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## Developing River Rating Curves: Ruvu River Basin, Tanzania

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Tanzania Integrated Water, Sanitation and Hygiene (iWASH) Program



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## **EXECUTIVE SUMMARY**

The Florida International Research iWASH Initiative Limited commissioned this study to assess and develop rating curves in the Ruvu River Sub-basin. The work concentrated at the six key strategic stations within the Sub-basin that include: Ngerengere at Konga 1HA9A, Ngerengere at Mgude, Ruvu at Morogoro - Dar es Salaam Road 1H8, Ruvu at Kibungo 1H5, Mgeta at Mgeta 1HB2 and Mgeta at Duthumi 1HB1411. Specifically, the work reviews the existing rating curves for the existing stations on the Ruvu, update and validate cross-sections at the six strategic stations, conduct flow measurements, conduct analysis and produce new rating equations for the six strategic stations. The work utilizes the historical stage-discharge measurements and the new measurements collected during the period November 2012 to May 2013.

Results indicate that most of the stations were established in the early 1950s and discharge measurement in these stations continued until late 1980s, with no measurements between early 1990s and mid 2000s. Review of the rating relationships indicates validity of historical data up to the early 1980s for most of the stations, but cannot be used to transform gauge heights (water levels) without modification. Assessment of physical characteristics at the six key stations revealed fair hydraulic controls. Nevertheless, special attention will be required to attend some observed threats at the channel hydraulic sections.

Validation of the new developed rating curves at the key gauging stations indicate that stage-discharge relationships require updating by new current meter measurements, as for some stations the number of data points that were used to develop the rating relationships were too few. Data records reveal existence of outliers, which is likely attributable among others to use of un-calibrated current meter/sampling equipment, poor measurement techniques, inexperienced sampling technicians and/or computational errors.

The new developed rating curves revealed absence of bias for all the stations except for 1H8. Of the six stations, only three stations namely 1H5, 1HB2 and 1HB1411 passed the 'goodness of fit' test, while the rest of the stations, 1HA15, 1HA9A and 1H8 the test criterion  $t$  was found to be consistently greater than the critical value, leading to the rejection of the null hypothesis of the assumption of random fluctuations. Therefore, the test detected the presence of abnormal long runs of positive or negative deviations. This most likely indicates presence of systematic trend in the deviations with time, indicating that the rating curves need adjustment for a shift in control. The study recommends for a need to increase the number of measured discharges at different stages so as to increase reliability of the rating curve equations. The findings are also considered to be indicative of the situation country wide, thus it is strongly recommend that the MoW (through its WSDP and other donors) make available additional funds to enable revisiting, testing and revision of rating curves on all major rivers to ensure higher confidence in the flow measurements.

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### ***ABBREVIATIONS AND ACRONYMS***

ADC	Acoustic Digital Current
EFA	Environmental Flow Assessment
IUCN	International Union for Conservation of Nature
iWASH	Integrated Water Sanitation and Hygiene
JICA	Japan International Cooperation Agency
NORAD	Norwegian Agency for Development Cooperation
WADA	Water and Development Alliance
WRBWO	Wami-Ruvu Basin Water Office

## 1.0 INTRODUCTION

### 1.1 Background

The iWASH / WADA program in collaboration with the Wami-Ruvu Basin Water Office (WRBWO) carried out initial Environmental Flow Assessments (EFA) for Ruvu river system. The Water Sector Development Programme is currently financing the installation of new gauging stations, and the rehabilitation of key existing stations. To enhance the reliability of data and information generated through EFA studies, the WRBWO and the Ministry of Water recommended that rating curves for existing key stations in the Ruvu sub-basin be reviewed. Rating curves are an important ingredient in determining water flows at any specific point, and therefore in the provision of reliable flow information on which to base decisions for allocation of water. Rating curves developed in the study are expected to be instrumental in supporting ongoing EFA studies.

### 1.2 Current state of rating curves in Wami-Ruvu Basin

The available rating curves for the Wami-Ruvu Basin are old. Most of them were derived between 1960s and 1990s. During that time there were very few anthropogenic activities and the river control section were less impacted. In recent times, there are increased human activities that have led to more generation of sediments and deposition in the rivers. The reliability of the existing rating equations in transforming water levels to discharge is very questionable as most of them either over or underestimate the discharge. This is a big challenge to the water basin management entrusted with management and allocation of water resources based on what is available in the rivers.

In view of the existing situation and in consideration of the importance of appropriate rating curves in the basin water management, iWASH has commissioned a study to undertake a study to review the existing rating curves on some key stations. The study starts with Ruvu sub-basin and later will extend to Wami sub-basin.

### 1.3 Objective and scope of the assignment

The objective of the assignment is to develop rating curves in the Ruvu River Sub-basin. The work concentrated at the six key strategic stations within the sub-basin that include: Ngerengere at Konga 1HA9A, Ngerengere at Mgude, Ruvu at Morogoro –Dar es Salaam Road 1H8, Ruvu at Kibungo 1H5, Mgeta at Mgeta 1HB2 and Mgeta at Duthumi 1HB1411.

### 1.4 Specific Tasks

The specific tasks of the assignment include:

- i. Review all existing rating curves for existing stations on the Ruvu, and assess the extent to which each station can be expected to have permanent or shifting controls

- ii. Update and validate cross-sections at each of the 6 stations listed above
- iii. Supervise flow measurements at each of the 6 stations for at least 5 different flow levels (low to high flows)
- iv. Carry out analysis and produce new rating equations for the 6 stations
- v. In the course of carrying out the activities (i) to (vi) ensure that the capacity of WRBWO staff (hydrologists and technicians) is enhanced through a well structured hands on learning process
- vi. Prepare a summary report documenting the process of developing the rating curves in the Ruvu sub-basin, and detailing implications to water resources management and accuracy of existing data and information.

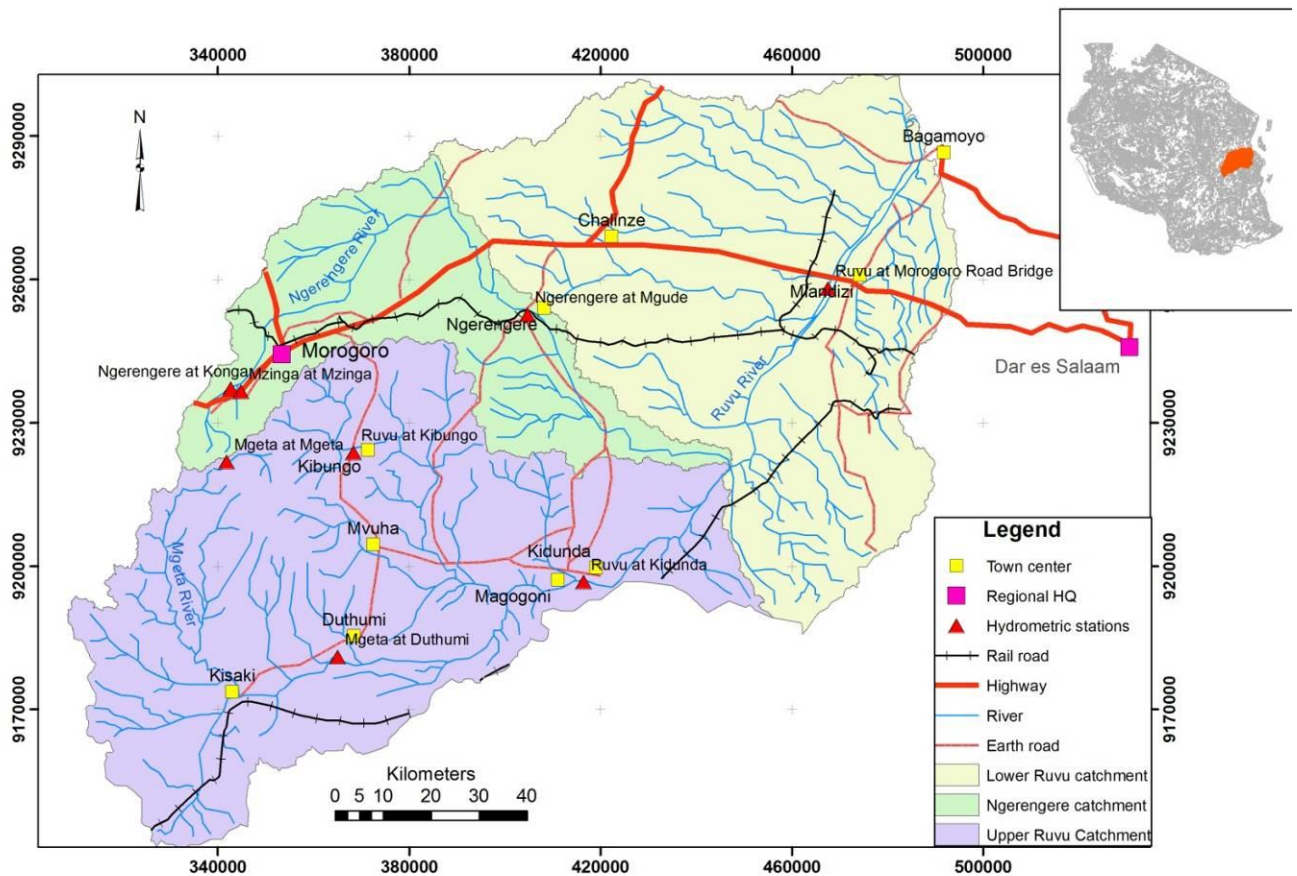
## 2.0 DESCRIPTION OF THE RUVU SUB-BASIN

The Ruvu River is one of the major rivers draining the Eastern Arc Mountains. The Ruvu sub-basin extends from Morogoro to the west of Dar es Salaam through the Coast and Dar es Salaam Regions (Figure 1), covering an area of about 17,700 km<sup>2</sup> of catchment which lies between latitudes 60° 05' and 70° 45' south and longitudes 37° 15' and 39° 00' east (IUCN, 2010). The Ruvu River sub-basin can be subdivided into three main sub-catchments namely, Upper Ruvu, Ngerengere and Lower Ruvu sub-catchments. The basin is mostly composed of low-lying areas along the Ruvu River and a slightly elevated hilly area with moderate undulation, which extends from west to east around Morogoro town with the exception for the Uluguru Mountains in the extreme west, which has an elevation of 2000 m above mean sea level. Isolated rolling hills are in the middle reach of the Ruvu River. The lowermost part of the river is the extreme eastern edge of the Basin, where low-lying alluvial flood-plains about 5–10 km wide are found at an elevation below 10m above mean sea level (URT/JICA, 1994).

The climate of Ruvu sub-basin varies according to the topography. The high mountain ranges of Uluguru receive more rainfall as compared to the lowland areas and rainfall is also spatially variable in the mountains. The eastern slopes of the Uluguru Mountains have mean annual rainfall in excess of 2500 mm while the western slopes of the mountains receive less (WRBWO, 2008). The Nguru-Rubeho Mountains receive between 800 and 1200mm, and the Ukaguru Mountains 1000-1800mm annually. Rainfall is much less in the plains which ranges between 800 and 1000mm near the coast but only 500-600 mm inland towards Dodoma and north of Wami sub-basin (Droogers *et al.*, 2006). Generally, the high rainfall month for both highland and lowland areas is April, with mean monthly rainfall amounting to about 300 mm in the highland and about 170 mm in the lowland.

Average monthly minimum and maximum temperatures are almost the same throughout the basin; the coldest month is August (about 18°C) and the hottest month is February (about 32°C). The annual average temperature is about 26°C.

The hydrology of the catchment is influenced by the topography and climate. Most of the rivers in the sub-basin originate from the Uluguru Mountain ranges. Many rivers in the sub-basin are perennial although some dry up during the dry season and experience high flows during periods of heavy rainfall. The major tributaries into the Ruvu River are Ngerengere and Mgeta Rivers.



**Figure 1: Ruvu Sub-basin map showing some important features**

Ruvu sub-basin benefits has multiple uses and benefits a huge population including biodiversity conservation, wildlife conservation, agriculture, pastoralism, domestic and industrial activities especially in Morogoro and Dar es Salaam. The major infrastructure projects in the Ruvu sub-basin are the lower and upper Ruvu intakes for the water supply to Dar es Salaam and the Bagamoyo, Mlandizi and Kibaha villages as well as Mindu dam in Morogoro.

### **3.0 REVIEW OF RATING CURVES FOR EXISTING STATIONS ON THE RUVU AND STATUS OF PERMANENT OR SHIFTING CONTROLS**

The available discharge measurements and gauged data at the existing gauged stations were collected from the Wami-Ruvu Basin Water Office including various reports (e.g. JICA/URT, 1994; JICA, 2012). The historical rating data were analyzed to reveal presence or absence of shift in control. The analysis was augmented by fieldwork at the six key stations. Table 1 presents status of the stations in the Ruvu sub-basin, while Table 2 presents the historical stage-discharge relationship for various stations in the sub-basin. The data indicate that most of the stations were established in the early 1950s and discharge measurement in these stations continued until late 1980s. The period from early 1990s until mid 2000s shows that there were no measurements taken. Discharge measurement commenced in 2007 at some of the stations and not covering all the stations.

Most of the rating relationships are valid up to the early 1980s and only Mgeta (1HB2) up to 1990 (Table 2). Generally, the stage-discharge relationships for most gauging stations are fitted using more than one segment with the exception of 1H10. The other observations are that the historical rating curves (Table 2) are fitted to shorter validity periods. The implications are that hydraulic controls at some gauging stations are changing over a shorter period and that the rating curves cannot be valid over a longer period. While that has been revealed, the motive for the choice of the used validity period in construction of historical rating curve is not highlighted in the document to support the above assertion. Therefore, in the absence of such information, one is tempted to assume that the shorter validity periods as used in JICA/URT (1994), (Table 2) could be a result of change in channel hydraulic control at the gauging station. Since most of the rating information is valid up to or before year 1990, the use of such curves to transform water levels to discharge is unlikely to give better results, hence necessitating developing of new stage-discharge relationships at stations. According to URT (1979), in order to have a permanent and stable stage-discharge relation, the stream channel must be capable of stabilizing and regulating the flow past the station site so that for a given stage the discharge past the station will always be the same. It is also important to note that very few rivers have absolutely stable characteristics. Thus, the calibration cannot be carried out once and for all, but has to be repeated as frequently as required by the rate of change in the stage-discharge relation (URT/NORAD, 1979).

Based on the physical characteristics at the key stations as outlined in Table 3, the gauging stations can be considered to have fair hydraulic controls. Special attention will be required to attend some observed threats at the channel hydraulic sections.

