoir capacity
WR1995	Water Resources of South Africa 1995
WR2005	Water Resources of South Africa 2005
WRC	Water Research Commission
WRSM2000	Water Resources Simulation Model 2000
WRYM	Water Resources Yield Model
Y_C	estimated catchment sediment yield
Y_S	standardised sediment yield value
Zalu Dam	proposed dam at the Zalu site

List of units

%	percentage
a	annum
ha	hectare
hrs	hours
km	kilometre
km²	square kilometre
ℓ	litre
ℓ/c/d	litre per capita per day
m	metre
m/km	metre per kilometre
m/s	metre per second
m³/s	cubic metre per second
masl	metre above sea level
million m³	million cubic metres
million m³/a	million cubic metres per annum
Mℓ/d	megalitre per day
mm	millimetre
MW	megawatt
s	second
t	ton
t/ km²/a	ton per square kilometre per annum
t/a	ton per annum

1 INTRODUCTION

The Department of Water Affairs (DWA) appointed **BKS (Pty) Ltd** in association with four sub-consultants (**Africa Geo-Environmental Services, KARIWA Project Engineers & Associates, Scherman Colloty & Associates and Urban-Econ**) with effect from 1 September 2010 to undertake the **Feasibility Study for Augmentation of the Lusikisiki Regional Water Supply Scheme**.

On 1 November 2012, BKS (Pty) Ltd was acquired by **AECOM Technology Corporation**. The new entity is a fully-fledged going concern with the same company registration number as that for BKS. As a result of the change in name and ownership of the company during the study period, all the final study reports will be published under the AECOM name.

1.1 BACKGROUND TO THE PROJECT

In the 1970s Consultants O'Connell Manthé and Partners and Hill Kaplan Scott recommended that a regional water supply scheme based on a dam on the Xura River and a main bulk supply reservoir close to Lusikisiki (located within the then defined "administration area" of the Zalu Dam) would provide potable water supply for the entire region between Lusikisiki and the coast, extending from the Mzimvubu River in the south west to the Msikaba River in the north east. Some areas up to 15 km inland of Lusikisiki would also be supplied. A **White Paper** describing the scheme was tabled by the Transkei Government in 1979. It was envisaged that the scheme would be constructed in phases. Details of the proposed phasing of the scheme are provided in Hill Kaplan Scott's *Lusikisiki Regional Water Supply: Preliminary Report*.

After the reincorporation of the Republic of Transkei into the Republic of South Africa (RSA) in 1994, the DWA took over responsibility for further development of the scheme. The Directorate: National Water Resource Planning commissioned the *Eastern Pondoland Basin Study* (EPBS) in 1999 to further investigate the water supply situation in the area, with a specific focus on further development in the area originally earmarked for the *Lusikisiki Regional Water Supply Scheme* (LRWSS). This detailed investigation was undertaken for surface and groundwater sources, which re-affirmed that the Zalu Dam

was the preferred source of surface water and recommended further investigation of groundwater sources to augment water supply to the entire area or to sub-areas.

In 2007, SRK Consulting undertook the *Lusikisiki Groundwater Feasibility Study* to investigate groundwater potential and compare the new data with data produced by earlier studies. This study reported that there is a relatively strong possibility of finding high yielding boreholes, and that a combination of surface water (Zalu Dam) and groundwater would be the most feasible solution for the LRWSS.

1.2 STUDY AREA

The study area comprises the entire region between Lusikisiki (up to about 15 km inland) and the coast, extending from the Mzimvubu River in the south-west to the Msikaba River in the north-east, as indicated on **Figure 1.1**. This area includes the Zalu Dam site and its catchment in the Xura River, conveyance routes between the dam and control reservoirs, as well as borehole sites that could be developed for augmentation of water supplies from groundwater and the routes of the main pipelines from the boreholes to the control reservoirs.

In the south-western part of the study area the preferred option is to develop local water supplies from groundwater for supplying smaller communities. The broken topography, deep river valleys and the distance from reservoirs in the bulk regional scheme, render supplies to these areas from Zalu Dam very costly.

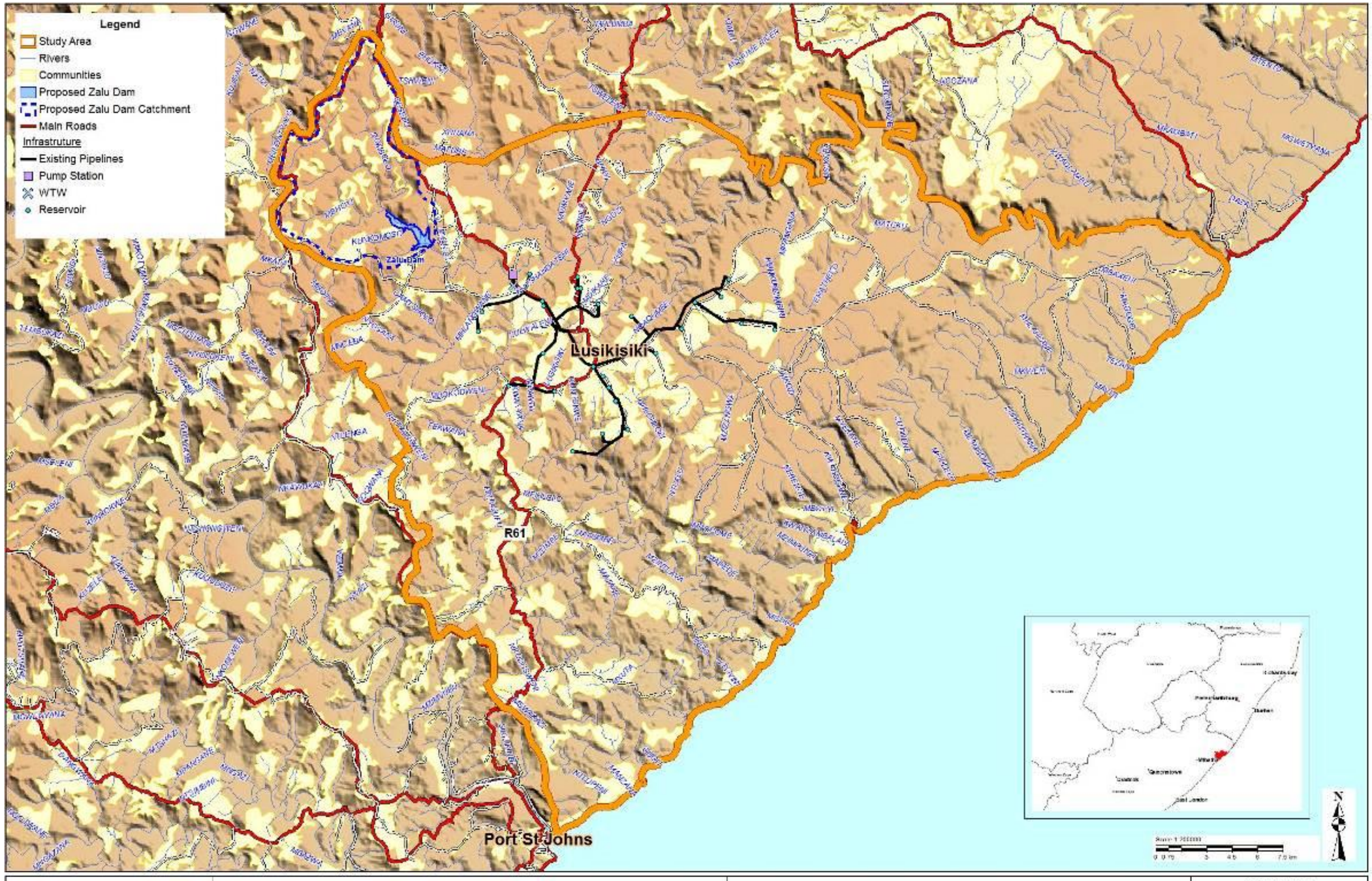


Figure 1.1: Study area

1.3 OBJECTIVE, SCOPE AND ORGANISATION OF THE STUDY

The objective of this study was to complete a comprehensive engineering investigation at feasibility level for the proposed *LRWSS*, including the possible Zalu Dam in the Xura River, and to define the most attractive composition and size of the water supply components, taking augmentation from groundwater resources into account.

This feasibility study provided for the assessment of all aspects that impact on the viability of utilising a combination of surface water (via the Zalu Dam on the Xura River) and groundwater (via boreholes) for the expansion of the existing water supply scheme to provide all water users in the study area with an appropriate level and assurance of water supply. The study is therefore required to:

- Identify all of the technical issues likely to affect implementation, and to define and evaluate all of the actions required to address these issues;
- Provide an estimate of cost with sufficient accuracy and reliability to ensure that management decisions can be made with confidence;
- Investigate irrigation viability; and
- Provide sufficient information to enable design and implementation to proceed without further investigation.

The required activities for this project have been grouped into 14 modules, as shown in **Table 1.1**.

Table 1.1: Study structure

Modules	Deliverable
1. PROJECT MANAGEMENT 1.1 Study initiation and inception 1.2 Project management and administration	**Inception Report**
2. WATER RESOURCES	**Water Resources Report**
2.1 Hydrology	♦ Hydrology chapter
2.2 Yield analysis	♦ Yield Analysis chapter
2.3 Reservoir sedimentation	♦ Sedimentation chapter
3. GROUNDWATER AUGMENTATION	**Assessment of Augmentation from Groundwater Report**
4. RESERVE - ECOLOGICAL WATER REQUIREMENTS	**Reserve Determination Report** ♦ Reserve Template
5. WATER REQUIREMENTS	
5.1 Domestic water requirements	**Domestic Water Requirements Report**
5.2 Agriculture / Irrigation potential	**Irrigation Development Report**
6. WATER SERVICE INFRASTRUCTURE	**Water Distribution Infrastructure Report**
6.1 Distribution infrastructure	♦ Chapter in Water Distribution Infrastructure Report
6.2 Water quality	♦ Chapter in Water Distribution Infrastructure Report
7. PROPOSED ZALU DAM	
7.1 Site investigations	**Materials & Geotechnical Investigations Report**
7.2 Dam technical details	**Zalu Dam Feasibility Design Report**, including design criteria, dam type selection, dam sizing
8. COST ESTIMATE AND COMPARISON	♦ Included in relevant reports
9. REGIONAL ECONOMICS	**Regional Economics Report**
10. ENVIRONMENTAL SCREENING	**Environmental Screening Report** ♦ Scope of work for EIA
11. PUBLIC PARTICIPATION	♦ Included in Environmental Screening Report
12. LEGAL, INSTITUTIONAL AND FINANCIAL ARRANGEMENTS	**Legal, Institutional and Financial Arrangements Report**
13. RECORD OF IMPLEMENTATION OF DECISIONS	**Record of Implementation Decisions Report**
14. MAIN REPORT AND REVIEWS	**Main Study Report**

1.4 SCOPE OF THIS REPORT

The following sections are deliverables from **Module 2** of the *Feasibility Study for Augmentation of the Lusikisiki Regional Water Supply Scheme.*

1.4.1 Hydrology

The hydrology section deals with the update of the meteorological and hydrological data of the Msikaba River catchment. The Msikaba River catchment comprises the quaternary catchments T60E, T60F and T60G. A summary of the WR2005 (WRC, 2009) results for the Msikaba River is given in **Table 1.2**.

Table 1.2: Summary of the WR2005 meteorological results for the Msikaba River

Quaternary catchment	Net catchment area	S-pan evaporation MAE WR2005	Rainfall MAP
	(km^2)	(mm)	(mm)
T60E	198	1 150	885
T60F	464	1 150	940
T60G	360	1 150	1 116

1.4.2 Sedimentation

The sedimentation section deals with the estimation of the volume of sediment that can be expected to accumulate in the proposed Zalu Dam.

1.4.3 Yield analysis

The yield analysis section describes the estimated yield of the proposed Zalu Dam in the Msikaba River catchment. A summary of the WR2005 (WRC, 2009) input data and estimated runoffs for the Msikaba River, is given in **Table 1.3**.

Table 1.3: Summary of the WR2005 land-use and flow results for the Msikaba River

Quaternary catchment	Catchment area net	Forestry area	Alien veg. area	Irrigation volume	Farm dams volume	Run-off MAR
	(km^2)	(km^2)	(km^2)	(million m^3/a)	(million m^3/a)	(million m^3/a)
T60E	198	2.90	1.60	0.00	0.00	26.79
T60F	464	0.00	3.80	0.00	0.00	89.20
T60G	360	0.00	0.00	0.00	0.00	96.41

2 HYDROLOGICAL ASSESSMENT

2.1 CATCHMENT DESCRIPTION

The *Lusikisiki Regional Water Supply Scheme* (LRWSS) study area is shown in **Appendix A- 1**. The Msikaba River catchment is shown in **Appendix A-2**. The natural MAR of the Msikaba River is approximately 212 million m³ (WRC, 2009) with a negligible reduction in present day run-off as a result of development. The major tributaries of the Msikaba River are the Xura, Kwadlambu and Mateku rivers.

The mean annual rainfall (MAR) over the Msikaba River catchment decreases from 1 500 mm at the coast to 800 mm inland at the headwaters of the Msikaba River. Monthly rainfall is fairly uniform over the study area.

The altitude of the sub-catchment varies between 800 m at the headwaters of the Msikaba River to sea level at the estuary.

The Msikaba River catchment constitutes three quaternary catchments, T60E, T60F and T60G. T60F was sub-divided into four quinaries for modelling purposes, namely:

- T60F1 the portion of T60F upstream of the proposed Zalu Dam in the Xura River;
- T60F2 the portion of T60F downstream of Zalu Dam to T6H004 in the Xura River;
- T60F3 the portion of T60F downstream of the T6H004 gauging station to the confluence of the Xura River with the Msikaba River; and
- T60F4 the proportion of T60F that contributes to the Msikaba River.

The Xura River catchment constitutes the quinary catchments: T60F1 & T60F2 & T60F3. T60F4 represents the portion of flow from T60F that does not contribute to the Xura River. The quaternary and quinary catchments are shown in **Appendix A-2** and summarised in **Table 2.1**.

Table 2.1: Quaternary and quinary catchments of the Msikaba River

Quaternary catchment	Description	Incremental catchment area (km²)	Cumulative catchment area (km²)
T60E	Headwaters of the Msikaba River to T60F4	198.0	198.0
T60F1	Xura River upstream of Zalu Dam	71.3	71.3[1]
T60F2	Xura River downstream of Zalu Dam to T6H004	21.6	92.9
T60F3	Xura River downstream of T6H004 to the confluence with Msikaba River	271.1	364.0
T60F4	Remainder of T60F contributing to Msikaba River	99.9	297.9
T60G	Msikaba River downstream of the confluence with the Xura River	360.0	1 021.9
Total Xura River catchment			**364.0**
Total Msikaba River catchment			**1 021.9**

[1]The catchment of the proposed Zalu Dam is less than 7% of the total catchment area of the Msikaba River

2.2 METHODOLOGY AND APPROACH

This report deals with the water resources of the Msikaba River catchment, which include an update and analysis of the meteorological and hydrological data for the hydrological years 1920 to 2007.

There is only one river gauging station in the entire Msikaba River, namely T6H004 on the Xura River, a tributary. The meter T6H005 measures the abstraction from the Xura River to the water treatment works (WTW) that serves the town Lusikisiki and its environments. The observed flow record was evaluated and used in rainfall-runoff calibration with the latest WRSM2000 rainfall-runoff model available (Version 2.4, September 2007). Naturalised flow and land-use records were generated for every quaternary catchment and also at the proposed Zalu Dam site.

The flow and land-use records are used in the system analyses with the WRYM to determine the present yield as well as the impacts of future developments on the yield and environment.

2.3 RAINFALL

2.3.1 Overview

Catchment rainfall data are required as primary input to the WRSM model. It is also needed for calculation of land-use water requirements and estimation of groundwater

recharge. Observed rainfall data, in every quaternary catchment of interest, were analysed and combined into catchment rainfall records which are spatially and temporally representative of the rainfall in the Msikaba River catchment. Point rainfall data records were also created to solve mass balance equations in the WRYM to calculate rainfall accruals at each reservoir modelled in the system analyses.

Data was sourced and processed from the DWA Water Resources Information Management System (Rain-IMS Version 3.10.0). The initial selection of rainfall data was based on the spatial as well as the temporal distribution of the rain gauges. Preliminary screening of the rain gauges was done by means of mass plots of the raw rainfall data at each gauge. Rain gauges not complying with the prescribed criteria of record length, stationary and completeness were discarded.

Rainfall data captured on databases often contain missing and unreliable data with flags. These flags reflect on the reliability of the data, e.g. estimated value (E), incomplete data (*), missing data (#), etc. However, not all unreliable data/outliers are flagged as unreliable, when captured. Therefore these unreliable data should be identified and also flagged. All rainfall values flagged as unreliable must be patched using rainfall data from adjacent gauges with similar characteristics. The patching process was performed using the ClassR/PatchR suite of programs, which are incorporated in the Rain-IMS.

2.3.2 Rain gauge selection

All available rain gauges in the Rain-IMS inside, or within close proximity to the Msikaba River catchment (T60E, T60F and T60G), were selected. The majority of the rainfall data in the Rain-IMS are monthly data from the South African Weather Service (SAWS). This data could be supplemented by measured rainfall data from DWA. However, no DWA rain gauges with adequate records were of sufficient length and reliability to be included in this study.

The positions of all selected rain gauges in the study area are shown in **Appendix A-3**. There are five rain gauges inside the Msikaba River catchment, and three outside the borders of the catchment with adequate length that were considered to give a good reflection of the rainfall in the Msikaba River catchment. The spatial distribution of these rain gauges is regarded as good. There is, however, concern that the rain gauges currently in operation do not adequately cover the catchment, and more rain gauges are required in the drier, upper western portion of the catchment.

A preliminary set of 13 rainfall records was selected for evaluation, based on the position of the rain gauges as well as record length. The available rain gauges in the catchment area are listed in **Appendix B-1** and the period of available data are shown as bar graphs in **Appendix B-2**.

To ensure that no reliable station is overlooked, the list of gauges was compared with rain gauges used in previous studies ((WRC, 1994), (WRC, 2009), (DWAF, 2001) and (DWAF, 2007)).

2.3.3 Processing of raw rainfall records

a) Verification of point rainfall records

An initial scanning procedure, considering the length of the records, reliability of data (MAPs and percentage gaps), consistency (mass plots) and geographical position, was undertaken to identify suitable gauges for the patching process. No patching from previous studies was accepted and all data patching were performed from scratch.

The time period selected for evaluation, based on the availability of historic rainfall records, was October 1920 to September 2008. All data before and after the desired period were discarded.

b) Determination of record value reliability

The monthly rainfall values of all the selected rain gauges were screened for suspect values (usually zero values in wet months). Only 13 stations were screened which made it possible to visually compare monthly rainfall at all the gauges, to detect suspect values. Potential errors were also compared against significant weather events (Caleum – incorporated in the WRYM) that occurred in the Lusikisiki area between 1961 and 2004.

c) Flagging of outlier values

Suspect monthly rainfall values were flagged as outliers. If there were many gaps either at the beginning or at the end of the record, the years with the gaps were omitted.

2.3.4 Infilling of raw rainfall records

a) Patching of outlier values

All flagged rainfall values have to be filled in or patched using rainfall data from surrounding gauges. This process, called patching, was performed using the ClassR/PatchR suite of programs, which are incorporated in the Rain-IMS. Rain gauges were grouped together for patching on the basis of close proximity, MAP and record period.

The values regarded as suspect, and therefore flagged for patching, are summarised in **Appendix B-3**. All flagged data, which include the data marked as unreliable and incomplete by DWA, are given as **Appendix B-4**.

The main function of the ClassR program is to group hydrological similar rain gauges. The ClassR classification is used as input to PatchR. The PatchR program patches missing and unreliable values. PatchR performs a simultaneous, multiple patching of monthly rainfall records in an iterative procedure.

Both ClassR and PatchR assisted in the process of identifying possible outlier values. These values were examined and considered for patching. If there were any doubt if a value was an outlier, the original value was accepted. If any new values were flagged, PatchR was run for a second time to patch the flagged values. A total of eight rainfall records were patched.

Appendix B-5 gives a detailed description of the gauges used to patch a specific record as well as the success of the patching. All patched rainfall records are also electronically available in the DWA Rain-IMS under the following headings:

- Study: Southern Africa
- Model: Rainfall
- Sub-area: Lusikisiki

b) Post processing of patched records

After the rainfall records were patched, all monthly values reduced as a result of the ClassR/PatchR patching, were replaced with the original observed values. The reason for not reducing values is that errors are normally introduced through gaps in the

record, leakage or overflowing of a rain gauge and one would normally expect a value to increase with patching. The MAP of each patched record was recalculated inside the Rain-IMS.

The patched rain gauges were also tested for stationarity. The stationarity of a rain gauge is determined by inspection of the single mass plot. Single mass plots are graphs of cumulative annual rainfall plotted against time and give an indication of the consistency of the data. Ideally the mass plot for a station should form a straight line, indicating stationary data. Cyclic deviations from this line indicate wetter and drier periods. Any significant change in the gradient of the mass plot indicates a change in continuity at the gauge. Breaks are usually caused by external factors, for example relocating the gauge or change to the surroundings. Most of the rain gauges showed mass plots that are essentially linear. Where deviations occurred they were generally over the same period. Only one rain gauge (012 9007 W at Bukazi) was considered to be non-stationary and discarded.

The patched records listed in **Appendix B-6** were evaluated for breaks in stationarity and rejected, where appropriate. The mass plots of the accepted patched rain gauges are attached in **Appendix B-7**.

2.3.5 Catchment rainfall

a) Catchment mean annual precipitation

The MAPs for the quaternary catchments in the WR90-study were calculated from a 1" x 1" rainfall data grid. Since the data period of the national database has grown by more than 10 years since the WR90 study, it was deemed necessary to confirm or adapt the WR90 MAPs. The MAPs of the rainfall records used in the WR90-study were compared with the extended MAP up to September 2008. No anomalies were encountered and the WR90 MAP values were accepted without change.

b) Catchment rainfall records

After the rainfall records in the catchment were patched, one representative rainfall record for the three quaternary catchments was compiled based on the spatial and temporal distribution of the available rain gauges.

It was noted that the monthly rainfall amongst the rain gauges were relatively homogeneous, with fairly constant rainfall between measured values. This improves the confidence in the catchment rainfall which should reflect on the spatial distribution of rainfall in the catchment. Because of the rainfall homogeneity, the criteria chosen to compile the catchment rainfall records from the point rainfall station were based on record length of the stations that are currently open. This was done to avoid using shorter rainfall records where the record period falls outside of the WRSM2000-calibration period, and which are not anymore operational. This resulted in some extension of rainfall data. The maximum number of years of extension never exceeded seven years.

The quaternary catchment rainfall records, which are attached in **Appendix B-8**, were created using the improved functionality within the RAIN-IMS. This involves expressing each monthly value as a percentage of the gauge's MAP and then calculating the average percentage for all the gauges used to create this particular catchment rainfall file.

These catchment rainfall files were multiplied with the MAP for each quaternary catchment for calculation of irrigation demands and for use by groundwater modellers.

2.3.6 Point rainfall records

In addition to catchment rainfall records, point rainfall records are also required at each reservoir to calculate the net evaporation losses from reservoirs. The only potential dam in the Msikaba River catchment is the proposed Zalu Dam.

The catchment rainfall record and the appropriate MAP at each reservoir are needed to calculate a representative point rainfall record in millimetre (mm) for each reservoir. The naming convention is to use a "ran" extension. The MAP of the rainfall record closest to a reservoir is adopted for calculating the MAP. The catchment MAP and the catchment rainfall file are used at dummy dams to create a point rainfall file.

Table 2.2 provides details for rainfall gauging station 0154 142 W, which was used to derive the point rainfall record for the proposed Zalu Dam.

Table 2.2: Details of the point rainfall record for the proposed Zalu Dam

Reservoir name	Closest rain gauge	MAP (un-patched rain gauge) (mm)	MAP (patched rain gauge) (mm)	Point rainfall file name
Proposed Zalu Dam	0154 142 W	987 (1908 - 1994)	1 003 (1920 - 2007)	Zalu.RAN

2.3.7 Rainfall results

Table 2.3 provides a comparison of the selected rain gauges between this study (LRWSS, 2011) and WR2005 and the Pondoland study for the relevant periods.

Table 2.3: Selected and rejected rain gauges in the Msikaba River catchment

SELECTED AND REJECTED RAIN GAUGES IN THE MSIKABA RIVER CATCHMENT									
Gauge number	Station name	Quat	Start year	End year	MAP (mm)	Used in previous studies			
						WR90	WR2005	Pondo-land	This study
0129 007 W	PORT ST JOHNS - BOS	T70B	1922	2008	1 246	Y	Y	N	N
01290068 A	CAPE HERMES -VRT	T70B	1938	1983	1 210	N	N	N	N
01290068 W	PORT ST JOHNS - POL	T70B	1937	2008	1 232	N	N	N	N
01290068 AW	CAPE HERMES - VRT	T70B	1886	2008	1 026	N	N	N	N
01290068 BW	PORT ST JOHNS - POL	T70B	1976	1977	-	N	N	N	N
0153 631 W	TABANKULU - BOS	T32H	1915	2008	1 170	N	Y	N	Y
0153 820 W	BUKAZI	T32H	1957	1974	778	N	N	N	N
0153 875 W	FLAGSTAFF - TNK	T60E	1899	2000	851	Y	Y	Y	Y
0154 142 W	LUSIKISIKI - TNK	T60F	1908	1994	987	Y	Y	Y	Y
0154 143 W	LUSIKISIKI PRISON	T60F	1995	2008	991	N	N	N	N
0154 151 W	MALONGWANA	T60B	1952	1967	1 096	N	N	N	N
0154 279 W	HOLY CROSS MISSION	T60F	1941	1973	939	N	N	Y	N
0154 354 W	NTSUBANE - BOS	T60H	1914	2008	1 484	Y	N	Y	Y
0154 796 W	MKAMBATI	T60G	1924	2008	1 218	Y	N	Y	Y
0239 058 I	MOUNVIEW P.M.B	N/a[1]	No record		0	N	N	N	N
0239 760 I	SAPEKOE Richmond	N/a[1]	No record		0	N	N	N	N
T6E001	LUSIKISIKI @Ntafufu	N/a[1]	No record		0	N	N	N	N
T6E002	LUSIKISIKI @Magwa	N/a[1]	No record		0	N	N	N	N
T6E003	FLAGSTAFF - TNK	N/a[1]	No record		0	N	N	N	N
T6E004	LUSIKISIKI	N/a[1]	No record		0	N	N	N	N

[1]*N/a= No data available*

Appendix B-9 shows the distribution of the average, minimum and maximum monthly rainfall in quaternary catchments T60E, T60F and T60G based on the record period 1920 to 2007. The seasonal variation of rainfall is very low and the annual maximum rainfall can occur in any month; notably some of the highest monthly rainfall figures were recorded during the month of July.

November to March constitutes the wet months, with May to August being the dry period. October, September and April are transitional months. The catchment MAPs are 885 mm, 940 mm and 1 116 mm in T60E, T60F and T60G, respectively.

Appendix B-10 shows the variation in the annual rainfall over the record period as well as its deviation from the MAP. This annual rainfall data was compared with MAP for each sub-catchment as can be seen on the graphs. It is interesting to note that the total annual rainfall is generally below the MAP.

The highest annual rainfall recorded were in the hydrological year 1996 when 1 300, 1 420 and 1 700 mm were recorded in T60E, T60F and T60G, respectively. The years with the lowest rainfall recorded are 1940 when 610, 620 and 740 mm were recorded in T60E, T60F and T60G, respectively.

2.4 EVAPORATION

2.4.1 Overview

Mean annual evaporation (MAE) is fairly constant from one year to the next, but differs significantly between months and seasons. Evaporation is therefore modelled in the hydrological models (WRSM2000 and WRYM) using 12 average monthly evaporation factors, rather than a time series of evaporation.

2.4.2 Monthly evaporation

There are no observed DWA evaporation records in this catchment. According to the WR2005-study (WRC, 2009), the Msikaba River catchment is situated in the WR2005-evaporation zone 30C with a S-pan MAE of 1 151 mm/a. The mean monthly gross S-pan evaporation as a percentage of the mean annual gross evaporation is given in **Table 2.4**.

Table 2.4: Mean monthly gross S-pan evaporation (% of MAE)

Evaporation zone	Average monthly S-pan evaporation											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
30C	8.70	8.76	11.18	12.02	10.41	9.95	7.71	6.34	4.74	5.24	7.22	7.73

The mean monthly gross S-pan and A-pan evaporation (in mm) are given in **Table 2.5**.

Table 2.5: Mean monthly gross S-pan and A-pan evaporation

Pan type	Average monthly evaporation												
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	MAE
S-Pan (mm)	100	101	129	138	120	114	89	73	55	60	83	89	**1 151**
A-Pan (mm)	134	135	165	176	156	150	122	105	85	91	116	122	**1 557**

Observed evaporation from pans are usually higher than the actual evaporation from dams because of the impact of the larger surface area of the reservoir, wind, humidity, etc. Twelve monthly S-pan-to-dam factors are therefore used to convert pan evaporation to dam evaporation. **Table 2.6** gives the S-pan-to-dam conversion factors adopted for this study.

Table 2.6: S-pan-to-dam conversion factors

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
0.81	0.82	0.83	0.84	0.88	0.88	0.88	0.87	0.85	0.83	0.81	0.81

2.4.3 Evaporation results

The mean average monthly evaporation (MAE) curve is shown in **Appendix C-1**. The S-Pan MAE for the Msikaba River catchment is 1 151 mm.

2.5 Catchment Developments

2.5.1 Overview

Land use throughout much of the area consists of small-scale or subsistence agriculture comprising cultivation of cash crops (predominantly maize and vegetables) and a variety of livestock. Afforestation, invasive alien plants (IAPs), irrigation and domestic water use are considered to be the main water users in the Msikaba River catchment.

2.5.2 Irrigation

Information on irrigation was obtained from **KARIWA Project Engineers** indicating that there is at present no significant irrigation in the Msikaba River catchment.

2.5.3 Domestic abstractions and return flows

The historic record of water abstracted for the Lusikisiki Water Treatment Works (WTW) from the Xura River at the bridge in the Xura River (at gauging station T6H004) and metered by T6H005, was used to model the domestic water supplied to Lusikisiki. The water abstraction has grown from approximately 0.75 million m^3/a in 1999 to 1.1 million m^3/a in 2007 and 1.4 million m^3/a in 2011.

2.5.4 Afforestation

Google Earth indicated very little afforestation development in the Msikaba River catchment, and **KARIWA** confirmed these observations. The WR2005 afforestation area of 2.9 km^2 in T60G was therefore accepted to be the only significant afforestation in the Msikaba River catchment.

2.5.5 Invasive alien plants

After some investigation, the adopted WR2005 (WRC, 2009) invasive alien plants (IAP) areas were accepted as being the best available information related to the reduction of run-off by IAP. **Table 2.7** summarises the IAP areas adopted for modelling.

Table 2.7: Areas of invasive alien plants (IAP) in the Msikaba River catchment

Quaternary catchment	Catchment area (km^2)	IAP area (km^2)	% of catchment covered by IAPs
T60E	198.0	1.6	0.8
T60F	464.0	3.8	0.8
T60G	360.0	0.0	0.0
MSIKABA RIVER TOTAL	**1 022.0**	**5.4**	**0.5**

2.6 DATA REQUIREMENTS FOR THE WRSM

The WRSM2000-model is a monthly rainfall-runoff model and rainfall data are used to extend and simulate time-series of flow records at points of interest for natural and present day development levels.

2.6.1 Meteorological data

Rainfall and evaporation data are required as input data to the WRSM2000 model.

a) Rainfall

Catchment rainfall records (as percentage of MAP) serve as the primary input to simulate runoff from rainfall in the WRSM2000 model for the Msikaba River catchment.

b) Evaporation

The MAE is fairly constant from one year to the next but there is a significant difference between the monthly and seasonal evaporation. Evaporation is therefore modelled in the WRSM2000 model using 12 average monthly evaporation values rather than a time series of evaporation.

2.6.2 Hydrological data (stream flow data)

a) Overview

Monthly flow data, which can either be an observed flow record or a calculated reservoir inflow record, are used to calibrate the monthly WRSM2000 model against the simulated flow from rainfall to obtain catchment specific rainfall-runoff parameters. After a satisfactory calibration is achieved, the calibration parameters are used as the simulation parameters to simulate a flow record for the entire rainfall period. The calibration parameters can be transferred to adjacent hydrological homogenous catchments and used as simulation parameters where there are insufficient flow data. The output of the WRSM2000 model is natural and present day flow and land-use records.

b) Evaluation of available flow data

The Department of Water Affairs (DWA) website of the Directorate: Hydrological Services was contacted for flow data and consulted regarding the reliability of the two flow records in the Msikaba River. A summary of the flow gauges in the Msikaba River catchment is given in **Table 2.8** and the evaluation of T6H004 is attached as **Appendix D-1.**

Table 2.8: Flow data in the Msikaba River catchment

Station	Place	Area (km²)	Latitude	Longitude	Data Available	Remarks
T6H004	Xura River @ Xura	92.9	31°19' 40"	29° 31' 36"	Mar 1992 to Nov 2010	Measure river flow
T6H005	Xura @ Lusikisiki WTW	N/A	N/A	N/A	Jun 2000 to Feb 2010	Measure water abstracted upstream of T6H004 for the WTW

The raw observed flow records for T6H004 and T6H005 are attached in **Appendix D-2** and the patched flow record for T6H004 is included in **Appendix D-3**.

2.7 CALIBRATION OF THE WRSM2000-MODEL

2.7.1 Methodology

Simulated monthly flow data are generally used to extend or infill observed flow data to obtain a complete record, covering the analysis period. The rainfall-runoff enhanced WRSM2000 model was used to calibrate simulated flow against measured flow at T6H004 for the period 1997 to 2007 and to simulate flow records for the period 1920 to 2007 for the Msikaba River catchment.

2.7.2 Modelling approach

Calibration of the WRSM2000 (enhanced) model consists of an iterative process where adjustments to the catchment parameters are made until the simulated values compare favourably with the observed flows. The regional set of parameters for the groundwater sub-module (Sami model), which is a sub-module of the WRSM2000 (enhanced) model, which is an update of the parameters used by the WRSM2005-study, was obtained from SSI, specialist consultants responsible for the development and updating of the WRSM. As a first estimate, values were based on the recommended regional parameters of the WR2005 results. Thereafter, the WRSM2000 parameters were adjusted until an optimal fit between the monthly simulated flows and the observed flows was achieved.

2.7.3 WRSM2000 configuration

The schematic diagrams for the WRSM2000 model setup are included in **Appendix E-1**.

The graphical comparison of the observed versus simulated flows for the calibration period (1997 to 2007) and the calibration statistics are attached as **Appendix F-1**.

Patching was done iteratively during calibration. Only values flagged as unreliable or incomplete were patched. Whenever the simulated monthly flow value was smaller than the observed value, the original value was accepted and only in exceptional circumstances not replaced by the simulated value as unreliable data flags is generally a result of missing data.

2.7.4 Calibration

Flow gauging station T6H004 is located in T60F in the Xura River downstream of the proposed Zalu Dam. The catchment area of T6H004 is 92.9 km². Water is abstracted just upstream of T6H004 and piped to the Lusikisiki WTW where it is measured at T6H005. The DWA Cradock Regional Office confirmed that the gauged data are considered to be of good quality from 1997 to date. Unfortunately the gauging capacity of the weir is exceeded at flows of more than 1.5 m quite often (13 months with exceedance flags occurring during the calibration period of 11 years). This means therefore that more confidence can be attached to the low flows than the high flows and calibration should be achieved through the best visual fit of the low, rather than the high flows.

The T60F catchment is considered to be largely natural and the effect of land-use on the runoff is considered to be very small. The calibration statistics are summarised in **Table** 2.9.

Table 2.9: Calibration statistics for gauge T6H004 (Oct 1997- Sep 2008)

Index	Unit	Observed	Simulated	Difference (%)
Mean annual runoff	million m³/a	15.27	15.67	-2.62
Mean (Log)	million m³/a	1.11	1.13	-1.80
Annual standard deviation	million m³/a	8.79	7.79	11.38
Standard deviation (Log)	-	0.27	0.25	7.41
Coefficient of variability	%	57.54	49.72	13.59
Seasonal index	%	20.46	23.05	-12.66

2.7.5 Regionalisation of parameters

The calibration parameters for T6H004 were adopted as the regionalised parameters in the quaternary catchment T60F. These calibration parameters were similar to the WR2005 regional parameters of T60E and T60G. Therefore the parameters for T60E and T60F were not adjusted for this study.

The LRWSS calibration parameters and WR2005 regional parameters are given in **Appendix F-2**. The LRWSS regionalised parameters are given in **Appendix G-1**.

2.8 NATURAL FLOW

2.8.1 Methodology

Natural flows were obtained by eliminating the influence of all land uses within a catchment from the observed flow of that catchment. The WRSM2000 rainfall-runoff model with all catchment developments and water demands included allows calibration against the observed flow record. The actual historic water supplied is therefore directly generated by the model.

The natural flow time series for the period October 1920 to September 2008 was obtained for each quaternary catchment, and quinary where required, by running the WRSM2000 model with calibration and regionalised parameters and no land-use influences. The regionalised parameters are given in **Appendix F-2**.

The catchment developments considered are:

- Irrigation demands and return flows;
- The impact of impoundments;
- Increased impervious areas in the urban areas;
- Abstractions and return flows from industrial and urban users;
- Impacts of mining on runoff;
- Inter-basin transfers;
- Afforestation and Invasive Alien Plant water usage; and
- Decreased areas of runoff as a result of mining activities.

2.8.2 Simulation results

Natural and present day flows were simulated with the WRSM2000 model using the regionalised WRSM2000-parameters shown in **Appendix G-1**. The simulated flow records per quaternary catchment for the entire Msikaba River catchment are given in **Appendix G-2** and summarised in **Table 2.10**.

The LRWSS results were compared with the WR2005 results for the period 1920 to 2005.

The LRWSS results were also compared with results from the Eastern Pondoland Basin Study (EPBS) (DWA, 2001) for the common record period from 1920 to 1996.

Table 2.10: Natural flow generated for the Msikaba River catchment

Quaternary catchment	Catchment area (km²)	1920 - 2007		1920 - 2005				1920 - 1996			
		LRWSS (2011)		LRWSS (2011)		WR2005 (2005)		LRWSS (2011)		EPBS (2001)	
		Natural MAR		Natural MAR		Natural MAR		Natural MAR		Natural MAR	
		(million m³)	(mm)	(million m³)	(mm)	(million m³)	(mm)	(million m³)	(mm)	(million m³)	(mm)
T60E	198.0	29.5	149.0	29.3	147.7	26.8	135.3	29.9	151.1	28.0	141.4
T60F	463.9	85.8	184.8	84.7	182.6	89.2	192.2	85.9	185.0	79.1	170.5
T60G	360.0	105.7	293.6	105.2	292.2	96.4	267.8	105.6	293.4	100.3	278.6
Total[1]	**1 021.9**	**221.0**	**216.3**	**219.2**	**214.5**	**212.4**	**207.8**	**221.4**	**216.7**	**207.4**	**203.0**

[1] The unit runoff (mm) from the catchment is not necessarily the same as the sum of the sub-catchments

Table 2.11 gives a breakdown of the natural flow in the Xura River. Mass plots of the natural flow data per quaternary catchment were created to test for stationarity and are included in **Appendix G-3**.

Table 2.11: Natural flow generated for the Xura River catchment

Quaternary catchment	Catchment area (km²)	Natural MAR (million m³/a)
T60F1	71.4	13.2
T60F2	21.5	4.0
T60F3	271.1	50.2
T60F4	99.9	18.5
Total T60F	**463.9**	**85.9**

Appendix G-4 gives a graphical view of the seasonal distribution of the natural flow per quaternary catchment. It is shown that there is a big variation of flow within a specific month, but that there are no big differences in the monthly average flow. There is a slight decrease in the average flow for the months May, June, July and August but high flows can occur in any month.

2.9 Present Day Flow

Estimates of present day flow data are based on the development level as in the hydrological year 2007. The present day development does not have a significant influence on the available water in the Msikaba River catchment. **Table 2.12** gives a

comparison of natural vs. present day MAR for the Msikaba quaternary and quinary catchments. Please note that the catchment area of T60F4 does not contribute to the runoff of the Xura River. The present day flow records that differ from the natural flow records are included in **Appendix H-1**.

Table 2.12: Present day flow generated for the Msikaba River catchment

Catchment	Catchment area (km^2)	Natural incremental MAR (million m^3/a)	Present day cumulative MAR (million m^3/a)
Msikaba River upstream of confluence with Xura River	297.9	48.0	47.5
Xura River upstream of Zalu Dam	71.3	13.1	12.5
Xura River downstream of Zalu Dam	292.7	54.2	53.1
Msikaba River downstream of the confluence with the Xura River	360.0	105.7	105.7
Total T60E,F&G	**1 021.9**	**221.0**	**218.8**

The water usage based on the present day development levels is given in **Table 2.13**.

Table 2.13: Present day water usage (2007)

Quaternary catchment	Catchment area (km^2)	Afforestation usage (million m^3/a)	Alien vegetation usage (million m^3/a)	Domestic usage (million m^3/a)
T60E	198.0	0.3	0.2	0.0
T60F1	71.3	0.0	0.6	0.0
T60F2	21.6	0.0	0.0	1.0
T60F3	271.1	0.0	0.0	0.0
T60F4	99.9	0.0	0.0	0.0
T60G	360.0	0.0	0.0	0.0
Total T60E,F&G	**1 021.9**	**0.3**	**0.8**	**1.0**

The present day water usage flow records are included in **Appendix H-2**.

2.10 Validation and Verification of the Streamflow

The validation and verification of the generated streamflow records are discussed in **Appendix J**. The results show no anomalies in the generated streamflow records.

3 SEDIMENTATION ASSESSMENT

3.1 SEDIMENT TRANSPORT IN GENERAL

Sediment transported by rivers is partly and often largely deposited in reservoirs, causing a loss in storage capacity and adversely affecting reservoir yield. This does not only impact on the effective life of a reservoir, but also influences the related infrastructure, e.g. outlet works, as well as the upstream backwater effects and riverine ecological systems. Reservoir sedimentation is dependent on catchment sediment yield, which is calculated according to catchment location and size, as well as sediment yield potential of the geological formations within the catchment.

The quantity of sediment transported by a given river depends upon the availability of transportable material, i.e. sediment yield potential of the soils within the catchment. Although transporting capacity determines the quantity of sediment that can be transported, either by aeolian transport or run-off, land use determines the potential sediment yield from a catchment. Therefore, one of the practical problems encountered in the analysis of catchment sediment yield is that it not only varies in space, but also in time as conditions change. In addition, both the varying water flow and sediment load in a river result in a water/sediment ratio that varies over a wide range with time.

3.2 APPROACH TO SEDIMENT PREDICTION

Sediment yield for the Zalu Dam catchment has previously been determined as follows:

- *Eastern Pondoland Basin Study* (EPBS) (DWAF, 2001): Sediment yield prediction by using a regional empirical method based on the 1992 Water Research Commission (WRC) sediment yield map with V_{20} = 0.8 million m³; and
- *Investigating the Potential to Supplement the Lusikisiki Rural Water Supply Scheme* (LRWSS Augmentation) (DWA, 2009), hereafter referred to as the SRK Lusikisiki Groundwater Feasibility Study Phase 2. No methodology provided, but with V_{20} = 1.1 million m³, where V_{20} is the reservoir sediment volume after 20 years.

However, subsequent to the completion of the above studies, an updated WRC sediment study titled *Sediment Yield Prediction for South Africa – 2010 Prediction*, hereafter referred to as the 2010 Sediment Yield Prediction (Water Research Commission, 2010)

has been completed. In order to evaluate or improve the previously determined sedimentation yield estimates, the catchment sediment yield was revisited and determined in terms of both the 1992 and 2010 sediment yield approaches. The results are also compared to the available recorded sedimentation of the nearby Mthatha Dam with the aim to arrive at a reliable estimate of the yield of the proposed Zalu Dam in the long-term, taking into account the loss of effective storage over time.

3.3 CATCHMENT DESCRIPTION

3.3.1 Dam site location

The proposed Zalu Dam is located on the Xura River, a tributary of the Msikaba River, approximately 50 km north-west of Port St Johns and 11 km north-west of Lusikisiki within the T60F quaternary catchment in the Eastern Cape. The catchment area of the proposed dam is 71.35 km². The proposed Zalu Dam catchment is bordered by the Mzimvubu River quaternary catchments T32H (north-west) and T36A (west) and the quaternary catchment T60J (south), as indicated in **Appendix A-4**.

No major existing dams are located in the Msikaba River catchment. Smaller dams in Drainage Region T60 include the Magwa and Mhlanga Dams to the south-east, while the Majola Dam is located to the south-west in Drainage Region T70. The closest large dam is the Mthatha Dam, located in quaternary catchment T20B on the Mthatha River, approximately 75 km to the south-west of the proposed Zalu Dam site, as indicated in **Appendix A-4**.

3.3.2 Catchment characteristics

The hydrological characteristics of the Zalu Dam catchment are summarised and compared to previously determined characteristics in **Table 3.1**.

Table 3.1: Zalu Dam catchment hydrological characteristics

Description	Reference Study (year)		
	LRWSS Augmentation (2011)	EPBS (2001)	SRK Groundwater Feasibility Study Phase 2 (LRWSS Augmentation) (2009)
Catchment area (km²)	71.35	71	71
Longest watercourse (km)	19.92[1]	17	17
Average catchment steepness (%)	14	14	14
Time of concentration (hours)	3.4	3.5	3.5
Mean annual precipitation (MAP)(mm)	900	920	935

[1] *Based on Google-information*

3.4 FLOOD PEAK ANALYSIS

A flood peak analysis at the Zalu Dam site in terms of various return periods, and based on three different flood peak calculation approaches, and different analyses for the *Rational Method and Synthetic Unit Hydrograph (SUH)*, were undertaken for the "coastal" and "inland" regions in terms of MAP as summarised in **Table 3.2**. These values are compared in **Table 3.3** with values previously determined during the *EPBS* and the *SRK Groundwater Study Phase 2.* The LRWSS values for the *Rational Method* and the *SUH* as indicated in **Table 3.3** are based on the average of the "coastal" and "inland" values as indicated in **Table 3.2**. The flood peak Q_T refers to a flood with a recurrence interval of 1 in T years, while Q_{RMF} refers to a flood peak associated with the Regional Maximum Flood (RMF).

Table 3.2: Zalu Dam catchment flood peak analysis

Return Period (years) *T*	Flood Peak Flow Q_T(m³/s)					
	Rational Method (coastal)	Rational Method (inland)	Alternative Rational Method	Unit Hydrograph Method (coastal)	Unit Hydrograph Method (inland)	Empirical (Midgley & Pitman)
2	82	107	85	31	56	-
5	116	152	154	50	88	-
10	152	199	215	72	124	101
20	201	263	284	98	167	136
50	289	378	388	143	239	189
100	386	505	486	192	312	239
200	476	622	550	200	476	622

Table 3.3: Zalu Dam catchment comparative flood peak analysis

Flood peak analysis method	Name of study	Flood peak Q_T (m³/s)							
		Return period (years)							
		2	5	10	20	50	100	200	RMF
Rational Method	EPBS	55	125	180	240	335	420	505	1 090
	SRK Groundwater Study Phase 2	81	132	182	246	386	548	625	1 090
	LRWSS	95	134	176	232	333	446	549	-
Synthetic unit hydrograph (SUH)	EPBS	43	75	98	126	166	199	234	-
	SRK Groundwater Study Phase 2	43	86	97	133	194	260	320	-
	LRWSS	43	69	98	132	191	252		-
MIPI (Midgley-Pitman)	EPBS	27	63	96	136	197	249	307	-
	LRWSS (based on Q_T / Q_{RMF})	-	-	101	136	189 (431)	239 (554)	(692)	1 090

The Rational Method is, in general, recommended for catchments smaller than 15 km² but can be used for catchments up to 70 km². The SUH is, in general, suitable for the determination of flood peaks for medium-sized rural catchments in the range of 15 to 5 000 km², but should be used with care for catchments less than 100 km². The Midgley-Pitman approach is a typical empirical equation based on the combination of experience, historic data and/or the results of other methods. It has no limitation in terms of area of application but is, in general, more suited to check the order of magnitude of the results obtained by means of the other methods.

For the purposes of the sedimentation investigation, and based on the applicability of the abovementioned methods to the catchment, the weighted average Q_{10} was determined as 35%, 45% and 20% of the Rational, SUH and Midgley-Pitman methods, respectively, i.e. approximately 125 m³/s.

3.5 Catchment Sediment Yield Potential

Land use throughout much of the area consists of small-scale or subsistence agriculture comprising cultivation of cash crops (predominantly maize and vegetables) and a variety of livestock. Afforestation, invasive alien plants (IAPs) and domestic water use are considered to be the main water users in the Msikaba River catchment.

3.5.1 Generalised sediment yield patterns

Sediment accumulation is recorded at a number of reservoirs, over many years, by the DWA and recorded on an annual basis in a Dam List issued by DWA Hydrographic Surveys. The analysis of these measurements has made it possible to calculate average sediment yields for the catchments related to these reservoirs. In order to make use of this recorded data, especially for the purposes of predicting sedimentation rates, various sediment yield maps were produced in the past. These maps are, in general, referred to as the 1975, 1992 and 2010 versions of the Sediment Yield Map. For the purposes of this investigation the 1992 and 2010 versions are briefly discussed below.

a) 1992 Sediment Yield Map

Using available recorded sedimentation data and additional data on sediment loads in rivers, the 1975 Sediment Yield Map was updated in 1992 under the direction of the Water Research Commission (WRC). The updated 1992 Sediment Yield Map (WRC, 1992) is based on dividing Southern Africa into nine sediment yield regions and subsequent calibration in terms of recorded yield values. Sediment yields are calculated according to catchment location and size, as well as sediment yield potential within the catchment. In the absence of comprehensive measured data this sediment yield map formed a basis for catchment sediment yield estimation for this study.

In terms of the 1992 Sediment Yield Map, sediment yield potential or erodibility is based on a distinction between 20 erodibility categories, representing eroding and transporting capacity (e.g. soil types, land use, rainfall characteristics, slopes, etc.). These erodibility index categories are combined to establish three classes of sediment yield potential, i.e. high, medium and low, creating the sediment yield map. Site specific catchment sediment yield is obtained through the equation

$$Y_C = Y_S \left[F_H * \frac{A_H}{A_T} + F_H * \frac{A_M}{A_T} + F_L * \frac{A_L}{A_T} \right]$$

where

Y_C = estimated catchment sediment yield (t/km²/a).
Y_S = standardised sediment yield (t/km²/a).
F_H = high yield potential factor
F_M = medium yield potential factor

F_L = low yield potential factor
A_H = size of area consisting of soils with high sediment yield potential (km²)
A_M = size of area consisting of soils with medium sediment yield potential (km²)
A_L = size of area consisting of soils with lower sediment yield potential (km²)
A_T = total catchment area (km²)

b) 2010 Sediment Yield Prediction

Updated methods were developed during the recent WRC sediment study *Sediment Yield Prediction for South Africa – 2010 Prediction*. These methods were developed to provide a better understanding of erosion and sediment yield as well as to incorporate more up-to-date information for efficient decision making in water resources planning. This is required for the purposes of sediment control in rivers, existing and future reservoirs, updated sediment yield prediction and analysis. The study involved the improvement of the 1992 Sediment Yield Map with a resulting ten relatively homogenous sediment yield regions demarcated across South Africa. Three sediment yield prediction methods, including probabilistic, empirical and mathematical modelling, are proposed.

Sediment transport is a hydrological process and therefore a function of the same parameters that influence all hydrological processes. During the *2010 Sediment Yield Prediction* research, sediment load was evaluated as a dependent variable in terms of the flood recurrence interval, average river slope, river network density, catchment area and weighted Erosion Hazard Class. Based on regression analysis, empirical equations were derived for the purpose of catchment sediment yield calculation for Regions 1, 2, 4, 5, 7 and 8. No equations for Regions 3, 6, 9 and 10 were derived because of poor and limited data. Instead, a probabilistic method is recommended for Regions 3, 6 and 9 while Region 10 should use locally observed data.

Sediment load applicable to the 2010 Sediment Yield Prediction Region 7 can be obtained through the empirical equation

$$Q_S = 30 * Q_{10}^{0.36} * S_0^{0.33} * R_{nd}^{0.29} * A_e^{0.61} * E_{IW}^{0.58}$$

where:

Q_S = sediment load (t/a)
Q_{10} = flood with a recurrence interval of 1 in 10 years (m^3/s)
R_{nd} = river network density (m/km^2)
A_e = effective catchment area (km^2)
E_{IW} = weighted erosion hazard class according to sub-catchment areas
S_O = average river slope (%)

c) Confidence bands

Previously, sedimentation prediction allowed a great deal of subjectivity in the estimation of catchment sediment yield. Both the 1992 and 2010 sediment yield prediction approaches, however, allow for the provision of some statistical band of confidence around the mean. Although the most likely yield value for an area still has to be estimated with due consideration of the availability of sediment within the catchment as well as other factors which influence sediment yield, it is possible to put some statistical meaning to an estimate and to bring catchment size into consideration.

3.5.2 Regional catchment sediment yield

Relevant regional catchment potential is described below in terms of both the 1992 and 2010 sediment yield prediction methodologies.

a) 1992 Sediment Yield Map

In terms of the 1992 Sediment Yield Map, the Zalu Dam catchment falls within Sediment Yield Region 9, located in the Eastern Cape, with a regional catchment sediment yield pattern with variability from 4 to 881 $t/km^2/a$. These catchment sediment yields were obtained from reservoir surveys available for 18 sites, with record lengths that vary in length from 8 to 72 years, resulting in a regional standard average catchment sediment yield of 185 $t/km^2/a$.

b) 2010 Sediment Yield Prediction

In terms of the 2010 Sediment Yield Prediction, the Zalu Dam catchment falls within Sediment Yield Region 7, located in the Eastern Cape, with measured sediment yield

values available from 18 reservoirs. Due to the varying reservoir catchment characteristics the associated catchment sediment yields vary between 94 t/km²/a and 1 509 t/km²/a.

3.5.3 Zalu Dam catchment sediment yield

Using the 1992 Sediment Yield Map and the 2010 Sediment Yield Prediction, site specific weighted average catchment sediment yield values were determined for the proposed Zalu Dam catchment.

a) 1992 Sediment Yield Map

With the Zalu Dam catchment located in the 1992 Sediment Yield Map Region 9, the site specific parameters for the Zalu Dam is summarised in **Table 3.4**. The associated erodibility index of the Zalu Dam catchment in terms of the 1992 Sediment Yield Map is graphically indicated in

Figure 3.1 while the sediment yield classification for the Zalu Dam catchment is graphically indicated in **Figure 3.2**. It is to be noted that the total Zalu Dam catchment primarily contains soils with a high sediment yield potential.

Substitution of the catchment yield equation provided in **Section 3.5.1** with the abovementioned information results in a site specific weighted average catchment sediment yield of 185 t/km²/a.

Table 3.4: 1992 Sediment yield map values for the Zalu Dam catchment

Parameter	Unit	Value
Regional standardised yield (Y^S)	t/km²/a	185
High yield potential factor (F_H)	-	1
Medium yield potential factor(F_M)	-	1
Low yield potential factor(F_L)	-	n/a
Area with high sediment yield potential(A_H)	km²	71.35
Area with medium sediment yield potential(A_M)	km²	0
Area with low sediment yield potential(A_L)	km²	0
Total catchment area	**km²**	**71.35**

n/a=not available

Allowing for some statistical confidence around the mean, confidence bands can be adopted with a multiplication factor applied to the weighted average catchment

sediment yield. For Region 9 of the *1992 Sediment Yield Map* these multiplication factors applicable to a catchment area of 71.35 km² for confidence bands of 80%, 90% and 95% as well as the associated catchment sediment yield are indicated in **Table 3.5**.

Table 3.5: **1992 Sediment Yield Map Region 9 confidence multiplication factors and associated catchment sediment yield for Zalu Dam**

Confidence band	Multiplication factor	Catchment sediment yield (t/km²/a)
80%	4	740
90%	7	1 295
95%	9	1 665

b) 2010 Sediment Yield Prediction

The associated erosion index of the Zalu Dam catchment in terms of the *2010* Sediment Yield Prediction is graphically indicated in

Figure 3.3, while the relevant Region 7 empirical equation parameters are defined below.

- Flood peak discharge Q_{10}

Based on the results of the Zalu Dam site flood frequency analysis as indicated in **Section 3.4**, the flood peak discharge for a recurrence interval of 10 years, Q_{10} is based on the assumption of a weighted average determined as approximately 125 m³/s for sediment prediction purposes.

- River network density, R_{nd}

The relevant river length at a scale of 1:500 000 is determined as 14.275 km (refer to **Figure 3.3**). The river network density R_{nd} is determined as:

R_{nd} = River length/catchment area = 14 275 / 71.35 = 200 m/km².

- Average river slope, S_O

The average river slope, S_O, is determined as (refer to **Figure 3.3**):

S_O = (highest point of river - lowest point of river) / river length= (927-593)/14 275
= 2.35%

- Weighted erosion hazard class, E_{IW}

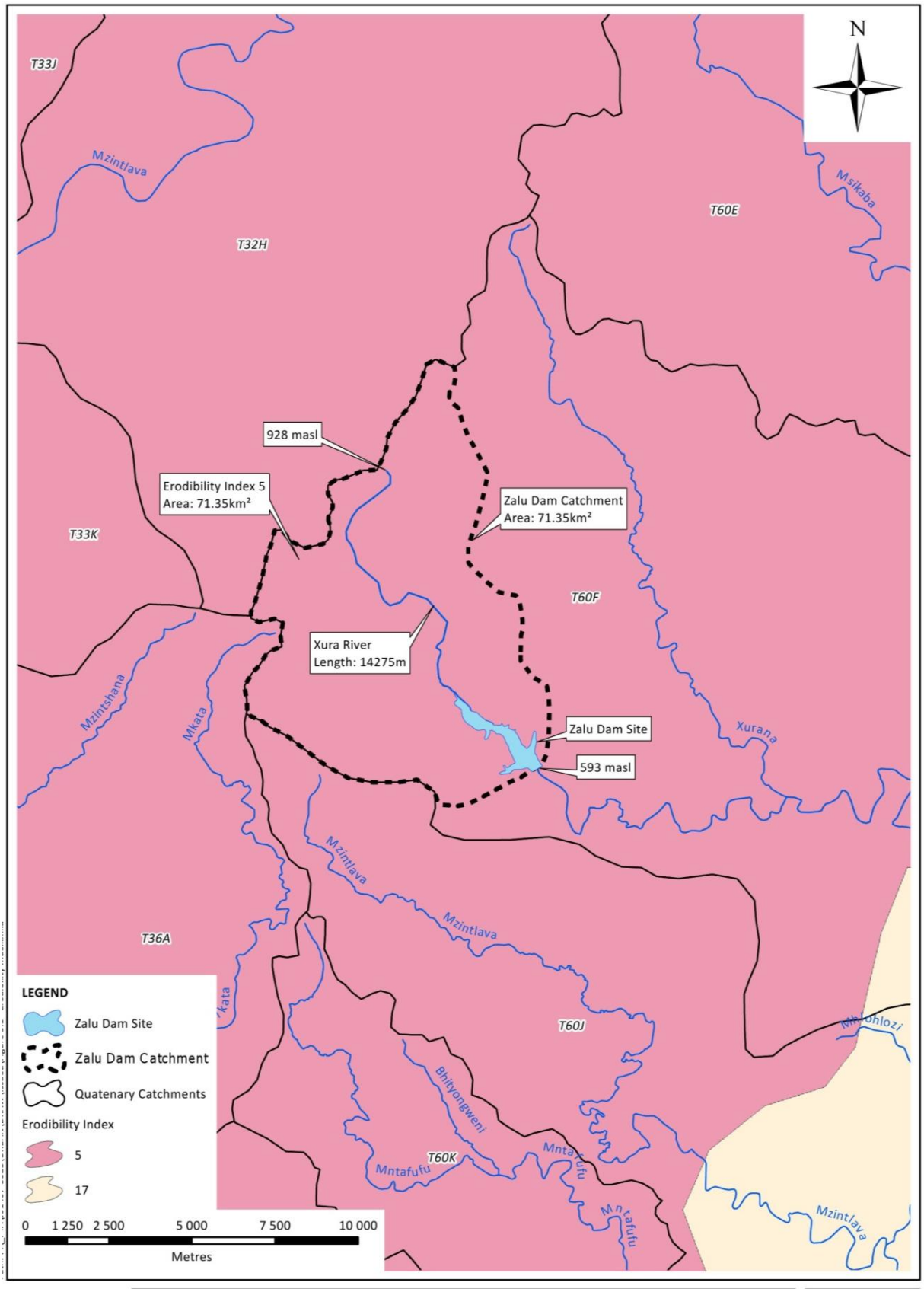


Figure 3.1: Zalu Dam Catchment: Erodibility Index (1992 Sediment Yield Map)

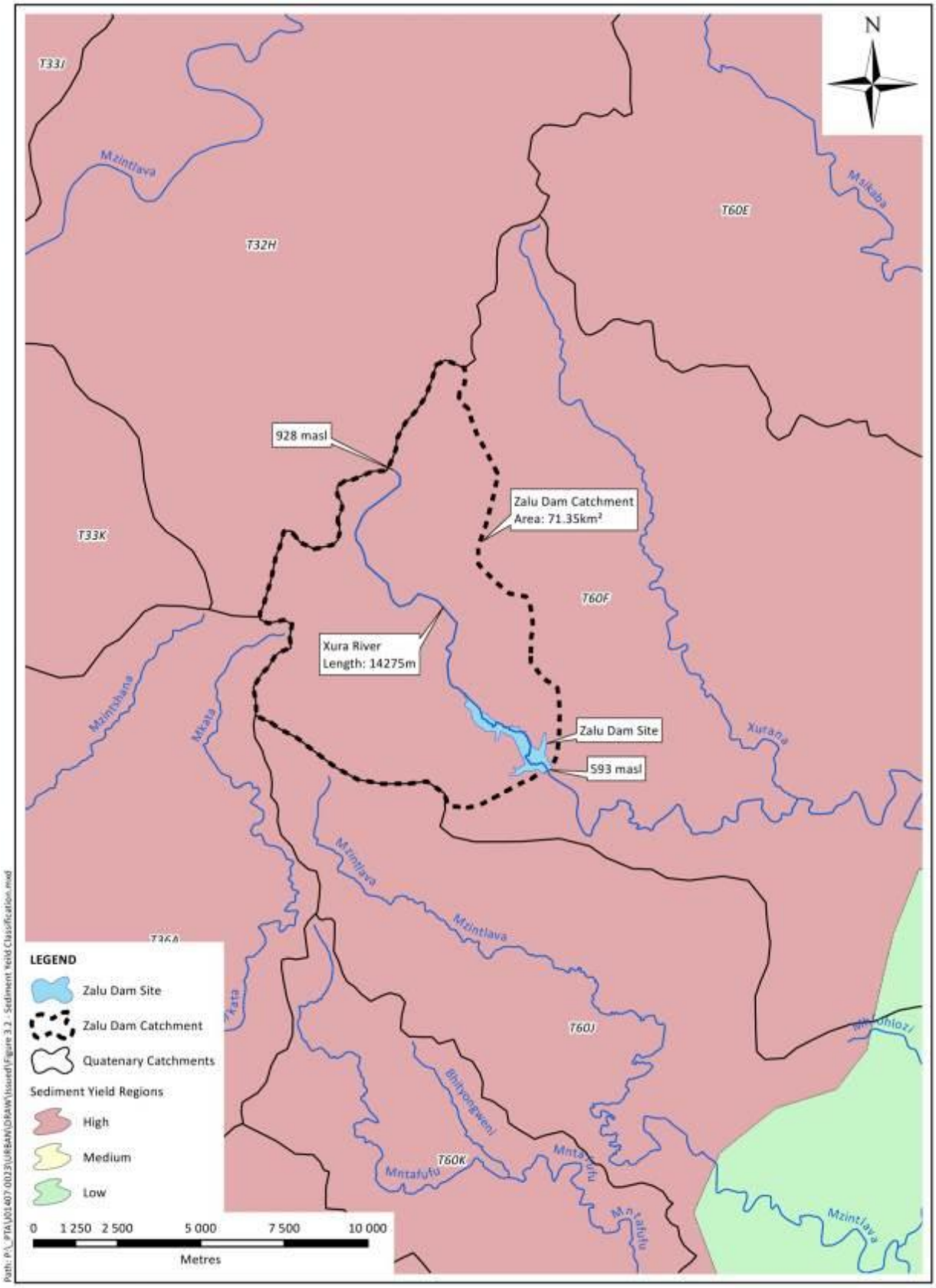


Figure 3.2: Zalu Dam Catchment: Sediment Yield Classification (1992 Sediment Yield Map)

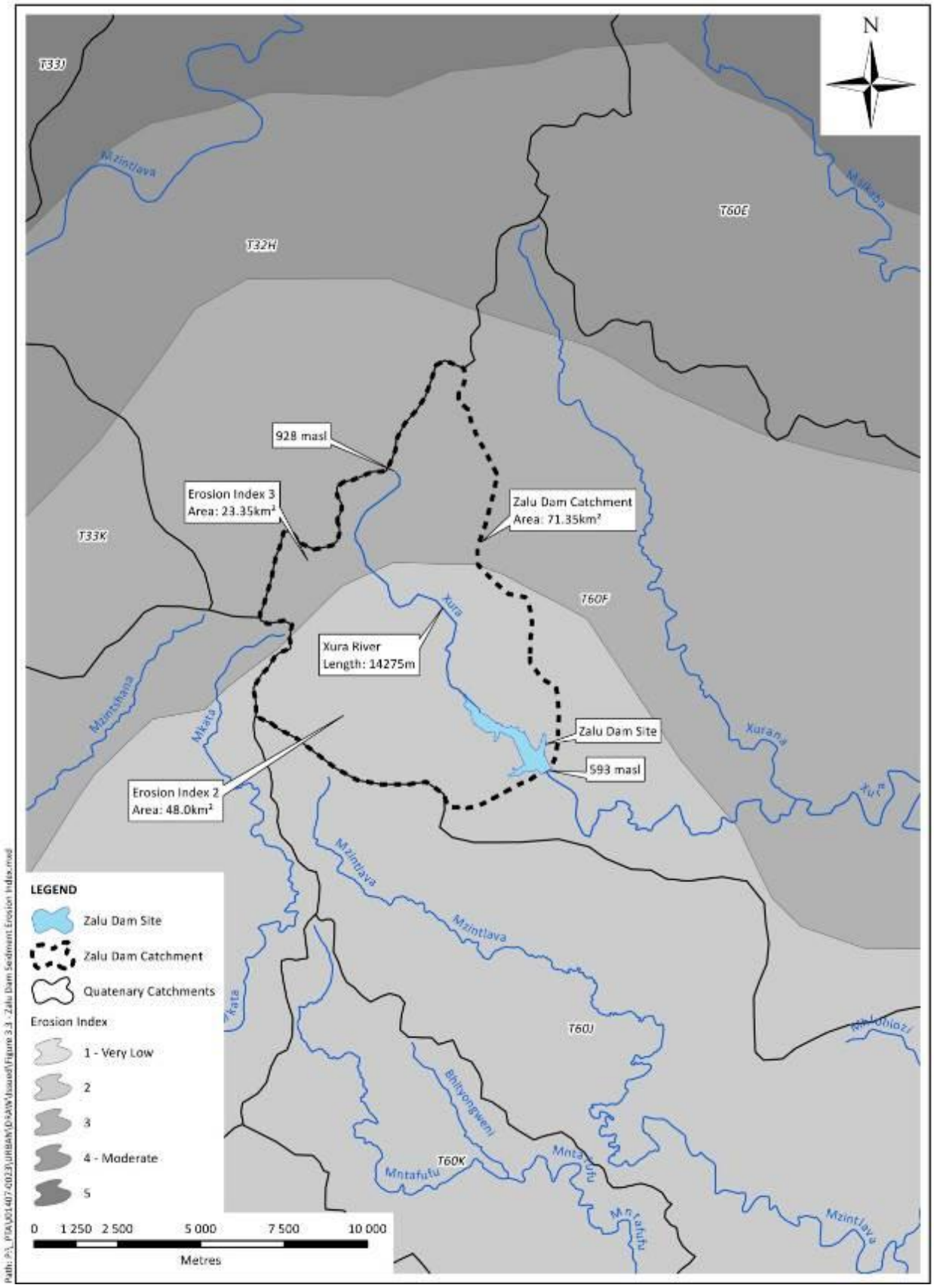


Figure 3.3: Zalu Dam site: Erosion Index (2010 Sediment Yield Prediction)

A summary of the Zalu Dam catchment erosion hazard class as deduced from **Figure 3.3** is provided in **Table 3.6**.

Table 3.6: Zalu Dam Erosion Hazard

Erosion hazard class	Area (km²)	Proportion of Area
2	48.00	0.673
3	23.35	0.327
Total	**71.35**	**1.000**

Based on the erosion hazard class summary provided in **Table 3.6**, the weighted erosion hazard class, E_{IW}, for the Zalu Dam catchment is:

E_{IW} = 0.673 x 2 + 0.327 x 3 = 2.327

With reference to the Region 7 empirical equation discussed in **Section 3.5.1**, a summary of the relevant Zalu Dam catchment Region 7 empirical equation parameters is provided in **Table 3.7**.

Table 3.7: Region 7 empirical equation parameters for the Zalu Dam catchment

Parameter		Value
Flood peak with a return period 1 in 10	(Q_{10})	180 m³/s
River density	(R_{nd})	200 m/km²
Average river slope	$[S_O)$	2.35%
Weighted Erosion Hazard Class	(E_{IW})	2.327
Effective catchment area	(A_e)	71.35 km²

Using and substituting the parameters indicated in **Table 3.7** in the Region 7 empirical equation, the predicted Zalu Dam catchment sediment load is:

$Q_1S = 30($ $Q_S = 30\,(125^{0.36}) * (2.35^{0.33}) * (200^{0.29}) * (71.35^{0.61}) * (2.327^{0.58}) = 23\,184\,t/a$

The estimated Zalu Dam catchment sediment yield is therefore 23 183 / 71.35 = 325 t/km²/a. This catchment sediment yield is a regional standardised value which should be compared with recorded catchment sediment yield from neighbouring dams, if available, and can be amended with the help of multiplication factors to illustrate the confidence in the result. Considering confidence bands of 80%, 90% and 95% as applicable to Region 7 of the *2010 Sediment Yield Prediction*, the relevant

multiplication factors and associated catchment sediment yield are indicated in **Table 3.8**.

Table 3.8: 2010 Sediment Yield Prediction Region 7 confidence multiplication factors and associated catchment sediment yield for the Zalu Dam catchment

Confidence band	Multiplication factor	Catchment sediment yield (t/km²/a)
50%	1.7	552.5
80%	3.0	975.0
90%	3.8	1235.0
95%	4.7	1 527.5

It is, however, always necessary to consider existing catchment conditions and compare the values obtained by means of the sediment yield map to recorded values for comparable catchments. Therefore a similar approach is to be followed to determine catchment sediment yield values based on regional standardised yield values for dams with recorded sediment accumulation data for comparison purposes.

3.5.4 Comparison of recorded and regionalised sediment yield

a) Recorded reservoir sedimentation

Sediment yields of catchments can be estimated from recorded reservoir sedimentation surveys in terms of dam characteristics and sediment accumulation data within reservoirs as listed in the DWA Hydrographic Surveys Dam List 2011 by converting recorded sediment volumes to annual sediment yields per unit area of catchment. An important factor in the conversion of sediment value into mass is the variable density of the sediment deposits.

The sediment volume in a reservoir after any given period of time has been found to follow a logarithmic relationship for accumulations in excess of approximately 10 years. It has been found that it is possible to express the volume V_T of a sediment deposit after T years as:

$$\frac{V_T}{V_{50}} = 0.376 \ln \frac{T}{3.5}$$

for $V \geq$ 10 years and V_{50} is the reservoir sediment volume after 50 years.

It is thus possible to convert the equivalent 50-year sedimentation volume into the volume after T years and vice versa. The choice of a 50 year volume as reference is arbitrary, but it is possible to estimate the average density after 50 years more accurately than after say 10 years.

A density value of 1 350 kg/m³ for the 50 year sedimentation was found to be realistic for all South African reservoirs. In order to convert the 50 year sediment mass to an annual mass, the average annual sediment yield is assumed to remain constant with time. This assumption allows working from a common base (i.e. 50-year sedimentation) to estimate the volume of sediment for any other period of time.

b) Recorded catchment sediment yield

Although located in Drainage Region T60, no reservoir survey data is available for the Magwa and Mhlanga Dams as they are not listed in the DWA Dam List 2011. In addition, no dam survey data is available for the listed Majola Dam. Dam survey information is, however, available for the Mthatha Dam in quaternary catchment T20B, approximately 75 km south-west of the proposed Zalu Dam site. The relevant information of the Mthatha Dam in terms of location number, recorded period, sediment volume V_T at end of period T, equivalent 50 year sediment volume V_{50}, effective catchment area (A_e) and average catchment sediment yield are provided in **Table 3.9**.

Table 3.9: Mthatha Dam recorded reservoir and catchment sedimentation rate

Record period	Date of dam construction	1977
	Date of latest survey	2010
	Survey record length	33
Original capacity (V_W) (million m³)		258.226
Latest capacity at full supply level (million m³)		250.023
Volume of sediment deposit (V_T) (million m³)		8.203
% Sedimentation		3.3
Equivalent 50 year sediment volume (V_{50}) (million m³)		9.723
Effective catchment (A_e) (km²)		886
Sediment yield (t/km²/a)		303
Sediment yield (million t/a)		0.263

The abovementioned analysis indicates that the recorded catchment sediment yield for the Mthatha Dam is 303 t/km²/a compared to the regional standardised value of 325 t/km²/a as determined in **Section 3.5.3b.**

c) Verification in terms of regionalised sediment yield

A comparison of the recorded Mthatha Dam catchment sediment yield value of 303 t/km²/a with the regionalised sediment yield value of 325 t/km²/a based on the 1992 Sediment Yield Map and 2010 Sediment Yield Prediction is provided below:

- 1992 Sediment yield map

In terms of the 1992 Sediment Yield Map, the Mthatha Dam is located in Region 9 with a regional standard average catchment sediment yield of 185 (t/km²/a).

Allowing for some statistical confidence around the mean, confidence bands can be adopted with a multiplication factor applied to the weighted average catchment sediment yield. For Region 9 of the 1992 Sediment Yield Map these multiplication factors applicable to the Mthatha Dam catchment of 886 km² for confidence bands of 50%, 80%, 90% and 95% are indicated in **Table 3.10**.

Table 3.10: Mthatha Dam regionalised sediment yield – 1992 Sediment Yield Map

Total effective catchment area (km²) A_T			886
Area of low yield potential (km²) A_L			0
Area of medium yield potential (km²) A_M			0
Area of high yield potential (km²) A_H			886
Regional catchment sediment yield (t/km²/a)	**50% Confidence**	**Multiplication factor**	1
		Yield (t/km²/a)	185
	80% Confidence	**Multiplication factor**	2.91
		Yield (t/km²/a)	537.5
	90% Confidence	**Multiplication factor**	4.45
		Yield (t/km²/a)	823.8
	95% Confidence	**Multiplication factor**	5.74
		Yield (t/km²/a)	1 061.9

The recorded Mthatha Dam catchment sediment yield of 303 t/km²/a results in a confidence multiplication factor of 1.64 when compared with the regional standardised catchment yield of 185 t/km²/a. This relates to a confidence of approximately 60% in the recorded Mthatha Dam catchment sediment yield value.

- 2010 Sediment Yield Prediction

In terms of the 2010 Sediment Yield Prediction the Mthatha Dam is located in Region 7. The relevant Region 7 empirical equation parameters for the Mthatha Dam catchment are defined below.

- Flood peak discharge, Q_{10}

A Q_{10} flood peak analysis for the Mthatha Dam catchment is summarised in **Table** 3.11. The relative weighting criteria are based on the Mthatha Dam catchment of 886 km².

Table 3.11: Flood peak analysis for Mthatha Dam catchment

Flood peak prediction methodology	Flood peak (m^3/s)	Relative weighting criteria	Weighting
Alternative Rational method	586	No limitation in terms of area of application	0.25
Rational Method	521	Area of application limited to 70 km^2	0.10
Unit hydrograph	343	Area of application 15 to 5 000 km^2	0.40
MIPI (Midgley & Pitman)	398	No limitation on area of application	0.25
Weighted average	**435**		**1.00**

- River network density, R_{nd} , and average river slope, S_o

The Mthatha Dam catchment comprises two quaternary catchments, i.e. T20A and T20B. The respective catchment areas, river lengths, river network densities and river slopes are indicated in **Table 3.12**.

Table 3.12: Mthatha Dam catchment characteristics – river network density and river slope

Catchment	Size (km^2)	River length (M)	River density R_{nd} (m/km^2)	River slope S_o (%)
T20A	481	105 993	220.36	5.63
T20B	405	60 443	149.24	1.89
Total	886	166 436	192.19	4.01

- Erosion Hazard Class

A summary of the Erosion Hazard Class for the Mthatha Dam catchment, comprising quaternary catchments T20A and T20B, is provided in **Table 3.13**.

Table 3.13: Mthatha Dam Erosion Hazard

Catchment	Erosion hazard	Class area (km²)	Proportion to total
T20A	4	5.79	0.012
	5	244.49	0.509
	6	223.96	0.466
	7	6.57	0.014
Subtotal		**480.81**	**1.000**
T20B	4	104.23	0.257
	5	137.90	0.340
	6	83.80	0.207
	7	79.25	0.196
Subtotal		**405.20**	**1.000**

Based on the erosion hazard class summary provided in **Table 3.13**, the weighted quaternary catchment T20A and T20B Erosion Hazard Classes, E_{IW} , are respectively:

$E_{IW\,(T20A)}$ = (0.012 x 4 + 0.509 x 5 + 0.466 x 6 + 0.014 x 7) = 5.487

$E_{IW\,(T20B)}$ = (0.257 x 4 + 0.340 x 5 + 0.207 x 6 + 0.196 x 7) = 5.342

Based on this, the overall weighted Mthatha Dam catchment Erosion Hazard Class is estimated as:

$$E_{IW} = \frac{E_{IW\,T20A}\ x\ A_{20A}}{A_T} + \frac{E_{IW\,T20B\ x}\ A_{T20B}}{A_T} = 3.045 + 2.5 = 5.545$$

A summary of the Mthatha Dam catchment Region 7 empirical equation parameters is provided in **Table 3.14**.

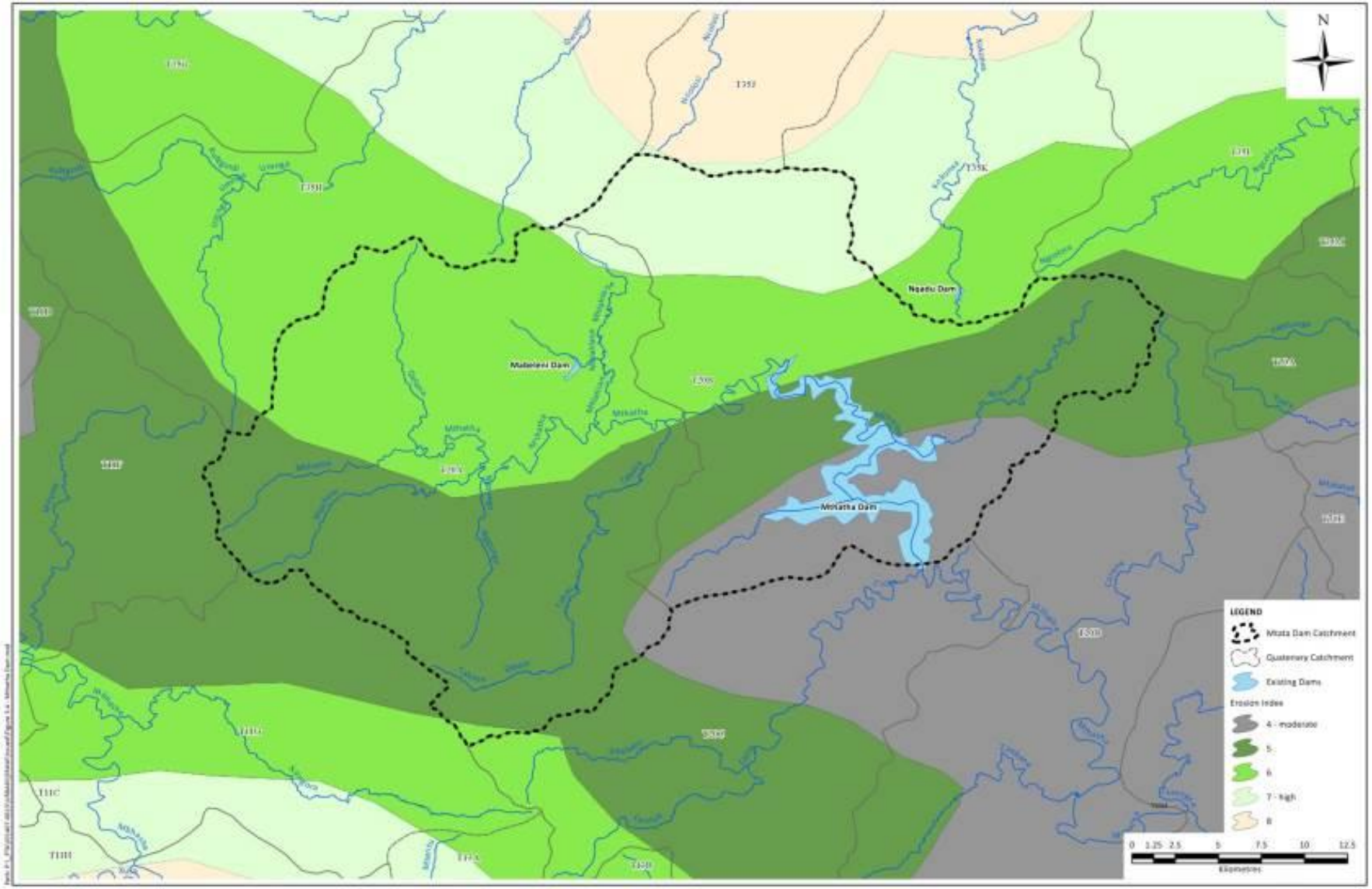


Figure 3.4: Mthatha Dam: Erodibility Index (1992 Sediment Yield Map)

Table 3.14: Region 7 empirical equation parameters for the Mthatha Dam catchment

Parameter		Value
Flood peak with a return period 1 in 10 years	$[(Q]_{10})$	435 m³/s
River density	$[(R]_{nd})$	192.2 m/km²
Average river slope	$[(S]_{O})$	4.01%
Weighted erosion hazard class	$[(E]_{IW})$	5.545
Effective catchment area	$[(A]_{e})$	886 km²

Using the Region 7 equation and substituting the parameters indicated in **Table 3.14**, the predicted Mthatha Dam catchment sediment load is:

Q_S = 30 $(435^{0.36})$ $(4.01^{0.33})$ $(192.2^{0.29})$ $(886^{0.61})$ $(5.545^{0.58})$ = 324 747.3 t/a

The predicted Mthatha Dam catchment sediment yield is therefore 320 461 / 886 = 361.7 t/km²/a, i.e. in the same order as to what is proposed for the Zalu Dam catchment.

Considering confidence bands of 50%, 80%, 90% and 95% applicable to Region 7 of the 2010 Sediment Yield Prediction, the relevant multiplication factors and associated catchment sediment yield are indicated in **Table 3.15**.

Table 3.15: 2010 Sediment Yield Prediction Region 7 confidence multiplication factors and associated catchment sediment yield for Mthatha Dam catchment

Confidence band	Multiplication factor	Catchment sediment yield (t/km²/a)
50%	1.2	439.5
80%	2.3	860.0
90%	3.1	1 159.4
95%	4.1	1 533.4

Given the recorded Mthatha Dam catchment sediment yield of 303 t/km²/a, it follows that, in terms of the 2010 Sediment Yield Prediction, it only corresponds to a confidence of approximately 20%.

- Sediment yield comparison

The findings of the Mthatha Dam catchment sediment yield calculations are summarised in **Table 3.16**.

Table 3.16: Comparison of Mthatha Dam catchment sediment yield

Recorded sediment yield (t/km²/a)	1992 Sediment yield map		2010 Sediment Yield Prediction	
	Confidence band	Yield (t/km²/a)	Confidence band	Yield (t/km²/a)
303	50%	185.0	50%	439.5
	80%	537.5	80%	860.0
	90%	823.8	90%	1 159.4
	95%	1 061.9	95%	1 533.4

Based on the 1992 Sediment Yield Map confidence bands, and with reference to **Section 3.5.4c**, the 2010 recorded Mthatha Dam catchment sediment yield of 303 t/km²/a results in a confidence of approximately 60%. In comparison, and based on the 2010 Sediment Yield Prediction confidence bands, the 2010 recorded Mthatha Dam catchment yield of 303 t/km²/a confirms to a confidence level of about 20%.

Given the catchment characteristics of steep slopes, high rainfall in the form of thunder storms, erodibility due to overgrazing and population density, the lower confidence levels related to the Mthatha Dam recorded sediment value should be used with great care for the purposes of future reservoir sedimentation prediction and is not recommended for reference purposes.

3.5.5 Recommended catchment sediment yield for Zalu Dam

As discussed in **Section 3.5.4**, it follows that the confidence levels related to the Mthatha Dam recorded sediment levels are low and that it should not be used for reference purposes. It is therefore recommended that future sedimentation predictions for the proposed Zalu Dam be based on the 2010 Sediment Yield Prediction regionalised sediment yield approach with a conservative confidence level of at least 80%. This results in an estimated Zalu Dam catchment sediment yield of 975 t/km²/a as indicated in **Table 3.8** and **Table 3.16**.

3.5.6 Comparison with previous studies

A comparison of the 2010 Sediment Yield Prediction Zalu Dam confidence related catchment sediment yield with the values determined previously in 2001 and 2009 for the *EPBS* and LRWSS Augmentation (refer to **Section 3.2**) is provided in **Table 3.17**.

Table 3.17: Comparison of Zalu Dam catchment sediment yield

Study	Sediment yield methodology	Reservoir sediment volume V_{20} (million m³)	Catchment sediment yield (t/km²/a)
EPBS (2001)	1992 Sediment Yield Map	0.8	462
SRK Groundwater Study Phase 2 (LRWSS Augmentation - 2009)	1992 Sediment Yield Map	1.1	635
LRWSS (2011)	**2010 Sediment Yield Prediction**:		
	50% Confidence		552.5
	65% Confidence		747.5
	80% Confidence		975

It follows from **Table 3.17** that the estimated *EPBS* and *SRK Groundwater Study Phase 2* (LWRSS Augmentation) Zalu Dam catchment sediment yield values are lower than the 2010 Sediment Yield Prediction higher confidence values. It appears that the *EPBS* and *SRK Groundwater Study Phase 2* (LWRSS Augmentation) catchment sediment yield estimates, when compared in terms of the 1992 Sediment Yield Map, relate to confidence levels of 65% and 72.5%, respectively. These values, however, only relate to confidence levels of approximately 45% and 55% in terms of the 2010 Sediment Yield Prediction, respectively. It is therefore recommended that future sedimentation predictions for the proposed Zalu Dam be based on the 2010 Sediment Yield Prediction regionalised sediment yield approach with a conservative confidence level of at least 80%.

3.6 SEDIMENT RETENTION WITHIN RESERVOIR

3.6.1 Reservoir trap efficiency

Having estimated the average annual sediment yield for a catchment, this sediment yield could be used to predict the volume which can be lost to reservoir storage. This volume loss is a function of the trap efficiency of the reservoir under consideration as well as a function of time.

The percentage of the total incoming sediment retained in a reservoir is referred to as the trap efficiency of a reservoir. It is commonly expressed as a ratio of the quantity of sediment deposited to the total sediment inflow. The sediment retained in the reservoir is a function of the relative size of the reservoir in comparison to the mean annual run-off (MAR) at the reservoir site. A reasonable estimate of reservoir trap efficiency can thus be based on the ratio of storage capacity to MAR, i.e. the full supply capacity (FSC/MAR) ratio. Depending upon the relative size of the reservoir, the percentage of the sediment to be retained is calculated and from this, the expected future sedimentation rate of the reservoir can be determined. These sediment rates can then be converted to expected volumes for different future dates.

Various trap efficiency curves have been developed for determining the percentage of incoming sediment which will be trapped within a reservoir. In general, the Brune curve is used for large storage or normal ponded reservoirs.

Based on the median Brune trap efficiency curve for normal ponded reservoirs, it follows that a trap efficiency of 97% could be expected for all reservoirs with capacity equal to 0.5 x MAR. For larger reservoirs with capacities equal to 1 x MAR or 1.5 x MAR a median trap efficiency of 98% could be expected.

Based on the 2010 Sediment Yield Prediction methodology, estimated sediment yield values for the proposed Zalu Dam as indicated in **Table 3.5**, expected sedimentation rates based on regionalised catchment yield values for confidence levels of 80%, 90% and 95% with consideration of sediment retention within the Zalu Dam, are summarised in **Table 3.18** for planning purposes.

It follows that expected sediment to be retained in the Zalu Dam is almost 100% of the catchment sediment yield and that there is very little variance in the sediment retention for the range of FSC/MAR ratios considered. For planning purposes, it is therefore recommended to use the maximum expected retained sediment volumes per confidence level to determine equivalent future sediment volumes.

Table 3.18: Expected sediment volumes to be retained in Zalu Dam

FSC / MAR ratio	Confidence level	Catchment sediment yield (t/km²/a) (2010 sediment yield prediction)	Percentage trapped sediment	Sediment yield (million t/a)	Expected retained sediment (million t/a)	Expected equivalent retained 50 year sediment volume (million m³)
0.5	80%	975	97	0.070	0.067	2. 48
	90%	1235	97	0.088	0.085	3.148
	95%	1 527.5	97	0.109	0.106	3.926
1.0	80%	975	98	0.070	0.068	2.519
	90%	1235	98	0.088	0.086	3.185
	95%	1 527.5	98	0.109	0.107	3.963
1.5	80%	975	98	0.070	0.068	2.519
	90%	1235	98	0.088	0.086	3.185
	95%	1 527.5	98	0.109	0.107	3.963

3.6.2 Future volumes of sediment deposit in reservoir

Based on the assumed catchment sediment yield values and the confidence level related, equivalent 50-year sediment volumes (V_{50}) as indicated in **Table 3.18**, the expected retained sediment volumes for a 1 x MAR dam for periods 10, 20, 30, 40 and 50 years after dam construction are indicated in **Table 3.19**.

Table 3.19: Future retained sediment volume in Zalu Dam

Confidence level	Catchment sediment yield (t/km²/a)	Sediment yield (million t/a)	Estimated future sediment volume (million m³)				
			Sedimentation period (years)				
			10	20	30	40	50
65%	747.5	0.052	0.762	1.265	1.56	1.77	1.93
80%	975.0	0.068	0.995	1.650	2.04	2.31	2.52
90%	1 235.0	0.086	1.257	2.087	2.57	2.92	3.19
95%	1 527.5	0.107	1.564	2.597	3.2	3.63	3.96

A comparison of the V_{20} reservoir sediment values with the *EPBS* and *SRK Groundwater Study Phase 2* (LWRSS Augmentation) values is provided in **Table 3.20.**

Table 3.20: Comparison of predicted reservoir V20 sediment volumes with previously estimated values

Study	Reservoir sediment volume V_{20} (million m³)	Percentage sediment of MAR
EPBS	0.8	6.1%
SRK Groundwater Study Phase 2 (LWRSS Augmentation)	1.1	8.4%
LWRSS	1.27[1]; 1.65[2]	9.60[1]; 12.50[2] %

[1] *65% Confidence*

[2] *80% Confidence*

With a Zalu Dam of 1 x MAR (13.16 million m³) it follows that the V_{20} at 65% and 80% confidence levels are approximately 9.6% and 12.5% of the 1 x MAR volume, respectively. Although the 65% values are not significantly more than the comparative *SRK Groundwater Study Phase 2* (LWRSS Augmentation), the 80% value is 50% more. Hence it is recommended to rather consider dam sizes of 1.5 or 2 x MAR.

3.7 ZALU DAM SEDIMENTATION RECOMMENDATIONS

The potential future catchment sediment yield of the Zalu Dam was compared to the Mthatha Dam, being the only nearby comparative dam. The 2010 dam survey records indicate a comparative catchment sediment yield of 303 t/km²/a for the Mthatha Dam catchment 33 years after construction. In terms of the 2010 Sediment Yield Prediction, this, however, corresponds to just more than a 20% confidence, with a result that the Mthatha Dam sediment records should not be used for the Zalu Dam sedimentation predictions.

In addition, the previously estimated *EPBS* and *SRK Groundwater Study Phase 2* (LWRSS Augmentation) Zalu Dam catchment sediment yield values are lower than the 2010 Sediment Yield Prediction higher confidence values. It appears that the *EPBS* and *SRK Groundwater Study Phase 2* (LWRSS Augmentation) catchment sediment yield estimates, when compared in terms of the 1992 Sediment Yield Map confidence bands, relate to confidence levels of 65% and 72.5%, respectively. However, in terms of the 2010 Sediment Yield Prediction these values only relate to confidence levels of approximately 45% and 55%, respectively.

Given the smaller Zalu Dam catchment, it is recommended that future sedimentation predictions for the smaller proposed Zalu Dam be based on the 2010 Sediment Yield

Prediction regionalised sediment yield approach, with a conservative confidence level of at least 65% but preferably 80%, resulting in an estimated Zalu Dam catchment sediment yield of 975 t/km²/a.

It is therefore recommended that future sedimentation predictions for the proposed Zalu Dam be based on the 2010 Sediment Yield Prediction regionalised sediment yield approach with a conservative confidence level of at least 80%.

With a Zalu Dam of 1 x MAR (13.16 million m³) it follows that the V_{20} at 65% and 80% confidence levels are approximately 9.6% and 12.5% of the 1 x MAR volume, respectively. Although the 65% values are not significantly more than the comparative *SRK Groundwater Study Phase 2* (LWRSS Augmentation), the 80% value is 50% more. Hence it is recommended to rather consider dam sizes of 1.5 or 2 x MAR.

4 YIELD ANALYSIS

4.1 METHODOLOGY

The yield analysis for the study area was executed using the latest version of the Water Resource Yield Model (WRYM) incorporated in the Water Resource Information Management System (WRIMS), version 3.8.2. The WRYM is a network model with a sophisticated network solver to analyse complex water resource systems under various operating scenarios. The strength of the model lies in the ability to change the operating rules via the external data files with no changes necessary to the actual program source code. The WRYM analyses are carried out under constant development levels, i.e. the system and the system requirements remain constant throughout the full simulation period.

Analyses using the WRYM were carried out to ascertain:

- The required Zalu Dam size for the expected 2040 domestic water requirements and possible irrigation development;
- Impact of the low flow EWR on the yield of Zalu Dam; and
- Flow regimes for various development scenarios to assist the Ecologists to study the consequences of various development scenarios (Methodology and results of the scenarios provided to the ecologists are included in **Appendix K**).

4.2 DATA INPUT FOR ANALYSES

4.2.1 Hydrology and climate

Hydrology and climate data are key inputs to the WRYM, and the updated rainfall, evaporation and flow data are discussed in detail in **Section 2: Hydrological Assessment** of this Report.

4.2.2 Water requirements

Only a brief summary of the water requirements in the Study area is given in this Section. More details on the water requirements are discussed in the relevant reports done as part of the LRWSS study. The main water requirements from the Xura River are listed and discussed in more detail below:

- Ecological water requirements;
- Domestic water requirements; and
- Irrigation water requirements.

Other smaller water uses include livestock water use and poultry / boiler production.

a) Ecological water requirements

Scherman, Colloty & Associates applying the **Intermediate Ecological Reserve Methodology** (IERM) (DWAF, 1999), coordinated the Ecological Water Requirements for the LRWSS, which comprises the Xura and Msikaba rivers. Two EWR sites were selected for Reserve determinations, namely:

- EWR1, downstream of the proposed Zalu Dam on the Xura River; and
- EWR2 on the main stem Msikaba River, downstream of its confluence with the Xura River.