**Table 1: Status of gauging stations in the Ruvu sub-basin**

SN.	River Name	Station code	Location			Altitude (m)	Catchment Area (km <sup>2</sup> )	Observation period		Discharge measurement range	Discharge measurement structure
			Name	Latitude	Longitude			Established	Status/Closed		
1	Ruvu	1H2	Ruvu Sisal Estate	6° 48'S	38° 39'E	27	12,488	Aug. 1950	Jun. 1959	n.d	
2	Ruvu	1H3	Kidunda	7° 16'S	38° 18'E	76	6,697	Aug. 1951	Oct. 1963	n.d	Cableway
3*	Ruvu	1H5	Kibungo	7° 1'S	37° 48'E	474	420	Oct. 1952	Operational	Oct 1952- Jun 1987; 26/3/2007-30/4/2013	Cableway
4*	Ruvu	1H8	Ruvu Bridge	6° 41' S	38° 41'E	15	15,190	Nov. 1958	Operational	11/12/1958-04-12-1981; 09-01-2007 – May 2013	Bridge
5	Ruvu	1H10	Mikula	7° 18'S	38° 10'E	80	5,870	Nov. 1965	Operational	23-08-1966 - 14-04-1989	Cableway
6	Ngerengerere	1HA1A	Utari Bridge	7° 2'S	38° 22' E	90	2,840	Oct. 1950	Operational	28-01-1966 - 30-03-1985; 1990	
7	Ngerengerere	1HA3	Kingolwira	6° 45'S	37° 48' E	425	690	Sep. 1950	Oct. 1963	28-05-2009 - 02-06-2010	
8	Ngerengerere	1HA4	Kilimanjaro	6° 46'S	37° 42'E	457	630	Apr. 1953	Oct. 1959	n.d	
9	Ngerengerere	1HA5	Kiluwa	6° 44'S	38° 06'E	198	1,646	Nov. 1953	Aug. 1967	29-07-1953 - 04-02-1969	Cableway
10	Ngerengerere	1HA6	Kihonda	6° 47'S	37° 39'E	466	461	Sep. 1950	Oct. 1963	n.d	
11	Mlali	1HA7	Mlali	6° 58'S	37° 32'E	518	18.1	Oct. 1953	Oct. 1963	n.d	Cableway
12	Morogoro	1HA8	Morogoro	6° 51'S	37° 40'E	543	23.3	Mar. 1954	Operational	16-04-1960 - 28-06-2011	Cableway

13	Ngerenger e	1HA9	Konga	6° 54'S	37° 37'E	530	20.5	Apr. 1954	Mar. 1960	n.d	Bridge/cableway
14*	Ngerenger e	1HA9A	Konga	6° 54'S	37° 37'E	530	20.5	Nov. 1962	Operational	08-11-1962 08-05-1984; 2-01-2007-May 2013	Bridge/cableway
16	Ngerenger e	1HA10	Mgera	6° 56'S	37° 34'E	518	15.4	Apr. 1954	Oct. 1963	n.d	
17	Ngerenger e	1HA15	Mgude	6° 48'S	38° 09'E	95	2,370	Oct. 1968	Dec. 1975	14-10-1968 - 04-06-1992; 18- 04-2008 - May, 2013	Cableway
18	Mgeta	1HB1	Kisaki	7° 28'S	37° 42'E	152	963	Nov. 1950	Dec. 1962	06-11-1950 - 24- 09-1963	Bridge
19*	Mgeta	1HB2	Mgeta	7° 02'S	37° 34'E	975	101	Jun. 1954	Operational	1/6/1954- 31/3/ 1988; 1/12/2006- 6/5/2013	Cableway
20	Mgeta	1HB3	Bunduki	7° 02'S	37° 37'E	1,220	46	Jun. 1954	1962	15-07-2011 – May, 2013	
21	Mgeta	1HB4	Luhuela	7° 01'S	37° 38'E	1,493	5	Dec. 1954	1963	n.d	
22	Mvuha	1HC2	Mvuha	7° 12'S	37° 51'E	274	251	Apr. 1954	Operational	25-02-1954 - 10-03-1984	Cableway
23*	Mgeta	Local	Duthumi	7° 24'S	37° 46'E	473	420	2011	Operational	15-07-2011 – May 2013	Cableway

\* Stations included in this study.

Note: n.d = no data

Source: JICA/URT, (1994); Kashaigili, (2011).



Table 2: Historical stage-discharge relationships at various gauging stations in the Ruvu sub-basin (JICA URT/, 1994)

Station code	Name of Station	Available period	Q = A * H <sup>B</sup> + C			Limit water level (m)	Correlation Coefficient, R (%)
			Coefficients				
			A	B	C		
1H2	Ruvu Sisal Estate	1952-1959	11.0240	1.66429		2.00	95.4
			1.02973	3.54281	23	6.00	97.5
1H3	Kidunda	1952-1966	24.1237	1.03527		1.60	96.2
			6.14850	2.44617	20	6.00	91.6
1H5	Kibungo	1959 - 1970	19.1636	3.10753		1.10	98.7
			40.6208	1.25447	-20	4.50	98.5
		1971-1980	23.0633	3.49743		1.10	96.9
			33.8732	1.41340	-10	4.50	99.8
		1981-1987	20.5394	2.89784		1.10	92.6
			51.7881	1.10724	-30	4.50	98.6
1H8	Ruvu Bridge	1958-1970	8.22767	1.81509		6.11	98.8
			100.475	1.50195	-1300	8.00	95.2
		1971-1981	9.06448	1.76623		6.11	98.8
			0.00002	8.23453	160	8.00	86.4
		1982	5.01726	1.71714		6.11	99.5
		1983 - 1985	9.18824	1.80456		6.11	99.2
			25.0344	1.95137	-600	8.00	99.9
		1986 - 1989	6.72828	1.79702		6.11	88.5
			0.00151	6.27380	50	8.00	96.4
		1H10	Mikula	1966 - 1984	11.448	1.896	
1HA1A	Utari Bridge	1966 - 1977	3.73814	3.35047		0.80	84.1
			3.62428	1.61445	-1	4.50	99.7
		1980 -1985	7.77635	2.94829		0.80	97.7
			3.04418	1.67539	1.5	4.50	99.1

Station code	Name of Station	Available period	Coefficients			Limit water level (m)	Correlation Coefficient, R (%)
			A	B	C		
1HA5	Kiluwa	1953 - 1960	3.35462	2.24316		1.50	95.3
			3.00350	2.25029		3.00	93.7
		1961	2.39806	2.66217		1.50	99.4
			3.00350	2.25029		3.00	93.7
		1962	0.56487	6.81209		1.50	98.7
			3.00350	2.25029		3.00	93.7
		1963 - 1969	2.44482	2.8857		1.50	95.1
			3.00350	2.25029		3.00	93.7
1HA15	Mgude	1968 - 1973	4.16574	1.48870		1.50	98.5
			3.00561	2.47466		4.00	98.3
		1974 - 1977	2.46166	2.79574		1.50	96.9
			0.35630	4.42856	5	4.00	90.3
		1978 - 1979	1.63595	2.88427		1.50	95.1
			4.02192	2.41713	-5	4.00	97.5
		1980 - 1986	3.24384	2.77980		1.50	96.2
			0.23692	4.85933	8	4.00	89.4
		1987 - 1992	0.69703	2.40865		1.50	91.7
			2.87339	2.76867	-7	4.00	97.2
1HB1	Kisaki	1950 - 1986	9.57690	1.02741		0.80	94.1
			31.9738	0.63273	-20	3.00	99.2
		1960 - 1963	7.26274	1.45101		0.80	77.2
			18.6199	0.89488	-10	3.00	97.5
1HB2	Mgeta	1958 - 1986	8.88722	2.14663		0.75	97.2
			7.95385	3.68474	2	1.50	98.8
		1980 - 1990	13.9812	2.95973		0.75	98.9

		4.56838	5.55936	5	1.50	99.9
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Station code	Name of Station	Available period	Coefficients			Limit water level (m)	Correlation Coefficient, R (%)
			A	B	C		
1HC2	Mvuha	1954 - 1956	6.81975	2.08840		2.00	93.8
			7.88480	1.88107		3.50	99.9
		1958 - 1980	2.25136	2.16116		2.00	75.5
			7.96119	1.86076	-20	3.50	75.8
		1981 - 1984	5.02611	2.82574		2.00	95.2
			59.5741	0.95754	-80	3.50	99.8

**Table 3:** Physical descriptions of the flow gauging stations at the key stations

Stn. Code	Catchment description	Station details	Observed threats on Control Section
1H5	Steep catchment of the Uluguru Mountains, well wooded with vegetation actively induced by natives	Types of gauges: Standard vertical; Benchmark: Concrete beacon on right bank near staff gauges. The BM assumed datum is at 8.283m. A hydraulic control is fairly stable open channel with cobbles, gravel, sand and debris deposition bed materials and grassy banks. The site is accessible throughout the year from Morogoro.	Deposition and development of an island at the channel cross-section leading to change from laminar to unsteady flow. Mining activities in the upstream of the gauging station accelerating sediments.
1H8	Upper part, steeply sloping catchment containing a wide range of vegetation; and lightly wooded grassland with some bushland and thickets grassland in the lowland areas.	Types of gauges: Standard vertical; Benchmark: Concrete beacon on left bank near staff gauges. The BM assumed datum is at 6.77m. A hydraulic control is fairly stable open channel with mixed clay bed and grassy banks. The site is accessible throughout the year from Morogoro and Dar es Salaam.	No major threats except minor erosions on the left bank following cattle watering.
1HB2	Upper steeply sloping catchment containing a wide range of vegetation	Types of gauges: standard vertical; Benchmark: is a concrete beacon on right bank near staff gauges and benchmark assumed datum is at 4.150m. A hydraulic control is permanent formed by rock outcrop and rapids about 18 meters downstream of the gauge; The site is accessible throughout the year using Mgeta road from Morogoro.	Erosion especially on the right bank. <i>(Stabilization of bank to avoid erosion will be necessary)</i>
1HA9A	Steep catchment of the Uluguru Mountains, with wide range of vegetation	Types of gauges: Standard vertical; Benchmark: Concrete beacon on left bank near staff gauges. The BM assumed datum is at 5.60m. A hydraulic control is fairly stable open channel with clay bed and grassy banks. The site is accessible throughout the year from Morogoro-Mzinga earth road.	Sedimentation following increased human activities in the upstream

1HA15	Catchment containing a wide range of vegetation largely influenced by human activities	Types of gauges: Standard vertical; Benchmark: Concrete beacon on left bank near staff gauges. The BM assumed datum is at 6.265m. A hydraulic control is fairly stable open channel with clay bed and grassy banks. The site is accessible throughout the year from Ngerengere earth road.	Erosion and deposition at the hydraulic control section following livestock crossing at the gauging station. <i>(This require special care to stop livestock crossings at the section and other human activities (e.g. brick making) near the river banks in the upstream)</i>
IHB1411	Upper part, steeply sloping catchment containing a wide range of vegetation; and lightly wooded grassland with some bushland and grassland in the lowland areas.	Types of gauges: Standard vertical; Benchmark: Concrete beacon on left bank near staff gauges. The BM assumed datum is at 5.573m. A hydraulic control is fairly stable open channel with clay bed and grassy banks. The site is mainly accessible in the dry season from Morogoro-Kisaki earth road	Erosion and deposition at the hydraulic control section following people fetching water and crossing at the section and livestock watering in the upstream of the channel hydraulic section.

## 4.0 UPDATING AND VALIDATION OF CROSS-SECTIONS

### 4.1 Check survey

The surveys were conducted at the key stations to check for the validity of the cross section and whether the gauges had been disturbed since the previous check survey. In this case wherever there were errors, corrections were made accordingly. The results of the check survey are provided in Table 4, while other details are provided in Appendix 1. During the process of check survey, the angle irons had the correction slots improved to be longer in order to allow more movements for corrections in future check surveys.

**Table 4: Results of Check Survey**

Stn. Code	Description
1H5	<p>Ruvu River at Kibungo- gauges numbers: 3.00-4.00m, 400-5.00 and 500-6.00m needed big adjustments which entailed dismantling and rebuilding.</p> <p>Observed a developed island at the channel hydraulic section and recommended to be removed in order to allow the flow hydro-dynamic processes to take place. This was dug-out and section cleared to reduce its effects on the uniform flow at the measuring site.</p>
1H8	Found to be in good order, no adjustment.
1HB2	An error was found between gauge plate number 0.0 to 1.00m and 1.00 to 2.00m, for which the 1.00 to 2.00m gauge was re-erected to comply with the appropriate levels of the range of the existing gauges.
1HA9A	A misleading error for the gauge plate that used to be considered 0.0 to 1.00m, but for which in reality it was 0.0 - 0.50m, but on top it used to read 1.00m. This error was noted and rectified and the gauge ranges now read 0.0-0.50m as the first gauge, second gauge reads 0.50- 1.00, 3 <sup>rd</sup> 1.00-2.00, 4 <sup>th</sup> 2.00-3.00, 5 <sup>th</sup> 3.00-400m and the last 4.00-500m. The total gauge range is up to 5.50m instead of 6.00m. Such errors might have had implications on the previously recorded water levels at the sections and subsequently on the computed discharges. Reviewing of historical water levels since last check survey was recommended.
1HA15	<p>The gauges 1.00-2.00, 2.00-300m and 3.00-4.00m were adjusted. Gauge no. 0.0-1.00 was found to be submerged in sand by 0.38m that is while the water level was 0.88. Actual depth was 0.50m.</p> <p>The banks at this station were found to be actively degraded by livestock movement across the measuring section. Recommend installing a signpost to bar the trespassing at section. Furthermore, the authorities, especially the village government should be informed. This station is important because its location may be taken to represent a larger part catchment of the Ngerengere River Catchment before its confluence with Ruvu river.</p>

IHB1411	<p>With the exception of fallen tree and logs that had to be removed and the site cleared to allow free movement of water through, no adjustment on the gauges as were found to be okay.</p> <p>The hydraulic control section was found to be susceptible to increased human activities on river banks as well as livestock watering. Special attention will be required to halt such activities in the river banks in particular at the channel hydraulic control section.</p>
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**4.2 River Gauging Section Cross-section survey**

The surveying of river gauging section cross-sections followed standard procedures using a dumpy level machine. Among others, the essence of defining these cross-sections is to help in the process of developing and checking reliability of rating curves. It was revealed that there exists no historical gauging section cross-sections at the key stations and if they were, the documents containing data were at large. Therefore, this work could be considered a first attempt to establish and document river gauging cross-sections at the gauging stations. The results for the six key stations are presented in Figures 2 through 7, and Appendix 2.

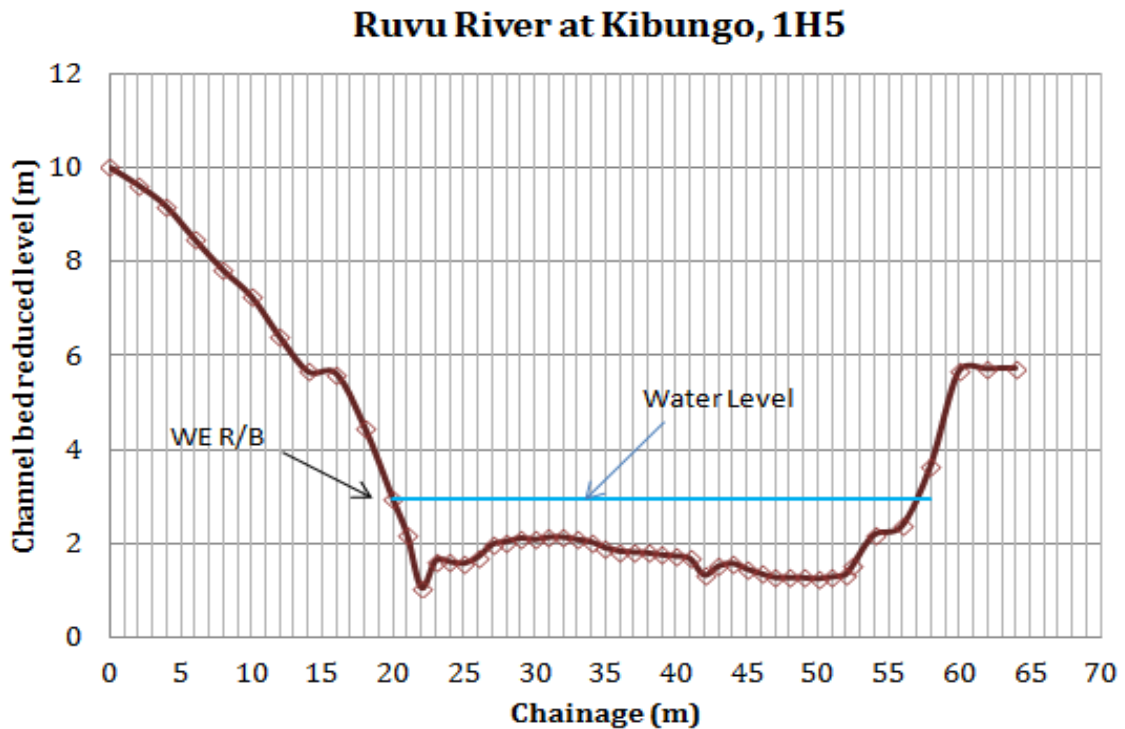


Figure 2: Gauging section cross-section for Ruvu River at Kibungo station (1H5)





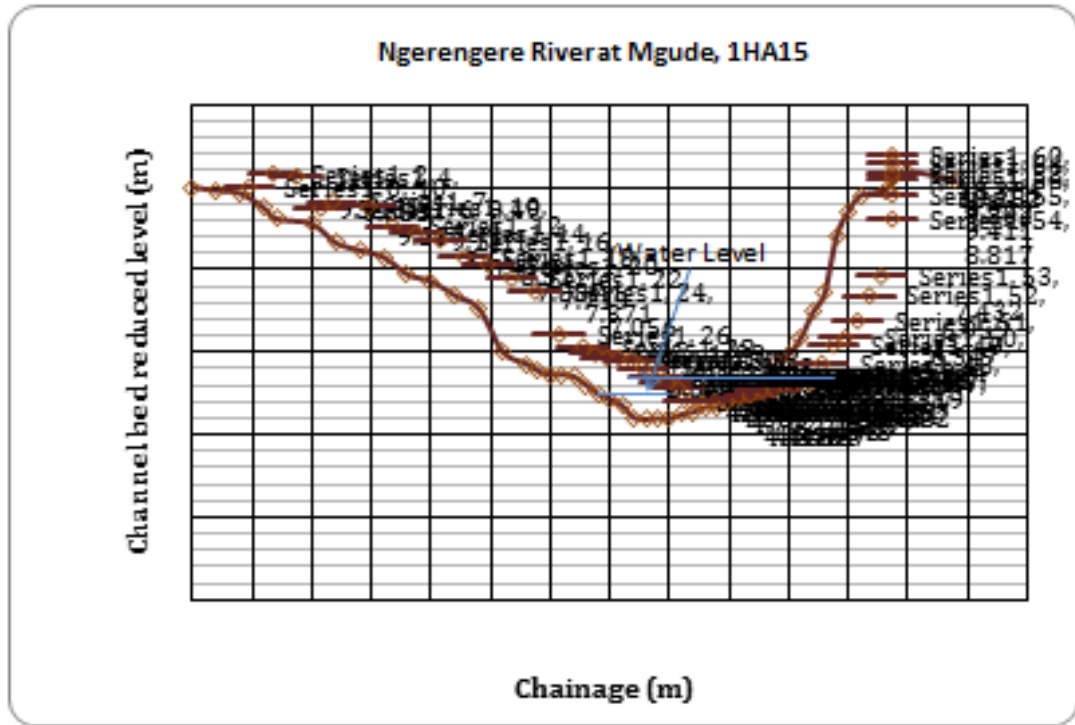


Figure 5: Gauging section cross-section for Ngerengere River at Mgude station

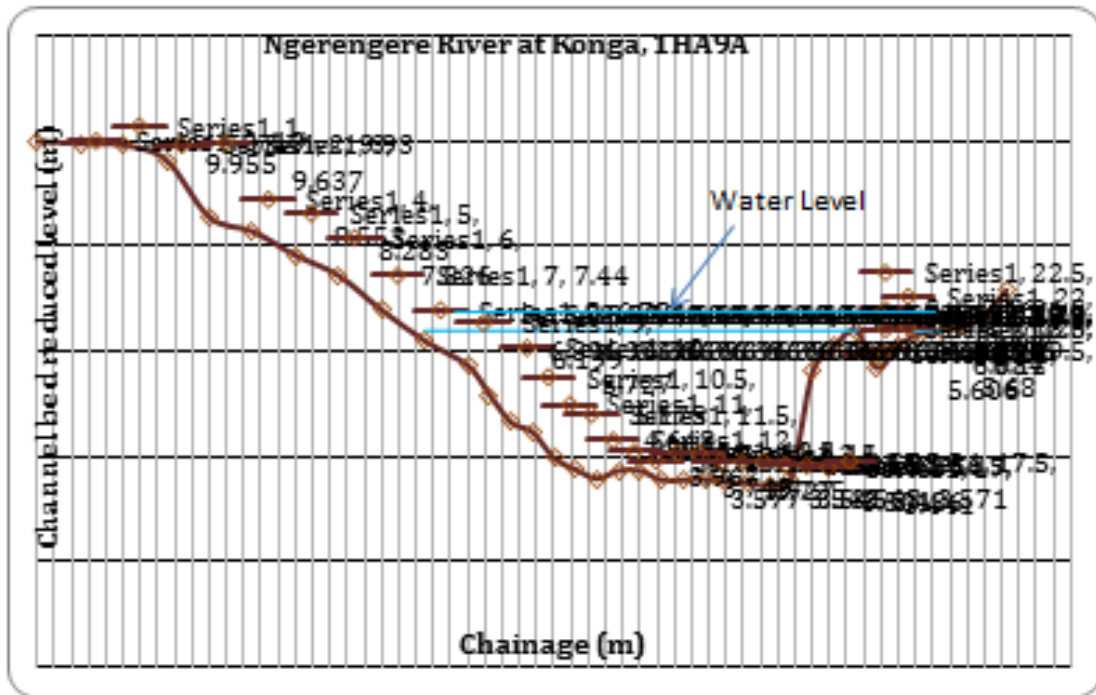
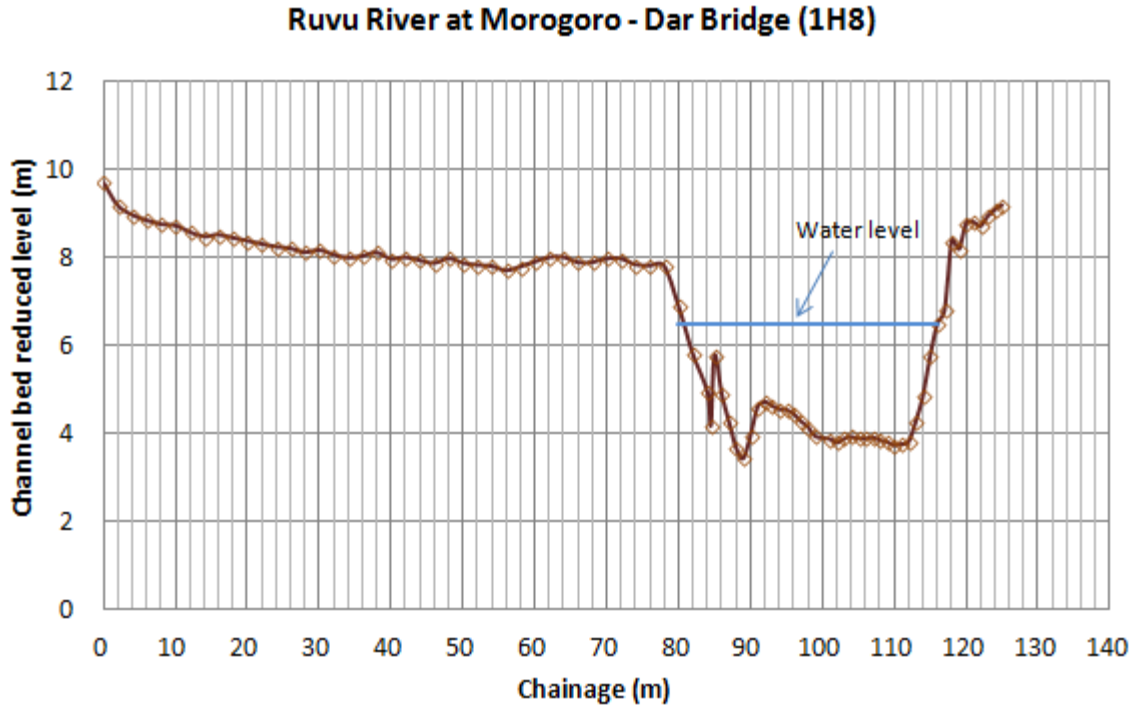


Figure 6: Gauging section cross-section for Ngerengere River at Konga station



**Figure 7:** Gauging section cross-section for Ruvu River at Morogoro-Dar Bridge station

## 5.0 DISCHARGE MEASUREMENTS

### 5.1 Fieldwork period and discharge measurements

The discharge measurements were conducted between December 2012 to June 2013. This period characterizes a wide range of flow variability from low flow to high flow which is suitable for rating curve development. WMO (1980) point out that if the discharge measurements cover the entire range of stage experienced during a period of time when the stage-discharge relation is stable, there is little problem in defining the discharge rating for that period.

The measurements of river flows were carried out using three discharge measurement methods; Propeller Type Current Meter, Acoustic Digital Current (ADC) Meter and Float methods. Detailed account on these methods could be found in (Kashaigili, 2011; Valimba, 2007). The use of different methods to estimate discharge enabled triangulation of the estimated discharges at a particular gauging station and thus increasing confidence on the measured values. A summary of the measured discharge at the six key stations is provided as Appendix 3.

## 5.2 Historical discharge measurements

The available historical discharge measurements dates back to 1950s and continued being collected until late 1980s and early 1990. Restart of measurements at some stations as earlier mentioned was in year 2007. All the collected historical discharge measurements for the key stations are listed in Appendix 4.

# 6.0 ANALYSIS AND PRODUCTION OF NEW RATING CURVE

## 6.1 Overview on rating curves

Both historical and new stage - discharge measurements at the six gauging stations were analysed. The qualitative and quantitative methods were used to assess validity and reliability of the rating curves. Qualitative analysis entailed review of rating plots of the current meter measurements from various periods in history. Quantitatively, statistical performance indicators were used to assess the reliability of the rating curves in the validation process.

Validation of a rating curve is required both after the relationship has first been fitted and subsequently when new gaugings have been carried out, to assess whether these indicate a change in rating. Validation is also used to assess the reliability of historical ratings. Current meter gauging is carried out with variable frequency depending on previous experience of the stability of the control and of the rating curve (DHV Consultant, 1999). As a minimum it is recommended that six gaugings per year are carried out even with a station with a stable section and previously gauged over the full range of level. At unstable sections many more gaugings are required. The deviation of such check gaugings from the previously established relationship is computed and any bias assessed to determine whether they belong to the same population as the previous stage-discharge relationship.

DHV Consultant, (1999) point out that graphical and numerical tests are designed to show whether gaugings fit the current relationship equally and without bias over the full range of flow and over the full time period to which it has been applied. If they do not, then a new rating should be developed but taking into account the deficiencies noted in validation.

The analysis emphasizes identification of data outliers and gauge shifts. An outlier is an observation that lies outside the overall pattern of a distribution (Moore and McCabe, 1999), denoting presence some sort of problem (Ndomba, 2007), mainly on the channel controls. Ndomba (2007) considers an outlier to a case which does not fit the model under study, or an error in measurement, and points

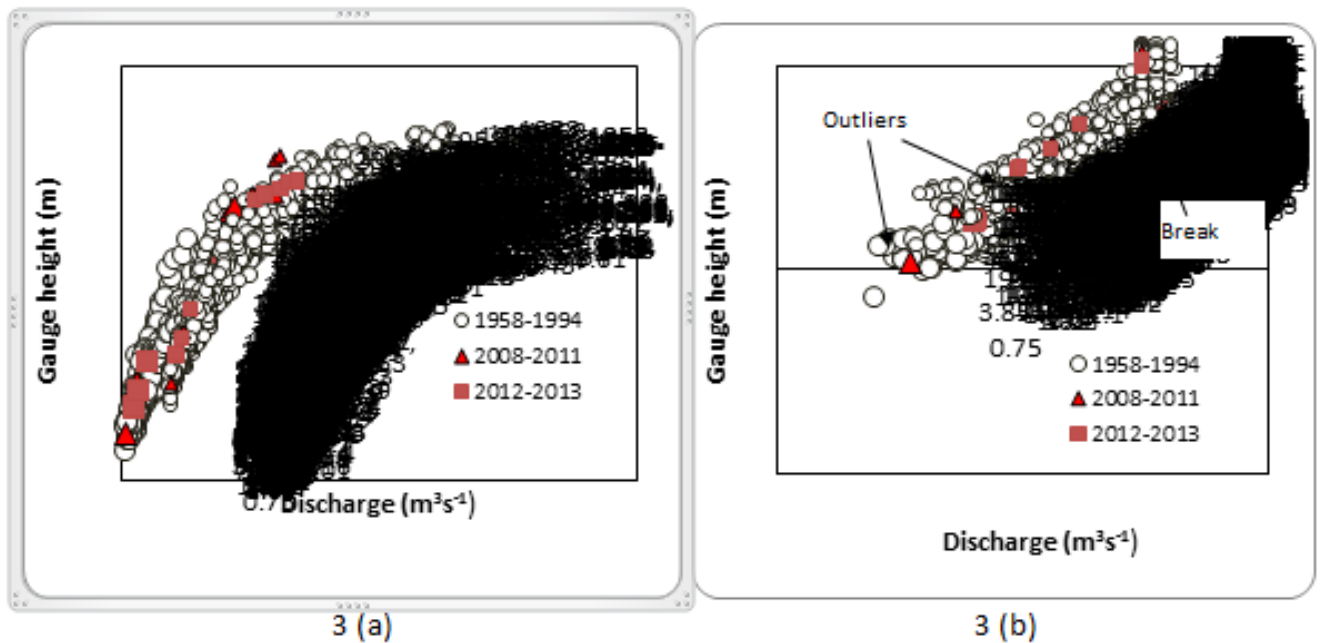
out that statistics derived from data sets that include outliers will often be misleading, but cautioned that deletion of outlier data is a controversial practice frowned on by many scientists and science instructors. Although mathematical criteria provides an objective and quantitative method for data rejection, it does not make the practice more scientifically or methodologically sound, especially in small data sets or other situations in which a normal distribution cannot be assumed. Rejection of outliers is more acceptable in areas of practice where the underlying model of the process being measured and the usual distribution of measurement error are confidently known. Accordingly, outliers usually demand special attention, since they may indicate problems in sampling or data collection or transcription. Alternatively, an outlier could be the result of a flaw in the assumed theory, calling for further investigation by the researcher (Ndomba, 2007).

Another important aspect is the investigation of shifts in the discharge rating. According to Rantz, (1982), shifts in the discharge rating reflect the fact that stage-discharge relations are not permanent but vary from time to time, either gradually or abruptly, because of changes in the physical features that form the control for the station. If a specific change in the rating stabilizes to the extent of lasting for more than a month or two, a new rating curve is usually prepared for the period of time during which the new stage-discharge relation is effective. If the effective period of a specific rating change is of shorter duration, the original rating curve is usually kept in effect, but during that period shifts or adjustments are applied to the recorded stage, so that the “new” discharge corresponding to a recorded stage is equal to the discharge from the original rating that corresponds to the adjusted stage (Ndomba, 2007).

Rantz, (1982) noted that if a group of consecutive measurements subsequently plot to the right or left of the average rating curve, it is usually clearly evident that a shift in the rating has occurred. An exception to that statement occurs where the rating curve is poorly defined and undefined in the range of discharge covered by the subsequent measurements; in that circumstance, the indication is that the original rating curve was in error and requires revision (Rantz, 1982). Stage-discharge relations are usually subject to minor random fluctuations resulting from the dynamic force of moving water, and because it is virtually impossible to sort out those minor fluctuations, a rating curve that averages the measured discharges within close limits is considered adequate (Rantz, 1982). Furthermore, it is recognized that discharge measurements are not error-free, and consequently an average curve drawn to fit a group of measurements is probably more accurate than any single measurement that is used to define the average curve (Rantz, 1982).

Based on data from Ruvu River at bridge (1H8), the rating curve presented in Figure 8 (a&b) is used to illustrate some preceding overviews on rating curve analysis. The data points in Figure 8 represent different periods of measurements. From Figure 8, it be noted that there very few outlier outside the overall pattern of the distribution as indicated. The data sets for succeeding periods (2008-2011 and 2012-2013) coincide well within the historical distribution. The data reveal a break in log transformed

data points at gauge height greater 5.34m, Figure 8(b) revealing change in channel section and start of flood plain. This suggests that two segment fitting curve for this station are needed.



**Figure 8:** a) Scatter plot of discharge versus gauge height for Ruvu River at Morogoro-Dar Bridge (1H8) gauging station; b) Log transformed data points of discharge against gauge height at same station.

## 6.2 The developed rating curves

The new rating equations were developed using Curve Expert software. The software optimizes the rating equation parameters ( $K$ ,  $H_0$  and  $n$ ) using an inbuilt optimization algorithm. The standard error of estimate, SE and the correlation coefficients are used as a performance indicator (Table 5).