The position and flow characteristics of the two sites are given in **Table 4.1**. The EWR positions are shown in **Figure 1** of **Appendix K**.

Table 4.1: Position and flow characteristics of the EWR sites

Name	Quaternary	Catchment area (km^2)	Coordinates	Natural MAR (million m^3/a)	Approximate present day MAR[1] (million m^3/a)
Xura_EWR1	T60F	77.4	31˚19.620' S, 29˚29.212' E	14.16	13.4
Msikaba_ EWR2	T60G	712.5	31˚15.105' S, 29˚44.931' E	128.9	126.7

The *Intermediate Reserve Determination* study reported that the Present Ecological State (PES) for EWR1 in the Xura River is a Category A/B and EWR2 in the Msikaba River a Category B. The EWR for the PES and one category lower were set, i.e. for EWR1 categories A/B and B/C, and for EWR2 categories B and C. The results for the various categories are shown in **Table 4.2**.

Table 4.2: Summary of the EWR results as a percentage of the natural MAR

EWR site	EC	Low Flow EWR				Maintenance high flow EWR		Long term mean EWR[2]	
		Maintenance Low[1]		Drought Low					
		(%Natural MAR)	million m^3	(%Natural MAR)	million m^3	(%Natural MAR)	million m^3	(% Natural MAR)	million m^3
EWR1	PES and REC: A/B	22.49	3.186	5.70	0.807	20.21	2.863	36.79	5.212
	AEC: B/C	16.19	2.294	4.75	0.673	14.19	2.009	28.71	4.067
EWR2	PES and REC: B	18.37	23.684	9.96	12.837	12.98	16.687	30.08	38.792
	AEC: C	13.25	17.09	8.34	10.751	7.42	9.565	22.88	29.457

[1] The Maintenance EWR equals the maintenance low flow EWR plus high Flow EWR

[2] Long term mean EWR takes into account periods when drought EWR is supplied i.e. combination of maintenance and drought flows.

b) Domestic water requirements

Domestic water requirements are discussed in detail in the report *Domestic Water Requirements* done as part of this Study. The 2040 estimated domestic requirement from surface and groundwater, is estimated to be 5.40 million m^3/a. The groundwater study done as part of this LRWSS study concluded that the groundwater available as yield is 0.92 million m^3/a. See the report *Domestic Water Requirements (P WMA 12/T60/00/4111)* done as part of the LRWSS Study)

c) Irrigation water requirements

Irrigation water requirements are discussed in detail in the report *Irrigation Potential Assessment* done as part of the LRWSS. The estimated water requirements for 2040 from the Zalu Dam, including 10% conveyance losses is 1.45 million m^3/a. The irrigation area with the best potential for agriculture is located downstream of the proposed Zalu Dam. See the report *Irrigation Potential Assessment (P WMA 12/T60/00/4211)* done as part of the LRWSS Study.

d) Other water requirements

Livestock water requirements discussed in more detail in the *Irrigation Potential Assessment*, were based on livestock numbers supplied and is estimated to be 2.592 million m^3/a. Current poultry / broiler production will require approximately 0.0016 million m^3/a. See the report *Irrigation Potential Assessment (P WMA 12/T60/00/4211)* done as part of the LRWSS Study.

4.2.3 Sedimentation

Based on the sediment analyses (discussed in **Section 3**), the expected equivalent 50 year sediment volume or storage capacity loss of 2.52 million m³ retained with an 80% confidence was accepted and modelled as the dead storage for the proposed Zalu Dam.

The proposed Zalu Dam site in the Xura River is upstream of the weir T6H004. The catchment area is 71.3 km^2. The height-area-capacity relationship for the Zalu Dam derived through inspection of contour intervals for the proposed Zalu Dam is given in **Table 4.3**.

Table 4.3: Height-area-capacity relationship for the proposed Zalu Dam

Contour (m)	Area (km^2)	Gross capacity (million m^3)	Percentage of MAR (%)	Sedimentation 80% (million m^3)	Net capacity (million m^3)
625.000	1.803	22.778	1.73	2.52	20.258
622.550	1.613	19.800	1.50	2.52	17.280
621.463	1.528	18.480	1.40	2.52	15.960
620.375	1.442	17.160	1.30	2.52	14.640
619.387	1.354	15.840	1.20	2.52	13.320
617.188	1.198	13.200	1.00	2.52	10.680
614.915	1.022	10.560	0.80	2.52	8.040
610.285	0.717	6.600	0.50	2.52	4.080
602.655	0.416	2.520	Dead storage	2.52	0.000
585.000	0.000	0.000	Bottom	2.52	0.000

4.3 SCENARIOS FOR YIELD ANALYSES AND DAM SIZING

4.3.1 Overview

Scenarios were drafted for various probable future development and water requirement options to establish the required storage volume of the Zalu Dam to meet the water requirements, after taking into account the contribution that best can be made from the groundwater sources. Water availability and associated construction and maintenance costs for various sizes of the potential Zalu Dam were derived to enable decision makers to make informed decisions on the proposed Zalu Dam.

The most beneficial and economic abstraction point(s) of the domestic water were investigated during the LRWSS study, and the following two abstraction points were considered for the purpose of yield analyses:

- the first option for water abstraction assumed that all domestic water will be abstracted at the proposed Zalu Dam; and
- the second option assumed that the existing WTW and the current infrastructure be upgraded and therefore all domestic abstractions will be from the weir T6H004.

The implications for the yield of abstracting a small portion of the water for domestic use at the dam to save on pumping costs were examined as a variation on the second option. This did not make any significant difference to the results.

4.3.2 Proposed development scenarios for the Xura River

The expected 2040 water requirements to be met from both surface water and groundwater resources are given in **Table 4.4**. It should be noted that the Ecological Water Requirements are non-consumptive.

This section only deals with the impact of the maintenance low flow at EWR1 on the yield of Zalu Dam. The impact of the Zalu Dam on the downstream portion of the Xura River was analysed in detail as part of the process to derive the ecological consequences of probable future development scenarios, and discussed in detail in the report *Intermediate Reserve Determination (P WMA 12/T60/00/3911)*. The methodology and scenarios provided for ecological analyses are discussed in the Reserve report are discussed in **Appendix K**.

Table 4.4: Expected 2040 water requirements in million m^3/a

Domestic	Irrigation	Total maintenance EWR at EWR1 (EC=A/B)[2]	Maintenance low flow EWR at EWR1 (EC=A/B)[2]
5.40	1.45[1]	6.05	3.19

[1] *Including a 10% allowance for losses*

[2] *EWR are non-consumptive*

The scenarios to select the dam size required for the various demands, and the option of the development of groundwater are shown in **Table 4.5** and discussed below:

Scenario 1: This scenario assumed that groundwater has been exploited to its full potential to yield 0.93 million m^3/a (see the report *Assessment of Augmentation from Groundwater,* done as part of the LRWSS study). The estimated domestic water requirement for 2040 to be provided from Zalu Dam is thus expected to be 4.47 million m^3/a. No provision is made for supplying irrigation.

Scenario 2: No ground water development, i.e. the total water requirement from Zalu Dam is 5.4 million m^3/a. No provision for irrigation.

Scenario 3: Scenario 1 plus irrigation development requiring 1.32 million m^3/a and providing for conveyance losses, i.e. gross irrigation requirement of 1.45 million m^3/a. The total water requirement from Zalu Dam is therefore 5.92 million m^3/a.

Scenario 4: Scenario 2 plus irrigation development. The total water requirement from Zalu Dam is therefore 6.85 million m^3/a.

Historic and stochastic yield analyses were performed with domestic abstractions at two alternative locations, i.e. directly from the proposed Zalu Dam, and at the weir T6H004 to establish what the impact of the position of the abstraction point will be on the yield of the proposed Zalu Dam. The topography and the expected continuous flow in the river will render river losses to be insignificant (less than 5%) and therefore ignored for the purpose of these analyses.

Table 4.5: Expected yields and water requirements for the various possible development scenarios

Scenario	Groundwater yield million m^3/a	Domestic Water Requirement million m^3/a	Irrigation Water Requirement million m^3/a	Water requirement from Zalu Dam million m^3/a
Scenario 1	0.93	4.47	0.00	4.47
Scenario 2	0.00	5.40	0.00	5.40
Scenario 3	0.93	5.40	1.45	5.92
Scenario 4	0.00	5.40	1.45	6.85

4.4 CONFIGURATION OF THE YIELD ANALYSIS OF THE PROPOSED ZALU DAM

4.4.1 Overview

The basic WRYM schematic layout of the study area is shown in **Appendix I** and the WRYM input data files are included in **Appendix L.** The data input to the WRYM are described in **Section 4.2**.

Yield analyses were done as listed below to establish:

- The required Zalu Dam size corresponding to various scenarios of water requirements (see **Section 4.3.2**); and
- The yield of Zalu Dam with a size of 0.5% MAR, 0.8% MAR, 1.2% MAR and 1.5% MAR.

It is important to note that for the purpose of the yield analyses only the low flow ecological water requirements (EWR) at EWR1, i.e. the EWR excluding floods and freshets, were set as a demand on the proposed Zalu Dam. The assumption that the full EWR will be provided by releases from the Zalu Dam, plus spills and tributary inflow downstream of the proposed dam was tested. These scenarios are described in detail in Appendix K and the results in the Intermediate Reserve report.

4.4.2 Proposed operation of water supply system

a) Abstraction point

The positioning of the abstraction point for domestic water has an enormous impact on the yield of the proposed Zalu Dam. The reason being that the EWR is a non-consumptive water user and if the abstraction point is at the weir T6H004, even the high EC of A/B at EWR1 upstream of T6H004 can be satisfied for the low flow EWR without additional EWR releases because the domestic water requirement is higher than the low flow EWR. The impact of the Zalu Dam on the remainder of the Xura River and EWR2 are discussed in detail in **Appendix K**.

Unfortunately the positioning of the abstraction point for domestic and irrigation was not clear at the beginning of the study. The most probable future operations now seem to be a negligible abstraction from the proposed Zalu Dam to a new tiny WTW close to the dam, with the bulk release through the Xura River, abstracted at the weir T6H004.

No formal investigation as to the location of irrigation abstraction was done. For the purposes of these analyses, the irrigation water was assumed to be abstracted directly from the proposed Zalu Dam.

b) Diversion at T6H004

Another unknown is the diversion capacity of the weir at T6H004. The incremental runoff between the dam and the weir is approximately 26% of the total runoff at the Zalu Dam. It was therefore assumed that the incremental catchment downstream of the Zalu Dam will improve/assist the required seasonal fluctuation. The irrigation and domestic water requirements will be released from the dam, routed through the river and abstracted at T6H004. Constraints such as abstraction and WTW capacities were included in the costing of the dam and other infrastructure (See *Water Distribution Infrastructure (P WMA 12/T60/00/4311)* and *Zalu Dam Feasibility Design (P WMA 12/T60/00/4511)* done as part of the LRWSS Study.

Analyses of the proposed Zalu Dam were done both for a stand-alone Zalu Dam as well as where the domestic water is abstracted at the weir T6H004. A summary of the EWR results are provided in **Table 4.2** as a percentage of the natural MAR as well a0s the volume required. The PES category was used as input to the WRYM.

4.5 YIELD ANALYSES RESULTS

4.5.1 Overview

The historic firm yield (HFY) from the proposed Zalu Dam, allowing 2.52 million m^3 dead storage for sediment accumulation (loss of storage capacity), was determined for the two different locations of the abstraction points. The EWR category used was the PES for EWR1 namely A/B.

These two abstraction locations are:

- Directly from Zalu Dam; and
- Downstream of Zalu Dam at T6H004 via river releases.

The schematic diagram of the WRYM setup for the 2nd option above is shown in **Appendix I**.

4.5.2 Sizing of the proposed Zalu Dam

The required size of the proposed Zalu Dam to meet specific scenarios of water supply is given in **Table 4.6** and shown graphically in **Figure 4.1**. All the scenario analyses are based on the release of the low flow A/B EWR1 requirement.

Table 4.6: The required size of the proposed Zalu Dam for various development options (natural MAR at the proposed Zalu Dam is 13.2 million m^3)

Scenario	Required yield (million m^3)	Required Zalu Dam size with abstraction at Zalu Dam				Required Zalu Dam size with abstraction at T6H004			
		Full supply level (masl)	Net full supply capacity (million m^3)	Gross full supply capacity (million m^3	% of MAR	Full supply level (masl)	Net full supply capacity (million m^3)	Gross full supply capacity (million m^3	% of MAR
1	4.47	615	7.7	10.2	0.8	608	2.4	4.9	0.4
2	5.40	619	13.1	15.6	1.2	610	4.0	6.5	0.5
3	5.92	623	17.2	19.7	1.5	612	5.1	7.6	0.6
4[1]	6.85	626	23.5	26.0	2.0	615	7.7	10.2	0.8

[1] *Extrapolation of the Stage/Area/Capacity information beyond known boundaries was necessary for Scenario 4*

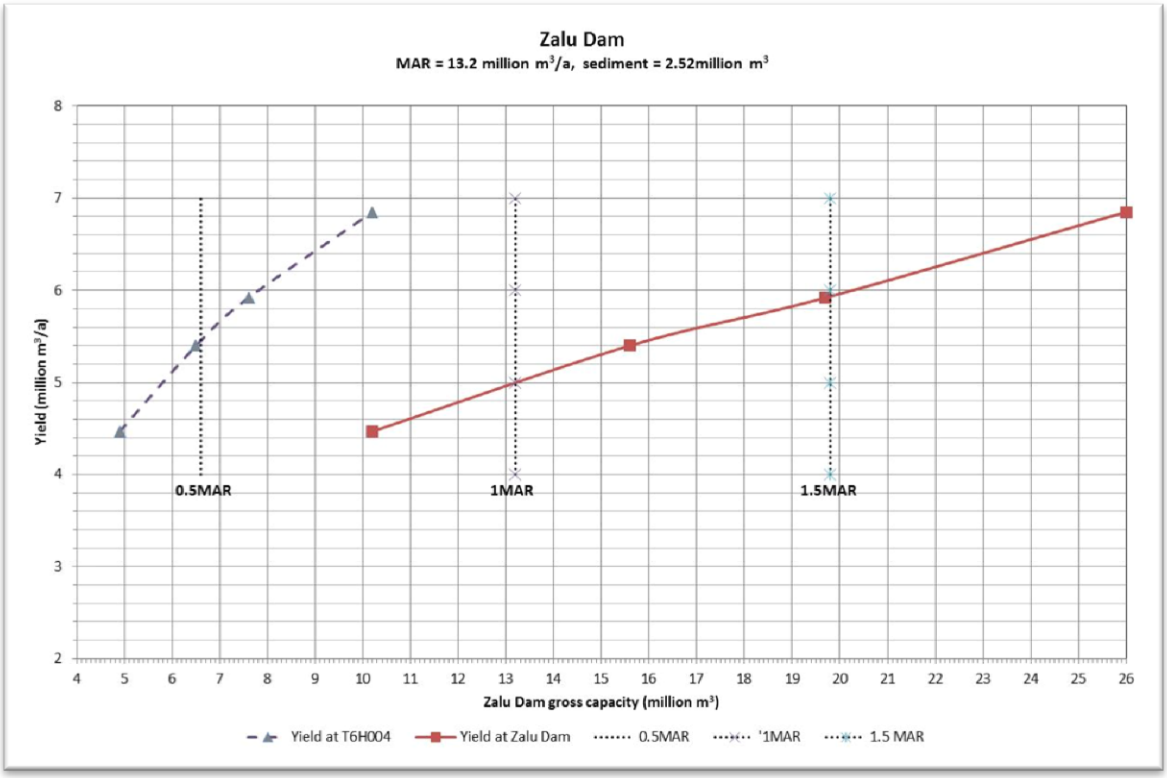


Figure 4.1: Comparison of the Zalu Dam HFY at two different abstraction points

Figure 4.1 shows that a 0.8 MAR Zalu Dam can supply 6.9 million m^3/a provided that the water is abstracted at the weir. A 0.8 MAR Zalu yields only 4.5 million m^3/a if the water is released directly from the proposed Zalu Dam. The difference being the low flow EWR that is satisfied from the water released for domestic purposes downstream of EWR1. These results show the benefit of water abstraction at the weir, rather than at Zalu Dam itself.

The Ecological consequences of the impact of the proposed Zalu Dam on the remainder of the Xura River downstream of the weir are discussed in detail in **Appendix K** and the implications are dealt with in the *Intermediate Reserve Determination* report done as part of this study.

4.5.3 Historic and stochastic yield analysis of the proposed Zalu Dam

Historic and stochastic yield results (in million m^3/a) are shown for water abstracted directly from the Zalu Dam and from the river at T6H004 in **Table 4.7** and in **Table 4.8**, respectively.

Table 4.7: Yield results (in million m^3/a) with the abstraction directly from the proposed Zalu Dam

Contour masl	Gross Capacity		Net Cap million m^3	HFY (no EWR)[1] million m^3/a	HFY with A/B EWR million m^3/a	HFY with low flow EWR (AB)[1] million m^3/a	With low flow AB EWR			
	million m^3	As pro-portion of MAR					Return Period (year)			
							1:20	1:50	1:100	1:200
622.6	19.8	1.5	17.3	8.16	4.66	6.10	8.00	7.04	6.50	6.17
619.4	15.8	1.2	13.3	7.46	4.09	5.43	7.22	6.30	5.79	5.52
614.9	10.6	0.8	8.0	6.17	3.30	4.52	5.70	5.06	4.68	4.38

Table 4.8: Yield results (in million m^3/a) with the abstraction point at T6H004

Contour masl	Gross Capacity		Net Cap million m^3	HFY (no EWR)[1] million m^3/a	HFY with low flow EWR (AB)[1] million m^3/a	With low flow AB EWR			
	million m^3	As pro-portion of MAR				Return Period (year)			
						1:20	1:50	1:100	1:200
622.6	**19.8**	**1.5**	**17.3**	**9.8**	**9.8**	**12.1**	**10.9**	**10.3**	**9.8**
614.9	10.6	0.8	8.0	7.4	7.4	9.4	8.4	7.9	7.5
612.0	**7.6**	**0.6**	**5.1**	**6.0**	**6.0**	**7.9**	**7.2**	**6.8**	**6.5**
610.3	6.6	0.5	4.1	5.2	5.2	7.2	6.6	6.2	5.9
607.5	5.1	0.4	2.86	4.1	4.1	5.6	5.3	5.1	4.9

[1] *EWR have an insignificant impact for scenario with abstraction at the weir*

The impact of the low flow category A/B EWR on yield is shown in **Figure 4.2** for the scenario with abstraction at Zalu Dam. It is shown that the yield of a 1.5 MAR Zalu Dam decreases by more than 40% if the full EWR for an ecological category (EC) of A/B is released and by approximately 25% if only the low flow EWR for an EC of AB is released. The implications of the EWR requirements downstream of the weir and the remainder of the Xura and Msikaba is addressed in **Appendix K** and the *Reserve Determination Report* done as part of this Study.

The low flow EWR has no impact on the yield with abstraction at the weir as explained in **Section 4.4.2a)**, and was therefore not further investigated.

The stochastic yield of the proposed Zalu Dam with abstraction at T6H004 is shown in **Figure 4.2**.

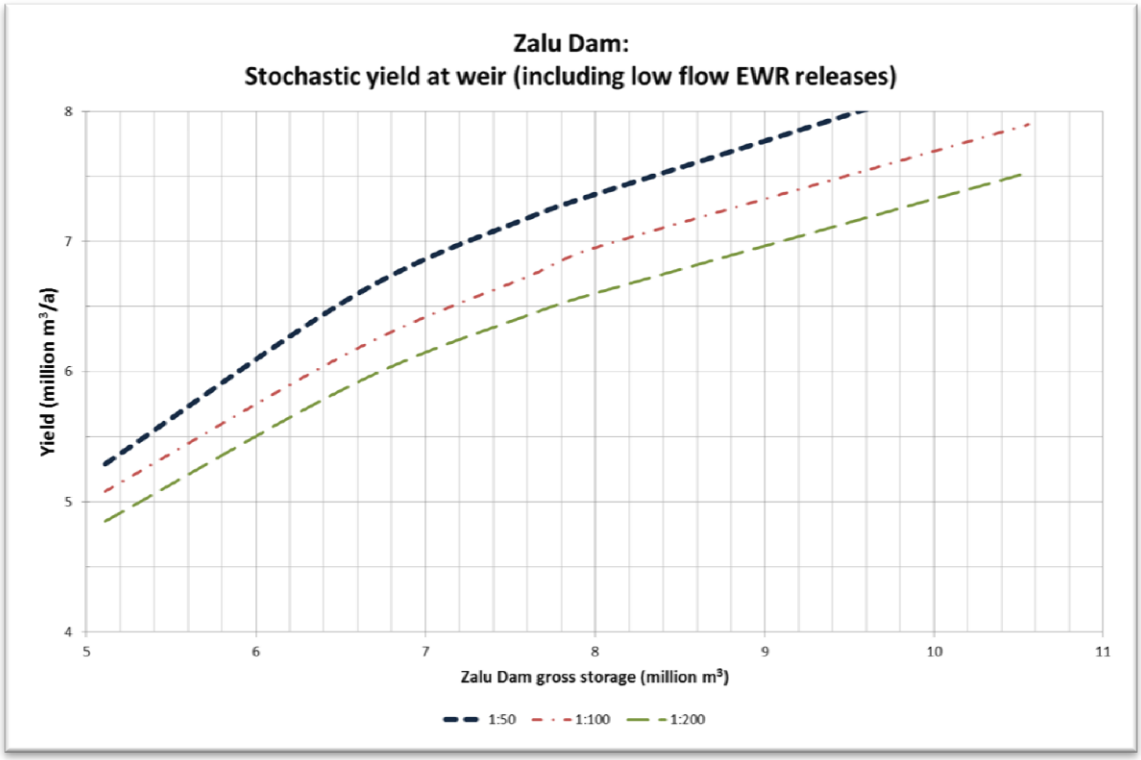


Figure 4.2: Historic firm yield of Zalu Dam, with low flow EWR

The yield-reliability curve for a 0.6 MAR Zalu with abstraction at the weir, is shown in **Figure 4.3** and indicates that for a requirement of 7.2 million, 6.2 million m³/a can be supplied with a 1:100 year reliability and an additional 1.0 million m³/a can be supplied at a higher risk of 1:50 years. Similarly, **Figure 4.4** shows that a 1.5 MAR Zalu with a water

requirement of 11.9 million m^3/a, can supply 8.3 million m^3/a with a 1:100 year reliability and the remaining 3.6 million m^3/a with a 1:50 year reliability.

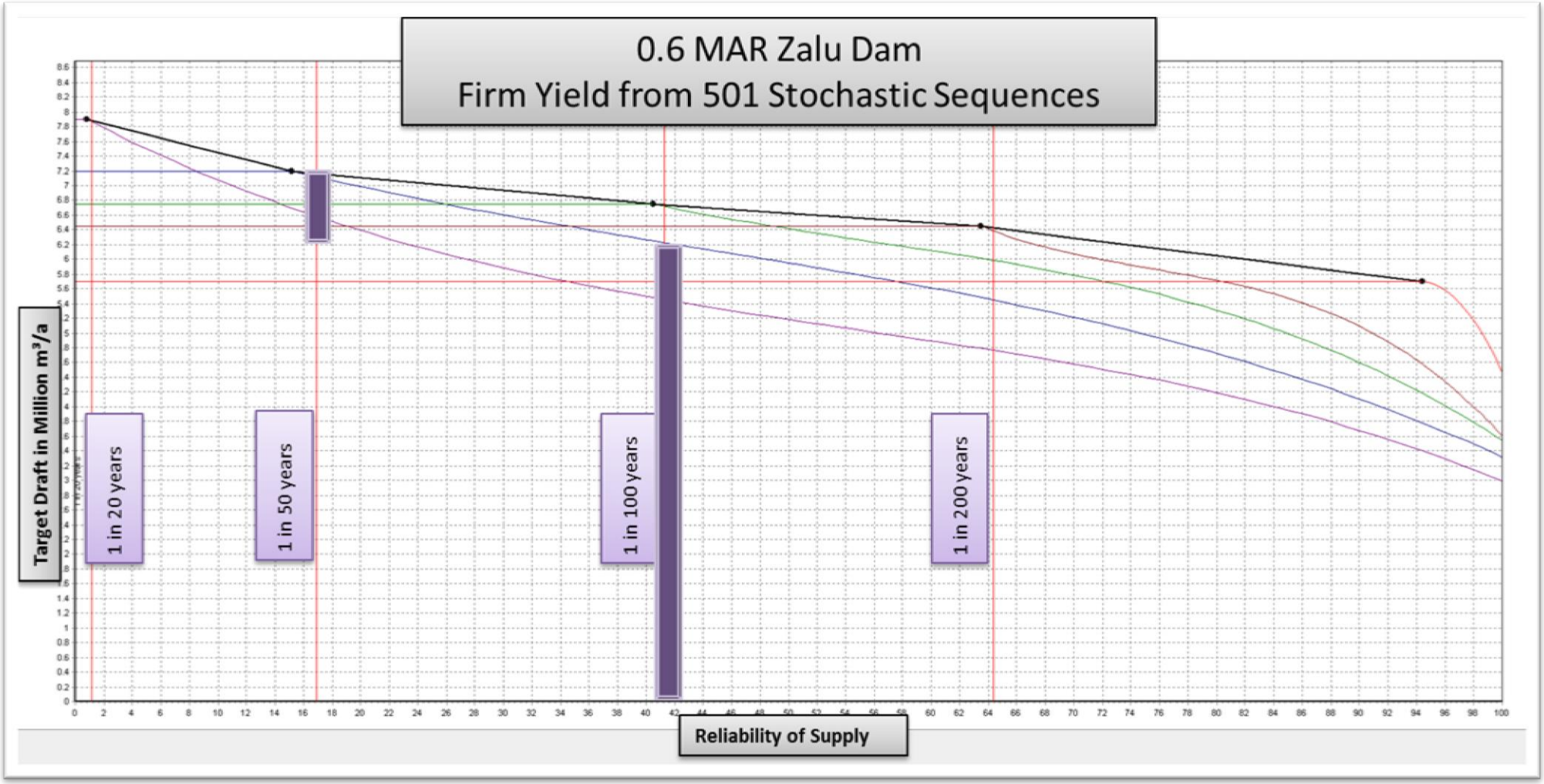


Figure 4.3: Stochastic yield of the proposed Zalu Dam with a capacity of 0.6 MAR (5.6 million m³/a and 512 masl) with abstraction at T6H004

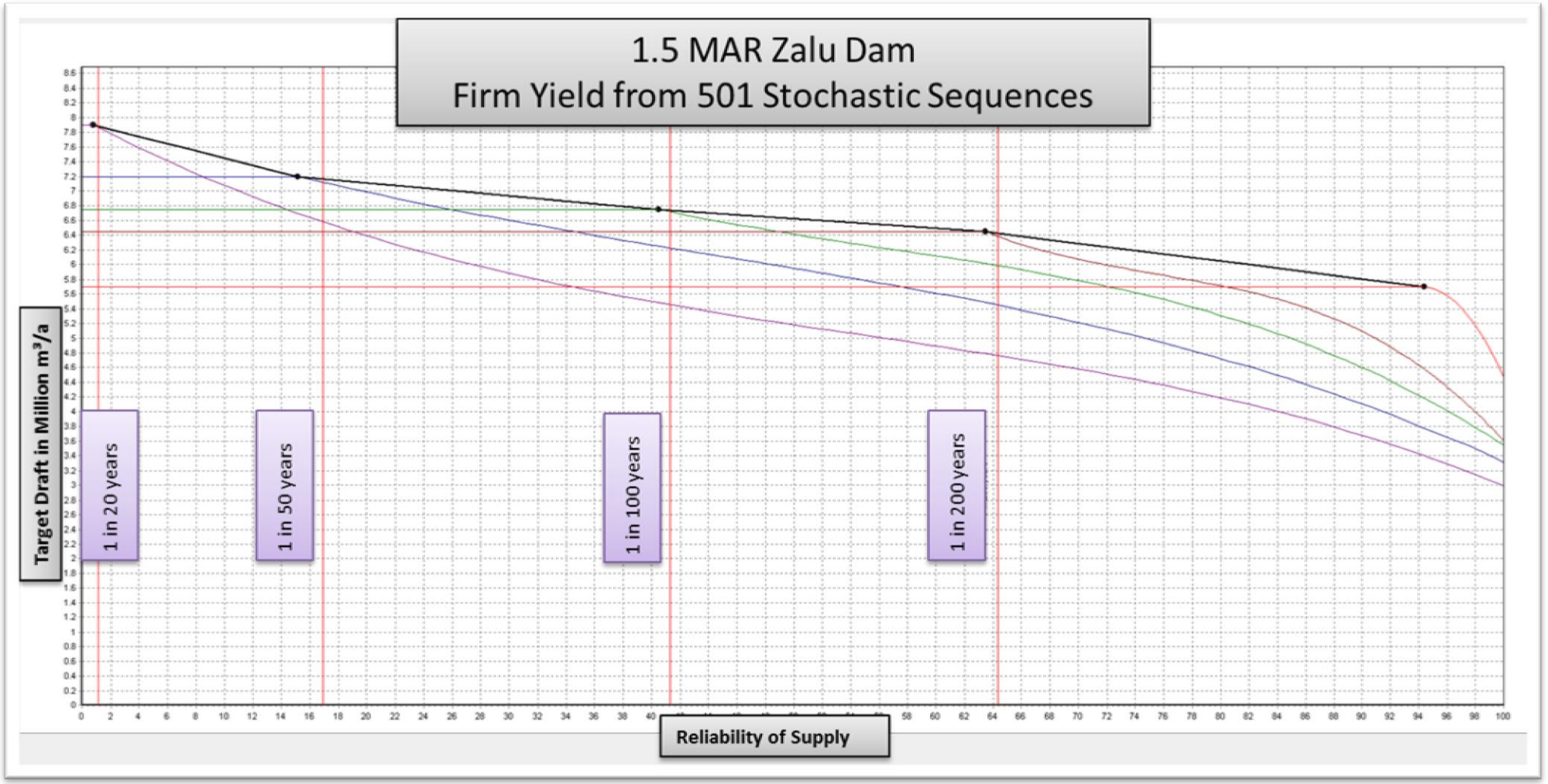


Figure 4.4: Stochastic yield of the proposed Zalu Dam with a capacity of 1.5 MAR (19.8 million m³/a and 623 masl) with abstraction at T6H004

5 CONCLUSIONS

5.1 HYDROLOGICAL ASSESSMENT

5.1.1 Rainfall

The mean annual rainfall over the Msikaba River catchment is fairly uniform over the study area with a good correlation between monthly rainfall of adjacent rainfall gauges. There are five rainfall gauges inside the catchment, and three outside the borders of the catchment with adequate length of data that were considered to give a good reflection of the rainfall in the Msikaba River catchment. The spatial distribution of these rain gauges is regarded as relatively good. There is, however some concern that the rain gauges currently operational do not adequately cover the catchment, and more rain gauges are required in the drier, upper western portion of the catchment. There are quite a number of rainfall gauges with long rainfall records starting in the 1920's which are still open. These records were used as far as possible to generate the catchment rainfall records.

5.1.2 Evaporation

No observed evaporation data are available and the WR2005 evaporation data were used in this study.

5.1.3 Flow

The simulated natural MAR for the LRWSS are on average, for comparative periods, three percent higher than the results from the WR2005-study (WRC, 2009). It is also seven percent higher than the results from the Pondoland Basin Study (DWA, 2001) (**Table 2.10**).

The difference in the results can be ascribed to the fact that a good calibration was achieved at the new gauging station T6H004 and also because the latest updated Sami-parameters for calibration and flow simulation was included in this study. The WR2005-study did not include calibration at T6H004. The updated Sami-parameters were also only available after completion of the WR2005-study. It was only necessary to change the WRSM2000 parameters slightly from the WR2005-study to achieve a good fit of observed vs. simulated flow data at T6H004.

The natural and present day MAR generated for the hydrological years 1920 to 2007 for the Msikaba and the Xura rivers are given in **Table 5.1** and **Table 5.2** respectively.

Table 5.1: Natural and present day MAR for the Msikaba River quaternary catchments

Quaternary catchment	Catchment area (km²)	Natural MAR (million m³)	Present day MAR (million m³)
T60E	198.0	29.5	29.0
T60F	463.9	85.8	84.1
T60G	360.0	105.7	105.7
Total T60E,T60F & T60G	**1 021.9**	**221.0**	**218.8**

Table 5.2: Natural and present day MAR for the T60F quinary catchments

Quaternary catchment	Catchment area (km²)	Natural MAR (million m³)
T60F1	71.4	13.2
T60F2	21.6	4.0
T60F3	271.1	50.2
T60F4	100.0	18.5
Total T60F	**463.9**	**85.8**

5.2 ZALU DAM SEDIMENTATION

The potential future catchment sediment yield for the Zalu Dam was compared to that for the Mthatha Dam, being the only nearby comparative dam. The 2010 dam survey records indicate a comparative catchment sediment yield of 303 t/km²/a for the Mthatha Dam catchment 33 years after construction. In terms of the 2010 Sediment Yield Prediction, this, however, corresponds to just more than 20% confidence, with a result that the Mthatha Dam sediment records should not be used for the Zalu Dam sedimentation predictions.

In addition, the previously estimated *EPBS* and *SRK Groundwater Study Phase 2* (LWRSS Augmentation) Zalu Dam catchment sediment yield values are lower than the 2010 Sediment Yield Prediction higher confidence values. It appears that the *EPBS* and *SRK Groundwater Study Phase 2* (LRWSS Augmentation) catchment sediment yield estimates, when compared in terms of the 1992 Sediment Yield Map confidence bands, relate to confidence levels of 65% and 72.5%, respectively. However, in terms of the 2010

Sediment Yield Prediction these values only relate to confidence levels of approximately 45% and 55%, respectively.

5.3 YIELD ANALYSES

Table 4.8 shows that the historic firm yield is even more conservative than a 1 in 200 year yield as it recorded a drought exceeding the severity of a 200 year drought during the late 1940s/early 1950s.

It is also shown in **Figure 4.1** that there is significant merit, expressed in terms of water availability for economic development options, in releasing domestic water supplies down the Xura River to be abstracted at the existing abstraction point. Irrigation will be developed downstream of the dam but the location of abstraction is not critical because the 2040 domestic requirements will provide the full low EWR.

In the most conservative outlook on development the domestic needs (5.4 million m^3/a) must be supplied and will be taken directly from Zalu Dam, no irrigation takes place, no groundwater is developed and EWR releases go separately from the releases from the dam. The gross storage required is about 15.6 million m^3/a or 1.2 MAR. But this Study showed that:

> *By changing the operating rule to allow domestic releases to go downstream, the EWR can be met so increasing the yield by about 2.7 million m^3/a to about 9 million m^3/a. This will accommodate the 1.45 million m^3/a needed for irrigation and leave some for a wider supply area or increasing the level of service to domestic users or even draw other economic activities.*

Furthermore, if there is full confidence in (a) the acceptability of groundwater as a complementary source, (b) the most effective means of supplying the EWR will be accepted and (c) irrigation will take time to be developed, then a dam with capacity 5.1 million m^3/a (0.6 MAR) will suffice. But:

> *Provision must be made in the design for significant raising of the Zalu Dam capacity, perhaps very soon after completion, to provide for a situation where groundwater development comes unstuck and / or irrigation suddenly becomes a reality.*

Since the dam capacities being envisaged are relatively small there is merit in using the site to the maximum of its potential. Since the water requirements are not there as yet, or in the foreseeable future, to justify maximum development, it is not realistic to match a dam size against a target yield.

6 RECOMMENDATIONS

6.1 HYDROLOGICAL ASSESSMENT

6.1.1 Rainfall

The decline of the number of gauges in the rainfall gauge network in the Msikaba River catchment is of great concern and closure of the rain gauge 0153 875 W (at Flagstaff) and 0154 142 W (at Lusikisiki–TNK) should be re-considered. Data at 0154 143 W (at Lusikisiki Prison) are considered unreliable and measurement at the gauge needs attention and should be improved or otherwise monitoring should be discontinued as the current data are worthless. In addition, more rain gauges are required in the drier, upper western portion of the catchment.

It is critical that a climate station, measuring at least evaporation and rainfall, be established at the proposed Zalu Dam.

6.1.2 Evaporation

No observed evaporation data are available and the WR2005 evaporation data, which are identical to the WR90 evaporation data for the evaporation zone C3, were used in this study.

6.1.3 Flow

Continued accurate gauging at T6H004 and T6H005 is essential for proper management of this water resource in future. Gauging of water levels, water abstractions and spills will be an essential part of the success of confidence in the water availability at the proposed Zalu Dam. The calculated inflow record at Zalu Dam will be useful to extend the rating curve at T6H004 to fill in gaps. Flow gauging is necessary at high water levels in the Xura River to extend the rating curve at T6H004 to reduce the number of times that the rating curve is exceeded.

6.2 SEDIMENTATION ASSESSMENT

It is recommended that future sedimentation predictions for the proposed Zalu Dam be based on the 2010 Sediment Yield Prediction regionalised sediment yield approach with a conservative confidence level of at least 80%.

With a Zalu Dam of 13.16 million m³ capacity (1 MAR) it follows that the 65% and 80% confidence levels are approximately 9.6% and 12.5% of the MAR by volume, respectively. Although the 65% values are not significant more than the comparative *SRK Groundwater Study Phase 2* (LRWSS Augmentation) (Consulting, 2007), the 80% value is 50% more.

6.3 YIELD ANALYSES

Apart from new irrigation development envisaged to be supplied from the proposed Zalu Dam, no major land use changes are expected in the Xura River catchment in the foreseeable future. Proposed land use changes and other developments should be subject to authorization only after their impact on the reserve and on the yield of the Zalu Dam has been assessed and the necessary precautions and mitigation measures are in place.

The location of water abstraction is critical to optimise the yield from the proposed Zalu Dam and it is recommended that the domestic water be abstracted at T6H004. Seasonality of releases from Zalu Dam must be addressed according to this and other recommendations in the *Intermediate Reserve Determination Report*. In the period leading up to the release of the full estimated 2040 water requirements for domestic use provision must be made in the operating rule of the system to fully comply with the low flow component of the ecological reserve.

The water source for the LRWSS is the proposed Zalu Dam, for a size of either 612 masl or 622 masl on the Xura River, which can support the estimated 5.4 million m³/a 2040 domestic demand plus the 1.45 million m³/a irrigation demand, augmented with groundwater development of seventeen production boreholes with a yield of 0.93 million m³/a.

7 CD WITH MSIKABA RIVER CATCHMENT HYDROLOGICAL DATA

A CD containing the hydrological data generated as part of this study for the Msikaba River catchment is included as **Appendix L**.

8 BIBLIOGRAPHY

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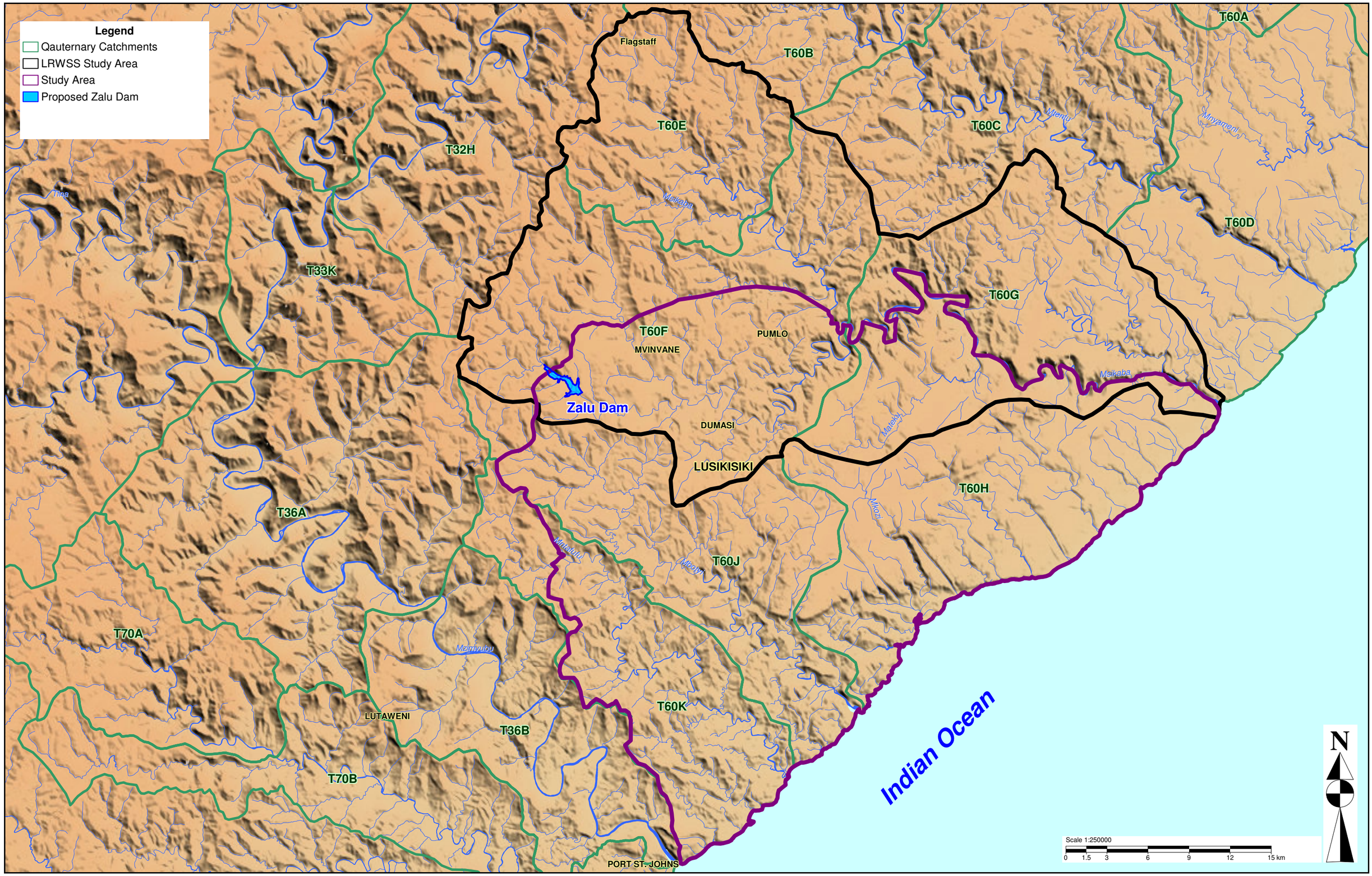
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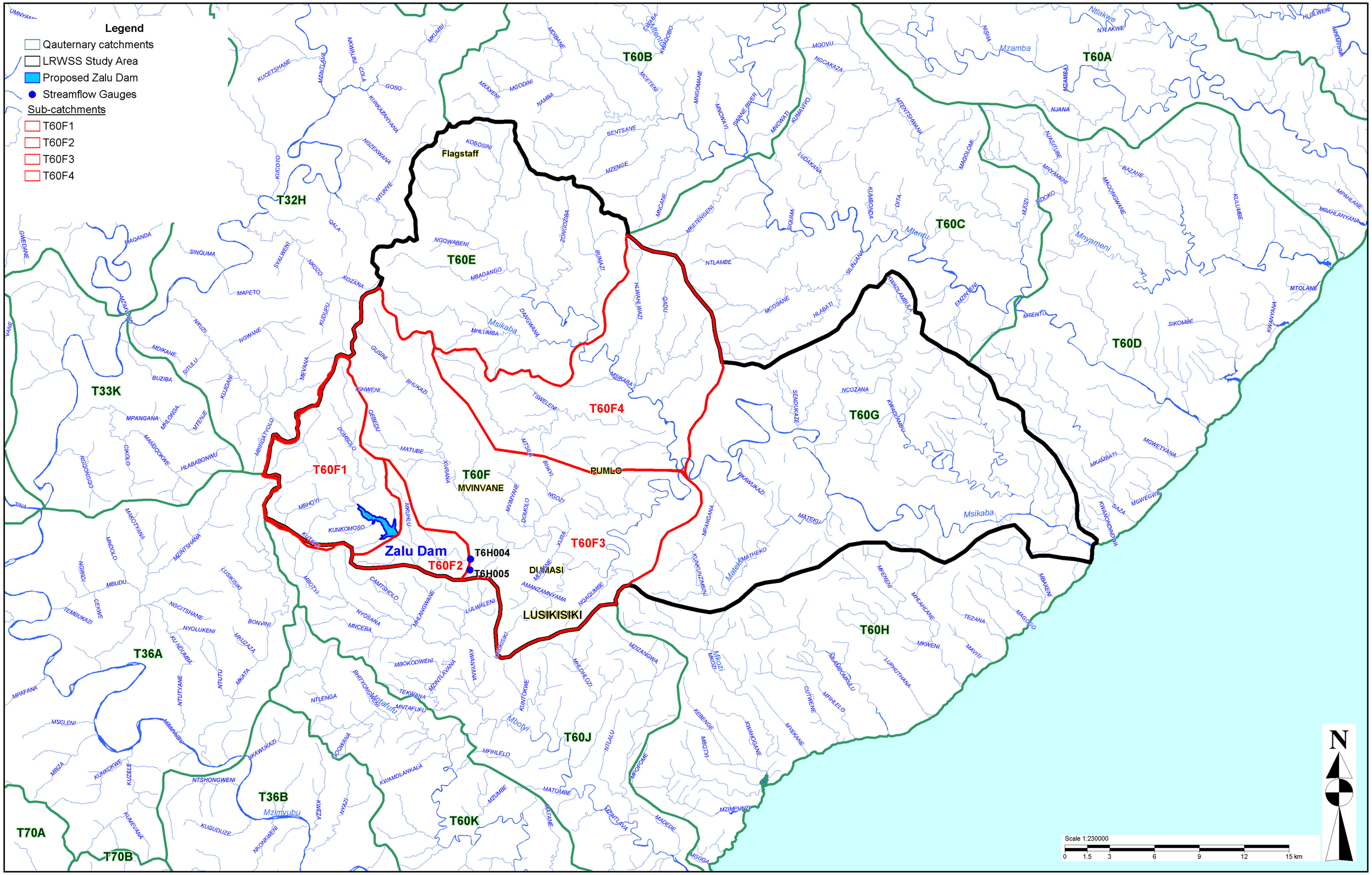
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Appendix A

Maps



BKS	**LUSIKISIKI REGIONAL WATER SUPPLY STUDY**	**Study Area**	**APPENDIX A-1** Drawn: LC Gallagher Checked: E van Niekerk Approved: E van Niekerk Date: 2011-05-10 Map Ref: P:/GISP/Water/Lusikisiki.Map View Ref: Study Area

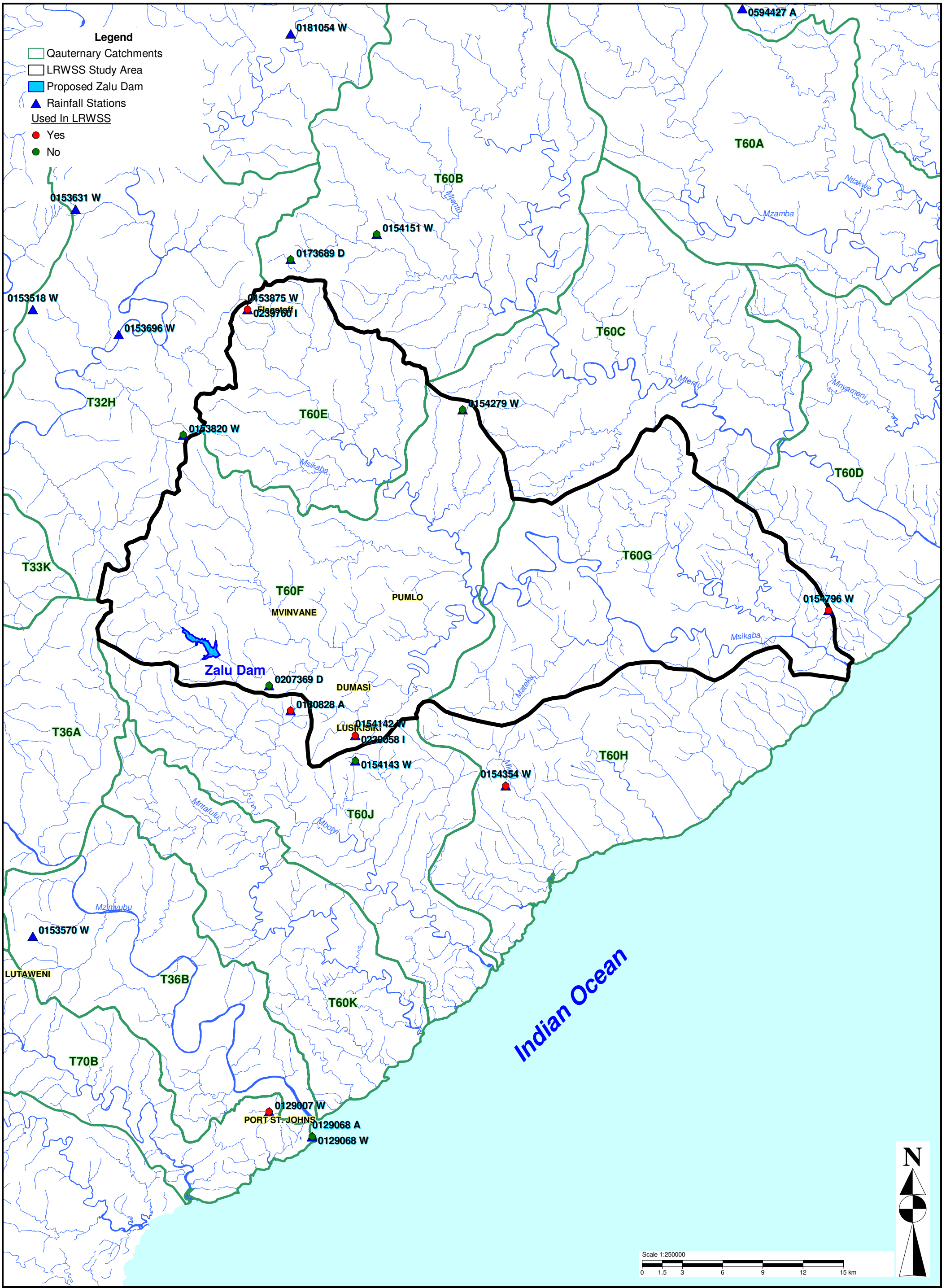


LUSIKISIKI REGIONAL WATER SUPPLY STUDY

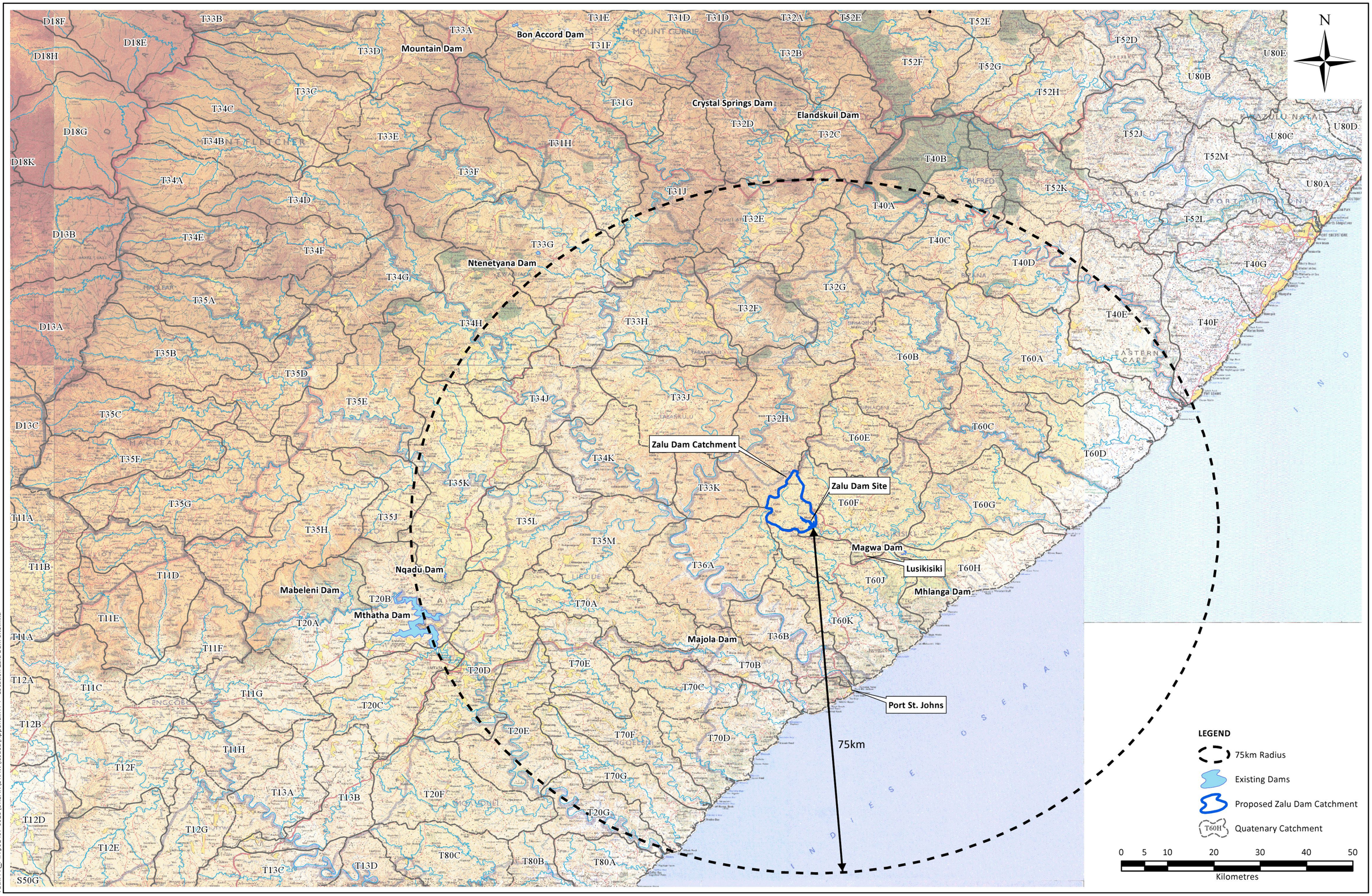
Detailed Information on the Msikaba River Catchment

APPENDIX A-2

Drawn:	LC Gallagher
Checked:	E van Niekerk
Approved:	E van Niekerk
Date:	2011-05-10
Map Ref:	P:/GISP/Water/Lusikisiki.Map
View Ref:	Msikaba River Catchment



BKS	**LUSIKISIKI REGIONAL WATER SUPPLY STUDY**	**Rainfall Network**	**APPENDIX A-3** Drawn: LC Gallagher Checked: E van Niekerk Approved: E van Niekerk Date: 2011-05-10 Map Ref: P:/GIS/P/Lusikisiki.map View Ref: Raingauges



Path: P:_PTA\J01407-0023\URBAN\DRAW\Issued\Appendix A-4 - Location Zalu Dam Site.mxd

FEASIBILITY STUDY FOR AUGMENTATION OF THE LUSIKISIKI REGIONAL WATER SUPPLY SCHEME

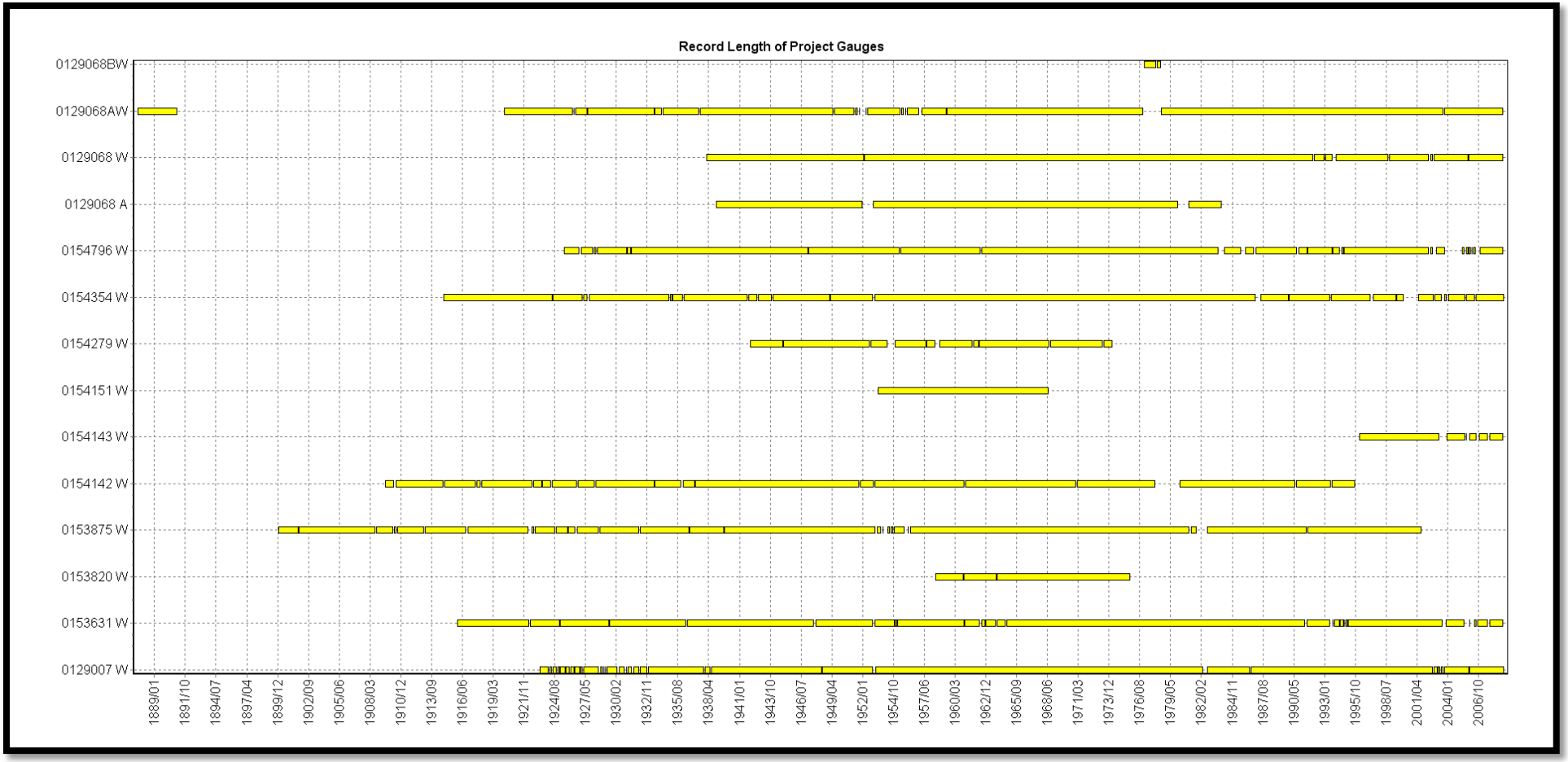
LOCATION OF PROPOSED ZALU DAM SITE

APPENDIX A-4

Appendix B

Rainfall

AVAILABLE RAINGAUGES FOR THE MSIKABA RIVER CATCHMENT									
Gauge Number	Station Name	Lat	Long	Start Year	End Year	Record length	MAP (mm)	Initial Selection (Y/N)	Reason for rejecting gauge
0129 007 W	PORT ST JOHNS - BOS	-31° 37'	29° 31'	1922	2008	87	1 246	Y	-
01290068 A	CAPE HERMES -VRT	-31° 38'	29° 33'	1938	1983	46	1 210	Y	-
01290068 W	PORT ST JOHNS - POL	-31° 38'	29° 33'	1937	2008	72	1 232	Y	-
01290068 AW	CAPE HERMES -VRT	-31° 38'	29° 33'	1886	2008	123	1 026	Y	-
01290068 BW	PORT ST JOHNS - POL	-31° 38'	29° 33'	1976	1977	2	0	N	Short
0153 631 W	TABANKULU - BOS	-31° 1'	29° 22'	1915	2008	94	1 170	Y	-
0153 820 W	BUKAZI	-31° 10'	29° 27'	1957	1974	18	778	Y	-
0153 875 W	FLAGSTAFF - TNK	-31° 5'	29° 30'	1899	2000	102	851	Y	-
0154 142 W	LUSIKISIKI - TNK	-31° 22'	29° 35'	1908	1994	87	987	Y	-
0154 143 W	LUSIKISIKI PRISON	-31° 23'	29° 35'	1995	2008	14	991	Y	-
0154 151 W	MALONGWANA	-31° 2'	29° 36'	1952	1967	16	1 096	Y	-
0154 279 W	HOLY CROSS MISSION	-31° 9'	29° 40'	1941	1973	33	939	Y	-
0154 354 W	NTSUBANE - BOS	-31° 24'	29° 42'	1914	2008	95	1 484	Y	-
0154 796 W	MKAMBATI	-31° 17'	29° 57'	1924	2008	85	1 218	Y	-
0239 058 I	MOUNVIEW P.M.B	-29° 32'	30° 27'	No record	-	1	0	N	Short
0239 760 I	SAPEKOE Richmond	-29° 56'	30° 9'	No record	-	1	0	N	Short
T6E001	LUSIKISIKI @ Ntafufu	-31° 29'	29° 31'	No record	-	0	N/a	N	Short
T6E002	LUSIKISIKI @ Magwa	-31° 22'	29° 39'	No record	-	0	N/a	N	Short
T6E003	FLAGSTAFF - TNK	-31° 03'	29° 32'	No record	-	0	N/a	N	Short
T6E004	LUSIKISIKI	-31° 20 '	29° 31'	No record	-	0	N/a	N	Short


Record Length of Project Gauges
0129068BW
0129068AW
0129068 W
0129068 A
0154796 W
0154354 W
0154279 W
0154151 W
0154143 W
0154142 W
0153875 W
0153820 W
0153631 W
0129007 W
1889/01
1891/10
1894/07
1897/04
1899/12
1902/09
1905/06
1908/03
1910/12
1913/09
1916/06
1919/03
1921/11
1924/08
1927/05
1930/02
1932/11
1935/08
1938/04
1941/01
1943/10
1946/07
1949/04
1952/01
1954/10
1957/06
1960/03
1962/12
1965/09
1968/06
1971/03
1973/12
1976/08
1979/05
1982/02
1984/11
1987/08
1990/05
1993/01
1995/10
1998/07
2001/04
2004/01
2006/10

DATA FLAGS INTRODUCED AND ADDED BY THIS STUDY		
Station number	**Record Period used**	**Additional flags added to the existing flags of the raw data**
0154796 W	1925 - 2007	Oct 1981
0154354 W	1920 - 2007	Flagged Feb 1999 to Jan 2000 (11 months - one month was already flagged (Jun 1999), Dec 1924, Oct 1999 to Jan2000
0154279 W	1942 - 1972	No additional flags
0154151 W	1953 - 1967	No additional flags
0154143 W	1996 - 2007	Dec 2007, Oct 1999, Nov 1999, Dec 1999
0154142 W	1920 -1994	Oct 1920, Dec 1920, Jan 1995
0153820 W	1958 - 1974	No additional flags
0153631 W	1920 - 2007	March 1925, Sep 2000, Oct 2000, Oct 2001 to Dec 2001, May 2003 to July 2007
0129068AW	1920 - 2007	Sep 52 to Dec 1954
0129068 W	1939 - 2007	Feb to Sep 1999
0129068 A	1939 - 1983	No additional flags
0129007 W	1923 - 2007	Feb 1999 (storms not zeros), Oct 1999 to Dec 1999, Apr 2003

Year	Month	0154796 W	0154354 W	0129007 W	0129068 W	0129068AW	0129068 A	0153631 W	0154151 W	0154143 W	0154142 W	0154279 W	0153875 W	0153820 W	0129068BW
MAP		1490	1480	1250	1230	1025	1200	1170	1100	990	980	940	860	777	N/A
1920	Oct		103			96		99			56		41		
1920	Nov		184			116		168			124		112		
1920	Dec		209			153		166			0 #		129		
1921	Jan		138			128		189			93		99		
1921	Feb		126			69		113			103		109		
1921	Mar		169			226		139			142		108		
1921	Apr		132			131		119			71		58		
1921	May		11			25		17			8		9		
1921	Jun		1			2		3			0		0		
1921	Jul		13			10		1			7		0		
1921	Aug		9			6		6			0		2		
1921	Sep		168			151		89			94		51		
1921	Oct		182			86		117			88		72		
1921	Nov		272			105		225			185		153		
1921	Dec		330			215		318			156		142		
1922	Jan		152			116		141			89		93		
1922	Feb		133			73		130			76		46		
1922	Mar		50			41		57			57		0 #		
1922	Apr		91			43		19			40		[		
1922	May		125			129		198			166		[		
1922	Jun		132			50		[			82		[		
1922	Jul		0			5		3			0		[		
1922	Aug		115			135		72			105		52		
1922	Sep		132			106		56			[		21		
1922	Oct		296		[	180		210			210		79		
1922	Nov		241		[	128		199			232		[		
1922	Dec		109		[	54		130			80		51		
1923	Jan		444		[	300		290			318		180		
1923	Feb		332		[	123		206			239		181		
1923	Mar		151		[	160		152			148		121		
1923	Apr		32		[	13		21			22		10		
1923	May		17	25		31		31			22		20		
1923	Jun		7	3		4		12			8		8		
1923	Jul		327	422		305		229			[		192		
1923	Aug		2	10		9		11			0		4		
1923	Sep		44	42		33		38			24		15		
1923	Oct		126	111		59		45			67		20		
1923	Nov		124	150		82		100			93		62		
1923	Dec		174	137		124		143			127		92		
1924	Jan		277	229		219		222			199		183		
1924	Feb		137	[		99 D		182			146		122		
1924	Mar		33	74		57		53			32		17		
1924	Apr		57	68		69		65			27		11		
1924	May		36	115		68		59			[		25		
1924	Jun		[	[		44		6			15		12		
1924	Jul		6	3		4		0			8		0		
1924	Aug		67	71		79		50			51		31		
1924	Sep		56	74		62		101			77		[		
1924	Oct		112	90		74		102			79		71		
1924	Nov		167		[	114		148			110		97		
1924	Dec		0 #	152		175		222			168		127		
1925	Jan		209	140		152		123			106		41		
1925	Feb		237		[	147		[			118		68		

Year	Month	0154796 W		0154354 W		0129007 W		0129068 W		0129068AW		0129068 A		0153631 W		0154151 W		0154143 W		0154142 W		0154279 W		0153875 W		0153820 W		0129068BW	
1925	Mar			296		226				275				0	#					254				204					
1925	Apr			113		75				97				66						95				35					
1925	May			28		36				45				26						25				18					
1925	Jun			19		16				14				0						6				0					
1925	Jul	35		34		35				36				14						32				11					
1925	Aug	13		19			[			16				7						9				0					
1925	Sep	114		207		110				147				86						112				41					
1925	Oct	120		79		44				86				84						47					[				
1925	Nov	63		159		104				105				197						127				115					
1925	Dec	155		110			[			94				155						103				94					
1926	Jan	128		154			[			88				232						115				182					
1926	Feb	132		197		224				175				151						120				82					
1926	Mar	176		230		179				200				307						247				229					
1926	Apr	19		60		47					[			27						49				20					
1926	May	112		7			[			12				36						26				23					
1926	Jun	92		103		116					[			54						75				62					
1926	Jul	3		5		0				5				2						3					[				
1926	Aug	13		18		21				15				24						26					[				
1926	Sep	101		126		106				133				102							[			73					
1926	Oct	124		179		193				55				118						115				75					
1926	Nov	139	P	224			[			235				116						155				76					
1926	Dec	168	P	182		123				102				243						169				102					
1927	Jan	52		133		92				71				163						104				104					
1927	Feb	122		121			[			71				99						98				49					
1927	Mar	309			[		[			342				340						349				223					
1927	Apr	8		5		0				2				7						6				1					
1927	May	15		19		25				15				25						24				10					
1927	Jun	2		0		0				6				0						0				0					
1927	Jul	16			[	3					[			15						0				9					
1927	Aug	41			[	37				35				24						20				21					
1927	Sep	80			[	76				64				48						74				40					
1927	Oct	91		149		150				128				187						113				101					
1927	Nov	28		41		23				30				85						41				19					
1927	Dec	135		177		158				107				202						167				159					
1928	Jan	106		183		101				117				305						156				148					
1928	Feb	139	P	167		110				128				148						146				160					
1928	Mar	57		121		127				187				98						99				87					
1928	Apr	29		27		31				40				14							[			7					
1928	May	58	P	72		83				88				23						33				16					
1928	Jun	21		17		11				14				0						15				13					
1928	Jul	14		8		20				15				0						0					[				
1928	Aug	111		127			[			174				64						86					[				
1928	Sep	30		33			[			42				46						18				25					
1928	Oct	98		122		144				92				61						93				67					
1928	Nov	117		197		199				134				111						105				90					
1928	Dec	84		140			[			75	D			123						130				91					
1929	Jan	132		186		138				103				187						126				86					
1929	Feb	53		131			[			107				89						107				51					
1929	Mar	204		222		230				144				208						128				122					
1929	Apr	22		22			[			14				5						6				27					
1929	May	43		82		86				39				43						53				38					
1929	Jun	278		281		257				208					[					133				88					
1929	Jul	81		132		139				130				24						68				44					
1929	Aug	69		99		71				64				36						56				11					

Year	Month	0154796 W		0154354 W		0129007 W		0129068 W		0129068AW		0129068 A		0153631 W		0154151 W		0154143 W		0154142 W		0154279 W		0153875 W		0153820 W		0129068BW	
1929	Sep	151		193		146	]			132				156						140				113					
1929	Oct	136		271		272				163				162						159				108					
1929	Nov	169		199		212				154				180						144				119					
1929	Dec	37		97		72				42				160						89				127					
1930	Jan	138		111		96				108				0	E					110				88					
1930	Feb	61		89		63				60				64						71				51					
1930	Mar	117		170		130				133				209						96				117					
1930	Apr	75		64			[			87				76						69				58					
1930	May	35		46			[			103				21						22				8					
1930	Jun	114		110		124				136				80						85				53					
1930	Jul	41		49		48				43				10						28				7					
1930	Aug	47		94		75				79				115						99				84					
1930	Sep	150		284		189				106				82						101				43					
1930	Oct	46		135		58				54				106						41				42					
1930	Nov	107		92		62				68				115						61				45	]				
1930	Dec	127		126			[			112				200						82				118					
1931	Jan	147	P	326		223				186				407						220				199					
1931	Feb	120		184			[			156				182						265				117					
1931	Mar	264		280		226				189				227						152				178					
1931	Apr	79		38		12				17				62						34				53					
1931	May	14		5		18				18				11						5				3					
1931	Jun	5	P	7		5				2				2						0				0					
1931	Jul	510		838			[			531				325						360				296					
1931	Aug	27		32			[			37				19						21				9					
1931	Sep	64		38		43				42				20						31				15					
1931	Oct	84		195		130				85				107						116				91					
1931	Nov	61		97		46				59				120						91				78					
1931	Dec	109		130		123				98				94						116				101					
1932	Jan	96		89		86				83				105						55				63					
1932	Feb	272		267		99				177				167						221				192					
1932	Mar	111		167			[			94				91						79					[				
1932	Apr	32		45		27				55				29						4				0					
1932	May	72		111		116				82				51						86				42					
1932	Jun	43		40		39				29				0						36				35					
1932	Jul	43		57		70				71				67						52				42					
1932	Aug	42		21		44				149				29						7				17					
1932	Sep	180		295		190				108				113						163				118					
1932	Oct	161		114		146				73				132						96				66					
1932	Nov	202		395		368				172				309						303				218					
1932	Dec	332		240			[			196				329						146				150					
1933	Jan	74		44		70				10				67						16				14					
1933	Feb	147		266		180				38				135						177				0	#				
1933	Mar	187		146		208				36				101						138				0	#				
1933	Apr	41		29		66				46				36						36				29					
1933	May	75		24		90				8				18						11				15					
1933	Jun	3		8		2				2				4						14				8					
1933	Jul	27		24		36					[			14							[			8					
1933	Aug	19		13		20				24				14						12				8					
1933	Sep	39		77		29				45				47						42				25					
1933	Oct	54		57		51				47				53						42				29					
1933	Nov	223		274		215				179				252						168				192					
1933	Dec	231		215		228				124				203						182				140					
1934	Jan	187		325		273				186				222						192				0	#				
1934	Feb	60		171		77				43				70						100				68					

Year	Month	0154796 W	0154354 W	0129007 W	0129068 W	0129068AW	0129068 A	0153631 W	0154151 W	0154143 W	0154142 W	0154279 W	0153875 W	0153820 W	0129068BW
1934	Mar	112	231	213		[		128			122		91		
1934	Apr	59	66	54		66		44			39		42		
1934	May	65	28	32		47		16			26		17		
1934	Jun	3	1	11		11		14			14		8		
1934	Jul	240	126	183		167		52			93		45		
1934	Aug	14	1	4		6		5			7		0		
1934	Sep	23	14	9		12		18			21		18]		
1934	Oct	58	72	104		84		80			65		50		
1934	Nov	106	[	226		90		184			143		150		
1934	Dec	211	227	255		176		194			135		185		
1935	Jan	88	103	117		105		139			99		117		
1935	Feb	88	[	58		29		92			43		45		
1935	Mar	135	236	169		185		100			152		89		
1935	Apr	212	159	223		194		136			157		109		
1935	May	188	168	219		144		93			126		100		
1935	Jun	140	222	120		68]		82			200		106		
1935	Jul	31	26	17		13		4			16		0		
1935	Aug	94	107	115		100		77			97		91		
1935	Sep	11	54	89		63		44			32		18		
1935	Oct	54	102	105		109		114			74		57		
1935	Nov	63	108	104		73		131			138		106		
1935	Dec	21	20	38		30		41			[		15		
1936	Jan	185	135	185		124		149			[		85		
1936	Feb	321	[	376		349		228			258		217		
1936	Mar	173	301	261		244		126			215		110		
1936	Apr	24	59	19		24		13			21		9		
1936	May	174	192	194		135		[			132		118		
1936	Jun	107	36	24		12		7			16		2		
1936	Jul	19	28	71		43 D		3			25		20		
1936	Aug	7	3	2		7		0			1		[		
1936	Sep	99	126	133		116		73			45		38		
1936	Oct	154	217	169		124]		163			135		111		
1936	Nov	331	522	410		247		393			273		274		
1936	Dec	64	87	119		143		107			48		69		
1937	Jan	153	95	127		85		77			84		104		
1937	Feb	128	295	289		246		267			[		178		
1937	Mar	179	174	169		151		108			190		74		
1937	Apr	48	65	56		61		37			35		14		
1937	May	4	14	14		11		10			13		12		
1937	Jun	9	23	22		6		14			7		9		
1937	Jul	88	68	96		[		7			22		4		
1937	Aug	51	57	66		51		16			20		12		
1937	Sep	66	72]	44		48		69			42		24		
1937	Oct	95	114	78	[	65		115			54		62		
1937	Nov	97	125	130	[	124		118			76		48		
1937	Dec	157	295	[	[	102		216			139		131		
1938	Jan	88	219	103	[	82		181			135		103		
1938	Feb	112	101	83	[	90]		163			81		117		
1938	Mar	66	85	62	73]	76		79			58		0 #		
1938	Apr	162	217	216	186	166		175			136		91		
1938	May	50	24	33	43	46		27			9		11		
1938	Jun	42	77	76	88	94		41			50		36		
1938	Jul	65	60	[	41	37		39			21		29		
1938	Aug	22	25	29	33	34		35			23		25		

Year	Month	0154796 W		0154354 W		0129007 W		0129068 W		0129068AW		0129068 A		0153631 W		0154151 W		0154143 W		0154142 W		0154279 W		0153875 W		0153820 W		0129068BW	
1938	Sep	12		21		28		22		24	D			28						22				17					
1938	Oct	72		75		89		57		53	]		[	120						63				76					
1938	Nov	126		196		204		190		188	]		[	174						126				118					
1938	Dec	147		169		181		164		161	]		[	200						149				123					
1939	Jan	84		267		136		101		89	D	101		217						158				126					
1939	Feb	146		262		276		237		194	D	237		380						213				164					
1939	Mar	122		178		160		126		111	D	126		82						101				54					
1939	Apr	51		48		36		38		38		38		82						26				58					
1939	May	132		78		94		98		89	D	98		62						56				42					
1939	Jun	17		12		4		6		13	D	6		21						0				15					
1939	Jul	68		115		101		85		78	D	85		54						96				51					
1939	Aug	13		29		25		26		23	D	26		15						3				109					
1939	Sep	206		284		251		231		211		231		184						181					[				
1939	Oct	111		155		147		121		104		121		108						79				79					
1939	Nov	59		115		107		109		105	D	109		121						85				69					
1939	Dec	139		243		190		198	E	170		198		161						127				108					
1940	Jan	41		111		126		105		94		105		130						73				0	#				
1940	Feb	50		148		204		143		145		143		280						133				90					
1940	Mar	94		142		91		82		95	D	82		172						93				107					
1940	Apr	46		36		38		34		37		34		60						29				44					
1940	May	111		172		77		68		68		68		116						153				116					
1940	Jun	32		3		10		8		11		8		23						0				17					
1940	Jul	4		6		9		7		7		7		1						3				0					
1940	Aug	45		30		32		55		55		55		5						14				10					
1940	Sep	76		101		109		119		116		119		67						76				0	#				
1940	Oct	38		56		40		39		43		39		64						35				69					
1940	Nov	159		298		200		167		138	D	167		199						197				120					
1940	Dec	155		128		101		86		66		86		159						87				67					
1941	Jan	89		113		122		102		88		102		136						73				82					
1941	Feb	28		54		39		36		35	]	36		48						44				53					
1941	Mar	116		114		198		153		150		153		102						76				55					
1941	Apr	43		42		53		54		61		54		112						39				61					
1941	May	9		7		20		21		19		21		0						6				5					
1941	Jun	49		48		64		79		81		79		16						21				8					
1941	Jul	25		24		39		52		45		52		9						14				10					
1941	Aug	40		35		37		31		35		31		23						24				25					
1941	Sep	72		59		58		59		80		59		34						22				24					
1941	Oct	72		155		121		98		108		98		71						92			[	94					
1941	Nov	133			[	156		103		106		103		181						90			[	80					
1941	Dec	81		69		86		85		79	]	85		83						34			[	67					
1942	Jan	389		328		256		221		147		221		250						170		154		170					
1942	Feb	47		93		95		68		64	]	68		166						97		71		70					
1942	Mar	145		147		163		148		152		148		156						133		116		111					
1942	Apr	39		83		81		80		75		80		114						63		39		0	#				
1942	May	113		110		169		125		120		125		34						81		56		44					
1942	Jun	0		0		2		1		1		1		0						0		0		0					
1942	Jul	4		0		6		8		8		8		2						0		3		4					
1942	Aug	81		89		70		55		58		55		25						35		51		45					
1942	Sep	79			[	93		74		74		74		81						55		69		39					
1942	Oct	100		143		94		102		97		102		109						103		94		78					
1942	Nov	100		475		471		414		305		414		320						312		277		289					
1942	Dec	187		195		269		222		191		222		186						140		180		181					
1943	Jan	130		108		194		181		131		181		175						100		109		82					
1943	Feb	55		96		81		87		64		87		94						70		88		74					

Year	Month	0154796 W	0154354 W	0129007 W	0129068 W	0129068AW	0129068 A	0153631 W	0154151 W	0154143 W	0154142 W	0154279 W	0153875 W	0153820 W	0129068BW
1943	Mar	198	203	162	140	131	140	147			155	151	128		
1943	Apr	150	194	191	153	145	153	163			126	143	103		
1943	May	34	38	80	72	58	72	69			31	20	38		
1943	Jun	66	67	39	37	31	37	62			36	33	31		
1943	Jul	12	17	15	12	13	12	22			17	18	20		
1943	Aug	154	182	213	207	206	207	104			144	114	95		
1943	Sep	60	52	65	53	64	53	47			42	49	48		
1943	Oct	110	137	153	115	122	115	155			93	117	98		
1943	Nov	154	195	201	181	139	181	199			140	145	168		
1943	Dec	142	136	147	119	109	119	178			145	150	157		
1944	Jan	82	[	166	105	103]	105	109			76	106	78		
1944	Feb	149	190	157	160	173	160	186			122	143	156		
1944	Mar	87	98	331	205	169	205	144			79	80	45		
1944	Apr	75	67	74	68	40	68	29			36	31	31		
1944	May	22	24	10	6	28	6	10			13	17	10		
1944	Jun	28	68	39	26	51	26	45			39	32	23		
1944	Jul	24	45	35	38	11	38	42			9	31	28		
1944	Aug	16	9	19	20	0	20	11			9	14	9		
1944	Sep	206	365	411	366	297	366	150			201	161	135		
1944	Oct	88	157	143	133	125	133	92			67	77	61		
1944	Nov	85	90	108	95	90	95	55			58	49	36		
1944	Dec	42	59	74	46	31	46	56			47		[48		
1945	Jan	148	213	179	133	112	133	266			146	157	149		
1945	Feb	131	203	241	230	169	230	172			111]	122	99		
1945	Mar	128	170	126	135	105	135	139			149	106	107		
1945	Apr	42	59	36	50	44	50	24			13	12	13		
1945	May	37	52	38	30	33	30	32			38	44	34		
1945	Jun	26	10	12	8	1	8	0			15	6	4		
1945	Jul	10	16	25	16	24	16	4			9	19	6		
1945	Aug	7	12	11	5	5	5	14			7	9	6		
1945	Sep	135	127	112	84	52	84	35			77	54	38		
1945	Oct	223	385	334	276	148	276	160			187	169	173		
1945	Nov	24	18	20	16	20	16	53			13	11	24		
1945	Dec	80	112	96	112	117	112	149			83	76	73		
1946	Jan	69	167	90	69	52	69	143			82	85	94		
1946	Feb	159	149	167	150	135	150	163			73	147	171		
1946	Mar	221	179	241	224	187	224	142			118	148	124		
1946	Apr	95	112	48	58	47	58	36			84	68	47		
1946	May	13	17	27	22	24	22	27			18	11	13		
1946	Jun	37	14	39	33	27	33	0			6	5	11		
1946	Jul	9	2	6	2	4	2	27			6	16	38		
1946	Aug	19	6	20	15	20	15	7			3	0	0		
1946	Sep	86	71	77	67	63	67	46			37	51	37		
1946	Oct	69	107	65	63	61	63	79			91	54	83		
1946	Nov	216	224	124	137	126	137	168			143	124	120		
1946	Dec	154	104	97	113	91	113	172			47	83	99		
1947	Jan	160	134	178	176	167	176	166			101	93	95		
1947	Feb	100	160	75	78	80	78	145			120	95	132		
1947	Mar	180 P	205	279	306	356	306	180			156	121	173		
1947	Apr	254	190	176	185	162	185	72			100	97	64		
1947	May	141	42	52	56	33 D	56	0			12	11	10		
1947	Jun	108	161	164	119	115 D	119	80			129	128	91		
1947	Jul	37	27	32	25	30 D	25	23			17	14	21		
1947	Aug	16	18	29	20	17	20	6			16	5	1		

Year	Month	0154796 W	0154354 W	0129007 W	0129068 W	0129068AW	0129068 A	0153631 W	0154151 W	0154143 W	0154142 W	0154279 W	0153875 W	0153820 W	0129068BW
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1947	Oct	51	89	91	70	63	70	[			45	55	50		
1947	Nov	203	553	271	230	196	230	383			449	373	312		
1947	Dec	117	201	216	211	170	211	164			117	114	117		
1948	Jan	97	144	121	107	90	107	147			62	117	83		
1948	Feb	156	201	233	217	224	217	193			128	163	188		
1948	Mar	218	188	224	249	238	249	159			115	88	63		
1948	Apr	109	98	206	191	154	191	54			49	60	33		
1948	May	18	1		[4	4	D 4	8			3	4	2		
1948	Jun	4	6	4	0	3	0	0			4	0	0		
1948	Jul	3	0	6	10	6	D 10	5			1	0	0		
1948	Aug	16	16	34	32	31	] 32	7			10	9	8		
1948	Sep	53	38	36	28	16	28	25			14	14	11		
1948	Oct	220	240	297	253	167	253	180			124	147	150		
1948	Nov	69	149	101	82	66	82	111			88	73	65		
1948	Dec	116	147	141	132	110	132	140			85	99	120		
1949	Jan	77	119	124	127	111	127	83			103	106	107		
1949	Feb	457	[	299	280	260	280	196			124	144	121		
1949	Mar	124	205	196	227	191	D 227	79			116	119	96		
1949	Apr	102	90	119	108	116	108	79			58	61	91		
1949	May	0	7	13	7	6	7	37			7	8	12		
1949	Jun	3	0	0	0		[0	0			0	0	0		
1949	Jul	13	11	11	5	10	5	25			12	18	19		
1949	Aug	48	40	49	33	34	33	26			14	19	14		
1949	Sep	77	125	95	] 110	77	110	67			49	57	] 34		
1949	Oct	127	122	138	113	85	113	110			53	78	75		
1949	Nov	227	308	262	283	112	D 283	167			117	136	141		
1949	Dec	79	138	114	87	61	87	144			61	69	107		
1950	Jan	149	201	211	199	0	E 199	211			103	159	170		
1950	Feb	66	154	134	135	0	E 135	293			140	130	129		
1950	Mar	47	99	63	61	0	E 61	239			98	80	158		
1950	Apr	158	73	93	79	0	E 79	72			70	81	55		
1950	May	158	73	122	147	0	E 147	89			77	59	60		
1950	Jun	2	0	6	0	0	E 0	7			3	3	5		
1950	Jul	51	46	73	60	0	E 60	50			44	43	38		
1950	Aug	123	61	101	89	0	E 89	128			56	73	68		
1950	Sep	26	49	53	63	0	E 63	50			23	25	40		
1950	Oct	109	181	135	145	0	E 145	145			94	84	67		
1950	Nov	36	36	48	44	0	E 44	84			23	37	77		
1950	Dec	204	272	252	227	0	E 227	336			179	235	212		
1951	Jan	124	249	169	147	0	E 147	138			74	118	95		
1951	Feb	68	100	49	40	0	E 40	140			50	60	103		
1951	Mar	121	128	105	114	0	E 114	142			100	171	114		
1951	Apr	40	40	63	43	38	43	27			28	15	30		
1951	May	35	16	25	19		[19	26			13	25	23		
1951	Jun	54	23	22	25	20	25	4			5	8	7		
1951	Jul	8	4	10	12		[12	5			6	4	4		
1951	Aug	57	62	67	50		[50	79			33	59	54		
1951	Sep	94	87	141	104		[104	112			72	47	62		
1951	Oct	194	239	191	179	124	179	183				[126	117		
1951	Nov	17	12	15	12		[12	39			13	21	28		
1951	Dec	241	342	320	294		[294	154			124	141	128		
1952	Jan	182	251	282	195		[	[190			146	116	97		
1952	Feb	69	89	131	[	[	[	[155			96	93	130		

Year	Month	0154796 W		0154354 W		0129007 W		0129068 W		0129068AW		0129068 A		0153631 W		0154151 W		0154143 W		0154142 W		0154279 W		0153875 W		0153820 W		0129068BW	
1952	Mar	119		167		305		292			[		[	128						134		121		80					
1952	Apr	87		93		115		106			[		[	75						84		103		83					
1952	May	59		24		109		85		51			[	28						17		11		18					
1952	Jun	9		8		22		17			[		[	20						10		9		5					
1952	Jul	17		12		34		24		21			[	20						15		8		4					
1952	Aug	0		0		5		5		0			[	14						2		1		3					
1952	Sep	165		151		156		138		0	#		[	82						86			[	52					
1952	Oct	34		83		76		69		0	#		[	62			[			46		37		46					
1952	Nov	161		184		116		121		0	#		[	108			[			65		33	]	28					
1952	Dec	93		101		140		133		0	#		[	171			[			95		53		0	#				
1953	Jan	131			[		[	149		0	#	149			[		[				[	72		0	#				
1953	Feb	174		119			[	67		0	#	67		145			[			89		95			[				
1953	Mar	101		107		102		115		0	#	115		104			[			66		61			[				
1953	Apr	54		78		53		57		0	#	57		130			[			71		58			[				
1953	May	25		19		27		42		0	#	42		10			[			8		6		8					
1953	Jun	23		9		40		35		0	#	35		8		4	]			11		7		5					
1953	Jul	0		0		4		6		0	#	6		5		1				0		0		0					
1953	Aug	72		61	D	44		32		0	#	32		46		38				42		42			[				
1953	Sep	74		193		138		131		0	#	131		120		74				162		95			[				
1953	Oct	119		124		178		147		0	#	147		144		110				120		94			[				
1953	Nov	221		338		278		206		0	#	206		150		153				163		122		117					
1953	Dec	212		120		160		144		0	#	144		259		204				91		123			[				
1954	Jan	98		76		129		104		0	#	104		140		112				89		93			[				
1954	Feb	61		67		50		62		0	#	62		156		108				56		113			[				
1954	Mar	117		222		142	D	141		0	#	141		192		114				174		95			[				
1954	Apr	27		21		46		52		0	#	52		37		16				11			[	19					
1954	May	94		85		112		97		0	#	97		92		67				78			[	69					
1954	Jun	76		63		91		84		0	#	84		47		22				47			[	28					
1954	Jul	24		36		21		20		0	#	20		25		11				23			[		[				
1954	Aug	12		22		30		22		0	#	22		7		7				4			[	6					
1954	Sep	100		168		112		79		0	#	79		91		96				78			[	59					
1954	Oct	384		396		273		254		0	#	254		185		259				213			[		[				
1954	Nov	110		82		92		92		0	#	92			[	86				72			[	65					
1954	Dec	68		100		110	D	84		0	#	84		94		87				85		107		0	#				
1955	Jan	240		269		190		198		173	D	198		273		200				176		197		0	#				
1955	Feb	194		220		222		205		177		205			[	270				178		133		0	#				
1955	Mar	291		161		105	D	114		104		114		72		68				67		45		0	#				
1955	Apr	23		34		28		21		26		21		79		53	#			44		54		0	#				
1955	May	54	P	37		37	D	45		60		45		34		11				16		10		9					
1955	Jun	24		44		40	D	44			[	44		29		34				30		14		25					
1955	Jul	0		0		0		0		0		0		2		1				0		2		0					
1955	Aug	2		0		0		3		4	D	3		0		0				0		5		1					
1955	Sep	152		187		163	D	140			[	140		67		81				102		86			[				
1955	Oct	116		106		133		108			[	108		88		63				68		55			[				
1955	Nov	113		155		162	D	157		151	D	157		120		136	#			101		106			[				
1955	Dec	13		49		35	D	36			[	36		65		71	#			40		45			[				
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1956	Feb	215		192		175	D	167		145	D	167		163		191				166		197		119					
1956	Mar	177		344		319	D	268		204		268		234		229				244		233			[				
1956	Apr	157		115		123	D	159		141		159		65		64				63		72		42					
1956	May	43		27		63	D	71		70	D	71		42		19				31		22		23					
1956	Jun	66		64		74		56		53	D	56		24		41				72		39		0					
1956	Jul	0		0		6		5		7	D	5		1		0				0		0		0					
1956	Aug	31		14		66		81		64	D	81		19		27				21		13		13					

Year	Month	0154796 W		0154354 W		0129007 W		0129068 W		0129068AW		0129068 A		0153631 W		0154151 W		0154143 W		0154142 W		0154279 W		0153875 W		0153820 W		0129068BW	
1956	Sep	122		164		90		130		113	]	130		52		54				75		48		59					
1956	Oct	241		179		189		153		137	D	153		81		99	#			104		84		67					
1956	Nov	214		418		287		288		211	D	288		153		170	#			281		196		176					
1956	Dec	353		401		297	D	291		224		291		228		341				286		290		213					
1957	Jan	169		176		167		202			[	202		188		185				103		100		137					
1957	Feb	155		160		158		138			[	138		165	D	124				89		121		84					
1957	Mar	213		203		241		240			[	240		182		157				151		151		144					
1957	Apr	215		240		213		164		123		164		98		100				114		103		70					
1957	May	15		27		50		48		44		48		16		24				26		15		17					
1957	Jun	59		55		73		79		83	D	79		18		25				43		34		18					
1957	Jul	8		12		12		16		17		16		6		6				13		11		11					
1957	Aug	44		55		43		42		39	D	42		52		32				50		51		40					
1957	Sep	143		103		148		152		75	D	152		110		85				92			[	88					
1957	Oct	94		127		90		85		69	D	85		108		102				94		139		89			[		
1957	Nov	112		104		132		122		80	D	122		162		146				82		106		143			[		
1957	Dec	132		304		91		87		69	D	87		118		79				159		93		85			[		
1958	Jan	159		207		204		190		151	D	190		160		241				166		186		143			[		
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1958	Oct	70		91		99		72		40	D	72		79		53				52			[	45		50			
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1958	Dec	79		130		144		132		104		132		214		172				104		128		128		118			
1959	Jan	63		95		97		94		72		94		123		99				79		52		68		83			
1959	Feb	138		147		100		95		83	D	95		116		133				82		124		113		105			
1959	Mar	91		90		77		76		46		76		176		125	#			89		78		113		93			
1959	Apr	62		81		83		72		66	D	72		90		90				55		74		83		63			
1959	May	154		383		87		79		50		79		242		284				240		278		242		209			
1959	Jun	0		8		0		0			[	0		0		0				1		0		0		0			
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1959	Aug	71		130		143		126		98		126		75		45				32		65		60		53			
1959	Sep	70		87		74		45		46		45		55		28	#			131		42		34		27			
1959	Oct	119		87		131		130		79		130		101		82				64		64		71		80			
1959	Nov	119		139		88		100		77	D	100		142		180				119		74		92		75			
1959	Dec	112		139		146		145		121		145		128		131	#			133		91		110		96			
1960	Jan	128		149		126		125		90		125		183		162				98		89		114		99			
1960	Feb	82		103		113		95		72		95		102		102				69		97		72		54			
1960	Mar	121		192		184		183		155	D	183		162		90				102		115		123		128			
1960	Apr	88		106		154		148		117	D	148		85		115				113		60		74		53			
1960	May	133		69		129		152		115	D	152		24		26				21		28		28		16			
1960	Jun	3		0		0		0		1		0		1		6				1		5		0		2			
1960	Jul	29		19		32		44		40	D	44		15		19				21		15		17		10			
1960	Aug	34		60		53		53		52	D	53		82		48				57		30		54		54			
1960	Sep	101		142		109		103		77		103		81		66				90		66		55		47			
1960	Oct	52		113		74		61		40	D	61		78		79				99		53		45		35			
1960	Nov	236		195		170		201		139		201		134		138				90		110		111		91			
1960	Dec	145		254		234		180		133		180		255		220				176		170		157			[		
1961	Jan	134		219		200		175		130	D	175			[	136				157		100		163		113			
1961	Feb	92		102		164		139		102		139		181		109					[	70		89		66			