**Table 5:** The new developed flow rating curve

Sno.	Gauging station code	Rating curve parameters ( $Q = K*(H-H_0)^n$ )			Standard Error (SE)	Correlation Coefficient ( $R^2$ ) %	Gauge height range, H (m)
		K	$H_0$	n			
1	1H5	34.3332	0.2655	0.8477	2.499	97.9	0 - 9
2	1HB2	19.8464	0.33895	1.16239	0.521	96.1	0 - 5
3	Duthumi	4.46541	-0.54018	1.75102	4.155	98.0	0 - 5
4	1HA15	2.90394	0.01624	2.50094	3.066	94.8	0 - 5
5	1HA9A	0.13151	-0.83164	3.68335	0.416	94.4	0 - 6
6	1H8	9.14891	0.09618	1.74165	2.91	95.2	0 - 5

		0.07367	0	4.48278	58.0	83.0	5 - 7
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**6.3 Required number of Discharge Measurement for Establishing a Reliable Rating Curve**

The required number of discharge measurements in order to obtain a reliable rating curve may be calculated from the formula (URT/NORAD, 1979):

$$n > \left( \frac{2S_D}{E} \right)^2 \dots\dots\dots (Equation 1)$$

Where,

n = number of required measurements

S<sub>D</sub> = standard deviation in percent (2S<sub>D</sub> is allowable width of scatter band). It is calculated separately for each range of stage having a separate control, and the test is applied separately to each range.

E = a specified precision expressed as a percentage, usually 5%

Table 6 presents the required number of measurements with variation in width of scatter band, E being taken as 5% (URT/NORAD, 1979):

**Table 6: Required number of measurements with variation in width of scatter band**

Width of scatter band, 2SD (%)	Minimum number of measurements, n
10	6
15	9
20	16
25	25
30	36

According to (URT/NORAD, 1979), it is recommended that ***n should never be less than 6 for any one interval of the range***. It is also provided that the reliability of the estimated rating curves and of the deviations of the measured discharges from the rating curves may generally be assessed by the concept of the acceptance region for the observations. Therefore, a pair of curves drawn, one on each side of the rating curve and each at a distance of two standard deviations (2SD), are called control curves and define the 95% acceptance region. That is, 95% out of every hundred (or nineteen

out of every twenty) measurements should be between the control curves. A single measurement lying far outside the (say  $3SD$ ) is most probably the result of faulty gauging equipment or of poor measuring practices (URT/NORAD, 1979). In the event where two or more consecutive points, either chronologically or over a range in stage, appear to be well on one side of a control curve, a change of the stage-discharge relation has probably occurred. Therefore, owing to shift in the station control, a new rating curve is required and the calibration of the station must be repeated.

Table 7 presents a summary on data points used to develop rating curves against the statistically derived number of required measurements. It should be noted that as per the requirements, the number of data points used to develop rating curve,  $N$ , should be greater than statistically derived number of required measurements,  $n$  (Table 7), and that  $n$  should never be less than 6 for any one interval of the range (URT/NORAD, 1979).

**Table 7:** Required number of discharge measurements for establishing a reliable rating curve

Gauging station	Data points used N	Percentage Standard Deviation, SD	Width of scatter band, 2SD	Number of required measurements, n	Stage ranges, H (m)	Remarks
1H5	36	34.7	69.4	770	0 - 9	Condition <i>unfulfilled</i>
1HB2	119	33.9	67.8	735	0 - 5	Condition <i>unfulfilled</i>
1HB1411	22	25.8	51.5	425	0 - 5	Condition <i>unfulfilled</i>
1HA15	494	112.8	225.6	8141	0 - 5	Condition <i>unfulfilled</i>
1HA9A	32	74.2	148.5	3528	0 - 5.5	Condition <i>unfulfilled</i>
1H8	745	26.5	53.0	450	0 - 5.35	Condition fulfilled
	286	17.7	35.4	201	5.35-7.0	Condition fulfilled

From Table 7, only 1H8 out of the six gauging stations passed the test, and thus the rating data points are considered sufficient based on this test (Table 7). This is likely attributed to the lower percentage standard deviation (SD) and greater number of data points (N) used to develop the rating curve equation for both high and low flow segments. Nevertheless, passing the reliability test for the required number of data points does not mean that the rating curves are okay and free from bias and random fluctuations or goodness of fit.

## 6.4 Rating curve validation

A number of methods are available in the literature to check the reliability of discharge rating curves. DHV Consultant, (1999) categorizes them into two namely, graphical validation and numerical validation tests.

### 6.4.1 Graphical validation tests

The graphical validation tests are considered the most effective method of validation. These include the following:

- Stage/discharge plot with the new gaugings
- Period/flow deviation scattergram
- Stage/flow deviation scattergram
- Cumulative deviation plot of gaugings
- Stage/discharge plots with gaugings distinguished by season

However, judgments based on graphical displays are often indicative rather than prescriptive - a judgment on the part of the data processor is still required (DHV Consultant, 1999). In the subsequent sections some of the above tests are illustrated using 1H8 rating data.

#### ***Stage - discharge plot with new gaugings***

The simplest means of validating the rating curve with respect to subsequent gaugings is to plot the existing rating curve with the new check gaugings. This is shown in the example for Station 1H8. New discharge measurements are plotted against existing rating curve established for the period 1958-1990 (Figure 9). Qualitatively, the data show a good fit to the new rating curve.



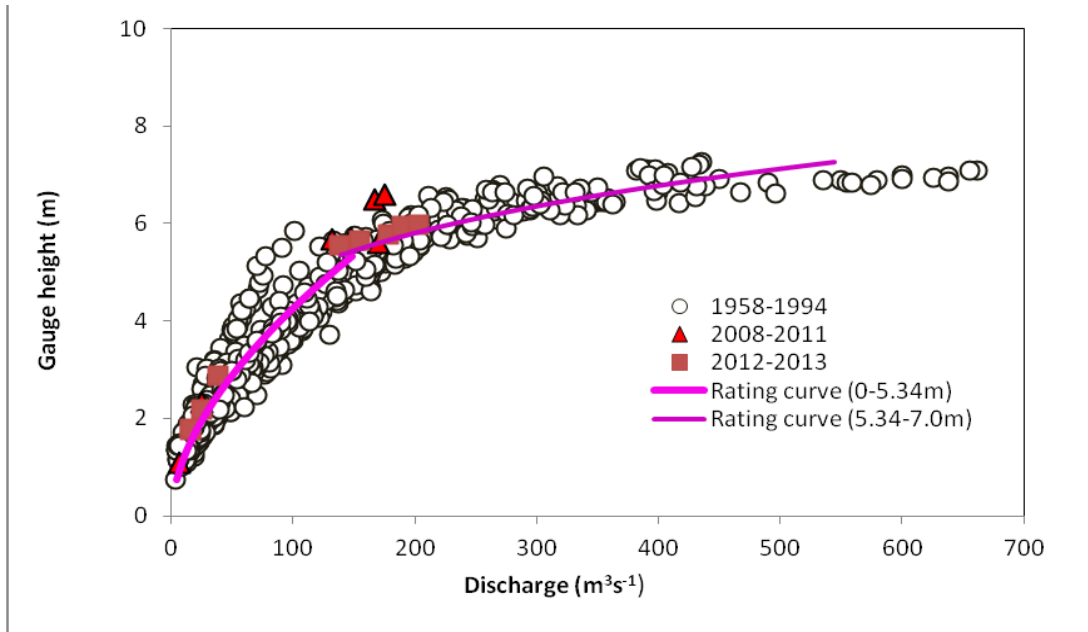


Figure 9: Period discharge measurements for Ruvu River at Morogoro Dar road plotted against the new rating curve

**Stage - flow deviation diagram**

Figure 10 present a scatter diagram of percentage deviation against gauge heights. From the plot it can be noted that at lower ranges of stage, the relationship is biased. This is likely a result of change in section control, thus necessitating developing of new rating curves.

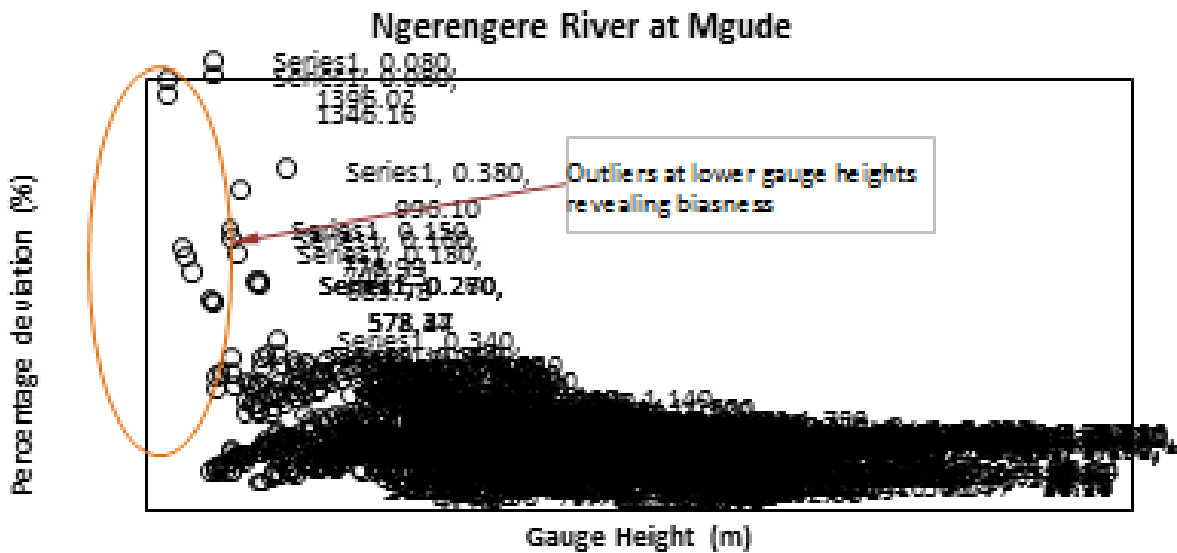


Figure 10: Stage-flow deviation scatter diagram for Ngerengere River rating curve (old) at Mgude station

The subsequent plots provide the relationships between historical discharge measurements and the recent measurements for different the study gauging station in the Ruvu sub-basin.

i) Ruvu River at Kibungo, 1H5

Rating Curve for Ruvu River at Kibungo

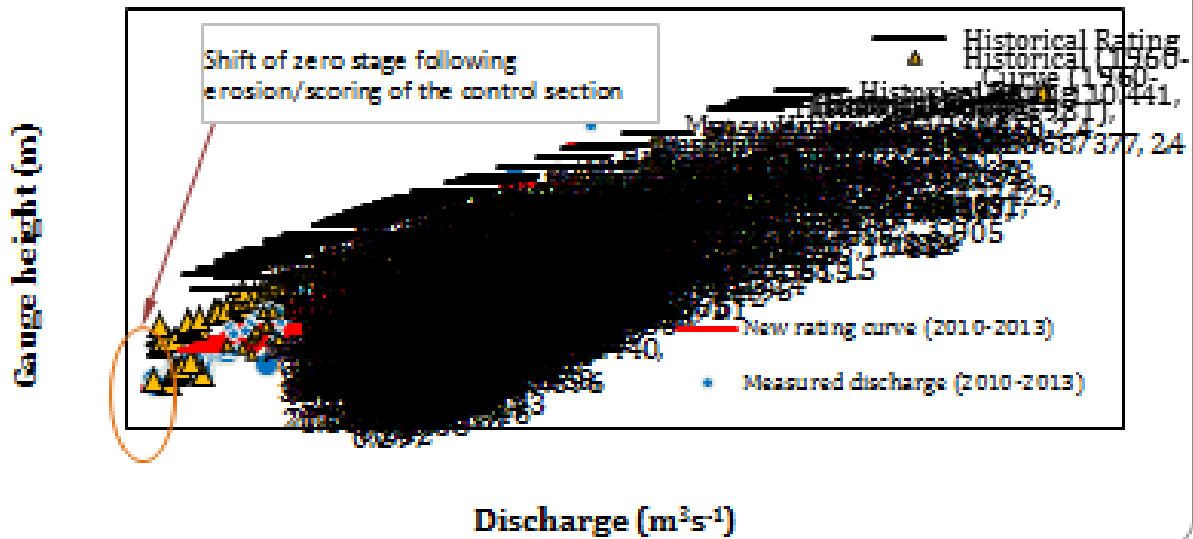


Figure 11: Rating curve for Ruvu River at Kibungo station established based on historical discharge measurement data for the period 1960 to 1981 inset with new measurements

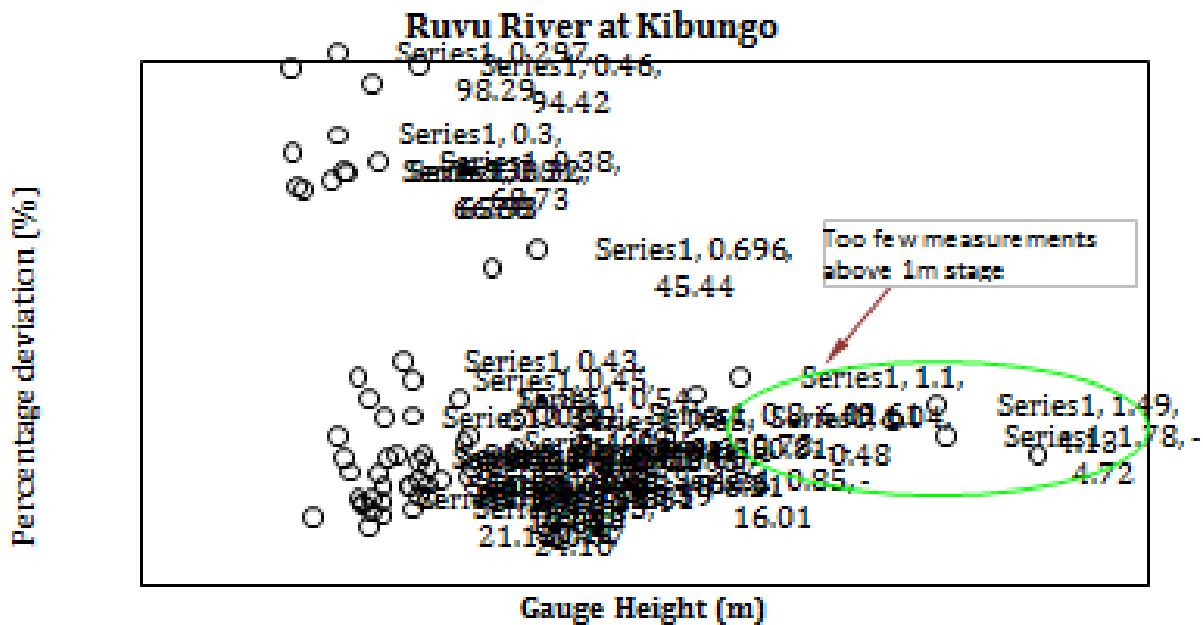


Figure 12: Stage-discharge deviation scatter diagram for Ruvu River at Kibungo station –new rating curve