Year	Month	0154796 W		0154354 W		0129007 W		0129068 W		0129068AW		0129068 A		0153631 W		0154151 W		0154143 W		0154142 W		0154279 W		0153875 W		0153820 W		0129068BW	
1961	Mar	173		140		121		152		129		152		155		110				82		85		127		93			
1961	Apr	305		378		315		289		186		289		154		188				210		225		129		156			
1961	May	94		47		104		106		66		106		33		24				23		41		27		41			
1961	Jun	22		8		5		29		20		29		8		12				3		0		16		4			
1961	Jul	93		100		129		111		100	D	111		9		20				11		27		11		6			
1961	Aug	21		12		49		43		41		43		14		5				7		5		8		4			
1961	Sep	80		76		72		41		43	D	41		42		46				39		36		33		29			
1961	Oct	108		93		102		98		60	D	98		54		66				32		36		41		30			
1961	Nov	172		227		231		198		175		198		196		130				148			[	140		168			
1961	Dec	101		158		177		162		122	D	162		154		146				123		126		102		70			
1962	Jan	111		148		104		85		80		85		152		184				90		131		108		131			
1962	Feb	87		137		145		134		118		134		179		185	#			115		132		141		124			
1962	Mar	209		230		180		161		133		161		111		103				204		204		86		106			
1962	Apr	51		53		48		46		47		46		31		22				36		18		24		23			
1962	May	59		37		46		39		44		39		39		27				47			[	26		39			
1962	Jun	2		0		5		1		1		1		0		0				0		0		0		2			
1962	Jul	3	P	0		3		6		4		6			[	0				3		0		0		0			
1962	Aug	126		86		97		93		91	D	93		44		38				59		67		42		35			
1962	Sep	70		53		46		46		48	D	46		33		34				30		26		26		13			
1962	Oct	137		212		175		148		94		148		134		130				142		128		120		96			
1962	Nov	219		173		164		157		146	D	157		181		142				139		164		143		139			
1962	Dec	91		108		151		142		107		142			[	157				97		96		94		71			
1963	Jan	218		273		249		170		164		170		261		223				182		243		216		199			
1963	Feb	43		141		90		78		65		78		64		106				73		92		89		88			
1963	Mar	460		452		369		390		236		390		300		196				315		275		279		273			
1963	Apr	46		40		80		75		71		75		69		55	#			60		33		49		45			
1963	May	85		92		61		63		55		63		9		0				16		3		19		9			
1963	Jun	40		18		19		21		18		21		6		12				12		9		5		14			
1963	Jul	228		279		195		169		136		169		129		115				146		132		123		122			
1963	Aug	3		6		13		12		13		12		4		22				2		3		7		2			
1963	Sep	47		23		34		29		17	D	29		17		27				15		19		13		12			
1963	Oct	191		165		195		158		91	D	158		169		132				98		101		127		103			
1963	Nov	136		145		143		136		117	D	136		181		191				105		90		175		123			
1963	Dec	147		168		126		75		76	D	75			[	134	#			78		126		107			[		
1964	Jan	323		282		243		251		197	D	251		205		148				155		166		183		151			
1964	Feb	165		268		195		175		110		175		113		109				99		129		90		90			
1964	Mar	79		150		197		182		165	D	182		213		118				117		123		117		126			
1964	Apr	108		112		111		98		105		98		125		93				72		97		190		94			
1964	May	44		23		26		31		20		31		6		0				13		7		6		7			
1964	Jun	211		352		179		201		117		201		171		210				288		350		200		183			
1964	Jul	19		11		11		15		11	D	15		13		8				6		11		7		5			
1964	Aug	36		16		20		11		26		11		19		8				9		12		10		4			
1964	Sep	47		74		73		57		63		57		79		42				70		87		74		69			
1964	Oct	152		150	#	159		134		106	D	134			[	224				122		183		162		124			
1964	Nov	69		122	D	54		45		29		45		43		42				35		25		20		20			
1964	Dec	69		144	D	68		50		62		50		103		117				107		93		73		64			
1965	Jan	107		160	D	161		111		126		111		111		167				108		108		121		106			
1965	Feb	81		86		66		57		45		57		123		171				105		74		97		76			
1965	Mar	24		35	D	22		34		26	D	34		60		31				28		36		24		19			
1965	Apr	57		32		83		54		58	D	54		22		22				29		21		22		24			
1965	May	93		81		93		84		79		84		77		47				58		51		53		53			
1965	Jun	238		230		242		201		231		201		167		151				180		178		168		157			
1965	Jul	41		55		44		36		34		36		70		50				61		52		54		45			
1965	Aug	89		100		88		98		90		98		78		67				55		69		62		61			

Year	Month	0154796 W		0154354 W		0129007 W		0129068 W		0129068AW		0129068 A		0153631 W		0154151 W		0154143 W		0154142 W		0154279 W		0153875 W		0153820 W		0129068BW	
1965	Sep	107	$	131		104		69		34	D	69		60		51				35	]	59		58		52			
1965	Oct	205		335		296		252		224		252		154		151	#			221		171		158		130			
1965	Nov	120		195		201		186		144		186		159		156				161		143		130		107			
1965	Dec	122		110		115		102		90		102		87		102	#			77		84		72		44			
1966	Jan	96		158		167		163		111	D	163		189		150	#			108		110		121		83			
1966	Feb	82		111		117		88		82		88		104		102				79		84		69		61			
1966	Mar	12		28		60		29		27		29		31		12				19		9		20		10			
1966	Apr	83		49		53		68		51	D	68		58		61				34		32		37		24			
1966	May	229		331		153		165		122	D	165		178		162				323		232		137		179			
1966	Jun	52		16		15		9		6	D	9		9		10				6		10		2		3			
1966	Jul	2		0		12		0		11		0		2		4				7		0		0		0			
1966	Aug	54		51		35		56		41	D	56		41		52				31		33		31		22			
1966	Sep	74		72		101		108		103	D	108		86		23				68		71		75		71			
1966	Oct	49		74		55		46		40	D	46		80		63				58		47		46		31			
1966	Nov	65		98		101		100		93	D	100		66		99				107		81		87		61			
1966	Dec	175		155		128		113		85	D	113		151		135				109		93		112		77			
1967	Jan	177		179		195		188		153		188		184		176				163		160		158		126			
1967	Feb	216		89		124		95		106	D	95		84		74				86		100		61		44			
1967	Mar	217		306		263		242		201	D	242		301		253				325		252		248		274			
1967	Apr	115		255		262		192		189	D	192		51		122				146		113		81		73			
1967	May	6		6		14		13		13		13		26		17				15		13		19		17			
1967	Jun	57		37		53		41		34		41		75		32				52		34		52		60			
1967	Jul	117		104		123		129		138		129		62		60				75		74		64		63			
1967	Aug	25		25		30		23		26	D	23		17		10				24		18		9		11			
1967	Sep	23		20		43		31		28	D	31		13		3				7		5		12		3			
1967	Oct	41		68		119		114		84	D	114		94		98				47		53		72		55			
1967	Nov	128		202		115		100		76	D	100		159		179				150		145		147		103			
1967	Dec	69		85		101		94		68		94		114		87				73		56		101		44			
1968	Jan	89		143		83		101		87	D	101		178		131				103		104		101		100			
1968	Feb	116		163		134		133		105	D	133		113		103				95		94		80		56			
1968	Mar	101		116		70		56		56	D	56		126		67				75		53		75		39			
1968	Apr	75		59		52		52		35	D	52		98		96				37		36		78		48			
1968	May	5		7		1		2		1	D	2		3		0				4		3	D	0		0			
1968	Jun	32		8		19		26		28		26		2		0				6		1		0		0			
1968	Jul	5		10		15		11		12		11		15			[			9		14		16		9			
1968	Aug	89		113		60		54		46	D	54		75			[			92		82		62		63			
1968	Sep	158		154		140		126		109		126		97			[			124			[	72		71			
1968	Oct	113		103		130		95		80		95		84						98		86		72		53			
1968	Nov	128		159		203		160		155	D	160		136						140		102		111		72			
1968	Dec	167		171		73		80		96	D	80		125						85		92		80		48			
1969	Jan	52		73		77		79		66	D	79		85						49		37		68		26			
1969	Feb	176		257		267		176		162	D	176		197						126		156		219		159			
1969	Mar	254		258		181		160		153		160		184						181		149		147		149			
1969	Apr	62		90		64		36		37	D	36		61						64		32		23		28			
1969	May	287		203		248		212		207	D	212		60						119		107		63		55			
1969	Jun	30		13		21		10		31	D	10		5						7		5		4		4			
1969	Jul	19		17		19		20		24		20		19						9		5	D	11		6			
1969	Aug	22		34		33		33		46		33		41						20		36		33		26			
1969	Sep	84		42		66		68		75	D	68		32						43		24		22		14			
1969	Oct	133		121		143		122		118		122		109						91		73		75		68			
1969	Nov	196		224		229		177		142		177		138						111		74		83		83			
1969	Dec	67		137		157		123		122	D	123		151						105		93		101		75			
1970	Jan	50		97		62		42		40	D	42		115						59		59		84		89			
1970	Feb	118		163		145		118		94	D	118		159						180		85		101		76			

Year	Month	0154796 W		0154354 W		0129007 W		0129068 W		0129068AW		0129068 A		0153631 W		0154151 W		0154143 W		0154142 W		0154279 W		0153875 W		0153820 W		0129068BW	
1970	Mar	54		28		40		44		40		44		52						42		37		26		16			
1970	Apr	89		57		75		48		58	D	48		30						41		17		32		21			
1970	May	57		37		45		42		44	D	42		47						33		37		52		38			
1970	Jun	143		94		63		68		71	D	68		43						81		42		34		38			
1970	Jul	0		2		0		0		11	D	0		6						0		0		0		3			
1970	Aug	178		465		271		215		148	D	215		94						241		102		87		89			
1970	Sep	63		75		80		71		74	D	71		82						75		80		79		66			
1970	Oct	252		331		318		315		132	D	132		183						176		224		163		166			
1970	Nov	130		171		235		202		183	D	202		121						112		86		90		53			
1970	Dec	105		108		118		94		91	D	94		151						85		104		110		104			
1971	Jan	127		144		155		105		140	D	140		146							[	104		107		71			
1971	Feb	81		164		149		138		116		138		182						141		94		119		124			
1971	Mar	131		91		92		65		73	D	65		118						49		77		82		64			
1971	Apr	79		169		156		48		94	D	48		107						85		67		39		51			
1971	May	290		177		196		131		220	D	131		103						108		128		87		83			
1971	Jun	7		0		8		6		4	D	6		11						1		14		5		5			
1971	Jul	136		135		141		116		118		116		70						75		67		48		51			
1971	Aug	183		191		151		147		76	D	147		77						131		85		79		98			
1971	Sep	52		58		54		53		72	D	53		61						50		52		46		29			
1971	Oct	129		229		134		137	D	151	D	137		198						230		324		185		231			
1971	Nov	105		120		150		108		125	D	108		131						97		67		73		60			
1971	Dec	107		177		121		118		102	D	118		104						85		145		83		75			
1972	Jan	91		127		51		68		89	D	68		175						123		91	D	145		138			
1972	Feb	180		348		287		254		285		254		246						202		205	#	185		165			
1972	Mar	71		62		82		78		82	D	78		119						47		85	#	76		52			
1972	Apr	61		27		92		110		107		110		54						37		15	D	27		15			
1972	May	33		13		44		25		19	D	25		14						18		11	D	6		15			
1972	Jun	66		35		36		48		34		48		27						38		32	D	23		16			
1972	Jul	31		19		31		27	D	30	D	27		11						10		7	D	7		4			
1972	Aug	51		82		40		36		39		36		2						19		7	D	1		6			
1972	Sep	35		29		33		25		24	D	25		21						19		17	D	22		19			
1972	Oct	42		69		53		40		54	D	40		95						61		42	D	50		29			
1972	Nov	177		190		177		208		227		208		217						146		148	D	152		117			
1972	Dec	100		170		163		160		169	D	160		135						116		59	#	105		74			
1973	Jan	94		156		115		113		112		113		113						98		95	D	95		142			
1973	Feb	53		113		90		74		99	D	74		169						99		99	D	92		78			
1973	Mar	114		131		139	#	119	D	132	D	119		156						89		71	D	87		75			
1973	Apr	119		140		261		192	D	255		192		69						74		36	D	63		40			
1973	May	0		0		0		0	D	1		0		2						0		0	D	0		1			
1973	Jun	0		0		5		0		3		0		0						0			[	0		0			
1973	Jul	11		11		17		25		23	D	25		17						13		10	D	8		10			
1973	Aug	124		71		92		82		110	D	82		50						52		52	#	40		46			
1973	Sep	144		103		161		186		189		186		87						42		56	#	38		58			
1973	Oct	88		140		137		107	D	85	D	107		94						70		56	D	68		36			
1973	Nov	187		236		173		152		217		152		176						143		155	D	111		120			
1973	Dec	103		78	#	61		70	D	152	D	70		113						61		41		54		54			
1974	Jan	87		197		167		102		107		102		222						113		121	D	90		115			
1974	Feb	177		155		165		118	D	162	D	118		100						103		121	#	110		116			
1974	Mar	112		137		158		132	D	122	D	132		271						135			[	140		182			
1974	Apr	75		74		63		69		64		69		72						60			[	25		53			
1974	May	201		222		171		181	D	205	D	181		147						169			[	128		160			
1974	Jun	56		37		43		53		71		53		36						36			[	42		40			
1974	Jul	21		30		14		9		15		9		5						0			[	0		0			
1974	Aug	3		25		13		15		12	D	15		7						3			[	0		4			

Year	Month	0154796 W		0154354 W		0129007 W		0129068 W		0129068AW		0129068 A		0153631 W		0154151 W		0154143 W		0154142 W		0154279 W		0153875 W		0153820 W		0129068BW	
1974	Sep	69		61		75		81		44		81		31						12			[	22		10			
1974	Oct	60		55		56		48		69	D	48		76						40				65		45			
1974	Nov	137		188		180		112		131	D	112		172						147				110		134			
1974	Dec	272		184		177		148		107	D	148		103						121				74		49			
1975	Jan	94		138		142		112		92	D	112		174						82				102		60			
1975	Feb	97		120		88		133		102	D	133		139						71				116		97			
1975	Mar	118		130		112		77		60	D	77		123						82				95		118			
1975	Apr	62		69		102		58		93	D	58		69						25				20		27			
1975	May	6		49		34		39		44		39		8						41				0		8			
1975	Jun	22		3		6		10		8	D	10		1						1				0		0			
1975	Jul	27		30		34		38		29		38		9						23				2		6			
1975	Aug	24		13		54		76		57		76		25						2				29		10			
1975	Sep	342		211		366		395		224	D	395		118						103				83		81			
1975	Oct	29		56		57		60		55	D	60		54						45				32					
1975	Nov	104		150		162		142		98	D	142		101						82				65					
1975	Dec	146		328		251		215		141	D	215		285						203				202					
1976	Jan	80		130		130		126		80		126		262						113				162					
1976	Feb	273		219		275		267		243		267		267						173				169					
1976	Mar	417		503	#	524		533	D	452	D	533		372						384				253					
1976	Apr	117		107		109		132		92	D	132		88						21				63					
1976	May	161		149		141		118		76	D	118		104						66				87					
1976	Jun	0		13		8		8		6	D	8		0						12				9					
1976	Jul	7		15		23		22		18	D	22		14						11				3					
1976	Aug	54		50		48		45		38		45		18						24				0					
1976	Sep	108		131		100		97		100	D	97		102						83				99					
1976	Oct	242		482		453		415		377		415		215						285				207					[
1976	Nov	45		108		57		41		32	D	41		79						52				40					[
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1977	Feb	272		344		198		138			[	138		118						166				49				141	
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1977	Aug	47		190		87		80			[	80		32						75				20				80	
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1977	Oct	150		145		92		90			[	90		170						76				97				88	
1977	Nov	230		239		274		232			[	232		139						77				101				229	D
1977	Dec	128		309		244		159			[	200		187						152				170				200	
1978	Jan	90		83		80		91			[	81		128							[			187	#			59	]
1978	Feb	77		99	#	138		130			[	130		127	#						[			80	#				[
1978	Mar	83		116	#	143	#	122			[	122		150							[			115	]				[
1978	Apr	719		908	#	434		646	#		[	568		481	#						[			267				568	
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1978	Jun	41		29		34		27			[	46		11							[			0				46	
1978	Jul	5		9		6		16			[	15		0							[			0	]			15	D
1978	Aug	62		78		71		47		38	D	38		30							[			31					[
1978	Sep	70		96	#	90		80		69	D	69		91							[			65					[
1978	Oct	213		296	#	174	#	164		105		105		149							[			119					
1978	Nov	151		142	#	133		130		96	D	96		143							[			98					
1978	Dec	61		168	#	132		143		91	D	91		190							[			74					
1979	Jan	118		107	#	58		88		75		75		177							[			62	]				
1979	Feb	86		131		77		60		62		62		100							[			118					

Year	Month	0154796 W		0154354 W		0129007 W		0129068 W		0129068AW		0129068 A		0153631 W		0154151 W		0154143 W		0154142 W		0154279 W		0153875 W		0153820 W		0129068BW	
1979	Mar	154		163	#	103	]	115		128		128		134							[			160					
1979	Apr	5		39		70		52		71		71		32	#						[			36					
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1979	Jul	49		178	#	129	#	133		95	D	95		83							[			75					
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1979	Sep	36		54	#	119		117		112	D	112		62							[			28					
1979	Oct	85		161	#	109		115		99		99		113							[			95					
1979	Nov	102		71	#	65		48		33	]	35		99							[			75	#				
1979	Dec	36		160	#	95		95		92	]	94		133							[			93					
1980	Jan	40		127	#	51	]	85		92			[	135	#						[			82	#				
1980	Feb	149		122	#	155		156		136	D		[	120							[			67	]				
1980	Mar	30		198	#	85	]	97		96			[	88							[			21					
1980	Apr	3		31	#	59	]	78		61			[	53						20				0	]				
1980	May	5		54		45		49		48			[	37						22	]			32					
1980	Jun	2		14	#	5		7		14			[	4						2				0					
1980	Jul	2		30	#	33		37		30			[	21						21				17					
1980	Aug	6		35	#	20		32		26	D		[	24	#					11				12					
1980	Sep	133	$	243	#	195		180		198	D		[	179	#					197				130	#				
1980	Oct	23	$	77	#	29	#	53		47			[	52	]					62				45					
1980	Nov	223	$	224	#	172	#	184		159	D		[	177	#					203				152	#				
1980	Dec	141	$	139	#	62		70		65			[	150	#					198	#			101					
1981	Jan	161	$	244	#	232	#	229		169		169		211	]					299					[				
1981	Feb	43	$	89	#	171		153		109	D	109		104						41	]				[				
1981	Mar	31	$	56	#	37		47		36		36		110						79	#				[				
1981	Apr	6	$	18	#	6		15		22	D	22		27	#					0				16					
1981	May	28	$	187	#	203	#	104		127		127		64	#					80				78					
1981	Jun	0		31		14		23		20		20		23	#					21				2					
1981	Jul	2		11		27		7	]	28		28		6						4				3					
1981	Aug	90	$	130	#	117	#	126		94		94		106						229	]			69	#				
1981	Sep	3	$	65		49		62		39		39		46						100	]			15					
1981	Oct	2		91	#	47		81		61		61		58	#					84	]				[				
1981	Nov	139		118	#	113		126		92	D	92		94	#					82	#				[				
1981	Dec	11		127	#	77	#	83		46	D	46		90	#					120					[				
1982	Jan	64	$	211	#	132		137		106	#	120		178	#					152	#				[				
1982	Feb	9	$	89	#	84		61		56		56		121	#					26	]				[				
1982	Mar	176	$	382	#	404	#	539		350		250		237	#					67	]				[				
1982	Apr	150	$	59	#	41		180		100		100		54	#					82	#				[				
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1982	Jun	2		28			[	27		23		23		26						26					[				
1982	Jul	1		28			[	34		28		28		34						48	]				[				
1982	Aug	0		8			[	11		13		13		11						8					[				
1982	Sep	6		67		37		63		58		58		38						120	#			16	]				
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1982	Dec	57		91		22		50		26	D	26		97						67	#			50					
1983	Jan	136	$	106		108		87		87	D	87		82						47				62					
1983	Feb	26	$	115		33	]	73		59		59		99						26				29					
1983	Mar	30		98		58		64		63	D	63		55						87	#			33					
1983	Apr	38		30		32		57		59		59		94						21	]			45					
1983	May	38		109	]	12		15	#	7		7		2						95	]			11					
1983	Jun	9		0	]	0		9		18		18		11						0				0					
1983	Jul	97		840		65		120		115	D	115		41						715				160					
1983	Aug	43	$	5	]	37		42	#	31	D	31		7						55				12					

Year	Month	0154796 W		0154354 W		0129007 W		0129068 W		0129068AW		0129068 A		0153631 W	0154151 W	0154143 W	0154142 W		0154279 W	0153875 W		0153820 W	0129068BW	
1983	Sep	78	Z	100		92		114		43		43		38			44	]		51				
1983	Oct	97	Z	134		71		66	]	83	D	83		86			66			52				
1983	Nov	167	Z	202		130		195		115	D	115		187			233	D		137				
1983	Dec	87	Z	142		41	]	150		111		111		124			45	]		117				
1984	Jan	148	Z	181		163		190	]	167			[	191			100	]		154				
1984	Feb	188	Z	129		374	#	79	]	112			[	178			316			121				
1984	Mar	181	Z	131	]	56		55		107			[	129			108			89				
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1984	Jul	122		87		267		231		192	D		[	37			19	]		21	]			
1984	Aug	42		31		21		31		11	D		[	34			3			25				
1984	Sep	95	$	69	]	46		75	#	39			[	37			19			10				
1984	Oct	86		79		54		79		71				84			202			74				
1984	Nov	366	$	142		132		183		232				207			96	]		148				
1984	Dec	243		105	#	29	]	65	#	58				106			62			81				
1985	Jan	126		203		80		100		70				155			129			117				
1985	Feb	360		684		270		325	#	193	#			229			380	]		250	#			
1985	Mar	104		78	#	42		66		57				70			49			44				
1985	Apr	26		39		20		36		35				25			42			32				
1985	May	12		11		7		10		11				5			0			0				
1985	Jun	35		27		13		10		16	D			15			22			15				
1985	Jul	20		39		2		4		5				6			0			3				
1985	Aug	0		0	]	0		11		8				0			0			0				
1985	Sep	53	Z	54		47		45		39	#			15			21			4				
1985	Oct	206	Z	313	]	185		268		131	D			245			340	#		195				
1985	Nov	172	Z	163	]	248		269		173	#			116			167	#		59				
1985	Dec	178	Z	33	]	97		129		88	D			133			73			112				
1986	Jan	153	Z	261	#	216	#	231	#	223	D			115			140	#		68				
1986	Feb	175	Z	51	]	55		62		52	D			102			180	#		71				
1986	Mar	8		172		154	#	154		146	D			121			50	]		75				
1986	Apr	52		98	#	79		104		90				67			0	]		13				
1986	May	10		15		16		19		19				0			14			6				
1986	Jun	16		12		11		9		10	D			17			10			14				
1986	Jul	4		3			[	0		4	D			1			0			0				
1986	Aug	212		153		122		164		74				84			0	]		86				
1986	Sep	108		179		135		115		127	D			66			53	]		54				
1986	Oct	155	Z	190		156	]	211		129	D			154			185	#		111				
1986	Nov	135	Z	108		134	D	150		104	D			177			234			129				
1986	Dec	98	Z		[	63		53	]	64	D			136			95			84				
1987	Jan	248			[	109		158	#	61	D			118			72			93				
1987	Feb	26			[	31		33	D	23	D			75			12			51				
1987	Mar	126	$		[	141		114	#	144				103			81			84				
1987	Apr	88			[	6		20		12	D			26			21			16				
1987	May	13			[	55		48		48				11			0			13				
1987	Jun	0		52		47		0		45	D			16			1			4	]			
1987	Jul	0		4		7		0		12	D			1			0			0				
1987	Aug	201	$	77		50		120	#	44				73			56	#		55				
1987	Sep	646		147	]	369		216		255	D			405			240	#		397				
1987	Oct	74		77		46		67		41				100			127			83				
1987	Nov	246		265		163		201		104				136			141	]		101				
1987	Dec	130		163		90		102		60				135			44	]		101				
1988	Jan	99		181		118		52		57				134			121			77				
1988	Feb	302		456		225		248		61				199			161	]		178				

Year	Month	0154796 W		0154354 W		0129007 W		0129068 W		0129068AW		0129068 A		0153631 W		0154151 W		0154143 W		0154142 W		0154279 W		0153875 W		0153820 W		0129068BW	
1988	Mar	557		498		220	#	239		148				212						436				190					
1988	Apr	51		99		68		105		63				64						54				71					
1988	May	263		75		147		173		121	D			69						104				60					
1988	Jun	91		16		9		23		18	D			26						10				0	]				
1988	Jul	66		83		35		13		40	D			37						6				28					
1988	Aug	148		116		52		25		30				59						17				36					
1988	Sep	61		37		51		8		38				41						53				30					
1988	Oct	92		142		104		103	D	68				58						57				107					
1988	Nov	195		327		95		138	D	84				173						115				168					
1988	Dec	315		333		214	#	213		229				198						130				153					
1989	Jan	81		79		44	#	51		31	D			110						55				51					
1989	Feb	338		385		180		262		193	D			248						281				224					
1989	Mar	81		128		123	#	134		134				55						88				81					
1989	Apr	159		87		283		236		189	D			138						213				141					
1989	May	46		29		20		29		23				33						11				9					
1989	Jun	75		29		30		33		27				5						17				30					
1989	Jul	14		42		25		22		21	D			46						0				17					
1989	Aug	0		14		6		3		3				0						4				0					
1989	Sep	130		77		69		72		54	D			16						0				19					
1989	Oct	222		232		200		306	#	188				132						547				127					
1989	Nov	178	$		[	264	#	275	#	224	D			267						227				281					
1989	Dec	47		0	#	62		100		84				181						53	#			78					
1990	Jan	142		285		121	#	130		111	D			210						215	#			92					
1990	Feb	69		84		26		37		29				70						10				44					
1990	Mar	354	Z	146		255		267		209	D			178						219				142					
1990	Apr	23		9		27		41		33				59						17				33					
1990	May	25		34		0		9		4				7						6				0					
1990	Jun	0		9		11		13		11				36						13				13					
1990	Jul	4		2		2		3		3				0							[			0					
1990	Aug	92	Z	107	#	83		119		105	D			71						58	#			136					
1990	Sep	67	Z	81		37		55		48				21						48				14					
1990	Oct	142	Z	207		122		104		83				128						120				75					
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1991	Jan	197		212	D	97		98		93				251						93				150					
1991	Feb	120		208		130		20		173	D			187						156				130					
1991	Mar	111		166		75		0	]	65	D			35						67				0					
1991	Apr	9		43		11		44		18				9						6				0					
1991	May	60		39		36		44		45				16						20				26					
1991	Jun	16		21		4		0		13					[					9				0					
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1991	Aug	111		43		51		54		50				5						21				0					
1991	Sep	95		60		102		135		120				94						67				65					
1991	Oct	134		257		117		176		123				188						136				148					
1991	Nov	251		225	#	145		204		139				128						137				77					
1991	Dec	69		150		84		103		114				0	]					119				20					
1992	Jan	104		97		113		0	]	159				116						57				128					
1992	Feb	68	Z	109		24			[	29				40	#					12				68					
1992	Mar	39		55		0	]	0	]	84				96						51				99					
1992	Apr	90		103		82		60		77				29	#					101				52					
1992	May	1		1		31		0	]	20				0						3				0					
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Year	Month	0154796 W		0154354 W		0129007 W		0129068 W		0129068AW		0129068 A		0153631 W		0154151 W		0154143 W		0154142 W		0154279 W		0153875 W		0153820 W		0129068BW	
1992	Sep	126		116		67		81		67				0	]					58				28					
1992	Oct	93		33	#	82		35		83				48						74				85					
1992	Nov	114	Z	134		42		19		45				67						67				87					
1992	Dec	208		93		189		26		147	D			96						37				120					
1993	Jan	84		178	#	113			[	114				206						72				71					
1993	Feb	76		92		29			[	58				74						71				87					
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1993	May	0		47		0		0		0				0						0				0					
1993	Jun	3		14		0		0		1				0						0				6					
1993	Jul	0		2		0		0		2				0						2				0					
1993	Aug	56			[	50		46		26	D				[					29				14					
1993	Sep	219		320		186		199		140					[						[			101					
1993	Oct	118	Z	169		110		80		78					[					86				108					
1993	Nov	109		143		83			[	106	D			166						79				84					
1993	Dec	291		282		173			[	151					[					182				143					
1994	Jan	56		97		115	#		[	66				175						73				73					
1994	Feb	465		438		258		286	#	268				282						349				196					
1994	Mar	70		83		94		147		50	D			98						105				152					
1994	Apr	27		15		12		3		9	]			20						0				0					
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1994	Jul	105	Z	106		38		48		39				65						84				58					
1994	Aug	218		178		92		70		107				64						75				17					
1994	Sep	18		33		6		6		9	D			3						0				0					
1994	Oct	29	Z	5		112		162	#	138					[					60				40					
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1994	Dec	428		325		266		325	#	245	D				[					59				91					
1995	Jan	68	Z	76		86		120	#	72				117						4	#			134					
1995	Feb	66		38		85		104		77					[					58				50					
1995	Mar	271		275	#	190		208	#	153	]			175						196				228					
1995	Apr	295		176		310		342	#	261				132						132				104					
1995	May	11		30		38		47		36				23						6				40					
1995	Jun	154		115		53		106		95				158						165				96					
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1995	Aug	3		21		3		5		4	D			0						6				0					
1995	Sep	55		80		51		65	D	57	D			70						139				60					
1995	Oct	75		109		124		103		129	#			88					[					79					
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1996	Feb	107		151		78		111	#	95				207					[					211					
1996	Mar	90		83		71		63		100	#			103				114	]					28					
1996	Apr	80		143		65		95		77	+			31				35						6					
1996	May	12		9		62		53	#	72	#			0				27						0					
1996	Jun	6		0		15		26		31				35				0						0					
1996	Jul	406	Z	77		191		192		229	D			85				194						100					
1996	Aug	16		30		23		25		16				17				9						16					
1996	Sep	43		31		35		54		48				20				49						48					
1996	Oct	222		225		145		198	#	140	D			139				119						49					
1996	Nov	283		370		283		274	#	253				231				298						211					
1996	Dec	102		184		76		82		52	#			116				55						77					
1997	Jan	261	D	236		141		224		168	#			161				112						134					
1997	Feb	149		136		209		237	#	257				218				80						119					

Year	Month	0154796 W		0154354 W		0129007 W		0129068 W		0129068AW		0129068 A		0153631 W		0154151 W		0154143 W		0154142 W		0154279 W		0153875 W		0153820 W		0129068BW	
1997	Mar	92			[	75		96		83	D			86				151						121	D				
1997	Apr	159			[	175		206		137	]			155				168						191					
1997	May	75			[	58		28		45				32				0						0					
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1997	Jul	67	D	86		48		67		32				44				59						46					
1997	Aug	12		29		17		23		19				46				26						28					
1997	Sep	158		119		95		95		119	D			47				45						50					
1997	Oct	115		119		88		104	#	88	]			118				78						91					
1997	Nov	294		210		227		223		185	]			171				112						164					
1997	Dec	81		134		62		84	#	63	D			86				150						56					
1998	Jan	69		131		123		160	#	105	D			216				172						116					
1998	Feb	195		357		141		125		17	]			271				184						222					
1998	Mar	198	Z	222		210		216	#	173	]			244				152						109					
1998	Apr	81		85		67		66	#	47	D			84				17						39					
1998	May	0	#	62		33		44		43				43				69						37					
1998	Jun	41		0		11		5		3				6				3						0					
1998	Jul	16		29		15		17	#	15				0				0						10					
1998	Aug	136		108		112		94		109				0				69						21					
1998	Sep	61		51		46		114		80				28				27						28					
1998	Oct	104		11		41			[	60	D			76				63						62					
1998	Nov	242		216		196		241		168	]			142				120						111					
1998	Dec	265		337		195		202		59				189				112						112					
1999	Jan	202		121		102		37		68	D			172				91						86					
1999	Feb	168		0	#	0	#	0	#	162	D			173				0	#					147					
1999	Mar	63	Z	0	#	0	#	0	#	211	D			113				0	#					82					
1999	Apr	15	Z	0	#	0	#	0	#	68	D			45				0	#					21					
1999	May	0		0		0		0		34				0				0						0					
1999	Jun	1			[	0		0		4				0				0						4					
1999	Jul	2		0		0		0		14				3				0						0					
1999	Aug	0		0		0		0		25				0				0						0					
1999	Sep	0		0		0		0		74	]			0				0						0					
1999	Oct	219	Z	0	#	0	#	206	#	0	]			172				0	#					164					
1999	Nov	83	Z	0	#	0	#	0	#	60				112				0	#					36					
1999	Dec	222	Z	0	#	0	#	0	#	68				244				0	#					173					
2000	Jan	252		0	#	299		305	#	312	]			283				262						199					
2000	Feb	350			[	116		128		95	D			155				142						135					
2000	Mar	490			[	192		199		190				248				193						97					
2000	Apr	142			[	172		260		208				163				123						70					
2000	May	82			[	84		60		78				58				121						64					
2000	Jun	0			[	12		8		2				0				0						0					
2000	Jul	13			[	35		0		53				0				0						0					
2000	Aug	14			[	0		0		18				0				4						0					
2000	Sep	73			[	73		94	#	81				0	#			65						64					
2000	Oct	106			[	72		84		64				0	#			62						70					
2000	Nov	114			[	92		59	#	107				137				158						66					
2000	Dec	109			[	173		68	#	104				135				180						182					
2001	Jan	73			[	54		24		97				196				52						52					
2001	Feb	46			[	73		89		77				161				102						102					
2001	Mar	141			[	117		74		133				134				90						35					
2001	Apr	43			[	112		51		104				169				34						61					
2001	May	101			[	8		8		22				0				27						25					
2001	Jun	0		0	]	24		47		7				0				0						0					
2001	Jul	56		138		63		85		87				101				0						16					
2001	Aug	26		29		45		53		30				29				20						20					

Year	Month	0154796 W		0154354 W		0129007 W		0129068 W		0129068AW		0129068 A		0153631 W		0154151 W		0154143 W		0154142 W		0154279 W		0153875 W		0153820 W		0129068BW	
2001	Sep	151		70		52		62		65				71				39						66					
2001	Oct	124		88		184		110	#	140				0	#			60											
2001	Nov	165		514		313		294	#	238	]			0	#			300											
2001	Dec	180		152		145		145		104	]			0	#			129											
2002	Jan	90		170		149		168	#	109	D			247				27											
2002	Feb	144		150		89		108		81				98				110											
2002	Mar	45		82		49		73		65				60				54											
2002	Apr	101		96		84		116		117				24				34											
2002	May		[	55		53		60		52				66				57	+										
2002	Jun		[	8		18			[	7				9				0	+										
2002	Jul	153		186		73		168	#	154				111				157											
2002	Aug	122		118		47		59	#	102				107				92											
2002	Sep	70		172		148		207		187	]			98				92											
2002	Oct		[	39			[		[	23	D			66				21											
2002	Nov		[		[	84		116		101				71				128											
2002	Dec		[	183		75		105		66				176				93											
2003	Jan	0		89		50		77		67				52				70											
2003	Feb	0		48			[	41		22				130				92											
2003	Mar	336	D	399		308		298		241	]			83				246											
2003	Apr	14		140		0	#	58		37				32					[										
2003	May	46		78			[	28		22				0	#				[										
2003	Jun	12		31			[	49		47	]			0	#				[										
2003	Jul	13			[	32		45	#	22				0	#				[										
2003	Aug	7			[		[	18			[				[				[										
2003	Sep	184			[		[	127			[				[				[										
2003	Oct	112		20	]	31		31		34	]				[				[										
2003	Nov		[	65		46		59		38					[				[										
2003	Dec		[	143		65		212	]	98	D			138	]				[										
2004	Jan		[		[	174		184		167				146				65											
2004	Feb		[	30		6		29		35	D			130				95											
2004	Mar		[	237		145		182		172				196				249											
2004	Apr		[	34		53		31		32				41				45											
2004	May		[	20		20		19		27				22				11											
2004	Jun		[	5		35		76		3				167				0											
2004	Jul		[	100		152		32		72				108				18											
2004	Aug		[	0		30		143		28				22				0											
2004	Sep		[	190		285		164		237				27				231											
2004	Oct		[	132		34		86		28				27				32											
2004	Nov		[	106		70		100		27				135				47											
2004	Dec		[	100		52		164		95				154				96											
2005	Jan		[	365		366		270		137				196				93											
2005	Feb		[	77		108		99		94	D			142				44											
2005	Mar		[	78		99		175		76				76				58											
2005	Apr		[	101		52		33		65	]			76				19											
2005	May	54		43		52		54		42	]			5				17											
2005	Jun	0		21		14		20	]	16	]			0				28											
2005	Jul	0		14		0		17		17	]			0				9											
2005	Aug		[		[	48		45		53	]				[				[										
2005	Sep	69		64		5		62		38	]				[			49											
2005	Oct	70		62		37		25		50	]				[				[										
2005	Nov		[	341		462			[	394	]				[				[										
2005	Dec	70		126			[	103		85	]				[				[										
2006	Jan	154		205		201		247		180	]			175				48											
2006	Feb		[	164		97		154		109	]				[			214											

Year	Month	0154796 W		0154354 W		0129007 W		0129068 W		0129068AW		0129068 A		0153631 W		0154151 W		0154143 W		0154142 W		0154279 W		0153875 W		0153820 W		0129068BW	
2006	Mar	92		117		85		108		99					[			59											
2006	Apr		[	93		124		133		149					[			68											
2006	May	76		147		86		149		104					[			6											
2006	Jun	162			[	28		38		42				30				14											
2006	Jul	0			[	0		44		0				0				0											
2006	Aug		[	146		173		133		155	D				[				[										
2006	Sep		[	271		150		237		121				51					[										
2006	Oct		[	279		261		352		248				432					[										
2006	Nov		[	126		101		135		78	D			168				65											
2006	Dec	207		456		163		222		94				115				207	D										
2007	Jan	70		148		78		116		106				170				32											
2007	Feb	64		60		54		43		41	]			90				21											
2007	Mar	77		167		81		174		92	]			259				63											
2007	Apr	140		156		119		145		106				136				76											
2007	May	0		0		0		0		0				7				0											
2007	Jun	21		42		38		91		23				0				64											
2007	Jul	0		0		0		0		0				0				0											
2007	Aug	27		45		0		41		54				11					[										
2007	Sep	70		47		0		20		29					[				[										
2007	Oct	210		207		122		194		137				168				81											
2007	Nov	114		151		195		195		148				101				98											
2007	Dec	110		103		79		230		42	]			330				0											
2008	Jan	214		465		177		247		248				78				253											
2008	Feb	96		102		63		345		41	D			0				0											
2008	Mar	120		138		89		105		91				25				50											
2008	Apr	97		237		143		185		166				100				162											
2008	May	18		36		0	]	44		27				64				171											
2008	Jun	71		251		116		170		42				41				307											
2008	Jul	0		0		0		0		0	]			0				0											
2008	Aug	21		25		0		37		35				15				15											
2008	Sep	54		48		20		69		64				86				32											
2008	Oct	100		197		30		94		75				43				0											
2008	Nov	208		193		57		218		108	D			77				120											
2008	Dec	85		69		23		71		33				112				0											
2009	Jan		[		[		[		[		[				[				[										
2009	Feb		[		[		[		[		[				[				[										
2009	Mar		[		[		[		[		[				[				[										
2009	Apr		[		[		[		[		[				[				[										
2009	May		[		[		[		[		[				[				[										
2009	Jun		[		[		[		[		[				[				[										
2009	Jul		[		[		[		[		[				[				[										
2009	Aug		[		[		[		[		[				[				[										
2009	Sep		[		[		[		[		[				[				[										

outlier - values were checked & accepted as reliable	
	Values checked & accepted as reliable
#	Values flagged as outliers
],[,#	Original flags from database for unreliable flags
D	Original flags from database for reliable flag (Drop)

SUMMARY OF RAINGAUGE PATCHING USING CLASSR AND PATCHR										
Name in RAIN-ims	**Raingauge number**	**Number of intact years**	**Number of stations used**	**Total variance**	**Sum of singular values**	**Number of seasons**	**Season months**	**Number of iterations to converge**	**β-matrix**	**Number of outliers**
Patch 1a	0154796 W	23	3	99.98	98.6	2	Sep-Mar	6	Ok	38
	0154354 W						Apr-Jun	6	Ok	41
	0129068AW									48
Patch 2a	0154354 W	23	3	99.98	98.6	2	Sep-Mar	7	Ok	41
	0154796 W						Apr-Jun	6	Ok	38
	0129068AW									48
Patch 11a	0129068AW	23	3	99.98	98.6	2	Sep-Mar	6	Ok	48
	0154354 W						Apr-Jun	6	Ok	41
	0154796 W									38
Patch 6a	0154142 W	19	4	99.95	97.2	2	Sep-Apr	11	Ok	22
	0154796 W						May-Aug	12	Ok	34
	0154354 W									45
	0129068AW									30
Patch 7b	0154354 W	27	3	98.9	91.7	3	Sep - Mar	7	Ok	31
	0154142 W						Apr - Jun	10	Ok	25
	0153875 W						Jul & Aug	12	Ok	15
Patch 9a	0153631 W	25	3	99.99	99.26	3	Sep-Mar	6	Ok	27
	0153875 W						Apr	8	Ok	20
	0154142 W						May-Aug	8	Ok	18
Patch 14a	0129007 W	17	4	99.96	97.42	3	Sep-Feb	7	Ok	25
	0154796 W						Mar-Apr	10	Ok	33
	0154354 W						May-Aug	6	Ok	32
	0129068AW									30

Patched rainfall data for 0154 796 W

154796W	1925	2007	12186											
154796W	1925	1 200	630	1 549	1 277	1 316	1 763	193	1 116	917	30	130	1 008	11 129
154796W	1926	1 236	1 931 +	1 387 +	517	1 218	3 092	83	153	18	155	412	804	11 006 +
154796W	1927	906	283	1 351	1 056	1 362 +	574	293	910 +	206	144	1 108	299	8 492 +
154796W	1928	983	1 166	838	1 324	529	2 037	216	425	2 777	808	686	1 513	13 302
154796W	1929	1 362	1 686	365	1 380	607	1 166	752	345	1 142	409	471	1 496	11 181
154796W	1930	463	1 071	1 266	2 389 +	1 204	2 638	790	137	51 +	5 101	272	642	16 024 +
154796W	1931	836	605	1 093	957	2 718	1 113	318	722	434	425	423	1 804	11 448
154796W	1932	1 608	2 024	3 316	739	1 471	1 867	409	747	33	335	185	391	13 125
154796W	1933	541	2 233	2 310	1 866	598	1 118	590	645	28	2 428	139	233	12 729
154796W	1934	582	1 055	2 112	877	877	1 347	2 118	1 879	1 397	305	937	112	13 598
154796W	1935	542	634	206	1 846	3 211	1 727	236	1 740	1 072	193	81	985	12 473
154796W	1936	1 537	3 307	644	1 534	1 279	1 793	477	43	89	881	510	659	12 753
154796W	1937	945	968	1 572	881	1 123	663	1 624	503	422	649	221	119	9 690
154796W	1938	719	1 258	1 469	841	1 455	1 221	509	1 320	168	675	132	2 063	11 830
154796W	1939	1 107	590	1 387	411	502	944	459	1 105	321	344	452	756	8 378
154796W	1940	384	1 590	1 547	891	283	1 156	428	238	485	254	401	722	8 379
154796W	1941	724	1 334	812	3 892	466	1 454	386	1 133	0	71	805	794	11 871
154796W	1942	1 004	1 004	1 867	1 295	551	1 983	1 499	338	657	122	1 540	597	12 457
154796W	1943	1 098	1 537	1 417	822	1 494	865	745	215	281	244	155	2 056	10 929
154796W	1944	880	846	416	1 480	1 311	1 280	424	366	256	450	73	1 354	9 136
154796W	1945	2 233	238	802	689	1 591	2 214	952	129	366	86	185	860	10 345
154796W	1946	685	2 160	1 543	1 604	1 002	2 105 +	2 536	1 407	1 080	371	161	962	15 616 +
154796W	1947	510	2 027	1 173	973	1 561	2 181	1 093	176	38	33	162	531	10 458
154796W	1948	2 198	686	1 164	766	4 573	1 239	1 021	0	30	129	481	770	13 057
154796W	1949	1 267	2 268	786	1 485	658	474	1 575	1 575	23	513	1 229	259	12 112
154796W	1950	1 090	363	2 043	1 242	681	1 212	400	351	542	418	573	939	9 854
154796W	1951	1 937	167	2 407	1 819	690	1 193	870	593	89	167	0	1 654	11 586
154796W	1952	341	1 614	926	1 311	1 738	1 008	536	252	225	136	721	743	9 551
154796W	1953	1 185	2 212	2 120	975	613	1 172	266	935	760	235	120	995	11 588
154796W	1954	3 835	1 095	680	2 395	1 935	2 910	230	602 +	240	0	165	1 515	15 602 +
154796W	1955	1 160	1 130	130	285	2 150	1 770	1 567	430	655	520	306	1 220	11 323
154796W	1956	2 410	2 135	3 530	1 690	1 550	2 130	2 153	150	586	79	444	1 434	18 291
154796W	1957	943	1 121	1 319	1 592	1 994	1 909	1 852	0	0	943	143	505	12 321
154796W	1958	702	1 026	789	632	1 380	905	615	1 535	0	653	710	700	9 647
154796W	1959	1 188	1 185	1 120	1 283	820	1 205	880	1 327	31	290	335	1 010	10 674
154796W	1960	521	2 355	1 448	1 335	920	1 730	3 045	935	215	929	453	795	14 681
154796W	1961	1 076	1 717	1 010	1 112	868	2 090	505	590	18	52 +	1 255	699	10 992 +
154796W	1962	1 370	2 192	907	2 177	430	4 601	455	845	400	2 275	285	465	16 402
154796W	1963	1 912	1 355	1 466	3 231	1 647	792	1 080	436	2 110	295	360	470	15 154
154796W	1964	1 515	690	685	1 071	812	241	568	932	2 384	413	890	943 +	11 144 +
154796W	1965	2 047	1 204	1 219	957	816	120	827	2 285	520	130	535	740	11 400
154796W	1966	489	645	1 752	1 768	2 155	2 170	1 145	55	570	1 170	250	232	12 401
154796W	1967	405	1 277	690	886	1 164	1 009	750	45	315	50	890	1 575	9 056
154796W	1968	1 132	1 280	1 665	515	1 755	2 535	620	2 865	295	485	220	840	14 207
154796W	1969	1 325	1 955	668	500	1 183	535	890	566	1 431	144	1 782	627	11 606
154796W	1970	2 519	1 298	1 052	1 268	808	1 305	789	2 900	65	1 355	1 830	521	15 710
154796W	1971	1 290	1 049	1 072	908	1 797	710	610	330	655	310	514	348	9 593
154796W	1972	422	1 768	1 002	937	525	1 143	1 188	0	0	110	1 242	1 440	9 777
154796W	1973	883	1 874	1 025	872	1 765	1 115	746	2 005	560	205	25	690	11 765
154796W	1974	595	1 370	2 715	935	970	1 180	615	55	215	265	235	3 416	12 566
154796W	1975	290	1 035	1 455	800	2 725	4 165	1 170	1 610	0	70	540	1 075	14 935
154796W	1976	2 420	445	615	1 740	2 715	1 140	290	100	520	250	465	535	11 235
154796W	1977	1 495	2 300	1 280	901	765	826	7 190	832 +	410	45	620	700	17 364 +
154796W	1978	2 130	1 510	610	1 180	860	1 520 *	45	85	180	1 043 +	772 +	1 310 +	11 181 *
154796W	1979	850	1 015	1 306 +	395	1 534 +	440	30	530 +	20	20	60	2 109 +	8 309 +
154796W	1980	812 *	2 112 *	2 236 *	1 838 +	1 383 *	741 *	375 *	1 406 *	0	20	1 215 *	588 +	10 322 *
154796W	1981	15	1 390 *	696 +	1 638 *	786 +	3 523 +	1 935 *	90	15	10	0	641 +	9 306 *
154796W	1982	1 025 *	170	703 +	1 695 *	1 337 *	300	375	383	87	974	352 +	788 +	6 940 *
154796W	1983	1 076 +	1 530 +	1 185 +	1 529 +	1 113 +	1 260 +	1 605	372	501	1 219	420	1 253 *	12 437 *
154796W	1984	864	2 846 *	2 426 *	1 259	3 595	1 042	262	121	354	197	0	574 +	10 542 *
154796W	1985	1 480 +	1 306 +	1 084 +	2 342 +	754 +	80	520	98	157	6	2 154	1 076	11 057 +
154796W	1986	1 497 +	977 +	864 +	2 476	255	2 319 *	881	130	0	0	1 580 *	6 953	16 177 *
154796W	1987	741	2 462	1 304	994	3 018	5 570	509	2 625	911	2 123	1 478	608	22 343
154796W	1988	923	1 954	3 146	812	3 382	805	1 590	455	747	140	4	1 295	15 253
154796W	1989	2 223	2 805 *	468	1 419	692	3 614 *	226	250	0	122	1 150 +	695 +	11 029 *
154796W	1990	1 484 +	477	506	1 972	1 204	1 110	92	601	155	73 +	1 111	953	9 738 +
154796W	1991	1 337	2 508	685	1 044	806 +	390	900	9	122	26	525	1 259	9 611 +
154796W	1992	931	988 +	2 080	842	761	939	542	4	31	0	564	2 192	9 874 +
154796W	1993	1 261 +	1 085	2 913	562	4 649	703	267	68	117	553 +	2 175	177	14 530 +
154796W	1994	481 +	343	4 276	1 435 *	658	2 710	2 949	108	1 536	59	31	551	14 426 *
154796W	1995	749	627	3 365	1 924	1 074	899	801	123	61	4 144	161	432	14 360
154796W	1996	2 218	2 834	1 023	2 610	1 489	920	1 586	753	3 751	671	117	1 584	19 556
154796W	1997	1 146	2 943	806	689	1 952	2 878 *	810	0	413	160	1 360	614	12 588 *
154796W	1998	1 041	2 421	2 646	2 023	1 683	1 938	744	0	11	16	0	0	12 523
154796W	1999	2 233	1 146	2 347	2 520	3 511	4 908	1 422	823	0	134	140	729	19 913
154796W	2000	1 062	1 143	1 086	734	457	1 409	426	1 010	0	558	259	1 505	9 649
154796W	2001	1 242	1 658	1 803	903	1 436	448	1 010	568 +	96 +	1 530	1 217	701	12 612 +
154796W	2002	403 +	1 208 +	1 310 +	0	0	3 361	141	461	124	126	74	1 840	9 048 +
154796W	2003	1 120	583 +	1 158 +	1 821 +	381 +	1 857 +	363 +	293 +	56 +	829 +	265 +	1 746 +	10 472 +
154796W	2004	935 +	790 +	913 +	2 492 +	780 +	746 +	847 +	535	0	0	612 +	690	9 340 +
154796W	2005	702	2 492 +	696	1 542	1 311 +	916	1 474 +	757	1 615	4	1 628 +	1 927 +	15 064 +
154796W	2006	2 268 +	1 018 +	2 068	702	639	772	1 403	0	211	0	267	698	10 046 +
154796W	2007	2 101	1 144	1 103	2 141	964	1 198	970	175	709	0	207	540	11 252
AVERAGE		1 186 #	1 403 #	1 398 #	1 331 #	1 359 #	1 568 #	924 #	648 #	459 #	505 #	568 #	1 020 #	12 186

Patched rainfall data for 0154 354 W

154354W	1920	2007	14819											
154354W	1920	1 030	1 839	2 085	1 381	1 264	1 691	1 318	110	13	132	87	1 682	12 632
154354W	1921	1 818	2 722	3 299	1 521	1 330	503	906	1 245	1 322	0	1 153	1 321	17 140
154354W	1922	2 959	2 410	1 087	4 443	3 319	1 509	317	172	73	3 270	15	437	20 011
154354W	1923	1 262	1 242	1 743	2 770	1 369	329	572	356	515 +	59	671	563	11 451 +
154354W	1924	1 122	1 670	2 424 +	2 091	2 372	2 959	1 134	281	190	343	186	2 070	16 842 +
154354W	1925	791	1 589	1 097	1 539	1 970	2 302	597	73	1 027	49	183	1 259	12 476
154354W	1926	1 793	2 240	1 819	1 325	1 207	4 268 +	48	190	0	205 +	416 +	996 +	14 507 +
154354W	1927	1 490	414	1 773	1 829	1 668	1 205	269	720	172	81	1 268	332	11 221
154354W	1928	1 224	1 971	1 403	1 855	1 305	2 224	216	822	2 809	1 324	987	1 933	18 073
154354W	1929	2 709	1 989	974	1 111	891	1 703	636	460	1 099	491	937	2 837	15 837
154354W	1930	1 347	915	1 260	3 259	1 840	2 798	382	53	66	8 378	324	381	21 003
154354W	1931	1 949	965	1 296	894	2 671	1 674	447	1 105	396	569	214	2 954	15 134
154354W	1932	1 136	3 954	2 404	436	2 657	1 461	294	237	83	241	125	772	13 800
154354W	1933	571	2 736	2 153	3 250	1 709	2 314	658	275	10	1 255	13	140	15 084
154354W	1934	722	1 327 +	2 268	1 033	827 +	2 363	1 588	1 683	2 224	260	1 069	536	15 900 +
154354W	1935	1 020	1 076	204	1 352	4 393 +	3 012	589	1 917	356	277	30	1 258	15 484 +
154354W	1936	2 172	5 216	868	954	2 947	1 741	650	137	229	681	574	799 +	16 968 +
154354W	1937	1 135	1 252	2 951	2 188	1 009	847	2 166	240	769	596	250	208	13 611
154354W	1938	749	1 959	1 694	2 670	2 617	1 781	483	783	119	1 145	291	2 844	17 135
154354W	1939	1 551	1 145	2 432	1 114	1 482	1 422	362	1 719	30	64	295	1 006	12 622
154354W	1940	561	2 979	1 283	1 134	541	1 135	419	66	482	242	348	591	9 781
154354W	1941	1 545	1 616 +	686	3 284	932	1 469	834	1 100	0	0	894	1 054 +	13 414 +
154354W	1942	1 427	4 752	1 951	1 081	958	2 028	1 935	383	665	170	1 823	517	17 690
154354W	1943	1 366	1 946	1 364	1 146 +	1 898	977	668	244	683	452	89	3 645	14 478 +
154354W	1944	1 567	898	587	2 125	2 029	1 700	593	523	97	158	117	1 268	11 662
154354W	1945	3 852	178	1 117	1 667	1 492	1 788	1 117	174	137	15	56	708	12 301
154354W	1946	1 069	2 242	1 038	1 335	1 600	2 045	1 897	424	1 607	265	178	1 043	14 743
154354W	1947	889	5 530	2 005	1 437	2 012	1 879	981	10	64	0	155	376	15 338
154354W	1948	2 396	1 489	1 469	1 189	4 768 +	2 049	903	66	0	106	403	1 245	16 083 +
154354W	1949	1 220	3 077	1 384	2 009	1 535	990	734	731	0	463	605	494	13 242
154354W	1950	1 806	363	2 718	2 485	1 004	1 282	403	158	226	36	615	873	11 969
154354W	1951	2 389	122	3 421	2 508	893	1 670	933	241	75	120	0	1 507	13 879
154354W	1952	833	1 843	1 013	1 638 +	1 191	1 065	782	185	85	0	612	1 934	11 181 +
154354W	1953	1 243	3 378	1 201	756	666	2 224	212	853	630	363	215	1 675	13 416
154354W	1954	3 960	817	1 000	2 686	2 195	1 610	335	370	440	0	3	1 873	15 289
154354W	1955	1 058	1 548	492	627	1 919	3 437	1 145	274	640	0	140	1 640	12 920
154354W	1956	1 791	4 180	4 005	1 760	1 603	2 028	2 395	265	545	123	545	1 030	20 270
154354W	1957	1 272	1 036	3 040	2 070	2 514	1 355	2 120	1	0	305	414	846	14 973
154354W	1958	905	2 760	1 298	945	1 465	895	810	3 830	78	770	1 302	874	15 932
154354W	1959	865	1 393	1 386	1 487	1 030	1 920	1 055	685	0	192	600	1 416	12 029
154354W	1960	1 130	1 945	2 540	2 185	1 015	1 395	3 784	470	80	1 002	117	755	16 418
154354W	1961	930	2 265	1 576	1 475	1 370	2 300	525	365	0	0	855	530	12 191
154354W	1962	2 120	1 726	1 080	2 725	1 405	4 520	395	915	175	2 790	63	230	18 144
154354W	1963	1 652	1 445	1 675	2 815	2 680	1 496	1 123	225	3 520	110	160	744	17 645
154354W	1964	1 740 +	1 220	1 442	1 595	858	349	318	810	2 299	550	995	1 310	13 486 +
154354W	1965	3 350	1 949	1 100	1 579	1 105	277	494	3 310	155	0	505	715	14 539
154354W	1966	735	975	1 550	1 785	890	3 055	2 550	55	365	1 040	250	200	13 450
154354W	1967	680	2 018	845	1 429	1 625	1 155	585	71	84	95	1 132	1 540	11 259
154354W	1968	1 028	1 586	1 710	725	2 566	2 580	896	2 030	130	170	340	420	14 181
154354W	1969	1 210	2 235	1 370	965	1 631	280	565	370	940	20	4 645	750	14 981
154354W	1970	3 310	1 710	1 075	1 440	1 635	912	1 690	1 770	0	1 350	1 905	575	17 372
154354W	1971	2 290	1 200	1 765	1 269	3 475	624	265	131	350	190	820	290	12 669
154354W	1972	690	1 895	1 700	1 555	1 134	1 310	1 404	0	0	110	710	1 030	11 538
154354W	1973	1 395	2 360	1 693 +	1 970	1 546	1 370	740	2 215	365	300	250	605	14 809 +
154354W	1974	545	1 875	1 840	1 375	1 195	1 300	690	485	30	300	130	2 105	11 870
154354W	1975	555	1 500	3 280	1 300	2 185	5 677 +	1 073	1 490	125	145	500	1 312	19 142 +
154354W	1976	4 824	1 077	1 130	1 645	3 435	1 265	320	75	190	381	1 900	1 433	17 675
154354W	1977	1 450	2 390	3 088	829	1 088 +	1 160 *	9 075 *	989	285	90	778	957 +	20 026 *
154354W	1978	2 962 *	1 673 +	1 682 *	1 318 +	1 310	1 836 +	391	626 *	58	1 779 *	818 +	1 638 +	13 705 *
154354W	1979	1 611 *	1 340 +	1 633 +	1 265 *	1 941 +	1 982 *	410 +	537	138 *	299 *	352 *	2 717 +	12 130 *
154354W	1980	818 +	2 238 *	1 385 *	2 444 *	1 594 +	682 +	247 +	1 870 *	313	107	1 304 *	654	12 648 *
154354W	1981	910 *	1 381 +	1 270 *	2 110 *	932 +	4 626 +	1 185 +	305	280	283	76	667	12 617 *
154354W	1982	929	2 653 *	913	1 058	1 146	978	296	1 090 *	145 +	8 400	356 +	995	15 698 *
154354W	1983	1 344	2 020	1 420	1 805	1 287	1 572 +	1 180	534 +	940	865	305	716 +	13 988 +
154354W	1984	785	1 422	1 045 *	2 030	6 840	1 116 +	390	108	265	394	33 +	540	14 883 *
154354W	1985	3 134 *	1 634 *	1 333 +	3 032 +	888 +	1 720	975 *	150	120	30	1 525	1 789	14 926 *
154354W	1986	1 902	1 079	1 036 +	2 111 +	372 +	2 031 +	475 +	372 +	520	40	770	6 356 +	17 064 +
154354W	1987	765	2 651	1 631	1 811	4 558	4 975	992	754	161	829	1 160	370	20 657
154354W	1988	1 421	3 265	3 329	791	3 854	1 284	874	285	290	423	135	769	16 720
154354W	1989	2 321	3 042 +	889 +	2 846	840	1 460	90	335	90	17	1 235 +	809	13 974 +
154354W	1990	2 074	978	1 497	2 115	2 080	1 656	429	388	208	396 *	433	602	12 509 *
154354W	1991	2 574	2 616 +	1 496	972	1 087	551	1 028	8	122	0	339	1 157	11 950 +
154354W	1992	1 201 +	1 343	930	1 783 *	916	225	690	472	138	19	424 +	3 199	10 889 *
154354W	1993	1 694	1 429	2 824	966	4 380	832	148	0	202	1 059	1 782	330	15 646
154354W	1994	52	628	3 247	758	382	3 047 +	1 759	300	1 148	208	210	802	12 541 +
154354W	1995	1 090	440	5 085	2 090	1 505	830	1 425	90	0	772	300	310	13 937
154354W	1996	2 250	3 695	1 843	2 360	1 357	1 192 +	1 574 +	640 +	4 519	860	290	1 194	21 774 +
154354W	1997	1 191	2 102	1 340	1 313	3 573	2 215	850	620	0	289	1 075	505	15 073
154354W	1998	111	2 160	3 370	1 213	2 198 +	2 674 +	794 +	215 +	15 +	82 +	156 +	0 +	12 988 +
154354W	1999	2 567 +	1 201 +	2 070 +	2 856 +	3 030 +	4 565 +	2 070 +	900 +	0 *	406 +	173 +	1 052 +	20 890 *
154354W	2000	1 170 +	1 495 +	1 437 +	1 153 +	840 +	1 834 +	895 +	604 +	30 +	1 380	290	700	11 828 +
154354W	2001	880	5 139	1 520	1 695	1 499	815	960	545	75	1 860	1 180	1 715	17 883
154354W	2002	390	1 502 +	1 830	885	475	3 994	1 400	775	310	193 +	128 +	2 171 +	14 053 +
154354W	2003	1 446 +	650	1 425	2 328 +	300	2 370	340	200	50	995	0	1 900	12 004 +
154354W	2004	1 320	1 063	1 000	3 650	770	780	1 013	434	213	135	643 +	636	11 657 +
154354W	2005	624	3406	1256	2045	1641	1168	927	1468	1026 +	0 *	1458	2708	17727 *
154354W	2006	2785	1260	4561	1479	602	1673	1555	0	417	0	454	465	15251
154354W	2007	2066	1511	1030	4651	1019	1375	2371	355	2508	0	248	480	17614
AVERAGE		1529 #	1922 #	1744 #	1772 #	1763 #	1804 #	1001 #	613 #	470 #	613 #	590 #	1163 #	14820

Patched rainfall data for 0129 7068 A

129068AW	1920	2007	10599											
129068AW	1920	964	1 163	1 526	1 280	687	2 260	1 313	246	15	97	60	1 507	11 118
129068A	1921	856	1 054	2 147	1 161	729	406	429	1 293	500	51	1 354	1 059	11 039
129068A	1922	1 801	1 284	542	2 997	1 225	1 597	126	311	38	3 050	92	326	13 389
129068A	1923	592	816	1 244	2 192	987	569	692	675	440	38	788	621	9 654
129068A	1924	735	1 137	1 748	1 522	1 467	2 745	966	454	135	364	162	1 471	12 906
129068A	1925	860	1 046	938	884	1 749	1 997	346 +	121	776 +	48	145	1 325	10 235 +
129068A	1926	547	2 346	1 021	711	709	3 416	18	147	58	254 +	354	639	10 220 +
129068A	1927	1 280	301	1 068	1 167	1 276	1 873	395	878	137	153	1 737	421	10 686
129068A	1928	919	1 342	745	1 029	1 072	1 442	135	393	2 078	1 301	640	1 315	12 411
129068A	1929	1 629	1 535	416	1 075	602	1 326	874	1 032	1 359	430	787	1 062	12 127
129068A	1930	539	679	1 118	1 863	1 563	1 885	170	175	20	5 310	370	422	14 114
129068A	1931	850	589	983	825	1 772	937	554	815	285	714	1 492	1 075	10 891
129068A	1932	729	1 720	1 963	98	382	356	463	79	20	341 +	238	445	6 834 +
129068A	1933	469	1 790	1 237	1 862	434	1 329 +	661	473	114	1 671	64	120	10 224 +
129068A	1934	840	898	1 755	1 052	286	1 846	1 935	1 441	1 245 +	134	1 000	633	13 065 +
129068A	1935	1 094	730	301	1 238	3 487	2 438	236	1 345	122	427	69	1 156	12 643
129068A	1936	1 352 +	2 468	1 433	852	2 459	1 509	612	114	58	689 +	506	480	12 532 +
129068A	1937	652	1 235	1 020	821	903 *	758	1 656	457	936	368	344	237	9 350 *
129068A	1938	702 +	1 875 *	1 612 *	887	1 936	1 105	380	893	125	778	227	2 114	11 545 *
129068A	1939	1 040	1 045	1 701	940	1 446	950	372	676	105	72	549	1 163	10 059
129068A	1940	433	1 376	664	882	551 +	1 504	614	193	813	452	349	800	8 631 +
129068A	1941	1 082	1 059	788 *	1 468	723 +	1 518	750	1 195	8	83	575	744	9 901 *
129068A	1942	971	3 045	1 913	1 306	640	1 313	1 449	580	313	127	2 064	640	14 361
129068A	1943	1 222	1 388	1 085	1 034 *	1 727	1 687	399	282	506	112	0	2 968	12 254 *
129068A	1944	1 249	903	309	1 116	1 692	1 045	440	333	13	241	51	524	7 916
129068A	1945	1 483	199	1 174	519	1 348	1 871	468	237	272	41	199	628	8 439
129068A	1946	614	1 263	911	1 672	795	3 561	1 616	330	1 154	298	168	1 320	13 702
129068A	1947	632	1 963	1 700	903	2 236	2 380	1 538	38	28	64	307 *	163	11 886 *
129068A	1948	1 673	656	1 101	1 113	2 598	1 905	1 159	61	148 +	97	337	771	11 619 +
129068A	1949	845	1 121	613	1 285 +	971 +	745 +	1 028 +	1 028 +	144 +	470 +	838 +	356 +	9 444 +
129068A	1950	1 144 +	502 +	1 636 +	1 412 +	786 +	978 +	378	332 +	196	339 +	529 +	755 +	8 987 +
129068A	1951	1 240	382 +	1 950 +	1 522 +	748 +	1 113 +	734 +	508	191 +	214	0	1 222 +	9 824 +
129068A	1952	666 +	1 249 +	832 +	1 137 +	1 038 +	865 +	546 +	290 +	257 +	198 +	599 +	877 +	8 554 +
129068A	1953	960 +	1 900 +	1 109 +	749 +	654 +	1 307 +	302 +	749 +	621 +	318 +	234 +	944 +	9 847 +
129068A	1954	2 393 +	792 +	785 +	1 725	1 772	1 041	260	595	336 +	0	39	1 230 +	10 968 +
129068A	1955	890 +	1 509	507 +	373	1 449	2 042	1 407	704	532	70	643	1 125 *	11 169 *
129068A	1956	1 370	2 114	2 237	1 233 +	1 152 +	1 405 +	1 231	440	827	172	391	750	13 322 +
129068A	1957	693	800	693	1 506	1 217	1 656	1 382	47	8	690	309	585	9 586
129068A	1958	401	1 268	1 038	721	829	460	659	502	149 +	736	978	464	8 205 +
129068A	1959	790	772	1 214	902	716	1 550	1 173	1 149	5	396	523	770	9 960
129068A	1960	398	1 390	1 334	1 302	1 024	1 293	1 856	662	197	998	410	428	11 292
129068A	1961	604	1 747	1 221	795	1 177	1 325	470	438	7	36	907	482	9 209
129068A	1962	942	1 460	1 069	1 636	653	2 356	707	547	179	1 355	129	171	11 204
129068A	1963	908	1 171	755	1 966	1 100	1 650	1 045	195	1 170	110	255	625	10 950
129068A	1964	1 061	285	623	1 258	450	258	577	790	2 312	338	897	337	9 186
129068A	1965	2 237	1 442	901	1 111	820	270	505	1 219	58	105	407	1 025	10 100
129068A	1966	401	934	852	1 529	1 055	2 007	1 894	132	338	1 378	255	277	11 052
129068A	1967	842	762	676	868	1 050	561	347	14	283	123	455	1 086	7 067
129068A	1968	797	1 553	964	663	1 616	1 530	369	2 070	310	240	462	748	11 322
129068A	1969	1 176	1 422	1 224	400	937	398	580	443	710	105	1 481	735	9 611
129068A	1970	1 320	1 831	909	1 402	1 160	731	936	2 197	39	1 175	755	717	13 172
129068A	1971	1 510	1 248	1 021	888	2 850	817	1 072	189	337	301	385	240	10 858
129068A	1972	543	2 268	1 687	1 116	985	1 315	2 550	6	30	230	1 101	1 892	13 723
129068A	1973	850	2 165	1 523	1 074	1 622	1 218	644	2 051	714	145	123	444	12 573
129068A	1974	687	1 313	1 073	921	1 021	604	928	438	82	285	569	2 242	10 163
129068A	1975	551	983	1 409	801	2 427	4 515	921	758	60	177	382	999	13 983
129068A	1976	3 766	315	139	1 200 +	2 009 +	960 +	335 +	196 +	418 +	329 +	738 +	677 +	11 082 +
129068A	1977	1 088 +	1 564 +	1 633 +	762 +	848 +	880 +	4 918 +	740 +	385 +	173 +	380	690	14 061 +
129068A	1978	1 045	959	907	747	621	1 280	705	506	66	946	695	1 122	9 599
129068A	1979	992	980 +	1 162 +	915	1 363	956	605	475	143	301	259	1 982	10 133 +
129068A	1980	468	1 589	651	1 691	1 087	360	215	1 268	195	277	939	390	9 130
129068A	1981	605	917	462	1 162 +	559	3 504	1 003	385	228	279	134	584	9 822 +
129068A	1982	1 372	169	260	869	593	630	587	69	179	1 147	307	429	6 611
129068A	1983	828	1 152	1 111	1 666	1 124	1 069	817	553	797	1 920	106	387	11 530
129068A	1984	708	2 318	581	701	3 376 +	572	349	106	160	48	75	505 +	9 499 +
129068A	1985	1 305	1 734 *	879	2 233	524	1 461	895	193	96	36	736	1 270	10 790 *
129068A	1986	1 293	1 037	642	606	234	1 435	120	481	452	121	440	2 551	9 412
129068A	1987	412	1 042	599	571	614	1 477	625	1 214	179	395	301	376	7 805
129068A	1988	679	844	2 287	308	1 925	1 340	1 889	231	268	206	28	540	10 545
129068A	1989	1 883	2 241	835	1 106	289	2 091	328	40	113	26	1 045	475	10 472
129068A	1990	825	525	931 +	930	1 729	650	176	453	133	49	502	1 197	8 100 +
129068A	1991	1 226	1 387	1 135	1 594	285	841	767	204	286	0	488	666	8 879
129068A	1992	831	449	1 465	1 140	581	319	334	0	8	21	262	1 397	6 807
129068A	1993	780	1 060	1 505	656	2 675	498	290 +	129	54	388	1 068	88	9 191 +
129068A	1994	1 375	527	2 447	722	771	1 880 +	2 605	357	947	190	35	573	12 429 +
129068A	1995	1 287 *	628	2 711 +	1 527 *	951	1 004 *	801 +	724 *	305	2 290	155	481	11 514 *
129068A	1996	1 398	2 530	1 145 +	1 683 *	2 568	829	1 369 *	448	2 524	324	186	1 190	15 952 *
129068A	1997	934 +	1 847 *	631	1 053	1 924 +	1 727 *	468	425	32	152	1 091	799	10 475 *
129068A	1998	596	1 678 *	589	678	1 617	2 107	679	341	42	135	254	741 *	8 541 *
129068A	1999	1 627 +	595	681	3 116 *	954	1 902	2 079	779	17	528	184	812	11 937 *
129068A	2000	637	1 073	1 043	970	769	1 330	1 042	220	70	871	301	649	8 975
129068A	2001	1 402	2 430 +	1 167 +	1 090	811	649	1 169	518	70	1 542	1 017	1 867 *	12 677 *
129068A	2002	226	1 013	662	668	219	2 408 *	365	217	465 *	223	200 +	1 371 +	7 740 *
129068A	2003	1 036 +	378	982	1 672	351	1 717	323	273	29	723	283	2 369	10 136 +
129068A	2004	278	274	951	1 368	936	764	752 +	475 +	176 +	173 *	598 +	589 +	7 322 *
129068A	2005	655 +	3943 *	879 +	1796 *	1122 +	985	1489	1041	424	3	1552	1205	12615 *
129068A	2006	2484	780	940	1063	636 +	1040 +	1061	0	229	2	542	285	9062 +
129068A	2007	1366	1475	870 +	2482	408	909	1660	271	421	0 +	345	640	10847 +
AVERAGE		1016	1258	1101	1176	1173	1376	865	535	362	481	504	870	10600

Patched rainfall data for 0154 142 W

154142W	1920	2007	10027											
154142W	1920	767 +	1 242	1 415 +	933	1 031	1 420	712	77	0	66	0	943	8 606 +
154142W	1921	875	1 849	1 564	894	758	569	403	1 661	819	0	1 051	935 +	11 378 +
154142W	1922	2 097	2 322	799	3 181	2 388	1 483	219	222	79	1 910 +	0	243	14 943 +
154142W	1923	666	929	1 269	1 990	1 456	319	271	173 +	153	84	506	771	8 587 +
154142W	1924	788	1 095	1 682	1 064	1 184	2 543	953	253	64	318	89	1 115	11 148
154142W	1925	467	1 269	1 033	1 151	1 200	2 471	488	263	747	25	258	958 +	10 330 +
154142W	1926	1 151	1 545	1 689	1 036	978	3 485	58	236	0	0	199	742	11 119
154142W	1927	1 132	413	1 674	1 560	1 461	985	272 +	333	145	0	861	179	9 015 +
154142W	1928	925	1 045	1 302	1 255	1 070	1 275	63	525	1 332	675	561	1 397	11 425
154142W	1929	1 590	1 439	891	1 104	711	957	691	216	848	282	993	1 008	10 730
154142W	1930	411	611	824	2 199	2 649	1 519	335	53	0	3 598	213	305	12 717
154142W	1931	1 157	907	1 162	545	2 210	786	38	864	364	521	69	1 632	10 255
154142W	1932	956	3 031	1 458	157	1 768	1 384	360	107	137	144 +	122	416	10 040 +
154142W	1933	416	1 676	1 822	1 919	1 001	1 221	388	259	139	933	71	208	10 053
154142W	1934	650	1 433	1 348	991	425	1 519	1 567	1 260	1 999	158	967	323	12 640
154142W	1935	740	1 383	223 +	955 +	2 583	2 152	208	1 320	155	247	8	450	10 424 +
154142W	1936	1 352	2 734	480	843	2 082 +	1 901	347	127	71	216	203	416	10 772 +
154142W	1937	543	764	1 391	1 354	810	578	1 362	94	502	209	231	215	8 053
154142W	1938	629	1 258	1 490	1 577	2 134	1 008	256	562	0	956	25	1 809	11 704
154142W	1939	787	849	1 269	734	1 330	926	285	1 532	0	33	140	755	8 640
154142W	1940	351	1 969	867	728	440	756	385	64	211	140	241	224	6 376
154142W	1941	917	901	344	1 702	972	1 329	627	813	0	0	351	545	8 501
154142W	1942	1 029	3 124	1 395	996	703	1 547	1 260	307	355	166	1 438	424	12 744
154142W	1943	931	1 403	1 452	758	1 215	787	364	132	391	91	86	2 013	9 623
154142W	1944	673	583	467	1 459	1 434 +	1 485	134	376	145	94	66	767	7 683 +
154142W	1945	1 870	127	828	820	727	1 176	844	183	58	59	28	371	7 091
154142W	1946	911	1 434	472	1 009	1 203	1 560	1 003	116	1 288	166	156	586	9 904
154142W	1947	446	4 487	1 167	618	1 284	1 147	485	33	41	5	101	140	9 954
154142W	1948	1 235	881	852	1 026	1 239	1 160	584	71	0	117	135	487	7 787
154142W	1949	534	1 170	605	1 027	1 396	976	701	769	28	437	561	229	8 433
154142W	1950	937	230	1 787	742	504	998	275	125	48	63	325	720	6 754
154142W	1951	1 513 +	129	1 236	1 464	956	1 342	839	167	99	145	20	858	8 768 +
154142W	1952	460	652	947	1 085 +	890	661	710	79	114	0	422	1 618	7 638 +
154142W	1953	1 195	1 630	905	890	555	1 740	110	775	470	230	40	780	9 320
154142W	1954	2 130	720	845	1 760	1 775	670	440	155	300	0	0	1 015	9 810
154142W	1955	680	1 005	400	540	1 660	2 440	625	305	720	0	210	750	9 335
154142W	1956	1 040	2 805	2 862	1 030	890	1 505	1 140	260	433	126	500	920	13 511
154142W	1957	940	820	1 590	1 660	1 855	550	1 140	0	0	320	170	480	9 525
154142W	1958	520	1 755	1 040	790	820	890	545	2 395	10	930	320	1 305	11 320
154142W	1959	643	1 185	1 330	980	692	1 022	1 133	212	14	205	566	902	8 884
154142W	1960	986	897	1 762	1 574	771 +	820	2 097	230	30	105	65	385	9 722 +
154142W	1961	321	1 480	1 225	900	1 145	2 041	358	465	0	25	590	300	8 850
154142W	1962	1 415	1 394	967	1 818	727	3 150	595	162	120	1 460	20	151	11 979
154142W	1963	983	1 048	775	1 553	986	1 170	720	125	2 875	55	85	702	11 077
154142W	1964	1 215	352	1 070	1 083	1 050	278	287	580	1 795	608	545	798 +	9 661 +
154142W	1965	2 210	1 610	774	1 078	787	194	343	3 225	57	72	310	675	11 335
154142W	1966	580	1 065	1 090	1 634	860	3 245	1 460	146	515	745	240	70	11 650
154142W	1967	469	1 502	729	1 034	950	752	371	42	56	85	922	1 238	8 150
154142W	1968	980	1 401	853	493	1 255	1 805	635	1 190	70	90	200	430	9 402
154142W	1969	905	1 105	1 050	590	1 800	415	410	330	805	0	2 406	745	10 561
154142W	1970	1 755	1 120	850	1 060 +	1 410	489	851	1 080	10	747	1 310	500	11 182 +
154142W	1971	2 302	973	850	1 225	2 017	470	373	178	380	104	185	190	9 247
154142W	1972	612	1 464	1 160	977	987	888	740	0	0	129	520	420	7 897
154142W	1973	700	1 433	610	1 128	1 030	1 351	597	1 685	360	0	25	123	9 042
154142W	1974	396	1 471	1 207	821	708	821	254	410	5	230	15	1 027	7 365
154142W	1975	452	822	2 030	1 127	1 729	3 843	772 +	661	121	106	242	831	12 736 +
154142W	1976	2 853	524	485	790	1 660	749	210	56	180	70	750	669	8 996
154142W	1977	760	771	1 522	622 +	756 +	793 +	4 630 +	628 +	169 +	62 +	519 +	670 +	11 902 +
154142W	1978	1 319 +	1 072 +	751 +	856 +	855 +	1 217 +	410 +	253 +	50 +	698 +	519 +	1 085 +	9 085 +
154142W	1979	873 +	907 +	1 052 +	685 +	1 286 +	721 +	195	332 +	20	210	113	1 970	8 364 +
154142W	1980	619	2 033	1 983 *	2 992	1 056 +	790 *	0	795	210	35	2 290 *	995 *	10 045 *
154142W	1981	844 *	915 +	1 195	1 518 *	617 +	3 069 +	986 +	210	264	482 *	80	1 195 *	9 732 *
154142W	1982	788 +	1 540 *	671 *	465	258	868 *	321 +	950 *	0	7 150	550	652 +	11 842 *
154142W	1983	658	2 328	995 +	1 295 +	3 158	1 083	734	175	305	353 +	29	186	11 299 +
154142W	1984	2 022	1 215 +	619	1 294	4 257 +	493	416	0	216	0	0	212	10 744 +
154142W	1985	3 404 *	1 668 *	733	2 011 +	1 802 *	1 276 +	716 +	140	95	0	1 003 +	1 232 +	10 083 *
154142W	1986	1 851 *	2 342	954	717	121	808	214	0	6	0	564 *	3 665 +	10 609 *
154142W	1987	1 266	1 593 +	1 005 +	1 210	2 518 +	4 362	540	1 040	100	60	165	525	14 384 +
154142W	1988	565	1 152	1 300	550	2 810	880	2 130	110	170	0	40	0	9 707
154142W	1989	5 470	2 265	668 +	2 150 *	543 +	2 192	165	60	125	26 +	769 +	475	14 515 *
154142W	1990	1 200	595	1 200	930	1 555	665	55	195	90	0	210	670	7 365
154142W	1991	1 360	1 365	1 185	565	120	510	1 005	30	0	0	155	580	6 875
154142W	1992	740	670	365	720	713	330	697	0	0	20	290	1 971 +	6 516 +
154142W	1993	855	785	1 823	731	3 485	1 049	0	220	0	843	745	0	10 536
154142W	1994	600	455	586	582 +	580	1 960	1 315	55	1 650	30	55	1 385	9 253 +
154142W	1995	781 @	396 @	3 194 @	1 384 @	1 016 @	623 @	984 @	56 @	0 *	235 @	210 @	305 @	9 184 *
154142W	1996	1 456 @	2 432 @	1 236 @	1 546 @	1 232 @	813 @	1 251 @	410 @	2 883 @	586 @	198 @	871 @	14 914 @
154142W	1997	841 @	1 389 @	876 @	949 @	2 282 @	1 460 @	578 @	399 @	13 @	202 @	627 @	465 @	10 081 @
154142W	1998	193 @	1 425 @	1 886 @	762 @	1 466 @	1 800 @	678 @	159 @	35 @	76 @	122 @	0 @	8 602 @
154142W	1999	1 641 @	767 @	1 203 @	1 814 @	1 723 @	2 665 @	1 617 @	570 @	21 @	275 @	130 @	742 @	13 168 @
154142W	2000	761 @	1 011 @	977 @	824 @	631 @	1 229 @	760 @	383 @	44 @	877 @	181 @	502 @	8 180 @
154142W	2001	758 @	3 231 @	1 039 @	1 153 @	969 @	611 @	766 @	332 @	61 @	1 122 @	713 @	1 159 @	11 914 @
154142W	2002	301 @	995 @	1 126 @	672 @	363 @	2 534 @	886 @	541 @	208 @	143 @	104 @	1 404 @	9 277 @
154142W	2003	970 @	464 @	974 @	1 544 @	278 @	1 597 @	293 @	121 @	49 @	624 @	0 *	1 472 @	8 386 *
154142W	2004	792 @	659 @	749 @	2 197 @	627 @	601 @	734 @	262 @	151 @	97 @	362 @	506 @	7 737 @
154142W	2005	499 @	2179 @	881 @	1357 @	1113 @	847 @	809 @	915 @	635 @	16 @	833 @	1679 @	11763 @
154142W	2006	1951 @	852 @	2625 @	1040 @	486 @	1134 @	1050 @	0 @	283 @	17 @	263 @	339 @	10040 @
154142W	2007	1355 @	1118 @	744 @	2972 @	651 @	932 @	1628 @	232 @	1752 @	0 @	144 @	423 @	11951 @
AVERAGE		1065 ##	1307 #	1134 #	1176 ##	1246 #	1303 #	685 #	427 ##	333 ##	370 #	372 #	756 #	10028

Patched rainfall data for 0129 007 W

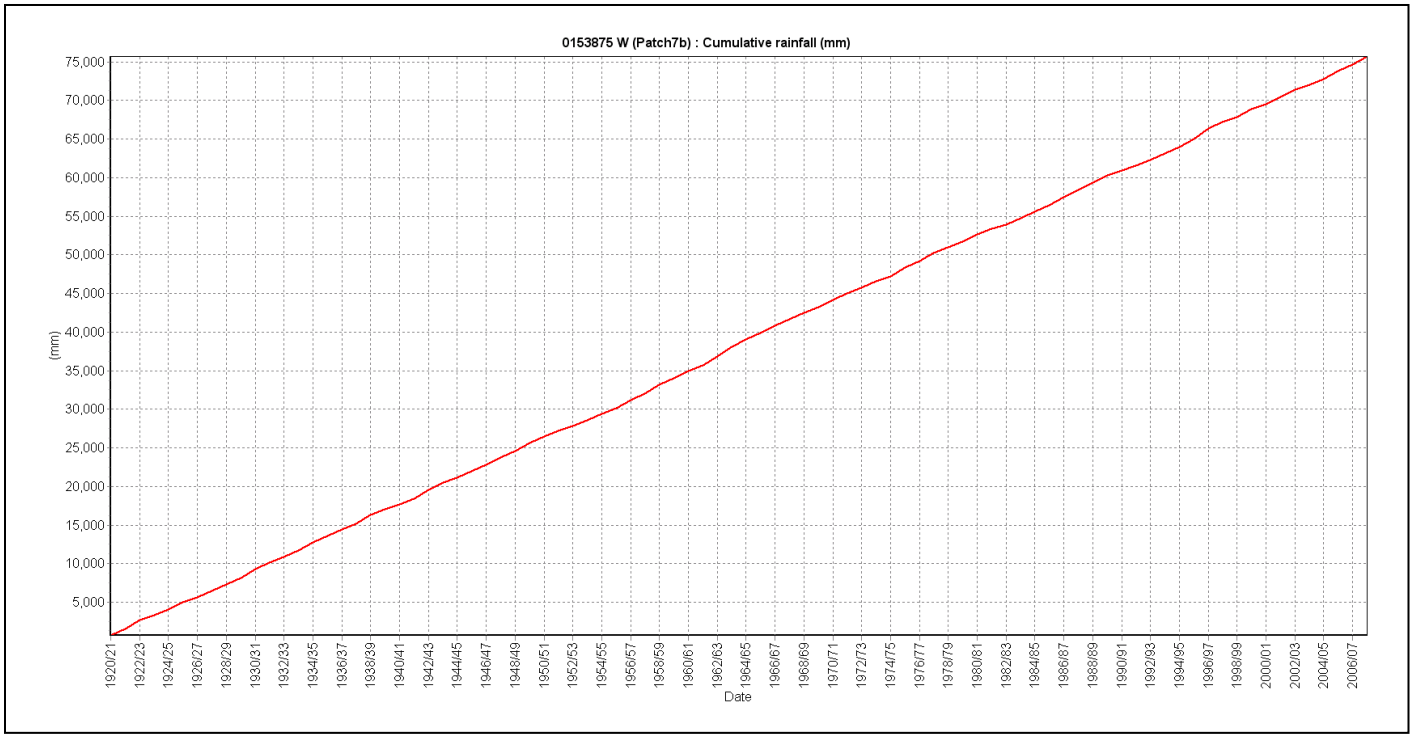
129007W	1923	2007	12619											
129007W	1923	1 110	1 496	1 372	2 288	1 207 +	736	677	1 146	459 +	31	706	737	11 965 +
129007W	1924	895	1 419 +	1 520	1 398	1 898 +	2 258	746	363	163	349	175 +	1 100	12 284 +
129007W	1925	441	1 035	1 089 +	1 175 +	2 243	1 793	472	273 +	1 159	0	211	1 060	10 951 +
129007W	1926	1 930	2 573 +	1 227	923	934 +	3 785 +	0	252	0	28	368	760	12 780 +
129007W	1927	1 501	226	1 580	1 009	1 104	1 267	312	830	114	198	1 625 +	435 +	10 201 +
129007W	1928	1 435	1 987	1 019 +	1 383	1 253 +	2 303	139 +	856	2 573	1 392	714	1 643 +	16 697 +
129007W	1929	2 716	2 123	721	961	634	1 302	886 +	907 +	1 241	476	752	1 889	14 608 +
129007W	1930	582	615	1 282 +	2 230	1 814 +	2 255	124	183	54	5 425 +	359 +	429	15 352 +
129007W	1931	1 298	457	1 227	859	991	1 184 +	272	1 162	389	701	437	1 901	10 878 +
129007W	1932	1 462	3 681	2 320 +	700	1 804	2 080	660	896	21	356	195	289	14 464 +
129007W	1933	511	2 154	2 277	2 725	767	2 132	536	315	112	1 832	36	92	13 489
129007W	1934	1 038	2 263	2 545	1 168	584	1 694	2 232	2 187	1 201	170	1 153	889	17 124
129007W	1935	1 049	1 042	378	1 852	3 760	2 612	189	1 941	244	713	23	1 329	15 132
129007W	1936	1 689	4 097	1 186	1 265	2 885	1 688	556	142	224	958	659	441	15 790
129007W	1937	784	1 297	1 707 +	1 027	828	624	2 163	334	758	426 +	292	277	10 517 +
129007W	1938	888	2 038	1 807	1 355	2 759	1 604	361	942	43	1 009	247	2 513	15 566
129007W	1939	1 470	1 065	1 896	1 262	2 042	906	381	770	97	87	318	1 092	11 386
129007W	1940	398	2 004	1 012	1 218	392	1 975	526	198	640	391	366	578	9 698
129007W	1941	1 209	1 563	860	2 564	949	1 627	813	1 694	15	56	699	933	12 982
129007W	1942	940	4 705	2 688	1 935	805	1 617	1 905	804	388	151	2 127	651	18 716
129007W	1943	1 525	2 008	1 472	1 659	1 572	3 306	736	104	393	351	193	4 114	17 433
129007W	1944	1 430	1 078	737	1 788	2 406	1 262	355	375	124	249	112	1 122	11 038
129007W	1945	3 344	198	955	903	1 667	2 412	482	270	394	56	195	774	11 650
129007W	1946	652	1 244	966	1 778	745	2 794	1 758	519	1 636	318	290	1 069	13 769
129007W	1947	905	2 713	2 159	1 213	2 328	2 241	2 059	63 +	38	63	335	356	14 473 +
129007W	1948	2 969	1 010	1 413	1 239	2 986	1 962	1 194	127	0	112	489	993 +	14 494 +
129007W	1949	1 384	2 616	1 143	2 105	1 339	629	930	1 219	58	733	1 008	531	13 695
129007W	1950	1 347	483	2 520	1 691	487	1 052	627	249	222	104	665	1 405	10 852
129007W	1951	1 906	152	3 195	2 822	1 305	3 050	1 154	1 092	216	341	53	1 560	16 846
129007W	1952	759	1 162	1 400	1 368 +	1 223 +	1 023	525	265	398	38	439	1 384	9 984 +
129007W	1953	1 777	2 781	1 603	1 286	499	1 419	460	1 115	910	210	300	1 115	13 475
129007W	1954	2 725	919	1 096	1 900	2 219	1 049	278	370	400	0	0	1 625	12 581
129007W	1955	1 325	1 615	353	421	1 747	3 192	1 229	634	735	55	655	899	12 860
129007W	1956	1 888	2 870	2 966	1 669	1 578	2 411	2 130	500	730	115	425	1 475	18 757
129007W	1957	903	1 320	905	2 038	1 773	1 754	2 200	43	0	1 045	320	945	13 246
129007W	1958	985	2 255	1 440	965	995	765	830	865	0	915	1 425	735	12 175
129007W	1959	1 305	883	1 460	1 260	1 125	1 835	1 540	1 290	0	320	525	1 090	12 633
129007W	1960	740	1 695	2 340	1 995	1 640	1 205	3 145	1 040	45	1 285	490	720	16 340
129007W	1961	1 020	2 305	1 770	1 035	1 450	1 800	475	455	45	25	970	460	11 810
129007W	1962	1 745	1 640	1 510	2 490	900	3 685	795	610	185	1 945	130	340	15 975
129007W	1963	1 950	1 430	1 255	2 430	1 950	1 970	1 110	255	1 790	110	195	730	15 175
129007W	1964	1 585	535	675	1 605	655	215	830	926	2 420	440	875	1 040	11 801
129007W	1965	2 955	2 005	1 145	1 670	1 170	600	525	1 530	150	115	345	1 010	13 220
129007W	1966	550	1 005	1 280	1 945	1 240	2 625	2 617	140	530	1 230	295	430	13 887
129007W	1967	1 190	1 150	1 005	825	1 335	700	520	10	185	150	595	1 395	9 060
129007W	1968	1 300	2 030	730	765	2 665	1 805	635	2 480	210	190	330	655	13 795
129007W	1969	1 430	2 285	1 565	615	1 450	400	745	450	625	0	2 705	800	13 070
129007W	1970	3 175	2 350	1 180	1 545	1 490	920	1 560	1 960	75	1 410	1 510	537	17 712
129007W	1971	1 340	1 495	1 210	507	2 865	815	915	440	360	310	395	330	10 982
129007W	1972	525	1 765	1 625	1 150	895	1 427 +	2 605	0	45	170	920	1 605	12 732 +
129007W	1973	1 370	1 730	605	1 665	1 650	1 575	625	1 710	425	140	125	750	12 370
129007W	1974	560	1 795	1 770	1 420	875	1 115	1 020	340	60	335	540	3 660	13 490
129007W	1975	565	1 615	2 510	1 300	2 750	5 240	1 090	1 410	80	230	480	1 000	18 270
129007W	1976	4 530	565	490	1 899	1 980	895	581	71	660	105	865	955	13 596
129007W	1977	918	2 740	2 435	800	1 380	1 430 *	4 340	730	340	60	710	895	16 349 *
129007W	1978	1 740 *	1 325	1 315	575	765	1 439 +	700	620 *	89 +	1 290 *	986	1 185	11 311 *
129007W	1979	1 085	645	950	1 008 +	1 545	952 +	592 *	450	45	325	200	1 945	9 692 *
129007W	1980	637 +	1 966 +	615	2 320 *	1 705	370	55	2 030 *	140	265	1 170 *	485	10 604 *
129007W	1981	470	1 125	766 *	1 315	840	4 035 *	408	343 +	205 +	245 +	117 +	372	10 021 *
129007W	1982	965	227 +	220	1 080	820 +	577	315	115	0	645	369	920	6 253 +
129007W	1983	705	1 300	1 323 +	1 630	3 735 *	555	860	215	256	2 665	205	460	11 468 *
129007W	1984	535	1 315	771 +	797	2 703	420	200	70	130	20	0	465	7 426 +
129007W	1985	1 845	2 480	965	2 729 +	545	1 576 +	791	155	105	37 +	1 220	1 351	13 799 +
129007W	1986	1 616 +	1 339	627	1 087	307	1 407	62	545	471	69	495	3 690	11 715 +
129007W	1987	460	1 631	899	1 175	2 249	2 616 +	680	1 473	92	346	515	505	12 641 +
129007W	1988	1 043	946	2 856 +	483 +	1 804	1 423 +	2 825	198	300	246	60	688	12 872 +
129007W	1989	2 000	2 739 +	623	1 745 +	261	2 546	272	0	110	20	827	370	11 513 +
129007W	1990	1 222	494	830	972	1 297	747	107	359	42	17	509	1 022	7 618
129007W	1991	1 173	1 445	844	1 131	235	818 +	818	305	183	0	653	667	8 272 +
129007W	1992	823	424	1 892	1 134	289	384	363	0	0	0	503	1 860	7 672
129007W	1993	1 100	825	1 733	1 150 *	2 576	942	124	95	45	380	922	60	9 617 *
129007W	1994	1 120	101	2 660	858	845	1 897	3 102	379	530	222	28	509	12 251
129007W	1995	1 241	633	2 355	1 310	783	707	649	620	146	1 908	225	351	10 928
129007W	1996	1 445	2 828	760	1 410	2 089	746	1 747	579	1 710	482	172	947	14 915
129007W	1997	880	2 268	621	1 233	1 409	2 096	670	330	110	145	1 122	464	11 348
129007W	1998	405	1 960	1 952	1 016	1 974 +	2 329 +	754 +	292 +	42 +	121 +	219 +	0 +	11 064 +
129007W	1999	2 011 +	856 +	1 199 +	2 989	1 162	1 923	1 723	839	120	348	0	734	13 904 +
129007W	2000	722	917	1 729	536	726	1 170	1 120	84	242	634	448	524	8 852
129007W	2001	1 837	3 132	1 450	1 488	890	485	843	530	180	730	465	1 475	13 505
129007W	2002	295 +	842	749	500	312 +	3 080	584 +	286 +	211 +	319	153 +	1 737 +	9 068 +
129007W	2003	305	463	648	1 744	60	1 445	527	199	350	1 519	298	2 853	10 411
129007W	2004	340	698	523	3 664	1 083	988	523	523	140	0	478	50	9 010
129007W	2005	369	4 623	1 038 +	2 007	972	852	1 235	862	275	0	1 733	1 499	15 465 +
129007W	2006	2 605	1 011	1 625	777	539	813	1 185	0	378	0	0	0	8 933
129007W	2007	1 217	1 948	792	1 774	630	890	1 433	266 +	1 160	0	0	200	10 310 +
AVERAGE		1296	1598	1364	1444	1402	1603	963	619	379	483	535	999	12619