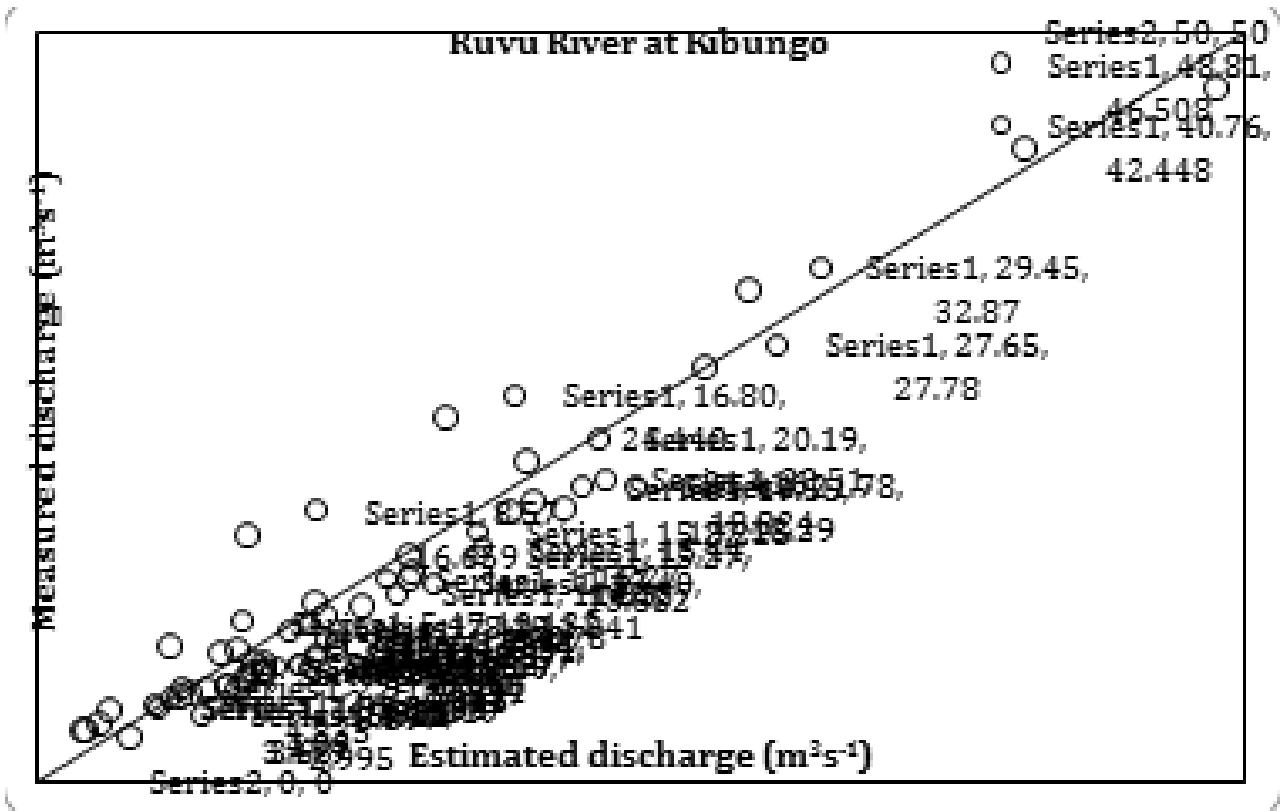


Figure 13: Comparison between estimated and measured discharges for Ruvu River at Kibungo

ii) Mgeta River at Mgeta

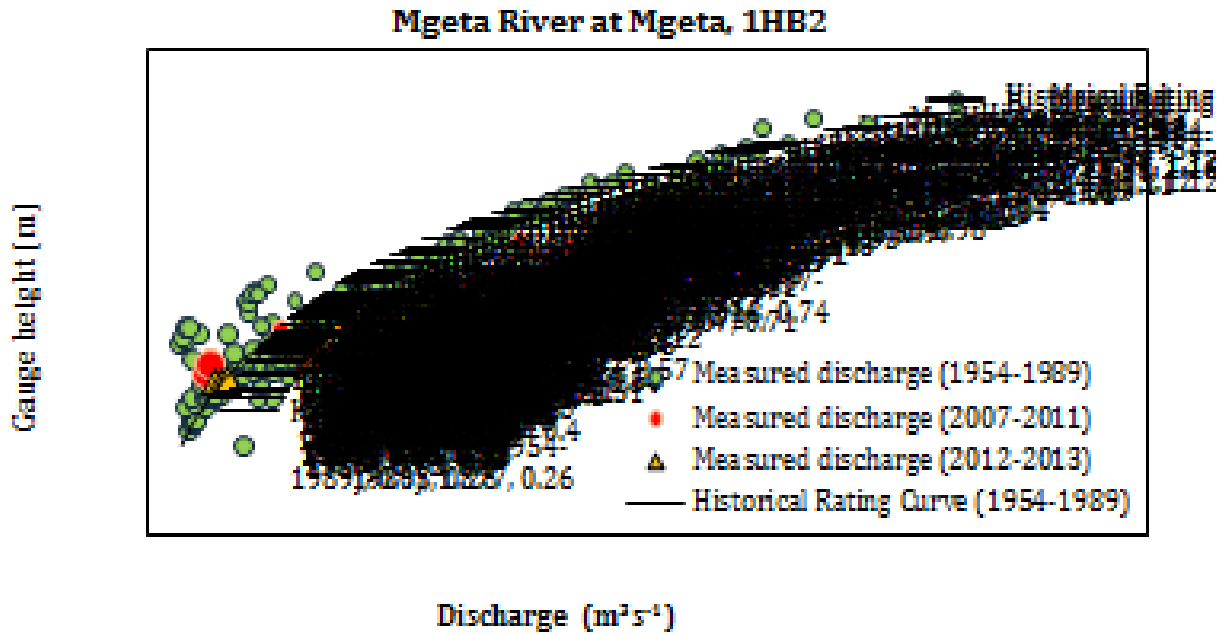


Figure 14: Rating curve for Mgeta River at Mgeta station established based on historical discharge measurement data for the period 1954 to 1989, inset with recent measurements

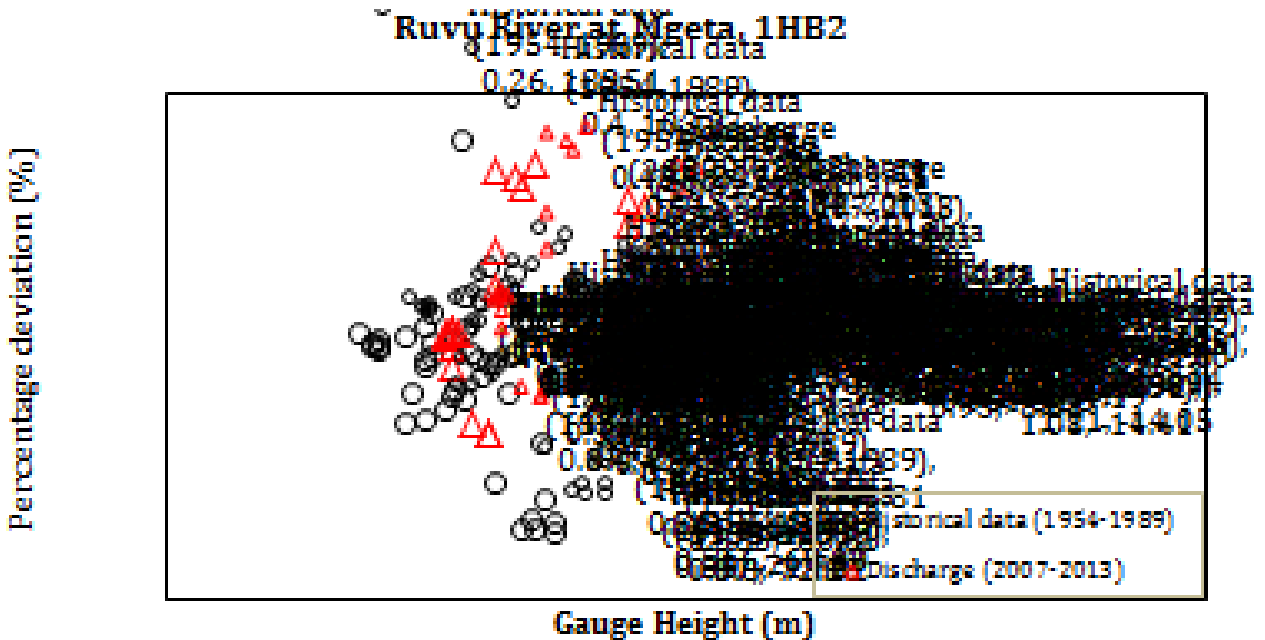


Figure 15: Stage-discharge deviation scatter diagram for Mgeta historical rating curve data and new gaugings

**Mgeta River at Mgeta, 1HB2**

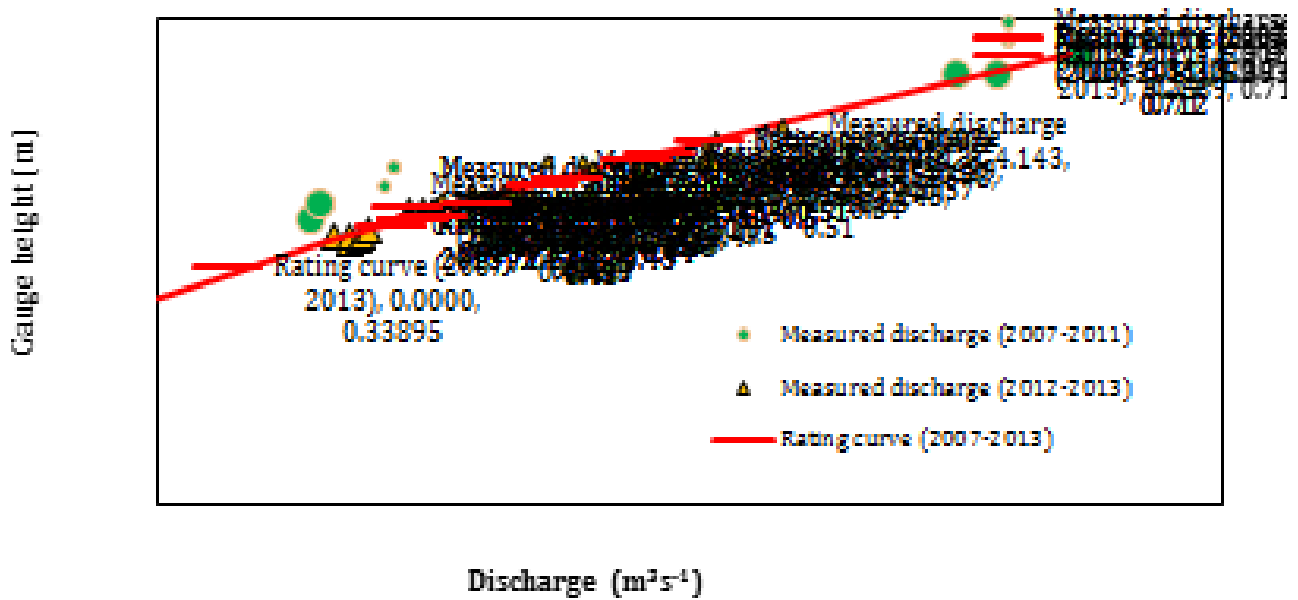


Figure 16: New rating curve for Mgeta River at Mgeta

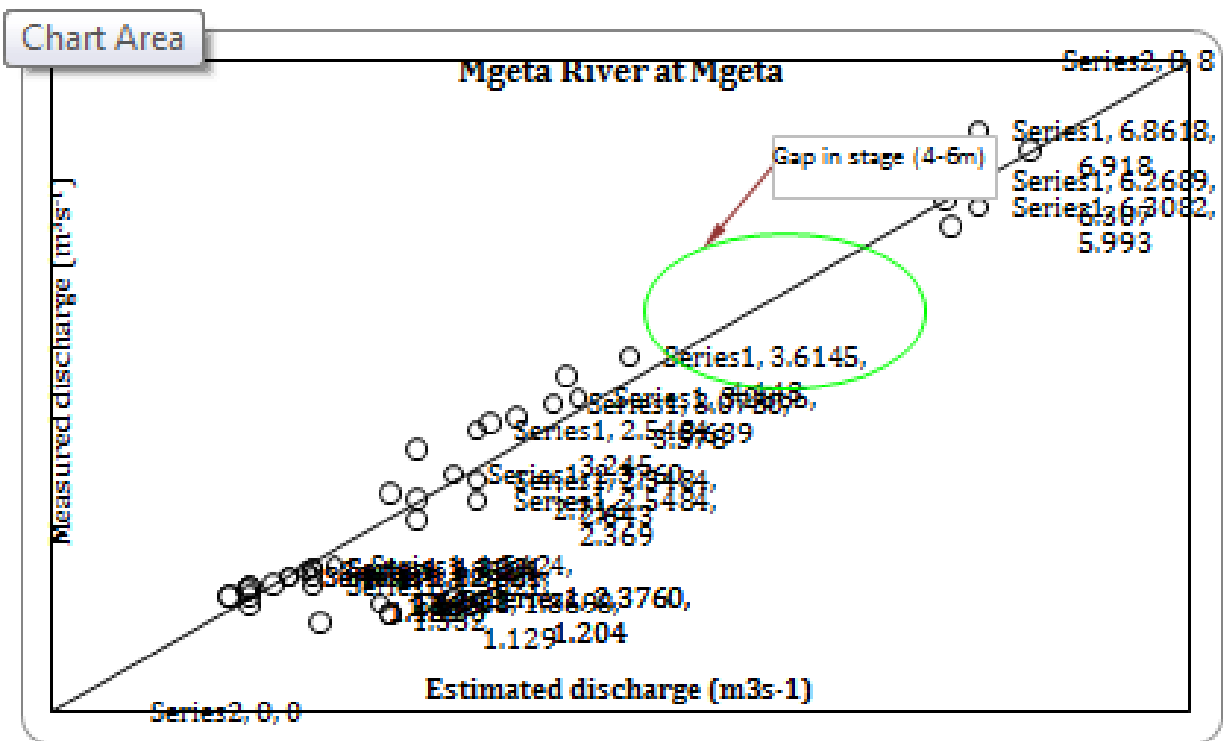


Figure 17: Comparison between estimated and measured discharges for Mgeta River at Mgeta using a new fitted rating curve

iii) Mgeta River at Duthumi

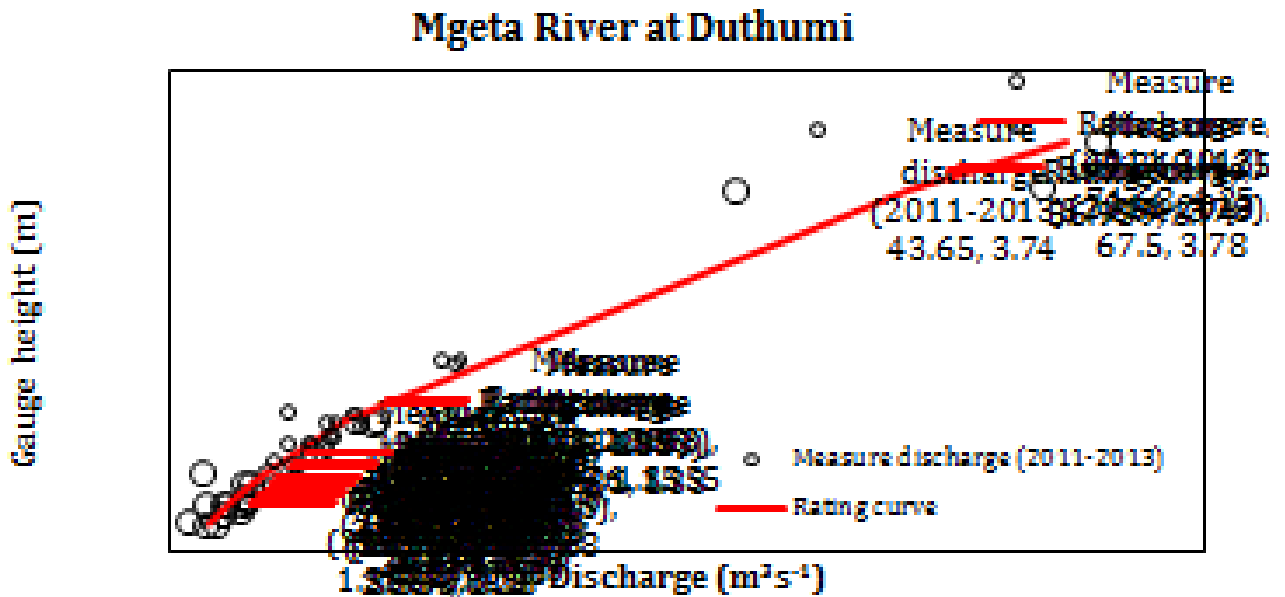


Figure 18: Rating curve for Mgeta River at Duthumi station (2011-2013)