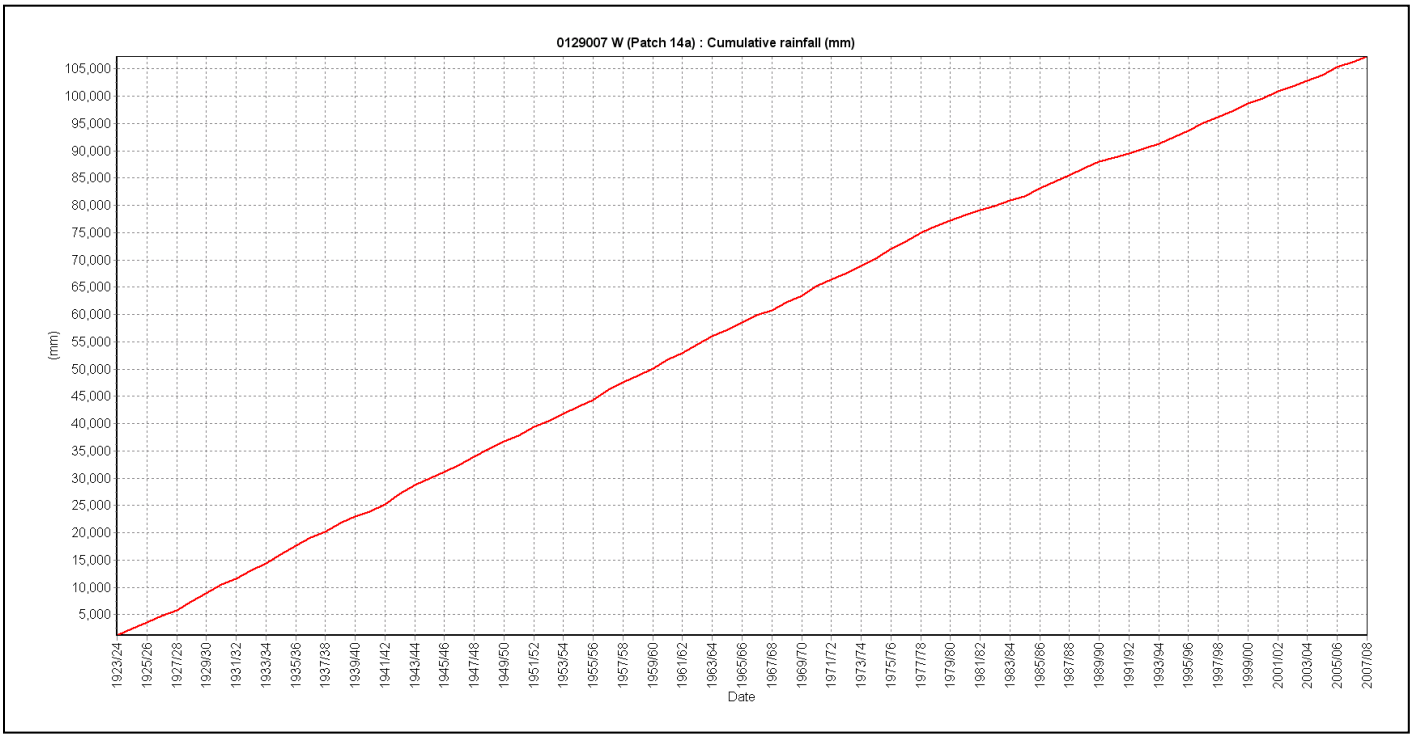
Patched rainfall data for 0153 631 W

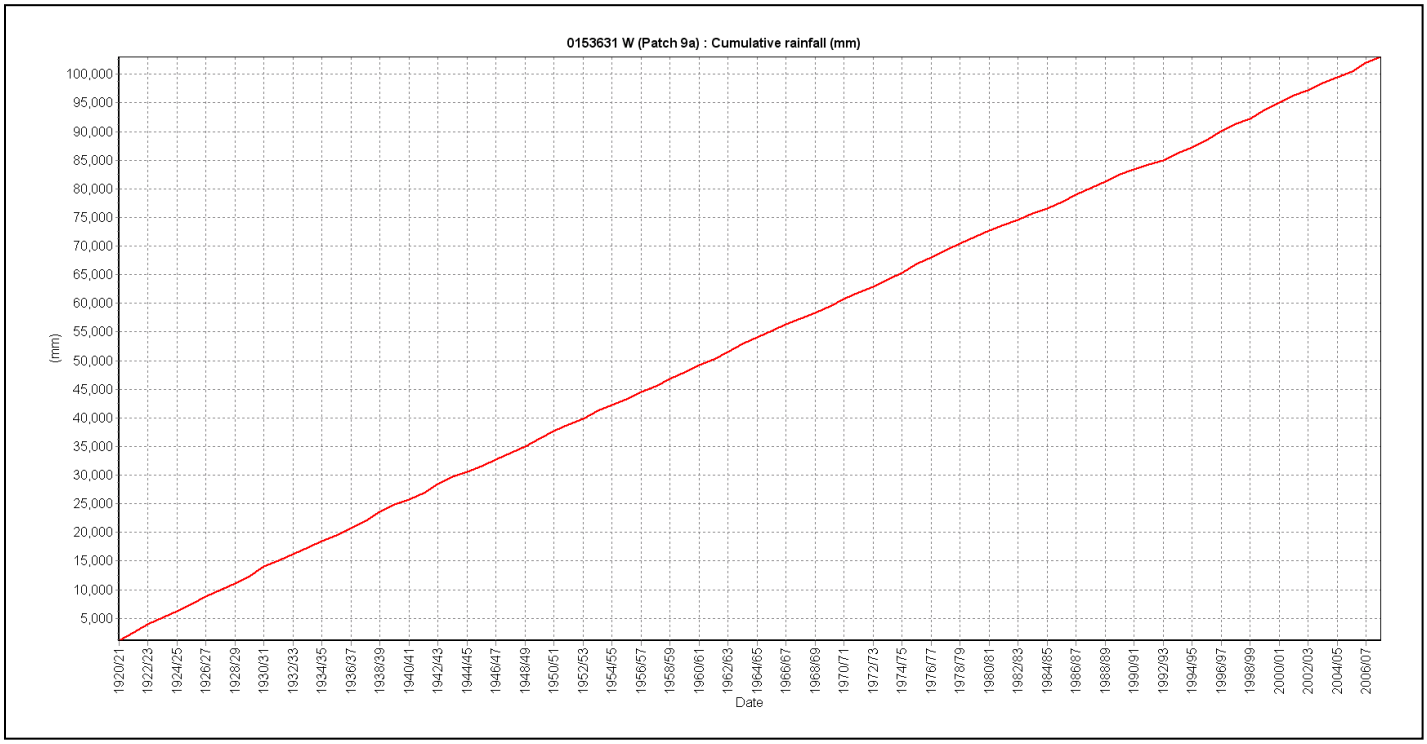
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1.	1920	991	1 678	1 662	1 892	1 133	1 391	1 191	169	25	10	59	892	11 093
1.	1921	1 174	2 245	3 183	1 411	1 298	574	188	1 976	526 +	25	715	561	13 876 +
1.	1922	2 099	1 985	1 301	2 897	2 062	1 516	214	310	121	2 292	110	376	15 283
1.	1923	452	1 002	1 434	2 215	1 821	527	648	585	64	0	495	1 012	10 255
1.	1924	1 017	1 475	2 224	1 226	1 097 +	2 600 +	661	263	0	137	73	855	11 628 +
1.	1925	844	1 966	1 554	2 318	1 508	3 073	272	357	543	18	236	1 021	13 710
1.	1926	1 178	1 156	2 433	1 625	989	3 400	69	254	0	152	243	480	11 979
1.	1927	1 865	848	2 017	3 045	1 476	975	140	231	0	0	636	458	11 691
1.	1928	612	1 105	1 234	1 868	885	2 082	51	432	904 +	241	356	1 556	11 326 +
1.	1929	1 623	1 800	1 599	1 274 +	640	2 093	757	209	797	99	1 151	820	12 862 +
1.	1930	1 064	1 154	1 995	4 070	1 823	2 273	615	111	15	3 253	190	203	16 766
1.	1931	1 065	1 201	940	1 051	1 674	906	286	508	0	671	287	1 126	9 715
1.	1932	1 323	3 091	3 285	670	1 350	1 008	364	175	43	140	137	465	12 051
1.	1933	533	2 517	2 025	2 221	703	1 280	441	163	140	516	53	178	10 770
1.	1934	801	1 840	1 936	1 394	917	1 002	1 361	926	823	43	765	440	12 248
1.	1935	1 136	1 311	413	1 485	2 284	1 255	134	1 258 +	69	30	0	733	10 108 +
1.	1936	1 633	3 926	1 071	766	2 674	1 080	371	99	137	73	164	690	12 684
1.	1937	1 153	1 179	2 164	1 812	1 634	785	1 751	267	409	394	346	275	12 169
1.	1938	1 197	1 744	2 003	2 165	3 800	820	815	620	205	538	149	1 843	15 899
1.	1939	1 080	1 209	1 611	1 304	2 798	1 724	603	1 163	234	10	51	669	12 456
1.	1940	637	1 993	1 590	1 360	481	1 021	1 119	0	157	89	229	343	9 019
1.	1941	709	1 808	826	2 499	1 659	1 560	1 142	343	0	20	251	813	11 630
1.	1942	1 093	3 204	1 855	1 754	941	1 474	1 627	693	618	221	1 042	465	14 987
1.	1943	1 551	1 991	1 784	1 088	1 864	1 439	294	97	452	421	106	1 500	12 587
1.	1944	924	545	562	2 662	1 717	1 387	238	318	0	36	135	348	8 872
1.	1945	1 598	533	1 486	1 425	1 628	1 420	362	274	0	269	73	455	9 523
1.	1946	791	1 679	1 717	1 658	1 445	1 801	715	0	803	228	64	665	11 566
1.	1947	813 +	3 827	1 636	1 469	1 933	1 588	535	79	0	51	69	254	12 254 +
1.	1948	1 802	1 111	1 397	825	1 955	785	792	371	0	251	264	668	10 221
1.	1949	1 098	1 666	1 435	2 107	2 925	2 386	719	886	74	500	1 276	501	15 573
1.	1950	1 454	840	3 364	1 379	1 404	1 424	270	262	36	51	787	1 122	12 393
1.	1951	1 829	391	1 536	1 897	1 550	1 278	752	276	198	198	141	816	10 862
1.	1952	615	1 084	1 711	1 385 +	1 449	1 041	1 296	100	80	48	458	1 195	10 462 +
1.	1953	1 437	1 504	2 589	1 395	1 555	1 917	367	921	465	246	65	905	13 366
1.	1954	1 848	996 +	936	2 732	1 895 +	718	786	339	289	20	0	672	11 231 +
1.	1955	881	1 197	649	292	1 630	2 339	648	424	242	9	188	516	9 015
1.	1956	805	1 525	2 283	1 877	1 651	1 822	980	156	177	59	519	1 104	12 958
1.	1957	1 075	1 617	1 180	1 599	1 748	884	833	53	30	145	165	419	9 748
1.	1958	785	1 647	2 142	1 230	1 163	1 764	902	2 420	3	608	747	546	13 957
1.	1959	1 014	1 421	1 282	1 834	1 016	1 622	847	237	10	150	818	805	11 056
1.	1960	778	1 339	2 550	2 058 +	1 810	1 545	1 535	325	80	90	140	420	12 670 +
1.	1961	535	1 955	1 535	1 524	1 786	1 110	310	390	3	46 +	440	325	9 959 +
1.	1962	1 335	1 805	1 308 +	2 610	640	2 995	685	90	55	1 290	40	170	13 023 +
1.	1963	1 690	1 805	1 402 +	2 045	1 125	2 125	1 250	55	1 710	125	190	790	14 312 +
1.	1964	1 985 +	430	1 030	1 110	1 230	595	220	765	1 670	700	775	597	11 107 +
1.	1965	1 536	1 592	865	1 890	1 035	306	575	1 778	90	20	410	859	10 956
1.	1966	800	658	1 505	1 840	840	3 005	505	255	745	620	170	125	11 068
1.	1967	939	1 590	1 142	1 782	1 128	1 258	982	30	15	154	753	973	10 746
1.	1968	835	1 361	1 252	851	1 969	1 844	611	604	50	190	414	323	10 304
1.	1969	1 086	1 382	1 507	1 147	1 587	521	296	466	425	61	943	819	10 240
1.	1970	1 825	1 212	1 505	1 457	1 819	1 182	1 072	1 026	105	695	769	609	13 276
1.	1971	1 983	1 313	1 036	1 750	2 460	1 190	535	140	270	105	22	205	11 009
1.	1972	950	2 170	1 350	1 125	1 694	1 561	689	15	0	170	502	870	11 096
1.	1973	944	1 762	1 125	2 221	1 004	2 714	717	1 473	355	52	68	307	12 742
1.	1974	756	1 719	1 030	1 742	1 385	1 225	693	75	12	90	247	1 182	10 156
1.	1975	542	1 014	2 854	2 617	2 673	3 717	880	1 037	0	140	175	1 021	16 670
1.	1976	2 147	789	1 995	1 560	1 183	1 180	350	60	325	40	315	799	10 743
1.	1977	1 704	1 385	1 865	1 275	1 385 +	1 501	4 814 *	526	110	0	295	907	13 515 *
1.	1978	1 486	1 434	1 903	1 771	1 000	1 344	551 +	275	65	829	223	620	11 501 +
1.	1979	1 128	989	1 325	1 385 +	1 204	884	528	365	38	208	235 *	2 048 +	10 277 *
1.	1980	789 +	2 097 +	1 502 *	2 846 +	1 043	1 104	290 +	858 +	231 *	60	1 056	456	12 048 *
1.	1981	1 385 +	1 385 +	1 442 +	1 775 *	1 385 +	2 374 *	699 +	288 *	264	338	110	381	10 413 *
1.	1982	1 621	814	970	815	991	545	940	16	110	407	72	378	7 679
1.	1983	858	1 873	1 240	1 909	1 775	1 290	1 023	145	230	365	340	374	11 422
1.	1984	844	2 070	1 062	1 554	2 286	704	251	45	145	59	0	150	9 170
1.	1985	2 447	1 160	1 334	1 150	1 022	1 208	673	0	172	6	837	658	10 667
1.	1986	1 535	1 766	1 358	1 180	749	1 031	260	105	160	10	730	4 046	12 930
1.	1987	996	1 360	1 354	1 341	1 987	2 118	637	685	260	370	593	410	12 111
1.	1988	575	1 733	1 980	1 100	2 476	554	1 380	325	50	460	0	161	10 794
1.	1989	1 319	2 674	1 809	2 098	695	1 778	587	65	360	0	707	209	12 301
1.	1990	1 283	786	1 190	2 505	1 865	352	89	160	37 +	59	51	937	9 314 +
1.	1991	1 875	1 277	651 +	1 163	929 +	961	849 +	0	0	80	234	623 +	8 642 +
1.	1992	480	670	960	2 057	735	155	866	0	0	0	174 +	1 399 +	7 496 +
1.	1993	1 424 +	1 660	1 906 +	1 750	2 820	975	195	0	209 +	650	640	25	12 254 +
1.	1994	739 +	673 +	1 221 +	1 170	834 +	1 749	1 321	230	1 580	0	0	700	10 217 +
1.	1995	880	800	2 058	3 867	2 070	1 030	310	0	350	850	165	204	12 584
1.	1996	1 390	2 305	1 160	1 605	2 175	860	1 550	320	3 095	440	460	470	15 830
1.	1997	1 175	1 710	860	2 160	2 705	2 440	835	425	60	0	0	280	12 650
1.	1998	760	1 415	1 890	1 720	1 725	1 125	450	0	0	30	0	0	9 115
1.	1999	1 715	1 120	2 440	2 829	1 554	2 482	1 630	580	0	0	0	990 +	15 340 +
1.	2000	1 056 +	1 369	1 345	1 964	1 614	1 340	1 690	0	0	1 007	285	708	12 378 +
1.	2001	1 385 +	1 385 +	1 385 +	2 465	984	595	235	662	90	1 106	1 070	975	12 337 +
1.	2002	655	710	1 764	515	1 304	828	322	322 +	322 +	322 +	322 +	1 385 +	8 771 +
1.	2003	1 385 +	1 385 +	1 385 +	1 457	1 299	1 960	405	220	1 668	1 079	220	272	12 735 +
1.	2004	272	1 350	1 536	1 956	1 420	760	760	48	4	0	322 +	1 385 +	9 813 +
1.	2005	1385 +	1385 +	1385 +	1752	1385 +	1385 +	699 +	322 +	299	0	322 +	511	10830 +
1.	2006	4322	1682	1149	1699	900	2590	1362	68	0	0	110	1385 +	15267 +
1.	2007	1675	1014	3304	780	0	250	1000	640	413	0	152	864	10092
AVERAGE			1504	1588	1729	1521	1436	742	393	283	291	338	717	11709

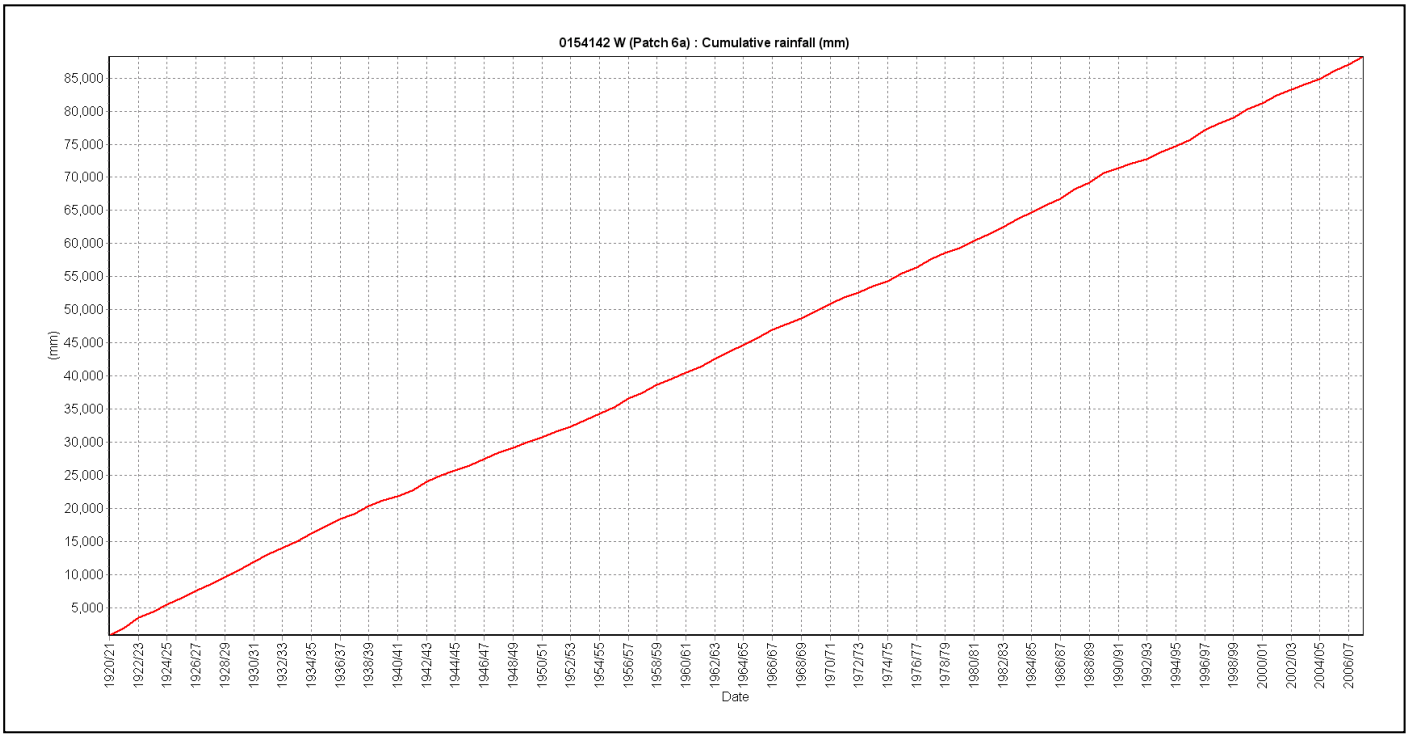
Patched rainfall data for 0153 875 W

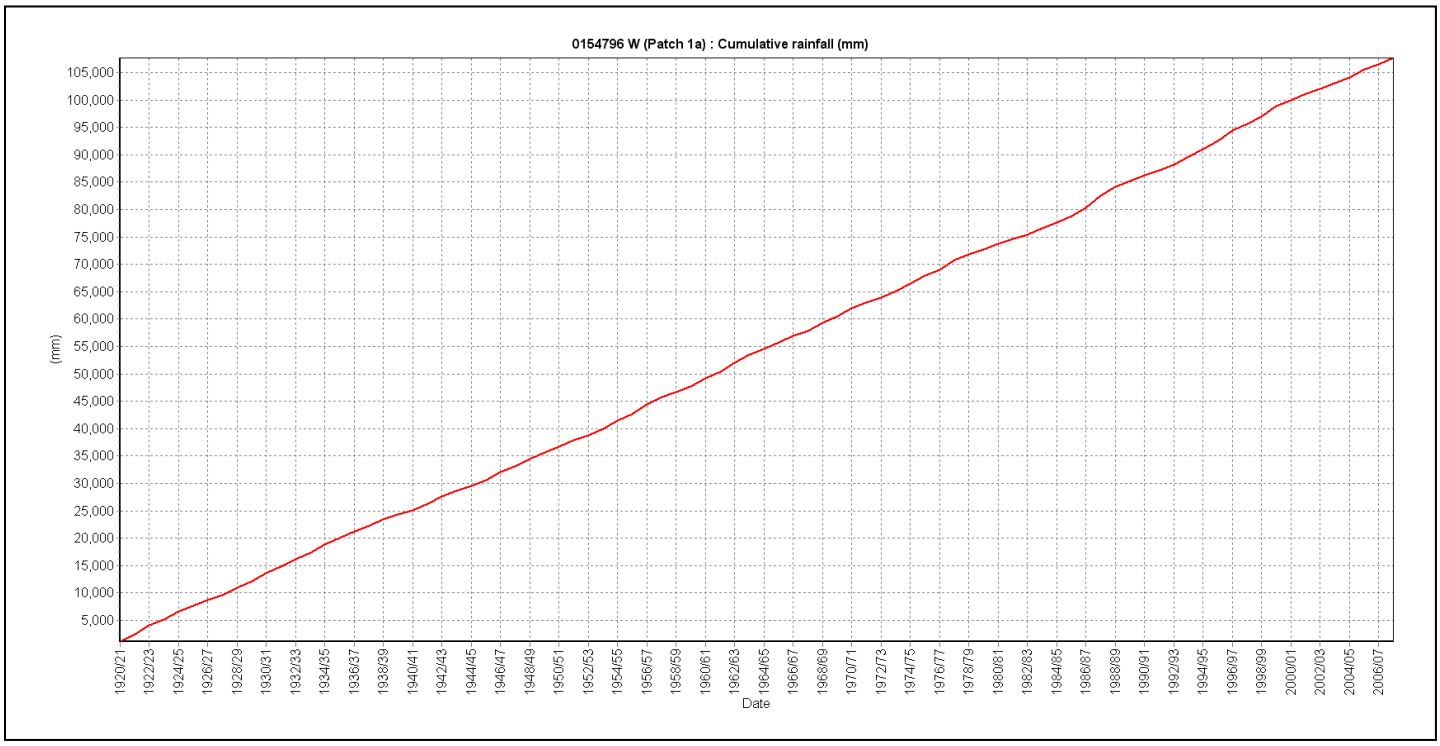
153875W	1920	2000	8584											
153875W	1920	409	1 123	1 285	990	1 088	1 079	582	89	0	0	20	514	7 179
153875W	1921	720	1 527	1 420	932	461	531 +	362 +	1 131 +	650 +	0 +	520	213	8 467 +
153875W	1922	1 656 +	1 619 +	506	1 804	1 807	1 210	97	195	84	1 920	38	152	11 088 +
153875W	1923	204	617	922	1 826	1 223	166	114	247	115	0	312	621 +	6 367 +
153875W	1924	713	973	1 270	413	675	2 040	347	178	0	107	0	406	7 122
153875W	1925	557 +	1 151	935	1 824	823	2 289	203	229	617	101 +	127 +	729	9 585 +
153875W	1926	749	757	1 018	1 043	488	2 230	8	97	0	86	211	396	7 083
153875W	1927	1 005	185	1 590	1 475	1 599	869	66	155	127	114 +	450 +	247	7 882 +
153875W	1928	666	899	908	855	513	1 222	267	384	882	442	114	1 132	8 284
153875W	1929	1 080	1 187	1 271	877	506	1 174	576	76	531	66	837	427	8 608
153875W	1930	415	639 +	1 180	1 994	1 168	1 784	528	25	0	2 955	89	145	10 922 +
153875W	1931	911	778	1 007	626	1 916	874 +	3	419	348	419	166	1 182	8 649 +
153875W	1932	660	2 184	1 498	139	1 464 +	1 053 +	293	150	84	79	79	254	7 937 +
153875W	1933	290	1 917	1 398	1 653 +	680	910	416	173	82	446	0	314 +	8 279 +
153875W	1934	503	1 504	1 854	1 165	453	894	1 091	1 001	1 059	0	912	181	10 617
153875W	1935	574	1 064	146	853	2 165	1 095	89	1 181	18	201	96 +	378	7 860 +
153875W	1936	1 106	2 743	686	1 037	1 783	739	137	117	89	38	123	244	8 842
153875W	1937	624	476	1 312	1 031	1 168	611 +	912	114	359	287	249	170	7 313 +
153875W	1938	755	1 177	1 228	1 257	1 644	538	582	419	148	506	1 090	1 521 +	10 865 +
153875W	1939	788	694	1 080	730 +	896	1 072	441	1 156	173	0	101	714 +	7 845 +
153875W	1940	689	1 202	666	815	530	554	605	51	79	98	251	241	5 781
153875W	1941	940	800	667	1 698	696	1 107	484 +	440	0	38	446	389	7 705 +
153875W	1942	779	2 886	1 814	820	744	1 282	1 033	382	306	203	954	477	11 680
153875W	1943	984	1 680	1 569	776	1 562	447	307	98	230	279	86	1 352	9 370
153875W	1944	608	360	479	1 489	993	1 074	125	338	38	56	56	376	5 992
153875W	1945	1 725	236	728	944	1 711	1 235	465	132	105	381	0	371	8 033
153875W	1946	828	1 204	987	947	1 320	1 728	642	97	910	207	13	384	9 267
153875W	1947	500	3 123	1 165	832	1 879	634	329	15	0	3	84	114	8 678
153875W	1948	1 495	647	1 203	1 073	1 208	959	910	120	0	191	135	335	8 276
153875W	1949	749	1 406	1 074	1 697	1 291	1 583	547	600	51	384	680	401	10 463
153875W	1950	668	771	2 119	954	1 028	1 141	298	228	69	43	541	623	8 483
153875W	1951	1 173	279	1 275	972	1 298	797	834	178	53	38	25	523	7 445
153875W	1952	457	282	788 +	992 +	806 +	691 +	526 +	76	46	0	261 +	1 246 +	6 171 +
153875W	1953	933 +	1 171	814 +	709 +	562 +	1 357 +	188	688	277	191 +	64	592	7 546 +
153875W	1954	1 891 +	648	746 +	1 468 +	1 364 +	816 +	320 +	158 +	254	0	8	1 005 +	8 678 +
153875W	1955	697 +	929 +	465 +	548 +	1 187	1 892 +	417	226	0	0	132	589	7 082 +
153875W	1956	669	1 755	2 130	1 370	842	1 435	704	171	175	110	403	878	10 642
153875W	1957	894	1 430	850	1 427	1 590	634	995	43	0	89	89	406	8 447
153875W	1958	451	2 108	1 277	677	1 134	1 130	825	2 419	0	765	600	335	11 721
153875W	1959	709	917	1 099	1 140	721	1 231	737	277	0	170	535	550	8 086
153875W	1960	445	1 110	1 567	1 630	892	1 274	1 290	270	158	110	75	332	9 153
153875W	1961	405	1 400	1 020	1 080	1 412	856	237	260	2	0	415	260	7 347
153875W	1962	1 200	1 427	937	2 155	893	2 794	485	190	50	1 230	70	130	11 561
153875W	1963	1 272	1 750	1 070	1 830	900	1 170	1 896	60	1 995	65	100	735	12 843
153875W	1964	1 615	203	730	1 208	970	242	218	530	1 680	540	623	580	9 139
153875W	1965	1 584	1 298	724	1 214	690	200	369	1 370	20	0	310	752	8 531
153875W	1966	456	868	1 120	1 577	614	2 475	806	190	520	635	90	118	9 469
153875W	1967	720	1 469	1 010	1 010	796	749	780	0	0	160	615	715	8 024
153875W	1968	719	1 113	803	681	2 190	1 465	230	630	35	105	330	220	8 521
153875W	1969	753	825	1 010	835	1 005	260	320	515	335	0	870	785	7 513
153875W	1970	1 630	899	1 095	1 065	1 190	820	385	870	45	475	785	455	9 714
153875W	1971	1 854	725	825	1 445	1 845	755	265	60	225	70	5	220	8 294
153875W	1972	500	1 515	1 050	945	920	870	625	0	0	80	400	380	7 285
153875W	1973	675	1 110	535	900	1 097	1 401	250	1 275	415	0	0	220	7 878
153875W	1974	650	1 095	740	1 022	1 160	952	200	0	0	15	293	828	6 955
153875W	1975	315	645	2 015	1 620	1 689	2 525	630	870	90	30	0	990	11 419
153875W	1976	2 065	400	1 636	872		746	40	95	255	40	200	690	7 524
153875W	1977	970	1 008	1 700	1 868 *	992 +	1 150 *	2 670	392	0	115 +	312	645	10 419 *
153875W	1978	1 190	975	742	992 +	1 180	1 600	355	0	25	745	60	275	8 139 +
153875W	1979	947	992 +	930	992 +	992 +	207	179 +	316	0	172	120	1 542 +	7 389 +
153875W	1980	445	1 583 +	1 010	2 204 +	992 +	992 +	160	780	20	30	685 *	150	8 635 *
153875W	1981	992 +	992 +	1 040 +	992 +	992 +	992 +	359 +	183 +	211 +	171 +	105 +	549 +	7 578 +
153875W	1982	1 005 *	317	500	615	286	329	447	110	0	1 600	115	510	5 498 *
153875W	1983	521	1 372	1 166	1 543	1 209	891	846	110	245	341 +	245	100	8 589 +
153875W	1984	735	1 475	811	1 170	3 375 +	440	315	0	150	30	0	40	8 541 +
153875W	1985	1 950	591	1 117	680	710	750	125	55	135	0	855	535	7 503
153875W	1986	1 111	1 285	836	930	510	835	160	130	88 +	0	545	3 968	10 398 +
153875W	1987	825	1 010	1 008	767	1 777	1 901	705	600	103 +	282	360	295	9 633 +
153875W	1988	1 068	1 677	1 525	508	2 239	811	1 412	90	295	172	0	186	9 983
153875W	1989	1 267	2 812	775	923	440	1 423	325	0	130	0	1 361	135	9 591
153875W	1990	750	608	1 062	1 497	1 301	0	0	255	0	0 +	0	649	6 122 +
153875W	1991	1 477	770	200	1 284	680	990	520	0	0	0	150	275	6 346
153875W	1992	845	870	1 200	710	867	330	750	0	61	0	140	1 005	6 778
153875W	1993	1 080	844	1 425	730	1 958	1 520	0	0	135	580	170	0	8 442
153875W	1994	395	350	910	1 336	500	2 280	1 038	395	959	0	0	600	8 763
153875W	1995	790	1 320	2 670	1 086	2 105	280	55	0	0	1 000	160	476	9 942
153875W	1996	485	2 106	772	1 340	1 193	1 205	1 913	0	3 205	460	275	498	13 452
153875W	1997	905	1 636	555	1 155	2 221	1 091	385	369	0	100	210	280	8 907
153875W	1998	622	1 107	1 120	857	1 466	818	205	0	35	0	0	0	6 230
153875W	1999	1 637	362	1 732	1 986	1 353	969	696	637	0	0	0	635	10 007
153875W	2000	695	660	1 820	520	1 015	345	610	250	0	160	200	658	6 933
AVERAGE		886	1 131	1 098	1 131	1 170	1 059	514	323	242	253	273	538	8 584

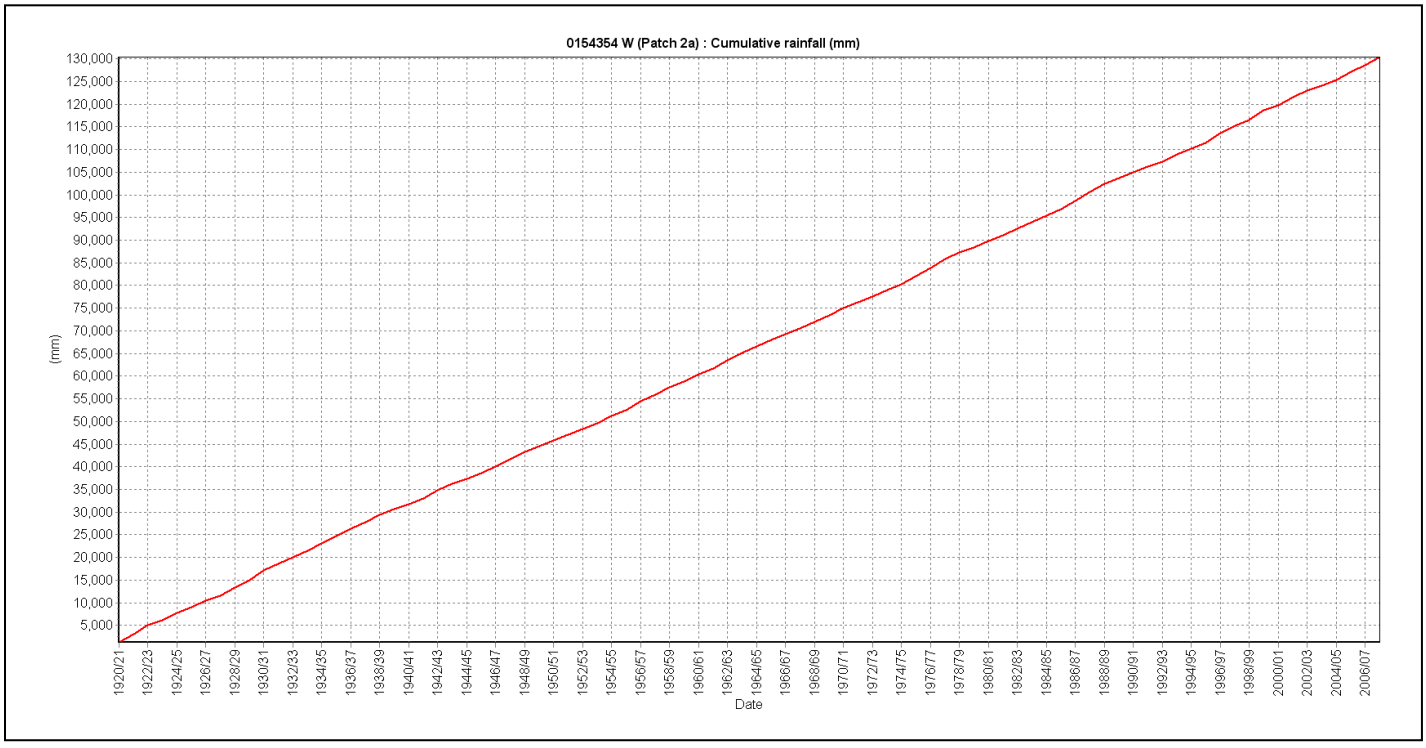

0153875 W (Patch7b) : Cumulative rainfall (mm)
(mm)
75,000
70,000
65,000
60,000
55,000
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
1920/21
1922/23
1924/25
1926/27
1928/29
1930/31
1932/33
1934/35
1936/37
1938/39
1940/41
1942/43
1944/45
1946/47
1948/49
1950/51
1952/53
1954/55
1956/57
1958/59
1960/61
1962/63
1964/65
1966/67
1968/69
1970/71
1972/73
1974/75
1976/77
1978/79
1980/81
1982/83
1984/85
1986/87
1988/89
1990/91
1992/93
1994/95
1996/97
1998/99
2000/01
2002/03
2004/05
2006/07
Date

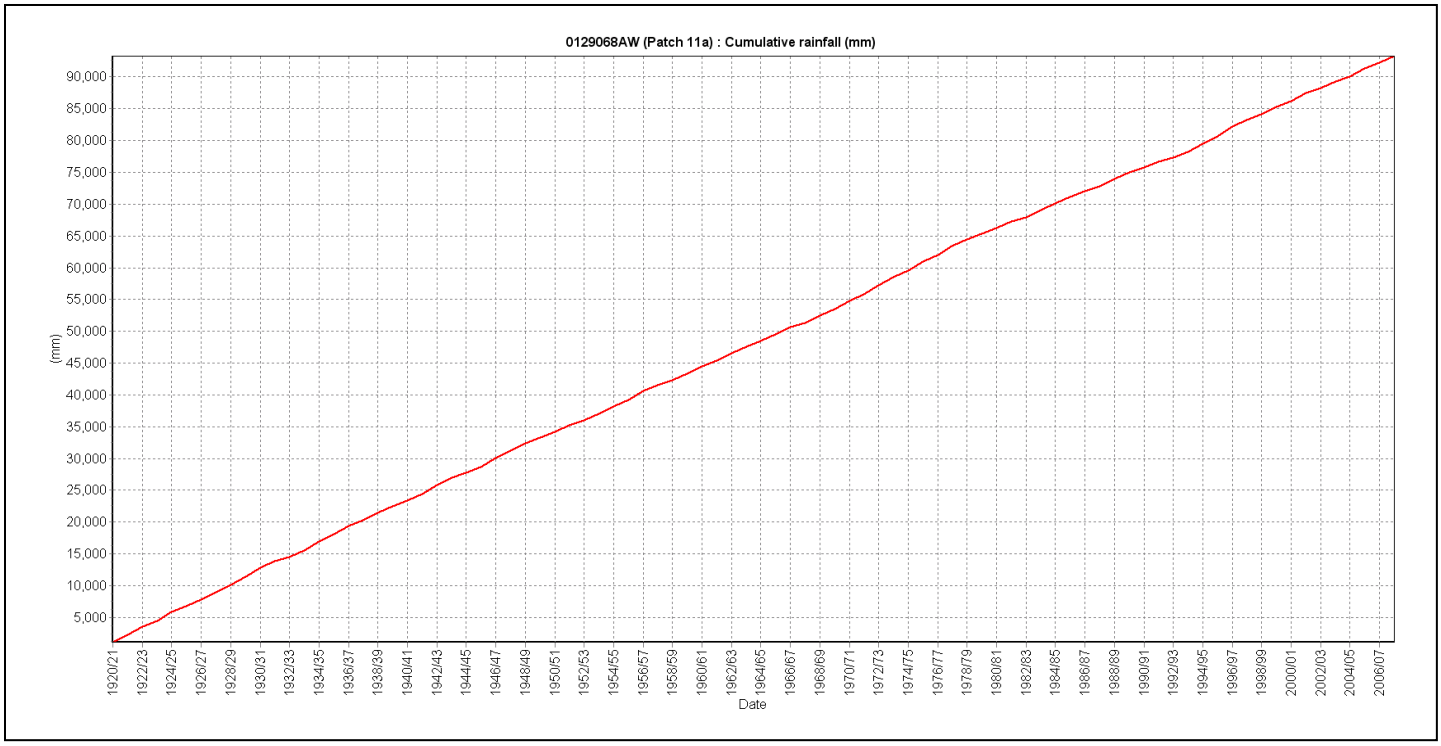

0129007 W (Patch 14a) : Cumulative rainfall (mm)
(mm)
105,000
100,000
95,000
90,000
85,000
80,000
75,000
70,000
65,000
60,000
55,000
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
1923/24
1925/26
1927/28
1929/30
1931/32
1933/34
1935/36
1937/38
1939/40
1941/42
1943/44
1945/46
1947/48
1949/50
1951/52
1953/54
1955/56
1957/58
1959/60
1961/62
1963/64
1965/66
1967/68
1969/70
1971/72
1973/74
1975/76
1977/78
1979/80
1981/82
1983/84
1985/86
1987/88
1989/90
1991/92
1993/94
1995/96
1997/98
1999/00
2001/02
2003/04
2005/06
2007/08
Date


0153631 W (Patch 9a) : Cumulative rainfall (mm)
(mm)
100,000
95,000
90,000
85,000
80,000
75,000
70,000
65,000
60,000
55,000
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
1920/21
1922/23
1924/25
1926/27
1928/29
1930/31
1932/33
1934/35
1936/37
1938/39
1940/41
1942/43
1944/45
1946/47
1948/49
1950/51
1952/53
1954/55
1956/57
1958/59
1960/61
1962/63
1964/65
1966/67
1968/69
1970/71
1972/73
1974/75
1976/77
1978/79
1980/81
1982/83
1984/85
1986/87
1988/89
1990/91
1992/93
1994/95
1996/97
1998/99
2000/01
2002/03
2004/05
2006/07
Date


0154142 W (Patch 6a) : Cumulative rainfall (mm)
(mm)
85,000
80,000
75,000
70,000
65,000
60,000
55,000
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
1920/21
1922/23
1924/25
1926/27
1928/29
1930/31
1932/33
1934/35
1936/37
1938/39
1940/41
1942/43
1944/45
1946/47
1948/49
1950/51
1952/53
1954/55
1956/57
1958/59
1960/61
1962/63
1964/65
1966/67
1968/69
1970/71
1972/73
1974/75
1976/77
1978/79
1980/81
1982/83
1984/85
1986/87
1988/89
1990/91
1992/93
1994/95
1996/97
1998/99
2000/01
2002/03
2004/05
2006/07
Date


0154796 W (Patch 1a) : Cumulative rainfall (mm)
(mm)
105,000
100,000
95,000
90,000
85,000
80,000
75,000
70,000
65,000
60,000
55,000
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
1920/21
1922/23
1924/25
1926/27
1928/29
1930/31
1932/33
1934/35
1936/37
1938/39
1940/41
1942/43
1944/45
1946/47
1948/49
1950/51
1952/53
1954/55
1956/57
1958/59
1960/61
1962/63
1964/65
1966/67
1968/69
1970/71
1972/73
1974/75
1976/77
1978/79
1980/81
1982/83
1984/85
1986/87
1988/89
1990/91
1992/93
1994/95
1996/97
1998/99
2000/01
2002/03
2004/05
2006/07
Date


0154354 W (Patch 2a) : Cumulative rainfall (mm)
(mm)
130,000
125,000
120,000
115,000
110,000
105,000
100,000
95,000
90,000
85,000
80,000
75,000
70,000
65,000
60,000
55,000
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
1920/21
1922/23
1924/25
1926/27
1928/29
1930/31
1932/33
1934/35
1936/37
1938/39
1940/41
1942/43
1944/45
1946/47
1948/49
1950/51
1952/53
1954/55
1956/57
1958/59
1960/61
1962/63
1964/65
1966/67
1968/69
1970/71
1972/73
1974/75
1976/77
1978/79
1980/81
1982/83
1984/85
1986/87
1988/89
1990/91
1992/93
1994/95
1996/97
1998/99
2000/01
2002/03
2004/05
2006/07
Date


0129068AW (Patch 11a) : Cumulative rainfall (mm)
(mm)
90,000
85,000
80,000
75,000
70,000
65,000
60,000
55,000
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
1920/21
1922/23
1924/25
1926/27
1928/29
1930/31
1932/33
1934/35
1936/37
1938/39
1940/41
1942/43
1944/45
1946/47
1948/49
1950/51
1952/53
1954/55
1956/57
1958/59
1960/61
1962/63
1964/65
1966/67
1968/69
1970/71
1972/73
1974/75
1976/77
1978/79
1980/81
1982/83
1984/85
1986/87
1988/89
1990/91
1992/93
1994/95
1996/97
1998/99
2000/01
2002/03
2004/05
2006/07
Date

AVERAGE RAINFALL ON CATCHMENT T60E (% of MAP)

DETAILS OF RAINFALL STATION USED

POSITION	MAP(MM)	PERIOD OF RECORD	LONG.
142	1002	1920 to 2007	29°35'
875	860	1920 to 2007	29°30'
631	1170	1920 to 2007	29°22'

RAINFALL INPUT AS PERCENTAGE OF MAP

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	YEAR(%)
1920	6.96	13.26	14.42	12.33	10.87	12.86	8.01	1.08	0.07	0.24	0.24	7.67	88.01
1921	9.04	18.46	19.77	10.6	8	5.58	3.27	15.53	6.74	0.07	7.54	5.53	110.13
1922	19.37	19.65	8.32	25.82	20.82	13.94	1.71	2.37	0.93	20.32	0.46	2.46	136.17
1923	4.29	8.33	11.88	20	14.77	3.2	3.18	3.19	1.13	0.27	4.3	7.85	82.39
1924	8.28	11.61	16.85	8.63	9.68	23.77	6.39	2.28	0.21	1.86	0.5	7.71	97.77
1925	6.11	14.28	11.48	17.5	11.47	25.84	3.18	2.77	6.42	0.52	2.02	8.92	110.51
1926	10.08	11.36	16.49	12.11	7.96	29.92	0.42	1.88	0	0.76	2.17	5.37	98.52
1927	12.97	4.5	17.47	19.58	15.26	9.42	1.55	2.36	0.97	0.44	6.42	2.85	93.79
1928	7.4	10.1	11.36	12.81	8.06	14.9	1.38	4.46	10.42	4.64	3.32	13.46	102.31
1929	14.09	14.51	12.44	10.7	6.14	13.69	6.68	1.6	7.14	1.47	9.82	7.34	105.62
1930	6	7.79	12.99	26.63	18.53	18.44	4.91	0.58	0.04	32.69	1.59	2.15	132.34
1931	10.41	9.45	10.44	7.23	19.54	8.58	0.95	5.94	2.55	5.26	1.69	13.21	95.25
1932	9.5	27.35	20.01	2.96	15.4	11.55	3.37	1.43	0.9	1.18	1.1	3.69	98.44
1933	4.02	20.17	17.24	19.11	7.96	11.23	4.15	1.99	1.17	6.3	0.38	2.41	96.13
1934	6.39	15.83	17.18	11.78	5.78	11.37	13.31	10.7	13.09	0.64	8.93	3.02	118.02
1935	7.92	12.45	2.48	10.71	23.49	14.97	1.41	12.55	0.78	1.68	0.39	5.05	93.88
1936	13.43	30.91	7.3	9	21.45	12.26	2.74	1.15	0.97	1.07	1.61	4.29	106.18
1937	7.5	7.74	15.87	13.66	11.87	6.52	13.05	1.51	4.22	2.93	2.71	2.15	89.73
1938	8.42	13.71	15.42	16.28	24.29	7.77	5.42	5.26	1.15	6.67	4.73	17.16	126.28
1939	8.74	8.95	12.99	8.98	15.86	12.14	4.37	12.89	1.33	0.13	1	7.18	94.56
1940	5.65	16.88	9.99	9.45	4.88	7.57	6.81	0.41	1.45	1.09	2.42	2.65	69.25
1941	8.71	11.24	6.08	19.36	10.65	13.15	7.21	5.38	0	0.2	3.61	5.63	91.22
1942	9.55	30.7	16.95	11.48	7.9	14.31	12.83	4.47	4.12	1.96	11.45	4.58	130.3
1943	11.32	16.85	15.99	8.62	15.4	8.45	3.23	1.09	3.47	2.58	0.92	16.21	104.13
1944	7.22	4.88	5.01	18.2	13.51	13.05	1.6	3.46	0.62	0.63	0.82	5	74
1945	17.45	2.85	9.8	10.44	13.68	12.74	5.64	1.9	0.59	2.43	0.3	3.96	81.78
1946	8.49	14.22	10.28	11.75	13.23	17.01	7.86	0.76	10.09	2	0.75	5.33	101.77
1947	5.73	37.93	13.05	9.46	17.06	10.79	4.41	0.39	0.13	0.17	0.85	1.63	101.6
1948	15.03	8.6	11.47	9.92	14.37	9.81	7.72	1.75	0	1.84	1.72	4.82	87.05
1949	7.8	14.08	10.26	15.99	17.98	16.18	6.5	7.4	0.5	4.36	8.13	3.74	112.92
1950	9.84	6.14	23.74	10.09	9.66	11.79	2.83	2.04	0.52	0.52	5.42	8	90.59
1951	14.79	2.62	13.42	14.04	12.62	11.19	8.16	2.03	1.09	1.19	0.56	7.2	88.91
1952	5.05	6.35	11.07	11.4	10.21	7.84	8.09	0.84	0.78	0.13	3.72	13.61	79.09
1953	11.68	14.24	13.54	9.68	8.45	16.5	2.14	7.86	3.96	2.2	0.56	7.46	98.27
1954	19.68	7.74	8.36	19.32	16.59	7.43	4.94	2.09	2.8	0.05	0.03	9.18	98.21
1955	7.47	10.35	4.98	4.75	14.76	22.11	5.54	3.09	3.08	0.02	1.74	6.24	84.13
1956	8.34	20.47	24.28	14.08	10.92	15.75	9.31	1.97	2.62	1.01	4.7	9.6	123.05
1957	9.65	12.87	11.94	15.6	17.31	6.8	10.02	0.31	0.08	1.82	1.38	4.36	92.14
1958	5.71	18.7	14.51	8.75	10.43	12.36	7.58	24.23	0.04	7.79	5.51	7.19	122.8
1959	7.77	11.54	12.33	12.9	7.99	12.79	9.03	2.45	0.07	1.76	6.28	7.42	92.33
1960	7.22	11.1	19.2	17.41	11.17	12.06	16.34	2.73	0.94	1.03	0.9	3.76	103.86
1961	4.16	15.91	12.4	11.52	14.37	13.26	2.99	3.66	0.01	0.21	4.82	2.93	86.24
1962	13.16	15.31	10.57	21.83	7.7	29.84	5.81	1.53	0.74	13.29	0.45	1.49	121.72
1963	13.01	15.41	10.71	18.08	9.97	14.48	13.3	0.8	22.16	0.79	1.21	7.43	127.35
1964	15.95	3.18	9.32	11.44	10.75	3.55	2.42	6.16	17.24	6.1	6.43	6.6	99.14
1965	17.86	14.92	7.84	13.67	8.24	2.29	4.2	21.1	0.52	0.29	3.4	7.6	101.93
1966	5.97	8.78	12.25	16.79	7.63	28.94	9.41	1.94	5.85	6.7	1.63	1.04	106.93
1967	7.02	15.22	9.59	12.43	9.45	8.98	7.05	0.22	0.22	1.34	7.59	9.66	88.77
1968	8.42	12.85	9.51	6.7	18.27	16.93	4.74	8.12	0.51	1.24	3.12	3.2	93.61
1969	9.02	10.81	11.7	8.46	14.4	3.87	3.44	4.42	5.18	0.17	14.06	7.85	93.38
1970	17.35	10.66	11.35	11.8	14.48	8.17	7.37	9.88	0.5	6.3	9.59	5.16	112.61
1971	20.49	9.78	8.97	14.66	20.86	7.88	3.79	1.22	2.9	0.91	0.69	2.06	94.21
1972	6.68	16.92	11.77	10.11	11.67	10.77	6.84	0.04	0	1.22	4.71	5.34	86.07
1973	7.63	14.08	7.3	13.56	10.53	17.65	4.99	14.74	3.81	0.14	0.27	2.13	96.83
1974	5.99	14.03	9.81	11.65	10.79	9.91	3.59	1.57	0.05	1.07	1.88	9.99	80.33
1975	4.26	8.12	22.69	17.48	19.91	33.16	7.51	8.52	0.75	0.86	1.3	9.51	134.07
1976	23.61	5.54	13.63	10.45	10.77	8.74	1.85	0.72	2.51	0.5	4.16	7.17	89.65
1977	11.14	10.41	16.96	8.11	10.3	10.75	33.05	5.1	0.87	0.65	3.77	7.31	118.42
1978	13.23	11.43	10.79	11.73	10.26	14.07	4.3	1.62	0.44	7.57	2.59	6.44	94.47
1979	9.78	9.67	10.87	10.06	11.55	5.71	2.84	3.36	0.17	1.95	1.33	18.36	85.65
1980	6.03	18.87	10.22	26.6	10.32	8.49	1.44	8.11	0.9	0.4	6.35	3.43	101.16
1981	9.96	10.83	12.11	11.29	9.84	18	6.66	2.13	2.44	2.22	0.98	4.9	91.36
1982	9.83	4.31	6.62	6.25	4.79	5.16	5.47	0.96	0.31	31.14	2.48	5.22	82.54
1983	6.65	18.39	11.36	15.72	20.24	10.73	8.63	1.42	2.61	3.53	2.01	2.07	103.36
1984	11.97	15.65	8.22	13.26	33.75	5.35	3.31	0.12	1.71	0.28	0	1.28	94.9
1985	18.64	9.09	10.56	12.6	7.61	10.59	4.78	0.67	1.32	0.01	9.03	8.04	92.94
1986	12.93	17.8	10.28	9.35	4.51	8.86	2.07	0.8	0.81	0.02	5.86	39.09	112.38
1987	10.24	13.08	11.1	10.81	20.92	27.91	6.34	7.73	1.47	2.34	3.63	4.05	119.62
1988	7.65	15.26	15.87	6.93	25.08	7.64	16.49	1.64	1.85	1.97	0.13	1.17	101.68
1989	26.86	26.05	10.37	15.39	5.49	17.87	3.48	0.38	1.94	0.08	9.84	2.69	120.44
1990	10.55	6.57	11.49	16.03	15.52	3.21	0.43	2.09	0.4	0.16	0.84	7.41	74.7
1991	15.59	11.16	6.57	10.16	5.68	8.27	7.77	0.09	0	0.22	1.76	4.77	72.04
1992	7.1	7.5	8.6	11	7.82	2.81	7.69	0	0.23	0.06	2	14.43	69.24
1993	11.08	10.61	17.01	10.24	27.21	12.15	0.55	0.73	1.11	6.9	4.96	0.07	102.62
1994	5.63	4.78	8.95	10.44	6.24	20.34	12.16	2.36	13.7	0.09	0.18	8.92	93.79
1995	8.16	8.71	26.83	19.83	17.43	6.09	4.36	0.18	0.99	7.07	1.78	3.44	104.87
1996	10.68	22.82	10.4	14.9	14.91	9.82	15.99	2.27	30.83	4.98	3.03	6.16	146.79
1997	9.65	15.83	7.51	13.78	23.9	16.03	5.79	3.96	0.21	1.05	2.89	3.42	104.02
1998	5.21	13.06	15.99	10.75	15.47	12.36	4.33	0.52	0.25	0.33	0.4	0	78.67
1999	16.69	7.14	17.66	21.79	15.4	19.69	12.72	6.01	0.06	0.91	0.43	7.75	126.25
2000	8.23	9.82	14.13	10.35	10.63	9.24	9.7	2.24	0.14	6.4	2.18	6.23	89.29
2001	8.97	24.76	11.04	14.81	9.63	6.11	5.22	4.14	0.65	9.33	7.1	10.62	112.38
2002	4.5	9.17	12.96	6.21	6.7	18.81	6.76	4.34	2.28	2.43	2.3	12.46	88.92
2003	11.01	7.58	10.65	13.13	6.1	16.04	2.86	1.48	5.06	6.62	0.62	9.98	91.13
2004	6.69	8.86	9.58	20.3	8.44	6.49	6.71	1.93	0.99	0.81	3.16	7.7	81.66
2005	7.65	18.18	10.05	14.07	11.5	9.77	6.62	7	4.35	1.09	5.68	12.79	108.75
2006	24.69	10.8	21.04	11.86	6.19	15.06	10.59	0.19	1.83	0.05	2.04	6.84	111.18
2007	13.89	10.23	14.65	21.3	4.91	7.19	13.14	3.36	12.16	0	1.53	5.66	108.02
AVERAGE	10.30	12.96	12.48	13.17	12.77	12.46	6.35	3.75	2.87	3.02	3.17	6.69	99.99

AVERAGE RAINFALL ON CATCHMENT T60F (% of MAP)
DETAILS OF RAINFALL STATION USED

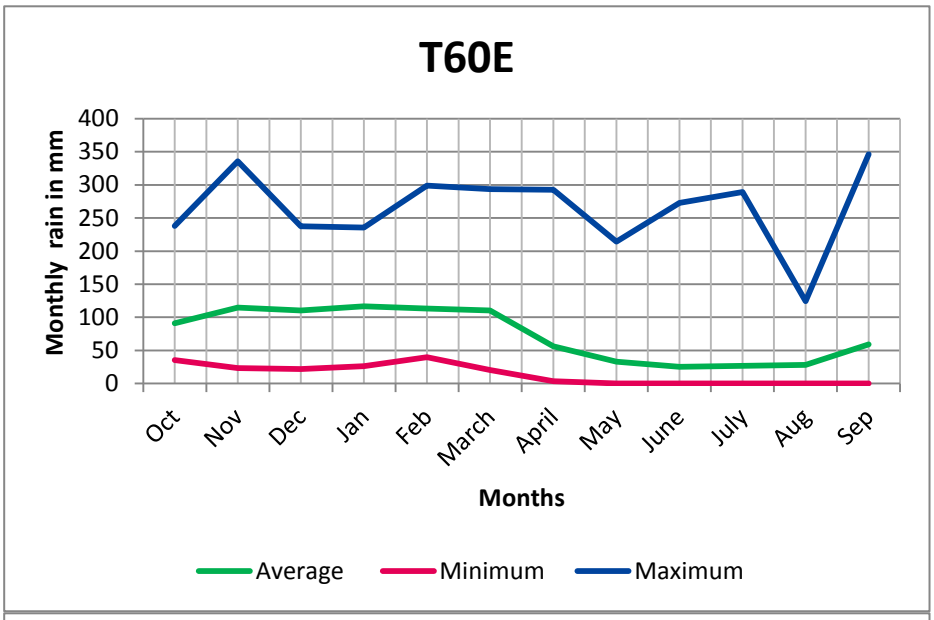
POSITION	MAP(MM)	PERIOD OF RECORD	LONG.
875	860	1920 to 2007	29°30'
142	1002	1920 to 2007	29°35'
354	1481	1920 to 2007	29°42'

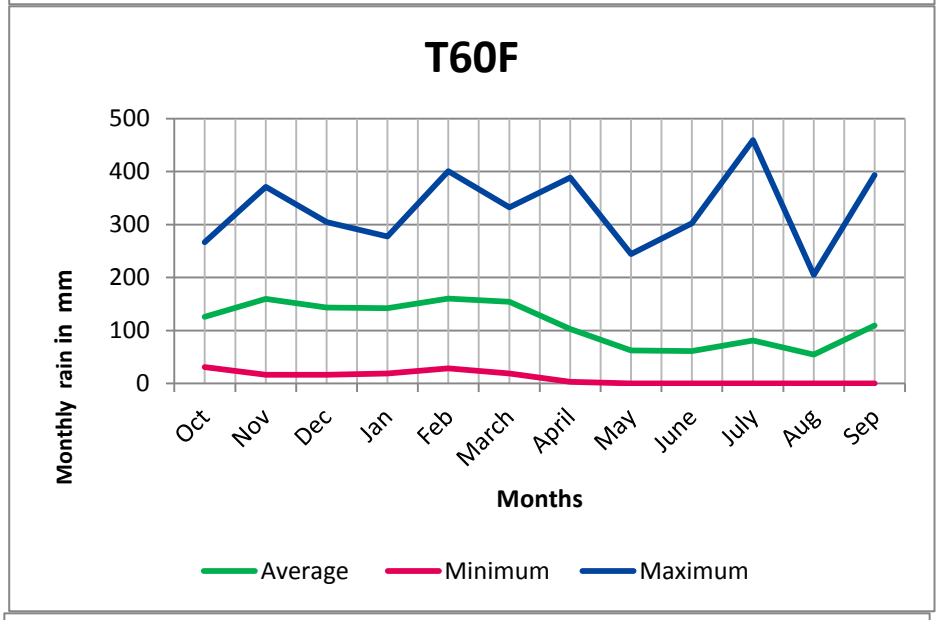
YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	YEAR
1920	6.45	12.62	14.38	10.04	10.49	12.71	7.59	0.84	0.02	0.51	0.27	8.91	84.83
1921	9.79	18.19	18.13	10.00	7.30	5.08	4.78	12.71	8.21	0.00	8.10	6.90	109.19
1922	20.05	19.42	7.06	27.57	22.41	13.01	1.81	1.88	0.75	21.15	0.18	2.38	137.67
1923	5.84	8.27	11.71	19.93	12.66	2.44	2.63	2.33	2.11	0.41	4.40	6.23	78.96
1924	7.91	11.17	15.97	9.84	11.89	23.02	7.06	2.16	0.64	2.24	0.71	9.94	102.55
1925	5.49	12.25	9.52	14.36	11.61	22.27	3.75	1.92	7.18	0.58	1.76	8.84	99.53
1926	10.76	13.11	13.65	10.47	7.86	29.84	0.33	1.58	0.00	0.79	2.41	6.24	97.04
1927	11.01	3.02	15.72	15.02	14.81	9.35	1.76	3.32	1.36	0.62	7.46	2.30	85.75
1928	8.41	11.39	11.00	11.66	8.48	13.98	1.73	5.08	14.17	6.93	4.52	13.38	110.73
1929	15.57	13.86	10.08	9.57	6.33	11.56	5.96	2.04	7.35	2.29	8.65	11.39	104.65
1930	6.00	6.56	10.15	22.37	17.48	18.26	4.02	0.39	0.14	42.27	1.78	2.43	131.85
1931	11.76	8.20	10.68	6.25	20.79	9.77	1.14	6.98	3.45	4.63	1.35	16.65	101.65
1932	8.29	27.44	16.06	2.04	17.53	11.97	2.99	1.47	0.96	1.32	0.99	4.10	95.16
1933	3.79	19.16	16.32	20.10	9.81	12.79	4.38	2.15	0.80	7.65	0.26	2.22	99.43
1934	5.73	13.58	16.77	10.13	5.03	13.83	13.01	11.85	15.76	1.11	9.15	2.98	118.93
1935	6.98	11.14	1.76	9.52	26.87	18.18	2.36	13.28	1.38	2.22	0.46	5.79	99.94
1936	13.67	31.46	6.20	8.97	20.46	13.10	3.14	1.18	1.09	2.39	2.44	4.12	108.22
1937	6.77	7.20	16.35	13.42	9.49	6.19	12.94	1.29	4.79	3.14	2.29	1.84	85.71
1938	6.70	13.15	13.52	16.12	19.36	9.44	4.19	5.25	0.84	7.71	4.96	18.31	119.55
1939	9.16	8.09	13.88	7.77	11.23	10.43	3.47	13.44	0.73	0.25	1.52	7.54	87.51
1940	5.10	17.91	8.35	8.13	4.73	7.21	4.56	0.55	2.09	1.39	2.55	3.00	65.57
1941	10.17	9.73	5.27	19.63	8.02	12.01	5.83	6.88	0.00	0.14	4.90	5.69	88.27
1942	9.65	32.27	16.06	8.92	7.37	14.67	12.55	3.36	3.86	1.72	12.58	4.42	127.43
1943	9.98	15.55	13.98	8.10	14.36	6.54	3.90	1.36	3.72	2.40	0.81	20.14	100.84
1944	8.12	5.35	4.73	15.40	13.18	12.92	2.26	3.73	0.84	0.88	0.69	6.86	74.96
1945	21.57	1.73	8.09	10.13	12.40	12.72	7.12	1.51	0.90	1.70	0.21	4.26	82.34
1946	8.64	14.48	7.73	10.03	12.71	16.49	10.09	1.71	11.42	1.95	0.96	5.78	101.99
1947	5.42	39.47	12.91	8.51	16.08	10.50	5.09	0.19	0.28	0.02	1.01	1.75	101.23
1948	15.29	8.78	10.80	10.24	19.53	12.18	7.50	0.84	0.00	1.36	1.87	5.72	94.11
1949	7.42	16.26	9.29	14.51	13.10	11.61	6.10	6.52	0.29	3.98	5.86	3.42	98.36
1950	9.77	4.57	20.27	11.75	7.92	10.62	2.97	1.65	0.93	0.45	4.56	6.77	82.23
1951	14.95	1.78	16.75	14.28	10.22	11.31	8.12	1.78	0.70	0.89	0.16	8.27	89.21
1952	5.17	7.41	8.48	11.14	8.76	7.27	6.16	0.97	0.74	0.00	3.79	14.56	74.45
1953	10.38	17.56	8.86	7.41	5.52	16.05	1.57	7.16	4.05	2.32	0.86	8.65	90.39
1954	23.32	6.74	7.95	17.59	16.13	9.01	3.45	1.96	2.97	0.00	0.03	11.48	100.63
1955	7.34	10.42	4.24	5.33	14.44	23.18	6.27	2.50	3.83	0.00	1.52	8.46	87.53
1956	10.08	25.54	26.79	12.69	9.83	15.13	11.91	2.12	3.34	1.12	4.45	8.78	131.78
1957	9.45	10.60	15.42	15.71	17.99	7.33	12.42	0.16	0.00	2.09	1.84	5.07	98.08
1958	5.51	20.22	11.33	7.37	10.42	9.35	6.83	25.96	0.20	7.79	6.32	7.60	118.90
1959	6.83	10.63	11.80	11.02	7.41	12.49	9.00	3.32	0.04	1.77	5.30	8.31	87.92
1960	7.54	11.66	17.65	16.47	8.30	10.80	20.49	2.86	0.89	3.03	0.77	4.26	104.72
1961	4.73	15.44	11.57	10.49	12.36	15.28	3.29	3.37	0.00	0.08	5.49	3.19	85.29
1962	14.12	14.05	9.27	20.53	9.04	31.48	4.74	3.33	0.98	15.90	0.47	1.52	125.43
1963	11.91	13.52	10.49	18.59	12.80	11.79	12.27	1.15	25.21	0.68	1.03	6.85	126.29
1964	14.21	4.70	9.63	11.87	9.18	2.64	2.51	5.80	17.65	5.35	6.46	7.85	97.85
1965	21.03	14.77	7.85	11.84	7.77	2.04	3.68	23.48	0.61	0.23	3.36	6.76	103.42
1966	5.35	9.10	11.45	15.56	7.24	27.26	13.72	1.34	4.55	7.28	1.70	1.14	105.69
1967	5.88	15.23	8.24	10.57	9.90	8.00	5.57	0.29	0.37	1.11	7.99	10.35	83.50
1968	8.36	12.54	9.79	5.91	18.43	17.48	5.02	10.96	0.66	1.08	2.70	3.22	96.15
1969	8.65	11.90	10.49	7.37	13.55	3.01	3.87	3.92	6.09	0.04	21.83	7.20	97.92
1970	19.60	11.05	9.49	10.89	12.98	6.85	8.12	10.94	0.20	7.36	11.68	4.72	113.88
1971	19.99	8.74	9.99	12.53	21.68	5.89	2.86	1.11	2.92	1.04	2.48	2.13	91.36
1972	5.52	15.00	11.75	10.41	9.40	9.27	8.04	0.00	0.00	0.98	4.87	5.18	80.42
1973	8.08	14.38	7.91	11.67	11.15	13.00	4.62	15.53	3.62	0.67	0.64	2.62	93.89
1974	5.06	13.35	11.02	9.78	9.54	9.34	3.17	2.45	0.08	1.49	1.47	11.36	78.11
1975	3.97	8.61	21.94	12.95	17.21	35.34	7.42	8.92	1.03	0.79	1.93	9.55	129.66
1976	28.35	5.71	10.49	9.71	15.13	8.23	1.57	0.72	2.01	1.24	7.54	8.12	98.82
1977	9.55	11.85	18.60	6.34	8.80	9.07	41.35	5.83	1.20	0.85	4.68	6.88	125.00
1978	13.83	11.11	7.69	9.65	10.36	14.38	3.61	1.66	0.39	7.72	3.80	8.36	92.56
1979	9.37	9.87	10.77	8.12	12.49	5.32	2.26	3.53	0.26	1.80	1.26	18.64	83.69
1980	5.62	17.90	8.57	23.78	10.94	6.88	1.17	9.04	1.48	0.47	5.84	3.61	95.30
1981	7.01	9.99	9.82	11.02	7.99	24.46	7.33	2.09	2.32	1.89	0.84	5.32	90.08
1982	7.30	2.61	5.91	6.31	4.54	5.81	3.46	1.38	0.32	48.89	3.07	6.38	95.98
1983	7.23	17.60	11.02	14.35	18.08	10.59	8.37	2.21	4.07	4.44	1.73	2.61	102.30
1984	11.34	12.95	7.36	13.40	42.63	5.85	3.48	0.24	1.89	1.00	0.07	2.07	102.28
1985	15.88	9.46	9.76	16.14	6.70	11.02	4.75	1.01	1.10	0.06	10.08	10.19	96.15
1986	12.83	15.20	8.74	10.74	3.21	10.49	2.40	1.34	1.53	0.09	5.52	41.87	113.96
1987	9.13	15.18	10.92	11.07	25.52	33.07	6.76	7.48	1.09	3.15	4.55	3.72	131.64
1988	9.21	17.68	17.72	5.57	26.70	8.96	14.52	1.35	2.36	1.61	0.43	2.45	108.56
1989	28.33	25.28	7.22	15.82	5.40	16.09	2.01	0.95	1.12	0.12	10.61	3.92	116.87
1990	11.56	6.53	11.47	13.65	14.89	5.93	1.14	2.51	0.76	0.11	1.67	6.09	76.31
1991	16.04	13.41	8.08	9.04	5.48	6.77	7.67	0.11	0.27	0.00	1.86	5.59	74.32
1992	8.44	8.62	7.95	8.14	7.79	2.88	6.77	1.06	0.54	0.10	2.46	17.65	72.40
1993	10.84	9.09	17.94	7.43	29.04	11.25	0.33	0.73	0.97	7.43	7.14	0.74	102.93
1994	3.64	4.28	12.78	8.82	4.72	22.21	12.35	2.38	11.78	0.56	0.65	8.73	92.90
1995	8.11	7.42	32.41	13.51	14.92	5.02	6.69	0.38	0.00	6.39	1.99	3.55	100.39
1996	11.78	24.56	11.25	15.64	11.77	10.05	15.11	2.80	32.18	5.66	2.37	7.51	150.68
1997	8.98	15.69	8.08	10.58	24.24	14.07	5.32	4.15	0.04	1.71	5.31	3.76	101.93
1998	3.30	13.89	18.20	8.58	15.50	15.17	4.83	1.01	0.28	0.43	0.75	0.00	81.94
1999	17.58	6.65	15.37	20.16	17.79	22.89	12.73	6.39	0.06	1.82	0.82	7.29	129.55
2000	7.85	9.28	13.53	7.35	7.92	9.55	6.90	3.60	0.21	6.64	2.03	5.79	80.65
2001	7.01	32.38	10.52	11.60	10.20	6.25	6.71	3.49	0.56	10.36	6.70	11.70	117.48
2002	3.51	10.53	12.05	6.74	4.06	25.45	9.00	5.17	2.06	1.95	1.67	13.40	95.59
2003	10.32	5.10	9.92	14.22	3.07	15.79	2.48	1.30	0.42	5.78	0.00	13.49	81.89
2004	8.89	7.41	7.46	22.94	6.12	6.08	6.83	2.77	1.46	1.12	3.69	5.18	79.95
2005	5.11	21.90	8.93	13.69	11.25	8.46	6.71	9.38	5.81	1.09	8.04	17.43	117.80
2006	18.64	8.85	28.03	10.35	4.98	11.45	10.20	0.00	2.77	0.05	2.75	3.94	102.01
2007	13.77	10.74	7.56	29.55	7.21	9.57	15.63	2.34	16.63	0.00	1.66	4.28	118.94
AVERAGE	10.21	12.94	11.85	12.21	12.41	12.44	6.51	3.97	3.12	3.54	3.53	7.27	99.99

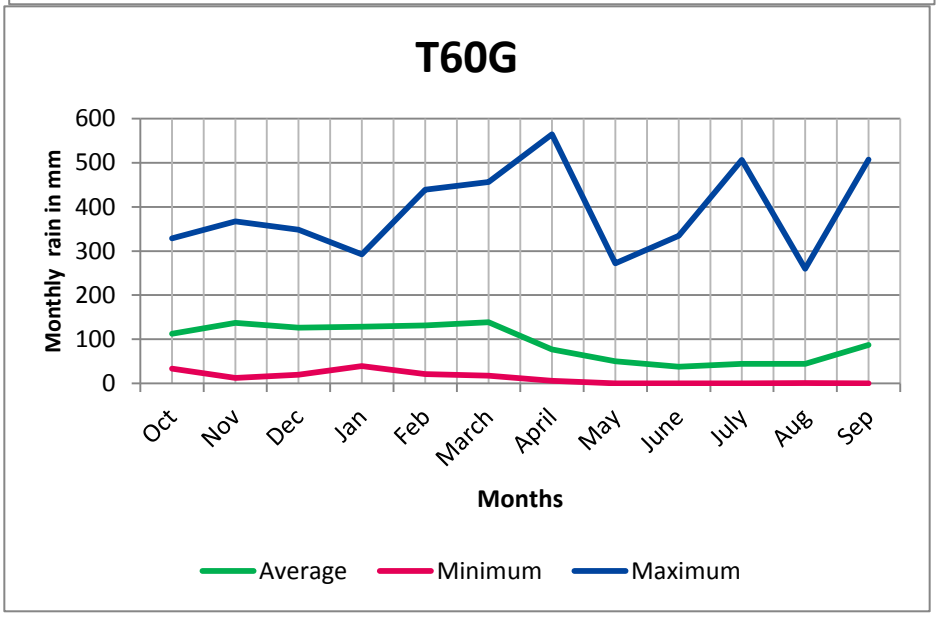
AVERAGE RAINFALL ON CATCHMENT T60G (% of MAP)
DETAILS OF RAINFALL STATION USED

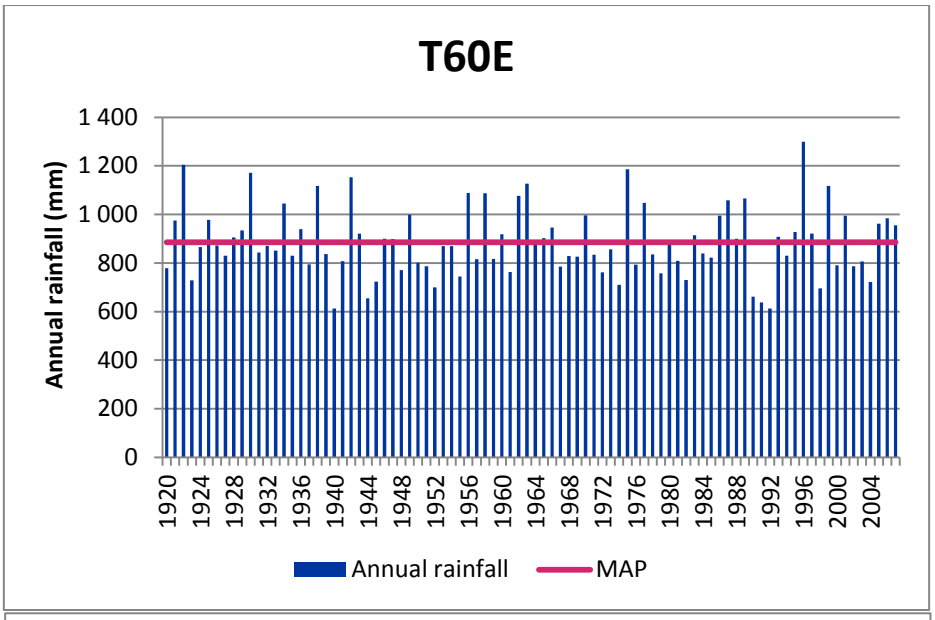
POSITION	MAP(MM)	PERIOD	LATITUDE	LONGITUDE
142	1002	1920 to 2007	-31°22'	29°35'
354	1481	1920 to 2007	-31°24'	29°42'
796	1225	1920 to 2007	-31°17'	29°57'

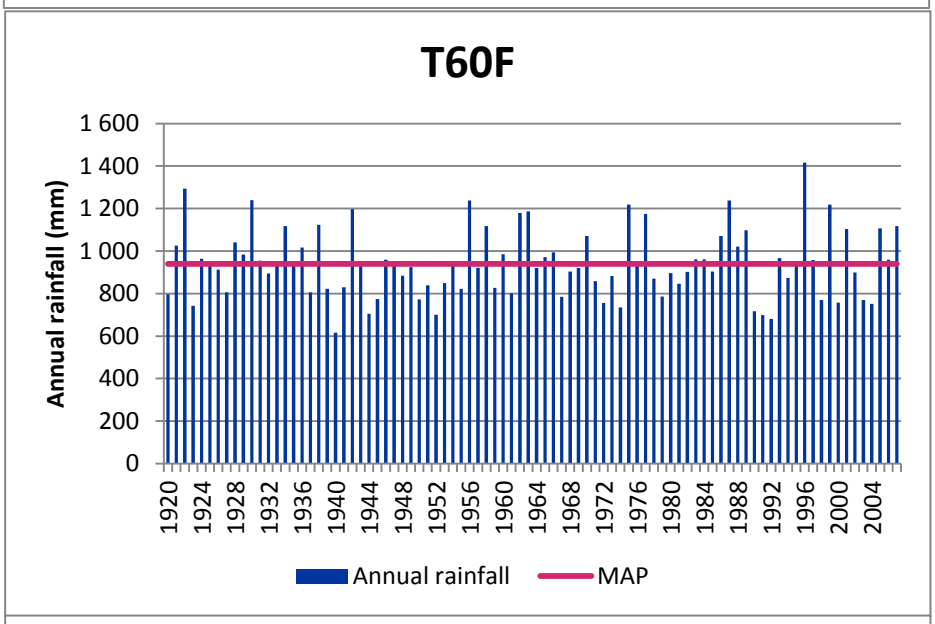
YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	YEAR
1920	7.41	12.17	13.90	9.49	9.00	12.90	9.13	1.19	0.12	0.86	0.43	10.80	87.40
1921	10.67	17.45	19.37	9.81	8.36	4.41	4.90	12.04	7.60	0.17	9.90	9.13	113.81
1922	19.64	17.99	7.46	29.59	21.60	12.00	1.95	1.99	0.61	22.56	0.31	3.03	138.73
1923	7.71	8.66	11.95	18.82	10.99	3.03	4.15	3.19	3.01	0.58	5.43	5.45	82.97
1924	7.68	11.02	16.20	12.75	14.18	21.72	8.61	2.73	1.11	2.91	1.24	12.81	112.96
1925	6.59	9.51	10.12	10.76	12.00	18.19	3.49	4.07	7.29	0.27	1.62	8.76	92.67
1926	11.22	15.44	13.49	7.83	9.28	29.61	0.52	1.62	0.04	0.88	2.71	6.89	99.53
1927	9.58	3.07	13.23	12.17	12.32	7.55	2.30	5.20	1.43	0.57	8.73	2.15	78.30
1928	8.50	11.08	9.76	11.95	7.93	14.79	1.28	4.75	18.30	7.42	5.95	13.11	114.82
1929	15.09	13.85	6.14	9.92	6.02	10.18	5.77	2.69	8.40	3.15	6.69	13.80	101.70
1930	5.65	7.00	9.02	21.15	16.22	18.52	4.12	0.66	0.28	44.70	2.17	3.61	133.10
1931	10.51	6.83	9.75	6.42	20.75	9.41	1.99	7.32	3.28	4.17	1.86	16.98	99.27
1932	10.11	24.49	19.28	3.51	15.86	12.97	2.97	2.92	0.73	1.93	1.19	4.18	100.14
1933	4.14	17.80	17.19	18.77	8.80	12.31	4.37	3.23	0.56	12.53	0.64	1.64	101.98
1934	5.37	10.62	15.33	8.00	5.66	14.03	14.55	13.09	15.45	1.94	8.17	2.58	114.79
1935	6.23	8.74	1.76	11.24	27.21	18.63	2.65	13.44	4.23	1.97	0.31	7.00	103.41
1936	13.56	29.83	5.30	9.12	17.03	15.12	3.91	0.84	0.99	4.64	3.35	4.97	108.66
1937	6.93	7.99	15.54	11.82	8.02	5.63	13.82	2.22	4.54	3.80	1.93	1.50	83.74
1938	5.73	12.01	12.76	13.54	16.94	10.68	3.32	7.22	0.72	7.59	1.09	18.03	109.63
1939	9.12	7.00	13.46	6.06	9.12	8.84	3.01	11.97	0.94	1.18	2.35	6.83	79.88
1940	3.47	17.58	9.98	7.39	3.45	8.21	3.38	1.00	3.10	1.70	2.67	4.03	65.96
1941	8.49	10.26	4.89	23.64	6.59	11.68	5.01	8.26	0.00	0.19	5.37	6.34	90.72
1942	9.36	23.81	14.11	9.27	5.99	15.10	12.62	2.80	4.46	1.26	13.07	4.19	116.04
1943	9.15	13.22	11.75	7.33	12.37	7.17	4.74	1.57	3.60	1.98	0.90	20.49	94.27
1944	8.16	6.26	4.00	13.66	12.90	12.24	2.93	3.42	1.39	1.89	0.68	9.08	76.61
1945	20.96	1.47	7.45	8.35	10.10	13.96	7.91	1.35	1.49	0.46	0.72	5.16	79.38
1946	7.30	15.69	8.10	10.72	10.32	15.52	14.50	5.16	10.84	2.15	1.35	6.91	108.56
1947	4.87	32.88	11.58	7.93	13.04	13.97	6.79	0.61	0.38	0.10	1.12	2.75	96.02
1948	15.48	8.14	9.30	8.17	27.29	11.84	6.75	0.38	0.08	0.97	2.66	6.51	97.57
1949	7.96	16.98	7.26	11.97	9.88	6.76	8.26	8.48	0.15	3.89	6.57	2.57	90.73
1950	10.14	2.56	17.62	11.44	5.78	9.50	2.91	1.72	2.14	1.42	4.02	6.91	76.16
1951	15.68	1.15	18.36	15.46	7.06	11.46	7.25	2.71	0.74	1.20	0.06	10.74	91.87
1952	4.33	10.70	7.95	10.86	10.37	7.33	5.58	1.36	1.18	0.37	4.74	11.75	76.52
1953	9.99	19.04	11.48	7.31	5.01	13.98	1.56	7.04	5.04	2.22	0.94	9.07	92.68
1954	26.43	7.21	6.91	18.41	16.11	13.77	2.84	2.98	2.64	0.00	0.45	11.71	109.46
1955	7.79	9.90	2.79	3.98	15.69	20.66	8.92	2.80	5.61	1.41	1.84	9.50	90.89
1956	14.04	24.54	28.14	11.98	10.78	15.36	15.04	1.86	4.26	0.91	4.09	9.28	140.28
1957	8.55	8.10	15.72	14.51	17.25	10.07	13.60	0.00	0.00	4.31	1.88	4.87	98.86
1958	5.67	14.84	8.52	6.47	9.78	7.43	5.30	20.76	0.20	6.60	5.92	8.21	99.70
1959	7.31	10.30	10.59	10.09	6.85	11.00	8.53	5.85	0.13	1.90	4.14	8.93	85.62
1960	7.24	13.76	15.51	13.78	7.35	10.57	23.77	4.36	0.86	5.13	1.71	5.14	109.18
1961	6.08	14.69	10.37	9.33	9.25	17.65	3.74	3.97	0.04	0.22	7.30	4.09	86.73
1962	13.20	14.48	8.11	18.10	6.75	33.17	4.10	4.89	1.88	17.32	0.98	2.28	125.26
1963	12.19	10.42	10.33	20.29	13.79	9.41	7.86	2.10	23.22	1.23	1.62	5.28	117.74
1964	12.08	5.79	8.66	10.10	7.63	2.36	3.21	6.28	17.63	4.38	6.47	8.17	92.76
1965	20.46	13.01	8.36	9.74	7.32	1.59	4.50	24.39	1.95	0.59	3.62	5.86	101.39
1966	4.91	7.49	11.88	14.26	10.72	23.57	13.71	0.75	4.08	8.00	2.04	1.31	102.72
1967	4.19	13.01	6.20	9.06	9.98	7.84	4.59	0.42	1.23	0.63	8.03	11.87	77.05
1968	8.65	11.71	11.21	4.67	14.72	18.70	5.81	16.32	1.32	2.00	2.02	4.66	101.79
1969	9.33	14.02	8.39	5.49	12.87	3.46	5.05	3.47	8.68	0.43	23.30	5.87	100.36
1970	20.14	11.10	8.10	10.21	10.56	7.23	8.78	15.46	0.21	9.21	13.62	4.37	118.99
1971	16.32	8.79	9.71	9.40	19.42	4.89	3.49	1.78	3.83	1.61	3.85	2.23	85.32
1972	4.73	13.94	10.41	9.29	7.26	9.01	8.85	0.00	0.00	0.97	6.70	7.63	78.79
1973	7.87	15.17	8.62	10.55	11.70	10.61	5.68	16.04	3.54	1.23	0.71	3.64	95.36
1974	4.16	12.84	15.54	8.37	7.68	8.86	4.07	2.60	0.66	2.16	0.98	17.44	85.36
1975	3.54	8.92	18.09	8.85	18.08	36.89	8.16	9.93	0.68	0.86	3.39	8.64	126.03
1976	26.93	5.37	5.83	11.06	20.64	8.44	2.20	0.62	2.44	1.77	8.03	6.90	100.23
1977	9.85	14.20	15.49	6.38	7.04	7.47	50.56	6.57	2.31	0.53	5.16	6.28	131.84
1978	15.01	11.44	6.47	9.02	8.13	12.15	2.36	1.90	0.78	7.67	5.66	10.86	91.45
1979	8.01	8.79	10.73	5.35	12.82	5.72	1.65	3.75	0.32	1.19	0.96	18.40	77.69
1980	5.82	16.51	7.04	20.25	10.58	4.68	1.24	9.80	1.40	0.41	7.62	4.63	89.98
1981	5.43	9.20	7.70	10.73	6.29	30.20	8.95	1.62	1.54	1.25	0.43	4.95	88.29
1982	7.36	1.84	5.89	6.45	5.92	5.35	2.75	2.00	0.56	45.34	3.58	6.56	93.60
1983	8.14	16.45	9.73	12.53	16.43	10.57	9.46	2.79	4.49	6.43	1.92	3.94	102.88
1984	10.84	11.24	6.42	12.29	39.33	6.98	2.97	0.57	2.27	1.42	0.07	3.49	97.89
1985	12.35	10.73	8.39	19.88	6.01	8.33	5.68	1.07	1.01	0.08	12.63	11.05	97.21
1986	12.61	12.88	7.86	13.87	1.93	11.61	4.17	1.19	1.19	0.09	4.88	45.41	117.69
1987	7.94	17.96	10.56	10.80	26.84	40.86	5.41	12.29	3.17	7.84	7.18	4.23	155.08
1988	7.58	16.49	20.37	5.81	27.22	8.00	13.37	2.24	3.25	1.33	0.44	5.25	111.35
1989	29.46	20.77	5.49	16.11	5.57	14.49	1.36	1.63	0.61	0.45	8.46	5.30	109.70
1990	12.70	5.47	8.73	13.22	13.13	8.95	1.39	3.15	1.18	0.30	4.69	6.17	79.08
1991	13.95	17.25	9.17	6.90	5.04	3.99	8.10	0.14	0.60	0.07	2.70	7.95	75.86
1992	7.69	7.94	8.96	7.68	6.50	4.15	5.34	1.07	0.39	0.10	3.45	19.72	72.99
1993	10.09	8.78	20.34	6.13	34.10	7.27	1.05	0.91	0.77	6.69	12.40	1.22	109.75
1994	3.43	3.86	20.89	5.62	4.57	20.75	16.35	1.15	12.25	0.72	0.73	7.91	98.23
1995	7.08	4.01	31.22	14.54	9.68	6.38	8.66	0.72	0.16	13.79	1.81	2.88	100.93
1996	15.94	24.11	11.04	17.55	11.20	7.89	12.01	4.85	29.96	5.71	1.62	9.89	151.77
1997	8.59	17.35	8.12	7.98	20.94	14.46	6.04	2.72	1.16	1.75	8.20	4.35	101.66
1998	3.72	16.18	21.05	10.76	14.40	17.27	6.06	1.01	0.18	0.48	0.75	0.00	91.86
1999	17.31	8.37	15.04	19.31	22.10	32.49	13.90	6.16	0.06	2.19	1.20	6.81	144.94
2000	8.05	9.83	9.43	7.33	5.23	12.05	5.70	5.38	0.21	7.54	1.95	7.34	80.04
2001	7.88	26.82	11.78	10.10	10.50	5.08	7.45	3.87	0.63	12.08	8.33	9.62	114.14
2002	2.98	9.98	11.43	4.22	2.27	26.56	6.48	4.79	1.72	1.25	0.83	14.56	87.07
2003	9.52	4.60	9.60	15.33	2.64	15.70	2.72	1.64	0.42	6.57	0.72	13.93	83.39
2004	8.15	6.74	7.23	22.30	5.95	5.79	7.02	3.30	0.98	0.62	4.31	4.99	77.38
2005	4.97	21.69	7.65	13.31	10.96	7.93	8.78	8.40	8.81	0.06	10.48	16.92	119.96
2006	18.93	8.44	24.62	8.69	4.71	9.63	10.81	0.00	2.45	0.05	2.62	4.07	95.02
2007	14.87	10.23	7.79	26.18	7.08	9.45	13.39	2.04	13.40	0.00	1.60	3.95	109.98
AVERAGE	10.06	12.29	11.35	11.49	11.76	12.43	6.93	4.48	3.38	3.98	3.99	7.84	99.99

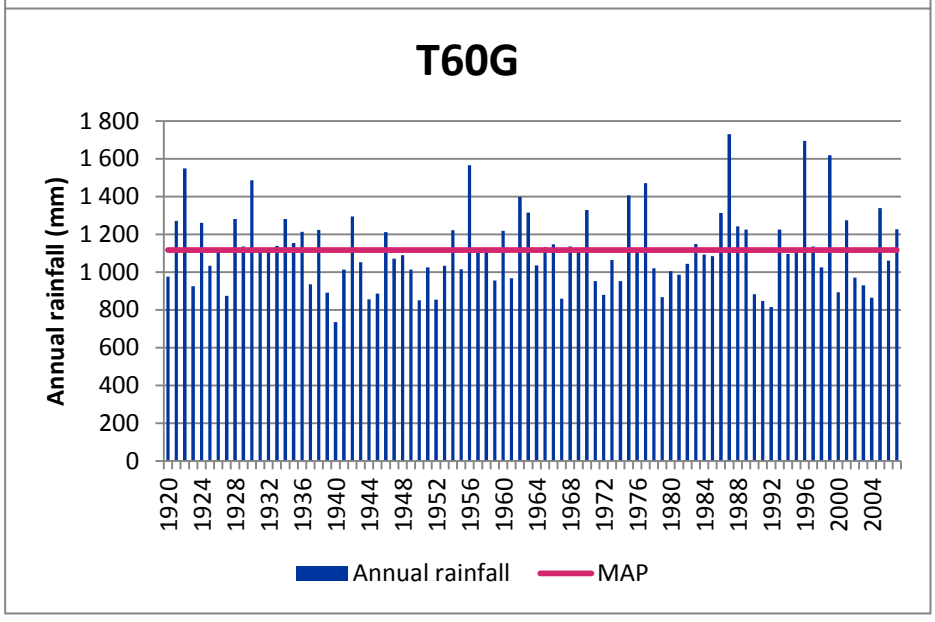

T60E
Monthly rain in mm
400
350
300
250
200
150
100
50
0
Oct
Nov
Dec
Jan
Feb
March
April
May
June
July
Aug
Sep
Months
Average
Minimum
Maximum


T60F
Monthly rain in mm
500
400
300
200
100
0
Oct
Nov
Dec
Jan
Feb
March
April
May
June
July
Aug
Sep
Months
Average
Minimum
Maximum


T60G
Monthly rain in mm
600
500
400
300
200
100
0
Oct
Nov
Dec
Jan
Feb
March
April
May
June
July
Aug
Sep
Months
Average
Minimum
Maximum

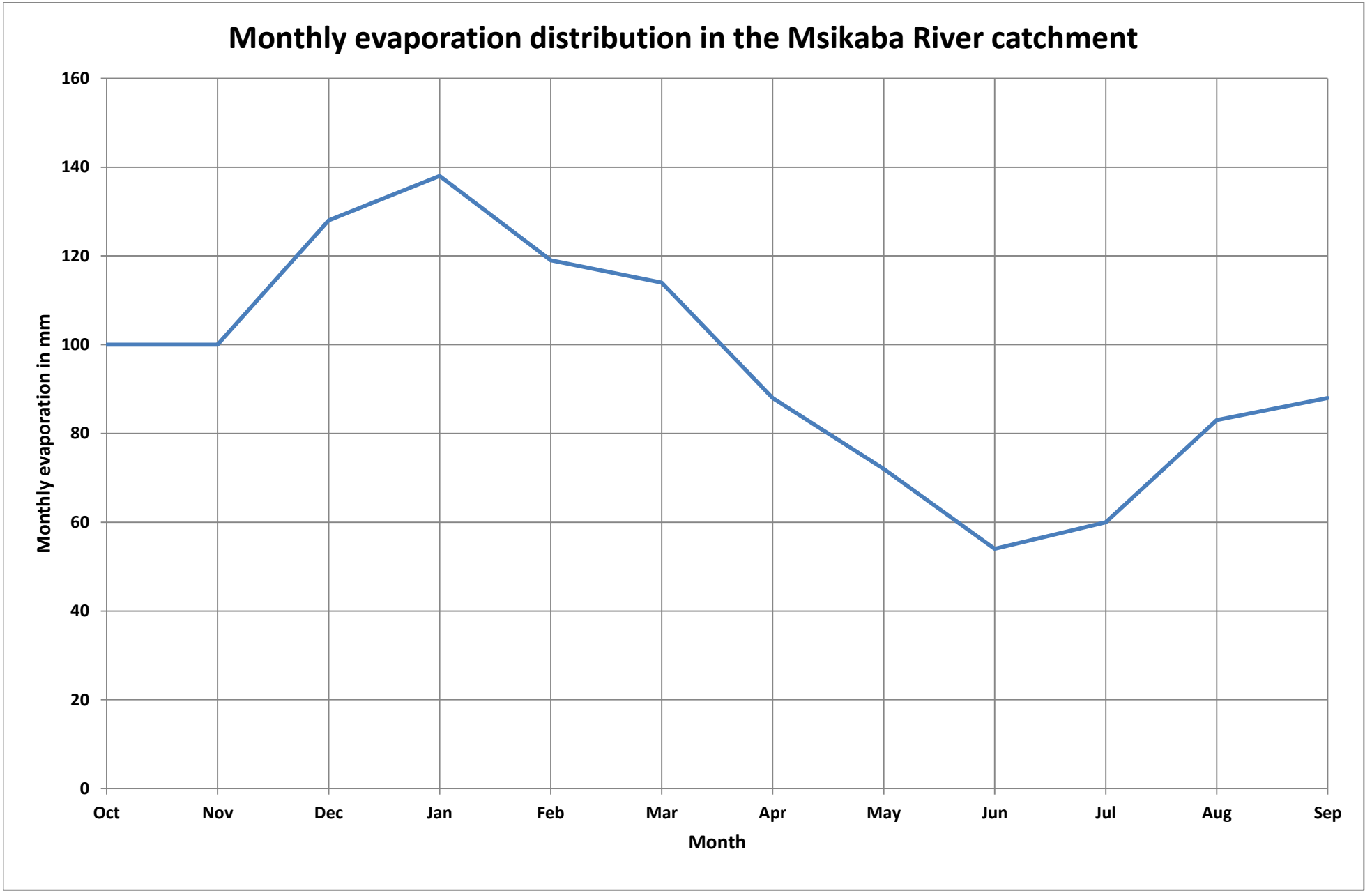

T60E
Annual rainfall (mm)
1 400
1 200
1 000
800
600
400
200
0
1920 1924 1928 1932 1936 1940 1944 1948 1952 1956 1960 1964 1968 1972 1976 1980 1984 1988 1992 1996 2000 2004
Annual rainfall
MAP


T60F
Annual rainfall (mm)
1 600
1 400
1 200
1 000
800
600
400
200
0
1920 1924 1928 1932 1936 1940 1944 1948 1952 1956 1960 1964 1968 1972 1976 1980 1984 1988 1992 1996 2000 2004
Annual rainfall
MAP


T60G
Annual rainfall (mm)
1 800
1 600
1 400
1 200
1 000
800
600
400
200
0
1920 1924 1928 1932 1936 1940 1944 1948 1952 1956 1960 1964 1968 1972 1976 1980 1984 1988 1992 1996 2000 2004
Annual rainfall
MAP

Appendix C

Evaporation


Monthly evaporation distribution in the Msikaba River catchment
Monthly evaporation in mm
160
140
120
100
80
60
40
20
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Month

Appendix D

Flow and dam inflow records

T6H004 Xura River at Xura 27
13 May 2009 – 13:40 – Gauge plate reading 0,010m

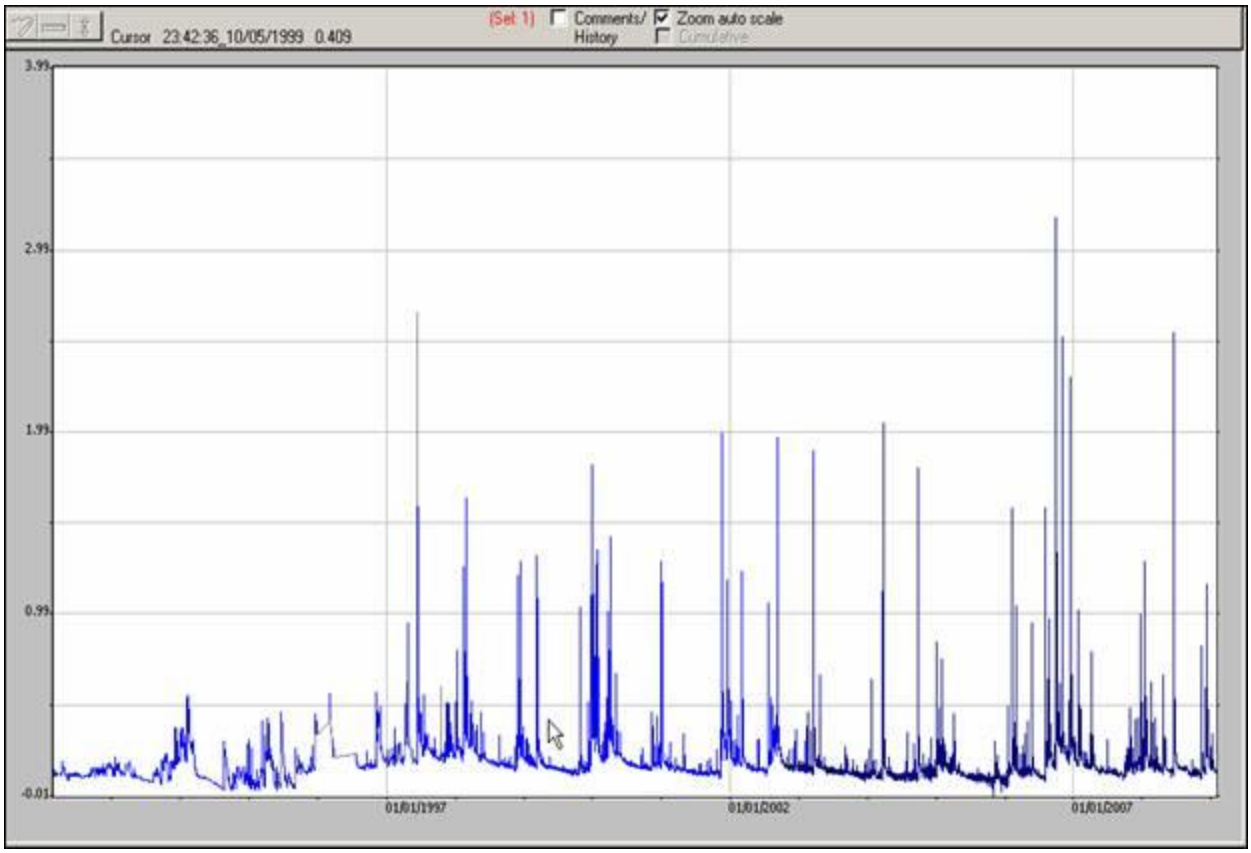


2 Notch Crump structure between bridge pillars. Structure was not changed.
Water Levels, Discharge Tables and Structure limits:

DT 1 Limit: 1.500 m
34.773 m^3/s
01/08/1995-Date

Structure limit:
1.500 m
34.773 m^3/s

T6H004 Xura River @ Xura 27
Data: 1/3/1992 – 17/3/2009
Gaps: 4.58%



NOTES:
Water Resource Planning: Primary - important station.
Flood Studies: Secondary
Water is pumped from the upstream pool and measured at T6H005 (Water Purification Plant).

REQUESTS:

Region:
* Maintain structure in working condition.
* Install a second logger to measure at the structure.

Flood Studies and Region:
* Extend Discharge Table – within bridge limits.

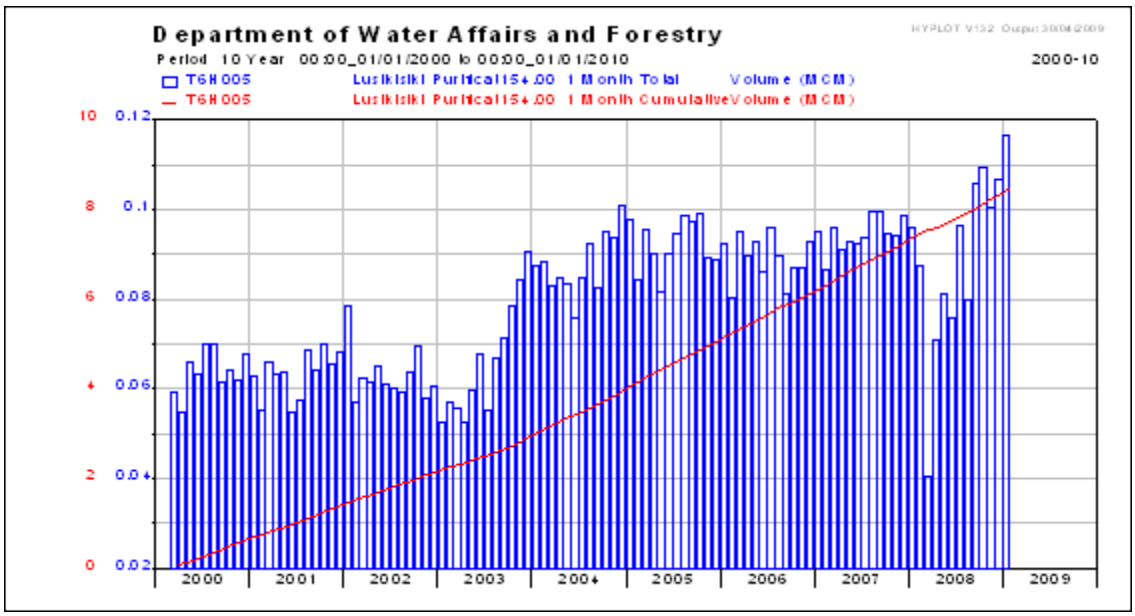
Hydrological Assessment:
* Investigate if this station can be considered for climate change.

Hydstra: *Investigate start date of data and discharge table – should possibly be the same. (Corrected dates of DT's).

T6H005 Lusikisiki Purification Works
13 May 2009 – Meter reading 359064 X $10m^3$



Month Total and Cumulative Abstraction Volume (million m^3) for T6H005.



RAW (UNPATCHED) HISTORICAL FLOW DATA AT GAUGE T6H004

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
1995	0.299 E	0.280 E	0.787	0.000	0.000	1.110	0.000	0.000	0.000	0.130	0.379	0.419 E	0.000 E
1996	0.398	2.680	0.783	0.571 E	0.781 E	0.835 E	2.840 E	1.060 E	2.320	2.540	1.500	0.995	17.303 E
1997	0.670 E	1.730 E	1.590	3.090	5.460 +	5.750	1.710	1.050	0.760	0.600	0.570	0.500	23.480 E
1998	0.490	0.790	4.410	0.810	0.500	2.810	0.490	0.420	0.340	0.310	0.250	0.210	11.830
1999	1.450	0.370 E	3.620 +	8.110	1.280	3.740	4.090	1.670	0.650	0.510	0.440	0.470	26.400 E
2000	0.390	0.870	0.770	2.530	0.450	0.350	0.310	0.330	0.250	0.220	0.190	0.250	6.910
2001	0.240	6.970 +	3.610	1.110	0.820	1.780	0.380	0.370	0.300	2.010	2.090	3.940 +	23.620 +
2002	0.540	0.400	0.550	0.360	0.420	3.070 +	0.710	0.370	0.260	0.260	0.230	0.330	7.500 +
2003	0.210	0.160	0.160	0.470	0.180	1.810 +	0.280	0.150	0.100	0.240	0.130	3.130 +	7.020 +
2004	0.390	0.190	0.250	1.660	0.550	0.330	0.510	0.200	0.130	0.100	0.100	0.080	4.490
2005	0.060	0.290	0.080	0.320	1.970 +	0.350	0.380	1.320	0.220	0.130	4.050 +	4.210 +	13.380 +
2006	6.050	3.210 +	3.110 +	1.350	0.920	0.540	1.030	0.280	0.330	0.250	0.190	0.150	17.410 +
2007	0.600	0.690	1.160	2.770	0.660	0.460	0.910	0.370	3.920 +	0.400	0.320	0.200	12.460 +

RAW (UNPATCHED) ABSTRACTION AT GAUGE T6H005

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
1999	0.000	0.000	0.000	0.000	0.000	0.059	0.055	0.066	0.063	0.070	0.070	0.062	0.445
2000	0.064	0.062	0.068	0.063	0.055	0.066	0.063	0.064	0.055	0.057	0.069	0.064	0.750
2001	0.070	0.065	0.068	0.079	0.057	0.063	0.062	0.065	0.061	0.060	0.059	0.064	0.773
2002	0.069	0.058	0.061	0.052	0.057	0.056	0.052	0.060	0.068	0.055	0.067	0.071	0.726
2003	0.078	0.084	0.090	0.087	0.088	0.083	0.085	0.083	0.076	0.085	0.092	0.083	1.014
2004	0.095	0.094	0.101	0.098	0.084	0.095	0.090	0.082	0.090	0.095	0.099	0.097	1.120
2005	0.099	0.089	0.089	0.092	0.080	0.095	0.089	0.093	0.086	0.096	0.089	0.081	1.078
2006	0.087	0.087	0.093	0.095	0.086	0.096	0.091	0.093	0.092	0.094	0.100	0.099	1.113
2007	0.095	0.094	0.098	0.096	0.087	0.040	0.071	0.081	0.076	0.096	0.080	0.106	1.020

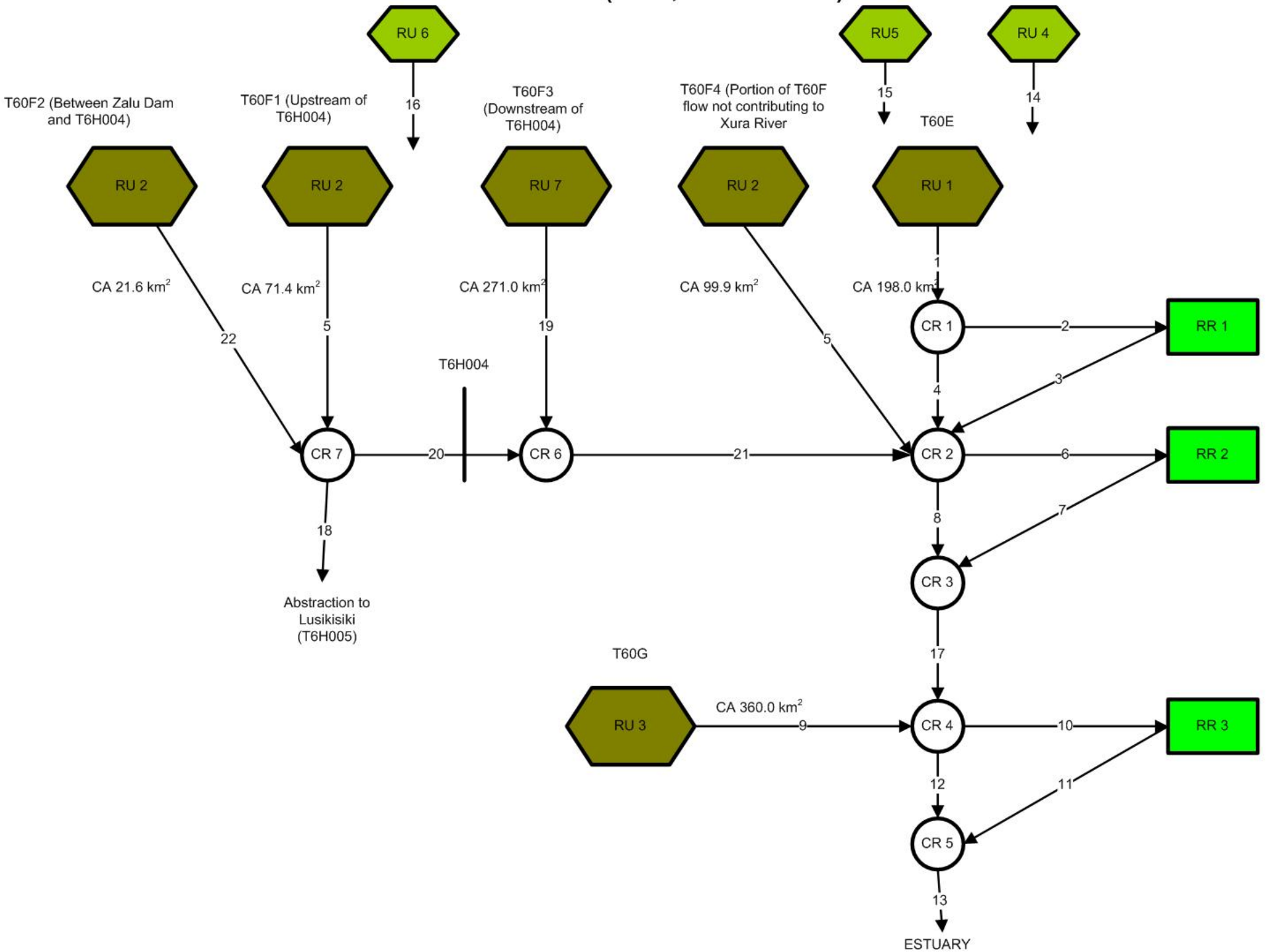
PATCHED HISTORICAL FLOW DATA AT GAUGE T6H004 (ZALU DAM INFLOW)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
1997	0.890 E	3.300 E	1.590	3.090	5.460 +	5.750	1.710	1.050	0.760	0.600	0.570	0.500	25.270 E
1998	0.490	0.790	4.410	0.810	0.500	2.810	0.490	0.420	0.340	0.310	0.250	0.210	11.830
1999	1.450	0.790 E	3.620 +	8.110	1.280	3.740	4.090	1.670	0.650	0.510	0.440	0.470	26.820 E
2000	0.390	0.870	0.770	2.530	0.450	0.350	0.310	0.330	0.250	0.220	0.190	0.250	6.910
2001	0.240	10.930 +	3.610	1.110	0.820	1.780	0.380	0.370	0.300	2.010	2.090	3.940 +	27.580 +
2002	0.540	0.400	0.550	0.360	0.420	3.910 +	0.710	0.370	0.260	0.260	0.230	0.330	8.340 +
2003	0.210	0.160	0.160	0.470	0.180	1.810 +	0.280	0.150	0.100	0.240	0.130	3.130 +	7.020 +
2004	0.390	0.190	0.250	1.660	0.550	0.330	0.510	0.200	0.130	0.100	0.100	0.080	4.490
2005	0.060	0.290	0.080	0.320	1.970 +	0.350	0.380	1.320	0.220	0.130	4.050 +	4.820 +	13.990 +
2006	6.050	3.210 +	8.940 +	1.350	0.920	0.540	1.030	0.280	0.330	0.250	0.190	0.150	23.240 +
2007	0.600	0.690	1.160	2.770	0.660	0.460	0.910	0.370	3.960 +	0.400	0.320	0.200	12.500 +

Appendix E

WRSM2000

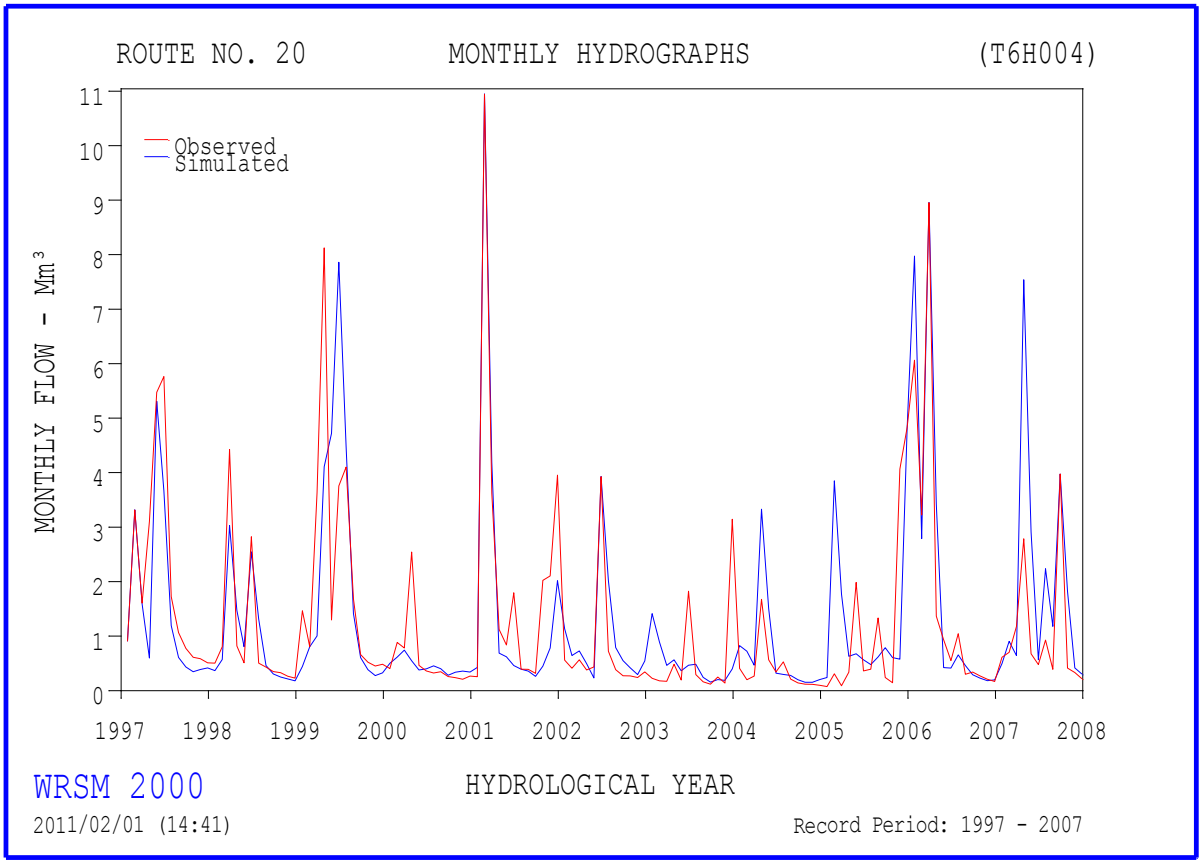
LUSIKISIKI RWSS
(T60E, T60F & T60G)



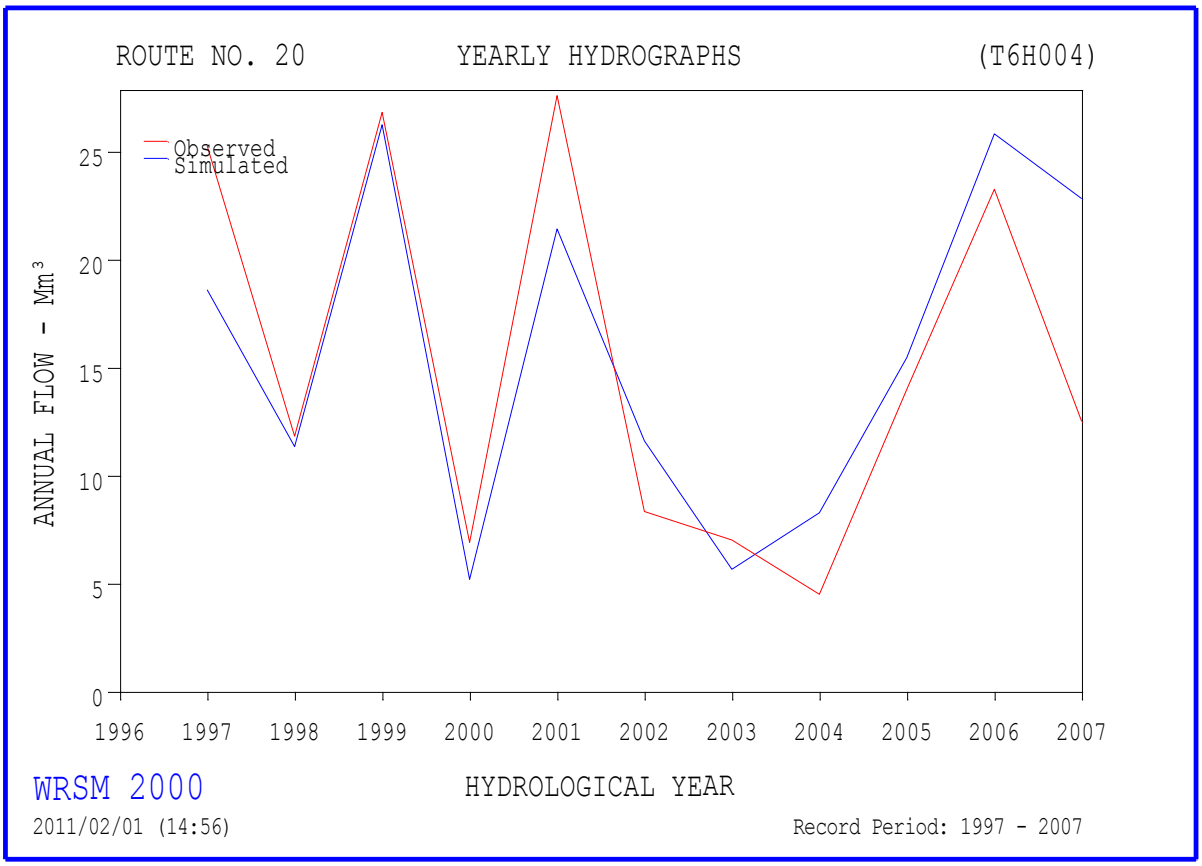
Appendix F

Calibration results

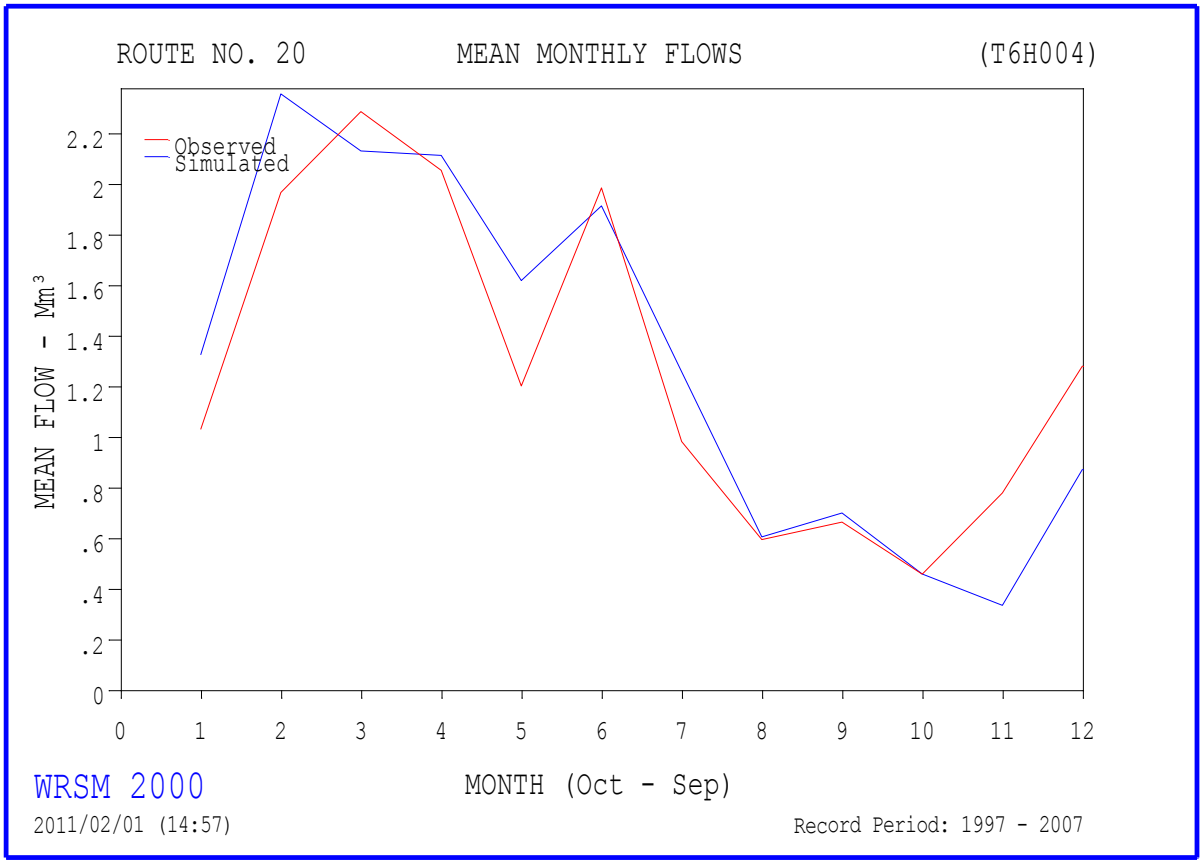
T6H004 – MONTHLY HYDROGRAPHS



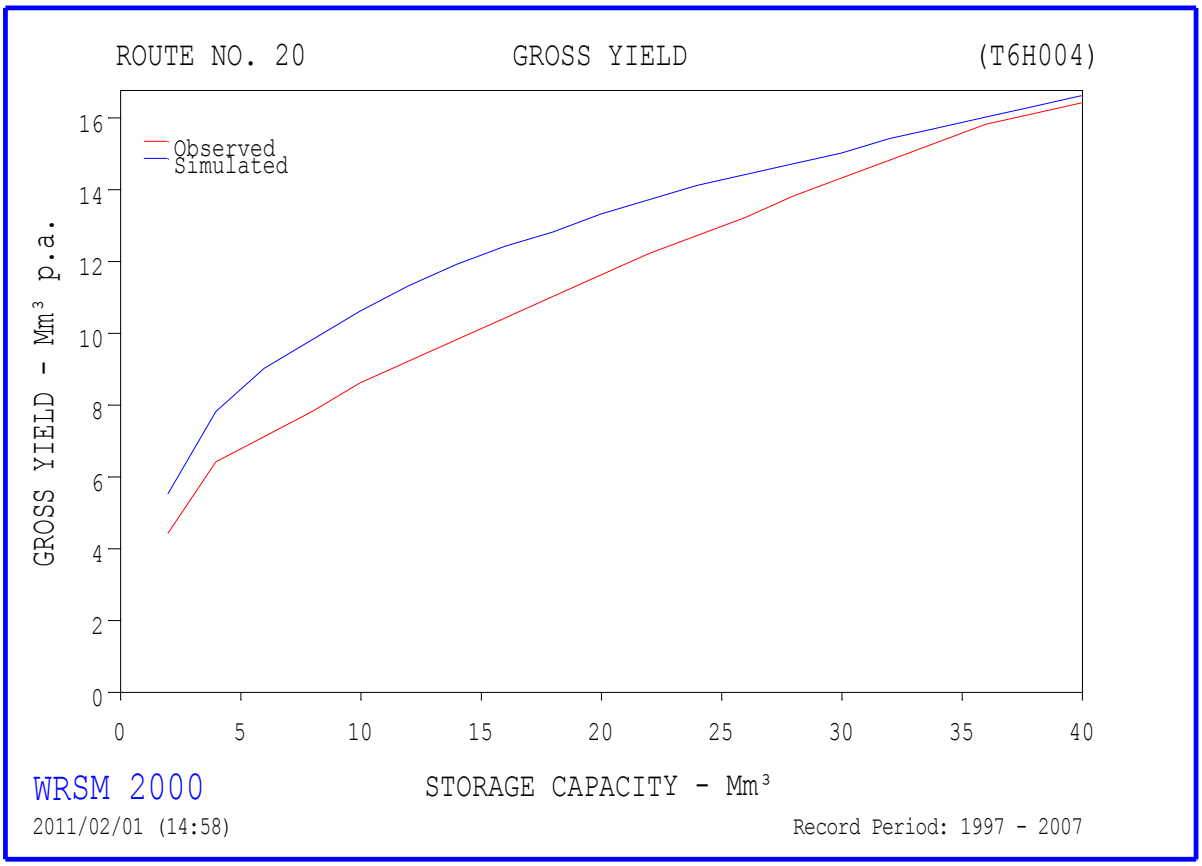
T6H004 – YEARLY HYDROGRAPHS



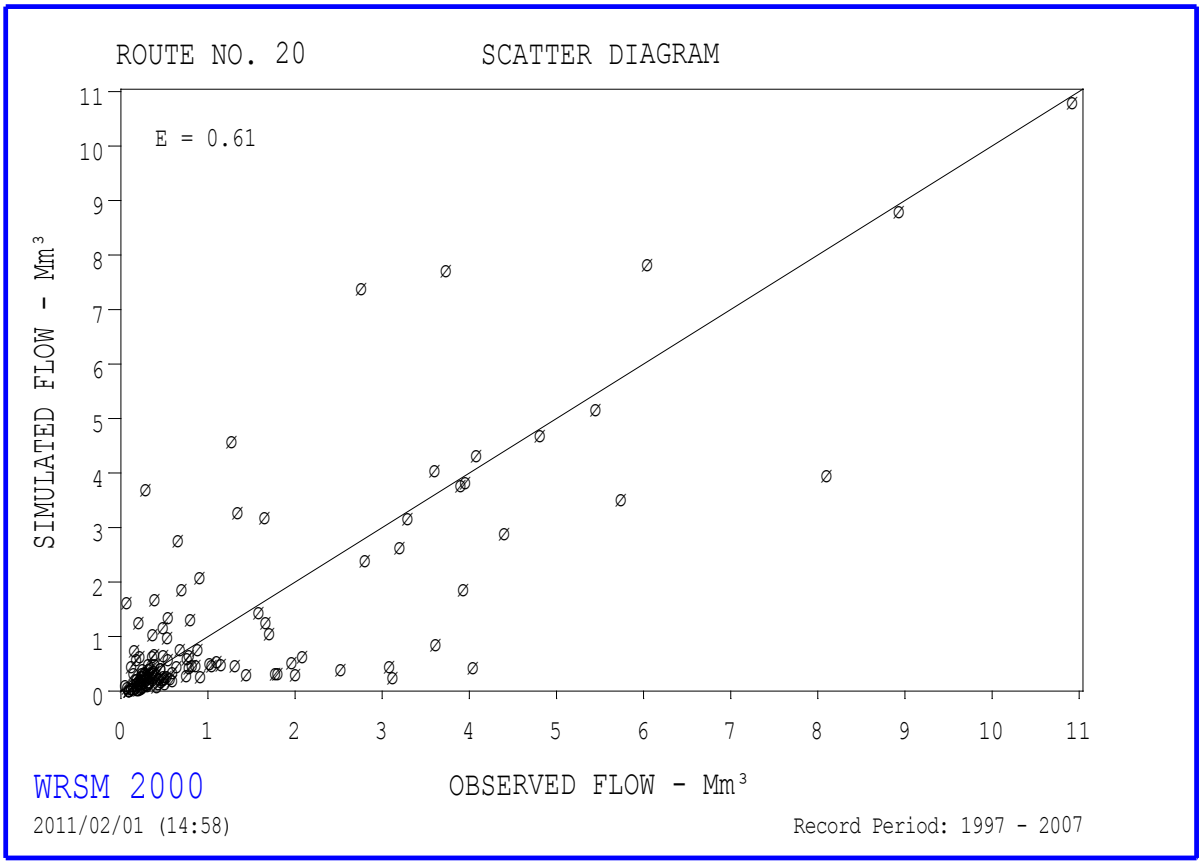
T6H004 – MEAN MONTHLY FLOWS



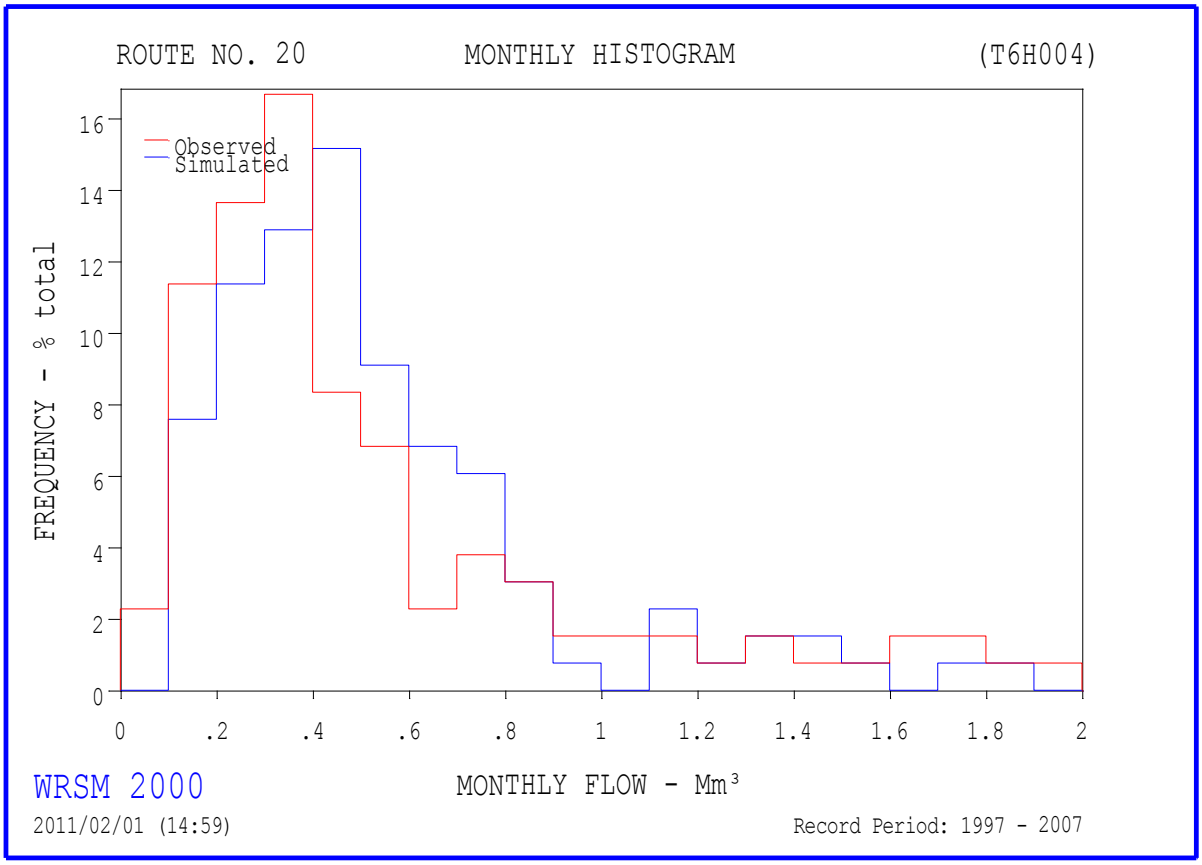
T6H004 – GROSS YIELD



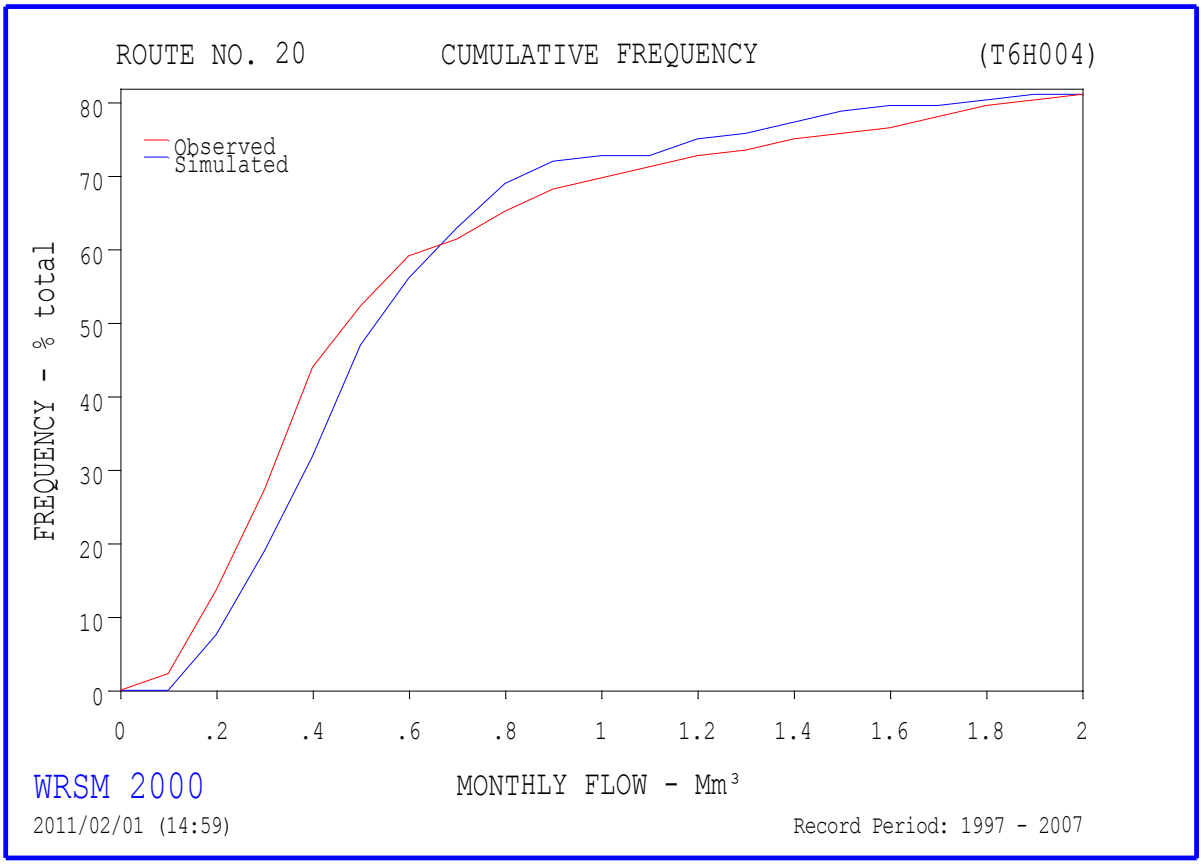
T6H004 – SCATTER DIAGRAM



T6H004 – HISTOGRAM OF MONTHLY FLOWS



T6H004 – CUMULATIVE FREQUENCY



Observations file:C:\LUSIKISIKI\WRSM2000\T6H004 - CHANGED.PRN

INDEX	UNITS	OBSERVED	SIMULATED
MEAN ANNUAL RUNOFF (M A R)	M**3*10**6	15.27	15.67
STANDARD DEVIATION OF ANNUAL FLOWS (S)	M**3*10**6	8.79	7.79
COEFFICIENT OF VARIABILITY (S/MAR)	PERCENT	57.54	49.71
COEFF. OF SKEWNESS	-	0.3804	0.0232
RANGE	PERCENT MAR	183.36	153.12
AUTOCORRELATION COEFF OF ANNUAL FLOWS	-	-0.3000	-0.1086
MEAN OF LOGS OF ANNUAL FLOWS	(M**3*10**6)	1.1102	1.1349
STD. DEV. OF LOGS OF ANNUAL FLOWS	-	0.2744	0.2544
INDEX OF SEASONAL VARIABILITY	PERCENT	20.46	23.05

Calibration parameters for T60

WR2005-Pitman Parameters

Sub-catchment	POW	GPOW	SL	HGSL	ST	FT	GW	HGW	ZMIN	ZMAX	TL	GL
T60E	3	3	0	0	200	15	0	2	999	999	0.25	0
T60F1	3	3	0	5.74	150	20	0	2	999	999	0.25	0
T60G	3	3	0	8.81	200	15	0	2	999	999	0.25	0

LWRSS calibration parameters

Sub-catchment	POW	GPOW	SL	HGSL	ST	FT	GW	HGW	ZMIN	ZMAX	TL	GL
T60F1	3	3	0	5.74	200	15	0	2	999	999	0.25	0

Sub-catchment	Aquifer thickness	Storativity	Initial Aquifer Storage	Static Water level	Max discharge rate	Ground-water evap area	Months to average recharge	Unsaturated Storage capacity	Initial unsa-turated storage	Perculation Power	Trans-misivity	Borehole distance to river	Parameter K2	Parameter K3	Interflow lag	Activate Groundwater Abstraction (mm^3)
T60F1	58.81	0.004582	269.48	139.88	2	4.64	1	27.42	2.52	0.2	10	1000	0.1	-3	0	0

Appendix G

Naturalisation

LWRSS naturalisation parameters

Sub-catchment	POW	GPOW	SL	HGSL	ST	FT	GW	HGW	ZMIN	ZMAX	TL	GL
T60E	3	3	0	0	200	15	0	2	999	999	0.25	0
T60F1	3	3	0	5.74	200	15	0	2	999	999	0.25	0
T60F2	3	3	0	5.74	200	15	0	2	999	999	0.25	0
T60F3	3	3	0	5.74	200	15	0	2	999	999	0.25	0
T60G	3	3	0	8.81	200	15	0	2	999	999	0.25	0

Sub-catchment	Aquifer thickness	Storativity	Initial Aquifer Storage	Static Water level	Max discharge rate	Ground-water evap area	Months to average recharge	Unsaturated Storage capacity	Initial unsa-turated storage	Perculation Power	Trans-misivity	Borehole distance to river	Parameter K2	Parameter K3	Interflow lag	Activate Groundwater Abstraction (mm^3)
T60E	57.62	0.004305	248.08	129.96	2	1.98	1	28.66	3.45	0.2	10	1000	0.1	-3	0	0
T60F1	58.81	0.004582	269.48	139.88	2	4.64	1	27.42	2.52	0.2	10	1000	0.1	-3	0	0
T60F2	58.81	0.004582	269.48	139.88	2	4.64	1	27.42	2.52	0.2	10	1000	0.1	-3	0	0
T60F3	58.81	0.004582	269.48	139.88	2	4.64	1	27.42	2.52	0.2	10	1000	0.1	-3	0	0
T60G	56.14	0.003138	176.17	91.32	2	3.6	1	23.3	1.95	0.2	10	1000	0.1	-3	0	0

NATURAL STREAMFLOW FOR QUATERNARY CATCHMENT T60E CATCHMENT AREA = 198 SQ KM

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOT	CUM
1920	0.99	1.49	2.14	2.02	1.77	1.94	1.98	1.36	0.87	0.70	0.60	0.74	16.61	16.61
1921	1.21	5.86	10.45	3.99	1.37	1.02	0.80	1.48	2.56	1.86	1.61	1.67	33.88	50.49
1922	9.60	14.91	5.07	11.16	13.70	6.18	1.82	0.95	0.78	6.91	3.47	1.13	75.69	126.18
1923	0.95	1.03	1.26	3.81	4.01	1.76	0.85	0.75	0.70	0.63	0.67	0.96	17.39	143.57
1924	1.36	1.78	4.01	2.20	1.26	9.86	4.49	1.33	0.89	0.75	0.65	0.77	29.37	172.94
1925	1.04	1.62	1.94	3.22	2.25	15.45	6.16	1.05	1.13	1.09	0.82	1.03	36.81	209.75
1926	1.64	2.06	4.48	2.59	1.40	16.73	6.51	0.80	0.62	0.54	0.53	0.62	38.52	248.27
1927	1.22	1.34	1.61	7.10	5.65	2.35	1.11	0.73	0.61	0.54	0.65	0.74	23.67	271.94
1928	0.84	1.17	1.33	1.36	1.17	1.48	1.19	0.80	1.31	1.83	1.44	2.63	16.54	288.48
1929	7.63	7.64	3.28	1.62	1.07	1.23	1.44	1.01	1.06	1.12	1.37	1.80	30.28	318.76
1930	1.61	1.35	1.43	12.75	11.47	10.12	3.74	1.00	0.66	20.54	8.17	1.18	74.01	392.77
1931	1.32	1.68	1.51	1.04	2.25	1.88	1.00	0.82	0.87	0.99	0.93	1.39	15.68	408.45
1932	2.24	20.69	15.79	3.80	1.12	1.69	1.28	0.81	0.62	0.56	0.51	0.51	49.61	458.06
1933	0.56	2.69	6.43	7.87	3.10	1.43	1.20	0.82	0.65	0.80	0.78	0.58	26.92	484.98
1934	0.66	1.37	5.26	2.90	1.12	1.06	1.76	3.83	9.25	4.07	1.75	1.56	34.58	519.56
1935	1.37	1.80	1.11	0.74	6.58	6.22	2.24	1.51	1.58	1.06	0.74	0.68	25.65	545.21
1936	1.31	23.58	8.77	1.07	5.26	3.22	1.48	0.84	0.63	0.57	0.52	0.55	47.79	593.00
1937	0.76	0.95	1.40	1.77	1.73	1.30	1.54	1.40	1.04	1.03	0.87	0.68	14.49	607.49
1938	0.80	1.48	2.97	3.70	14.39	5.65	1.22	1.09	0.91	1.03	1.23	6.35	40.82	648.31
1939	3.78	2.07	1.88	1.41	1.62	2.10	1.55	1.88	1.88	1.10	0.73	0.80	20.80	669.11
1940	0.98	2.33	1.96	1.23	0.78	0.65	0.75	0.62	0.48	0.46	0.44	0.44	11.12	680.23
1941	0.64	1.13	0.94	1.31	1.75	1.79	1.71	1.40	0.95	0.62	0.56	0.67	13.48	693.71
1942	1.03	20.62	12.52	3.18	1.25	1.48	3.08	2.17	1.46	1.21	1.63	1.82	51.43	745.14
1943	1.95	8.14	6.66	2.36	1.64	1.70	1.10	0.71	0.66	0.72	0.62	1.28	27.52	772.66
1944	2.15	1.42	0.78	1.09	1.85	2.11	1.40	0.83	0.66	0.53	0.44	0.48	13.74	786.40
1945	1.57	1.50	0.93	0.89	1.18	1.66	1.46	0.94	0.63	0.56	0.47	0.43	12.22	798.62
1946	0.67	1.39	1.58	1.30	1.44	4.89	2.91	1.22	1.31	1.53	0.93	0.78	19.96	818.58
1947	0.87	26.40	10.43	1.65	2.38	2.04	1.41	0.82	0.55	0.46	0.40	0.37	47.77	866.35
1948	0.84	1.52	1.40	1.16	1.37	1.56	1.41	1.02	0.63	0.53	0.49	0.52	12.44	878.79
1949	0.75	1.41	1.59	1.66	6.46	7.13	2.98	1.62	1.24	1.04	1.36	1.33	28.58	907.37
1950	1.43	1.36	8.65	4.01	1.28	1.40	1.10	0.72	0.56	0.47	0.55	0.88	22.42	929.79
1951	2.67	1.80	1.16	1.49	1.68	1.74	1.65	1.18	0.78	0.63	0.49	0.59	15.85	945.64
1952	0.77	0.74	0.83	0.94	1.00	0.94	0.98	0.76	0.50	0.40	0.41	0.99	9.25	954.89
1953	2.62	5.66	3.25	1.59	1.10	1.61	1.40	1.15	1.27	1.09	0.75	0.78	22.27	977.16
1954	7.36	3.84	1.31	2.59	5.52	2.71	1.12	0.82	0.71	0.61	0.45	0.63	27.67	1 004.83
1955	1.05	1.32	0.94	0.48	0.71	8.05	3.85	1.13	0.92	0.73	0.55	0.63	20.36	1 025.19
1956	0.95	7.55	16.23	6.02	1.85	3.51	2.50	1.50	1.04	0.85	0.82	1.20	44.02	1 069.21
1957	1.78	2.49	2.09	2.02	6.28	3.02	1.49	1.14	0.68	0.59	0.54	0.56	22.69	1 091.90
1958	0.68	2.73	3.41	1.82	1.18	1.44	1.53	16.08	6.41	1.62	1.82	1.73	40.45	1 132.35
1959	1.76	1.93	1.95	1.75	1.36	1.43	1.72	1.33	0.83	0.66	0.79	1.11	16.63	1 148.98
1960	1.32	1.55	6.17	6.13	2.72	1.86	7.19	3.45	1.08	0.81	0.63	0.59	33.49	1 182.47
1961	0.62	1.21	1.86	1.56	1.73	2.15	1.51	0.98	0.72	0.54	0.57	0.62	14.06	1 196.53
1962	1.09	4.35	2.68	7.69	3.54	17.45	6.94	1.16	0.77	1.40	1.60	0.88	49.54	1 246.07
1963	1.25	4.88	2.84	3.73	2.29	1.98	5.11	2.55	12.59	5.54	1.17	1.12	45.04	1 291.11
1964	4.43	2.42	1.04	1.05	1.17	0.86	0.57	0.63	4.54	3.31	2.35	2.04	24.41	1 315.52
1965	9.69	9.09	3.12	1.44	1.32	0.78	0.58	5.46	3.00	1.06	0.85	1.02	37.39	1 352.91
1966	1.19	1.22	1.36	1.81	1.58	16.37	6.91	1.58	1.32	1.68	1.40	0.84	37.26	1 390.17
1967	0.82	1.54	1.74	1.42	1.29	1.17	1.14	0.81	0.53	0.47	0.67	1.24	12.84	1 403.01
1968	1.66	2.03	1.70	0.99	1.38	6.51	3.21	1.47	1.21	0.83	0.72	0.66	22.37	1 425.38
1969	0.88	1.33	1.48	1.09	1.25	1.03	0.62	0.59	0.75	0.70	1.25	2.13	13.11	1 438.49
1970	10.38	4.94	1.93	1.55	1.76	1.64	1.34	1.66	1.42	1.29	1.87	1.87	31.67	1 470.16
1971	11.72	5.41	1.65	1.55	8.52	3.94	1.14	0.76	0.67	0.64	0.53	0.47	37.01	1 507.17
1972	0.58	1.39	1.99	1.44	1.33	1.46	1.37	0.87	0.54	0.46	0.54	0.69	12.65	1 519.82
1973	0.91	1.54	1.40	1.18	1.29	3.99	2.38	4.35	2.78	1.33	0.76	0.55	22.46	1 542.28
1974	0.61	1.16	1.42	1.20	1.21	1.25	0.96	0.64	0.46	0.40	0.39	0.66	10.35	1 552.63
1975	0.90	0.86	6.56	6.48	9.80	28.18	9.73	2.03	1.56	1.00	0.74	0.95	68.78	1 621.41
1976	13.30	5.69	1.62	1.48	1.33	1.27	0.87	0.57	0.52	0.51	0.54	0.77	28.47	1 649.88
1977	1.35	1.81	4.22	2.23	1.12	1.26	24.30	9.33	1.38	0.92	0.80	0.98	49.67	1 699.55
1978	1.76	2.36	1.91	1.51	1.36	1.70	1.50	0.91	0.64	0.83	0.98	0.97	16.44	1 715.99
1979	1.36	1.63	1.49	1.18	1.18	0.98	0.65	0.55	0.47	0.44	0.42	1.54	11.89	1 727.88
1980	1.95	8.57	4.02	12.90	5.46	1.46	0.89	0.89	0.91	0.67	0.74	0.82	39.30	1 767.18
1981	1.07	1.56	1.64	1.41	1.23	3.82	2.44	1.17	0.86	0.78	0.63	0.60	17.21	1 784.39
1982	0.95	0.95	0.64	0.46	0.37	0.34	0.39	0.38	0.30	16.74	6.86	1.40	29.79	1 814.18
1983	1.26	5.83	3.29	1.93	9.41	4.46	1.84	1.28	0.91	0.91	0.82	0.64	32.57	1 846.75
1984	0.99	3.69	2.26	1.36	22.46	8.33	0.93	0.61	0.51	0.48	0.41	0.36	42.38	1 889.13
1985	1.01	2.03	1.60	1.42	1.15	1.10	1.02	0.67	0.51	0.44	0.65	1.18	12.77	1 901.90
1986	2.20	9.62	4.32	1.25	0.76	0.69	0.61	0.44	0.38	0.35	0.44	27.69	48.75	1 950.65
1987	12.98	4.96	2.54	1.47	6.81	21.23	7.62	1.77	1.45	1.10	0.99	0.91	63.86	2 014.51
1988	1.04	1.80	4.36	2.19	9.65	4.36	5.23	2.68	1.05	0.89	0.68	0.52	34.46	2 048.97
1989	9.98	23.04	7.88	1.93	1.40	2.20	1.65	0.88	0.67	0.59	0.86	1.05	52.13	2 101.10
1990	1.25	1.37	1.25	1.62	3.39	1.82	0.60	0.46	0.42	0.39	0.36	0.49	13.42	2 114.52
1991	1.40	2.30	1.53	0.95	0.72	0.67	0.83	0.66	0.43	0.36	0.34	0.40	10.57	2 125.09
1992	0.61	0.77	0.74	0.74	0.72	0.46	0.47	0.43	0.29	0.25	0.25	0.73	6.47	2 131.56
1993	1.88	2.10	5.40	2.79	14.30	6.16	1.35	0.64	0.51	0.70	0.99	0.72	37.52	2 169.08
1994	0.62	0.62	0.61	0.68	0.62	2.43	3.93	2.18	4.11	2.51	0.96	0.97	20.23	2 189.31
1995	1.39	1.44	13.51	11.66	8.16	2.96	1.01	0.68	0.53	0.73	0.84	0.70	43.62	2 232.93
1996	1.04	11.31	5.08	1.80	2.74	2.04	5.94	2.97	24.39	9.75	1.92	1.53	70.50	2 303.43
1997	1.77	5.60	2.79	1.42	10.95	8.89	2.96	1.35	0.96	0.74	0.69	0.69	38.80	2 342.23
1998	0.74	1.19	1.97	1.73	1.90	2.27	1.64	0.93	0.62	0.52	0.44	0.37	14.33	2 356.56
1999	0.84	1.52	2.84	9.78	6.55	10.16	6.89	2.68	1.37	0.91	0.67	0.77	44.99	2 401.55
2000	1.17	1.44	1.74	1.54	1.33	1.29	1.44	1.22	0.77	0.86	0.92	0.90	14.61	2 416.16
2001	1.23	13.83	5.89	1.87	1.67	1.14	0.88	0.82	0.69	0.99	1.59	2.08	32.67	2 448.83
2002	1.85	1.48	1.58	1.06	0.69	1.36	1.89	1.38	1.06	0.90	0.76	1.21	15.21	2 464.04
2003	2.14	1.87	1.44	1.39	1.05	1.37	1.31	0.74	0.73	1.10	0.95	1.07	15.17	2 479.21
2004	1.40	1.34	1.18	3.78	2.29	1.03	0.89	0.75	0.56	0.47	0.47	0.68	14.82	2 494.03
2005	1.02	5.14	2.94	1.56	1.61	1.48	1.28	1.29	1.33	1.06	0.98	1.69	21.36	2 515.39
2006	20.13	8.16	10.4	4.62	1.23	1.45	2.09	1.41	0.87	0.69	0.58	0.71	52.32	2 567.71
2007	1.5	2.14	2.38	8.91	3.71	0.9	1.34	1.48	2.16	1.83	1.03	0.92	28.31	2 596.02
% of to	8.27	14.40	11.74	9.46	11.32	12.91	8.33	5.19	5.28	5.20	3.43	4.47	100.00	
Averag	2.44	4.25	3.46	2.79	3.34	3.81	2.46	1.53	1.56	1.53	1.01	1.32	29.50	
SD	3.454	5.456	3.366	2.790	3.906	4.924	3.057	1.983	3.024	2.969	1.121	2.938	16.141	
CV	1.416	1.284	0.972	1.000	1.170	1.293	1.244	1.296	1.940	1.937	1.107	2.229	0.547	

NATURAL STREAMFLOW FOR QUATERNARY CATCHMENT T60F1 CATCHMENT AREA = 71.35 SQ KM

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOT	CUM
1920	0.31	0.52	0.79	0.66	0.57	0.69	0.72	0.48	0.3	0.25	0.21	0.29	5.79	5.79
1921	0.54	3.19	3.91	1.37	0.47	0.34	0.3	0.52	0.92	0.7	0.62	0.72	13.6	19.39
1922	5.02	6.34	1.96	5.23	6.67	2.68	0.66	0.33	0.26	3.33	1.53	0.39	34.41	53.80
1923	0.37	0.43	0.51	2.18	1.24	0.5	0.28	0.24	0.24	0.23	0.25	0.33	6.78	60.58
1924	0.45	0.62	1.5	0.86	0.6	4.77	2.07	0.51	0.34	0.29	0.25	0.35	12.61	73.19
1925	0.48	0.61	0.63	0.63	0.7	4.73	1.95	0.37	0.41	0.42	0.3	0.38	11.61	84.80
1926	0.66	1.62	1.34	0.7	0.47	6.75	2.58	0.27	0.21	0.19	0.19	0.24	15.2	100.00
1927	0.45	0.42	0.48	0.75	1.56	0.91	0.4	0.27	0.24	0.2	0.27	0.3	6.26	106.26
1928	0.34	0.54	0.6	0.53	0.44	0.57	0.45	0.31	1.43	1.46	0.86	2.25	9.78	116.04
1929	4.24	3.24	1.17	0.5	0.36	0.4	0.45	0.34	0.39	0.45	0.53	1.33	13.39	129.43
1930	0.91	0.54	0.46	2.94	3.55	4.04	1.47	0.33	0.22	13.18	4.76	0.45	32.85	162.28
1931	0.57	0.69	0.59	0.38	1.84	1.08	0.42	0.35	0.4	0.43	0.36	1.63	8.76	171.04
1932	1.13	8.31	4.79	0.95	0.45	0.78	0.54	0.32	0.24	0.21	0.19	0.19	18.11	189.15
1933	0.21	1.18	2.43	3.74	1.5	0.7	0.58	0.36	0.26	0.35	0.34	0.23	11.89	201.04
1934	0.25	0.46	1.83	1	0.36	0.43	1.22	2.37	5.22	2.04	0.69	0.62	16.48	217.52
1935	0.51	0.62	0.37	0.24	4.17	4.7	1.48	0.68	0.66	0.46	0.31	0.29	14.48	232.00
1936	0.59	10.26	3.72	0.38	2.07	1.68	0.69	0.31	0.23	0.23	0.23	0.24	20.62	252.62
1937	0.3	0.35	0.56	0.74	0.62	0.43	0.55	0.51	0.39	0.41	0.33	0.24	5.43	258.05
1938	0.26	0.48	0.71	1.58	3.74	1.6	0.47	0.39	0.32	0.39	0.51	3.64	14.09	272.14
1939	2	0.77	0.73	0.54	0.46	0.53	0.41	0.6	0.62	0.36	0.25	0.29	7.55	279.69
1940	0.36	1.78	1	0.38	0.24	0.21	0.22	0.17	0.15	0.16	0.16	0.16	5	284.69
1941	0.28	0.47	0.35	0.82	0.64	0.53	0.5	0.47	0.36	0.22	0.22	0.28	5.13	289.82
1942	0.43	9.46	5.3	1.13	0.37	0.51	1.5	0.89	0.47	0.4	0.62	0.74	21.82	311.64
1943	0.72	2.76	1.9	0.69	0.57	0.54	0.35	0.25	0.24	0.26	0.22	2.16	10.65	322.29
1944	1.35	0.62	0.32	0.37	0.61	0.8	0.55	0.32	0.25	0.2	0.16	0.2	5.77	328.06
1945	3.45	1.5	0.29	0.29	0.4	0.6	0.61	0.41	0.25	0.21	0.17	0.16	8.34	336.40
1946	0.27	0.58	0.55	0.4	0.45	1.8	1.17	0.59	0.74	0.7	0.43	0.34	8.02	344.42
1947	0.36	11.53	4.77	0.7	0.77	0.72	0.55	0.32	0.2	0.17	0.14	0.14	20.37	364.79
1948	0.33	0.64	0.56	0.46	2.27	1.36	0.69	0.44	0.24	0.2	0.18	0.21	7.58	372.37
1949	0.32	1.28	0.85	0.6	0.73	0.77	0.63	0.55	0.4	0.34	0.4	0.37	7.23	379.60
1950	0.45	0.42	1.88	1.08	0.48	0.46	0.36	0.23	0.18	0.15	0.17	0.26	6.15	385.75
1951	1.09	0.69	0.51	0.75	0.66	0.61	0.62	0.44	0.26	0.2	0.15	0.21	6.2	391.95
1952	0.3	0.31	0.3	0.31	0.32	0.29	0.28	0.21	0.15	0.12	0.13	0.39	3.12	395.07
1953	1.18	3.94	1.62	0.38	0.24	0.41	0.41	0.34	0.4	0.37	0.26	0.31	9.85	404.92
1954	5.35	2.22	0.46	0.66	2.11	1.11	0.43	0.28	0.25	0.21	0.16	0.27	13.49	418.41
1955	0.5	0.58	0.39	0.18	0.28	4.21	1.84	0.44	0.35	0.29	0.2	0.28	9.54	427.95
1956	0.52	6.71	9.12	2.79	0.63	1.22	1.68	0.83	0.42	0.35	0.32	0.45	25.03	452.98
1957	0.66	0.77	1.7	1.71	3.12	1.34	0.7	0.54	0.29	0.24	0.22	0.24	11.54	464.52
1958	0.29	2.39	1.32	0.48	0.4	0.44	0.44	6.74	2.64	0.61	0.74	0.74	17.24	481.76
1959	0.7	0.71	0.71	0.59	0.44	0.5	0.64	0.53	0.33	0.25	0.28	0.42	6.09	487.85
1960	0.54	0.67	2.58	2.35	0.92	0.54	4.33	1.87	0.39	0.33	0.27	0.24	15.05	502.90
1961	0.26	0.51	0.73	0.57	0.57	1.55	0.83	0.35	0.25	0.19	0.21	0.24	6.27	509.17
1962	0.47	2.07	1.11	2.59	1.27	8.36	3.15	0.44	0.32	1.73	0.98	0.33	22.82	531.99
1963	0.45	1.31	0.88	2.11	1.2	0.79	1.63	0.85	6.66	2.69	0.41	0.39	19.38	551.37
1964	1.19	0.78	0.44	0.45	0.45	0.29	0.19	0.22	2.21	1.38	0.84	0.82	9.26	560.63
1965	6	4.46	1.26	0.5	0.44	0.26	0.19	3.38	1.59	0.38	0.31	0.36	19.12	579.75
1966	0.4	0.44	0.51	0.65	0.56	5.9	4.23	1.17	0.43	0.58	0.52	0.31	15.7	595.45
1967	0.28	0.55	0.62	0.45	0.44	0.41	0.36	0.25	0.17	0.16	0.24	0.5	4.43	599.88
1968	0.7	1.24	0.81	0.38	0.8	3.05	1.38	0.68	0.61	0.37	0.29	0.26	10.57	610.45
1969	0.33	0.56	0.6	0.4	0.43	0.34	0.21	0.21	0.29	0.28	3.72	1.84	9.21	619.66
1970	5.45	2.63	0.74	0.51	0.58	0.52	0.46	0.69	0.59	0.55	1.76	1.05	15.54	635.20
1971	4.71	2.11	0.63	0.57	3.76	1.62	0.34	0.24	0.22	0.22	0.21	0.2	14.82	650.02
1972	0.22	0.46	0.69	0.55	0.46	0.45	0.48	0.33	0.19	0.16	0.19	0.25	4.43	654.45
1973	0.35	0.8	0.64	0.44	0.48	0.62	0.53	2.16	1.22	0.5	0.28	0.21	8.24	662.69
1974	0.22	0.41	0.57	0.45	0.39	0.41	0.31	0.22	0.17	0.15	0.14	0.27	3.7	666.39
1975	0.38	0.36	3.05	1.5	2.4	11.77	4.14	0.79	0.62	0.38	0.28	0.38	26.06	692.45
1976	8.02	3.09	0.52	0.44	0.59	0.63	0.36	0.21	0.19	0.19	0.26	0.45	14.95	707.40
1977	0.64	0.91	3.15	1.32	0.34	0.37	12.9	4.81	0.58	0.37	0.34	0.41	26.14	733.54
1978	1.21	1.22	0.67	0.41	0.41	0.62	0.55	0.32	0.22	0.31	0.4	0.47	6.82	740.36
1979	0.66	0.72	0.64	0.44	0.44	0.39	0.23	0.2	0.17	0.16	0.15	1.15	5.36	745.72
1980	0.9	3.15	1.45	3.86	1.77	0.52	0.29	0.33	0.37	0.27	0.28	0.31	13.49	759.21
1981	0.34	0.45	0.47	0.42	0.37	4.18	1.87	0.48	0.33	0.29	0.22	0.22	9.63	768.84
1982	0.31	0.26	0.17	0.14	0.12	0.12	0.13	0.12	0.1	15.7	5.63	0.59	23.38	792.22
1983	0.58	2.86	1.45	0.69	2.93	1.46	0.69	0.5	0.4	0.44	0.37	0.27	12.63	804.85
1984	0.41	0.83	0.63	0.49	13.29	4.75	0.37	0.23	0.19	0.19	0.16	0.14	21.68	826.53
1985	0.36	0.71	0.58	0.71	0.54	0.46	0.42	0.27	0.2	0.16	0.27	0.6	5.27	831.80
1986	2.16	3.23	1.31	0.47	0.28	0.27	0.26	0.19	0.16	0.15	0.18	12.56	21.22	853.02
1987	5.44	2.95	1.36	0.58	5.29	11.89	3.85	0.7	0.55	0.42	0.42	0.38	33.82	886.84
1988	0.46	2.67	3.52	1.21	4.63	2.03	1.97	0.98	0.39	0.33	0.25	0.21	18.63	905.47
1989	5.43	9.35	2.93	0.62	0.51	0.61	0.53	0.29	0.22	0.19	0.31	0.45	21.45	926.92
1990	0.59	0.63	0.54	0.6	1.18	0.71	0.29	0.21	0.18	0.16	0.15	0.19	5.4	932.32
1991	0.77	2.09	1.04	0.39	0.27	0.23	0.28	0.23	0.16	0.13	0.12	0.16	5.88	938.20
1992	0.28	0.4	0.35	0.25	0.23	0.16	0.16	0.16	0.12	0.1	0.1	0.66	2.96	941.16
1993	1.7	1.04	2.53	1.15	6.1	2.54	0.48	0.22	0.17	0.26	0.45	0.36	17.02	958.18
1994	0.24	0.21	0.28	0.33	0.22	1.97	2.23	0.95	1.06	0.77	0.37	0.38	9	967.18
1995	0.54	0.52	8.04	3.17	1.57	0.8	0.39	0.29	0.19	0.24	0.28	0.25	16.28	983.46
1996	0.42	6.09	2.51	1.13	0.82	0.67	2.29	1.14	10.48	4.2	0.73	0.59	31.08	1 014.54
1997	0.71	2.62	1.23	0.47	4.21	2.9	0.92	0.48	0.34	0.27	0.3	0.33	14.78	1 029.32
1998	0.29	0.45	2.41	1.15	0.64	2.01	1.02	0.36	0.24	0.19	0.17	0.14	9.06	1 038.38
1999	0.35	0.64	0.78	3.26	3.72	6.18	3.54	1.14	0.52	0.36	0.27	0.3	21.07	1 059.45
2000	0.45	0.54	0.65	0.49	0.34	0.37	0.41	0.37	0.27	0.31	0.34	0.32	4.85	1 064.30
2001	0.39	8.72	3.36	0.6	0.54	0.42	0.36	0.34	0.25	0.4	0.67	1.65	17.7	1 082.00
2002	0.94	0.56	0.63	0.42	0.23	3.17	1.64	0.68	0.49	0.37	0.28	0.49	9.9	1 091.90
2003	1.17	0.76	0.44	0.52	0.35	0.44	0.45	0.25	0.18	0.23	0.22	0.38	5.39	1 097.29
2004	0.74	0.64	0.44	2.73	1.26	0.32	0.3	0.28	0.23	0.2	0.2	0.24	7.57	1 104.86
2005	0.27	3.14	1.48	0.56	0.6	0.52	0.45	0.56	0.69	0.54	0.53	3.9	13.24	1 118.10
2006	6.31	2.24	7.05	2.74	0.4	0.4	0.59	0.44	0.3	0.25	0.22	0.23	21.17	1 139.27
2007	0.47	0.79	0.58	6.07	2.38	0.48	1.83	0.98	3.22	1.51	0.39	0.32	19.01	1 158.28
% of total	8.98	15.06	11.40	8.03	10.30	12.62	8.35	4.96	5.26	6.12	3.80	5.14	100.00	
Average	1.18	1.98	1.50	1.06	1.36	1.66	1.10	0.65	0.69	0.81	0.50	0.68	13.16	
SD	1.693	2.494	1.679	1.106	1.905	2.297	1.608	0.941	1.434	2.200	0.850	1.436	7.463	
CV	1.432	1.259	1.119	1.047	1.405	1.382	1.464	1.443	2.069	2.730	1.701	2.125	0.567	

NATURAL STREAMFLOW FOR QUATERNARY CATCHMENT T60F2 CATCHMENT AREA = 21.55 SQ KM

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOT	CUM
1920	0.09	0.16	0.24	0.2	0.17	0.21	0.22	0.14	0.09	0.07	0.06	0.09	1.75	1.75
1921	0.16	0.96	1.18	0.41	0.14	0.1	0.09	0.16	0.28	0.21	0.19	0.22	4.1	5.85
1922	1.52	1.89	0.59	1.58	2	0.81	0.2	0.1	0.08	1	0.46	0.12	10.35	16.2
1923	0.11	0.13	0.15	0.66	0.38	0.15	0.08	0.07	0.07	0.07	0.07	0.09	2.02	18.22
1924	0.13	0.18	0.45	0.26	0.17	1.43	0.62	0.15	0.1	0.08	0.07	0.1	3.75	21.97
1925	0.14	0.17	0.18	0.18	0.2	1.42	0.59	0.11	0.12	0.12	0.08	0.11	3.42	25.39
1926	0.19	0.49	0.4	0.21	0.13	2.04	0.76	0.08	0.06	0.05	0.05	0.07	4.53	29.92
1927	0.13	0.12	0.14	0.23	0.47	0.28	0.12	0.08	0.07	0.06	0.07	0.08	1.83	31.75
1928	0.1	0.16	0.17	0.15	0.13	0.16	0.13	0.09	0.43	0.43	0.26	0.68	2.89	34.64
1929	1.28	0.98	0.35	0.15	0.11	0.12	0.13	0.1	0.11	0.13	0.16	0.4	4.02	38.66
1930	0.28	0.16	0.13	0.88	1.07	1.22	0.44	0.1	0.06	3.98	1.44	0.13	9.9	48.56
1931	0.17	0.21	0.18	0.11	0.56	0.33	0.13	0.1	0.12	0.13	0.11	0.49	2.62	51.18
1932	0.34	2.51	1.44	0.29	0.13	0.23	0.16	0.09	0.07	0.06	0.05	0.05	5.44	56.62
1933	0.06	0.36	0.73	1.13	0.45	0.21	0.17	0.11	0.08	0.1	0.1	0.07	3.56	60.18
1934	0.07	0.13	0.55	0.3	0.11	0.12	0.37	0.71	1.58	0.61	0.21	0.18	4.95	65.13
1935	0.15	0.18	0.11	0.07	1.26	1.42	0.45	0.2	0.2	0.13	0.09	0.08	4.35	69.48
1936	0.17	3.1	1.12	0.11	0.62	0.51	0.21	0.09	0.07	0.07	0.07	0.07	6.2	75.68
1937	0.09	0.1	0.16	0.22	0.18	0.13	0.16	0.15	0.12	0.12	0.1	0.07	1.59	77.27
1938	0.07	0.14	0.21	0.47	1.13	0.48	0.14	0.12	0.09	0.12	0.15	1.1	4.22	81.49
1939	0.6	0.23	0.22	0.16	0.14	0.16	0.12	0.18	0.18	0.11	0.07	0.09	2.25	83.74
1940	0.11	0.53	0.3	0.11	0.07	0.06	0.06	0.05	0.04	0.04	0.04	0.05	1.48	85.22
1941	0.08	0.14	0.11	0.24	0.19	0.16	0.15	0.14	0.11	0.07	0.06	0.08	1.53	86.75
1942	0.13	2.86	1.6	0.34	0.11	0.15	0.45	0.27	0.14	0.12	0.18	0.22	6.57	93.32
1943	0.21	0.83	0.57	0.21	0.17	0.16	0.1	0.07	0.07	0.08	0.06	0.65	3.19	96.51
1944	0.41	0.19	0.1	0.11	0.18	0.24	0.17	0.09	0.07	0.06	0.05	0.06	1.72	98.23
1945	1.04	0.45	0.09	0.08	0.12	0.18	0.18	0.12	0.07	0.06	0.05	0.05	2.49	100.72
1946	0.08	0.17	0.17	0.12	0.13	0.54	0.35	0.18	0.22	0.21	0.13	0.1	2.41	103.13
1947	0.11	3.48	1.44	0.21	0.23	0.22	0.16	0.09	0.06	0.05	0.04	0.04	6.14	109.27
1948	0.1	0.19	0.17	0.14	0.68	0.41	0.21	0.13	0.07	0.06	0.05	0.06	2.26	111.53
1949	0.09	0.38	0.26	0.18	0.22	0.23	0.19	0.16	0.12	0.1	0.12	0.11	2.15	113.68
1950	0.13	0.12	0.56	0.33	0.15	0.14	0.11	0.07	0.05	0.04	0.05	0.08	1.83	115.51
1951	0.33	0.21	0.15	0.23	0.2	0.18	0.18	0.13	0.08	0.06	0.04	0.06	1.86	117.37
1952	0.09	0.09	0.09	0.09	0.1	0.09	0.08	0.06	0.04	0.03	0.04	0.12	0.92	118.29
1953	0.35	1.19	0.49	0.12	0.07	0.12	0.12	0.1	0.12	0.11	0.08	0.09	2.96	121.25
1954	1.61	0.67	0.14	0.2	0.63	0.34	0.13	0.08	0.07	0.06	0.05	0.08	4.06	125.31
1955	0.15	0.17	0.12	0.06	0.08	1.27	0.55	0.13	0.11	0.08	0.06	0.08	2.86	128.17
1956	0.15	2.03	2.75	0.84	0.19	0.37	0.51	0.25	0.13	0.1	0.1	0.13	7.54	135.71
1957	0.2	0.23	0.51	0.52	0.94	0.4	0.21	0.16	0.08	0.07	0.07	0.07	3.46	139.17
1958	0.09	0.72	0.4	0.14	0.12	0.13	0.13	2.04	0.79	0.18	0.22	0.22	5.18	144.35
1959	0.21	0.21	0.21	0.18	0.13	0.15	0.19	0.16	0.1	0.07	0.08	0.12	1.8	146.15
1960	0.16	0.2	0.78	0.71	0.28	0.16	1.31	0.56	0.12	0.1	0.08	0.07	4.51	150.66
1961	0.08	0.15	0.22	0.17	0.17	0.46	0.25	0.1	0.07	0.05	0.06	0.07	1.86	152.52
1962	0.14	0.62	0.33	0.78	0.38	2.53	0.95	0.13	0.09	0.52	0.3	0.1	6.88	159.4
1963	0.13	0.4	0.27	0.63	0.36	0.24	0.49	0.26	2.01	0.81	0.12	0.12	5.83	165.23
1964	0.36	0.24	0.13	0.13	0.13	0.08	0.05	0.06	0.66	0.42	0.25	0.24	2.77	168
1965	1.81	1.34	0.38	0.15	0.13	0.08	0.06	1.02	0.48	0.11	0.09	0.11	5.75	173.75
1966	0.12	0.13	0.15	0.19	0.16	1.78	1.28	0.35	0.13	0.17	0.15	0.09	4.71	178.46
1967	0.08	0.16	0.18	0.13	0.13	0.12	0.11	0.07	0.05	0.04	0.07	0.15	1.29	179.75
1968	0.21	0.37	0.24	0.11	0.24	0.92	0.42	0.2	0.18	0.11	0.09	0.07	3.17	182.92
1969	0.1	0.17	0.18	0.12	0.13	0.1	0.06	0.06	0.08	0.08	1.12	0.55	2.75	185.67
1970	1.65	0.79	0.22	0.15	0.17	0.15	0.14	0.21	0.18	0.16	0.53	0.32	4.67	190.34
1971	1.42	0.63	0.19	0.17	1.13	0.49	0.1	0.07	0.06	0.06	0.06	0.06	4.45	194.79
1972	0.06	0.14	0.2	0.16	0.13	0.13	0.14	0.1	0.05	0.05	0.05	0.07	1.29	196.08
1973	0.1	0.24	0.19	0.13	0.14	0.18	0.16	0.65	0.37	0.15	0.08	0.06	2.47	198.55
1974	0.06	0.12	0.17	0.14	0.12	0.12	0.09	0.06	0.05	0.04	0.04	0.08	1.09	199.64
1975	0.11	0.11	0.92	0.45	0.72	3.55	1.25	0.24	0.19	0.11	0.08	0.11	7.85	207.49
1976	2.42	0.93	0.16	0.13	0.18	0.19	0.11	0.06	0.05	0.05	0.08	0.13	4.49	211.98
1977	0.19	0.27	0.95	0.4	0.1	0.11	3.9	1.45	0.18	0.11	0.1	0.12	7.88	219.86
1978	0.36	0.37	0.2	0.12	0.12	0.18	0.16	0.09	0.06	0.09	0.12	0.14	2.03	221.89
1979	0.19	0.21	0.19	0.13	0.13	0.11	0.07	0.06	0.05	0.05	0.04	0.34	1.58	223.47
1980	0.27	0.95	0.43	1.16	0.53	0.16	0.09	0.1	0.11	0.08	0.08	0.09	4.05	227.52
1981	0.1	0.13	0.14	0.12	0.11	1.26	0.56	0.15	0.1	0.08	0.06	0.06	2.88	230.4
1982	0.09	0.07	0.05	0.04	0.03	0.03	0.04	0.03	0.03	4.74	1.7	0.18	7.04	237.44
1983	0.17	0.86	0.43	0.21	0.88	0.44	0.21	0.15	0.12	0.13	0.11	0.08	3.79	241.23
1984	0.12	0.25	0.19	0.14	4.01	1.43	0.11	0.07	0.06	0.05	0.04	0.04	6.53	247.76
1985	0.11	0.21	0.17	0.21	0.16	0.14	0.12	0.08	0.06	0.05	0.08	0.18	1.56	249.32
1986	0.65	0.97	0.39	0.14	0.08	0.08	0.08	0.05	0.05	0.04	0.05	3.79	6.39	255.71
1987	1.64	0.89	0.41	0.17	1.6	3.59	1.16	0.21	0.16	0.13	0.12	0.11	10.2	265.91
1988	0.14	0.8	1.06	0.36	1.4	0.61	0.6	0.3	0.11	0.1	0.07	0.06	5.61	271.52
1989	1.64	2.82	0.88	0.19	0.15	0.18	0.16	0.08	0.06	0.06	0.09	0.13	6.44	277.96
1990	0.17	0.18	0.16	0.18	0.35	0.21	0.08	0.06	0.05	0.04	0.04	0.05	1.59	279.55
1991	0.23	0.63	0.31	0.12	0.08	0.07	0.08	0.07	0.04	0.04	0.03	0.04	1.74	281.29
1992	0.08	0.12	0.1	0.08	0.07	0.05	0.05	0.04	0.03	0.03	0.03	0.2	0.86	282.15
1993	0.51	0.31	0.76	0.35	1.84	0.77	0.15	0.06	0.05	0.08	0.13	0.11	5.12	287.27
1994	0.07	0.06	0.08	0.1	0.06	0.59	0.67	0.29	0.32	0.23	0.11	0.11	2.7	289.97
1995	0.16	0.16	2.43	0.95	0.47	0.24	0.12	0.08	0.06	0.07	0.08	0.07	4.9	294.87
1996	0.12	1.84	0.75	0.34	0.25	0.2	0.69	0.35	3.17	1.27	0.22	0.18	9.37	304.24
1997	0.21	0.79	0.37	0.14	1.27	0.87	0.28	0.14	0.1	0.08	0.09	0.1	4.43	308.67
1998	0.08	0.13	0.72	0.35	0.19	0.6	0.31	0.11	0.07	0.06	0.05	0.04	2.7	311.37
1999	0.1	0.19	0.24	0.98	1.12	1.87	1.07	0.34	0.15	0.1	0.08	0.09	6.34	317.71
2000	0.13	0.16	0.19	0.14	0.1	0.11	0.12	0.11	0.08	0.09	0.1	0.09	1.42	319.13
2001	0.11	2.63	1.01	0.18	0.16	0.12	0.11	0.1	0.07	0.12	0.2	0.49	5.3	324.43
2002	0.28	0.16	0.19	0.13	0.07	0.96	0.49	0.2	0.14	0.11	0.08	0.14	2.96	327.39
2003	0.35	0.23	0.13	0.15	0.1	0.13	0.13	0.07	0.05	0.07	0.06	0.11	1.6	328.99
2004	0.22	0.19	0.13	0.82	0.38	0.09	0.09	0.08	0.07	0.06	0.06	0.07	2.26	331.25
2005	0.08	0.95	0.44	0.17	0.18	0.16	0.13	0.17	0.21	0.16	0.16	1.18	3.98	335.23
2006	1.91	0.67	2.13	0.83	0.12	0.12	0.18	0.13	0.09	0.07	0.06	0.07	6.37	341.6
2007	0.14	0.24	0.17	1.83	0.71	0.14	0.55	0.3	0.97	0.45	0.11	0.09	5.72	347.32
% of total	8.97	15.09	11.41	8.03	10.30	12.66	8.36	4.93	5.24	6.10	3.75	5.10	100.00	
Average	0.35	0.60	0.45	0.32	0.41	0.50	0.33	0.19	0.21	0.24	0.15	0.20	3.95	
SD	0.512	0.754	0.507	0.334	0.575	0.694	0.486	0.285	0.434	0.665	0.258	0.434	2.257	
CV	1.447	1.266	1.126	1.053	1.414	1.389	1.473	1.464	2.096	2.764	1.739	2.156	0.572	

NATURAL STREAMFLOW FOR QUATERNARY CATCHMENT T60F3 CATCHMENT AREA = 271.09 SQ KM

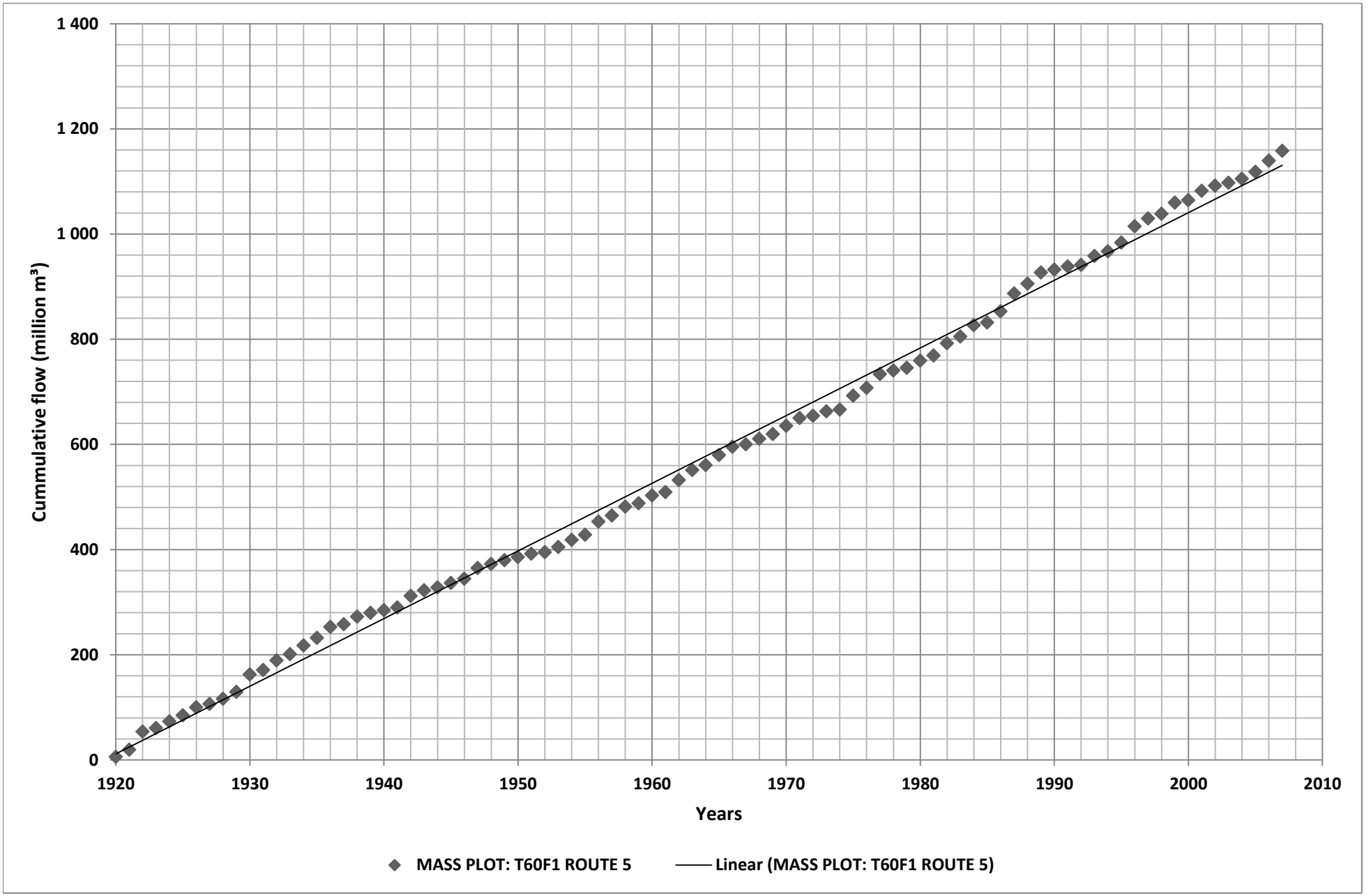
YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOT	CUM
1920	1.19	1.99	3.00	2.51	2.17	2.62	2.75	1.83	1.14	0.93	0.80	1.09	22.01	22.01
1921	2.04	12.12	14.85	5.21	1.80	1.31	1.13	1.99	3.51	2.65	2.36	2.75	51.70	73.71
1922	19.09	24.11	7.45	19.88	25.48	10.19	2.51	1.25	1.00	12.64	5.80	1.49	130.88	204.60
1923	1.40	1.62	1.94	8.26	4.73	1.90	1.07	0.92	0.92	0.88	0.95	1.26	25.85	230.45
1924	1.73	2.39	5.71	3.26	2.29	18.24	7.86	1.97	1.30	1.13	0.97	1.34	48.20	278.65
1925	1.86	2.35	2.43	2.43	2.71	18.03	7.40	1.45	1.61	1.64	1.18	1.48	44.56	323.20
1926	2.56	6.15	5.07	2.65	1.81	25.65	9.85	1.07	0.83	0.74	0.74	0.95	58.07	381.27
1927	1.76	1.64	1.89	2.84	5.93	3.46	1.57	1.08	0.96	0.82	1.06	1.18	24.21	405.48
1928	1.35	2.11	2.32	2.06	1.74	2.20	1.73	1.23	5.50	5.55	3.28	8.59	37.67	443.16
1929	16.10	12.34	4.44	1.93	1.37	1.54	1.73	1.31	1.50	1.73	2.04	5.04	51.08	494.23
1930	3.47	2.08	1.76	11.18	13.51	15.35	5.58	1.26	0.85	50.07	18.11	1.72	124.96	619.20
1931	2.16	2.65	2.27	1.48	6.99	4.10	1.60	1.36	1.56	1.67	1.40	6.21	33.44	652.63
1932	4.30	31.57	18.20	3.62	1.72	3.00	2.09	1.21	0.91	0.83	0.73	0.75	68.94	721.57
1933	0.83	4.48	9.28	14.21	5.68	2.69	2.22	1.40	1.01	1.34	1.32	0.91	45.38	766.95
1934	0.96	1.76	7.00	3.79	1.37	1.64	4.65	9.05	19.84	7.73	2.65	2.37	62.78	829.73
1935	1.94	2.37	1.39	0.91	15.87	17.86	5.62	2.57	2.54	1.75	1.20	1.12	55.13	884.86
1936	2.24	38.98	14.15	1.44	7.85	6.39	2.63	1.21	0.91	0.88	0.88	0.91	78.47	963.33
1937	1.15	1.34	2.14	2.83	2.37	1.64	2.12	1.97	1.52	1.58	1.29	0.94	20.88	984.21
1938	1.00	1.83	2.72	6.04	14.23	6.09	1.82	1.50	1.23	1.51	1.96	13.82	53.74	1 037.95
1939	7.63	2.94	2.78	2.05	1.75	2.03	1.59	2.29	2.36	1.37	0.95	1.13	28.86	1 066.81
1940	1.39	6.79	3.81	1.45	0.93	0.83	0.85	0.68	0.59	0.61	0.61	0.63	19.17	1 085.97
1941	1.07	1.80	1.33	3.14	2.45	1.99	1.91	1.81	1.37	0.83	0.83	1.07	19.62	1 105.59
1942	1.64	35.96	20.14	4.30	1.41	1.97	5.73	3.38	1.80	1.51	2.35	2.81	82.99	1 188.59
1943	2.74	10.50	7.26	2.62	2.16	2.05	1.34	0.95	0.91	1.00	0.83	8.22	40.59	1 229.18
1944	5.11	2.34	1.23	1.41	2.35	3.05	2.10	1.22	0.98	0.79	0.64	0.78	21.99	1 251.17
1945	13.12	5.74	1.12	1.10	1.52	2.28	2.35	1.56	0.96	0.82	0.64	0.62	31.84	1 283.01
1946	1.02	2.21	2.10	1.51	1.72	6.86	4.45	2.24	2.83	2.67	1.64	1.29	30.54	1 313.55
1947	1.38	43.81	18.12	2.67	2.93	2.76	2.09	1.21	0.78	0.64	0.56	0.53	77.48	1 391.03
1948	1.28	2.43	2.15	1.77	8.64	5.15	2.62	1.67	0.94	0.76	0.70	0.83	28.94	1 419.96
1949	1.21	4.87	3.24	2.29	2.78	2.94	2.40	2.09	1.54	1.29	1.53	1.42	27.61	1 447.57
1950	1.73	1.62	7.15	4.12	1.84	1.76	1.40	0.89	0.70	0.60	0.67	1.01	23.49	1 471.06
1951	4.15	2.61	1.94	2.86	2.49	2.33	2.36	1.67	1.02	0.78	0.60	0.80	23.62	1 494.68
1952	1.17	1.21	1.15	1.18	1.23	1.13	1.09	0.83	0.58	0.46	0.49	1.48	11.98	1 506.65
1953	4.48	14.97	6.18	1.45	0.90	1.56	1.56	1.30	1.54	1.40	0.99	1.18	37.51	1 544.17
1954	20.31	8.44	1.75	2.49	8.01	4.22	1.63	1.06	0.94	0.83	0.60	1.02	51.31	1 595.48
1955	1.89	2.21	1.49	0.70	1.07	15.99	6.99	1.67	1.36	1.10	0.79	1.07	36.33	1 631.81
1956	1.98	25.49	34.64	10.60	2.39	4.65	6.37	3.16	1.61	1.34	1.23	1.72	95.17	1 726.98
1957	2.52	2.94	6.47	6.52	11.86	5.08	2.66	2.08	1.10	0.93	0.86	0.93	43.94	1 770.92
1958	1.12	9.10	5.03	1.82	1.52	1.70	1.70	25.62	10.05	2.33	2.81	2.83	65.62	1 836.54
1959	2.68	2.70	2.71	2.27	1.69	1.90	2.44	2.02	1.26	0.97	1.09	1.61	23.34	1 859.88
1960	2.09	2.57	9.83	8.95	3.49	2.07	16.45	7.12	1.51	1.28	1.04	0.93	57.33	1 917.21
1961	1.02	1.96	2.81	2.17	2.18	5.90	3.16	1.35	0.97	0.72	0.82	0.94	24.00	1 941.21
1962	1.83	7.87	4.21	9.86	4.82	31.77	11.98	1.68	1.23	6.59	3.73	1.27	86.83	2 028.04
1963	1.73	4.99	3.35	8.03	4.55	3.00	6.19	3.24	25.30	10.27	1.59	1.48	73.73	2 101.77
1964	4.52	2.96	1.70	1.73	1.73	1.11	0.74	0.84	8.42	5.26	3.22	3.13	35.34	2 137.11
1965	22.78	16.94	4.79	1.89	1.67	1.01	0.75	12.85	6.05	1.48	1.18	1.38	72.78	2 209.89
1966	1.55	1.70	1.94	2.49	2.15	22.42	16.10	4.44	1.66	2.22	1.98	1.18	59.83	2 269.72
1967	1.09	2.13	2.37	1.72	1.68	1.59	1.40	0.97	0.68	0.61	0.92	1.94	17.10	2 286.82
1968	2.68	4.71	3.08	1.45	3.05	11.61	5.25	2.61	2.33	1.42	1.12	0.99	40.30	2 327.11
1969	1.29	2.14	2.30	1.51	1.66	1.32	0.82	0.81	1.10	1.07	14.12	6.99	35.14	2 362.25
1970	20.72	10.03	2.83	1.94	2.21	1.98	1.78	2.64	2.27	2.12	6.69	3.98	59.17	2 421.43
1971	17.91	8.01	2.40	2.17	14.30	6.15	1.31	0.91	0.85	0.85	0.80	0.75	56.41	2 477.84
1972	0.84	1.78	2.65	2.11	1.76	1.71	1.83	1.26	0.75	0.63	0.74	0.97	17.03	2 494.87
1973	1.35	3.05	2.44	1.68	1.83	2.37	2.05	8.22	4.64	1.89	1.09	0.82	31.43	2 526.30
1974	0.85	1.56	2.17	1.72	1.51	1.56	1.21	0.85	0.65	0.57	0.53	1.03	14.23	2 540.52
1975	1.47	1.37	11.60	5.71	9.12	44.72	15.75	3.01	2.36	1.46	1.07	1.45	99.10	2 639.62
1976	30.47	11.74	2.00	1.70	2.24	2.41	1.38	0.83	0.72	0.72	1.01	1.72	56.94	2 696.56
1977	2.44	3.45	11.99	5.01	1.31	1.42	49.00	18.27	2.21	1.43	1.29	1.58	99.40	2 795.97
1978	4.58	4.63	2.55	1.56	1.58	2.38	2.12	1.24	0.87	1.18	1.56	1.82	26.06	2 822.02
1979	2.52	2.77	2.45	1.66	1.71	1.50	0.91	0.77	0.68	0.62	0.58	4.41	20.58	2 842.60
1980	3.42	11.97	5.52	14.67	6.75	2.01	1.12	1.25	1.42	1.02	1.08	1.18	51.42	2 894.02
1981	1.29	1.73	1.80	1.61	1.40	15.89	7.12	1.83	1.26	1.10	0.85	0.85	36.73	2 930.75
1982	1.20	0.99	0.67	0.56	0.47	0.47	0.50	0.45	0.39	59.64	21.39	2.25	88.98	3 019.74
1983	2.22	10.89	5.50	2.65	11.14	5.55	2.62	1.90	1.51	1.67	1.40	1.04	48.09	3 067.83
1984	1.56	3.17	2.40	1.87	50.49	18.06	1.42	0.90	0.74	0.72	0.61	0.55	82.47	3 150.31
1985	1.38	2.73	2.21	2.69	2.06	1.77	1.62	1.04	0.75	0.63	1.02	2.29	20.20	3 170.50
1986	8.21	12.29	4.97	1.78	1.09	1.05	1.02	0.72	0.64	0.58	0.69	47.74	80.76	3 251.26
1987	20.66	11.23	5.17	2.20	20.10	45.16	14.62	2.67	2.08	1.62	1.59	1.45	128.57	3 379.83
1988	1.77	10.18	13.38	4.59	17.59	7.70	7.49	3.73	1.48	1.26	0.96	0.80	70.91	3 450.75
1989	20.64	35.51	11.18	2.38	1.96	2.34	2.02	1.10	0.86	0.75	1.21	1.72	81.68	3 532.43
1990	2.27	2.40	2.07	2.29	4.46	2.69	1.10	0.80	0.72	0.62	0.58	0.74	20.74	3 553.17
1991	2.94	7.97	3.95	1.49	1.05	0.89	1.09	0.91	0.61	0.52	0.49	0.63	22.54	3 575.71
1992	1.10	1.53	1.34	0.99	0.88	0.63	0.62	0.62	0.46	0.39	0.39	2.53	11.48	3 587.19
1993	6.47	3.98	9.61	4.39	23.19	9.65	1.83	0.84	0.67	0.99	1.73	1.37	64.73	3 651.93
1994	0.94	0.80	1.09	1.25	0.85	7.49	8.48	3.60	4.04	2.91	1.41	1.44	34.29	3 686.22
1995	2.08	2.00	30.54	12.03	5.98	3.04	1.48	1.10	0.73	0.93	1.09	0.95	61.94	3 748.16
1996	1.59	23.13	9.54	4.29	3.13	2.57	8.74	4.34	39.82	15.98	2.78	2.27	118.19	3 866.35
1997	2.72	10.00	4.68	1.79	16.00	11.06	3.49	1.83	1.29	1.02	1.15	1.25	56.29	3 922.64
1998	1.10	1.73	9.20	4.37	2.44	7.62	3.87	1.39	0.92	0.75	0.65	0.55	34.59	3 957.23
1999	1.36	2.47	2.98	12.41	14.15	23.48	13.47	4.32	1.99	1.36	1.04	1.16	80.19	4 037.41
2000	1.71	2.06	2.47	1.86	1.32	1.42	1.58	1.43	1.04	1.21	1.32	1.25	18.68	4 056.09
2001	1.52	33.14	12.77	2.29	2.07	1.60	1.39	1.29	0.99	1.56	2.58	6.33	67.52	4 123.61
2002	3.57	2.13	2.40	1.61	0.88	12.07	6.27	2.59	1.87	1.43	1.10	1.87	37.80	4 161.41
2003	4.44	2.89	1.68	1.98	1.34	1.67	1.73	0.97	0.71	0.88	0.85	1.48	20.63	4 182.03
2004	2.82	2.43	1.67	10.38	4.80	1.21	1.17	1.10	0.88	0.75	0.76	0.91	28.88	4 210.92
2005	1.04	11.93	5.63	2.13	2.29	2.00	1.72	2.16	2.65	2.05	2.01	14.84	50.44	4 261.36
2006	23.99	8.53	26.80	10.44	1.52	1.52	2.25	1.67	1.15	0.96	0.84	0.88	80.55	4 341.91
2007	1.80	3.04	2.20	23.08	9.07	1.83	6.93	3.72	12.25	5.72	1.48	1.23	72.35	4 414.26
% of to	8.98	15.04	11.39	8.02	10.29	12.61	8.35	4.97	5.28	6.13	3.81	5.15	100.00	
Averag	4.50	7.54	5.71	4.02	5.16	6.32	4.19	2.49	2.65	3.07	1.91	2.58	50.16	
SD	6.427	9.472	6.375	4.204	7.240	8.726	6.107	3.574	5.445	8.357	3.229	5.457	28.335	
CV	1.427	1.256	1.116	1.045	1.402	1.380	1.459	1.435	2.056	2.719	1.689	2.114	0.565	