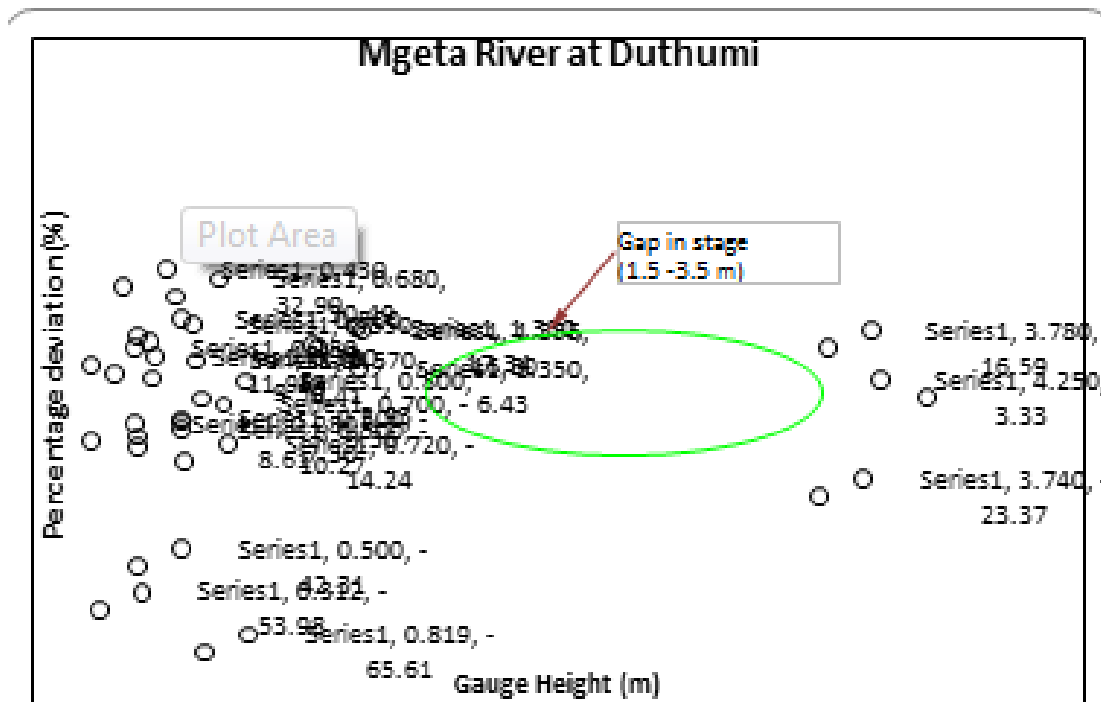


Figure 19: Stage-discharge deviation scatter diagram for Mgeta River rating curve at Duthumi station

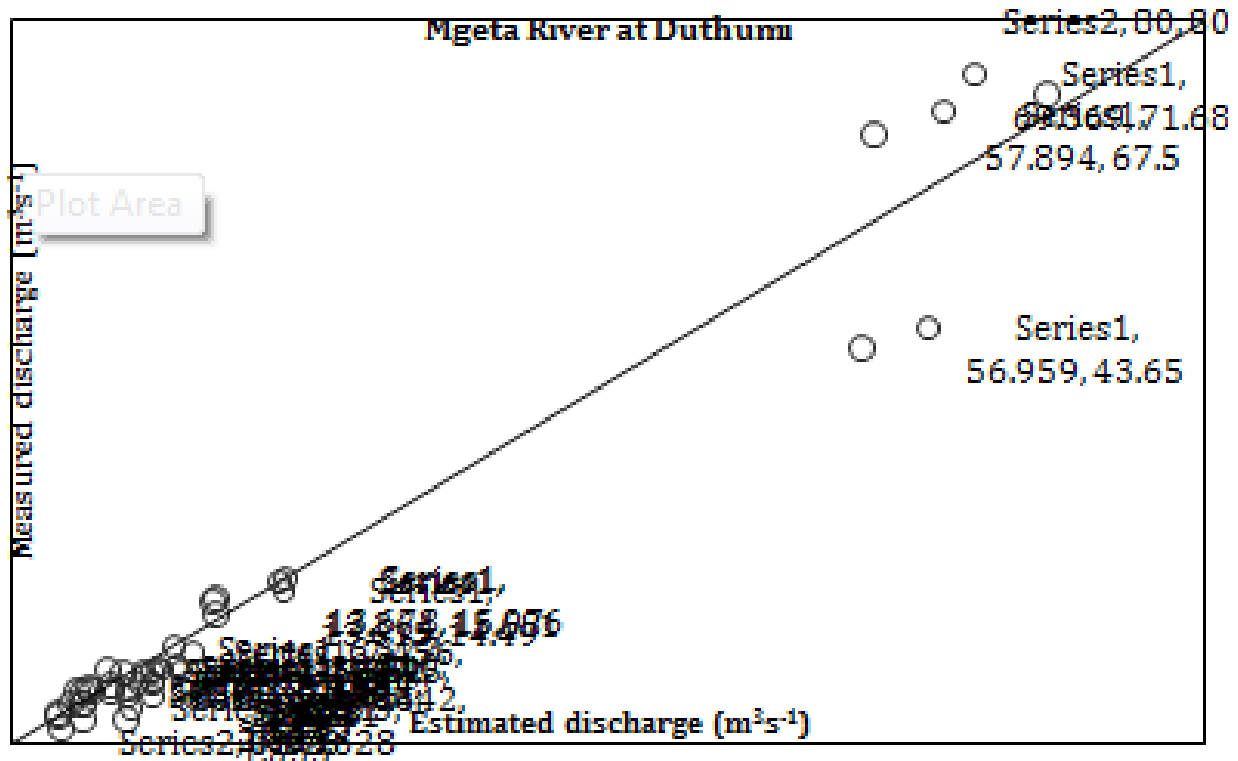


Figure 20: Comparison between estimated and measured discharges for Mgeta River at Duthumi using a new fitted rating curve (2011-2013)

iv) Ngerengere River at Mgude

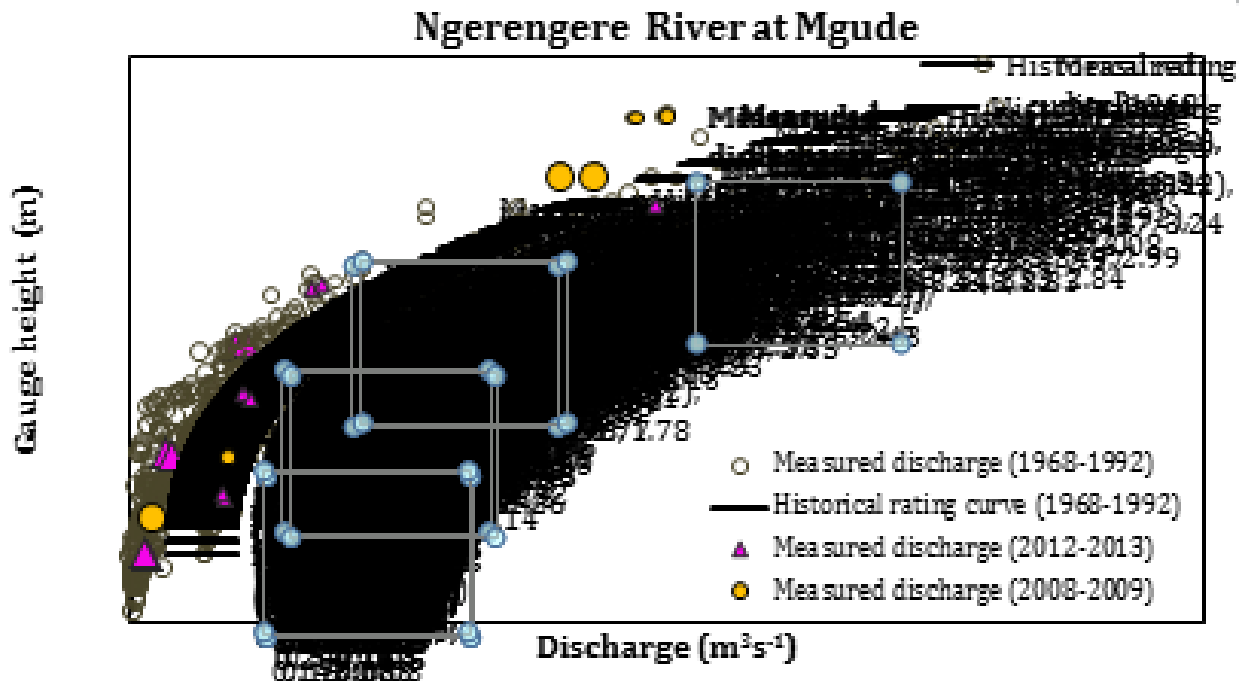


Figure 21: Old rating curve for Ngerengere River at Mgude station

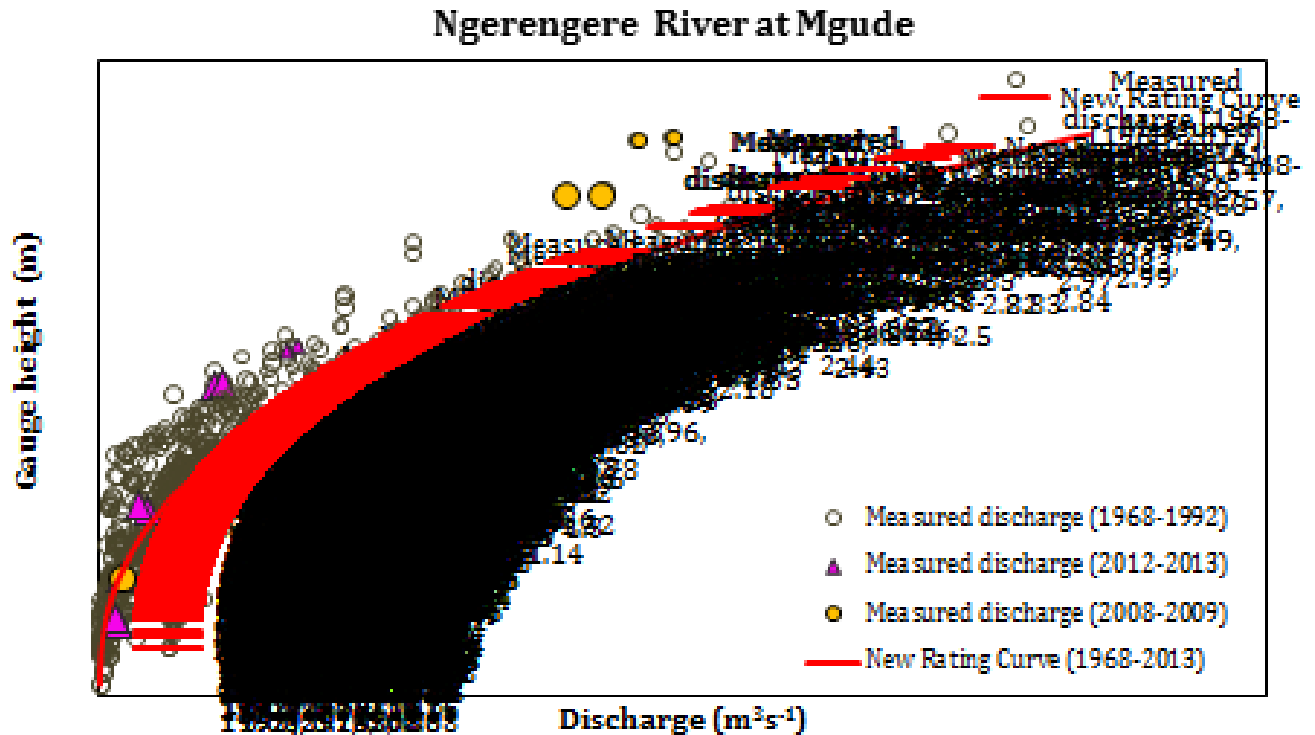


Figure 22: Fitted rating curves for Ngerengere River at Mgude station

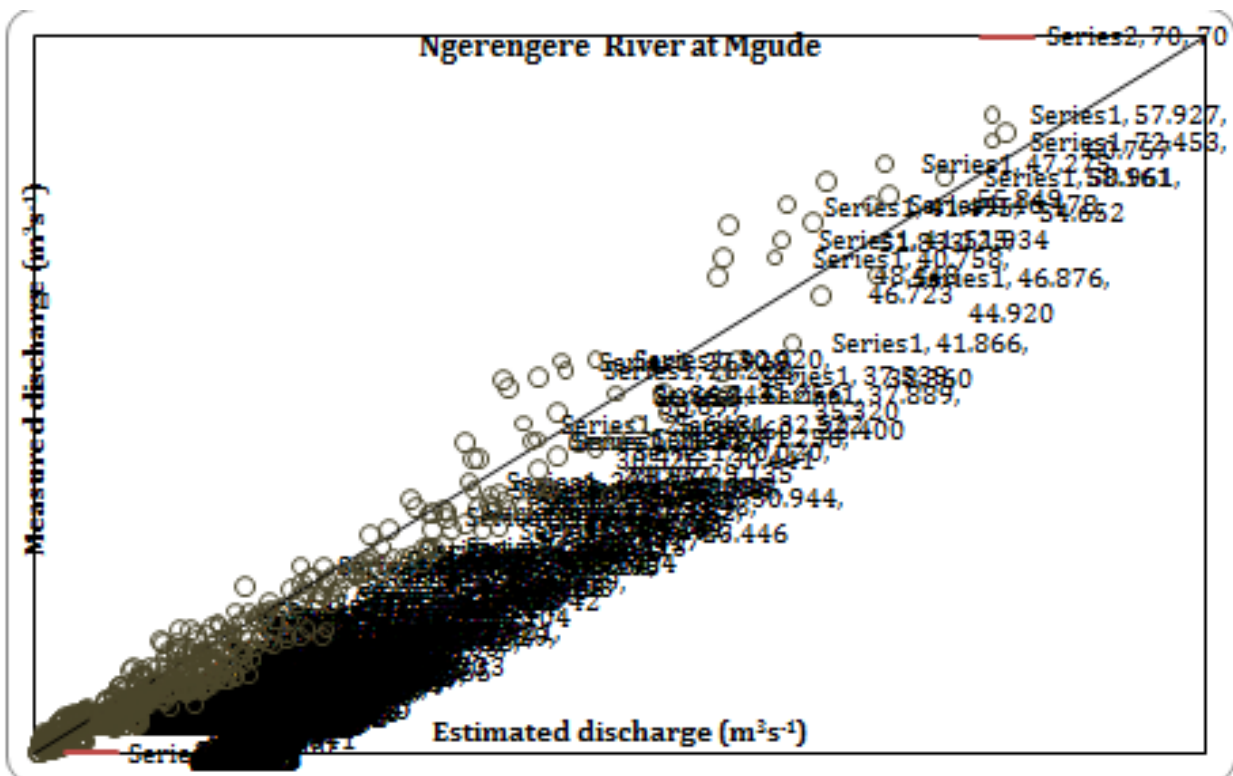


Figure 23: Comparison between estimated and measured discharges for Ngerengere River at Mgude station using a new fitted rating curve

v) Ngerengere River at Konga



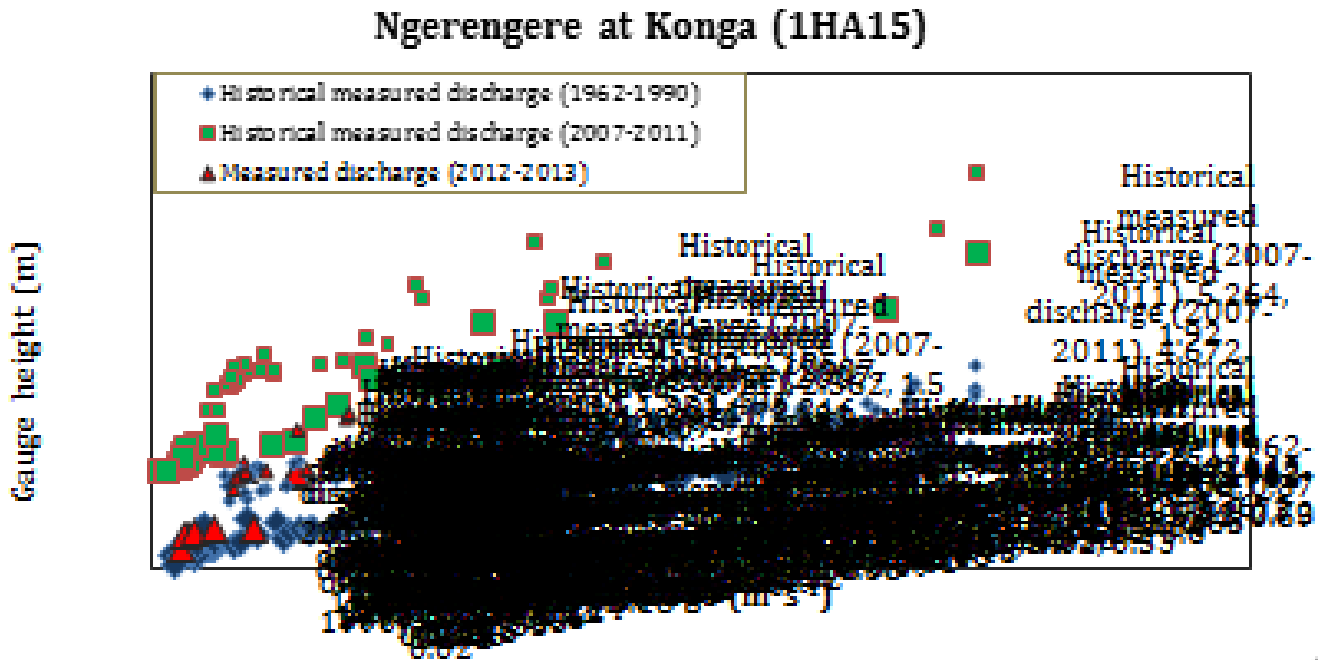


Figure 24: Plot of historical measurements (1962-1990) and recent measurements during the period 2007-2011 and 2012-2013 (The data reveal inconsistency possibly due to shift in section control).