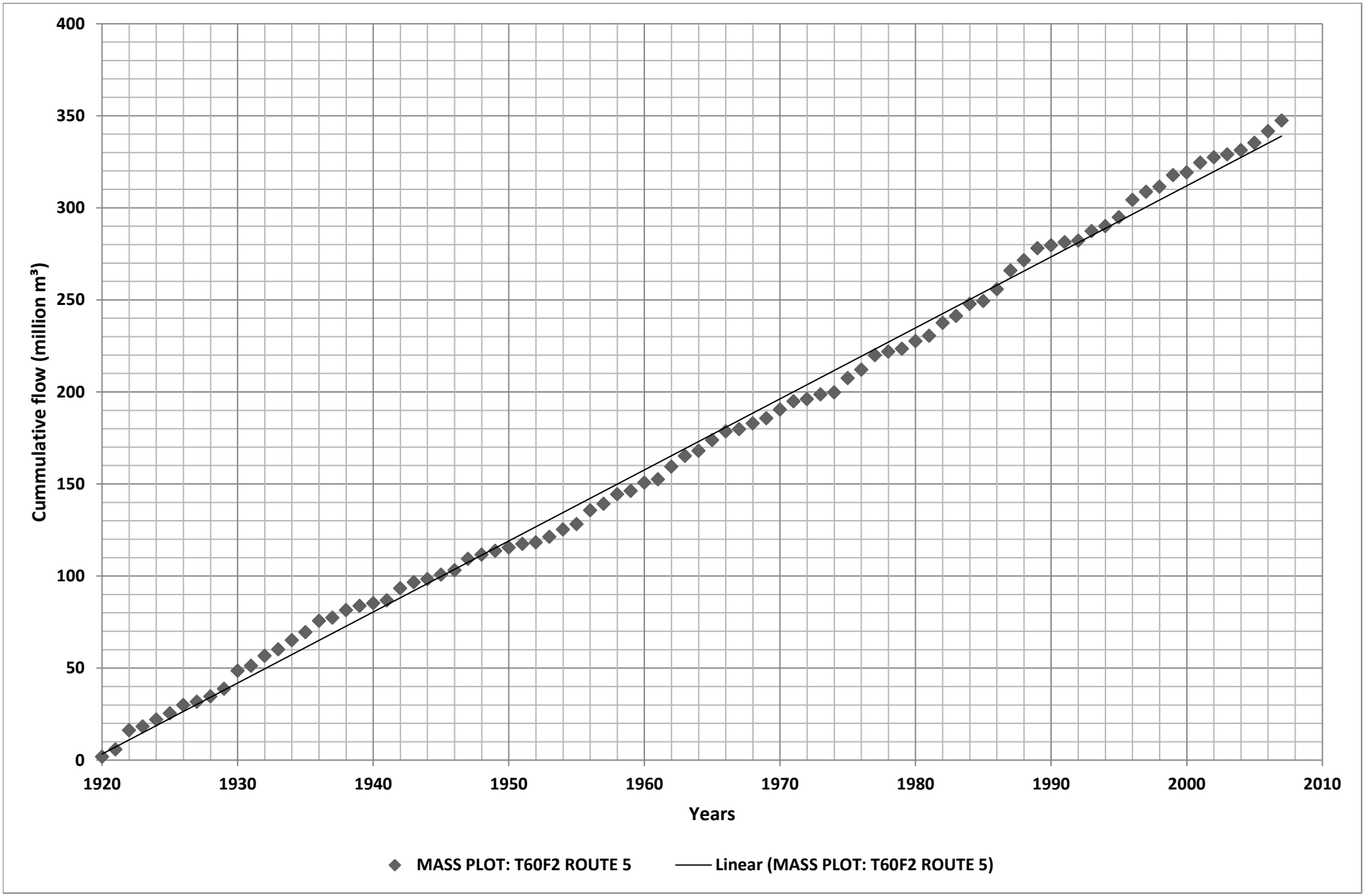
NATURAL STREAMFLOW FOR QUATERNARY CATCHMENT T60F4 CATCHMENT AREA = 99.91 SQ KM

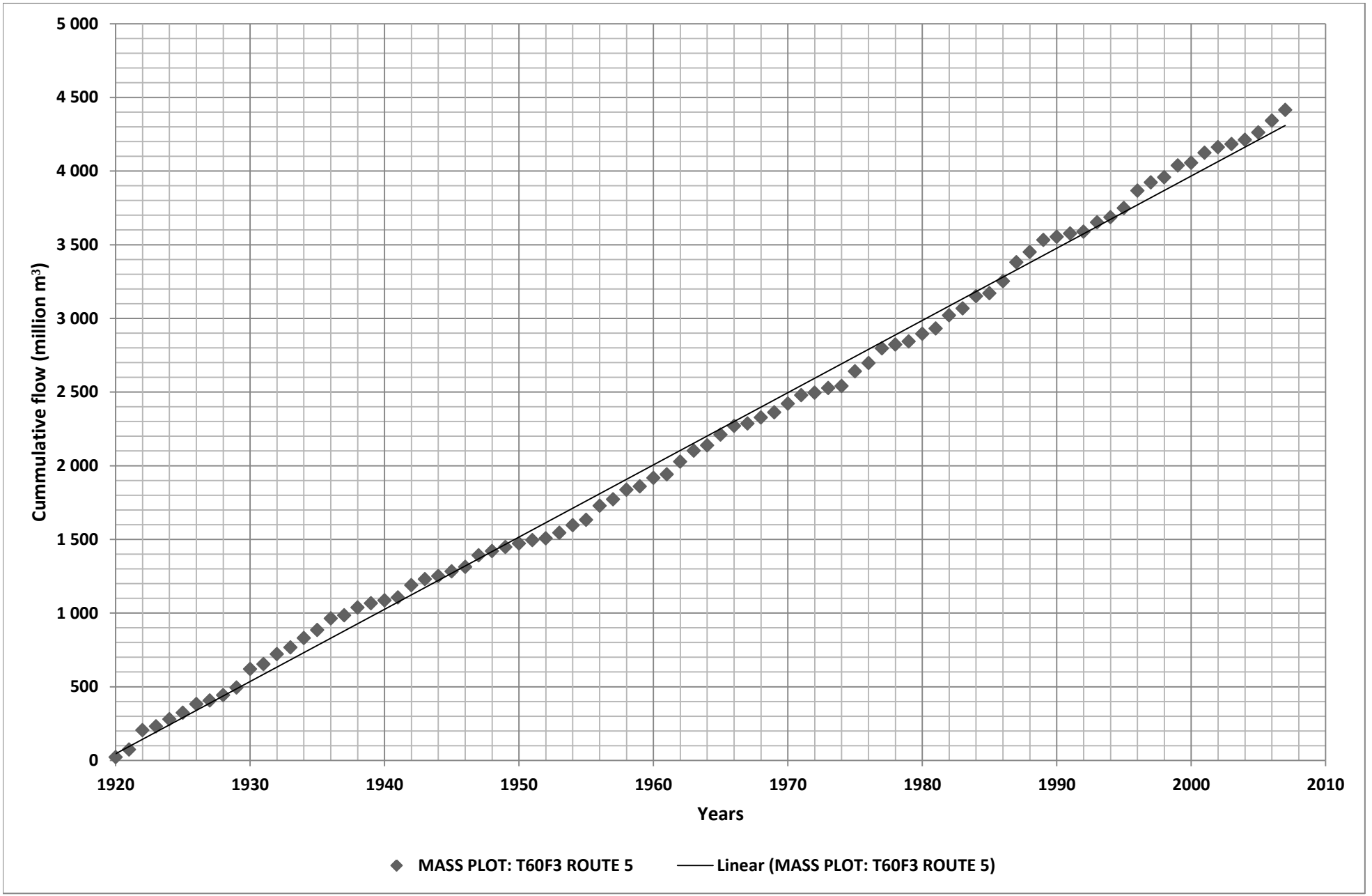
YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOT	CUM
1920	0.44	0.73	1.10	0.92	0.80	0.96	1.02	0.67	0.42	0.34	0.30	0.40	8.11	8.11
1921	0.75	4.46	5.47	1.92	0.66	0.48	0.42	0.73	1.30	0.97	0.87	1.01	19.06	27.17
1922	7.03	8.88	2.75	7.33	9.39	3.75	0.92	0.46	0.37	4.66	2.14	0.55	48.24	75.40
1923	0.52	0.60	0.71	3.05	1.74	0.70	0.40	0.34	0.34	0.32	0.35	0.46	9.53	84.93
1924	0.64	0.88	2.11	1.20	0.84	6.72	2.89	0.73	0.48	0.42	0.36	0.50	17.76	102.69
1925	0.68	0.87	0.89	0.90	1.00	6.64	2.73	0.53	0.59	0.60	0.43	0.55	16.42	119.12
1926	0.95	2.26	1.87	0.98	0.67	9.46	3.63	0.39	0.30	0.27	0.27	0.35	21.40	140.52
1927	0.65	0.61	0.70	1.05	2.19	1.28	0.58	0.40	0.35	0.30	0.39	0.44	8.92	149.44
1928	0.50	0.78	0.86	0.76	0.64	0.81	0.64	0.46	2.03	2.04	1.21	3.17	13.89	163.32
1929	5.94	4.55	1.63	0.71	0.51	0.57	0.64	0.48	0.55	0.64	0.75	1.86	18.82	182.15
1930	1.28	0.77	0.65	4.12	4.98	5.66	2.06	0.47	0.31	18.46	6.68	0.64	46.06	228.20
1931	0.80	0.97	0.83	0.54	2.58	1.51	0.59	0.50	0.57	0.62	0.51	2.29	12.32	240.53
1932	1.59	11.63	6.71	1.34	0.64	1.10	0.77	0.45	0.34	0.30	0.27	0.28	25.41	265.94
1933	0.31	1.65	3.42	5.24	2.10	0.99	0.82	0.52	0.37	0.49	0.49	0.33	16.72	282.66
1934	0.35	0.65	2.58	1.39	0.50	0.60	1.71	3.33	7.31	2.85	0.97	0.87	23.14	305.80
1935	0.72	0.88	0.51	0.33	5.85	6.58	2.07	0.95	0.93	0.64	0.44	0.41	20.32	326.12
1936	0.83	14.37	5.21	0.53	2.89	2.35	0.97	0.44	0.33	0.33	0.33	0.34	28.92	355.04
1937	0.42	0.50	0.79	1.04	0.87	0.60	0.78	0.73	0.56	0.58	0.47	0.34	7.69	362.73
1938	0.37	0.68	1.00	2.22	5.24	2.24	0.67	0.55	0.45	0.56	0.72	5.10	19.81	382.54
1939	2.81	1.08	1.02	0.76	0.64	0.75	0.58	0.84	0.87	0.50	0.35	0.42	10.63	393.17
1940	0.51	2.50	1.40	0.53	0.34	0.30	0.32	0.25	0.22	0.23	0.23	0.23	7.06	400.24
1941	0.39	0.66	0.49	1.16	0.90	0.74	0.71	0.67	0.51	0.31	0.31	0.40	7.23	407.47
1942	0.60	13.25	7.42	1.58	0.52	0.72	2.11	1.24	0.67	0.56	0.87	1.04	30.59	438.05
1943	1.01	3.87	2.67	0.97	0.80	0.76	0.50	0.35	0.33	0.37	0.31	3.03	14.96	453.01
1944	1.88	0.86	0.46	0.52	0.86	1.13	0.77	0.45	0.36	0.29	0.23	0.29	8.11	461.12
1945	4.84	2.11	0.41	0.41	0.56	0.84	0.86	0.58	0.36	0.30	0.24	0.23	11.73	472.85
1946	0.38	0.81	0.77	0.55	0.64	2.53	1.64	0.82	1.04	0.99	0.61	0.48	11.26	484.11
1947	0.51	16.15	6.68	0.98	1.08	1.02	0.77	0.44	0.29	0.23	0.21	0.19	28.55	512.66
1948	0.47	0.90	0.79	0.65	3.19	1.90	0.97	0.61	0.34	0.28	0.26	0.30	10.66	523.33
1949	0.45	1.80	1.20	0.84	1.02	1.08	0.88	0.77	0.57	0.48	0.56	0.53	10.17	533.50
1950	0.64	0.60	2.63	1.52	0.68	0.65	0.51	0.33	0.26	0.22	0.25	0.37	8.66	542.16
1951	1.53	0.96	0.72	1.05	0.92	0.86	0.87	0.62	0.37	0.29	0.22	0.30	8.70	550.86
1952	0.43	0.44	0.42	0.43	0.46	0.41	0.40	0.30	0.21	0.17	0.18	0.54	4.41	555.28
1953	1.65	5.52	2.28	0.54	0.33	0.57	0.58	0.48	0.57	0.52	0.36	0.43	13.83	569.10
1954	7.49	3.11	0.65	0.92	2.95	1.56	0.60	0.39	0.35	0.30	0.22	0.38	18.91	588.01
1955	0.70	0.81	0.55	0.26	0.40	5.89	2.58	0.62	0.50	0.40	0.29	0.39	13.39	601.40
1956	0.73	9.39	12.76	3.91	0.88	1.71	2.35	1.16	0.60	0.49	0.46	0.63	35.08	636.48
1957	0.93	1.08	2.39	2.40	4.37	1.87	0.98	0.76	0.40	0.34	0.32	0.34	16.19	652.67
1958	0.41	3.36	1.85	0.67	0.56	0.62	0.62	9.44	3.71	0.86	1.04	1.04	24.19	676.86
1959	0.99	1.00	1.00	0.83	0.62	0.70	0.90	0.74	0.47	0.36	0.40	0.59	8.60	685.46
1960	0.77	0.95	3.62	3.30	1.29	0.76	6.06	2.63	0.56	0.47	0.38	0.34	21.13	706.59
1961	0.37	0.72	1.03	0.80	0.80	2.17	1.17	0.50	0.36	0.27	0.30	0.35	8.84	715.43
1962	0.67	2.90	1.55	3.63	1.77	11.71	4.41	0.62	0.45	2.43	1.38	0.47	32.00	747.43
1963	0.64	1.84	1.24	2.96	1.68	1.11	2.28	1.19	9.33	3.78	0.58	0.55	27.17	774.60
1964	1.66	1.09	0.62	0.64	0.64	0.41	0.27	0.31	3.10	1.94	1.18	1.15	13.03	787.63
1965	8.40	6.25	1.77	0.70	0.62	0.37	0.28	4.73	2.23	0.54	0.43	0.51	26.82	814.45
1966	0.57	0.62	0.72	0.92	0.79	8.26	5.93	1.64	0.61	0.82	0.73	0.44	22.05	836.50
1967	0.40	0.78	0.88	0.64	0.62	0.58	0.51	0.36	0.25	0.23	0.34	0.71	6.30	842.80
1968	0.99	1.73	1.14	0.53	1.12	4.28	1.94	0.96	0.86	0.53	0.41	0.36	14.85	857.66
1969	0.47	0.79	0.85	0.56	0.61	0.48	0.30	0.30	0.41	0.40	5.21	2.58	12.95	870.61
1970	7.64	3.69	1.04	0.71	0.81	0.73	0.65	0.97	0.84	0.78	2.46	1.47	21.81	892.41
1971	6.60	2.95	0.89	0.80	5.27	2.27	0.48	0.33	0.31	0.31	0.30	0.28	20.79	913.20
1972	0.31	0.65	0.98	0.78	0.65	0.63	0.67	0.47	0.28	0.23	0.27	0.36	6.28	919.48
1973	0.50	1.12	0.90	0.62	0.67	0.88	0.75	3.03	1.71	0.70	0.40	0.30	11.58	931.06
1974	0.31	0.58	0.80	0.64	0.56	0.58	0.44	0.32	0.24	0.21	0.20	0.38	5.24	936.31
1975	0.54	0.51	4.28	2.10	3.36	16.48	5.80	1.11	0.87	0.54	0.40	0.54	36.52	972.83
1976	11.23	4.33	0.74	0.62	0.83	0.89	0.51	0.30	0.27	0.27	0.37	0.63	20.99	993.82
1977	0.90	1.27	4.42	1.84	0.48	0.53	18.06	6.74	0.81	0.53	0.48	0.58	36.64	1 030.45
1978	1.69	1.70	0.94	0.57	0.58	0.88	0.78	0.46	0.32	0.43	0.57	0.67	9.60	1 040.06
1979	0.93	1.02	0.90	0.61	0.63	0.55	0.33	0.29	0.25	0.23	0.22	1.62	7.58	1 047.64
1980	1.26	4.41	2.04	5.41	2.49	0.74	0.41	0.46	0.53	0.38	0.40	0.43	18.95	1 066.59
1981	0.48	0.64	0.66	0.60	0.52	5.86	2.62	0.67	0.46	0.40	0.31	0.32	13.54	1 080.13
1982	0.44	0.37	0.25	0.20	0.18	0.18	0.18	0.17	0.14	21.98	7.88	0.83	32.80	1 112.92
1983	0.82	4.01	2.03	0.97	4.10	2.05	0.97	0.70	0.56	0.62	0.52	0.38	17.73	1 130.65
1984	0.57	1.17	0.88	0.69	18.61	6.65	0.52	0.33	0.27	0.27	0.22	0.20	30.40	1 161.04
1985	0.51	1.00	0.82	0.99	0.76	0.65	0.60	0.39	0.28	0.23	0.38	0.84	7.44	1 168.49
1986	3.02	4.53	1.83	0.66	0.40	0.39	0.37	0.26	0.23	0.21	0.25	17.59	29.76	1 198.25
1987	7.62	4.14	1.90	0.81	7.41	16.65	5.39	0.99	0.77	0.60	0.59	0.54	47.39	1 245.64
1988	0.65	3.75	4.93	1.69	6.48	2.84	2.76	1.37	0.54	0.46	0.35	0.30	26.14	1 271.77
1989	7.61	13.09	4.12	0.88	0.72	0.86	0.74	0.41	0.32	0.28	0.45	0.63	30.10	1 301.87
1990	0.84	0.89	0.76	0.85	1.65	0.99	0.41	0.29	0.26	0.23	0.21	0.27	7.65	1 309.52
1991	1.08	2.94	1.45	0.55	0.39	0.33	0.40	0.34	0.23	0.19	0.18	0.23	8.31	1 317.83
1992	0.40	0.57	0.49	0.36	0.33	0.23	0.23	0.23	0.17	0.15	0.14	0.93	4.23	1 322.06
1993	2.38	1.47	3.54	1.62	8.55	3.56	0.68	0.31	0.25	0.37	0.64	0.50	23.86	1 345.91
1994	0.35	0.30	0.40	0.46	0.31	2.76	3.12	1.32	1.49	1.07	0.52	0.53	12.64	1 358.55
1995	0.77	0.74	11.25	4.44	2.20	1.12	0.54	0.40	0.27	0.34	0.40	0.35	22.83	1 381.38
1996	0.59	8.52	3.52	1.58	1.16	0.95	3.22	1.60	14.68	5.89	1.02	0.84	43.56	1 424.94
1997	1.00	3.68	1.73	0.66	5.90	4.08	1.28	0.67	0.48	0.38	0.43	0.46	20.74	1 445.68
1998	0.40	0.64	3.39	1.61	0.90	2.81	1.43	0.51	0.34	0.28	0.24	0.20	12.75	1 458.43
1999	0.50	0.91	1.10	4.58	5.21	8.65	4.97	1.59	0.73	0.50	0.38	0.43	29.55	1 487.99
2000	0.63	0.76	0.91	0.69	0.49	0.53	0.58	0.53	0.38	0.45	0.48	0.46	6.88	1 494.87
2001	0.56	12.22	4.70	0.84	0.76	0.59	0.51	0.48	0.36	0.57	0.95	2.33	24.88	1 519.75
2002	1.32	0.79	0.89	0.59	0.33	4.45	2.31	0.95	0.69	0.53	0.40	0.69	13.93	1 533.68
2003	1.64	1.06	0.62	0.73	0.50	0.62	0.64	0.36	0.26	0.32	0.32	0.54	7.60	1 541.29
2004	1.04	0.90	0.61	3.83	1.77	0.45	0.43	0.40	0.32	0.28	0.28	0.34	10.65	1 551.93
2005	0.38	4.39	2.07	0.78	0.85	0.74	0.63	0.79	0.98	0.76	0.74	5.47	18.59	1 570.52
2006	8.84	3.14	9.88	3.85	0.56	0.56	0.83	0.61	0.42	0.36	0.31	0.33	29.69	1 600.21
2007	0.66	1.12	0.81	8.51	3.34	0.68	2.56	1.37	4.51	2.11	0.54	0.45	26.66	1 626.87
% of total	8.98	15.04	11.39	8.02	10.29	12.61	8.35	4.97	5.28	6.13	3.81	5.15	100.00	
Average	1.66	2.78	2.11	1.48	1.90	2.33	1.54	0.92	0.98	1.13	0.70	0.95	18.49	
SD	2.369	3.491	2.349	1.550	2.668	3.216	2.251	1.317	2.007	3.080	1.190	2.011	10.443	
CV	1.427	1.256	1.116	1.045	1.402	1.380	1.459	1.435	2.056	2.719	1.689	2.114	0.565	

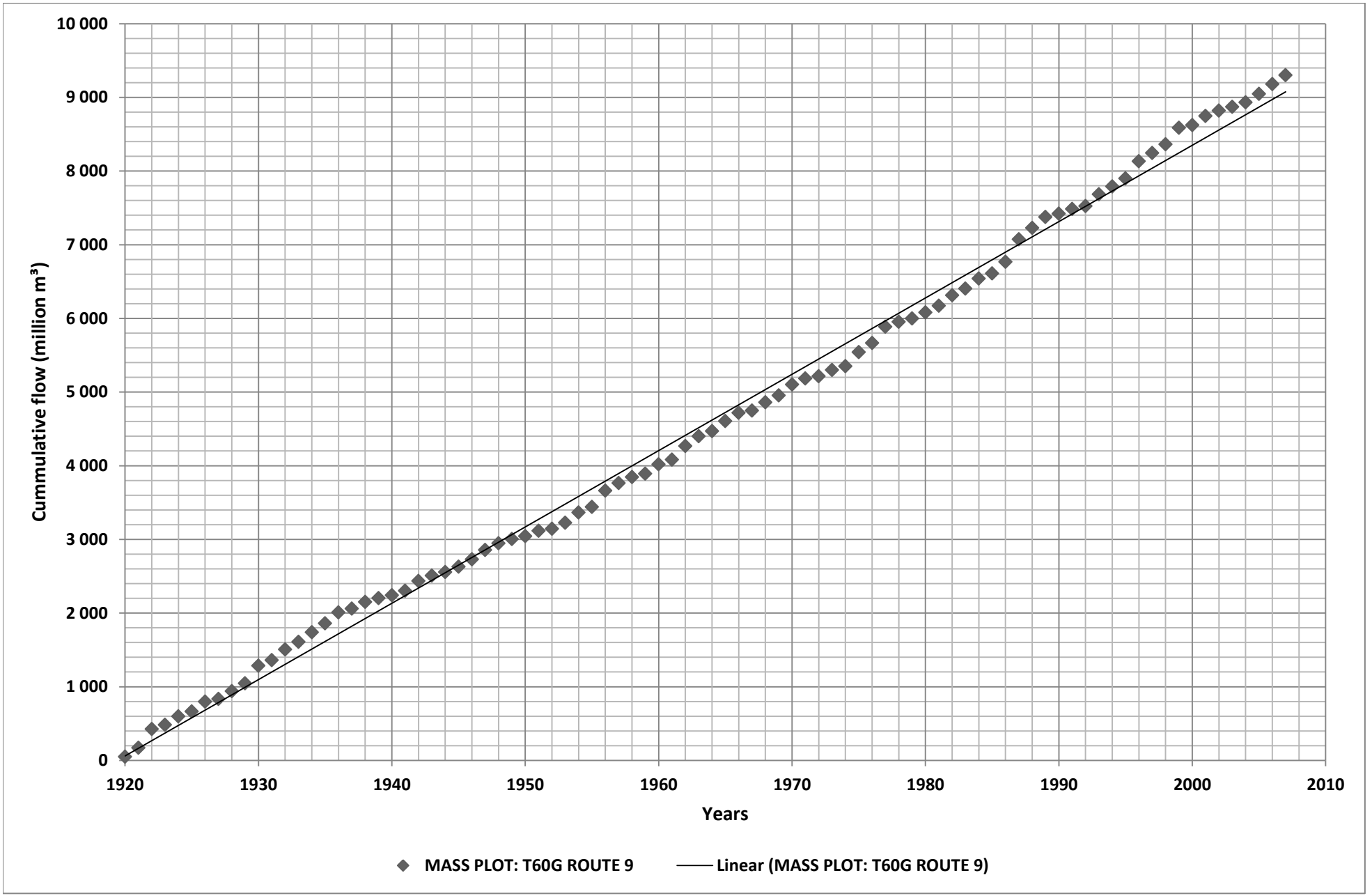
NATURAL STREAMFLOW FOR QUATERNARY CATCHMENT T60G CATCHMENT AREA = 360 SQ KM

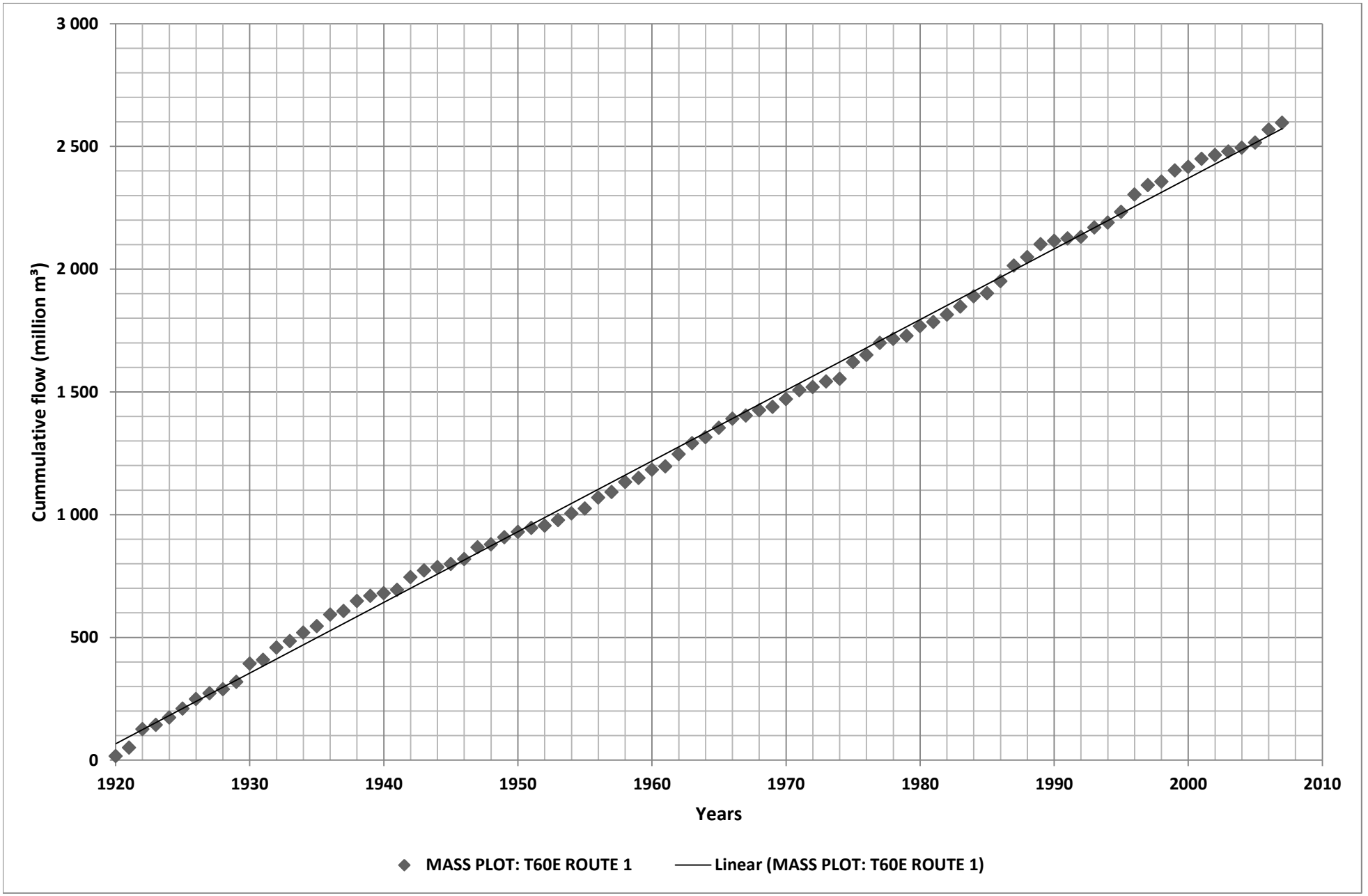
YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOT	CUM
1920	2.57	3.45	11.54	5.82	3.14	6.53	6.22	3.30	1.76	1.38	1.15	1.96	48.82	48.82
1921	7.15	28.10	34.23	11.07	3.12	2.22	1.80	3.93	9.14	4.86	4.24	10.47	120.35	169.17
1922	38.94	40.23	11.82	45.73	48.27	19.43	4.42	1.73	1.37	30.01	12.35	2.16	256.45	425.62
1923	2.53	3.35	3.97	21.80	10.51	2.73	1.69	1.61	1.67	1.54	1.71	2.28	55.39	481.01
1924	2.98	5.35	18.24	10.69	13.10	36.99	15.14	3.40	2.19	1.94	1.67	3.41	115.10	596.11
1925	4.48	4.55	4.02	3.63	5.05	24.80	9.96	2.35	3.08	2.89	1.85	2.42	69.08	665.19
1926	9.07	23.03	16.79	5.24	2.69	50.19	18.43	1.51	1.17	1.04	1.09	1.59	131.83	797.02
1927	3.04	2.68	2.88	3.91	7.36	4.39	2.16	1.87	1.79	1.39	2.04	2.35	35.84	832.86
1928	2.58	5.53	4.25	3.65	3.22	11.34	5.22	1.80	25.03	18.09	6.55	20.37	107.64	940.50
1929	30.05	24.17	7.51	2.43	2.10	2.39	2.74	2.20	2.94	3.73	3.78	20.48	104.51	1 045.01
1930	9.46	3.41	2.98	23.01	24.76	30.48	10.52	1.93	1.28	94.86	33.59	2.80	239.09	1 284.10
1931	3.64	3.94	3.38	2.39	20.21	9.48	2.66	2.48	2.85	2.88	2.40	19.01	75.31	1 359.41
1932	16.98	48.68	41.28	10.32	4.78	11.57	5.23	2.01	1.56	1.40	1.26	1.31	146.39	1 505.80
1933	1.50	13.46	23.93	27.30	9.47	6.53	3.98	2.34	1.72	6.32	4.17	1.84	102.56	1 608.36
1934	1.73	2.72	12.79	6.06	2.03	3.18	19.46	25.00	35.71	12.66	4.16	3.61	129.11	1 737.47
1935	2.93	3.32	1.90	1.64	38.54	39.27	10.88	10.77	6.26	3.39	2.06	2.08	123.04	1 860.51
1936	11.98	64.13	22.03	2.25	12.51	19.73	7.34	1.89	1.35	1.59	1.91	2.04	148.75	2 009.26
1937	2.55	3.02	11.75	6.43	3.30	2.38	8.19	4.67	2.64	2.87	2.32	1.57	51.69	2 060.95
1938	1.58	2.93	8.14	9.35	20.54	10.44	3.27	2.77	2.45	2.88	2.76	22.42	89.52	2 150.47
1939	15.41	5.32	7.75	3.97	2.19	2.61	2.12	4.17	3.44	2.10	1.64	1.99	52.72	2 203.19
1940	2.12	15.64	7.96	2.73	1.51	1.44	1.49	1.11	1.08	1.19	1.17	1.27	38.71	2 241.90
1941	2.01	3.37	2.56	24.85	10.15	3.20	3.17	3.40	2.72	1.56	1.58	2.25	60.81	2 302.71
1942	3.44	44.00	26.54	6.40	2.26	7.36	15.68	6.77	2.74	2.37	10.27	5.89	133.72	2 436.43
1943	4.21	15.17	9.87	3.54	3.12	3.28	2.47	1.75	1.60	1.67	1.32	21.85	69.87	2 506.30
1944	13.07	4.39	2.02	2.23	6.27	9.80	4.47	1.94	1.60	1.42	1.16	1.72	50.11	2 556.41
1945	32.65	12.55	1.65	1.63	2.08	7.56	5.18	2.78	1.72	1.32	1.00	1.12	71.24	2 627.65
1946	1.83	13.43	6.81	2.85	3.16	15.36	23.42	9.01	13.87	7.03	2.44	2.40	101.60	2 729.25
1947	2.67	60.67	26.66	4.28	3.77	13.63	6.76	2.43	1.45	1.12	0.96	0.97	125.35	2 854.60
1948	5.49	4.73	3.58	2.65	40.45	21.49	5.36	2.34	1.35	1.11	1.11	1.55	91.21	2 945.81
1949	2.57	20.07	8.87	3.02	3.42	2.89	2.94	4.02	3.02	2.34	2.94	2.61	58.70	3 004.51
1950	3.19	2.67	11.31	6.35	2.73	2.49	2.09	1.39	1.21	1.18	1.28	1.90	37.79	3 042.30
1951	17.41	7.55	11.35	15.77	6.20	3.28	3.78	2.83	1.81	1.38	1.03	1.76	74.17	3 116.47
1952	2.69	3.18	3.15	2.75	3.13	2.89	2.41	1.71	1.20	0.98	1.11	2.73	27.92	3 144.39
1953	10.29	33.18	14.74	3.49	1.70	2.65	2.53	2.20	2.93	2.74	1.81	2.28	80.54	3 224.93
1954	51.04	19.47	2.86	14.01	21.04	17.64	5.96	1.91	1.73	1.42	1.04	1.97	140.09	3 365.02
1955	3.95	5.81	3.10	1.04	1.99	30.10	14.33	3.65	2.98	2.74	1.90	2.61	74.19	3 439.21
1956	18.21	51.63	66.03	21.20	4.25	17.35	25.50	8.89	2.57	2.24	1.99	3.06	222.92	3 662.13
1957	4.85	4.23	15.63	14.60	22.55	9.45	17.60	7.31	1.51	1.57	1.66	1.70	102.67	3 764.80
1958	2.08	10.12	5.64	2.31	2.22	2.46	2.27	30.14	12.33	3.16	3.99	5.42	82.11	3 846.91
1959	4.59	7.64	4.99	3.55	2.70	3.01	3.92	4.00	2.68	1.86	1.86	2.85	43.66	3 890.57
1960	3.94	15.13	19.42	12.75	4.64	3.25	42.86	16.79	2.64	2.54	2.32	2.09	128.37	4 018.94
1961	2.44	11.84	6.57	3.32	2.98	18.86	8.24	2.32	1.70	1.21	1.62	2.20	63.31	4 082.25
1962	8.93	20.49	8.38	15.97	7.17	59.01	21.62	2.80	2.35	23.88	10.28	2.05	182.93	4 265.18
1963	3.52	8.16	5.10	24.88	19.05	6.38	4.00	2.98	40.59	16.24	2.46	2.20	135.54	4 400.72
1964	6.72	4.48	2.84	2.70	2.51	1.59	1.15	1.49	22.38	10.83	4.69	7.75	69.12	4 469.84
1965	40.24	27.31	7.33	2.93	2.52	1.49	1.18	32.08	13.47	2.48	2.00	2.29	135.33	4 605.17
1966	2.47	2.54	3.25	8.76	5.43	39.49	30.32	7.82	2.22	3.49	3.46	2.02	111.27	4 716.44
1967	1.64	2.96	3.12	2.26	2.57	2.74	2.31	1.52	1.12	1.01	1.56	8.16	30.97	4 747.41
1968	8.86	12.27	7.04	2.67	3.22	25.82	10.95	23.78	10.18	2.45	1.89	1.80	110.92	4 858.33
1969	2.79	14.59	7.09	2.07	2.50	2.28	1.65	1.64	2.63	2.85	38.80	15.84	94.75	4 953.08
1970	37.70	21.78	5.54	2.90	3.24	3.07	3.28	23.37	9.85	4.29	24.05	10.47	149.55	5 102.63
1971	23.49	10.91	3.90	3.18	21.79	9.06	1.93	1.48	1.53	1.63	1.66	1.56	82.10	5 184.73
1972	1.54	4.28	4.13	3.29	2.54	2.56	3.30	2.35	1.29	1.05	1.47	2.62	30.43	5 215.16
1973	3.63	18.78	8.58	3.04	3.61	4.98	3.67	22.23	10.12	2.91	1.80	1.47	84.82	5 299.98
1974	1.53	2.79	15.49	7.12	2.40	2.50	2.22	1.69	1.30	1.19	1.07	12.12	51.42	5 351.40
1975	6.49	3.07	19.45	8.62	18.39	81.70	29.64	11.65	5.47	2.04	1.76	2.58	190.85	5 542.25
1976	52.46	19.72	2.32	2.24	23.44	10.41	2.44	1.42	1.23	1.30	2.00	3.23	122.21	5 664.46
1977	6.69	18.68	20.28	6.75	1.97	1.99	111.55	42.06	4.21	2.40	2.20	2.75	221.52	5 885.98
1978	17.73	15.95	5.37	2.32	2.28	3.24	2.77	1.68	1.30	1.93	3.12	9.68	67.36	5 953.34
1979	7.45	4.47	4.17	2.56	2.73	2.83	1.64	1.35	1.20	1.04	0.93	12.96	43.33	5 996.67
1980	7.28	21.75	9.27	19.94	9.28	2.74	1.47	2.02	2.52	1.69	2.09	2.70	82.75	6 079.42
1981	2.55	2.98	2.77	2.55	2.20	47.52	21.25	3.91	1.86	1.51	1.14	1.19	91.43	6 170.85
1982	1.89	1.56	1.08	0.99	0.98	1.00	0.91	0.81	0.72	94.25	33.65	3.71	141.55	6 312.40
1983	4.15	23.58	10.36	4.22	17.92	9.62	6.22	3.78	2.74	3.58	3.13	2.27	91.57	6 403.97
1984	3.36	10.06	5.05	2.82	78.50	28.23	2.40	1.45	1.21	1.23	1.01	0.98	136.30	6 540.27
1985	2.27	7.20	4.53	20.53	8.68	2.41	2.41	1.74	1.23	1.01	2.20	14.09	68.31	6 608.58
1986	21.02	18.89	6.81	4.68	2.62	2.07	2.42	1.61	1.21	1.01	1.16	96.34	159.84	6 768.42
1987	39.30	29.33	12.03	3.78	45.20	102.91	31.77	14.67	7.20	6.24	7.21	4.37	304.02	7 072.44
1988	3.76	22.06	35.23	11.29	37.91	15.28	14.20	6.54	2.49	2.14	1.51	1.53	153.93	7 226.37
1989	49.31	53.87	14.62	7.28	4.00	6.99	3.77	1.55	1.24	1.08	1.67	2.66	148.04	7 374.41
1990	10.43	5.62	2.76	3.33	9.62	5.51	2.34	1.59	1.40	1.16	1.29	1.90	46.95	7 421.36
1991	11.59	29.06	11.22	2.51	1.64	1.22	1.55	1.48	1.03	0.88	0.89	1.50	64.57	7 485.93
1992	2.69	3.15	2.90	2.19	1.70	1.28	1.22	1.09	0.81	0.68	0.75	18.59	37.04	7 522.97
1993	16.74	6.66	28.67	11.05	57.23	21.18	2.13	1.19	0.97	1.44	9.10	5.02	161.38	7 684.35
1994	1.90	1.47	15.77	7.02	1.43	16.78	29.81	10.24	10.42	5.63	1.97	2.20	104.64	7 788.99
1995	3.19	2.51	48.00	27.15	6.44	2.94	3.02	2.36	1.39	7.43	4.78	2.23	111.42	7 900.41
1996	15.01	49.58	19.12	18.44	9.74	3.64	9.27	5.40	66.04	28.60	4.66	3.85	233.36	8 133.77
1997	6.95	27.21	10.95	2.57	22.50	21.83	7.28	2.73	1.93	1.64	2.37	2.99	110.96	8 244.73
1998	2.42	13.18	34.11	12.80	12.18	24.89	9.65	2.42	1.50	1.19	1.03	0.87	116.25	8 360.98
1999	5.50	4.84	14.68	26.44	40.44	75.24	40.70	9.49	2.96	2.08	1.67	1.92	225.94	8 586.92
2000	3.01	4.04	3.92	2.71	1.82	2.45	3.08	2.89	2.17	2.59	2.79	2.80	34.26	8 621.18
2001	3.76	50.94	23.13	4.57	3.55	2.75	2.49	2.53	1.87	6.29	10.92	13.53	126.32	8 747.50
2002	5.70	3.25	4.00	2.35	1.11	27.20	11.96	3.38	2.58	1.92	1.41	6.45	71.32	8 818.82
2003	10.96	5.10	2.64	7.81	3.81	5.59	3.56	1.67	1.20	1.63	1.74	7.26	52.95	8 871.77
2004	7.40	4.22	2.61	23.51	9.79	1.97	2.06	2.07	1.58	1.22	1.29	1.66	59.38	8 931.15
2005	1.87	27.06	11.22	3.43	3.87	3.38	3.52	5.82	12.33	5.83	5.62	31.96	115.92	9 047.07
2006	44.95	14.81	40.4	15.63	2.14	2.15	3.6	2.71	1.76	1.44	1.26	1.39	132.24	9 179.31
2007	8.72	9.69	4.49	36.54	14.3	3.05	13.16	6.23	15.03	7.08	2.01	1.73	122.01	9 301.32
% of to	9.65	14.24	11.05	8.11	9.97	12.89	8.78	5.24	4.92	5.56	3.80	5.78	100.00	
Averag	10.20	15.05	11.68	8.57	10.54	13.63	9.28	5.54	5.20	5.88	4.02	6.11	105.70	
SD	12.589	15.010	11.653	8.819	14.099	18.646	14.349	7.615	9.492	14.641	6.772	11.473	56.280	
CV	1.234	0.997	0.997	1.029	1.338	1.368	1.546	1.376	1.825	2.490	1.684	1.878	0.532	

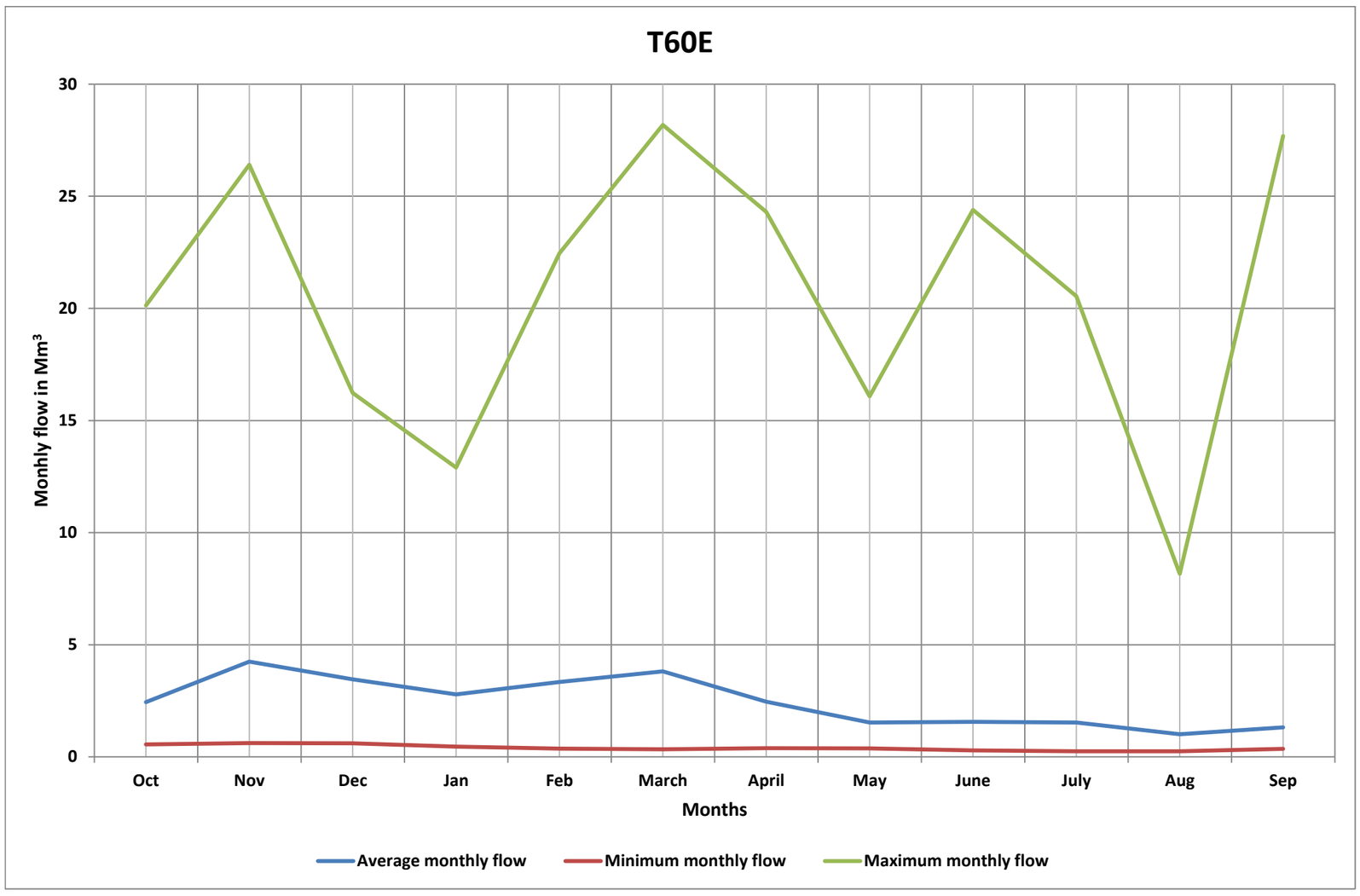

1 400
1 200
1 000
800
600
400
200
0
Cummulative flow (million m³)
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
Years
MASS PLOT: T60F1 ROUTE 5
Linear (MASS PLOT: T60F1 ROUTE 5)

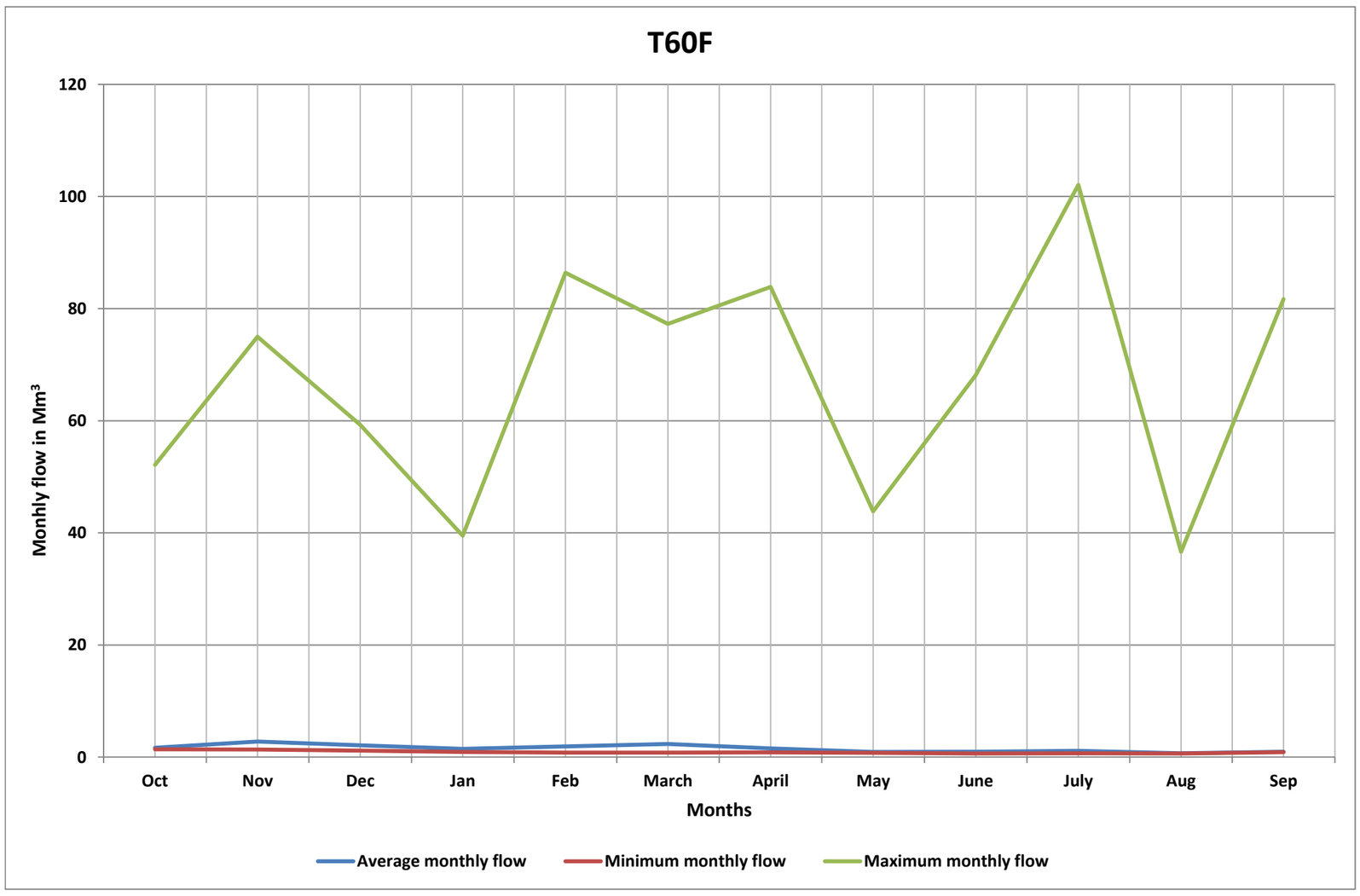

400
350
300
250
200
150
100
50
0
Cummulative flow (million m³)
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
Years
MASS PLOT: T60F2 ROUTE 5
Linear (MASS PLOT: T60F2 ROUTE 5)

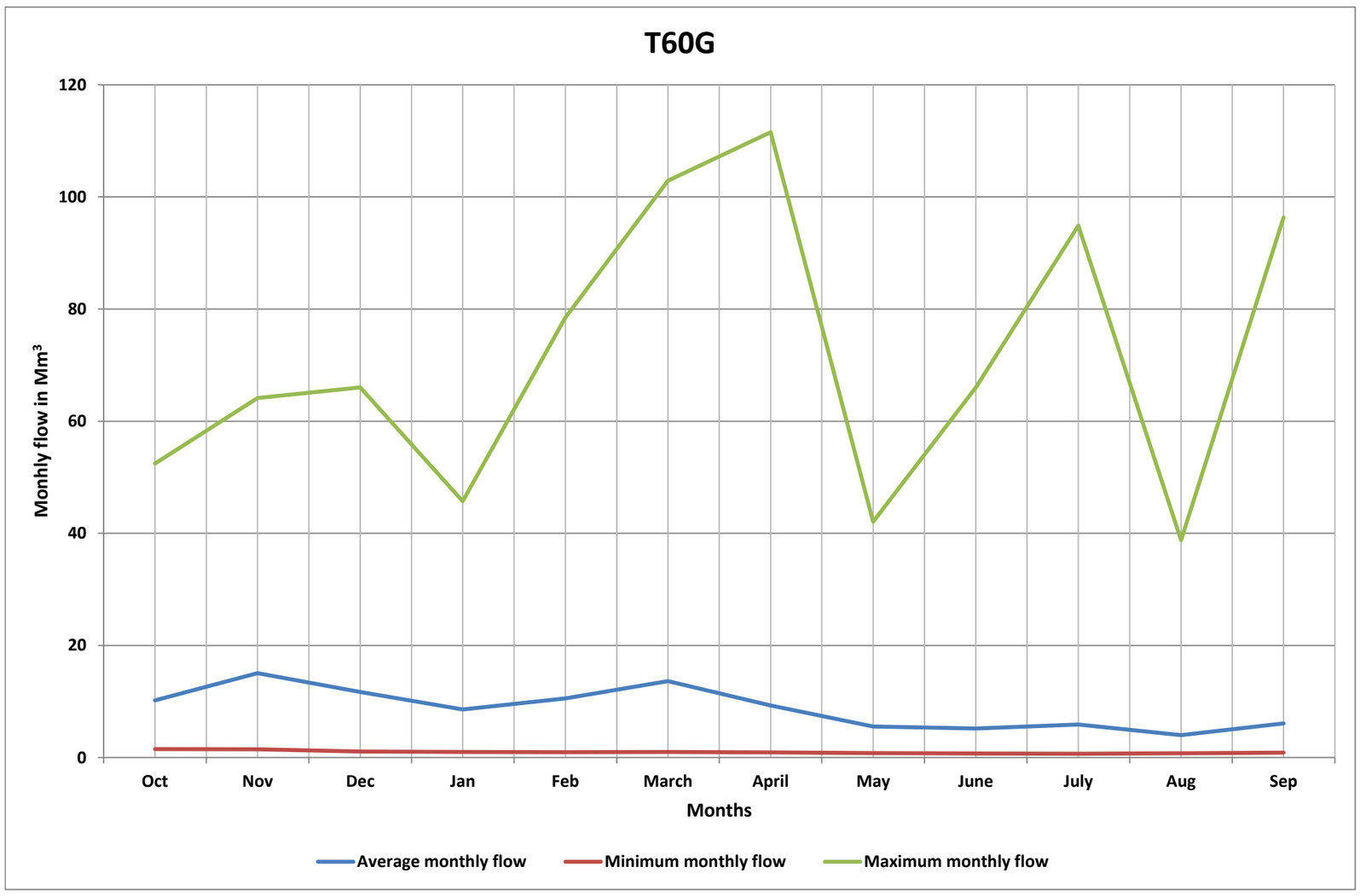

5 000
4 500
4 000
3 500
3 000
2 500
2 000
1 500
1 000
500
0
Cummulative flow (million m3)
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
Years
MASS PLOT: T60F3 ROUTE 5
Linear (MASS PLOT: T60F3 ROUTE 5)


10 000
9 000
8 000
7 000
6 000
5 000
4 000
3 000
2 000
1 000
0
Cummulative flow (million m³)
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
Years
MASS PLOT: T60G ROUTE 9
Linear (MASS PLOT: T60G ROUTE 9)


3 000
2 500
2 000
1 500
1 000
500
0
Cummulative flow (million m³)
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
Years
MASS PLOT: T60E ROUTE 1
Linear (MASS PLOT: T60E ROUTE 1)


T60E
Monhly flow in Mm³
30
25
20
15
10
5
0
Oct
Nov
Dec
Jan
Feb
March
April
May
June
July
Aug
Sep
Months
Average monthly flow
Minimum monthly flow
Maximum monthly flow


T60F
Monhly flow in Mm³
120
100
80
60
40
20
0
Oct
Nov
Dec
Jan
Feb
March
April
May
June
July
Aug
Sep
Months
Average monthly flow
Minimum monthly flow
Maximum monthly flow


T60G
Monhly flow in Mm³
120
100
80
60
40
20
0
Oct
Nov
Dec
Jan
Feb
March
April
May
June
July
Aug
Sep
Months
Average monthly flow
Minimum monthly flow
Maximum monthly flow

Appendix H

Present day flow records

PRESENT DAY FLOW RECORD FOR MSIKABA RIVER UPSTREAM OF CONFLUENCE WITH XURA CATCHMENT AREA = 297.9KM^2

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOT	CUM
1920	1.41	2.18	3.19	2.89	2.53	2.86	2.96	2.00	1.27	1.03	0.89	1.12	24.34	1.38
1921	1.93	10.21	15.73	5.86	2.00	1.47	1.20	2.17	3.80	2.79	2.44	2.64	52.27	2.82
1922	16.44	23.62	7.78	18.32	22.93	9.86	2.73	1.39	1.13	11.43	5.55	1.66	122.83	6.31
1923	1.45	1.61	1.94	6.79	5.68	2.43	1.23	1.08	1.03	0.94	1.01	1.39	26.57	1.45
1924	1.97	2.62	6.05	3.36	2.07	16.38	7.31	2.03	1.35	1.16	0.99	1.26	46.54	2.45
1925	1.70	2.45	2.79	4.06	3.21	21.87	8.81	1.56	1.70	1.67	1.23	1.56	52.61	3.07
1926	2.55	4.27	6.27	3.52	2.03	25.95	10.06	1.17	0.91	0.80	0.79	0.96	59.28	3.21
1927	1.85	1.92	2.28	8.01	7.74	3.61	1.66	1.11	0.95	0.83	1.03	1.17	32.12	1.97
1928	1.32	1.92	2.16	2.09	1.78	2.26	1.80	1.25	3.31	3.83	2.61	5.75	30.07	1.38
1929	13.43	12.08	4.88	2.30	1.55	1.77	2.05	1.47	1.58	1.73	2.09	3.62	48.55	2.52
1930	2.85	2.09	2.04	16.63	16.28	15.65	5.76	1.45	0.95	38.74	14.75	1.79	118.98	6.16
1931	2.09	2.61	2.31	1.55	4.79	3.36	1.57	1.30	1.42	1.59	1.41	3.65	27.67	1.31
1932	3.78	32.06	22.31	5.10	1.73	2.75	2.02	1.24	0.95	0.85	0.77	0.78	74.33	4.13
1933	0.86	4.29	9.73	12.96	5.16	2.39	1.99	1.33	1.00	1.28	1.25	0.90	43.12	2.24
1934	0.99	1.99	7.73	4.24	1.59	1.63	3.43	7.10	16.40	6.87	2.68	2.39	57.09	2.88
1935	2.06	2.64	1.60	1.06	12.29	12.68	4.29	2.43	2.47	1.68	1.17	1.08	45.45	2.13
1936	2.11	37.67	13.88	1.57	8.04	5.53	2.42	1.26	0.95	0.88	0.84	0.88	76.02	3.98
1937	1.16	1.43	2.16	2.77	2.56	1.87	2.29	2.10	1.58	1.59	1.33	1.00	21.85	1.21
1938	1.15	2.12	3.92	5.85	19.44	7.82	1.87	1.62	1.34	1.57	1.92	11.33	59.95	3.40
1939	6.54	3.10	2.86	2.14	2.23	2.81	2.10	2.68	2.70	1.58	1.06	1.20	30.99	1.73
1940	1.47	4.79	3.33	1.73	1.10	0.94	1.06	0.86	0.69	0.68	0.66	0.66	17.95	0.92
1941	1.02	1.77	1.41	2.44	2.61	2.49	2.38	2.04	1.44	0.91	0.86	1.06	20.41	1.12
1942	1.61	33.57	19.75	4.72	1.74	2.16	5.14	3.38	2.10	1.74	2.46	2.82	81.20	4.28
1943	2.92	11.86	9.22	3.31	2.40	2.42	1.57	1.05	0.97	1.08	0.92	4.28	41.97	2.29
1944	3.98	2.26	1.22	1.59	2.67	3.19	2.15	1.26	1.01	0.81	0.66	0.76	21.56	1.14
1945	6.38	3.59	1.33	1.28	1.71	2.46	2.29	1.50	0.97	0.85	0.70	0.66	23.70	1.02
1946	1.04	2.17	2.32	1.83	2.04	7.33	4.51	2.02	2.32	2.48	1.53	1.25	30.83	1.66
1947	1.36	42.25	16.99	2.62	3.42	3.04	2.15	1.24	0.83	0.68	0.60	0.55	75.72	3.97
1948	1.29	2.38	2.16	1.78	4.53	3.42	2.35	1.61	0.96	0.80	0.74	0.81	22.82	1.03
1949	1.18	3.18	2.75	2.46	7.35	8.08	3.83	2.35	1.78	1.50	1.89	1.83	38.18	2.38
1950	2.04	1.93	11.10	5.46	1.93	2.02	1.59	1.03	0.81	0.68	0.79	1.23	30.62	1.86
1951	4.15	2.74	1.85	2.51	2.56	2.56	2.48	1.77	1.13	0.90	0.70	0.87	24.21	1.32
1952	1.18	1.16	1.23	1.35	1.44	1.33	1.35	1.04	0.70	0.56	0.58	1.51	13.45	0.77
1953	4.22	11.08	5.48	2.11	1.41	2.14	1.95	1.60	1.81	1.59	1.09	1.19	35.67	1.85
1954	14.70	6.88	1.95	3.46	8.37	4.23	1.69	1.19	1.04	0.90	0.66	0.99	46.07	2.30
1955	1.73	2.10	1.47	0.73	1.09	13.77	6.36	1.73	1.40	1.11	0.83	1.01	33.32	1.69
1956	1.66	16.78	28.81	9.87	2.69	5.17	4.82	2.62	1.61	1.32	1.26	1.80	78.43	3.66
1957	2.67	3.53	4.45	4.38	10.53	4.85	2.44	1.87	1.07	0.92	0.85	0.89	38.45	1.89
1958	1.08	6.04	5.20	2.47	1.71	2.02	2.12	25.26	10.03	2.44	2.81	2.73	63.92	3.36
1959	2.71	2.89	2.91	2.54	1.95	2.10	2.58	2.04	1.28	1.01	1.18	1.68	24.85	1.38
1960	2.06	2.47	9.66	9.32	3.97	2.58	13.12	6.04	1.61	1.26	0.99	0.91	54.00	2.78
1961	0.98	1.90	2.85	2.32	2.49	4.27	2.66	1.45	1.06	0.79	0.86	0.95	22.60	1.17
1962	1.73	7.17	4.18	11.16	5.26	28.98	11.28	1.75	1.21	3.79	2.94	1.33	80.80	4.12
1963	1.86	6.63	4.03	6.62	3.94	3.04	7.31	3.71	21.74	9.26	1.72	1.64	71.49	3.74
1964	6.01	3.48	1.64	1.67	1.78	1.26	0.83	0.93	7.54	5.20	3.48	3.14	36.96	2.03
1965	17.92	15.20	4.85	2.11	1.91	1.13	0.85	10.07	5.18	1.58	1.26	1.51	63.55	3.10
1966	1.73	1.81	2.05	2.69	2.34	24.35	12.74	3.18	1.90	2.46	2.10	1.26	58.62	3.09
1967	1.20	2.29	2.58	2.03	1.88	1.73	1.63	1.15	0.77	0.69	0.99	1.92	18.85	1.07
1968	2.61	3.71	2.80	1.51	2.47	10.66	5.10	2.39	2.04	1.34	1.11	1.01	36.75	1.86
1969	1.33	2.09	2.29	1.63	1.83	1.48	0.90	0.88	1.14	1.09	6.43	4.66	25.76	1.09
1970	17.82	8.55	2.93	2.23	2.53	2.33	1.96	2.60	2.23	2.05	4.29	3.29	52.82	2.63
1971	18.12	8.29	2.50	2.32	13.62	6.16	1.59	1.08	0.97	0.94	0.82	0.74	57.13	3.07
1972	0.87	2.01	2.92	2.19	1.95	2.06	2.01	1.32	0.81	0.68	0.80	1.03	18.64	1.05
1973	1.39	2.63	2.27	1.77	1.93	4.79	3.09	7.30	4.46	2.02	1.14	0.84	33.62	1.86
1974	0.90	1.71	2.19	1.81	1.75	1.80	1.38	0.94	0.69	0.60	0.58	1.02	15.35	0.86
1975	1.42	1.35	10.70	8.46	13.03	44.50	15.47	3.09	2.39	1.52	1.12	1.47	104.51	5.72
1976	24.30	9.93	2.32	2.07	2.13	2.13	1.36	0.85	0.78	0.77	0.90	1.39	48.93	2.36
1977	2.22	3.03	8.56	4.03	1.57	1.76	42.05	15.96	2.15	1.42	1.26	1.54	85.57	4.12
1978	3.41	4.01	2.83	2.04	1.91	2.54	2.24	1.35	0.94	1.24	1.53	1.62	25.68	1.36
1979	2.26	2.61	2.35	1.76	1.78	1.51	0.96	0.83	0.71	0.66	0.63	3.13	19.21	0.99
1980	3.16	12.81	5.99	18.15	7.89	2.17	1.28	1.33	1.42	1.04	1.13	1.23	57.59	3.26
1981	1.53	2.16	2.27	1.98	1.72	9.60	5.02	1.82	1.30	1.17	0.92	0.91	30.39	1.43
1982	1.37	1.30	0.87	0.65	0.54	0.51	0.56	0.54	0.44	38.40	14.63	2.22	62.04	2.47
1983	2.05	9.73	5.27	2.86	13.34	6.44	2.76	1.95	1.45	1.51	1.32	1.01	49.69	2.70
1984	1.54	4.79	3.10	2.01	40.80	14.88	1.43	0.93	0.77	0.74	0.62	0.56	72.18	3.52
1985	1.50	2.98	2.38	2.38	1.88	1.73	1.60	1.05	0.78	0.66	1.01	1.99	19.92	1.06
1986	5.18	13.96	6.08	1.88	1.15	1.06	0.96	0.69	0.60	0.55	0.68	44.93	77.75	4.04
1987	20.44	9.03	4.42	2.24	14.09	37.75	12.97	2.72	2.19	1.68	1.55	1.43	110.51	5.30
1988	1.67	5.51	9.21	3.84	15.94	7.14	7.90	4.02	1.57	1.33	1.01	0.80	59.97	2.85
1989	17.40	35.92	11.93	2.76	2.09	3.02	2.37	1.27	0.98	0.86	1.29	1.65	81.53	4.32
1990	2.07	2.23	1.98	2.43	4.98	2.78	1.00	0.74	0.68	0.61	0.56	0.75	20.80	1.11
1991	2.45	5.19	2.95	1.48	1.10	0.98	1.21	0.99	0.65	0.54	0.51	0.62	18.65	0.87
1992	0.99	1.33	1.21	1.09	1.03	0.68	0.69	0.65	0.46	0.40	0.38	1.65	10.56	0.53
1993	4.22	3.52	8.84	4.36	22.63	9.63	2.02	0.93	0.74	1.05	1.61	1.20	60.76	3.10
1994	0.95	0.90	0.99	1.13	0.92	5.14	6.98	3.47	5.53	3.54	1.47	1.48	32.51	1.67
1995	2.13	2.15	24.52	15.92	10.23	4.05	1.53	1.07	0.79	1.05	1.22	1.04	65.70	3.60
1996	1.60	19.59	8.51	3.34	3.85	2.96	9.05	4.53	38.88	15.56	2.90	2.34	113.12	5.83
1997	2.73	9.18	4.49	2.05	16.65	12.81	4.20	1.99	1.41	1.10	1.11	1.14	58.85	3.20
1998	1.13	1.80	5.32	3.30	2.76	5.03	3.04	1.42	0.95	0.79	0.68	0.57	26.76	1.18
1999	1.33	2.39	3.89	14.16	11.64	18.69	11.77	4.26	2.07	1.39	1.03	1.18	73.80	3.71
2000	1.78	2.17	2.61	2.19	1.79	1.79	1.98	1.72	1.13	1.29	1.38	1.34	21.16	1.20
2001	1.76	25.80	10.50	2.66	2.39	1.71	1.37	1.28	1.03	1.54	2.51	4.36	56.91	2.68
2002	3.13	2.24	2.44	1.63	1.00	5.78	4.15	2.30	1.72	1.41	1.14	1.87	28.80	1.24
2003	3.74	2.90	2.02	2.09	1.52	1.96	1.92	1.09	0.98	1.39	1.25	1.59	22.44	1.24
2004	2.41	2.21	1.76	7.53	4.02	1.45	1.30	1.13	0.86	0.74	0.74	1.00	25.16	1.21
2005	1.37	9.42	4.96	2.30	2.42	2.19	1.88	2.05	2.28	1.80	1.69	7.12	39.49	1.74
2006	28.71	11.20	20.15	8.42	1.76	1.97	2.87	1.99	1.27	1.03	0.87	1.02	81.28	4.30
2007	2.13	3.21	3.16	17.24	6.99	1.56	3.87	2.82	6.63	3.92	1.55	1.35	54.43	2.31
% of to	8.54	14.66	11.61	8.89	10.92	12.81	8.34	5.10	5.28	5.56	3.57	4.73	100.00	
Averag	4.05	6.96	5.51	4.22	5.18	6.08	3.96	2.42	2.51	2.64	1.70	2.24	47.47	
SD	5.675	8.801	5.566	4.161	6.392	7.987	5.241	3.255	4.968	5.950	2.230	4.854	26.007	
CV	1.400	1.265	1.010	0.986	1.233	1.313	1.323	1.346	1.982	2.255	1.315	2.163	0.548	

PRESENT DAY FLOW RECORD FOR XURA RIVER UPSTREAM OF ZALU DAM CATCHMENT AREA = 71.3 KM2

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOT	AVE
1920	0.30	0.49	0.75	0.63	0.54	0.65	0.69	0.45	0.28	0.23	0.20	0.27	5.48	0.48
1921	0.51	3.04	3.74	1.32	0.45	0.32	0.28	0.49	0.87	0.65	0.58	0.68	12.95	1.13
1922	4.78	6.11	1.93	5.03	6.43	2.61	0.65	0.31	0.25	3.16	1.46	0.37	33.10	2.86
1923	0.34	0.40	0.47	2.07	1.20	0.47	0.25	0.22	0.21	0.20	0.22	0.29	6.34	0.56
1924	0.41	0.57	1.44	0.83	0.54	4.51	2.00	0.47	0.30	0.26	0.21	0.30	11.82	1.04
1925	0.43	0.54	0.56	0.56	0.63	4.48	1.87	0.33	0.37	0.37	0.26	0.33	10.73	0.94
1926	0.59	1.54	1.29	0.68	0.42	6.48	2.44	0.24	0.18	0.16	0.15	0.20	14.38	1.25
1927	0.40	0.37	0.43	0.72	1.47	0.88	0.39	0.24	0.21	0.17	0.23	0.26	5.77	0.51
1928	0.30	0.49	0.54	0.49	0.41	0.51	0.43	0.29	1.34	1.37	0.83	2.14	9.14	0.80
1929	4.07	3.12	1.14	0.47	0.33	0.37	0.42	0.31	0.36	0.41	0.49	1.27	12.76	1.10
1930	0.88	0.51	0.42	2.79	3.41	3.91	1.44	0.31	0.20	12.74	4.62	0.42	31.65	2.72
1931	0.53	0.64	0.55	0.35	1.74	1.04	0.41	0.32	0.37	0.40	0.33	1.54	8.23	0.72
1932	1.09	8.04	4.61	0.93	0.42	0.73	0.51	0.29	0.21	0.19	0.17	0.17	17.36	1.49
1933	0.19	1.12	2.30	3.56	1.44	0.65	0.54	0.33	0.24	0.32	0.31	0.21	11.20	0.98
1934	0.22	0.42	1.73	0.96	0.34	0.39	1.17	2.26	5.06	1.97	0.65	0.58	15.73	1.36
1935	0.47	0.58	0.36	0.21	3.96	4.51	1.44	0.66	0.62	0.42	0.28	0.26	13.78	1.19
1936	0.54	9.93	3.60	0.34	1.95	1.62	0.68	0.29	0.21	0.21	0.20	0.21	19.78	1.70
1937	0.27	0.32	0.51	0.68	0.58	0.40	0.51	0.47	0.36	0.37	0.30	0.21	4.98	0.44
1938	0.23	0.44	0.66	1.50	3.57	1.53	0.46	0.36	0.29	0.36	0.47	3.46	13.32	1.15
1939	1.91	0.76	0.68	0.51	0.42	0.50	0.38	0.56	0.57	0.35	0.22	0.27	7.14	0.62
1940	0.33	1.68	0.96	0.37	0.22	0.19	0.20	0.15	0.13	0.14	0.14	0.14	4.64	0.40
1941	0.25	0.43	0.33	0.77	0.62	0.50	0.47	0.44	0.35	0.21	0.20	0.26	4.82	0.42
1942	0.40	9.12	5.10	1.10	0.35	0.48	1.43	0.86	0.44	0.37	0.58	0.69	20.92	1.80
1943	0.67	2.64	1.83	0.68	0.53	0.50	0.33	0.23	0.22	0.24	0.20	2.04	10.11	0.87
1944	1.29	0.60	0.31	0.34	0.57	0.77	0.53	0.29	0.23	0.18	0.15	0.18	5.45	0.47
1945	3.27	1.42	0.28	0.26	0.36	0.55	0.57	0.40	0.23	0.19	0.15	0.14	7.82	0.68
1946	0.24	0.53	0.53	0.38	0.42	1.71	1.12	0.58	0.72	0.68	0.42	0.31	7.64	0.66
1947	0.33	11.17	4.62	0.69	0.75	0.71	0.52	0.30	0.18	0.15	0.13	0.12	19.66	1.68
1948	0.30	0.59	0.52	0.43	2.15	1.30	0.67	0.43	0.22	0.18	0.16	0.19	7.14	0.62
1949	0.29	1.20	0.82	0.57	0.68	0.72	0.60	0.51	0.38	0.31	0.37	0.34	6.80	0.59
1950	0.42	0.39	1.78	1.04	0.47	0.43	0.34	0.21	0.16	0.14	0.16	0.24	5.78	0.50
1951	1.02	0.66	0.49	0.72	0.63	0.57	0.58	0.43	0.25	0.19	0.14	0.19	5.87	0.50
1952	0.28	0.29	0.27	0.28	0.30	0.27	0.26	0.20	0.13	0.10	0.11	0.36	2.86	0.25
1953	1.12	3.75	1.56	0.38	0.22	0.38	0.38	0.31	0.37	0.34	0.24	0.28	9.32	0.80
1954	5.08	2.12	0.45	0.63	2.01	1.08	0.42	0.26	0.23	0.20	0.14	0.24	12.86	1.10
1955	0.46	0.54	0.38	0.17	0.26	3.99	1.75	0.43	0.33	0.26	0.18	0.25	9.00	0.77
1956	0.48	6.42	8.90	2.73	0.59	1.18	1.62	0.82	0.40	0.33	0.30	0.42	24.17	2.05
1957	0.62	0.72	1.63	1.65	3.01	1.30	0.66	0.51	0.27	0.22	0.21	0.22	11.02	0.94
1958	0.27	2.26	1.27	0.47	0.37	0.41	0.41	6.40	2.52	0.57	0.69	0.69	16.31	1.40
1959	0.66	0.66	0.66	0.55	0.41	0.46	0.59	0.49	0.30	0.23	0.26	0.39	5.66	0.49
1960	0.50	0.62	2.46	2.25	0.90	0.50	4.14	1.81	0.38	0.31	0.25	0.22	14.34	1.22
1961	0.24	0.47	0.68	0.54	0.53	1.47	0.80	0.32	0.23	0.17	0.19	0.22	5.87	0.50
1962	0.44	1.96	1.06	2.46	1.22	8.17	3.07	0.41	0.30	1.65	0.94	0.32	22.01	1.87
1963	0.42	1.26	0.85	2.00	1.16	0.74	1.58	0.83	6.42	2.59	0.41	0.36	18.61	1.58
1964	1.14	0.75	0.41	0.42	0.42	0.26	0.17	0.19	2.08	1.32	0.78	0.76	8.72	0.75
1965	5.75	4.30	1.23	0.46	0.41	0.24	0.17	3.19	1.52	0.36	0.28	0.33	18.23	1.55
1966	0.37	0.40	0.46	0.60	0.51	5.60	4.08	1.15	0.40	0.54	0.48	0.28	14.87	1.27
1967	0.25	0.51	0.57	0.41	0.40	0.37	0.33	0.22	0.15	0.13	0.21	0.46	4.02	0.35
1968	0.64	1.16	0.78	0.37	0.77	2.91	1.33	0.63	0.57	0.36	0.27	0.23	10.03	0.85
1969	0.31	0.52	0.56	0.38	0.40	0.32	0.19	0.19	0.26	0.25	3.52	1.75	8.64	0.74
1970	5.22	2.53	0.73	0.47	0.54	0.48	0.43	0.65	0.55	0.52	1.66	1.01	14.80	1.26
1971	4.50	2.02	0.59	0.53	3.58	1.57	0.32	0.22	0.20	0.20	0.19	0.17	14.09	1.20
1972	0.19	0.43	0.64	0.52	0.42	0.41	0.44	0.30	0.17	0.14	0.17	0.22	4.05	0.35
1973	0.32	0.77	0.62	0.42	0.44	0.57	0.51	2.05	1.17	0.49	0.27	0.19	7.83	0.66
1974	0.20	0.38	0.53	0.43	0.36	0.38	0.29	0.20	0.15	0.13	0.12	0.24	3.40	0.29
1975	0.35	0.34	2.90	1.43	2.29	11.61	4.09	0.74	0.59	0.36	0.26	0.35	25.32	2.13
1976	7.70	2.97	0.49	0.41	0.55	0.59	0.34	0.19	0.17	0.17	0.24	0.41	14.23	1.20
1977	0.59	0.87	3.00	1.27	0.31	0.34	12.51	4.67	0.57	0.35	0.31	0.38	25.19	2.12
1978	1.16	1.18	0.65	0.38	0.38	0.58	0.51	0.30	0.20	0.28	0.37	0.44	6.42	0.54
1979	0.61	0.67	0.60	0.42	0.41	0.36	0.21	0.18	0.15	0.14	0.13	1.08	4.95	0.42
1980	0.85	2.99	1.37	3.69	1.69	0.50	0.28	0.30	0.34	0.24	0.26	0.28	12.79	1.08
1981	0.31	0.42	0.43	0.39	0.34	3.97	1.78	0.47	0.30	0.26	0.20	0.20	9.07	0.77
1982	0.29	0.23	0.15	0.12	0.10	0.10	0.11	0.10	0.08	15.11	5.44	0.58	22.41	1.89
1983	0.54	2.74	1.39	0.66	2.82	1.42	0.65	0.47	0.37	0.41	0.34	0.25	12.06	1.01
1984	0.38	0.80	0.61	0.45	12.95	4.63	0.36	0.21	0.17	0.17	0.14	0.12	21.01	1.76
1985	0.33	0.66	0.55	0.68	0.52	0.42	0.39	0.24	0.17	0.14	0.24	0.55	4.89	0.41
1986	2.05	3.08	1.27	0.44	0.26	0.25	0.24	0.16	0.14	0.13	0.16	12.10	20.29	1.71
1987	5.25	2.88	1.34	0.54	5.09	11.65	3.77	0.66	0.51	0.40	0.39	0.35	32.82	2.75
1988	0.43	2.53	3.37	1.17	4.41	1.95	1.90	0.96	0.36	0.30	0.23	0.19	17.80	1.50
1989	5.15	9.10	2.84	0.58	0.47	0.57	0.49	0.26	0.20	0.17	0.28	0.41	20.53	1.72
1990	0.54	0.57	0.49	0.55	1.12	0.68	0.27	0.18	0.16	0.13	0.12	0.16	4.98	0.42
1991	0.73	1.98	1.00	0.37	0.24	0.20	0.25	0.21	0.13	0.11	0.10	0.14	5.46	0.46
1992	0.25	0.36	0.32	0.24	0.20	0.14	0.14	0.14	0.10	0.08	0.08	0.62	2.67	0.23
1993	1.61	0.99	2.41	1.10	5.88	2.45	0.48	0.20	0.16	0.24	0.42	0.33	16.27	1.36
1994	0.22	0.19	0.26	0.30	0.20	1.86	2.12	0.91	1.02	0.74	0.36	0.35	8.53	0.72
1995	0.51	0.49	7.75	3.06	1.52	0.78	0.36	0.26	0.17	0.22	0.26	0.22	15.61	1.31
1996	0.38	5.78	2.40	1.10	0.81	0.63	2.19	1.11	10.26	4.11	0.73	0.56	30.07	2.51
1997	0.67	2.50	1.20	0.44	4.02	2.77	0.90	0.45	0.31	0.25	0.28	0.30	14.09	1.18
1998	0.26	0.42	2.28	1.11	0.59	1.91	0.99	0.34	0.22	0.17	0.15	0.12	8.56	0.72
1999	0.32	0.59	0.75	3.10	3.58	6.03	3.42	1.12	0.50	0.33	0.25	0.28	20.27	1.69
2000	0.41	0.50	0.60	0.45	0.31	0.34	0.38	0.34	0.24	0.28	0.31	0.29	4.44	0.37
2001	0.36	8.36	3.22	0.57	0.50	0.38	0.33	0.31	0.23	0.37	0.62	1.56	16.80	1.40
2002	0.90	0.52	0.58	0.40	0.20	3.01	1.56	0.64	0.46	0.34	0.26	0.45	9.33	0.78
2003	1.12	0.73	0.41	0.48	0.33	0.40	0.41	0.24	0.16	0.20	0.20	0.35	5.04	0.42
2004	0.68	0.61	0.42	2.59	1.19	0.30	0.28	0.26	0.20	0.17	0.18	0.21	7.10	0.59
2005	0.24	2.98	1.4	0.54	0.56	0.49	0.42	0.52	0.65	0.52	0.49	3.72	12.54	1.05
2006	6.15	2.19	6.9	2.67	0.37	0.37	0.55	0.41	0.28	0.23	0.2	0.21	20.54	1.71
2007	0.43	0.74	0.55	5.79	2.27	0.45	1.74	0.95	3.06	1.45	0.37	0.3	18.1	1.51
% of to	8.93	15.11	11.46	8.03	10.31	12.71	8.40	4.92	5.23	6.10	3.74	5.05	100.00	
Averag	1.12	1.89	1.44	1.01	1.29	1.59	1.05	0.62	0.66	0.76	0.47	0.63	12.54	
SD	1.628	2.412	1.630	1.062	1.846	2.241	1.562	0.902	1.396	2.125	0.822	1.383	7.258	
CV	1.455	1.274	1.134	1.055	1.429	1.407	1.483	1.462	2.128	2.779	1.754	2.183	0.579	

PRESENT DAY FLOW RECORD FOR QUATERNARY T60E CATCHMENT AREA = 198.9 KM2

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOT	CUM
1920	0.97	1.45	2.09	1.97	1.73	1.90	1.94	1.33	0.85	0.69	0.59	0.72	16.23	1.38
1921	1.18	5.75	10.26	3.94	1.34	0.99	0.78	1.44	2.50	1.82	1.57	1.63	33.21	2.82
1922	9.41	14.74	5.03	10.99	13.54	6.11	1.81	0.93	0.76	6.77	3.41	1.11	74.59	6.31
1923	0.93	1.01	1.23	3.74	3.94	1.73	0.83	0.74	0.69	0.62	0.66	0.93	17.04	1.45
1924	1.33	1.74	3.94	2.16	1.23	9.66	4.42	1.30	0.87	0.74	0.63	0.76	28.78	2.45
1925	1.02	1.58	1.90	3.16	2.21	15.23	6.08	1.03	1.11	1.07	0.80	1.01	36.19	3.07
1926	1.60	2.01	4.40	2.54	1.36	16.49	6.43	0.78	0.61	0.53	0.52	0.61	37.88	3.21
1927	1.20	1.31	1.58	6.96	5.55	2.33	1.08	0.71	0.60	0.53	0.64	0.73	23.20	1.97
1928	0.82	1.14	1.30	1.33	1.14	1.45	1.16	0.79	1.28	1.79	1.40	2.58	16.18	1.38
1929	7.49	7.53	3.25	1.59	1.04	1.20	1.41	0.99	1.03	1.09	1.34	1.76	29.73	2.52
1930	1.57	1.32	1.39	12.51	11.30	9.99	3.70	0.98	0.64	20.28	8.07	1.15	72.92	6.16
1931	1.29	1.64	1.48	1.01	2.21	1.85	0.98	0.80	0.85	0.97	0.90	1.36	15.35	1.31
1932	2.19	20.43	15.60	3.76	1.09	1.65	1.25	0.79	0.61	0.55	0.50	0.50	48.92	4.13
1933	0.55	2.64	6.31	7.72	3.06	1.40	1.17	0.81	0.63	0.79	0.76	0.57	26.40	2.24
1934	0.64	1.34	5.15	2.85	1.09	1.03	1.72	3.77	9.09	4.02	1.71	1.52	33.95	2.88
1935	1.34	1.76	1.09	0.73	6.44	6.10	2.22	1.48	1.54	1.04	0.73	0.67	25.13	2.13
1936	1.28	23.30	8.67	1.04	5.15	3.18	1.45	0.82	0.62	0.55	0.51	0.54	47.10	3.98
1937	0.74	0.93	1.37	1.73	1.69	1.27	1.51	1.37	1.02	1.01	0.86	0.66	14.16	1.21
1938	0.78	1.44	2.92	3.63	14.20	5.58	1.20	1.07	0.89	1.01	1.20	6.23	40.14	3.40
1939	3.73	2.02	1.84	1.38	1.59	2.06	1.52	1.84	1.83	1.08	0.71	0.78	20.36	1.73
1940	0.96	2.29	1.93	1.20	0.76	0.64	0.74	0.61	0.47	0.45	0.43	0.43	10.89	0.92
1941	0.63	1.11	0.92	1.28	1.71	1.75	1.67	1.37	0.93	0.60	0.55	0.66	13.18	1.12
1942	1.01	20.32	12.33	3.14	1.22	1.44	3.03	2.14	1.43	1.18	1.59	1.78	50.61	4.28
1943	1.91	7.99	6.55	2.34	1.60	1.66	1.07	0.70	0.64	0.71	0.61	1.25	27.01	2.29
1944	2.10	1.40	0.76	1.07	1.81	2.06	1.38	0.81	0.65	0.52	0.43	0.47	13.45	1.14
1945	1.54	1.48	0.92	0.87	1.15	1.62	1.43	0.92	0.61	0.55	0.46	0.43	11.97	1.02
1946	0.66	1.36	1.55	1.28	1.40	4.80	2.87	1.20	1.28	1.49	0.92	0.77	19.57	1.66
1947	0.85	26.10	10.31	1.64	2.34	2.02	1.38	0.80	0.54	0.45	0.39	0.36	47.17	3.97
1948	0.82	1.48	1.37	1.13	1.34	1.52	1.38	1.00	0.62	0.52	0.48	0.51	12.16	1.03
1949	0.73	1.38	1.55	1.62	6.33	7.00	2.95	1.58	1.21	1.02	1.33	1.30	28.01	2.38
1950	1.40	1.33	8.47	3.94	1.25	1.37	1.08	0.70	0.55	0.46	0.54	0.86	21.96	1.86
1951	2.62	1.78	1.13	1.46	1.64	1.70	1.61	1.15	0.76	0.61	0.48	0.57	15.51	1.32
1952	0.75	0.72	0.81	0.92	0.98	0.92	0.95	0.74	0.49	0.39	0.40	0.97	9.04	0.77
1953	2.57	5.56	3.20	1.57	1.08	1.57	1.37	1.12	1.24	1.07	0.73	0.76	21.84	1.85
1954	7.21	3.77	1.30	2.54	5.42	2.67	1.09	0.80	0.69	0.60	0.44	0.61	27.16	2.30
1955	1.03	1.29	0.92	0.47	0.69	7.88	3.78	1.11	0.90	0.71	0.54	0.62	19.93	1.69
1956	0.93	7.39	16.05	5.96	1.81	3.46	2.47	1.46	1.01	0.83	0.80	1.17	43.35	3.66
1957	1.74	2.45	2.06	1.98	6.16	2.98	1.46	1.11	0.67	0.58	0.53	0.55	22.26	1.89
1958	0.67	2.68	3.35	1.80	1.15	1.40	1.50	15.82	6.32	1.58	1.77	1.69	39.73	3.36
1959	1.72	1.89	1.91	1.71	1.33	1.40	1.68	1.30	0.81	0.65	0.78	1.09	16.25	1.38
1960	1.29	1.52	6.04	6.02	2.68	1.82	7.06	3.41	1.05	0.79	0.61	0.57	32.87	2.78
1961	0.61	1.18	1.82	1.52	1.69	2.10	1.49	0.95	0.70	0.52	0.56	0.60	13.76	1.17
1962	1.06	4.27	2.63	7.53	3.49	17.27	6.87	1.13	0.76	1.36	1.56	0.86	48.80	4.12
1963	1.22	4.79	2.79	3.66	2.26	1.93	5.03	2.52	12.41	5.48	1.14	1.09	44.32	3.74
1964	4.35	2.39	1.02	1.03	1.14	0.85	0.56	0.62	4.44	3.26	2.30	1.99	23.93	2.03
1965	9.52	8.95	3.08	1.41	1.29	0.76	0.57	5.34	2.95	1.04	0.83	1.00	36.73	3.10
1966	1.16	1.19	1.33	1.77	1.55	16.09	6.81	1.54	1.29	1.64	1.37	0.82	36.57	3.09
1967	0.80	1.51	1.70	1.39	1.26	1.15	1.12	0.79	0.52	0.46	0.65	1.21	12.55	1.07
1968	1.62	1.98	1.66	0.98	1.35	6.38	3.16	1.43	1.18	0.81	0.70	0.65	21.90	1.86
1969	0.86	1.30	1.44	1.07	1.22	1.00	0.60	0.58	0.73	0.69	1.22	2.08	12.81	1.09
1970	10.18	4.86	1.89	1.52	1.72	1.60	1.31	1.63	1.39	1.27	1.83	1.82	31.01	2.63
1971	11.52	5.34	1.61	1.52	8.35	3.89	1.11	0.75	0.66	0.63	0.52	0.46	36.34	3.07
1972	0.56	1.36	1.94	1.41	1.30	1.43	1.34	0.85	0.53	0.45	0.53	0.67	12.36	1.05
1973	0.89	1.51	1.37	1.15	1.26	3.91	2.34	4.27	2.75	1.32	0.74	0.54	22.04	1.86
1974	0.59	1.13	1.39	1.17	1.19	1.22	0.94	0.62	0.45	0.39	0.38	0.64	10.11	0.86
1975	0.88	0.84	6.42	6.36	9.67	28.02	9.67	1.98	1.52	0.98	0.72	0.93	67.99	5.72
1976	13.07	5.60	1.58	1.45	1.30	1.24	0.85	0.55	0.51	0.50	0.53	0.76	27.94	2.36
1977	1.32	1.76	4.14	2.19	1.09	1.23	23.99	9.22	1.34	0.89	0.78	0.96	48.93	4.12
1978	1.72	2.31	1.89	1.47	1.33	1.66	1.46	0.89	0.62	0.81	0.96	0.95	16.08	1.36
1979	1.33	1.59	1.45	1.15	1.15	0.96	0.63	0.54	0.46	0.43	0.41	1.51	11.63	0.99
1980	1.90	8.40	3.95	12.74	5.40	1.43	0.87	0.87	0.89	0.66	0.73	0.80	38.64	3.26
1981	1.05	1.52	1.61	1.38	1.20	3.74	2.40	1.15	0.84	0.77	0.61	0.59	16.85	1.43
1982	0.93	0.93	0.62	0.45	0.36	0.33	0.38	0.37	0.30	16.42	6.75	1.39	29.24	2.47
1983	1.23	5.72	3.24	1.89	9.24	4.39	1.79	1.25	0.89	0.89	0.80	0.63	31.96	2.70
1984	0.97	3.62	2.22	1.32	22.19	8.23	0.91	0.60	0.50	0.47	0.40	0.36	41.78	3.52
1985	0.99	1.98	1.56	1.39	1.12	1.08	1.00	0.66	0.50	0.43	0.63	1.15	12.48	1.06
1986	2.16	9.43	4.25	1.22	0.75	0.67	0.59	0.43	0.37	0.34	0.43	27.34	47.99	4.04
1987	12.82	4.89	2.52	1.43	6.68	21.10	7.58	1.73	1.42	1.08	0.96	0.89	63.12	5.30
1988	1.02	1.76	4.28	2.15	9.46	4.30	5.14	2.65	1.03	0.87	0.66	0.50	33.83	2.85
1989	9.79	22.83	7.81	1.88	1.37	2.16	1.63	0.86	0.66	0.58	0.84	1.02	51.43	4.32
1990	1.23	1.34	1.22	1.58	3.33	1.79	0.59	0.45	0.42	0.38	0.35	0.48	13.15	1.11
1991	1.37	2.25	1.50	0.93	0.71	0.65	0.81	0.65	0.42	0.35	0.33	0.39	10.34	0.87
1992	0.59	0.76	0.72	0.73	0.70	0.45	0.46	0.42	0.29	0.25	0.24	0.72	6.33	0.53
1993	1.84	2.05	5.30	2.74	14.08	6.07	1.34	0.62	0.49	0.68	0.97	0.70	36.90	3.10
1994	0.60	0.60	0.59	0.67	0.61	2.38	3.86	2.15	4.04	2.47	0.95	0.95	19.87	1.67
1995	1.36	1.41	13.27	11.48	8.03	2.93	0.99	0.67	0.52	0.71	0.82	0.69	42.87	3.60
1996	1.01	11.07	4.99	1.76	2.69	2.01	5.83	2.93	24.20	9.67	1.88	1.50	69.56	5.83
1997	1.73	5.50	2.76	1.39	10.75	8.73	2.92	1.32	0.93	0.72	0.68	0.68	38.11	3.20
1998	0.73	1.16	1.93	1.69	1.86	2.22	1.61	0.91	0.61	0.51	0.44	0.37	14.01	1.18
1999	0.83	1.48	2.79	9.58	6.43	10.04	6.80	2.67	1.34	0.89	0.65	0.75	44.25	3.71
2000	1.15	1.41	1.70	1.50	1.30	1.26	1.40	1.19	0.75	0.84	0.90	0.88	14.28	1.20
2001	1.20	13.58	5.80	1.82	1.63	1.12	0.86	0.80	0.67	0.97	1.56	2.03	32.03	2.68
2002	1.81	1.45	1.55	1.04	0.67	1.33	1.84	1.35	1.03	0.88	0.74	1.18	14.87	1.24
2003	2.10	1.84	1.40	1.36	1.02	1.34	1.28	0.73	0.72	1.07	0.93	1.05	14.84	1.24
2004	1.37	1.31	1.15	3.70	2.25	1.00	0.87	0.73	0.54	0.46	0.46	0.66	14.51	1.21
2005	0.99	5.03	2.89	1.52	1.57	1.45	1.25	1.26	1.3	1.04	0.95	1.65	20.9	1.74
2006	19.87	8.06	10.27	4.57	1.2	1.41	2.04	1.38	0.85	0.67	0.56	0.69	51.59	4.3
2007	1.47	2.09	2.35	8.73	3.65	0.88	1.31	1.45	2.12	1.81	1.01	0.9	27.77	2.31
% of to	8.26	14.42	11.75	9.45	11.32	12.94	8.34	5.18	5.28	5.20	3.42	4.46	100.00	
Averag	2.39	4.18	3.40	2.74	3.28	3.75	2.42	1.50	1.53	1.51	0.99	1.29	28.99	
SD	3.401	5.390	3.322	2.745	3.853	4.877	3.022	1.953	2.994	2.927	1.105	2.900	15.949	
CV	1.421	1.290	0.976	1.002	1.175	1.300	1.250	1.302	1.955	1.943	1.114	2.244	0.550	

PRESENT DAY FLOW RECORD FOR QUATERNARY T60F1&T60F2 CATCHMENT AREA = 71.3 KM2

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOT	AVE
1920	0.23	0.49	0.83	0.69	0.58	0.76	0.78	0.49	0.27	0.17	0.15	0.21	5.65	0.63
1921	0.53	3.87	4.78	1.63	0.48	0.36	0.27	0.54	1.04	0.76	0.66	0.76	15.69	1.47
1922	6.16	7.89	2.42	6.48	8.33	3.37	0.78	0.32	0.24	4.04	1.84	0.37	42.23	3.72
1923	0.35	0.42	0.51	2.61	1.49	0.57	0.25	0.19	0.19	0.16	0.19	0.26	7.20	0.73
1924	0.42	0.63	1.78	0.99	0.61	5.89	2.53	0.53	0.31	0.23	0.20	0.28	14.41	1.35
1925	0.46	0.61	0.63	0.63	0.73	5.86	2.36	0.35	0.40	0.39	0.26	0.33	13.02	1.23
1926	0.68	1.92	1.59	0.80	0.46	8.48	3.12	0.23	0.16	0.11	0.12	0.16	17.83	1.63
1927	0.43	0.39	0.46	0.85	1.84	1.12	0.45	0.23	0.20	0.13	0.22	0.24	6.55	0.66
1928	0.30	0.55	0.61	0.55	0.45	0.64	0.49	0.30	1.68	1.70	1.01	2.70	10.99	1.04
1929	5.25	4.00	1.39	0.52	0.35	0.45	0.48	0.33	0.40	0.45	0.56	1.56	15.75	1.44
1930	1.06	0.58	0.46	3.57	4.39	5.09	1.81	0.32	0.19	16.63	5.97	0.44	40.52	3.55
1931	0.60	0.75	0.62	0.37	2.20	1.33	0.46	0.34	0.41	0.43	0.35	1.91	9.78	0.94
1932	1.34	10.45	5.96	1.12	0.46	0.92	0.60	0.30	0.20	0.15	0.14	0.11	21.76	1.95
1933	0.15	1.37	2.93	4.59	1.80	0.82	0.64	0.36	0.23	0.32	0.33	0.16	13.69	1.27
1934	0.19	0.45	2.17	1.16	0.37	0.47	1.46	2.89	6.56	2.47	0.77	0.65	19.61	1.77
1935	0.53	0.67	0.37	0.18	5.13	5.89	1.81	0.78	0.74	0.46	0.29	0.24	17.09	1.56
1936	0.62	12.93	4.62	0.36	2.47	2.08	0.82	0.30	0.20	0.17	0.19	0.17	24.92	2.22
1937	0.26	0.32	0.57	0.79	0.67	0.49	0.59	0.54	0.40	0.40	0.32	0.18	5.51	0.57
1938	0.21	0.48	0.76	1.87	4.61	1.96	0.53	0.39	0.31	0.38	0.54	4.45	16.49	1.51
1939	2.41	0.90	0.80	0.57	0.47	0.61	0.43	0.65	0.68	0.36	0.22	0.25	8.35	0.81
1940	0.34	2.11	1.16	0.39	0.20	0.21	0.19	0.12	0.10	0.08	0.10	0.08	5.08	0.53
1941	0.23	0.47	0.34	0.91	0.72	0.62	0.55	0.50	0.38	0.18	0.18	0.23	5.32	0.55
1942	0.43	11.89	6.60	1.34	0.38	0.59	1.80	1.05	0.51	0.39	0.68	0.80	26.46	2.34
1943	0.79	3.37	2.30	0.79	0.61	0.62	0.36	0.22	0.21	0.22	0.18	2.58	12.26	1.14
1944	1.59	0.69	0.31	0.35	0.66	0.98	0.63	0.30	0.23	0.14	0.11	0.13	6.13	0.61
1945	4.22	1.77	0.27	0.25	0.39	0.68	0.67	0.44	0.23	0.16	0.11	0.08	9.27	0.89
1946	0.22	0.61	0.60	0.40	0.46	2.21	1.39	0.67	0.87	0.80	0.47	0.31	9.01	0.86
1947	0.35	14.55	5.96	0.81	0.89	0.88	0.61	0.31	0.17	0.10	0.09	0.05	24.77	2.19
1948	0.30	0.68	0.59	0.47	2.75	1.66	0.80	0.48	0.22	0.14	0.13	0.15	8.36	0.80
1949	0.28	1.48	0.98	0.65	0.80	0.91	0.72	0.59	0.42	0.32	0.41	0.35	7.92	0.77
1950	0.46	0.42	2.24	1.27	0.53	0.53	0.37	0.20	0.14	0.09	0.12	0.21	6.58	0.65
1951	1.25	0.77	0.55	0.85	0.74	0.71	0.69	0.48	0.25	0.15	0.10	0.15	6.70	0.66
1952	0.27	0.29	0.26	0.28	0.31	0.32	0.27	0.18	0.10	0.04	0.07	0.37	2.76	0.33
1953	1.37	4.85	1.94	0.40	0.20	0.46	0.43	0.33	0.42	0.35	0.23	0.27	11.25	1.05
1954	6.60	2.69	0.50	0.74	2.55	1.38	0.48	0.26	0.22	0.16	0.10	0.21	15.89	1.44
1955	0.51	0.61	0.40	0.13	0.25	5.22	2.23	0.49	0.36	0.25	0.16	0.23	10.83	1.01
1956	0.53	8.35	11.55	3.47	0.69	1.51	2.05	0.99	0.45	0.33	0.31	0.44	30.68	2.68
1957	0.72	0.85	2.04	2.06	3.86	1.67	0.79	0.59	0.27	0.20	0.19	0.18	13.42	1.23
1958	0.26	2.88	1.57	0.51	0.39	0.50	0.47	8.36	3.23	0.65	0.82	0.80	20.44	1.83
1959	0.77	0.77	0.77	0.63	0.45	0.57	0.71	0.56	0.32	0.20	0.26	0.40	6.41	0.64
1960	0.57	0.72	3.13	2.85	1.09	0.62	5.38	2.28	0.42	0.31	0.25	0.18	17.80	1.60
1961	0.22	0.53	0.80	0.61	0.61	1.88	0.99	0.34	0.23	0.12	0.17	0.18	6.67	0.66
1962	0.48	2.48	1.30	3.14	1.52	10.66	3.94	0.46	0.31	2.07	1.16	0.31	27.83	2.44
1963	0.46	1.56	1.02	2.52	1.44	0.93	1.99	1.01	8.35	3.30	0.45	0.37	23.40	2.07
1964	1.41	0.90	0.44	0.46	0.46	0.31	0.15	0.17	2.66	1.64	0.95	0.89	10.43	0.98
1965	7.46	5.54	1.52	0.51	0.45	0.27	0.16	4.12	1.92	0.38	0.28	0.32	22.94	2.03
1966	0.39	0.43	0.51	0.69	0.59	7.35	5.28	1.42	0.45	0.61	0.55	0.26	18.52	1.66
1967	0.24	0.58	0.65	0.45	0.44	0.45	0.36	0.21	0.12	0.08	0.19	0.50	4.25	0.46
1968	0.75	1.43	0.93	0.39	0.92	3.79	1.67	0.75	0.68	0.38	0.27	0.20	12.15	1.12
1969	0.31	0.59	0.63	0.41	0.44	0.38	0.18	0.17	0.27	0.24	4.56	2.19	10.35	0.97
1970	6.78	3.22	0.86	0.53	0.62	0.59	0.50	0.77	0.65	0.58	2.10	1.22	18.43	1.65
1971	5.83	2.55	0.68	0.60	4.63	2.02	0.35	0.20	0.19	0.17	0.17	0.12	17.50	1.57
1972	0.16	0.46	0.74	0.58	0.47	0.50	0.50	0.32	0.15	0.09	0.14	0.19	4.29	0.46
1973	0.32	0.91	0.71	0.46	0.49	0.71	0.60	2.62	1.46	0.54	0.28	0.15	9.25	0.87
1974	0.17	0.40	0.60	0.47	0.39	0.46	0.31	0.18	0.12	0.07	0.08	0.21	3.47	0.38
1975	0.37	0.35	3.72	1.78	2.93	15.12	5.27	0.90	0.70	0.38	0.26	0.36	32.14	2.78
1976	10.03	3.80	0.55	0.45	0.63	0.74	0.38	0.17	0.14	0.12	0.23	0.43	17.68	1.58
1977	0.68	1.05	3.85	1.57	0.33	0.41	16.34	6.04	0.67	0.36	0.33	0.40	32.03	2.78
1978	1.43	1.45	0.76	0.40	0.41	0.72	0.60	0.31	0.19	0.27	0.41	0.47	7.41	0.72
1979	0.70	0.79	0.69	0.45	0.45	0.43	0.21	0.15	0.13	0.09	0.09	1.31	5.49	0.56
1980	1.02	3.85	1.70	4.75	2.12	0.62	0.29	0.31	0.38	0.22	0.26	0.26	15.79	1.42
1981	0.31	0.45	0.47	0.41	0.35	5.19	2.27	0.54	0.32	0.25	0.18	0.16	10.91	1.01
1982	0.28	0.21	0.10	0.07	0.05	0.10	0.07	0.05	0.03	19.76	7.06	0.65	28.42	2.48
1983	0.62	3.51	1.72	0.77	3.61	1.82	0.78	0.54	0.41	0.44	0.37	0.22	14.81	1.33
1984	0.40	0.96	0.70	0.50	16.88	6.03	0.40	0.20	0.15	0.12	0.10	0.05	26.50	2.31
1985	0.34	0.77	0.62	0.80	0.60	0.52	0.44	0.24	0.15	0.09	0.24	0.62	5.41	0.55
1986	2.60	3.96	1.56	0.49	0.26	0.29	0.25	0.14	0.11	0.07	0.12	15.79	25.64	2.24
1987	6.79	3.67	1.65	0.61	6.60	15.20	4.86	0.79	0.60	0.43	0.43	0.36	41.99	3.60
1988	0.47	3.23	4.33	1.44	5.72	2.51	2.42	1.17	0.40	0.30	0.22	0.14	22.36	1.97
1989	6.70	11.83	3.61	0.67	0.54	0.71	0.57	0.26	0.18	0.13	0.29	0.43	25.90	2.26
1990	0.61	0.66	0.54	0.62	1.38	0.85	0.28	0.15	0.13	0.08	0.08	0.10	5.50	0.56
1991	0.87	2.50	1.21	0.39	0.23	0.23	0.26	0.19	0.10	0.05	0.05	0.07	6.15	0.61
1992	0.24	0.38	0.33	0.22	0.18	0.15	0.11	0.10	0.06	0.01	0.03	0.70	2.50	0.30
1993	2.03	1.20	3.07	1.35	7.64	3.18	0.55	0.19	0.13	0.22	0.47	0.33	20.36	1.79
1994	0.20	0.15	0.24	0.30	0.17	2.41	2.72	1.12	1.27	0.88	0.39	0.35	10.20	0.94
1995	0.57	0.55	10.08	3.92	1.90	0.98	0.40	0.27	0.15	0.20	0.26	0.19	19.47	1.72
1996	0.41	7.53	3.05	1.35	0.97	0.79	2.80	1.38	13.35	5.28	0.87	0.63	38.40	3.29
1997	0.79	3.18	1.47	0.48	5.20	3.59	1.11	0.51	0.34	0.23	0.29	0.29	17.46	1.55
1998	0.25	0.45	2.89	1.36	0.69	2.46	1.23	0.36	0.21	0.13	0.11	0.05	10.19	0.94
1999	0.32	0.68	0.89	3.98	4.61	7.86	4.41	1.38	0.58	0.34	0.25	0.26	25.56	2.19
2000	0.45	0.56	0.69	0.49	0.32	0.40	0.42	0.36	0.24	0.27	0.32	0.27	4.79	0.43
2001	0.37	10.90	4.13	0.66	0.57	0.46	0.36	0.32	0.22	0.39	0.73	1.94	21.06	1.78
2002	1.09	0.58	0.67	0.44	0.18	3.92	1.97	0.76	0.53	0.36	0.26	0.49	11.25	0.97
2003	1.37	0.87	0.44	0.53	0.35	0.49	0.48	0.23	0.14	0.17	0.18	0.35	5.60	0.47
2004	0.80	0.71	0.45	3.31	1.48	0.36	0.30	0.26	0.19	0.13	0.15	0.18	8.33	0.69
2005	0.23	3.83	1.74	0.61	0.65	0.61	0.48	0.61	0.78	0.59	0.57	4.79	15.48	1.29
2006	7.96	2.76	8.93	3.40	0.41	0.45	0.66	0.46	0.29	0.21	0.18	0.17	25.88	2.15
2007	0.47	0.88	0.63	7.53	2.89	0.55	2.20	1.16	3.95	1.81	0.40	0.28	22.76	1.90
% of to	8.91	15.50	11.58	7.94	10.43	13.30	8.48	4.73	5.09	5.88	3.46	4.70	100.00	
Averag	1.37	2.39	1.79	1.23	1.61	2.05	1.31	0.73	0.79	0.91	0.53	0.73	15.42	
SD	2.141	3.167	2.136	1.394	2.422	2.936	2.048	1.187	1.829	2.790	1.079	1.818	9.519	
CV	1.557	1.325	1.196	1.138	1.505	1.431	1.565	1.629	2.329	3.076	2.023	2.506	0.617	

PRESENT DAY FLOW RECORD FOR QUATERNARY T60F3 CATCHMENT AREA = 271.1 KM2

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOT	CUM
1920	1.19	1.99	3.00	2.51	2.17	2.62	2.75	1.83	1.14	0.93	0.80	1.09	22.01	22.01
1921	2.04	12.12	14.85	5.21	1.80	1.31	1.13	1.99	3.51	2.65	2.36	2.75	51.70	73.71
1922	19.09	24.11	7.45	19.88	25.48	10.19	2.51	1.25	1.00	12.64	5.80	1.49	130.88	204.60
1923	1.40	1.62	1.94	8.26	4.73	1.90	1.07	0.92	0.92	0.88	0.95	1.26	25.85	230.45
1924	1.73	2.39	5.71	3.26	2.29	18.24	7.86	1.97	1.30	1.13	0.97	1.34	48.20	278.65
1925	1.86	2.35	2.43	2.43	2.71	18.03	7.40	1.45	1.61	1.64	1.18	1.48	44.56	323.20
1926	2.56	6.15	5.07	2.65	1.81	25.65	9.85	1.07	0.83	0.74	0.74	0.95	58.07	381.27
1927	1.76	1.64	1.89	2.84	5.93	3.46	1.57	1.08	0.96	0.82	1.06	1.18	24.21	405.48
1928	1.35	2.11	2.32	2.06	1.74	2.20	1.73	1.23	5.50	5.55	3.28	8.59	37.67	443.16
1929	16.10	12.34	4.44	1.93	1.37	1.54	1.73	1.31	1.50	1.73	2.04	5.04	51.08	494.23
1930	3.47	2.08	1.76	11.18	13.51	15.35	5.58	1.26	0.85	50.07	18.11	1.72	124.96	619.20
1931	2.16	2.65	2.27	1.48	6.99	4.10	1.60	1.36	1.56	1.67	1.40	6.21	33.44	652.63
1932	4.30	31.57	18.20	3.62	1.72	3.00	2.09	1.21	0.91	0.83	0.73	0.75	68.94	721.57
1933	0.83	4.48	9.28	14.21	5.68	2.69	2.22	1.40	1.01	1.34	1.32	0.91	45.38	766.95
1934	0.96	1.76	7.00	3.79	1.37	1.64	4.65	9.05	19.84	7.73	2.65	2.37	62.78	829.73
1935	1.94	2.37	1.39	0.91	15.87	17.86	5.62	2.57	2.54	1.75	1.20	1.12	55.13	884.86
1936	2.24	38.98	14.15	1.44	7.85	6.39	2.63	1.21	0.91	0.88	0.88	0.91	78.47	963.33
1937	1.15	1.34	2.14	2.83	2.37	1.64	2.12	1.97	1.52	1.58	1.29	0.94	20.88	984.21
1938	1.00	1.83	2.72	6.04	14.23	6.09	1.82	1.50	1.23	1.51	1.96	13.82	53.74	1 037.95
1939	7.63	2.94	2.78	2.05	1.75	2.03	1.59	2.29	2.36	1.37	0.95	1.13	28.86	1 066.81
1940	1.39	6.79	3.81	1.45	0.93	0.83	0.85	0.68	0.59	0.61	0.61	0.63	19.17	1 085.97
1941	1.07	1.80	1.33	3.14	2.45	1.99	1.91	1.81	1.37	0.83	0.83	1.07	19.62	1 105.59
1942	1.64	35.96	20.14	4.30	1.41	1.97	5.73	3.38	1.80	1.51	2.35	2.81	82.99	1 188.59
1943	2.74	10.50	7.26	2.62	2.16	2.05	1.34	0.95	0.91	1.00	0.83	8.22	40.59	1 229.18
1944	5.11	2.34	1.23	1.41	2.35	3.05	2.10	1.22	0.98	0.79	0.64	0.78	21.99	1 251.17
1945	13.12	5.74	1.12	1.10	1.52	2.28	2.35	1.56	0.96	0.82	0.64	0.62	31.84	1 283.01
1946	1.02	2.21	2.10	1.51	1.72	6.86	4.45	2.24	2.83	2.67	1.64	1.29	30.54	1 313.55
1947	1.38	43.81	18.12	2.67	2.93	2.76	2.09	1.21	0.78	0.64	0.56	0.53	77.48	1 391.03
1948	1.28	2.43	2.15	1.77	8.64	5.15	2.62	1.67	0.94	0.76	0.70	0.83	28.94	1 419.96
1949	1.21	4.87	3.24	2.29	2.78	2.94	2.40	2.09	1.54	1.29	1.53	1.42	27.61	1 447.57
1950	1.73	1.62	7.15	4.12	1.84	1.76	1.40	0.89	0.70	0.60	0.67	1.01	23.49	1 471.06
1951	4.15	2.61	1.94	2.86	2.49	2.33	2.36	1.67	1.02	0.78	0.60	0.80	23.62	1 494.68
1952	1.17	1.21	1.15	1.18	1.23	1.13	1.09	0.83	0.58	0.46	0.49	1.48	11.98	1 506.65
1953	4.48	14.97	6.18	1.45	0.90	1.56	1.56	1.30	1.54	1.40	0.99	1.18	37.51	1 544.17
1954	20.31	8.44	1.75	2.49	8.01	4.22	1.63	1.06	0.94	0.83	0.60	1.02	51.31	1 595.48
1955	1.89	2.21	1.49	0.70	1.07	15.99	6.99	1.67	1.36	1.10	0.79	1.07	36.33	1 631.81
1956	1.98	25.49	34.64	10.60	2.39	4.65	6.37	3.16	1.61	1.34	1.23	1.72	95.17	1 726.98
1957	2.52	2.94	6.47	6.52	11.86	5.08	2.66	2.08	1.10	0.93	0.86	0.93	43.94	1 770.92
1958	1.12	9.10	5.03	1.82	1.52	1.70	1.70	25.62	10.05	2.33	2.81	2.83	65.62	1 836.54
1959	2.68	2.70	2.71	2.27	1.69	1.90	2.44	2.02	1.26	0.97	1.09	1.61	23.34	1 859.88
1960	2.09	2.57	9.83	8.95	3.49	2.07	16.45	7.12	1.51	1.28	1.04	0.93	57.33	1 917.21
1961	1.02	1.96	2.81	2.17	2.18	5.90	3.16	1.35	0.97	0.72	0.82	0.94	24.00	1 941.21
1962	1.83	7.87	4.21	9.86	4.82	31.77	11.98	1.68	1.23	6.59	3.73	1.27	86.83	2 028.04
1963	1.73	4.99	3.35	8.03	4.55	3.00	6.19	3.24	25.30	10.27	1.59	1.48	73.73	2 101.77
1964	4.52	2.96	1.70	1.73	1.73	1.11	0.74	0.84	8.42	5.26	3.22	3.13	35.34	2 137.11
1965	22.78	16.94	4.79	1.89	1.67	1.01	0.75	12.85	6.05	1.48	1.18	1.38	72.78	2 209.89
1966	1.55	1.70	1.94	2.49	2.15	22.42	16.10	4.44	1.66	2.22	1.98	1.18	59.83	2 269.72
1967	1.09	2.13	2.37	1.72	1.68	1.59	1.40	0.97	0.68	0.61	0.92	1.94	17.10	2 286.82
1968	2.68	4.71	3.08	1.45	3.05	11.61	5.25	2.61	2.33	1.42	1.12	0.99	40.30	2 327.11
1969	1.29	2.14	2.30	1.51	1.66	1.32	0.82	0.81	1.10	1.07	14.12	6.99	35.14	2 362.25
1970	20.72	10.03	2.83	1.94	2.21	1.98	1.78	2.64	2.27	2.12	6.69	3.98	59.17	2 421.43
1971	17.91	8.01	2.40	2.17	14.30	6.15	1.31	0.91	0.85	0.85	0.80	0.75	56.41	2 477.84
1972	0.84	1.78	2.65	2.11	1.76	1.71	1.83	1.26	0.75	0.63	0.74	0.97	17.03	2 494.87
1973	1.35	3.05	2.44	1.68	1.83	2.37	2.05	8.22	4.64	1.89	1.09	0.82	31.43	2 526.30
1974	0.85	1.56	2.17	1.72	1.51	1.56	1.21	0.85	0.65	0.57	0.53	1.03	14.23	2 540.52
1975	1.47	1.37	11.60	5.71	9.12	44.72	15.75	3.01	2.36	1.46	1.07	1.45	99.10	2 639.62
1976	30.47	11.74	2.00	1.70	2.24	2.41	1.38	0.83	0.72	0.72	1.01	1.72	56.94	2 696.56
1977	2.44	3.45	11.99	5.01	1.31	1.42	49.00	18.27	2.21	1.43	1.29	1.58	99.40	2 795.97
1978	4.58	4.63	2.55	1.56	1.58	2.38	2.12	1.24	0.87	1.18	1.56	1.82	26.06	2 822.02
1979	2.52	2.77	2.45	1.66	1.71	1.50	0.91	0.77	0.68	0.62	0.58	4.41	20.58	2 842.60
1980	3.42	11.97	5.52	14.67	6.75	2.01	1.12	1.25	1.42	1.02	1.08	1.18	51.42	2 894.02
1981	1.29	1.73	1.80	1.61	1.40	15.89	7.12	1.83	1.26	1.10	0.85	0.85	36.73	2 930.75
1982	1.20	0.99	0.67	0.56	0.47	0.47	0.50	0.45	0.39	59.64	21.39	2.25	88.98	3 019.74
1983	2.22	10.89	5.50	2.65	11.14	5.55	2.62	1.90	1.51	1.67	1.40	1.04	48.09	3 067.83
1984	1.56	3.17	2.40	1.87	50.49	18.06	1.42	0.90	0.74	0.72	0.61	0.55	82.47	3 150.31
1985	1.38	2.73	2.21	2.69	2.06	1.77	1.62	1.04	0.75	0.63	1.02	2.29	20.20	3 170.50
1986	8.21	12.29	4.97	1.78	1.09	1.05	1.02	0.72	0.64	0.58	0.69	47.74	80.76	3 251.26
1987	20.66	11.23	5.17	2.20	20.10	45.16	14.62	2.67	2.08	1.62	1.59	1.45	128.57	3 379.83
1988	1.77	10.18	13.38	4.59	17.59	7.70	7.49	3.73	1.48	1.26	0.96	0.80	70.91	3 450.75
1989	20.64	35.51	11.18	2.38	1.96	2.34	2.02	1.10	0.86	0.75	1.21	1.72	81.68	3 532.43
1990	2.27	2.40	2.07	2.29	4.46	2.69	1.10	0.80	0.72	0.62	0.58	0.74	20.74	3 553.17
1991	2.94	7.97	3.95	1.49	1.05	0.89	1.09	0.91	0.61	0.52	0.49	0.63	22.54	3 575.71
1992	1.10	1.53	1.34	0.99	0.88	0.63	0.62	0.62	0.46	0.39	0.39	2.53	11.48	3 587.19
1993	6.47	3.98	9.61	4.39	23.19	9.65	1.83	0.84	0.67	0.99	1.73	1.37	64.73	3 651.93
1994	0.94	0.80	1.09	1.25	0.85	7.49	8.48	3.60	4.04	2.91	1.41	1.44	34.29	3 686.22
1995	2.08	2.00	30.54	12.03	5.98	3.04	1.48	1.10	0.73	0.93	1.09	0.95	61.94	3 748.16
1996	1.59	23.13	9.54	4.29	3.13	2.57	8.74	4.34	39.82	15.98	2.78	2.27	118.19	3 866.35
1997	2.72	10.00	4.68	1.79	16.00	11.06	3.49	1.83	1.29	1.02	1.15	1.25	56.29	3 922.64
1998	1.10	1.73	9.20	4.37	2.44	7.62	3.87	1.39	0.92	0.75	0.65	0.55	34.59	3 957.23
1999	1.36	2.47	2.98	12.41	14.15	23.48	13.47	4.32	1.99	1.36	1.04	1.16	80.19	4 037.41
2000	1.71	2.06	2.47	1.86	1.32	1.42	1.58	1.43	1.04	1.21	1.32	1.25	18.68	4 056.09
2001	1.52	33.14	12.77	2.29	2.07	1.60	1.39	1.29	0.99	1.56	2.58	6.33	67.52	4 123.61
2002	3.57	2.13	2.40	1.61	0.88	12.07	6.27	2.59	1.87	1.43	1.10	1.87	37.80	4 161.41
2003	4.44	2.89	1.68	1.98	1.34	1.67	1.73	0.97	0.71	0.88	0.85	1.48	20.63	4 182.03
2004	2.82	2.43	1.67	10.38	4.80	1.21	1.17	1.10	0.88	0.75	0.76	0.91	28.88	4 210.92
2005	1.04	11.93	5.63	2.13	2.29	2.00	1.72	2.16	2.65	2.05	2.01	14.84	50.44	4 261.36
2006	23.99	8.53	26.80	10.44	1.52	1.52	2.25	1.67	1.15	0.96	0.84	0.88	80.55	4 341.91
2007	1.80	3.04	2.20	23.08	9.07	1.83	6.93	3.72	12.25	5.72	1.48	1.23	72.35	4 414.26
% of to	8.98	15.04	11.39	8.02	10.29	12.61	8.35	4.97	5.28	6.13	3.81	5.15	100.00	
Averag	4.50	7.54	5.71	4.02	5.16	6.32	4.19	2.49	2.65	3.07	1.91	2.58	50.16	
SD	6.427	9.472	6.375	4.204	7.240	8.726	6.107	3.574	5.445	8.357	3.229	5.457	28.335	
CV	1.427	1.256	1.116	1.045	1.402	1.380	1.459	1.435	2.056	2.719	1.689	2.114	0.565	

PRESENT DAY FLOW RECORD FOR XURA RIVER CATCHMENT AREA = 364.0 KM2

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOT	AVE
1920	1.42	2.48	3.83	3.20	2.75	3.38	3.53	2.32	1.41	1.10	0.95	1.30	27.66	4.07
1921	2.57	15.99	19.63	6.84	2.28	1.67	1.40	2.53	4.55	3.41	3.02	3.51	67.39	10.03
1922	25.25	32.00	9.87	26.36	33.81	13.56	3.29	1.57	1.24	16.68	7.64	1.86	173.11	21.37
1923	1.75	2.04	2.45	10.87	6.22	2.47	1.32	1.11	1.11	1.04	1.14	1.52	33.05	4.62
1924	2.15	3.02	7.49	4.25	2.90	24.13	10.39	2.50	1.61	1.36	1.17	1.62	62.61	9.59
1925	2.32	2.96	3.06	3.06	3.44	23.89	9.76	1.80	2.01	2.03	1.44	1.81	57.58	5.76
1926	3.24	8.07	6.66	3.45	2.27	34.13	12.97	1.30	0.99	0.85	0.86	1.11	75.90	10.99
1927	2.19	2.03	2.35	3.69	7.77	4.58	2.02	1.31	1.16	0.95	1.28	1.42	30.76	2.99
1928	1.65	2.66	2.93	2.61	2.19	2.84	2.22	1.53	7.18	7.25	4.29	11.29	48.66	8.97
1929	21.35	16.34	5.83	2.45	1.72	1.99	2.21	1.64	1.90	2.18	2.60	6.60	66.83	8.71
1930	4.53	2.66	2.22	14.75	17.90	20.44	7.39	1.58	1.04	66.70	24.08	2.16	165.48	19.92
1931	2.76	3.40	2.89	1.85	9.19	5.43	2.06	1.70	1.97	2.10	1.75	8.12	43.22	6.28
1932	5.64	42.02	24.16	4.74	2.18	3.92	2.69	1.51	1.11	0.98	0.87	0.86	90.70	12.20
1933	0.98	5.85	12.21	18.80	7.48	3.51	2.86	1.76	1.24	1.66	1.65	1.07	59.07	8.55
1934	1.15	2.21	9.17	4.95	1.74	2.11	6.11	11.94	26.40	10.20	3.42	3.02	82.39	10.76
1935	2.47	3.04	1.76	1.09	21.00	23.75	7.43	3.35	3.28	2.21	1.49	1.36	72.22	10.25
1936	2.86	51.91	18.77	1.80	10.32	8.47	3.45	1.51	1.11	1.05	1.07	1.08	103.39	12.40
1937	1.41	1.66	2.71	3.62	3.04	2.13	2.71	2.51	1.92	1.98	1.61	1.12	26.39	4.31
1938	1.21	2.31	3.48	7.91	18.84	8.05	2.35	1.89	1.54	1.89	2.50	18.27	70.23	7.46
1939	10.04	3.84	3.58	2.62	2.22	2.64	2.02	2.94	3.04	1.73	1.17	1.38	37.21	4.39
1940	1.73	8.90	4.97	1.84	1.13	1.04	1.04	0.80	0.69	0.69	0.71	0.71	24.25	3.23
1941	1.30	2.27	1.67	4.05	3.17	2.61	2.46	2.31	1.75	1.01	1.01	1.30	24.94	5.07
1942	2.07	47.85	26.74	5.64	1.79	2.56	7.53	4.43	2.31	1.90	3.03	3.61	109.45	11.14
1943	3.53	13.87	9.56	3.41	2.77	2.67	1.70	1.17	1.12	1.22	1.01	10.80	52.85	5.82
1944	6.70	3.03	1.54	1.76	3.01	4.03	2.73	1.52	1.21	0.93	0.75	0.91	28.12	4.18
1945	17.34	7.51	1.39	1.35	1.91	2.96	3.02	2.00	1.19	0.98	0.75	0.70	41.11	5.94
1946	1.24	2.82	2.70	1.91	2.18	9.07	5.84	2.91	3.70	3.47	2.11	1.60	39.55	8.47
1947	1.73	58.36	24.08	3.48	3.82	3.64	2.70	1.52	0.95	0.74	0.65	0.58	102.25	10.45
1948	1.58	3.11	2.74	2.24	11.39	6.81	3.42	2.15	1.16	0.90	0.83	0.98	37.30	7.60
1949	1.49	6.35	4.22	2.94	3.58	3.85	3.12	2.68	1.96	1.61	1.94	1.77	35.53	4.89
1950	2.19	2.04	9.39	5.39	2.37	2.29	1.77	1.09	0.84	0.69	0.79	1.22	30.07	3.15
1951	5.40	3.38	2.49	3.71	3.23	3.04	3.05	2.15	1.27	0.93	0.70	0.95	30.32	6.18
1952	1.44	1.50	1.41	1.46	1.54	1.45	1.36	1.01	0.68	0.50	0.56	1.85	14.74	2.33
1953	5.85	19.82	8.12	1.85	1.10	2.02	1.99	1.63	1.96	1.75	1.22	1.45	48.76	6.71
1954	26.91	11.13	2.25	3.23	10.56	5.60	2.11	1.32	1.16	0.99	0.70	1.23	67.20	11.67
1955	2.40	2.82	1.89	0.83	1.32	21.21	9.22	2.16	1.72	1.35	0.95	1.30	47.16	6.18
1956	2.51	33.84	46.19	14.07	3.08	6.16	8.42	4.15	2.06	1.67	1.54	2.16	125.85	18.58
1957	3.24	3.79	8.51	8.58	15.72	6.75	3.45	2.67	1.37	1.13	1.05	1.11	57.36	8.56
1958	1.38	11.98	6.60	2.33	1.91	2.20	2.17	33.98	13.28	2.98	3.63	3.63	86.06	6.84
1959	3.45	3.47	3.48	2.90	2.14	2.47	3.15	2.58	1.58	1.17	1.35	2.01	29.75	3.64
1960	2.66	3.29	12.96	11.80	4.58	2.69	21.83	9.40	1.93	1.59	1.29	1.11	75.13	10.70
1961	1.24	2.49	3.61	2.78	2.79	7.78	4.15	1.69	1.20	0.84	0.99	1.12	30.67	5.28
1962	2.31	10.35	5.51	13.00	6.34	42.43	15.92	2.14	1.54	8.66	4.89	1.58	114.66	15.24
1963	2.19	6.55	4.37	10.55	5.99	3.93	8.18	4.25	33.65	13.57	2.04	1.85	97.13	11.30
1964	5.93	3.86	2.14	2.19	2.19	1.42	0.89	1.01	11.08	6.90	4.17	4.02	45.77	5.76
1965	30.24	22.48	6.31	2.40	2.12	1.28	0.91	16.97	7.97	1.86	1.46	1.70	95.72	11.28
1966	1.94	2.13	2.45	3.18	2.74	29.77	21.38	5.86	2.11	2.83	2.53	1.44	78.35	9.27
1967	1.33	2.71	3.02	2.17	2.12	2.04	1.76	1.18	0.80	0.69	1.11	2.44	21.35	2.58
1968	3.43	6.14	4.01	1.84	3.97	15.40	6.92	3.36	3.01	1.80	1.39	1.19	52.45	9.24
1969	1.60	2.73	2.93	1.92	2.10	1.70	1.00	0.98	1.37	1.31	18.68	9.18	45.49	7.90
1970	27.50	13.25	3.69	2.47	2.83	2.57	2.28	3.41	2.92	2.70	8.79	5.20	77.60	12.46
1971	23.74	10.56	3.08	2.77	18.93	8.17	1.66	1.11	1.04	1.02	0.97	0.87	73.91	6.84
1972	1.00	2.24	3.39	2.69	2.23	2.21	2.33	1.58	0.90	0.72	0.88	1.16	21.32	2.54
1973	1.67	3.96	3.15	2.14	2.32	3.08	2.65	10.84	6.10	2.43	1.37	0.97	40.68	7.07
1974	1.02	1.96	2.77	2.19	1.90	2.02	1.52	1.03	0.77	0.64	0.61	1.24	17.70	4.29
1975	1.84	1.72	15.32	7.49	12.05	59.84	21.02	3.91	3.06	1.84	1.33	1.81	131.24	15.90
1976	40.50	15.54	2.55	2.15	2.87	3.15	1.76	1.00	0.86	0.84	1.24	2.15	74.62	10.18
1977	3.12	4.50	15.84	6.58	1.64	1.83	65.34	24.31	2.88	1.79	1.62	1.98	131.43	18.46
1978	6.01	6.08	3.31	1.96	1.99	3.10	2.72	1.55	1.06	1.45	1.97	2.29	33.47	5.61
1979	3.22	3.56	3.14	2.11	2.16	1.93	1.12	0.92	0.81	0.71	0.67	5.72	26.07	3.61
1980	4.44	15.82	7.22	19.42	8.87	2.63	1.41	1.56	1.80	1.24	1.34	1.44	67.21	6.90
1981	1.60	2.18	2.27	2.02	1.75	21.08	9.39	2.37	1.58	1.35	1.03	1.01	47.64	7.62
1982	1.48	1.20	0.77	0.63	0.52	0.57	0.57	0.50	0.42	79.40	28.45	2.90	117.40	11.80
1983	2.84	14.40	7.22	3.42	14.75	7.37	3.40	2.44	1.92	2.11	1.77	1.26	62.90	7.63
1984	1.96	4.13	3.10	2.37	67.37	24.09	1.82	1.10	0.89	0.84	0.71	0.60	108.97	11.36
1985	1.72	3.50	2.83	3.49	2.66	2.29	2.06	1.28	0.90	0.72	1.26	2.91	25.61	5.69
1986	10.81	16.25	6.53	2.27	1.35	1.34	1.27	0.86	0.75	0.65	0.81	63.53	106.40	13.32
1987	27.45	14.90	6.82	2.81	26.70	60.36	19.48	3.46	2.68	2.05	2.02	1.81	170.56	25.33
1988	2.24	13.41	17.71	6.03	23.31	10.21	9.91	4.90	1.88	1.56	1.18	0.94	93.27	12.83
1989	27.34	47.34	14.79	3.05	2.50	3.05	2.59	1.36	1.04	0.88	1.50	2.15	107.58	12.34
1990	2.88	3.06	2.61	2.91	5.84	3.54	1.38	0.95	0.85	0.70	0.66	0.84	26.24	3.91
1991	3.81	10.47	5.16	1.88	1.28	1.12	1.35	1.10	0.71	0.57	0.54	0.70	28.69	5.38
1992	1.34	1.91	1.67	1.21	1.06	0.78	0.73	0.72	0.52	0.40	0.42	3.23	13.98	3.09
1993	8.50	5.18	12.68	5.74	30.83	12.83	2.38	1.03	0.80	1.21	2.20	1.70	85.09	13.45
1994	1.14	0.95	1.33	1.55	1.02	9.90	11.20	4.72	5.31	3.79	1.80	1.79	44.49	8.72
1995	2.65	2.55	40.62	15.95	7.88	4.02	1.88	1.37	0.88	1.13	1.35	1.14	81.41	9.29
1996	2.00	30.66	12.59	5.64	4.10	3.36	11.54	5.72	53.17	21.26	3.65	2.90	156.59	19.45
1997	3.51	13.18	6.15	2.27	21.20	14.65	4.60	2.34	1.63	1.25	1.44	1.54	73.75	9.25
1998	1.35	2.18	12.09	5.73	3.13	10.08	5.10	1.75	1.13	0.88	0.76	0.60	44.78	9.69
1999	1.68	3.15	3.87	16.39	18.76	31.34	17.88	5.70	2.57	1.70	1.29	1.42	105.75	18.83
2000	2.16	2.62	3.16	2.35	1.64	1.82	2.00	1.79	1.28	1.48	1.64	1.52	23.47	2.86
2001	1.89	44.04	16.90	2.95	2.64	2.06	1.75	1.61	1.21	1.95	3.31	8.27	88.58	10.53
2002	4.66	2.71	3.07	2.05	1.06	15.99	8.24	3.35	2.40	1.79	1.36	2.36	49.05	5.94
2003	5.81	3.76	2.12	2.51	1.69	2.16	2.21	1.20	0.85	1.05	1.03	1.83	26.23	4.41
2004	3.62	3.14	2.12	13.69	6.28	1.57	1.47	1.36	1.07	0.88	0.91	1.09	37.21	4.95
2005	1.27	15.76	7.37	2.74	2.94	2.61	2.20	2.77	3.43	2.64	2.58	19.63	65.92	9.66
2006	31.95	11.29	35.73	13.84	1.93	1.97	2.91	2.13	1.44	1.17	1.02	1.05	106.43	11.02
2007	2.27	3.92	2.83	30.61	11.96	2.38	9.13	4.88	16.20	7.53	1.88	1.51	95.11	10.17
% of total	8.96	15.14	11.43	8.00	10.32	12.77	8.38	4.91	5.23	6.07	3.73	5.04	100.00	
Average	5.88	9.93	7.50	5.25	6.77	8.38	5.50	3.22	3.43	3.98	2.45	3.31	65.59	
SD	8.568	12.639	8.511	5.598	9.662	11.661	8.155	4.762	7.274	11.147	4.308	7.275	37.853	
CV	1.458	1.272	1.135	1.067	1.427	1.392	1.484	1.479	2.119	2.800	1.762	2.200	0.577	

PRESENT DAY FLOW RECORD FOR QUATERARY T60F4 CATCHMENT AREA = 364.0 KM2

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOT	CUM
1920	0.44	0.73	1.10	0.92	0.80	0.96	1.02	0.67	0.42	0.34	0.30	0.40	8.11	8.11
1921	0.75	4.46	5.47	1.92	0.66	0.48	0.42	0.73	1.30	0.97	0.87	1.01	19.06	27.17
1922	7.03	8.88	2.75	7.33	9.39	3.75	0.92	0.46	0.37	4.66	2.14	0.55	48.24	75.40
1923	0.52	0.60	0.71	3.05	1.74	0.70	0.40	0.34	0.34	0.32	0.35	0.46	9.53	84.93
1924	0.64	0.88	2.11	1.20	0.84	6.72	2.89	0.73	0.48	0.42	0.36	0.50	17.76	102.69
1925	0.68	0.87	0.89	0.90	1.00	6.64	2.73	0.53	0.59	0.60	0.43	0.55	16.42	119.12
1926	0.95	2.26	1.87	0.98	0.67	9.46	3.63	0.39	0.30	0.27	0.27	0.35	21.40	140.52
1927	0.65	0.61	0.70	1.05	2.19	1.28	0.58	0.40	0.35	0.30	0.39	0.44	8.92	149.44
1928	0.50	0.78	0.86	0.76	0.64	0.81	0.64	0.46	2.03	2.04	1.21	3.17	13.89	163.32
1929	5.94	4.55	1.63	0.71	0.51	0.57	0.64	0.48	0.55	0.64	0.75	1.86	18.82	182.15
1930	1.28	0.77	0.65	4.12	4.98	5.66	2.06	0.47	0.31	18.46	6.68	0.64	46.06	228.20
1931	0.80	0.97	0.83	0.54	2.58	1.51	0.59	0.50	0.57	0.62	0.51	2.29	12.32	240.53
1932	1.59	11.63	6.71	1.34	0.64	1.10	0.77	0.45	0.34	0.30	0.27	0.28	25.41	265.94
1933	0.31	1.65	3.42	5.24	2.10	0.99	0.82	0.52	0.37	0.49	0.49	0.33	16.72	282.66
1934	0.35	0.65	2.58	1.39	0.50	0.60	1.71	3.33	7.31	2.85	0.97	0.87	23.14	305.80
1935	0.72	0.88	0.51	0.33	5.85	6.58	2.07	0.95	0.93	0.64	0.44	0.41	20.32	326.12
1936	0.83	14.37	5.21	0.53	2.89	2.35	0.97	0.44	0.33	0.33	0.33	0.34	28.92	355.04
1937	0.42	0.50	0.79	1.04	0.87	0.60	0.78	0.73	0.56	0.58	0.47	0.34	7.69	362.73
1938	0.37	0.68	1.00	2.22	5.24	2.24	0.67	0.55	0.45	0.56	0.72	5.10	19.81	382.54
1939	2.81	1.08	1.02	0.76	0.64	0.75	0.58	0.84	0.87	0.50	0.35	0.42	10.63	393.17
1940	0.51	2.50	1.40	0.53	0.34	0.30	0.32	0.25	0.22	0.23	0.23	0.23	7.06	400.24
1941	0.39	0.66	0.49	1.16	0.90	0.74	0.71	0.67	0.51	0.31	0.31	0.40	7.23	407.47
1942	0.60	13.25	7.42	1.58	0.52	0.72	2.11	1.24	0.67	0.56	0.87	1.04	30.59	438.05
1943	1.01	3.87	2.67	0.97	0.80	0.76	0.50	0.35	0.33	0.37	0.31	3.03	14.96	453.01
1944	1.88	0.86	0.46	0.52	0.86	1.13	0.77	0.45	0.36	0.29	0.23	0.29	8.11	461.12
1945	4.84	2.11	0.41	0.41	0.56	0.84	0.86	0.58	0.36	0.30	0.24	0.23	11.73	472.85
1946	0.38	0.81	0.77	0.55	0.64	2.53	1.64	0.82	1.04	0.99	0.61	0.48	11.26	484.11
1947	0.51	16.15	6.68	0.98	1.08	1.02	0.77	0.44	0.29	0.23	0.21	0.19	28.55	512.66
1948	0.47	0.90	0.79	0.65	3.19	1.90	0.97	0.61	0.34	0.28	0.26	0.30	10.66	523.33
1949	0.45	1.80	1.20	0.84	1.02	1.08	0.88	0.77	0.57	0.48	0.56	0.53	10.17	533.50
1950	0.64	0.60	2.63	1.52	0.68	0.65	0.51	0.33	0.26	0.22	0.25	0.37	8.66	542.16
1951	1.53	0.96	0.72	1.05	0.92	0.86	0.87	0.62	0.37	0.29	0.22	0.30	8.70	550.86
1952	0.43	0.44	0.42	0.43	0.46	0.41	0.40	0.30	0.21	0.17	0.18	0.54	4.41	555.28
1953	1.65	5.52	2.28	0.54	0.33	0.57	0.58	0.48	0.57	0.52	0.36	0.43	13.83	569.10
1954	7.49	3.11	0.65	0.92	2.95	1.56	0.60	0.39	0.35	0.30	0.22	0.38	18.91	588.01
1955	0.70	0.81	0.55	0.26	0.40	5.89	2.58	0.62	0.50	0.40	0.29	0.39	13.39	601.40
1956	0.73	9.39	12.76	3.91	0.88	1.71	2.35	1.16	0.60	0.49	0.46	0.63	35.08	636.48
1957	0.93	1.08	2.39	2.40	4.37	1.87	0.98	0.76	0.40	0.34	0.32	0.34	16.19	652.67
1958	0.41	3.36	1.85	0.67	0.56	0.62	0.62	9.44	3.71	0.86	1.04	1.04	24.19	676.86
1959	0.99	1.00	1.00	0.83	0.62	0.70	0.90	0.74	0.47	0.36	0.40	0.59	8.60	685.46
1960	0.77	0.95	3.62	3.30	1.29	0.76	6.06	2.63	0.56	0.47	0.38	0.34	21.13	706.59
1961	0.37	0.72	1.03	0.80	0.80	2.17	1.17	0.50	0.36	0.27	0.30	0.35	8.84	715.43
1962	0.67	2.90	1.55	3.63	1.77	11.71	4.41	0.62	0.45	2.43	1.38	0.47	32.00	747.43
1963	0.64	1.84	1.24	2.96	1.68	1.11	2.28	1.19	9.33	3.78	0.58	0.55	27.17	774.60
1964	1.66	1.09	0.62	0.64	0.64	0.41	0.27	0.31	3.10	1.94	1.18	1.15	13.03	787.63
1965	8.40	6.25	1.77	0.70	0.62	0.37	0.28	4.73	2.23	0.54	0.43	0.51	26.82	814.45
1966	0.57	0.62	0.72	0.92	0.79	8.26	5.93	1.64	0.61	0.82	0.73	0.44	22.05	836.50
1967	0.40	0.78	0.88	0.64	0.62	0.58	0.51	0.36	0.25	0.23	0.34	0.71	6.30	842.80
1968	0.99	1.73	1.14	0.53	1.12	4.28	1.94	0.96	0.86	0.53	0.41	0.36	14.85	857.66
1969	0.47	0.79	0.85	0.56	0.61	0.48	0.30	0.30	0.41	0.40	5.21	2.58	12.95	870.61
1970	7.64	3.69	1.04	0.71	0.81	0.73	0.65	0.97	0.84	0.78	2.46	1.47	21.81	892.41
1971	6.60	2.95	0.89	0.80	5.27	2.27	0.48	0.33	0.31	0.31	0.30	0.28	20.79	913.20
1972	0.31	0.65	0.98	0.78	0.65	0.63	0.67	0.47	0.28	0.23	0.27	0.36	6.28	919.48
1973	0.50	1.12	0.90	0.62	0.67	0.88	0.75	3.03	1.71	0.70	0.40	0.30	11.58	931.06
1974	0.31	0.58	0.80	0.64	0.56	0.58	0.44	0.32	0.24	0.21	0.20	0.38	5.24	936.31
1975	0.54	0.51	4.28	2.10	3.36	16.48	5.80	1.11	0.87	0.54	0.40	0.54	36.52	972.83
1976	11.23	4.33	0.74	0.62	0.83	0.89	0.51	0.30	0.27	0.27	0.37	0.63	20.99	993.82
1977	0.90	1.27	4.42	1.84	0.48	0.53	18.06	6.74	0.81	0.53	0.48	0.58	36.64	1 030.45
1978	1.69	1.70	0.94	0.57	0.58	0.88	0.78	0.46	0.32	0.43	0.57	0.67	9.60	1 040.06
1979	0.93	1.02	0.90	0.61	0.63	0.55	0.33	0.29	0.25	0.23	0.22	1.62	7.58	1 047.64
1980	1.26	4.41	2.04	5.41	2.49	0.74	0.41	0.46	0.53	0.38	0.40	0.43	18.95	1 066.59
1981	0.48	0.64	0.66	0.60	0.52	5.86	2.62	0.67	0.46	0.40	0.31	0.32	13.54	1 080.13
1982	0.44	0.37	0.25	0.20	0.18	0.18	0.18	0.17	0.14	21.98	7.88	0.83	32.80	1 112.92
1983	0.82	4.01	2.03	0.97	4.10	2.05	0.97	0.70	0.56	0.62	0.52	0.38	17.73	1 130.65
1984	0.57	1.17	0.88	0.69	18.61	6.65	0.52	0.33	0.27	0.27	0.22	0.20	30.40	1 161.04
1985	0.51	1.00	0.82	0.99	0.76	0.65	0.60	0.39	0.28	0.23	0.38	0.84	7.44	1 168.49
1986	3.02	4.53	1.83	0.66	0.40	0.39	0.37	0.26	0.23	0.21	0.25	17.59	29.76	1 198.25
1987	7.62	4.14	1.90	0.81	7.41	16.65	5.39	0.99	0.77	0.60	0.59	0.54	47.39	1 245.64
1988	0.65	3.75	4.93	1.69	6.48	2.84	2.76	1.37	0.54	0.46	0.35	0.30	26.14	1 271.77
1989	7.61	13.09	4.12	0.88	0.72	0.86	0.74	0.41	0.32	0.28	0.45	0.63	30.10	1 301.87
1990	0.84	0.89	0.76	0.85	1.65	0.99	0.41	0.29	0.26	0.23	0.21	0.27	7.65	1 309.52
1991	1.08	2.94	1.45	0.55	0.39	0.33	0.40	0.34	0.23	0.19	0.18	0.23	8.31	1 317.83
1992	0.40	0.57	0.49	0.36	0.33	0.23	0.23	0.23	0.17	0.15	0.14	0.93	4.23	1 322.06
1993	2.38	1.47	3.54	1.62	8.55	3.56	0.68	0.31	0.25	0.37	0.64	0.50	23.86	1 345.91
1994	0.35	0.30	0.40	0.46	0.31	2.76	3.12	1.32	1.49	1.07	0.52	0.53	12.64	1 358.55
1995	0.77	0.74	11.25	4.44	2.20	1.12	0.54	0.40	0.27	0.34	0.40	0.35	22.83	1 381.38
1996	0.59	8.52	3.52	1.58	1.16	0.95	3.22	1.60	14.68	5.89	1.02	0.84	43.56	1 424.94
1997	1.00	3.68	1.73	0.66	5.90	4.08	1.28	0.67	0.48	0.38	0.43	0.46	20.74	1 445.68
1998	0.40	0.64	3.39	1.61	0.90	2.81	1.43	0.51	0.34	0.28	0.24	0.20	12.75	1 458.43
1999	0.50	0.91	1.10	4.58	5.21	8.65	4.97	1.59	0.73	0.50	0.38	0.43	29.55	1 487.99
2000	0.63	0.76	0.91	0.69	0.49	0.53	0.58	0.53	0.38	0.45	0.48	0.46	6.88	1 494.87
2001	0.56	12.22	4.70	0.84	0.76	0.59	0.51	0.48	0.36	0.57	0.95	2.33	24.88	1 519.75
2002	1.32	0.79	0.89	0.59	0.33	4.45	2.31	0.95	0.69	0.53	0.40	0.69	13.93	1 533.68
2003	1.64	1.06	0.62	0.73	0.50	0.62	0.64	0.36	0.26	0.32	0.32	0.54	7.60	1 541.29
2004	1.04	0.90	0.61	3.83	1.77	0.45	0.43	0.40	0.32	0.28	0.28	0.34	10.65	1 551.93
2005	0.38	4.39	2.07	0.78	0.85	0.74	0.63	0.79	0.98	0.76	0.74	5.47	18.59	1 570.52
2006	8.84	3.14	9.88	3.85	0.56	0.56	0.83	0.61	0.42	0.36	0.31	0.33	29.69	1 600.21
2007	0.66	1.12	0.81	8.51	3.34	0.68	2.56	1.37	4.51	2.11	0.54	0.45	26.66	1 626.87
% of total	8.98	15.04	11.39	8.02	10.29	12.61	8.35	4.97	5.28	6.13	3.81	5.15	100.00	
Average	1.66	2.78	2.11	1.48	1.90	2.33	1.54	0.92	0.98	1.13	0.70	0.95	18.49	
SD	2.369	3.491	2.349	1.550	2.668	3.216	2.251	1.317	2.007	3.080	1.190	2.011	10.443	
CV	1.427	1.256	1.116	1.045	1.402	1.380	1.459	1.435	2.056	2.719	1.689	2.114	0.565	

PRESENT DAY FLOW RECORD FOR THE MSIKABA RIVER CATCHMENT AREA = 1 021.9 KM2

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOT	AVE
1920	5.41	8.12	18.56	11.91	8.42	12.77	12.71	7.61	4.45	3.51	2.99	4.37	100.83	4.07
1921	11.65	54.30	69.59	23.77	7.40	5.37	4.41	8.64	17.48	11.06	9.70	16.63	240.00	10.03
1922	80.63	95.85	29.46	90.40	105.00	42.84	10.43	4.69	3.75	58.12	25.55	5.68	552.40	21.37
1923	5.72	6.99	8.37	39.46	22.41	7.64	4.24	3.81	3.81	3.52	3.86	5.20	115.02	4.62
1924	7.11	10.99	31.77	18.30	18.07	77.50	32.84	7.94	5.16	4.46	3.83	6.29	224.25	9.59
1925	8.49	9.96	9.87	10.74	11.70	70.57	28.54	5.71	6.78	6.59	4.52	5.78	179.25	5.76
1926	14.86	35.38	29.72	12.21	6.99	110.27	41.46	3.99	3.06	2.68	2.74	3.65	267.01	10.99
1927	7.07	6.63	7.51	15.60	22.86	12.57	5.84	4.30	3.89	3.17	4.36	4.93	98.72	2.99
1928	5.56	10.10	9.34	8.35	7.18	16.44	9.25	4.57	35.53	29.18	13.46	37.41	186.36	8.97
1929	64.84	52.58	18.22	7.17	5.37	6.16	7.00	5.31	6.42	7.64	8.48	30.70	219.89	8.71
1930	16.85	8.16	7.25	54.39	58.95	66.57	23.67	4.96	3.27	200.30	72.43	6.76	523.56	19.92
1931	8.49	9.95	8.58	5.79	34.19	18.26	6.30	5.49	6.24	6.56	5.57	30.78	146.18	6.28
1932	26.39	122.76	87.76	20.17	8.69	18.24	9.94	4.76	3.63	3.23	2.90	2.95	311.41	12.20
1933	3.34	23.60	45.86	59.06	22.12	12.42	8.83	5.43	3.96	9.25	7.08	3.81	204.75	8.55
1934	3.87	6.93	29.69	15.25	5.36	6.93	29.01	44.03	78.51	29.73	10.26	9.02	268.58	10.76
1935	7.46	9.00	5.25	3.80	71.83	75.70	22.59	16.55	12.01	7.27	4.72	4.51	240.71	10.25
1936	16.95	153.70	54.67	5.62	30.86	33.73	13.20	4.66	3.41	3.53	3.82	4.00	328.17	12.40
1937	5.12	6.11	16.62	12.83	8.91	6.38	13.20	9.27	6.14	6.44	5.25	3.68	99.95	4.31
1938	3.94	7.36	15.54	23.11	58.81	26.31	7.48	6.28	5.32	6.33	7.19	52.02	219.70	7.46
1939	31.98	12.26	14.19	8.73	6.64	8.06	6.23	9.79	9.18	5.40	3.88	4.57	120.92	4.39
1940	5.32	29.33	16.27	6.29	3.75	3.42	3.58	2.76	2.46	2.56	2.55	2.63	80.90	3.23
1941	4.33	7.40	5.65	31.35	15.92	8.30	8.00	7.75	5.91	3.48	3.44	4.61	106.15	5.07
1942	7.12	125.42	73.03	16.77	5.78	12.09	28.35	14.58	7.14	6.02	15.76	12.33	324.38	11.14
1943	10.66	40.90	28.65	10.26	8.30	8.37	5.74	3.96	3.69	3.97	3.25	36.93	164.69	5.82
1944	23.76	9.67	4.78	5.58	11.95	17.02	9.34	4.72	3.81	3.16	2.58	3.40	99.79	4.18
1945	56.37	23.65	4.37	4.26	5.70	12.98	10.49	6.28	3.88	3.14	2.45	2.48	136.05	5.94
1946	4.11	18.42	11.83	6.59	7.38	31.76	33.78	13.94	19.89	12.98	6.08	5.24	172.00	8.47
1947	5.75	161.29	67.73	10.37	11.02	20.31	11.61	5.19	3.22	2.53	2.20	2.10	303.33	10.45
1948	8.36	10.22	8.48	6.67	56.37	31.72	11.12	6.10	3.47	2.81	2.68	3.34	151.31	7.60
1949	5.25	29.60	15.84	8.42	14.36	14.82	9.89	9.06	6.76	5.44	6.77	6.20	132.41	4.89
1950	7.42	6.64	31.81	17.21	7.04	6.80	5.45	3.51	2.85	2.54	2.86	4.34	98.47	3.15
1951	26.97	13.67	15.70	21.99	12.00	8.87	9.32	6.75	4.21	3.22	2.43	3.58	128.71	6.18
1952	5.31	5.84	5.80	5.56	6.10	5.67	5.12	3.77	2.58	2.04	2.24	6.09	56.13	2.33
1953	20.36	64.07	28.35	7.45	4.21	6.81	6.46	5.43	6.70	6.07	4.12	4.93	164.97	6.71
1954	92.64	37.48	7.06	20.69	39.98	27.47	9.76	4.43	3.94	3.31	2.40	4.19	253.36	11.67
1955	8.08	10.74	6.46	2.61	4.40	65.07	29.91	7.53	6.09	5.20	3.68	4.91	154.67	6.18
1956	22.39	102.26	141.03	45.13	10.01	28.68	38.75	15.66	6.24	5.24	4.79	7.02	427.19	18.58
1957	10.75	11.55	28.58	27.55	48.80	21.04	23.49	11.85	3.95	3.62	3.57	3.71	198.47	8.56
1958	4.53	28.13	17.43	7.11	5.85	6.69	6.55	89.38	35.64	8.59	10.43	11.78	232.11	6.84
1959	10.74	14.01	11.38	8.98	6.78	7.57	9.65	8.61	5.54	4.05	4.39	6.54	98.25	3.64
1960	8.65	20.90	42.04	33.88	13.19	8.52	77.81	32.23	6.18	5.38	4.60	4.12	257.50	10.70
1961	4.67	16.23	13.02	8.42	8.26	30.92	15.05	5.47	3.96	2.85	3.47	4.27	116.58	5.28
1962	12.97	38.01	18.07	40.13	18.76	130.42	48.82	6.70	5.10	36.33	18.10	4.96	378.36	15.24
1963	7.57	21.33	13.49	42.05	28.97	13.36	19.49	10.93	95.99	39.06	6.22	5.69	304.16	11.30
1964	18.66	11.81	6.63	6.55	6.49	4.26	2.86	3.43	41.00	22.92	12.34	14.91	151.85	5.76
1965	88.41	64.99	18.49	7.44	6.55	3.90	2.94	59.13	26.62	5.92	4.72	5.50	294.60	11.28
1966	6.14	6.49	7.75	14.63	10.51	93.61	64.44	16.86	6.22	8.78	8.08	4.72	248.23	9.27
1967	4.17	7.95	8.72	6.45	6.56	6.51	5.70	3.85	2.69	2.40	3.67	12.52	71.18	2.58
1968	14.90	22.12	13.85	6.01	9.66	51.87	22.96	29.54	15.22	5.59	4.40	4.00	200.11	9.24
1969	5.72	19.42	12.32	5.62	6.43	5.47	3.56	3.50	5.14	5.24	63.91	29.68	166.02	7.90
1970	83.01	43.58	12.17	7.60	8.60	7.97	7.52	29.38	15.01	9.04	37.12	18.97	279.97	12.46
1971	65.34	29.76	9.48	8.27	54.33	23.38	5.18	3.66	3.53	3.59	3.44	3.17	213.13	6.84
1972	3.41	8.53	10.44	8.17	6.72	6.82	7.64	5.25	2.99	2.46	3.14	4.82	70.39	2.54
1973	6.69	25.37	13.99	6.96	7.86	12.85	9.41	40.37	20.68	7.37	4.31	3.27	159.13	7.07
1974	3.46	6.46	20.45	11.13	6.05	6.32	5.12	3.67	2.76	2.43	2.25	14.38	84.47	4.29
1975	9.75	6.15	45.47	24.57	43.46	186.04	66.12	18.65	10.92	5.41	4.21	5.86	426.61	15.90
1976	117.26	45.19	7.18	6.45	28.45	15.69	5.56	3.28	2.88	2.92	4.15	6.77	245.77	10.18
1977	12.02	26.22	44.69	17.35	5.18	5.57	218.94	82.33	9.24	5.62	5.08	6.26	438.50	18.46
1978	27.15	26.04	11.50	6.32	6.19	8.87	7.73	4.59	3.30	4.62	6.61	13.59	126.51	5.61
1979	12.93	10.64	9.66	6.45	6.67	6.28	3.72	3.10	2.72	2.41	2.23	21.81	88.61	3.61
1980	14.88	50.38	22.48	57.51	26.04	7.53	4.17	4.91	5.73	3.98	4.55	5.37	207.54	6.90
1981	5.68	7.33	7.31	6.56	5.68	78.21	35.66	8.10	4.74	4.02	3.09	3.10	169.47	7.62
1982	4.74	4.06	2.72	2.27	2.04	2.09	2.05	1.85	1.58	212.05	76.72	8.83	320.99	11.80
1983	9.04	47.71	22.86	10.50	46.01	23.43	12.38	8.16	6.10	7.20	6.22	4.53	204.15	7.63
1984	6.85	18.98	11.25	7.21	186.67	67.21	5.65	3.48	2.88	2.81	2.34	2.14	317.46	11.36
1985	5.49	13.68	9.74	26.39	13.22	6.43	6.07	4.07	2.92	2.38	4.47	18.99	113.85	5.69
1986	37.01	49.10	19.42	8.83	5.11	4.48	4.65	3.15	2.56	2.21	2.65	204.81	343.99	13.32
1987	87.20	53.27	23.28	8.84	85.99	201.03	64.22	20.85	12.06	9.97	10.78	7.61	585.10	25.33
1988	7.67	40.98	62.15	21.16	77.16	32.63	32.01	15.47	5.93	5.04	3.71	3.27	307.17	12.83
1989	94.05	137.13	41.35	13.09	8.58	13.05	8.72	4.19	3.26	2.82	4.45	6.46	337.14	12.34
1990	15.38	10.91	7.35	8.67	20.45	11.84	4.72	3.28	2.92	2.47	2.50	3.49	93.98	3.91
1991	17.85	44.73	19.34	5.87	4.02	3.32	4.12	3.56	2.39	1.98	1.93	2.83	111.93	5.38
1992	5.02	6.38	5.79	4.49	3.79	2.73	2.64	2.46	1.79	1.48	1.55	23.47	61.58	3.09
1993	29.46	15.36	50.19	21.14	110.70	43.65	6.53	3.15	2.52	3.71	12.91	7.91	307.24	13.45
1994	3.99	3.32	18.10	9.70	3.37	31.81	47.99	18.42	21.26	12.96	5.25	5.47	181.64	8.72
1995	7.97	7.21	113.14	59.02	24.54	11.01	6.44	4.80	3.06	9.61	7.35	4.40	258.54	9.29
1996	18.62	99.83	40.22	27.42	17.69	9.96	29.87	15.65	158.09	65.43	11.20	9.08	503.06	19.45
1997	13.19	49.58	21.59	6.89	60.35	49.29	16.08	7.05	4.98	3.99	4.91	5.67	243.57	9.25
1998	4.89	17.16	51.52	21.83	18.08	40.00	17.78	5.59	3.57	2.86	2.47	2.04	187.79	9.69
1999	8.52	10.38	22.44	56.99	70.85	125.26	70.36	19.45	7.60	5.16	3.99	4.52	405.51	18.83
2000	6.95	8.82	9.69	7.26	5.24	6.06	7.06	6.39	4.58	5.37	5.81	5.67	78.90	2.86
2001	7.41	120.78	50.53	10.18	8.57	6.51	5.61	5.43	4.11	9.78	16.73	26.17	271.80	10.53
2002	13.49	8.20	9.51	6.03	3.17	48.98	24.36	9.03	6.70	5.11	3.90	10.68	149.17	5.94
2003	20.51	11.76	6.78	12.41	7.02	9.70	7.68	3.96	3.02	4.07	4.03	10.68	101.62	4.41
2004	13.42	9.57	6.50	44.74	20.08	5.00	4.83	4.56	3.52	2.85	2.94	3.75	121.75	4.95
2005	4.51	52.24	23.55	8.47	9.24	8.17	7.60	10.63	18.04	10.27	9.89	58.71	221.33	9.66
2006	105.61	37.30	96.29	37.89	5.83	6.10	9.39	6.82	4.46	3.64	3.15	3.47	319.97	11.02
2007	13.12	16.81	10.47	84.39	33.24	6.98	26.17	13.94	37.87	18.53	5.44	4.60	271.56	10.17
% of to	9.20	14.60	11.29	8.25	10.28	12.84	8.57	5.11	5.09	5.71	3.73	5.33	100.00	
Averag	20.13	31.95	24.69	18.04	22.49	28.08	18.74	11.17	11.14	12.50	8.16	11.66	218.76	
SD	26.369	35.758	25.115	17.845	29.403	37.690	27.415	14.942	21.478	31.607	13.020	23.335	117.437	
CV	1.310	1.119	1.017	0.989	1.307	1.342	1.463	1.337	1.928	2.528	1.595	2.001	0.537	

PRESENT DAY AIP WATER USAGE FOR QUATERNARY CATCHMENT T60F1 **CATCHMENT AREA = 71.35 SQ KM**

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOT
1920	0.01	0.03	0.04	0.03	0.03	0.04	0.03	0.03	0.02	0.02	0.01	0.02	0.31
1921	0.03	0.15	0.17	0.05	0.02	0.02	0.02	0.03	0.05	0.05	0.04	0.04	0.67
1922	0.24	0.23	0.03	0.20	0.24	0.07	0.01	0.02	0.01	0.17	0.07	0.02	1.31
1923	0.03	0.03	0.04	0.11	0.04	0.03	0.03	0.02	0.03	0.03	0.03	0.04	0.46
1924	0.04	0.05	0.06	0.03	0.06	0.26	0.07	0.04	0.04	0.03	0.04	0.05	0.77
1925	0.05	0.07	0.07	0.07	0.07	0.25	0.08	0.04	0.04	0.05	0.04	0.05	0.88
1926	0.07	0.08	0.05	0.02	0.05	0.27	0.14	0.03	0.03	0.03	0.04	0.04	0.85
1927	0.05	0.05	0.05	0.03	0.09	0.03	0.01	0.03	0.03	0.03	0.04	0.04	0.48
1928	0.04	0.05	0.06	0.04	0.03	0.06	0.02	0.02	0.09	0.09	0.03	0.11	0.64
1929	0.17	0.12	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.06	0.64
1930	0.03	0.03	0.04	0.15	0.14	0.13	0.03	0.02	0.02	0.44	0.14	0.03	1.20
1931	0.04	0.05	0.04	0.03	0.10	0.04	0.01	0.03	0.03	0.03	0.03	0.09	0.52
1932	0.04	0.27	0.18	0.02	0.03	0.05	0.03	0.03	0.03	0.02	0.02	0.02	0.74
1933	0.02	0.06	0.13	0.18	0.06	0.05	0.04	0.03	0.02	0.03	0.03	0.02	0.67
1934	0.03	0.04	0.10	0.04	0.02	0.04	0.05	0.11	0.16	0.07	0.04	0.04	0.74
1935	0.04	0.04	0.01	0.03	0.21	0.19	0.04	0.02	0.04	0.04	0.03	0.03	0.72
1936	0.05	0.33	0.12	0.04	0.12	0.06	0.01	0.02	0.02	0.02	0.03	0.03	0.85
1937	0.03	0.03	0.05	0.06	0.04	0.03	0.04	0.04	0.03	0.04	0.03	0.03	0.45
1938	0.03	0.04	0.05	0.08	0.17	0.07	0.01	0.03	0.03	0.03	0.04	0.18	0.76
1939	0.09	0.01	0.05	0.03	0.04	0.03	0.03	0.04	0.05	0.01	0.03	0.02	0.43
1940	0.03	0.10	0.04	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.34
1941	0.03	0.04	0.02	0.05	0.02	0.03	0.03	0.03	0.01	0.01	0.02	0.02	0.31
1942	0.03	0.34	0.20	0.03	0.02	0.03	0.07	0.03	0.03	0.03	0.04	0.05	0.90
1943	0.05	0.12	0.07	0.01	0.04	0.04	0.02	0.02	0.02	0.02	0.02	0.12	0.55
1944	0.06	0.02	0.01	0.03	0.04	0.03	0.02	0.03	0.02	0.02	0.01	0.02	0.31
1945	0.18	0.08	0.01	0.03	0.04	0.05	0.04	0.01	0.02	0.02	0.02	0.02	0.52
1946	0.03	0.05	0.02	0.02	0.03	0.09	0.05	0.01	0.02	0.02	0.01	0.03	0.38
1947	0.03	0.36	0.15	0.01	0.02	0.01	0.03	0.02	0.02	0.02	0.01	0.02	0.70
1948	0.03	0.05	0.04	0.03	0.12	0.06	0.02	0.01	0.02	0.02	0.02	0.02	0.44
1949	0.03	0.08	0.03	0.03	0.05	0.05	0.03	0.04	0.02	0.03	0.03	0.03	0.45
1950	0.03	0.03	0.10	0.04	0.01	0.03	0.02	0.02	0.02	0.01	0.01	0.02	0.34
1951	0.07	0.03	0.02	0.03	0.03	0.04	0.04	0.01	0.01	0.01	0.01	0.02	0.32
1952	0.02	0.02	0.03	0.03	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.03	0.26
1953	0.06	0.19	0.06	0.00	0.02	0.03	0.03	0.03	0.03	0.03	0.02	0.03	0.53
1954	0.27	0.10	0.01	0.03	0.10	0.03	0.01	0.02	0.02	0.01	0.02	0.03	0.65
1955	0.04	0.04	0.01	0.01	0.02	0.22	0.09	0.01	0.02	0.03	0.02	0.03	0.54
1956	0.04	0.29	0.22	0.06	0.04	0.04	0.06	0.01	0.02	0.02	0.02	0.03	0.85
1957	0.04	0.05	0.07	0.06	0.11	0.04	0.04	0.03	0.02	0.02	0.01	0.02	0.51
1958	0.02	0.13	0.05	0.01	0.03	0.03	0.03	0.34	0.12	0.04	0.05	0.05	0.90
1959	0.04	0.05	0.05	0.04	0.03	0.04	0.05	0.04	0.03	0.02	0.02	0.03	0.44
1960	0.04	0.05	0.12	0.10	0.02	0.04	0.19	0.06	0.01	0.02	0.02	0.02	0.69
1961	0.02	0.04	0.05	0.03	0.04	0.08	0.03	0.03	0.02	0.02	0.02	0.02	0.40
1962	0.03	0.11	0.05	0.13	0.05	0.19	0.08	0.03	0.02	0.08	0.04	0.01	0.82
1963	0.03	0.05	0.03	0.11	0.04	0.05	0.05	0.02	0.24	0.10	0.00	0.03	0.75
1964	0.05	0.03	0.03	0.03	0.03	0.03	0.02	0.03	0.13	0.06	0.06	0.06	0.56
1965	0.25	0.16	0.03	0.04	0.03	0.02	0.02	0.19	0.07	0.02	0.03	0.03	0.89
1966	0.03	0.04	0.05	0.05	0.05	0.30	0.15	0.02	0.03	0.04	0.04	0.03	0.83
1967	0.03	0.04	0.05	0.04	0.04	0.04	0.03	0.03	0.02	0.03	0.03	0.04	0.42
1968	0.06	0.08	0.03	0.01	0.03	0.14	0.05	0.05	0.04	0.01	0.02	0.03	0.55
1969	0.02	0.04	0.04	0.02	0.03	0.02	0.02	0.02	0.03	0.03	0.20	0.09	0.56
1970	0.23	0.10	0.01	0.04	0.04	0.04	0.03	0.04	0.04	0.03	0.10	0.04	0.74
1971	0.21	0.09	0.04	0.04	0.18	0.05	0.02	0.02	0.02	0.02	0.02	0.03	0.74
1972	0.03	0.03	0.05	0.03	0.04	0.04	0.04	0.03	0.02	0.02	0.02	0.03	0.38
1973	0.03	0.03	0.02	0.02	0.04	0.05	0.02	0.11	0.05	0.01	0.01	0.02	0.41
1974	0.02	0.03	0.04	0.02	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.03	0.30
1975	0.03	0.02	0.15	0.07	0.11	0.16	0.05	0.05	0.03	0.02	0.02	0.03	0.74
1976	0.32	0.12	0.03	0.03	0.04	0.04	0.02	0.02	0.02	0.02	0.02	0.04	0.72
1977	0.05	0.04	0.15	0.05	0.03	0.03	0.39	0.14	0.01	0.02	0.03	0.03	0.97
1978	0.05	0.04	0.02	0.03	0.03	0.04	0.04	0.02	0.02	0.03	0.03	0.03	0.38
1979	0.05	0.05	0.04	0.02	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.07	0.39
1980	0.05	0.16	0.08	0.17	0.08	0.02	0.01	0.03	0.03	0.03	0.02	0.03	0.71
1981	0.03	0.03	0.04	0.03	0.03	0.21	0.09	0.01	0.03	0.03	0.02	0.02	0.57
1982	0.02	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.59	0.19	0.01	0.98
1983	0.04	0.12	0.06	0.03	0.11	0.04	0.04	0.03	0.03	0.03	0.03	0.02	0.58
1984	0.03	0.03	0.02	0.04	0.34	0.12	0.01	0.02	0.02	0.02	0.02	0.02	0.69
1985	0.03	0.05	0.03	0.03	0.02	0.04	0.03	0.03	0.03	0.02	0.03	0.05	0.39
1986	0.11	0.15	0.04	0.03	0.02	0.02	0.02	0.03	0.02	0.02	0.02	0.46	0.94
1987	0.19	0.07	0.02	0.04	0.20	0.24	0.08	0.04	0.04	0.02	0.03	0.03	1.00
1988	0.03	0.14	0.15	0.04	0.22	0.08	0.07	0.02	0.03	0.03	0.02	0.02	0.85
1989	0.28	0.25	0.09	0.04	0.04	0.04	0.04	0.03	0.02	0.02	0.03	0.04	0.92
1990	0.05	0.06	0.05	0.05	0.06	0.03	0.02	0.03	0.02	0.03	0.03	0.03	0.46
1991	0.04	0.11	0.04	0.02	0.03	0.03	0.03	0.02	0.03	0.02	0.02	0.02	0.41
1992	0.03	0.04	0.03	0.01	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.04	0.30
1993	0.09	0.05	0.12	0.05	0.22	0.09	0.00	0.02	0.01	0.02	0.03	0.03	0.73
1994	0.02	0.02	0.02	0.03	0.02	0.11	0.11	0.04	0.04	0.03	0.01	0.03	0.48
1995	0.03	0.03	0.29	0.11	0.05	0.02	0.03	0.03	0.02	0.02	0.02	0.03	0.68
1996	0.04	0.31	0.11	0.03	0.01	0.04	0.10	0.03	0.22	0.09	0.00	0.03	1.01
1997	0.04	0.12	0.03	0.03	0.19	0.13	0.02	0.03	0.03	0.02	0.02	0.03	0.69
1998	0.03	0.03	0.13	0.04	0.05	0.10	0.03	0.02	0.02	0.02	0.02	0.02	0.51
1999	0.03	0.05	0.03	0.16	0.14	0.15	0.12	0.02	0.02	0.03	0.02	0.02	0.79
2000	0.04	0.04	0.05	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.41
2001	0.03	0.36	0.14	0.03	0.04	0.04	0.03	0.03	0.02	0.03	0.05	0.09	0.89
2002	0.04	0.04	0.05	0.02	0.03	0.16	0.08	0.04	0.03	0.03	0.02	0.04	0.58
2003	0.05	0.03	0.03	0.04	0.02	0.04	0.04	0.01	0.02	0.03	0.02	0.03	0.36
2004	0.06	0.03	0.02	0.14	0.07	0.02	0.02	0.02	0.03	0.03	0.02	0.03	0.49
2005	0.03	0.16	0.08	0.02	0.04	0.03	0.03	0.04	0.04	0.02	0.04	0.18	0.71
2006	0.16	0.05	0.15	0.07	0.03	0.03	0.04	0.03	0.02	0.02	0.02	0.02	0.64
2007	0.04	0.05	0.03	0.28	0.11	0.03	0.09	0.03	0.16	0.06	0.02	0.02	0.92
AVERAGE	0.06	0.09	0.06	0.05	0.06	0.07	0.05	0.04	0.04	0.04	0.03	0.04	0.63

PRESENT DAY FLOW AIP WATER USAGE FOR QUATERNARY CATCHMENT T60E **CATCHMENT AREA = 198.00 SQ KM**

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOT
1920	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.01	0.13
1921	0.01	0.04	0.08	0.02	0.01	0.01	0.01	0.02	0.02	0.01	0.02	0.01	0.26
1922	0.07	0.08	0.03	0.07	0.07	0.03	0.01	0.01	0.01	0.05	0.03	0.00	0.48
1923	0.01	0.01	0.01	0.03	0.03	0.02	0.01	0.00	0.00	0.00	0.00	0.01	0.14
1924	0.01	0.01	0.03	0.02	0.01	0.08	0.03	0.01	0.01	0.00	0.01	0.00	0.23
1925	0.01	0.02	0.01	0.03	0.02	0.10	0.04	0.00	0.01	0.01	0.00	0.01	0.26
1926	0.01	0.02	0.03	0.02	0.02	0.12	0.04	0.01	0.01	0.00	0.00	0.00	0.28
1927	0.01	0.01	0.01	0.06	0.04	0.01	0.01	0.01	0.00	0.01	0.00	0.00	0.19
1928	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.02	0.01	0.03	0.14
1929	0.05	0.05	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.22
1930	0.01	0.01	0.01	0.11	0.06	0.05	0.02	0.01	0.01	0.14	0.05	0.01	0.49
1931	0.01	0.02	0.01	0.01	0.01	0.02	0.01	0.01	0.00	0.01	0.01	0.01	0.13
1932	0.02	0.13	0.09	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.00	0.31
1933	0.01	0.02	0.05	0.06	0.02	0.01	0.01	0.00	0.01	0.00	0.01	0.00	0.21
1934	0.01	0.01	0.04	0.02	0.01	0.01	0.01	0.03	0.07	0.02	0.02	0.01	0.25
1935	0.01	0.01	0.01	0.00	0.05	0.05	0.01	0.01	0.01	0.01	0.00	0.00	0.20
1936	0.01	0.15	0.05	0.01	0.04	0.02	0.01	0.01	0.01	0.01	0.01	0.00	0.32
1937	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.00	0.01	0.12
1938	0.00	0.02	0.02	0.03	0.09	0.03	0.01	0.01	0.01	0.01	0.01	0.05	0.28
1939	0.03	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.00	0.01	0.01	0.16
1940	0.01	0.02	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.09
1941	0.01	0.01	0.00	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.00	0.11
1942	0.01	0.15	0.09	0.02	0.01	0.01	0.02	0.01	0.01	0.01	0.02	0.01	0.36
1943	0.02	0.06	0.04	0.01	0.02	0.02	0.01	0.00	0.01	0.00	0.00	0.01	0.19
1944	0.02	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.11
1945	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.00	0.10
1946	0.00	0.01	0.01	0.01	0.01	0.04	0.02	0.01	0.02	0.02	0.00	0.00	0.16
1947	0.01	0.16	0.06	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.30
1948	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.00	0.10
1949	0.00	0.01	0.01	0.02	0.05	0.05	0.02	0.01	0.01	0.01	0.01	0.01	0.22
1950	0.01	0.01	0.07	0.03	0.01	0.01	0.00	0.01	0.01	0.00	0.00	0.01	0.17
1951	0.02	0.01	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.00	0.01	0.13
1952	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.01	0.07
1953	0.02	0.04	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.18
1954	0.06	0.03	0.01	0.02	0.04	0.02	0.01	0.01	0.01	0.00	0.00	0.01	0.21
1955	0.01	0.01	0.01	0.00	0.01	0.07	0.03	0.01	0.01	0.01	0.00	0.00	0.16
1956	0.00	0.06	0.09	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.29
1957	0.02	0.02	0.02	0.01	0.05	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.17
1958	0.00	0.02	0.03	0.01	0.01	0.02	0.01	0.13	0.04	0.01	0.02	0.01	0.31
1959	0.02	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.00	0.00	0.01	0.14
1960	0.01	0.01	0.05	0.04	0.02	0.01	0.05	0.01	0.01	0.01	0.01	0.01	0.24
1961	0.00	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.11
1962	0.01	0.03	0.02	0.06	0.02	0.09	0.04	0.01	0.00	0.01	0.02	0.01	0.32
1963	0.01	0.04	0.03	0.03	0.02	0.02	0.03	0.01	0.09	0.03	0.01	0.01	0.33
1964	0.03	0.02	0.00	0.01	0.01	0.00	0.00	0.00	0.04	0.03	0.02	0.02	0.19
1965	0.07	0.06	0.02	0.01	0.01	0.01	0.00	0.05	0.03	0.01	0.01	0.01	0.27
1966	0.01	0.01	0.01	0.01	0.01	0.14	0.05	0.02	0.01	0.01	0.01	0.01	0.29
1967	0.01	0.01	0.02	0.01	0.01	0.00	0.01	0.01	0.00	0.00	0.01	0.01	0.10
1968	0.01	0.02	0.01	0.00	0.01	0.06	0.02	0.01	0.01	0.01	0.01	0.00	0.18
1969	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.00	0.01	0.00	0.01	0.02	0.11
1970	0.08	0.04	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.25
1971	0.09	0.03	0.01	0.01	0.07	0.02	0.01	0.00	0.00	0.00	0.00	0.01	0.27
1972	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.10
1973	0.01	0.01	0.01	0.01	0.01	0.04	0.02	0.03	0.02	0.00	0.01	0.00	0.17
1974	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.09
1975	0.01	0.01	0.05	0.05	0.06	0.08	0.03	0.02	0.02	0.00	0.01	0.01	0.35
1976	0.11	0.04	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.22
1977	0.01	0.02	0.03	0.02	0.01	0.01	0.16	0.06	0.02	0.01	0.01	0.01	0.34
1978	0.01	0.01	0.01	0.02	0.01	0.02	0.01	0.00	0.01	0.00	0.01	0.01	0.13
1979	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.00	0.00	0.00	0.01	0.01	0.09
1980	0.02	0.07	0.03	0.08	0.03	0.01	0.00	0.01	0.00	0.01	0.00	0.00	0.28
1981	0.01	0.02	0.01	0.01	0.01	0.03	0.02	0.01	0.01	0.00	0.01	0.00	0.14
1982	0.00	0.01	0.01	0.00	0.01	0.00	0.00	0.01	0.00	0.14	0.05	0.01	0.24
1983	0.01	0.04	0.02	0.01	0.07	0.03	0.02	0.01	0.01	0.01	0.01	0.00	0.25
1984	0.01	0.03	0.02	0.02	0.13	0.05	0.01	0.00	0.00	0.00	0.01	0.00	0.27
1985	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.10
1986	0.02	0.08	0.03	0.01	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.20	0.36
1987	0.08	0.03	0.01	0.01	0.05	0.05	0.02	0.01	0.01	0.00	0.01	0.00	0.32
1988	0.01	0.02	0.03	0.02	0.08	0.02	0.03	0.01	0.00	0.01	0.01	0.01	0.26
1989	0.08	0.13	0.04	0.02	0.01	0.02	0.01	0.01	0.00	0.00	0.01	0.01	0.34
1990	0.01	0.01	0.01	0.02	0.03	0.01	0.00	0.00	0.00	0.01	0.01	0.00	0.10
1991	0.01	0.02	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.08
1992	0.01	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.05
1993	0.01	0.02	0.04	0.03	0.11	0.04	0.00	0.01	0.01	0.01	0.01	0.01	0.27
1994	0.01	0.01	0.01	0.00	0.01	0.02	0.03	0.01	0.03	0.02	0.00	0.01	0.15
1995	0.01	0.01	0.11	0.08	0.05	0.01	0.01	0.00	0.01	0.01	0.01	0.00	0.32
1996	0.01	0.10	0.04	0.01	0.02	0.01	0.04	0.01	0.12	0.05	0.01	0.01	0.43
1997	0.02	0.04	0.01	0.01	0.08	0.07	0.02	0.01	0.01	0.01	0.00	0.01	0.28
1998	0.00	0.01	0.02	0.01	0.01	0.02	0.01	0.01	0.00	0.01	0.00	0.00	0.11
1999	0.00	0.01	0.02	0.08	0.05	0.06	0.03	0.00	0.01	0.01	0.01	0.00	0.31
2000	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.12
2001	0.01	0.11	0.04	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.26
2002	0.01	0.01	0.01	0.00	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.12
2003	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.00	0.01	0.12
2004	0.01	0.01	0.01	0.03	0.02	0.01	0.00	0.01	0.01	0.00	0.01	0.01	0.12
2005	0.01	0.04	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.17
2006	0.13	0.05	0.05	0.02	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.32
2007	0.01	0.02	0.01	0.07	0.02	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.22
AVERAGE	0.02	0.03	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.21

PRESENT DAYAFFORESTATION WATER USAGE FOR QUATERNARY CATCHMENT T60E **CATCHMENT AREA = 198.00 SQ KM**

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOT
1920	0.01	0.02	0.03	0.03	0.02	0.03	0.03	0.02	0.01	0.01	0.01	0.01	0.24
1921	0.02	0.06	0.11	0.02	0.02	0.02	0.01	0.03	0.04	0.02	0.03	0.02	0.40
1922	0.12	0.09	0.02	0.10	0.09	0.04	0.01	0.02	0.01	0.08	0.03	0.01	0.62
1923	0.01	0.02	0.02	0.04	0.04	0.02	0.02	0.01	0.01	0.01	0.01	0.02	0.21
1924	0.02	0.03	0.04	0.02	0.02	0.12	0.04	0.02	0.01	0.01	0.01	0.01	0.36
1925	0.01	0.03	0.03	0.04	0.02	0.12	0.04	0.01	0.02	0.01	0.01	0.02	0.36
1926	0.02	0.03	0.04	0.03	0.03	0.13	0.04	0.01	0.01	0.01	0.01	0.01	0.37
1927	0.01	0.02	0.02	0.09	0.06	0.01	0.02	0.02	0.00	0.01	0.01	0.01	0.28
1928	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.03	0.02	0.03	0.23
1929	0.08	0.06	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.02	0.33
1930	0.02	0.02	0.02	0.14	0.10	0.07	0.02	0.01	0.01	0.11	0.05	0.02	0.60
1931	0.02	0.03	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.02	0.02	0.21
1932	0.03	0.13	0.10	0.02	0.02	0.03	0.02	0.01	0.01	0.00	0.01	0.01	0.38
1933	0.01	0.03	0.07	0.09	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.31
1934	0.01	0.02	0.06	0.02	0.02	0.02	0.02	0.04	0.10	0.03	0.03	0.02	0.38
1935	0.02	0.02	0.01	0.01	0.08	0.07	0.01	0.02	0.02	0.02	0.01	0.01	0.32
1936	0.02	0.14	0.05	0.02	0.06	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.37
1937	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.21
1938	0.01	0.03	0.03	0.04	0.11	0.04	0.01	0.02	0.02	0.02	0.02	0.07	0.40
1939	0.03	0.03	0.02	0.02	0.02	0.03	0.02	0.03	0.03	0.01	0.01	0.02	0.27
1940	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.14
1941	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.02	0.01	0.01	0.01	0.01	0.19
1942	0.02	0.15	0.11	0.02	0.02	0.02	0.03	0.02	0.02	0.02	0.03	0.03	0.46
1943	0.03	0.09	0.07	0.01	0.03	0.03	0.02	0.01	0.01	0.01	0.01	0.02	0.32
1944	0.03	0.01	0.01	0.01	0.03	0.03	0.01	0.01	0.01	0.01	0.00	0.01	0.18
1945	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.00	0.15
1946	0.01	0.02	0.02	0.01	0.02	0.05	0.02	0.01	0.02	0.03	0.00	0.01	0.23
1947	0.02	0.14	0.06	0.00	0.02	0.01	0.02	0.01	0.01	0.01	0.01	0.00	0.30
1948	0.02	0.02	0.02	0.02	0.02	0.03	0.02	0.01	0.00	0.01	0.01	0.01	0.18
1949	0.01	0.02	0.03	0.03	0.07	0.07	0.02	0.02	0.02	0.01	0.02	0.02	0.36
1950	0.02	0.02	0.11	0.04	0.02	0.02	0.01	0.01	0.01	0.00	0.01	0.02	0.28
1951	0.02	0.01	0.02	0.02	0.02	0.03	0.03	0.02	0.02	0.01	0.01	0.01	0.21
1952	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.02	0.13
1953	0.03	0.06	0.03	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.25
1954	0.09	0.04	0.00	0.03	0.06	0.02	0.02	0.01	0.01	0.01	0.00	0.01	0.29
1955	0.01	0.02	0.01	0.00	0.01	0.11	0.04	0.01	0.01	0.01	0.01	0.01	0.27
1956	0.01	0.09	0.10	0.03	0.03	0.03	0.01	0.02	0.02	0.01	0.02	0.02	0.38
1957	0.03	0.02	0.01	0.03	0.07	0.03	0.02	0.02	0.01	0.01	0.00	0.01	0.25
1958	0.01	0.03	0.04	0.01	0.02	0.02	0.02	0.13	0.04	0.03	0.03	0.02	0.40
1959	0.03	0.02	0.02	0.03	0.02	0.02	0.03	0.02	0.01	0.01	0.01	0.02	0.25
1960	0.02	0.02	0.08	0.06	0.02	0.02	0.08	0.02	0.02	0.02	0.01	0.01	0.37
1961	0.01	0.02	0.03	0.02	0.03	0.03	0.01	0.02	0.01	0.01	0.01	0.01	0.19
1962	0.02	0.05	0.02	0.09	0.03	0.09	0.04	0.02	0.01	0.02	0.03	0.02	0.42
1963	0.02	0.05	0.03	0.04	0.02	0.03	0.05	0.02	0.08	0.03	0.02	0.02	0.39
1964	0.04	0.02	0.01	0.02	0.02	0.01	0.01	0.01	0.06	0.03	0.03	0.03	0.29
1965	0.09	0.08	0.02	0.02	0.02	0.01	0.01	0.07	0.03	0.01	0.01	0.01	0.38
1966	0.02	0.02	0.02	0.02	0.02	0.15	0.06	0.03	0.02	0.02	0.02	0.01	0.40
1967	0.01	0.02	0.03	0.02	0.02	0.01	0.02	0.01	0.01	0.00	0.01	0.02	0.18
1968	0.02	0.03	0.02	0.00	0.02	0.08	0.03	0.02	0.02	0.01	0.01	0.00	0.29
1969	0.01	0.02	0.02	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.02	0.03	0.20
1970	0.12	0.04	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.03	0.03	0.41
1971	0.11	0.04	0.03	0.02	0.11	0.03	0.02	0.01	0.01	0.00	0.01	0.01	0.40
1972	0.01	0.02	0.03	0.02	0.02	0.02	0.02	0.01	0.01	0.00	0.01	0.01	0.18
1973	0.02	0.02	0.02	0.02	0.02	0.05	0.03	0.05	0.02	0.00	0.01	0.00	0.25
1974	0.01	0.02	0.02	0.02	0.01	0.02	0.01	0.01	0.00	0.00	0.01	0.01	0.15
1975	0.02	0.01	0.08	0.07	0.07	0.07	0.03	0.03	0.03	0.01	0.01	0.01	0.45
1976	0.13	0.05	0.03	0.02	0.02	0.02	0.01	0.01	0.00	0.00	0.00	0.01	0.30
1977	0.02	0.03	0.04	0.02	0.02	0.02	0.15	0.06	0.02	0.02	0.02	0.02	0.40
1978	0.02	0.03	0.01	0.03	0.02	0.03	0.02	0.01	0.01	0.01	0.01	0.01	0.22
1979	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.16
1980	0.03	0.10	0.04	0.08	0.03	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.38
1981	0.01	0.03	0.02	0.02	0.02	0.05	0.02	0.02	0.01	0.01	0.01	0.01	0.22
1982	0.01	0.01	0.01	0.00	0.01	0.00	0.00	0.01	0.00	0.18	0.06	0.00	0.31
1983	0.02	0.06	0.02	0.03	0.10	0.04	0.03	0.02	0.02	0.01	0.02	0.01	0.36
1984	0.01	0.04	0.02	0.02	0.14	0.05	0.02	0.01	0.01	0.01	0.01	0.00	0.32
1985	0.01	0.03	0.02	0.02	0.02	0.01	0.02	0.00	0.01	0.01	0.01	0.02	0.18
1986	0.02	0.12	0.04	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.15	0.40
1987	0.08	0.04	0.01	0.02	0.07	0.07	0.02	0.02	0.02	0.01	0.02	0.01	0.42
1988	0.01	0.03	0.04	0.02	0.11	0.04	0.05	0.01	0.01	0.01	0.01	0.01	0.38
1989	0.11	0.09	0.03	0.03	0.02	0.02	0.01	0.01	0.01	0.00	0.02	0.02	0.37
1990	0.01	0.02	0.02	0.03	0.03	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.17
1991	0.02	0.04	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.14
1992	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.01	0.01	0.09
1993	0.02	0.03	0.06	0.03	0.11	0.04	0.00	0.01	0.01	0.01	0.02	0.01	0.35
1994	0.01	0.01	0.01	0.01	0.01	0.03	0.04	0.02	0.04	0.02	0.00	0.02	0.20
1995	0.02	0.02	0.13	0.10	0.07	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.43
1996	0.02	0.14	0.05	0.03	0.03	0.01	0.06	0.02	0.08	0.04	0.02	0.02	0.52
1997	0.03	0.06	0.02	0.02	0.11	0.09	0.02	0.02	0.02	0.01	0.01	0.01	0.41
1998	0.01	0.02	0.03	0.02	0.02	0.03	0.02	0.02	0.01	0.01	0.00	0.00	0.20
1999	0.01	0.02	0.03	0.13	0.07	0.06	0.05	0.01	0.02	0.02	0.01	0.01	0.43
2000	0.01	0.02	0.03	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.02	0.01	0.21
2001	0.02	0.14	0.05	0.03	0.03	0.01	0.02	0.01	0.01	0.01	0.02	0.03	0.38
2002	0.02	0.02	0.02	0.01	0.01	0.02	0.03	0.02	0.02	0.01	0.02	0.02	0.22
2003	0.03	0.01	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.02	0.01	0.02	0.21
2004	0.02	0.02	0.02	0.05	0.02	0.02	0.01	0.01	0.01	0.00	0.01	0.01	0.19
2005	0.02	0.07	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.01	0.02	0.03	0.29
2006	0.13	0.05	0.08	0.02	0.02	0.02	0.03	0.02	0.01	0.01	0.01	0.01	0.40
2007	0.02	0.03	0.02	0.11	0.03	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.33
AVERAGE	0.03	0.04	0.03	0.03	0.04	0.03	0.02	0.02	0.02	0.02	0.01	0.02	0.30

PRESENT DAY DOMESTIC ABSTRACTION FROM THE XURA RIVER TO LUSIKISIKI WTW

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOT	
1920	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1921	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1922	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1923	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1924	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1925	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1926	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1927	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1928	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1929	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1930	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1931	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1932	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1933	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1934	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1935	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1936	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1937	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1938	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1939	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1940	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1941	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1942	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1943	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1944	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1945	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1946	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1947	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1948	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1949	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1950	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1951	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1952	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1953	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1954	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1955	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1956	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1957	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1958	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1959	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1960	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1961	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1962	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1963	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1964	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1965	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1966	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1967	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1968	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1969	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1970	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1971	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1972	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1973	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1974	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1975	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1976	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1977	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1978	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1979	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1980	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1981	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1982	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1983	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1984	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1985	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1986	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1987	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1988	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1989	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1990	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1991	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1992	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1993	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1994	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1995	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1996	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1997	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1998	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
1999	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
2000	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
2001	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
2002	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
2003	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
2004	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
2005	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
2006	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
2007	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	0.09
% of total	8.82	8.82	9.80	9.80	8.82	3.92	6.86	7.84	7.84	9.80	7.84	10.78	100.00	
Average	0.09	0.09	0.10	0.10	0.09	0.04	0.07	0.08	0.08	0.10	0.08	0.11	1.02	

Appendix I

Validation and verification of natural flow records

Appendix I: VERIFICATION AND VALIDATION OF STOCHASTIC FLOW SEQUENCES

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1. STOCHASTIC ANALYSIS OF STREAMFLOW DATA

The firm yield value derived from a single historic flow sequence can be very misleading and depends, to a large extent, on the period of record and severity of the critical period. In order to assess the yield from a system, it is normal practice to extend a flow record using a rainfall/run-off model to extend the various measured flow records to produce longer records that spans the record period of the measured rainfall.