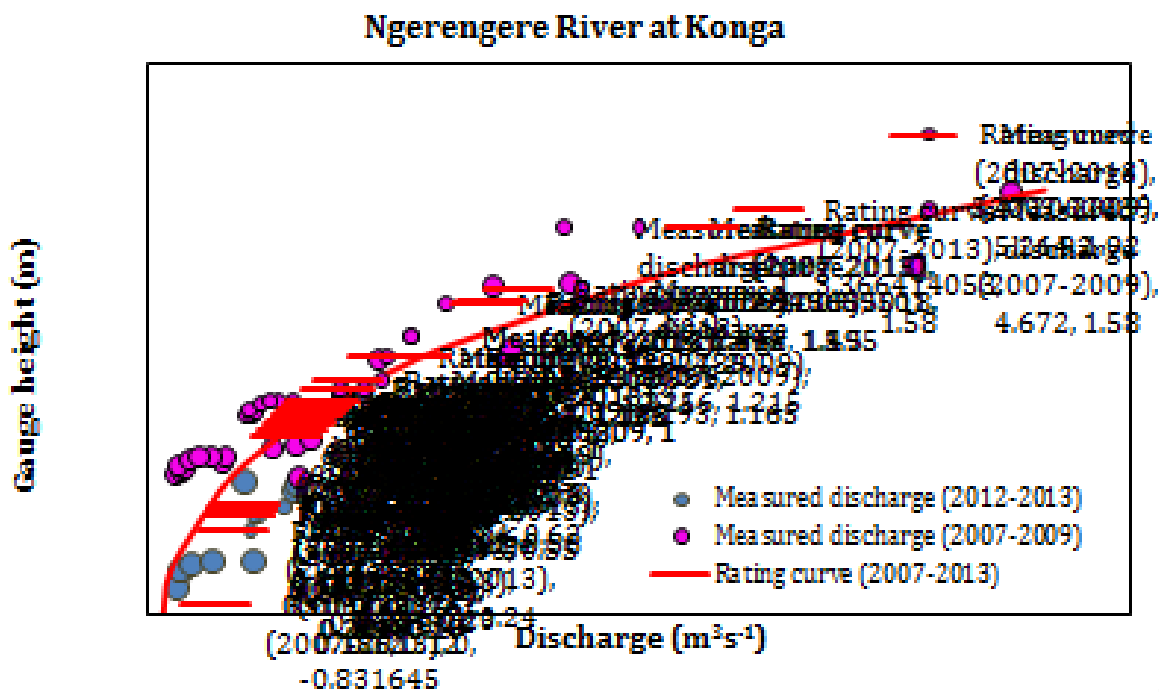


Figure 25: New rating curve for Ngerengere River at Konga station (2007-2013)

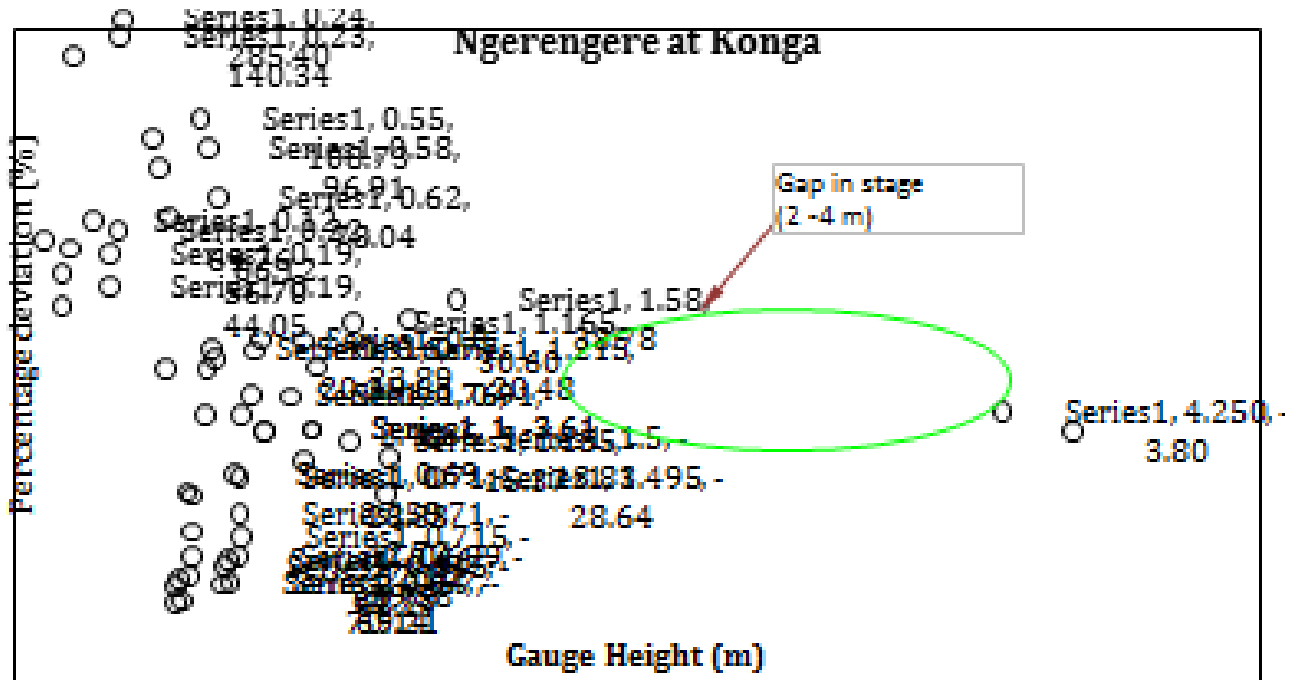


Figure 26: Stage-flow deviation scatter diagram for Ngerengere River rating curve at Konga station

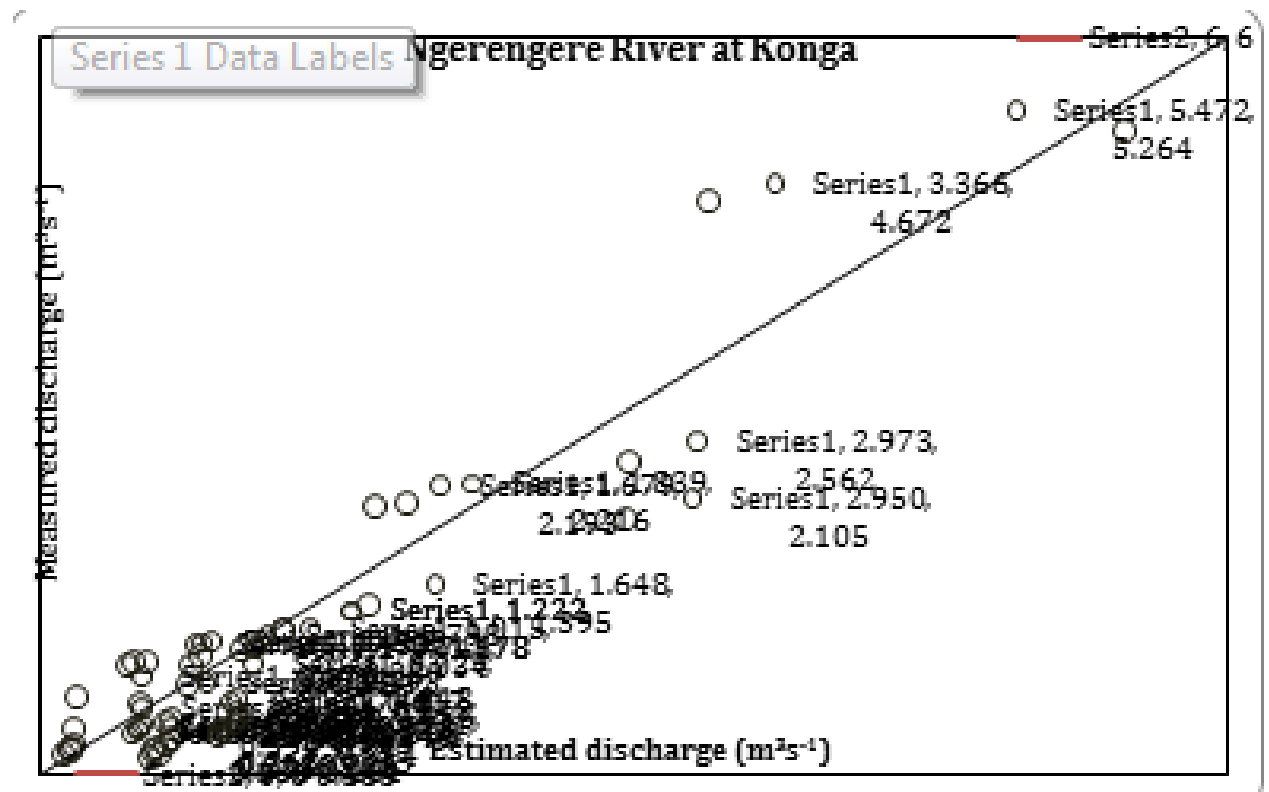


Figure 27: Comparison between estimated and measured discharges for Ngerengere River at Konga station using a new fitted rating curve

vi) Ruvu River at Morogoro-Dar es Salaam Bridge

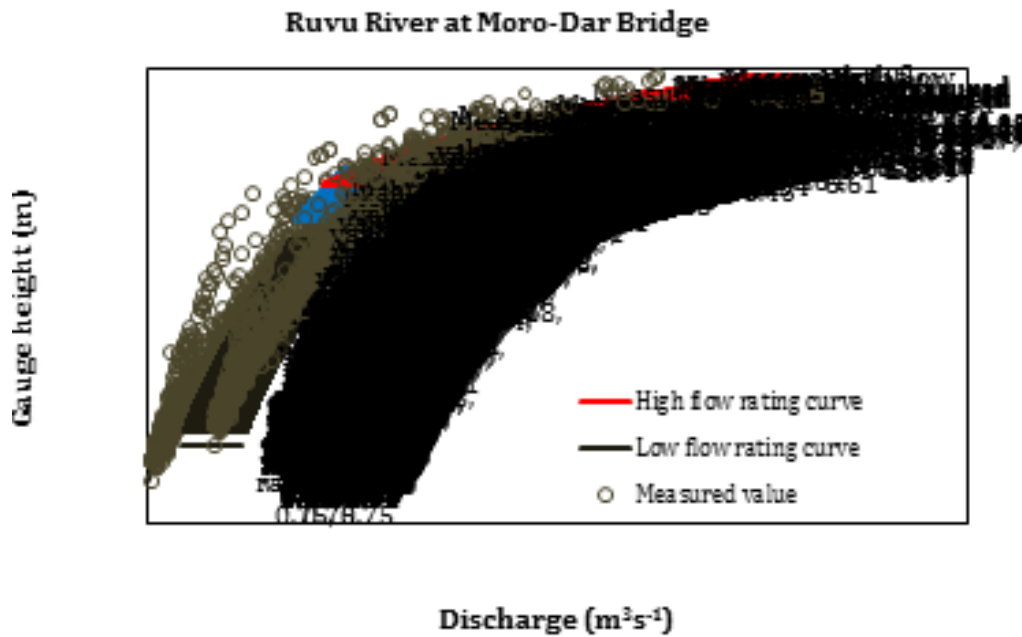


Figure 28: Historical rating curves and measured discharge for Ruvu River at Moro-Dar Road Bridge

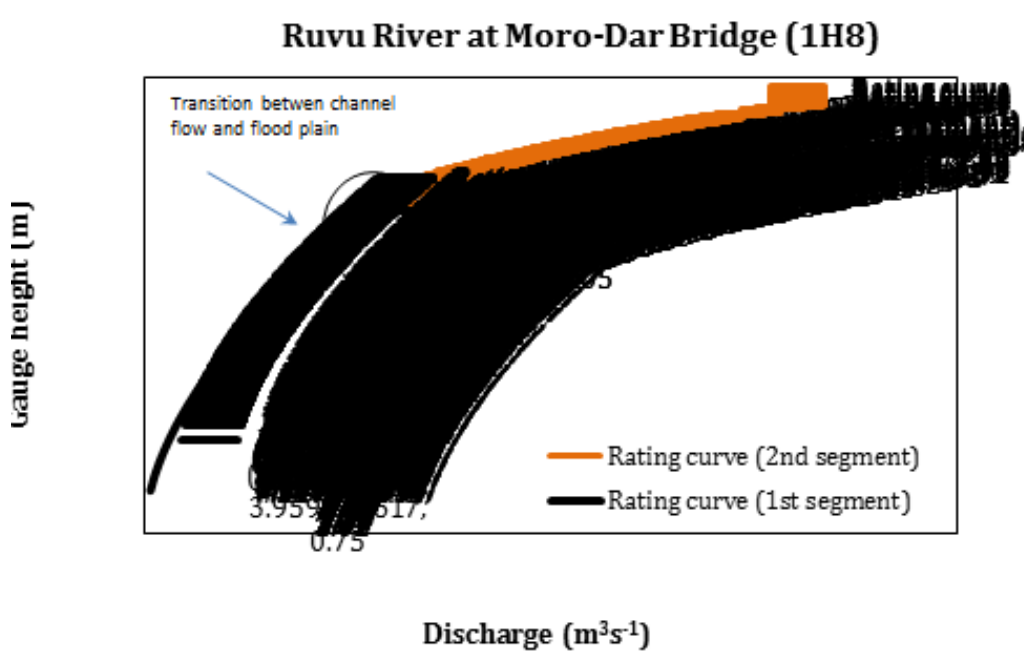
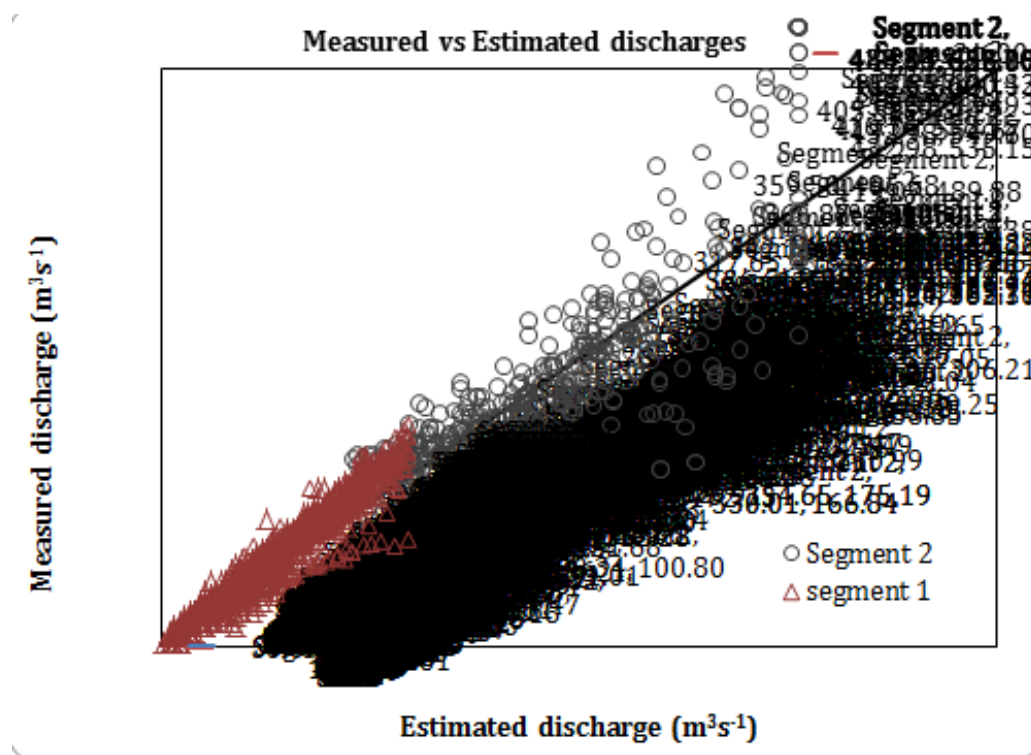


Figure 29: Fitted rating curves for different flow ranges for Ruvu River at Moro-Dar Road Bridge



**Figure 30:** Comparison between estimated and measured discharges for Ruvu River at Morogoro – Dar es Salaam Bridge (1960-2013).