The historic firm yield drops significantly as the period of record increases. It should be noted that as a record becomes longer, the historic firm yield will never increase. The yield can either remain constant or decrease, depending on the location of the critical period in the record.

A single historic firm yield value can however be very misleading. Even though the recorded record length has been extended and contains the worst drought sequence in memory, it is not possible to relate the historic firm yield to a specific risk of failure or reliability directly from the record without additional analyses. As water resource systems become more complex and capital intensive, it is increasingly important to estimate the likely risk of failure associated with specific yield values. To achieve this, it is necessary to generate flow sequences stochastically, which can be used to derive reliability and risk of failure information associated with various system yields.

As the need for information on reliability grows, the use of stochastic flow sequences is becoming increasingly popular in water resource studies. It is no longer satisfactory to say that the yield from a system is 20 million m^3/a. Such a figure could for example indicate 20 million m^3/a with a risk of failure of either once in every 10 years or once in every 200 years. Clearly the reliabilities of the two yields are completely different, hence the need to be more specific and to relate each yield value to a particular reliability.

The major objective of using stochastic generation software is to provide alternative realistic flow sequences that can be analysed in the same manner as the historic flow sequence. One of the main problems associated with the use of generated flow sequences concerns the validity of such sequences. Before the end user can place his/her confidence in results based on stochastically generated flow sequences, it is first necessary to provide confirmation that the stochastic flow sequences are in fact realistic and plausible.

Two different classes of tests are used in the checking procedure, namely verification tests and validation tests. Verification involves resampling various statistics from the generated sequences to ensure that the model can reproduce the statistics from the historic sequence with reasonable accuracy. Tests of the mean and standard deviation are two examples of verification tests.

Validation tests involve testing certain features of the stochastically generated flows that were not involved directly in the generation of the flows. Tests in this category include various storage checks such as maximum deficit, duration of maximum deficit, minimum run-sums and yield-capacity checks.

The WRIMS program was used for the generation and testing of stochastic streamflow sequences. The WRIMS incorporates three programs and these are ANNUAL, CROSSYR and GENTST-programs.

The ANNUAL-program (Mark 6, named ANLMK6) was used in the stochastic analysis of streamflow data and selects the distribution for modelling annual flows which selects the appropriate ARMA (p,q) model.

The CROSSYR-program, CRSMK6 was used to compute the inter-dependence between the annual flow residuals from the various stations.

GENTST generates 500 replicate sets of streamflow sequences, each as long as the original historical sample which is 88 years (1920 to 2007). Each of the 500 sequences for each gauge is re-sampled and its basic statistics computed.

It should be noted that the stochastic flow generation techniques used are considered to be appropriate for a wide variety of hydrological conditions experienced in South Africa. In areas with critical periods of less than one year or greater than 20 years, the methodology may not be applicable.

In certain cases, a short critical period is experienced as a result of reservoir storage that is small relative to the annual inflow. In such cases it may be found that a stochastic model based on monthly flows rather than annual flows is required since the critical drought period may continue from the end of one year into the beginning of the next year. Unfortunately the current stochastic model was not designed to simulate such conditions and therefore cannot be used with confidence when critical periods of less than one year are experienced.

2. VERIFICATION AND VALIDATION TESTS

The T6 sub-catchment in the Lusikisiki area was divided into three quaternary catchments; T60E, T60F and T60G. T60F was further sub-dived into quinaries T60F1, T60F2, T60F3 and T60F4, as previously explained.

The tests were done per hydrological zone. The hydrological zones were sometimes combined where the test results were unacceptable.

2.1 MONTHLY AND ANNUAL MEANS

The first and most basic verification test carried out on the stochastically generated flow sequences involves comparing the monthly and annual means of each stochastic flow sequence with those of the historic flow record. The test is based on 500 stochastically generated flow sequences – each of the same length as the historic flow sequence. The number of 500 sequences was selected by the WRIMS program and hence it is considered to be acceptable. The mean annual run-off (MAR) of each sequence is calculated together with the 12 monthly averages. The results are then displayed in the form of box plots with the historic values indicated by arrowheads. The acceptability criteria require that the annual historic means are generally between the 25th percentile and the 75th percentile limits of the stochastically generated flows.

2.2 MONTHLY AND ANNUAL STANDARD DEVIATIONS

The second verification test carried out involves the assessment of the monthly and annual standard deviations (SDs) of the generated and historic flow sequences.

The annual SDs are particularly important in water resource studies where reservoir yield calculations are involved. The yield from a reservoir will be considerably greater for a low annual SD compared to that obtained when the SD of the annual totals is high.

The results are also then displayed in the form of box plots with the historic values indicated by arrowheads. The acceptability criteria require that the annual historic means are generally between the 25th percentile and the 75th percentile limits of the stochastically generated flows.

2.3 MINIMUM RUN-SUMS

Minimum run-sums are usually given for a particular time period such as 12 months, 24 months, 36 months etc. The 12-month minimum run-sum for a given sequence is the lowest flow to occur during the complete sequence for 12 consecutive months. This is a validation test since the run-sum characteristics of the historic flow sequence are not used in any way to generate the stochastic flow sequences.

It is sometimes found that the historic minimum run-sums are greater or less than the maximum or minimum simulated values respectively. When examining the minimum run-sum results however, the general lengths of critical period experienced in the catchment area (also a function of reservoir storage) should be taken into account. If, for example, the average historical critical periods experienced in a given catchment are in the order of two years, it is more important to produce realistic 12 month, 24 month and 36 month minimum run-sums. Obviously it is desirable to match the minimum run-sums for all durations. This is often not achieved, however, in these cases more significance should be placed on the minimum run-sums most appropriate to the given catchment area.

2.4 MAXIMUM DEFICITS AND DEFICIT DURATIONS

The maximum deficit and deficit duration tests are validation tests where a given draft expressed as a percentage of the MAR is applied to a semi-infinite reservoir starting full. Three tests are undertaken, the maximum deficit test, the duration of maximum deficit test and the duration of longest depletion test. The results are again simply a variation on the presentation of the results depicted in the minimum run-sum plots and the yield-capacity diagrams.

The maximum deficit test provides a record of the minimum reservoir storage required for each sequence to provide an uninterrupted supply for demands of 40 %, 50 %, 60 %, 70 % and 80 % of each generated MAR. The duration of maximum deficit test records the duration in months of the drought event causing the maximum deficit. The duration is the period from full supply to maximum deficit and back to full supply. The maximum duration is obviously the total record length (= 88 years or 1056 months in this case).

The third and final test in this set is the duration of the longest depletion that again can be equal to the total record length. The depletion is given in months and does not necessarily tie in with the drought event causing the maximum deficit although in many cases the same event causes both maximum deficit and longest depletion.

2.5 YIELD-CAPACITY

The yield-capacity test is a storage based validation test and is simply the minimum reservoir capacity required to meet a given yield for each of the 500 stochastically generated sequences. This test is simply a different form of presenting the results derived from the minimum run-sum test with the variation that the yields are expressed as percentages of the historical MAR, whereas in the minimum run-sum test, the drafts are a function of the generated MAR. The results are expressed in terms of the historic MAR and yields of 20 %, 40 %, 60 %, 80 % and 100 % of the MAR are used. The yield-capacity test assumes that there are no evaporation losses from the reservoir surface.

The yield-capacity test is a most useful visual validation test because it summarises so much of the behaviour of both the historical flows and of the generated flows. Ideally the stochastic points (indicated by the small squares) should show a reasonable spread around the values obtained from the historic flow sequence. This is assuming that the historic record contained periods of average severity as would be expected from the available record length. In such cases historic values should also be reasonably close to the median values of the stochastic flow sequences. If the results from the historic record are considerably lower than the median values from the stochastic sequences or even outside the range of generated values, it would indicate that the recorded data contain a period of extreme severity. In such cases the critical period in question should be carefully examined for possible errors.

3. RESULTS

A summary of the results for the Msikaba River quaternary catchments are given in **Table 3-1**. It shows that the natural flow data performed adequately when subjected to the verification and validation tests. The fit for the duration of maximum deficit and the duration of longest depletion, were always acceptable but not particularly good. The most important criterion, namely the Yield-capacity-curves showed generally very good matches between the historical and generated values. This is an indication that the historical records have been well prepared and is homogeneous.

Table 3-1 Results of the verification and validation tests for the Lusikisiki quaternary-catchments (T60E, T60F & T60G)

Catchment	MAR (10^6m^3)	Monthly and annual means	Annual STD	N-month run sums				Yield Capacity
				N-month run sums	Max deficit	Duration of max deficit	Duration of longest depletion	
T60E	29.5	Good	Good	Good	Good	Good	Fair	Good
T60F	85.8	Good	Good	Good	Good	Fair	Good	Good
T60G	105.7	Good	Good	Good	Good	Fair	Fair	Good

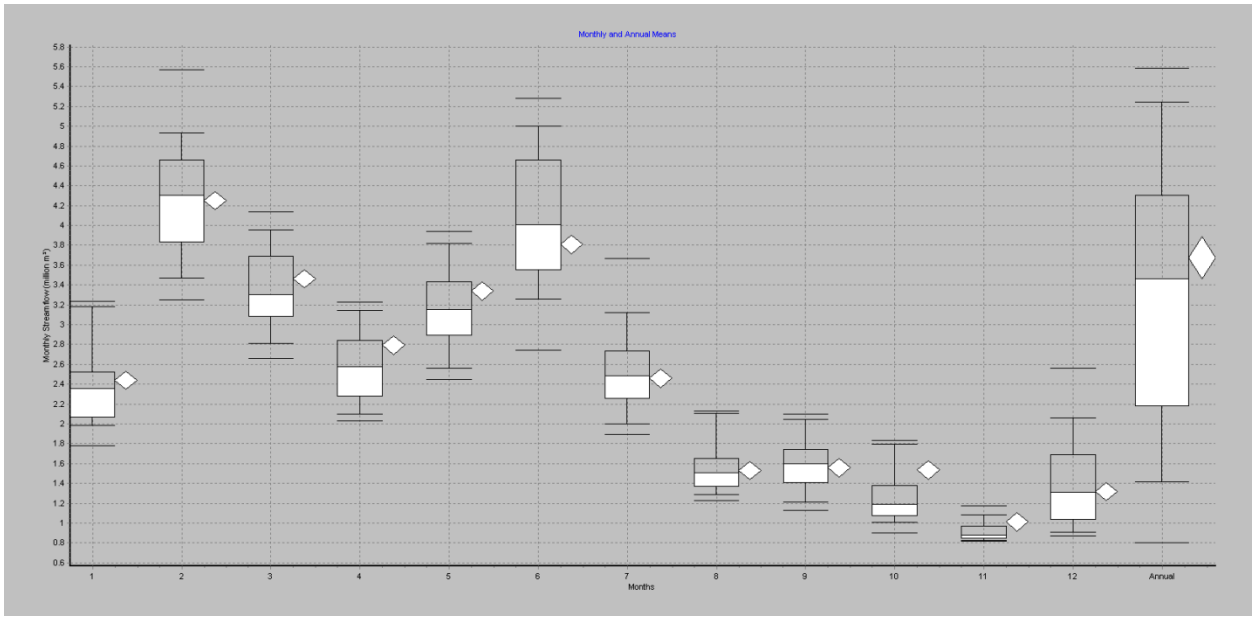
4. CONCLUSIONS

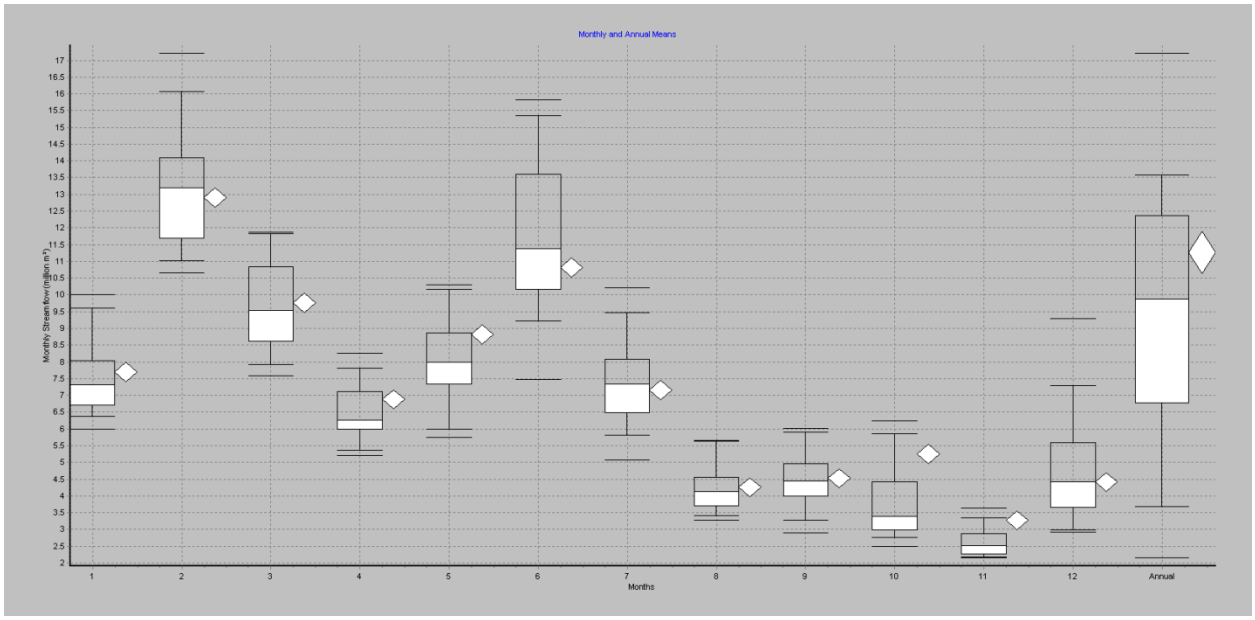
In the stochastic checks the historic values are usually positioned between the 25% and 75% limits suggested by the stochastic sequences. In some instances, however, this was not the case and the explanation can lie with an error in the historic flow record, problems with the stochastic flow generation or a legitimate natural anomaly.

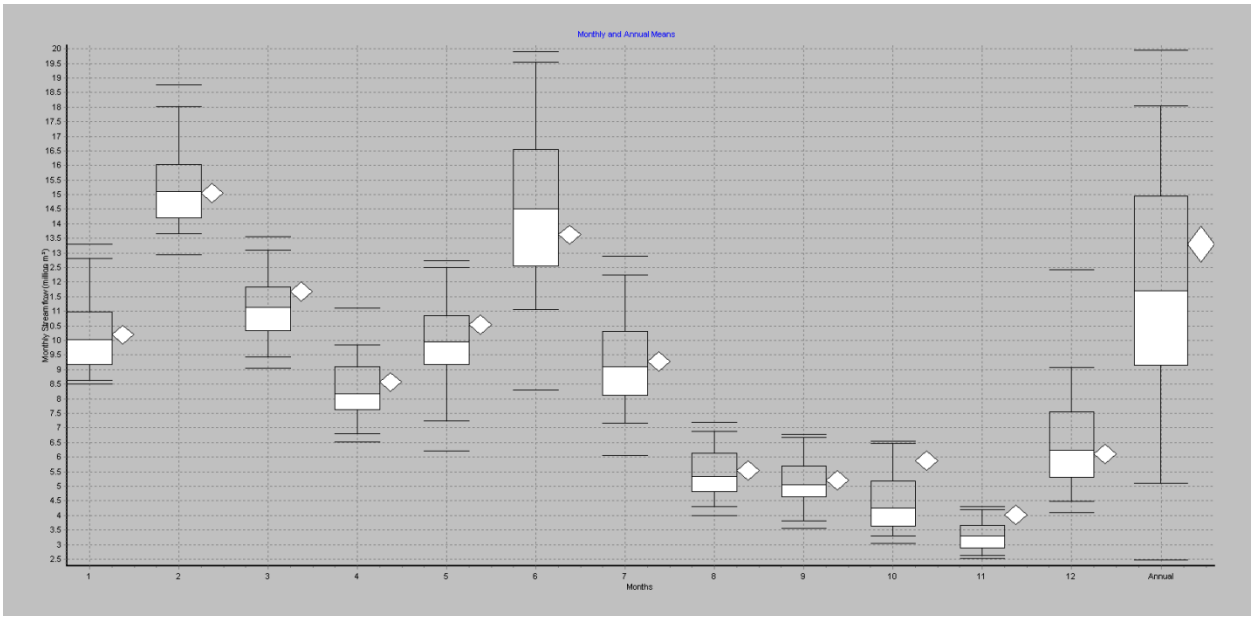
The model used in this study is considered to be one of the most reliable models available and has been thoroughly tested over the years. It should also be remembered that no stochastic model is perfect, particularly one in which stochastic sequences are generated simultaneously at multiple sites. No model is capable of producing perfect results at all gauges and any possible errors or anomalies should be judged individually to ensure that they are not data errors or large enough to have a significant influence on the overall results. The time and effort required to address a possible problem should also be compared to the benefit to be gained.

It is difficult to specify when a possible problem becomes large enough to investigate in more detail. A judgement call will be made on a combination of these tests and not on one test alone.

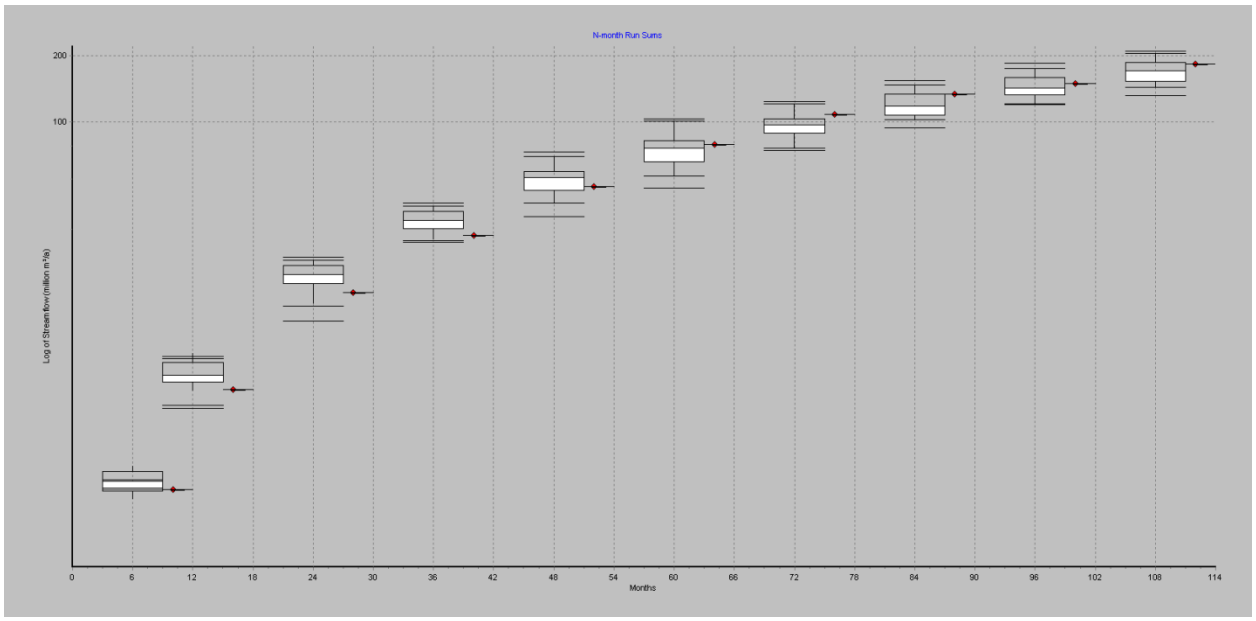
Based on the experience gained during previous simulations of stochastic streamflows in this system as well as other parts of Southern Africa, these results are considered to be acceptable.


Monthly and Annual Means
Monthly Streamflow (million m³)
Months
1
2
3
4
5
6
7
8
9
10
11
12
Annual

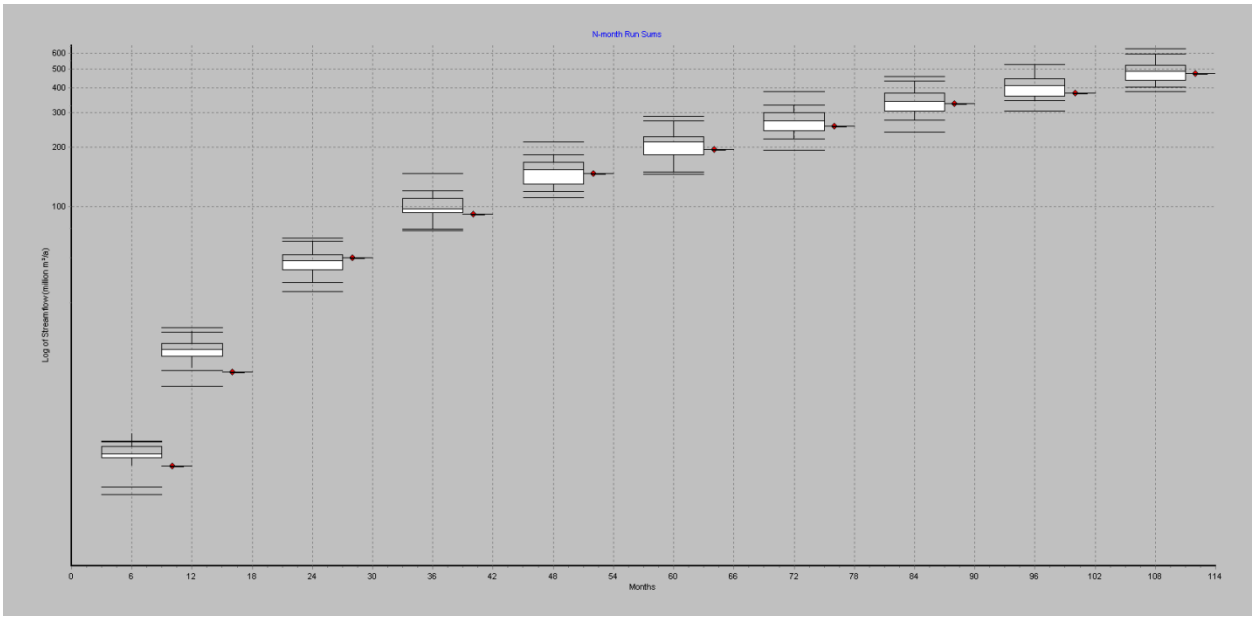

Monthly and Annual Means
Monthly Streamflow (million m³)
Months
1
2
3
4
5
6
7
8
9
10
11
12
Annual


Monthly and Annual Means
Monthly Stream flow (million m³)
Months
1
2
3
4
5
6
7
8
9
10
11
12
Annual

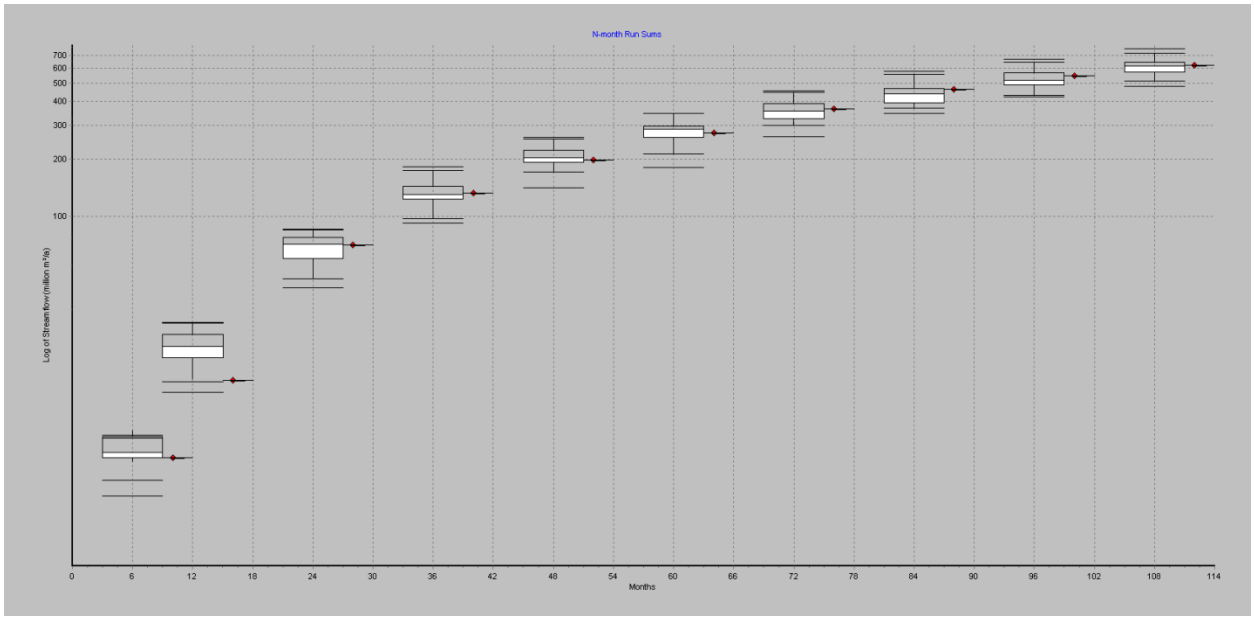
T60E


N-month Run Sums
Log of Stream flow (million m³/s)
200
100
0
6
12
18
24
30
36
42
48
54
60
66
72
78
84
90
96
102
108
114
Months

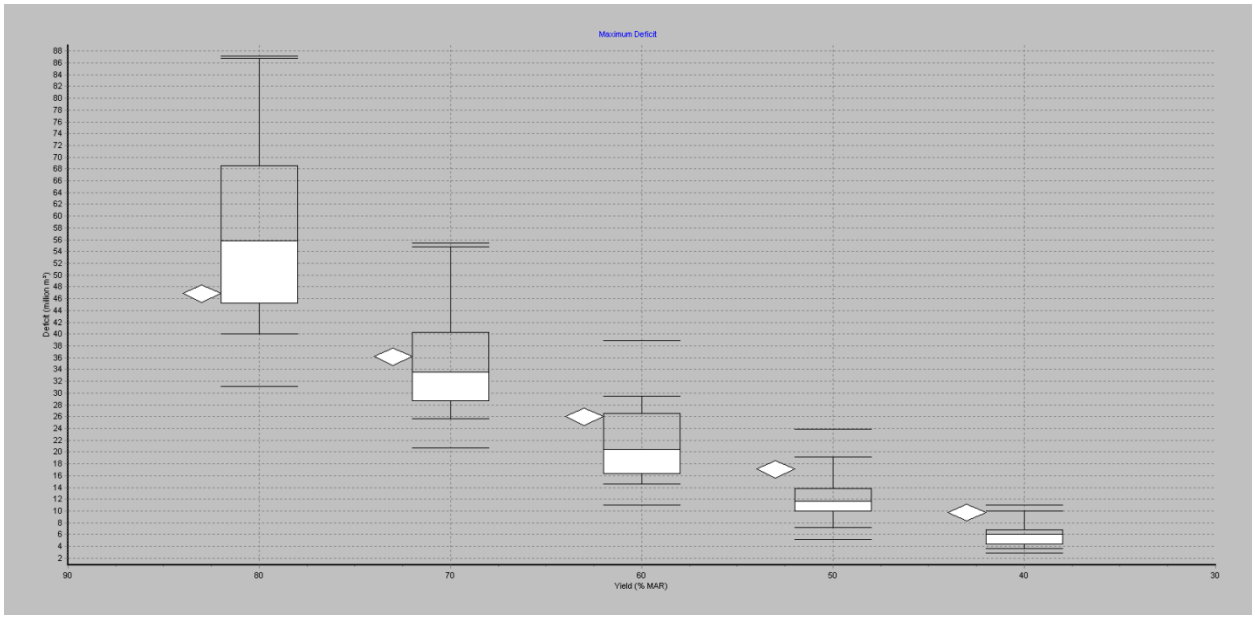
T60F


N-month Run Sums
Log of Stream flow (million m³/s)
600
500
400
300
200
100
0
6
12
18
24
30
36
42
48
54
60
66
72
78
84
90
96
102
108
114
Months

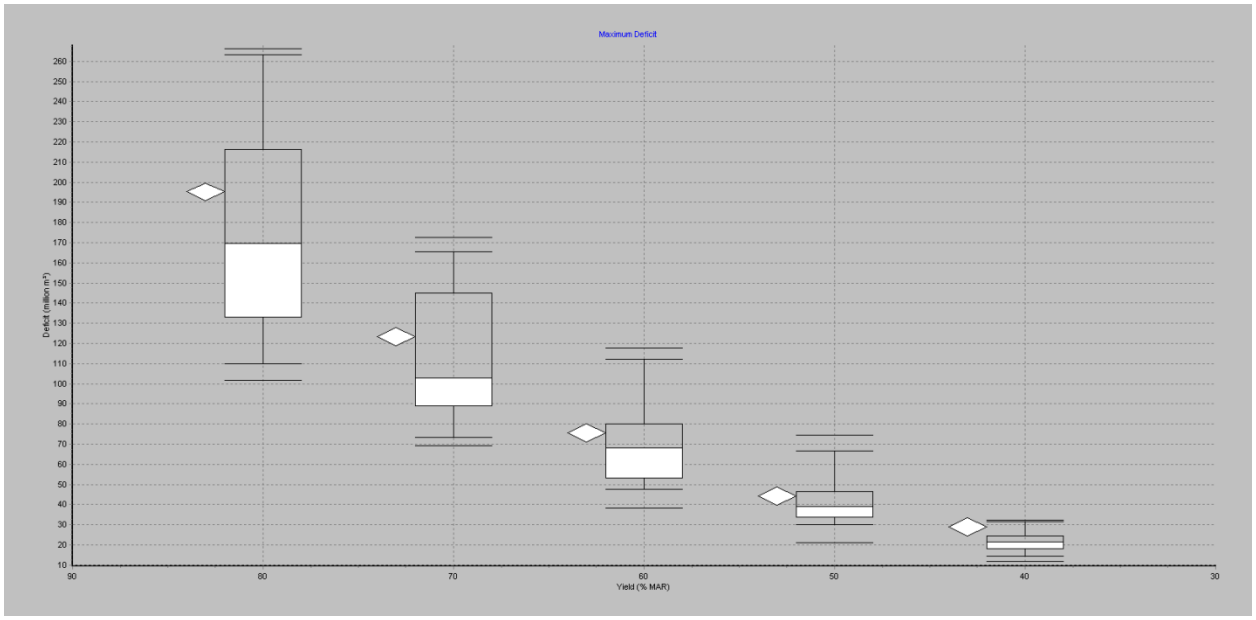
T60G


N-month Run Sums
Log of Stream flow (million m³/a)
Months

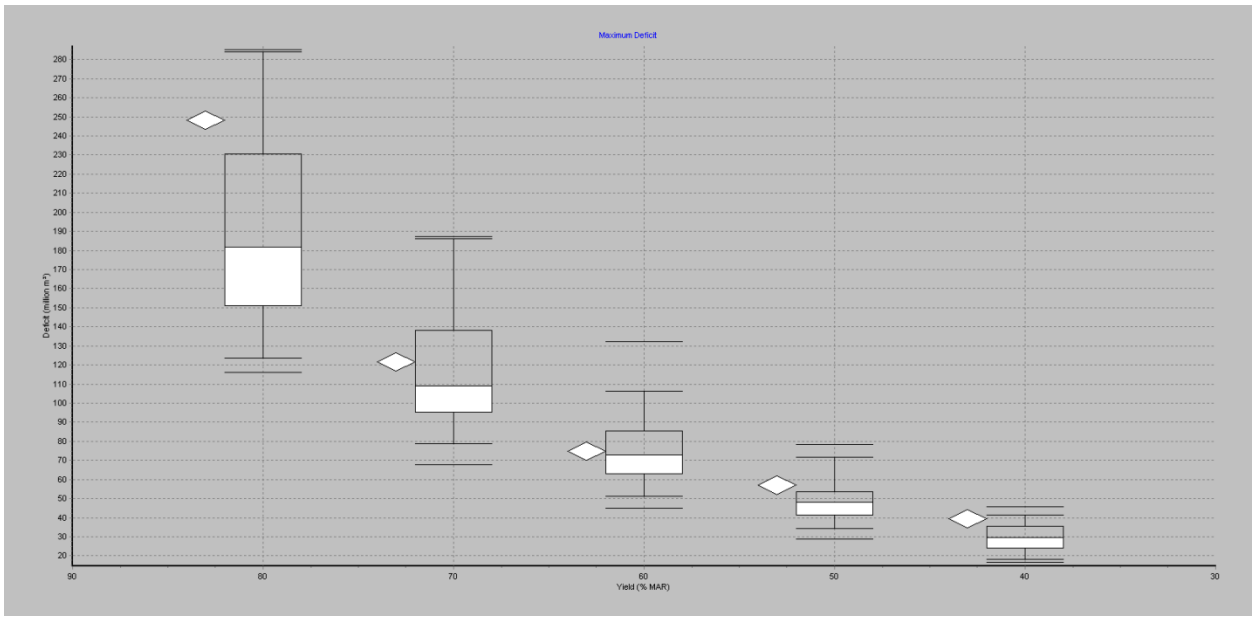
T60E


Maximum Deficit
Deficit (million m³)
Yield (% MAR)

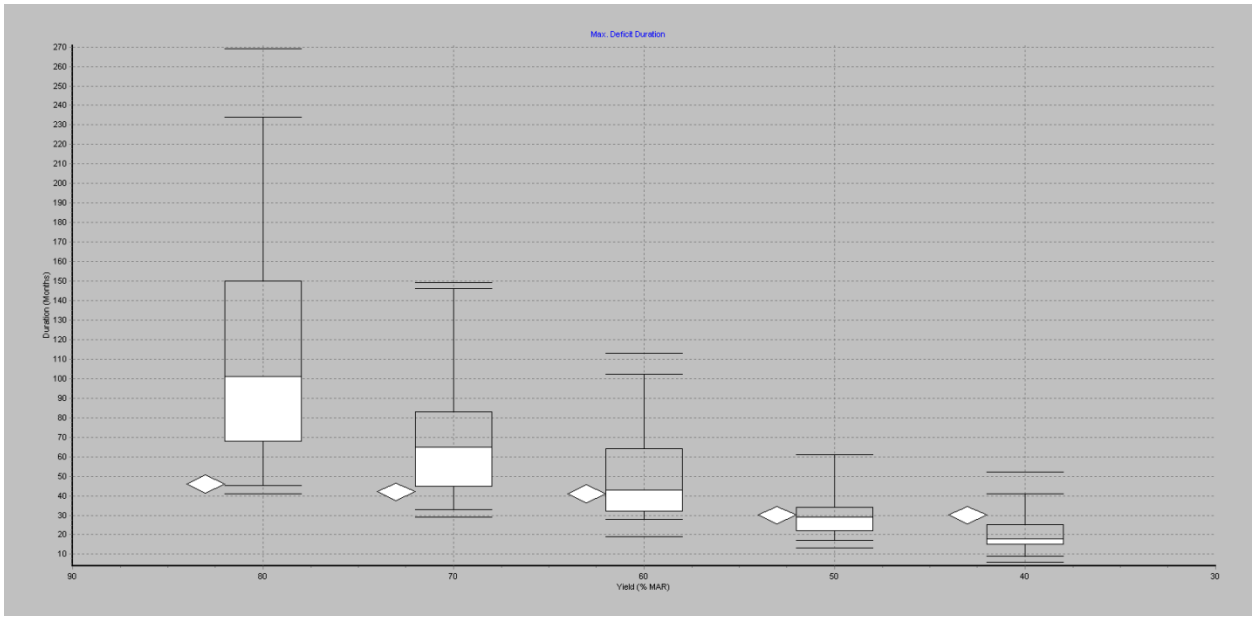
T60F


Maximum Deficit
Deficit (million m³)
Yield (% MAR)

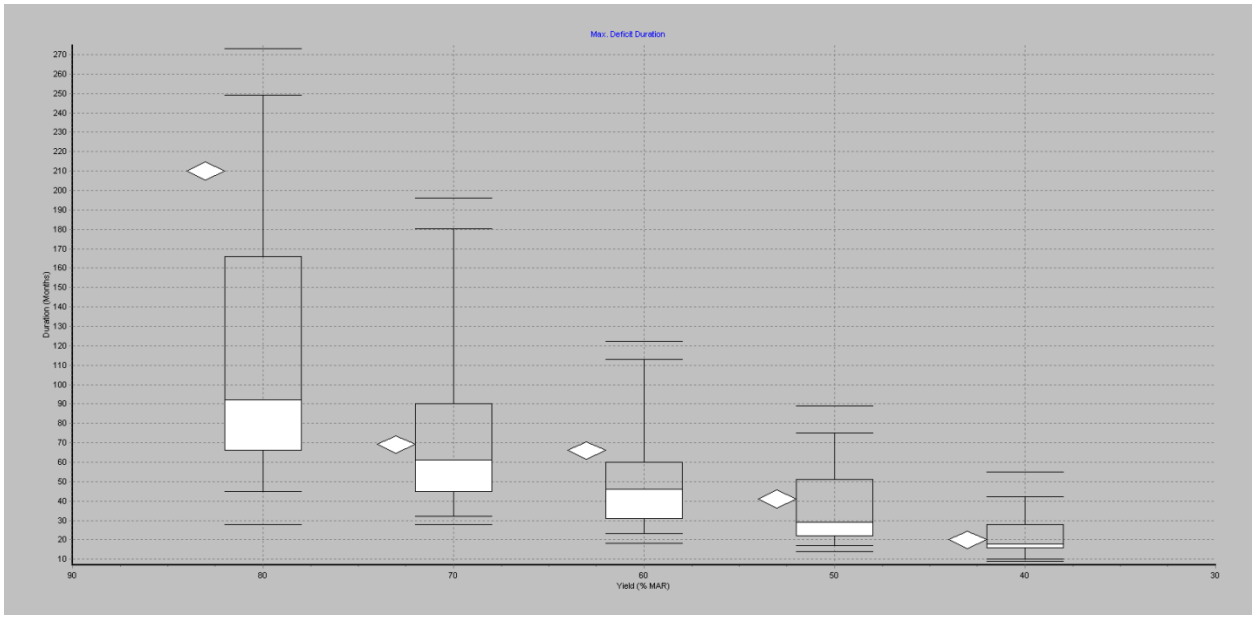
T60G


Maximum Deficit
Deficit (million m³)
Yield (% MAR)

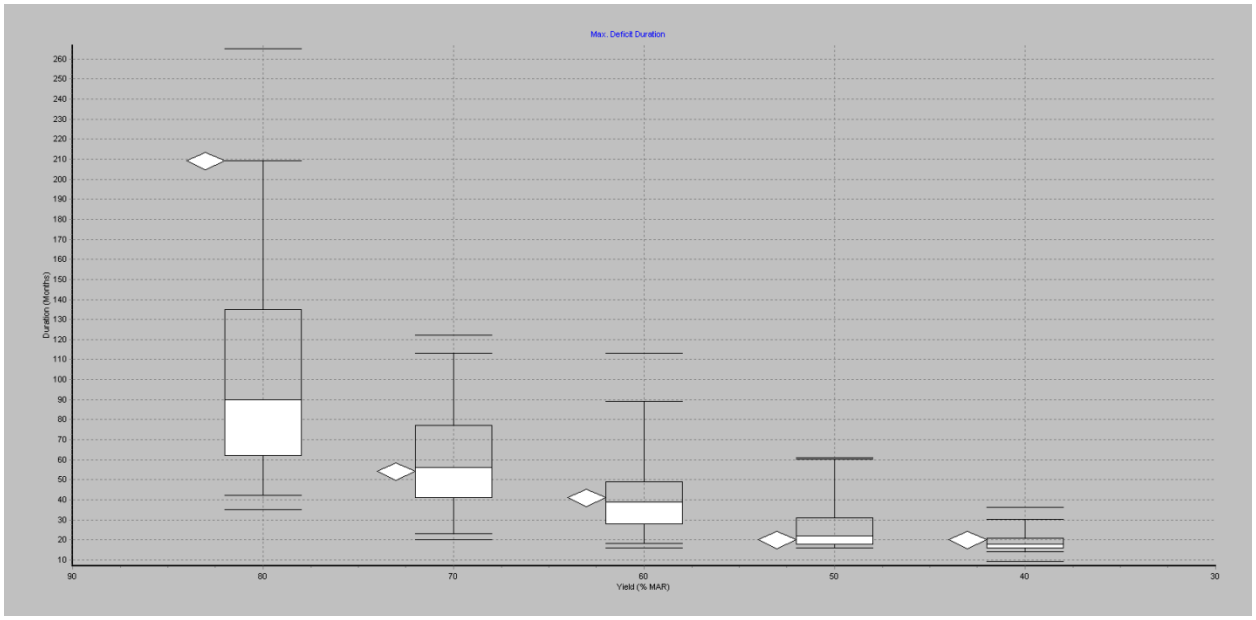
T60E


Max. Deficit Duration
Duration (Months)
Yield (% MAR)

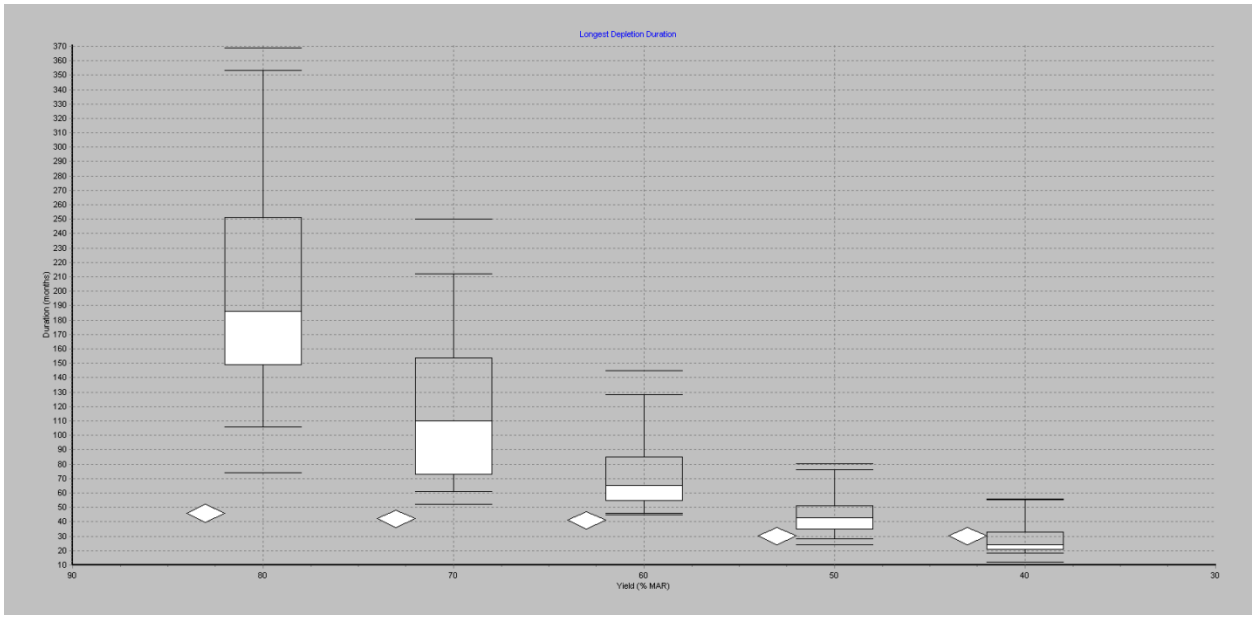
T60F


Max. Deficit Duration
Duration (Months)
Yield (% MAR)

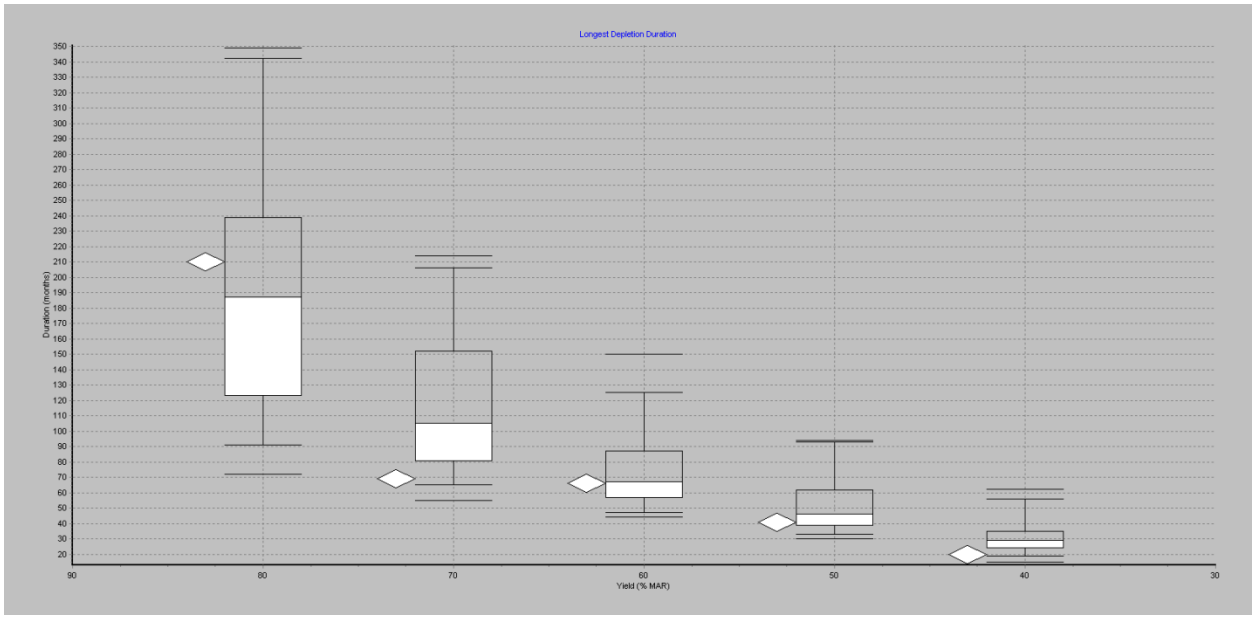
T60G


Max. Deficit Duration
Duration (Months)
Yield (% MAR)

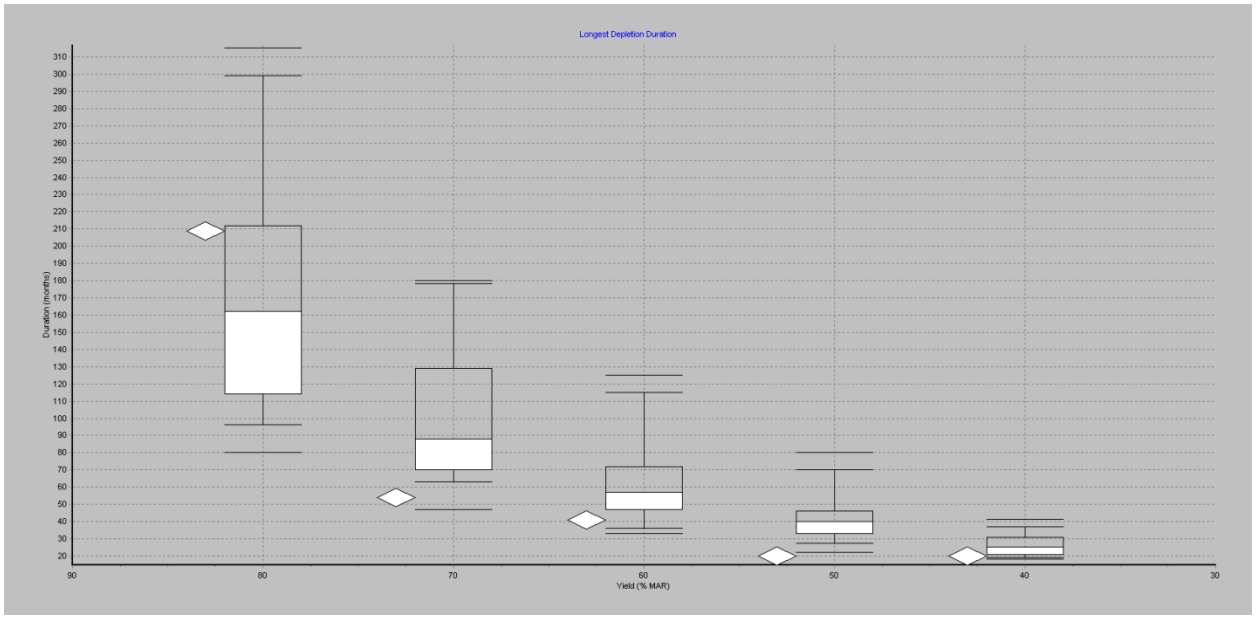
T60E


Longest Depletion Duration
Duration (months)
Yield (% MAR)

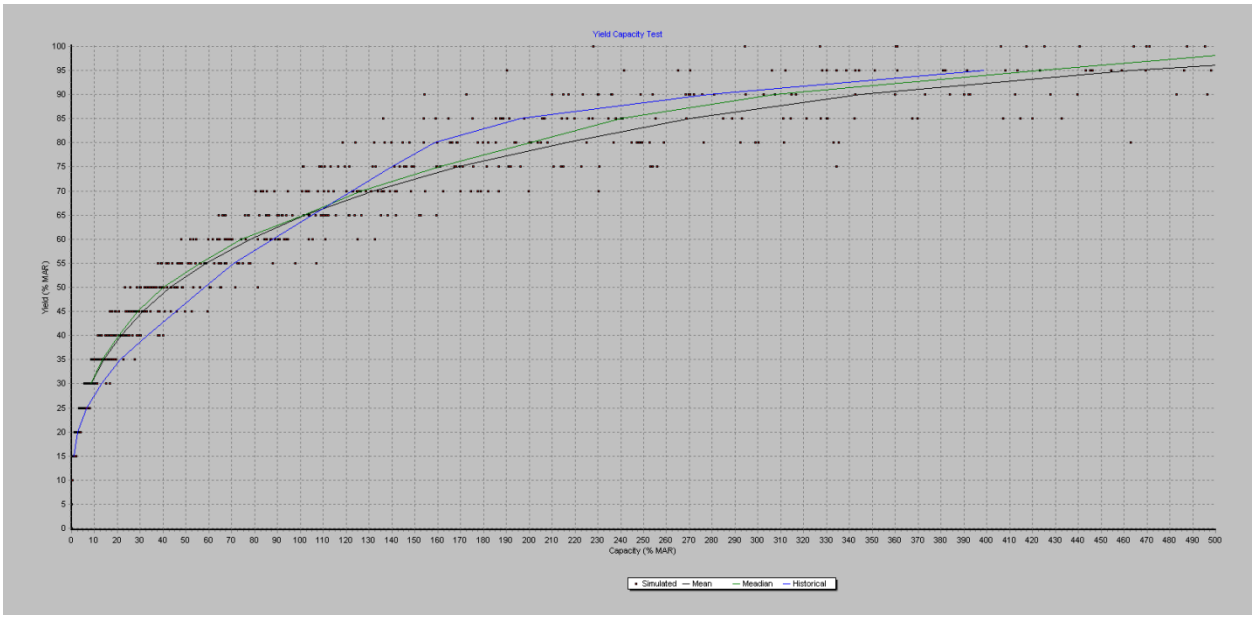
T60F


Longest Depletion Duration
Duration (months)
Yield (% MAR)

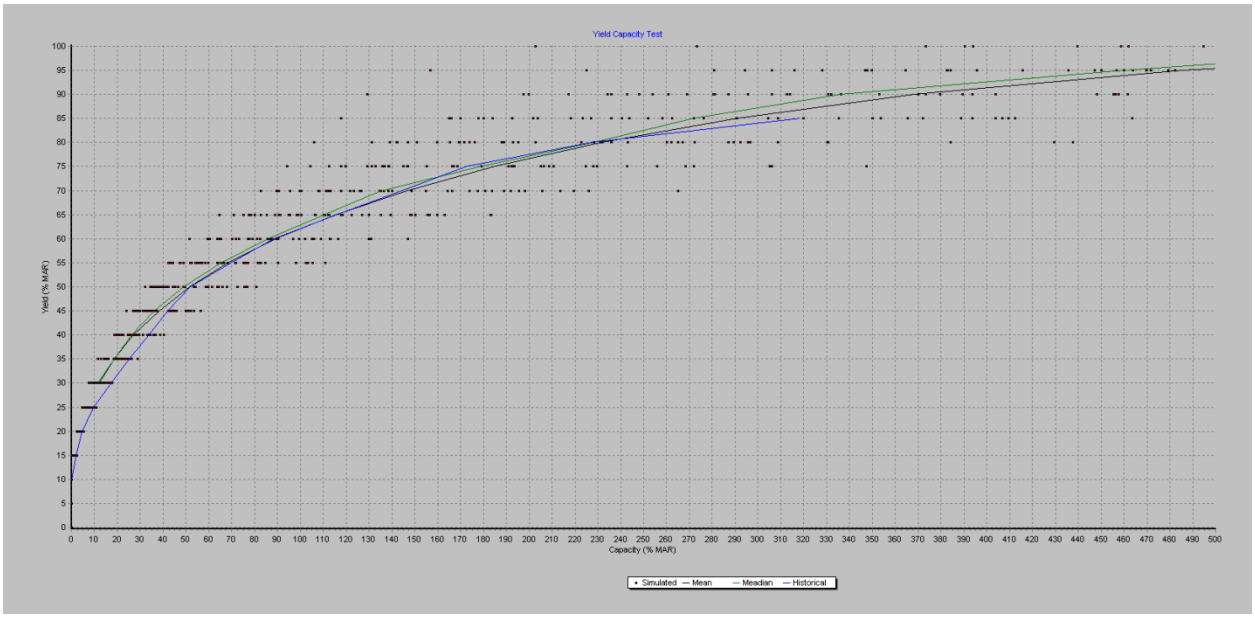
T60G


Longest Depletion Duration
Duration (months)
Yield (% MAR)

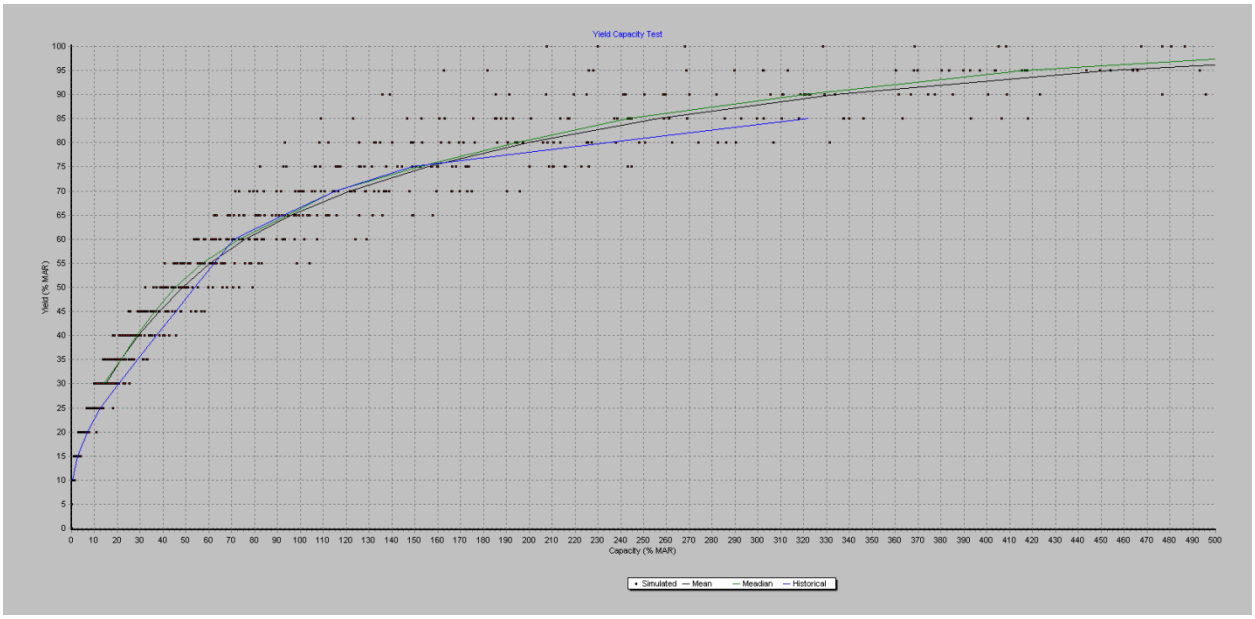
T60E


Yield Capacity Test
Yield (% MAR)
Capacity (% MAR)
Simulated
Mean
Meadian
Historical

T60F


Yield Capacity Test
Yield (% MAR)
Capacity (% MAR)
Simulated
Mean
Meadian
Historical

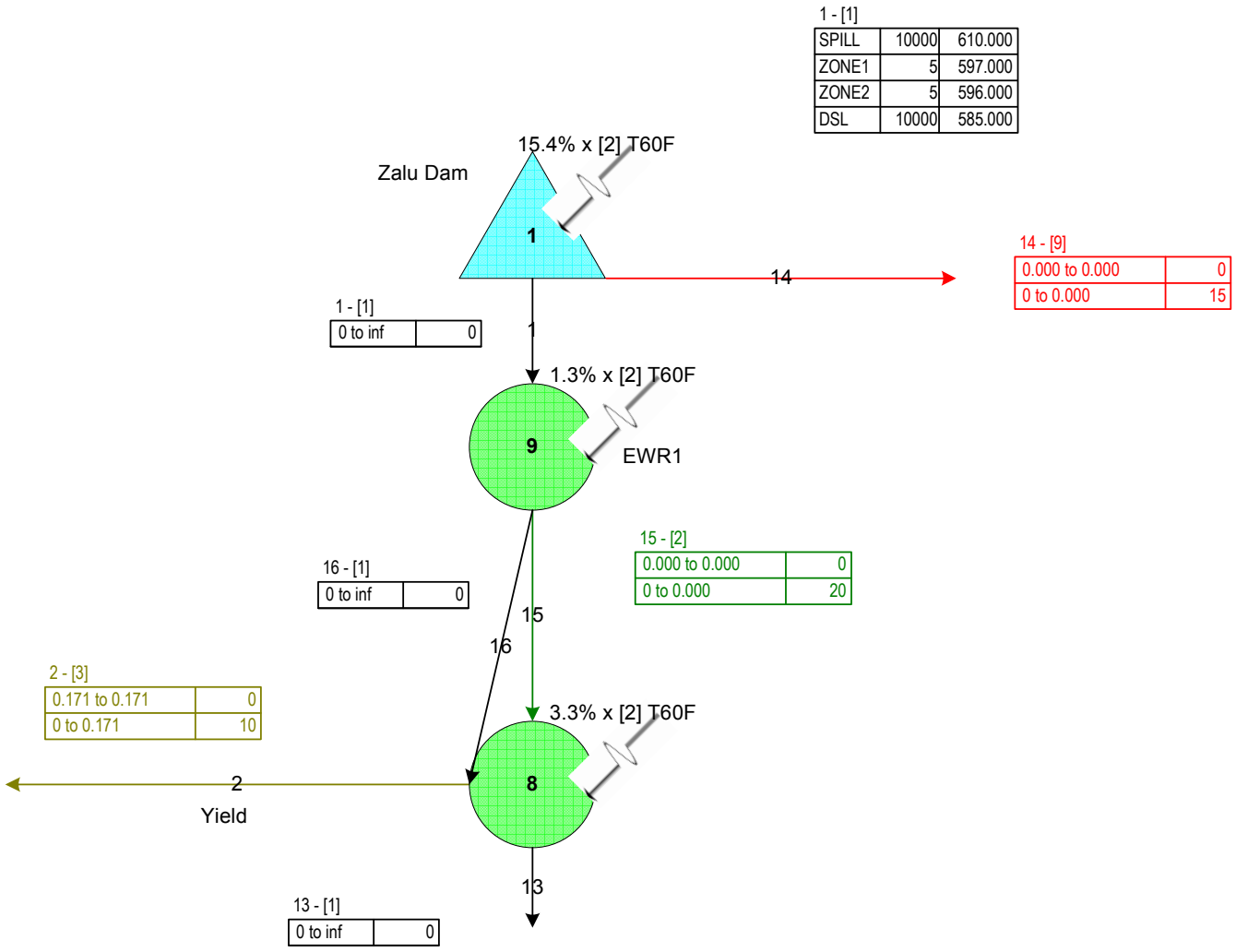
T60G


Yield Capacity Test
Yield (% MAR)
Capacity (% MAR)
Simulated
Mean
Meadian
Historical

Appendix J

Schematic diagram of yield analyses for Zalu Dam

Yield Analyses for the proposed Zalu Dam



Appendix K

Ecological Analyses

Methodology for the Ecological Consequences of the proposed developments on the Xura River

1 OVERVIEW

This task entails the development and analysis of the most probable future development scenarios in the Xura River catchment using the Water Resources Yield Model (WRYM). It deals with the impact of the proposed Zalu Dam and increased domestic and irrigation abstractions on the ecology. The aim of this task is to not only investigate the impact of development on the Xura River at EWR 1 downstream of the proposed Zalu Dam, but also on the remainder of the Xura River down to the confluence with the Msikaba River.

2 AVAILABLE EWR RESULTS

In addition to the Intermediate Reserve results (See **Intermediate Reserve Determination Report**) prepared as part of the greater LWRSS, results from an independent ecological study (instream environment) for DWA: Chief Directorate RDM on classifying and updating of the instream Present Ecological State (PES) of various reaches of the Xura River, were available for analyses. This Study is referred to as the PES Study and is described in more detail in the **Intermediate Reserve Determination** report. The classified reaches of the Xura River identified by the PES are shown in **Figure** 1 below.

The PES Study identified the following instream Ecological Category (EC) on the Xura River:

- The Xura River down to the gauging weir T6H004 (**Reach A**) which is currently in a near natural Ecological Category (EC) of A/B;
- The small stretch of the Xura River downstream of the gauge T6H004 to just upstream of the confluence with one of the major tributaries (**Reach B**), namely Xurana River (indicated with red arrow in Figure 1), deteriorates to an instream EC of C; and
- The long downstream reach to the Msikaba River recovers to an instream EC of B (**Reach C**).

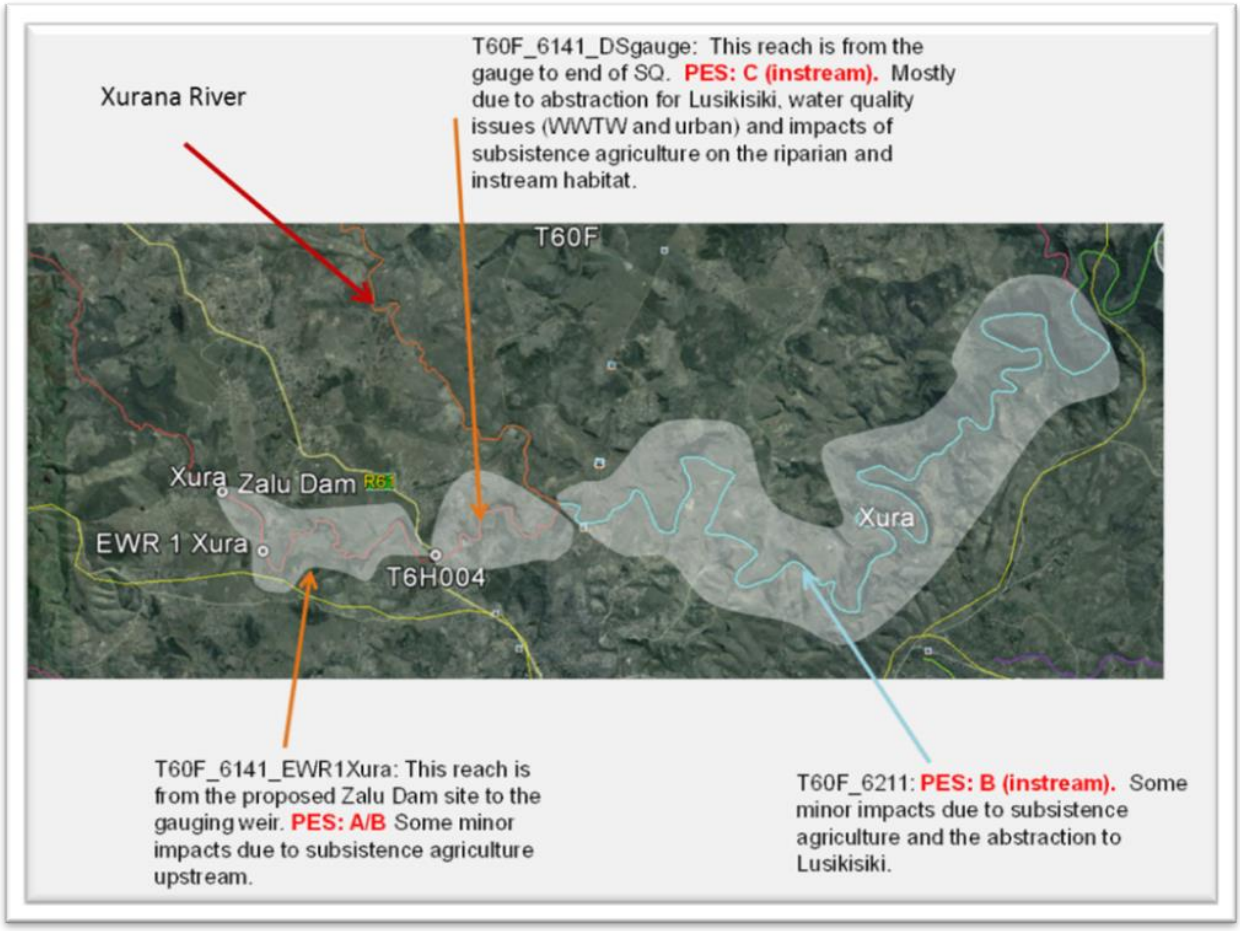


Figure 1: Xura River reaches (tributary: Xurana indicated with red arrow)

3. System Operation for Reserve Analyses

For the purpose of the reserve scenario analyses, the WRYM was used. The analyses were done with no implicit releases from the proposed Zalu Dam to meet the ecological requirements at EWR 2 in the Msikaba River downstream of the confluence with the Xura River. The releases for EWR 2 was ignored since a sensitivity analyses confirmed that the impact of the proposed Zalu Dam in the upper reaches of the Xura River has a very small impact on EWR 2 in the Msikaba River, downstream of its confluence with the Xura River.

To put the impact of EWR in perspective it should be noted that the natural MAR at EWR 1 is small in comparison to that of EWR 2, namely 11% of the MAR at EWR 2. The MAR of the proposed Zalu Dam is less than 20% of the entire Xura River.

The availability of the PES results for the entire Xura River allowed the LWRSS Study Team to analyse the impact of the proposed developments on the ecology related to low flow

conditions of the entire Xura River, rather than just at EWR 1 downstream of the proposed Zalu Dam. It should be noted that the high flow EWR are only available at EWR 1 and EWR 2. It is not possible to extrapolate the floods and freshets to other stretches in the river as is the case with the low flows.

4 EXTRAPOLATION OF INTERMEDIATE RESERVE EWR RESULTS

Intermediate level Reserve results (**low flow** and **high flow EWR**) are available for Reach 1 (EWR 1) for the Ecological Categories (EC) A/B and B/C. However **low flow EWRs** at the outlets of Reaches 2 and Reach 3 were also required for analyses of the remainder of the Xura River.

Subsequently, the **low flow** ecological water requirements (EWR) for an EC of C upstream of the confluence of the Xurana in the Xura, and a Category B upstream of the confluence with the Msikaba River were extrapolated using the available Intermediate Reserve results at EWR 1 and the Desktop Reserve Model. The extrapolated EWRs were based on the intermediate reserve ECs of A/B and B/C at EWR 1 and relationships for the wet and dry season between the desktop Categories.

EWRs were required at the outlets of:

- EWR 1, EC of A/B;
- Reach B, EC of C; and
- Reach C, EC of B.

The Intermediate EWR 1 results for a Category A/B were used. No high level reserves were available at the outlets of Reach 2 and Reach 3 and were extrapolated as described in **Section 4.1**.

4.1 LOW FLOW EWR

Subsequently, **low flow** EWRs were extrapolated using the low flow results of the Intermediate Reserve at EWR 1 for the categories A/B and B/C together with the Desktop Reserve Model (without floods / high flows), and scaled flow records. The extrapolated EWRs were based on the low flow Intermediate reserve for ECs of A/B and B/C at EWR 1, and the low flow desktop EWRs for the A/B, B, B/C and C Ecological Categories. Factors

representative of the relationship between the wet and dry months for the maintenance and drought EWR low flow, were derived between the various categories and between the Desktop Model and the Intermediate reserve results for EWR 1.

Table 4-1: Summary of the low flow data for EWR 1 and the extrapolated EWRs for the Reach 2 and Reach 3 summarises the low flow results obtained from extrapolation at Reach 2 and Reach 3 as well as the original low flow results from the Intermediate Reserve Study at Reach 1 (EWR 1). The data files are included in **Appendix A** of this report and electronically in **Appendix L** of the main report.

Table 4-1: Summary of the low flow data for EWR 1 and the extrapolated EWRs for the Reach 2 and Reach 3

Name	nMAR	Maintenance Low Flow		Drought Low Flow		Long Term low Flow	
		EWR	% of MAR	EWR	% of MAR	EWR	EWR
	million m^3/a	million m^3/a	%	million m^3/a	%	million m^3/a	%
EWR 1_AB	14.160	3.186	22.49	0.807	5.70	5.212	36.79
Reach_2_C	19.724	2.547	12.91	0.940	4.77	2.761	14.00
Reach_3_B	66.890	11.821	17.67	3.791	5.67	11.107	16.60

4.2 High Flow EWR

It is not possible to extrapolate floods and freshets from an Intermediate Reserve determination to another site and ecological category. It is however noted that the incremental catchment run-off downstream of the proposed Zalu Dam are presently in a near-natural state with no significant land-use and the proposed Zalu Dam run-off constitutes less than 20% of the Xura River catchment run-off. It was therefore assumed that the frequency and magnitude of floods and freshets in the Xura River downstream of the confluence with the Xurana River will be adequate without any additional releases from Zalu Dam. The floods and freshets at EWR 1 were however included in the analyses of the river reach downstream of Zalu Dam.

Thus, high flow analyses were only done in the Xura River for EWR 1.

5 Scenario Selection for the Ecological Analyses

Scenarios to reflect the most probable future developments were created in consultation with DWA. Yield analyses indicated that there are huge benefits to the yield if domestic

abstractions were released from the proposed Zalu Dam via the Xura River, and abstracted at the weir, T6H004. The reason is that the low flow EWR is smaller than the domestic requirement from Zalu Dam for the year 2040, which means that no EWR needs to be released. The scenarios selected for the ecological consequences analyses therefore only investigated domestic releases via the river.

Very little information on the infrastructure to divert water from the Xura River at T6H004 to the Water Treatment Works (WTW) is available. The incremental catchment inflow to the Xura River between the proposed Zalu Dam and the weir T6H004, were therefore not used for the domestic water abstraction, i.e. the total domestic water requirement was released from the proposed Zalu Dam, ignoring all incremental catchment between the dam and weir for abstraction purposes. Irrigation abstraction was assumed to be directly from Zalu Dam. It is important to note that for the purpose of these analyses that **no ecological water was released from the proposed Zalu Dam**.

The scenarios selected for analyses are shown in **Table 5-1**.

Table 5-1: Proposed scenarios to determine the ecological consequences of the proposed developments

Scenario	Zalu Dam 607.5m 4.89 million m^3	Zalu Dam 610.2m 6.53 million m^3	Zalu Dam 611.5m 7.64 million m^3	Zalu Dam 614.48m 10.19 million m^3	Domestic abstraction at T6H004 million m^3/a	Irrigation direct from Zalu dam million m^3/a
1	√				4.47	
2		√			5.40	
3			√		4.47	1.452
4				√	5.40	1.452

6 RESULTS OF THE ECOLOGICAL ANALYSES

It is important to note that all results are simulations without specifically releasing the EWR from the proposed Zalu Dam. The analyses reflect on the flow in the river relating to the proposed development scenarios to study the impact thereof if no water at all is implicitly released to meet the Reserve requirements.

Also shown are the low flow EWR for the three sites and the natural base flow (natural base flow is only available for EWR 1).

It is shown in **Figure 2** that the flow in the Xura River always exceeds the low flow EWR in all the above instances with the exception of the second reach (just before confluence with the Xuruana tributary). The exceedance of requirement vs. availability is however small.

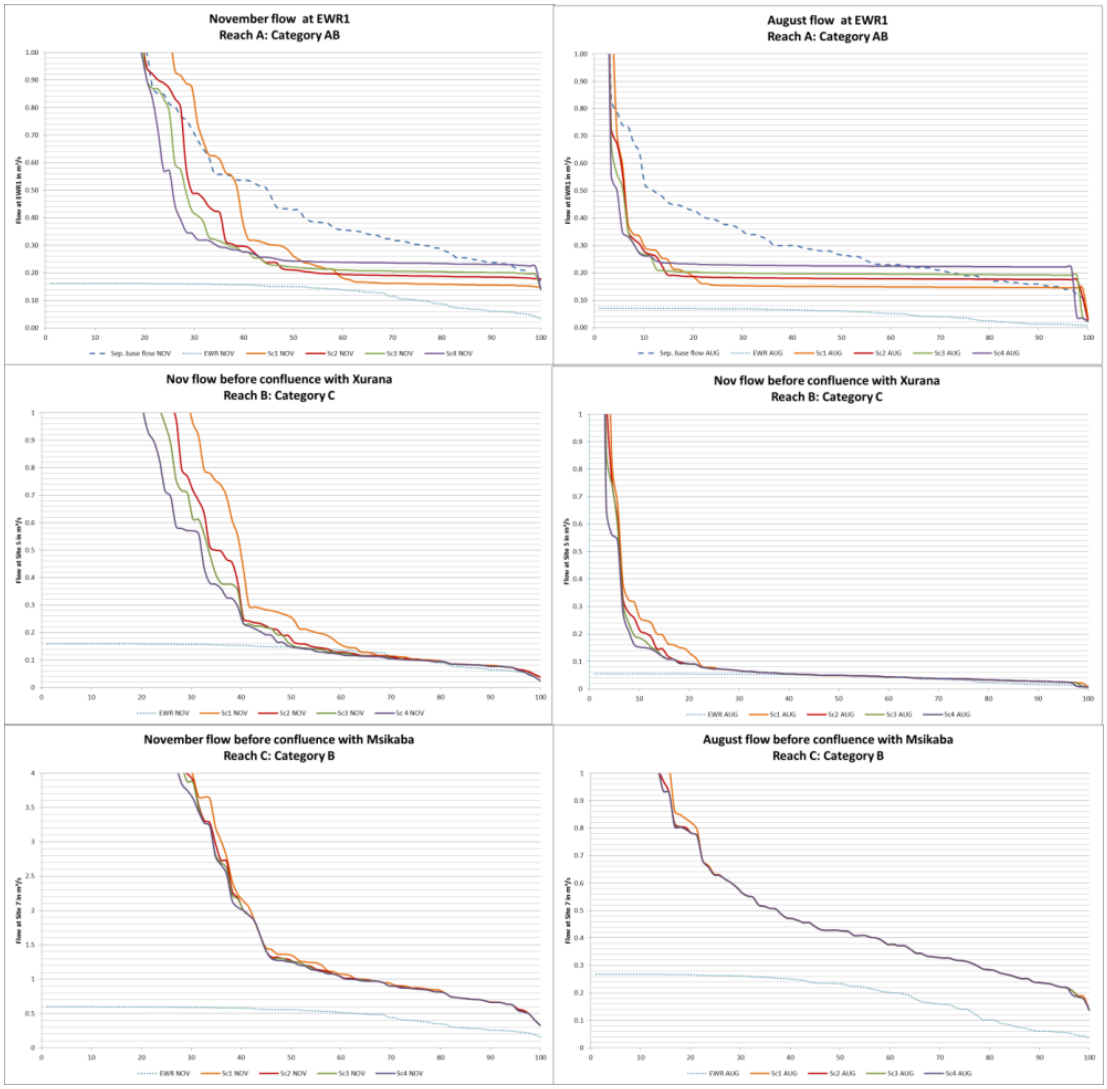


Figure 2: Comparison of flow during wet and dry months for various scenarios

6.2 HIGH FLOWS (FLOODS) ANALYSES

Modelling of daily flow data is required to determine the impact of the proposed developments on the floods. The observed flow record at T6H004 has approximately 12 years of data and exceeds its gauging capacity above 1.5m (34.77 m^3/s). All simulations are based on monthly simulated flows with the monthly WRYM and results will only be an indication of the frequency and volumes of spills.

It can be seen in **Table 6-1** that the frequency of spilling months reduces by approximately 50% between **Scenario 1** (least developed scenario) with **Scenario 4** (most developed scenario). Scenarios 1, 2, 3 and 4 show that the expected frequency of the proposed Zalu Dam spilling is 45%, 34%, 30% and 23%, respectively.

The total annual **volume** specified for floods at EWR 1 according to the Intermediate Reserve determination is 2.86 million m^3/a. A summary of the spill analyses at EWR 1 is provided in **Figure 3**. It is seen that the total annual volume of spills exceed the flood requirement of EWR, but compliance with specific monthly volumes decreases from 62% to 47%.

Table 6-1: Summary of the spill analyses (Intermediate reserve requirement of 2.9 million m^3/a)

Scenario	Average high flow EWR supplied (million m^3/a)	Number of shortages	Longest consecutive years with shortages
Scenario 1	7.19	33 (38% of the years)	5 years
Scenario 2	5.47	42 (49% of the years)	6 years
Scenario 3	5.16	43 (51% of the years	6 years
Scenario 4	4.16	47(53% of the years)	8 years

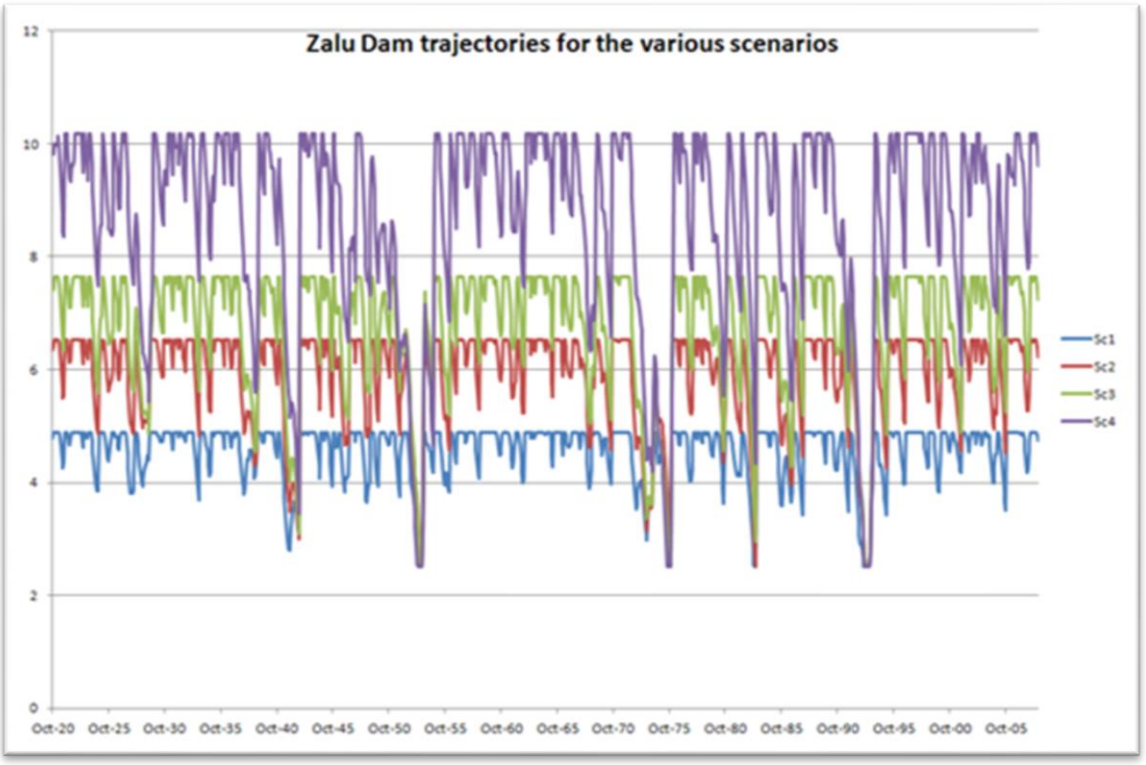


Figure 3: Monthly trajectories of the proposed Zalu Dam for the four scenarios

6.3 SEASONALITY

For the analyses of the seasonality at EWR 1 in the Xura River the incremental contribution of the catchment downstream of the proposed Zalu Dam to the EWR 1 was included. Please note that the seasonality refers to both high and low flows. Figure 4 and

Figure 5 compares the seasonal variation in monthly flow between the dry (5% assurance) and wet (60% assurance) season at EWR 1. The dry season flows are compared with the **natural base flow** at 5% assurance, whilst the wet season flows are compared against the base plus natural flow (**total flow at EWR 1**) at 60% assurance as the base flow does not adequately show the implications of the proposed developments on the wet season. Figure 4 shows that even the base flow of the natural flow has some seasonality during drought years, which is not seen in any of the scenarios after the Zalu Dam was built. It is also seen that the monthly flow variation between the two extreme scenarios is small as the incremental contribution of the catchment remains constant for these two scenarios. The differences in flow can be ascribed to the different domestic water requirements and thus releases from Zalu Dam for the two scenarios.

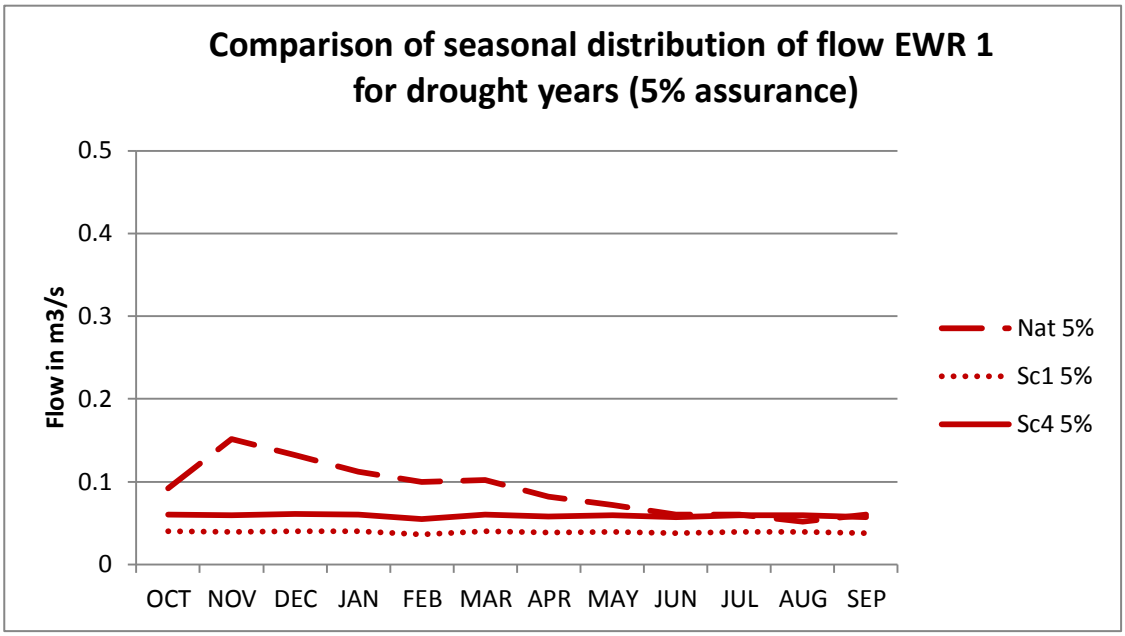


Figure 4: Comparison of the seasonal distribution for the dry season at EWR 1 (5% assurance)

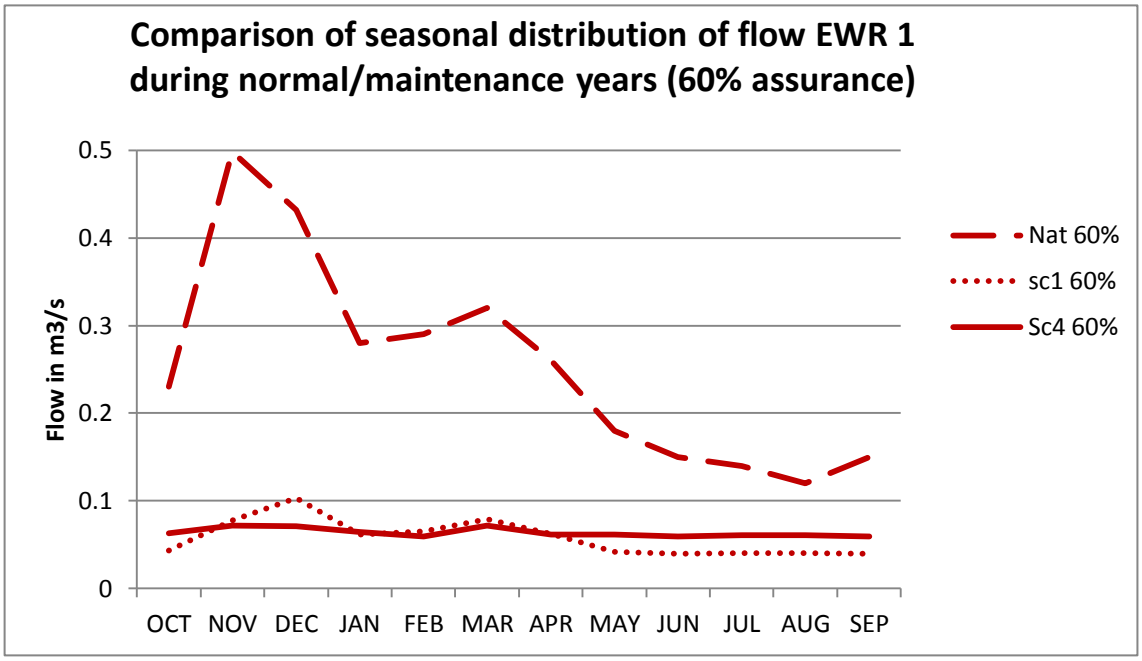


Figure 5: Seasonal distribution of flow for the wet season (60% assurance)

Appendix A: Low flow EWR derived at:

- EWR 1 (Category A/B)
- River Reach2 (Category C)
- River Reach3 (Category B)

EWR table at the EWR 1 EC = AB(low flow only): EWR at the outlet of Reach 2: EC C

Desktop version:	2	Virgin MAR = 14.166 mcm
BFI	0.431	Distribution type: T Reg. Coast
MONTH	Maintenance Low Flow cumec	Drought Low Flow cumec
OCTOBER	0.088	0.020
NOVEMBER	0.136	0.040
DECEMBER	0.127	0.037
JANUARY	0.110	0.030
FEBRUARY	0.132	0.037
MARCH	0.140	0.042
APRIL	0.121	0.034
MAY	0.086	0.020
JUNE	0.076	0.015
JULY	0.075	0.015
AUGUST	0.059	0.008
SEPTEMBER	0.065	0.010
TOTAL MCM	3.186	0.807
% of nMAR	22.49	5.70

EWR 1: Assurance rules (m^3/s) for PES AB (low flow only)

Month	10%	20%	30%	40%	50%	60%	70%	80%	90%	99%
Oct	0.105	0.104	0.103	0.099	0.093	0.081	0.065	0.045	0.028	0.021
Nov	0.162	0.162	0.16	0.157	0.15	0.139	0.119	0.092	0.061	0.041
Dec	0.152	0.151	0.15	0.147	0.141	0.13	0.112	0.086	0.057	0.038
Jan	0.131	0.131	0.13	0.127	0.122	0.113	0.097	0.074	0.048	0.031
Feb	0.158	0.157	0.156	0.152	0.146	0.135	0.116	0.089	0.058	0.038
Mar	0.167	0.167	0.165	0.162	0.155	0.143	0.123	0.095	0.063	0.043
Apr	0.145	0.144	0.142	0.137	0.128	0.113	0.092	0.067	0.045	0.035
May	0.103	0.102	0.1	0.097	0.09	0.079	0.063	0.044	0.028	0.021
Jun	0.091	0.09	0.089	0.085	0.079	0.069	0.054	0.037	0.022	0.015
Jul	0.09	0.089	0.087	0.084	0.078	0.067	0.053	0.036	0.022	0.015
Aug	0.07	0.07	0.069	0.066	0.061	0.052	0.04	0.026	0.014	0.008
Sep	0.078	0.077	0.076	0.073	0.068	0.059	0.045	0.03	0.017	0.01

EWR table at the outlet of Reach 2: EC C

Desktop version:	2	Virgin MAR = 19.724 mcm
BFI	0.431	Distribution type: T Reg. Coast
MONTH	Maintenance Low Flow cumec	Drought Low Flow cumec
OCTOBER	0.068	0.024
NOVEMBER	0.114	0.044
DECEMBER	0.106	0.041
JANUARY	0.089	0.034
FEBRUARY	0.108	0.041
MARCH	0.118	0.047
APRIL	0.100	0.038
MAY	0.067	0.024
JUNE	0.057	0.019
JULY	0.056	0.019
AUGUST	0.041	0.012
SEPTEMBER	0.046	0.014
TOTAL MCM	2.546	0.939
% OF VIRGIN	12.908	4.761

Reach 2: Assurance rules (m^3/s) for PES C

Month	10%	20%	30%	40%	50%	60%	70%	80%	90%	99%
Oct	0.093	0.092	0.091	0.088	0.083	0.073	0.06	0.045	0.031	0.025
Nov	0.159	0.158	0.157	0.154	0.147	0.137	0.119	0.093	0.064	0.045
Dec	0.147	0.147	0.145	0.143	0.137	0.127	0.11	0.087	0.059	0.042
Jan	0.125	0.124	0.123	0.121	0.116	0.108	0.094	0.073	0.049	0.034
Feb	0.152	0.152	0.15	0.147	0.142	0.131	0.114	0.089	0.061	0.043
Mar	0.165	0.164	0.162	0.159	0.153	0.142	0.123	0.097	0.066	0.047
Apr	0.135	0.135	0.133	0.129	0.121	0.108	0.089	0.067	0.048	0.039
May	0.091	0.09	0.089	0.086	0.081	0.072	0.059	0.044	0.03	0.024
Jun	0.077	0.077	0.076	0.073	0.068	0.06	0.049	0.036	0.025	0.02
Jul	0.076	0.076	0.075	0.072	0.067	0.059	0.048	0.035	0.025	0.019
Aug	0.055	0.055	0.054	0.052	0.048	0.043	0.034	0.025	0.016	0.012
Sep	0.062	0.062	0.061	0.059	0.055	0.049	0.039	0.028	0.019	0.015

EWR table at the outlet of Reach 3: EC B

Desktop version:	2	Virgin MAR = 66.89 mcm
BFI	0.431	Distribution type: T Reg. Coast
MONTH	Maintenance Low Flow cumec	Drought Low Flow cumec
OCTOBER	0.328	0.096
NOVEMBER	0.499	0.186
DECEMBER	0.466	0.171
JANUARY	0.405	0.138
FEBRUARY	0.482	0.172
MARCH	0.511	0.196
APRIL	0.447	0.158
MAY	0.323	0.094
JUNE	0.288	0.072
JULY	0.283	0.072
AUGUST	0.225	0.041
SEPTEMBER	0.247	0.050
TOTAL MCM	11.823	3.793
% OF VIRGIN	17.67	5.67

Reach 2: Assurance rules (m^3/s) for PES B

Month	10%	20%	30%	40%	50%	60%	70%	80%	90%	99%
Oct	0.392	0.389	0.384	0.371	0.348	0.308	0.251	0.183	0.125	0.098
Nov	0.596	0.594	0.588	0.577	0.555	0.516	0.452	0.36	0.255	0.189
Dec	0.556	0.555	0.55	0.54	0.52	0.483	0.423	0.336	0.237	0.173
Jan	0.484	0.483	0.479	0.47	0.453	0.421	0.367	0.289	0.198	0.14
Feb	0.581	0.58	0.574	0.564	0.543	0.504	0.44	0.348	0.243	0.176
Mar	0.611	0.609	0.604	0.592	0.57	0.53	0.465	0.372	0.266	0.199
Apr	0.534	0.531	0.524	0.508	0.478	0.428	0.355	0.269	0.195	0.16
May	0.386	0.383	0.378	0.366	0.342	0.303	0.246	0.18	0.122	0.095
Jun	0.344	0.342	0.336	0.324	0.302	0.265	0.212	0.151	0.098	0.074
Jul	0.338	0.336	0.33	0.318	0.296	0.259	0.208	0.148	0.097	0.074
Aug	0.269	0.267	0.262	0.252	0.234	0.203	0.158	0.107	0.063	0.042
Sep	0.295	0.293	0.289	0.279	0.259	0.226	0.178	0.122	0.074	0.051

Appendix B (Appendix L of the main report):

Electronic data files (*.mrv, *.tab, *.rul) and schematic diagram for the low flow EWR derived at:

- EWR 1 (Category A/B)
- River Reach2 (Category C)
- River Reach3 (Category B)