#### 6.4.2 Numerical validation tests

Literature (e.g. URT/NORAD, 1979; DHV Consultant, 1999) provide methods for conducting statistical validation of the rating curves. The two criteria are commonly used to test a rating curve for absence of bias (URT/NORAD, 1979):

- i) The average of the percentage differences between the measured discharges and the discharges estimated by means of the rating curve should not be significantly different from zero. This is tested using t-test.
- ii) The number of positive and negative deviations of measured discharges from the rating curve should be evenly distributed, i.e. the difference in number of pluses and minuses should not be more than can be explained by chance fluctuations. This is tested by sign test.

Cautions are given that the two tests are only applicable for stations where the stage-discharge relation is permanent and not affected by variable backwater or highly unsteady flow conditions.

URT, (1979) further recommends that after the rating curve has been checked for absence of bias, it should next be checked for shifts in control. The errors due to shifting controls would be a systematic nature. This is checked by the run of sign test to reveal goodness of fit.

**Test for absence from bias in signs**

A well-balanced rating curve must ensure that the number of positive and negative deviations of the observed values from the rating curve is evenly distributed (DHV Consultant, 1999). That is, the difference in number between the two should not be more than can be explained by chance fluctuations. The test is employed to see if the curve has been established in a balanced manner so that the two sets of discharge values, observed and estimated (from the curve), may be reasonably supposed to represent the same population (DHV Consultant, 1999).

This test is performed by counting observed points falling on either side of the curve. If  $Q_m$  is the observed value and  $Q_c$  the estimated value, then the expression,  $Q_m - Q_c$ , should have an equal chance of being positive or negative (DHV Consultant, 1999). In other words, the probability of  $Q_m - Q_c$  being positive or negative is 0.5. Hence, assuming the successive signs to be independent of each other, the sequence of the differences may be considered as distributed according to the Binomial law  $(p+q) N$ , where  $N$  is the number of observations, and  $p$  and  $q$ , are the probabilities of occurrence of positive and negative values are 0.5 each. The expected number of positive signs is positive signs is  $Np$ . Its standard deviation is  $\sqrt{Npq}$ . The “t” statistic is then found by dividing the difference between the actual number of positive signs  $N_1$  and expected number of positive signs  $Np$  by its standard deviation  $\sqrt{Npq}$ .

$$t = \frac{|N_1 - Np| - 0.5}{\sqrt{Npq}} \dots\dots\dots \text{(Equation 2)}$$

The resulting value is compared with the critical value of “t” statistic for 5% significance level for the degrees of freedom equal to the total number of stage discharge data. *If the value of the critical “t” statistic is more than that obtained for the observed data then it can be considered that the data does not show any bias with respect to sign of the deviations between observed and computed discharges* (DHV Consultant, 1999).

**Test for absence from bias in values**

This test is designed to see if a particular stage discharge curve, on average, yields significant under estimates or over estimates as compared to the actual observations on which it is based. (see for example Figure 10 for stage-flow deviation scattergrams). The percentage differences are first worked out as (DHV Consultant, 1999):

$$P = 100 (Q_m - Q_c) / Q_c \dots\dots\dots \text{(Equation 3)}$$

If there are N observations and  $P_1, P_2, P_3, \dots, P_N$  are the percentage differences and  $P_{av}$  is the average of these differences, the standard error,  $Se$ , of  $P_{av}$  is given by:

$$Se = \sqrt{\frac{\sum_{i=1}^N (P_i - P_{av})^2}{N(N-1)}} \dots\dots\dots \text{(Equation 4)}$$

The average percent  $P_{av}$  is tested against its standard error to see if it is significantly different from zero. The “t” statistic for in this case is computed as:

$$t = (P_{av} - 0) / Se \dots\dots\dots \text{(Equation 5)}$$

If the critical value of “t” statistic for 5% significance level and N degrees of freedom is greater than the value computed above then it may be considered that there is no statistical bias in the observed values with respect to their magnitudes as compared with that obtained by the rating curve. The percentage differences have been taken as they are comparatively independent of the discharge volume and are approximately normally distributed about zero mean value for an unbiased curve (DHV Consultant, 1999).

**The run of sign test – the Goodness of fit test**

Due to changes in the flow regime, it is possible that long runs of positive and/or negative deviations are obtained at various stages. This may also be due to inappropriate fitting of the rating curve. This test is carried out for long runs of positive and negative deviations of the observed values from the stage-discharge curve. The test is designed to ensure a balanced fit in reference to the deviations over different stages (DHV Consultant, 1999).

The test is based on the number of changes of sign in the series of deviations (observed value minus expected or computed value). First of all, the signs of deviations, positive or negative, in discharge measurements in ascending order of stage are recorded. Then starting from the second sign of the series, “0” or “1” is placed under sign if the sign agrees or does not agree respectively with the sign immediately preceding it. For example,

+ - + + + - - - + + + -  
 1 1 0 0 0 1 0 0 0 1 0 0 0 1

If there are  $N$  numbers in the original series, then there will be  $(N - 1)$  numbers in the derived series 11000100010001. If the observed values are regarded as arising from random fluctuations about the values estimated from the curve, the probability of a change in sign could be taken to be 0.5.

However, this assumes that the estimated value is the median rather than the mean. If  $N$  is fairly large, a practical criterion may be obtained by assuming successive signs to be independent (i.e. by assuming that they arise only from random fluctuations), so that the number of “1”s (or “0”s) in the derived sequence of  $(N - 1)$  members may be judged as a binomial variable with parameters  $(N - 1)$  and 0.5. From the above derived series, the actual number of changes of sign is noted. The expected number of changes of sign is computed by multiplying total possible numbers (i.e.  $N - 1$ ) with the probability of change of sign (i.e. 0.5). The statistical significance of the departure of the actual number of change of signs from the expected number is known by finding the “t” statistic as follows:

$$t = \frac{|N' - (N - 1)p| - 0.5}{\sqrt{(N - 1)pq}} \dots\dots\dots \text{(Equation 6)}$$

where  $N'$  denotes the actual number changes of sign.

If the critical value of “t” statistic, for  $(N - 1)$  degrees of freedom, is more than that computed above then it can be considered to be having adequate goodness of fit (DHV Consultant, 1999). Otherwise, the results will indicate that there is significant bias in the fitted curve with respect to long runs of positive or negative deviations.

In this study, three testing criteria namely paired t-test, the sign test, and the run of sign test were applied. As highlighted above, the first two criteria are commonly used to test a rating curve for absence of bias, and the last one tests a rating curve for random fluctuations or goodness of fit. The null hypotheses of “no bias” and “non-random fluctuations” fail to be rejected when the test criterion,  $t$  is less than corresponding  $t$  - table value at 5% level of significance. The results of statistical validation of the developed rating curves are presented in Tables 8 and 9. Generally, the results in Table 8 suggest an absence of bias in the newly developed rating curves for all the stations except for 1H8. From Table 9, three stations namely 1H5, 1HB2 and 1HB1411 passed the goodness of fit test. The rest of the stations, 1HA15, 1HA9A and 1H8 the test criterion  $t$  is consistently greater than the critical value, leading to the rejection of the null hypothesis of the assumption of random fluctuations. Therefore, the test detected the presence of abnormal long runs of positive or negative deviations. This most likely indicates there is a systematic trend in the deviations with time, indicating that the rating curves need adjustment for a shift in control.

**Table 8:** Result of sign test (*a test for bias*)

| S/N | Gauging station code | Total number of observations, $N$ | Number of positive signs, $n1$ | Expected number of positive signs, $np$ | Standard error of $np$ , SE | Test criterion, $t$ | Critical t-value from T-Table at 5% level of significance | Remarks  |
|-----|----------------------|-----------------------------------|--------------------------------|---|-----------------------------|---------------------|---|----------|
| 1   | 1H5                  | 36                                | 16                             | 18.0                                    | 3.0                         | 1.463               | 1.96  | Unbiased |
| 2   | 1HB2                 | 119                               | 70                             | 59.5                                    | 5.45                        | 0.567               | 2.101   | Unbiased |
| 3   | 1HB1411              | 22                                | 13                             | 11                                      | 2.35                        | 0.285               | 2.08  | Unbiased |
| 4   | 1HA15                | 494                               | 301                            | 247                                     | 11.11                       | 1.570               | 1.96  | Unbiased |
| 5   | 1HA9A                | 32                                | 17                             | 16                                      | 2.83                        | 0.177               | 1.96  | Unbiased |
| 6   | 1H8                  | 286                               | 125                            | 143                                     | 8.456                       | 2.188               | 1.96  | Biased   |



**Table 9:** Result of run of sign test (*a goodness of fit test*)

| S/N | Gauging station code | Total number of observations, $n$ | Number of positive signs, $n1$ | Expected number of changes in sign, $(n-1)p$ | Standard error of $(n-1)p$ , SE | Test criterion, $t$ | Critical t-value from T-Table at 5% level of significance | Remarks  |
|-----|----------------------|-----------------------------------|--------------------------------|--|---------------------------------|---------------------|---|--|
| 1   | 1H5                  | 36                                | 15                             | 17.5   | 2.96                            | 1.014               | 1.96  | Non- random fluctuations                                   |
| 2   | 1HB2                 | 119                               | 49                             | 59   | 5.43                            | 1.93                | 2.101   | Non- random fluctuations                                   |
| 3   | 1HB1411              | 22                                | 11                             | 10.5   | 2.29                            | 0                   | 2.08  | Non- random fluctuations                                   |
| 4   | 1HA15                | 494                               | 195                            | 246.5  | 11.1                            | 4.68                | 1.96  | Random fluctuation, needs adjustment for shift in controls |
| 5   | 1HA9A                | 32                                | 8                              | 15.5   | 2.78                            | -2.87               | 1.96  | Random fluctuation, needs adjustment for shift in controls |
| 6   | 1H8                  | 286                               | 119                            | 142.5  | 8.441                           | 2.84                | 1.96  | Random fluctuation, needs adjustment for shift in controls |

## 7.0 CONCLUSION AND RECOMMENDATIONS

### 7.1 Conclusions

Available historical stage-discharge measurements and existing rating curves for existing stations on the Ruvu have been collected. The data indicate that most of the stations were established in the early 1950s and discharge measurement in these stations continued until late 1980s. The period from early 1990s until mid 2000s shows that there were no measurements taken. Discharge measurement commenced in 2007 at some of the stations and not covering all the stations. Review of the rating relationships indicates validity up to the early 1980s for most of the stations and cannot be used to transform gauge heights (water levels) without modification. Based on the physical characteristics at the key stations, the gauging stations can be considered to have fair hydraulic controls. Special attention will be required to attend some observed threats at the channel hydraulic sections.

Cross-section survey at the key gauging stations was conducted and new plots produced. Check surveys were also conducted at key stations to adjust the gauges. Five out of the six key gauging stations were found to be out of range and were adjusted to the required reduced levels and related information documented. Discharge measurements were conducted between December 2012 and June 2013. Together with few prior measurements conducted since mid 2000s and some historical observations for some key gauging stations, new rating curves at the key gauging stations have been developed and evaluated through qualitative and quantitative methods assess validity and reliability of the rating curves. Results indicate that stage-discharge relationships require updating by new current meter measurements as for some stations the number of data points that were used to develop the rating relationships were too little. Outliers have been revealed in data records and this among others could be a result of use of un-calibrated current meter/sampling equipment, poor measurement techniques, inexperienced sampling technicians and/or computational errors.

The results revealed absence of bias in the newly developed rating curves for all the stations except for 1H8. The three stations namely 1H5, 1HB2 and 1HB1411 passed the goodness of fit test, while the rest of the stations, 1HA15, 1HA9A and 1H8 the test criterion  $t$  was found to be consistently greater than the critical value, leading to the rejection of the null hypothesis of the assumption of random fluctuations. Therefore, the test detected the presence of abnormal long runs of positive or negative deviations. This most likely indicates presence of systematic trend in the deviations with time, indicating that the rating curves need adjustment for a shift in control.

## 7.2 Recommendations

The findings from this study revealed a number of issues as presented in the document and the following are the recommendations towards improving estimates from rating curves for enhanced water resources management in the Ruvu sub-basin and the country as a whole:

- i. The current meter equipment used have not been calibrated for long time and surpassed the recommended 25 measurements after which calibration should have been done. Therefore, there is a need to undertake calibration to minimize equipment errors and thus reduce the likeliness of outliers. Since the calibration of measuring of current meter could be considered a requirement country wide, establishment of calibration facility/tank is vital; and this is recommended to be housed at the Ministry of Water.
- ii. The number of new current meter measurements used in developing the new rating curves for some stations were too few. Therefore, concerted effort is needed to increase the number of measured discharges at different stage so as to increase reliability of the rating curve equations.
- iii. The three gauging stations (1H5, 1HB2 and 1HB1411) passed the goodness of fit and the bias test but failed on the required number of measurements for establishing a reliable rating curve. To improve the reliability of rating curves, more measurements are inevitable. In view of this, the following short, medium and long-term strategies are recommended for the WRBWO:

### Short term:

- Continue with flow measurement at different ranges of flow stages. This also applies to medium and long-term strategies.
- Capacity building on rating curve development among the Water Basin Office Officials
- Calibrate the current meter(s)
- Conduct check survey before and after rain seasons

### Medium term:

- Resurvey and ensure stability of the control sections
- Conduct check survey before and rain season

## Long term:

- Ensure stability of the control sections
  - Check and validate rating curves.
- iv. The two gauging stations (1HA15 and 1HA9A) passed the biasness test, but failed the goodness of fit test and the required number of measurements for establishing a reliable rating curve. Therefore, in order to improve the reliability of rating curves, more measurements will be required as well as all the issues listed under (iii above) for short, medium and long-term strategies.
- v. The station 1H8 passed the required number of discharge measurements for establishing a reliable rating, but failed the bias and the goodness of fit tests, implying a change on the stage-discharge relationship. Therefore, together with the recommendation (iii), there will be a need to develop new rating curve based on new measurements and the calibration of the station.
- vi. The findings of study provide a sample test case of the rating curve situation in the Ruvu sub-basin. It is therefore recommended to the WRBWO to check and validate all the other existing stations' rating curves. For new stations, flow measurements should be conducted at variable stages to enable development of the rating curves. Surveying and documentation of the gauging sections cross-section and control sections will be paramount.
- vii. The findings of this study are indicative of the situation country-wide. The study has revealed that discharge measurement continued until late 1980s and there are no or very few measurements done in the sub-basin from early 1990s until mid 2000s. This is indeed a situation in most of the basins in Tanzania, thus rendering most of the historical rating curves unsuitable for transforming post-1980s/90s stage data to discharge. Therefore, more financial resources will be needed to support development and validation of the rating curves. It is therefore recommended that the MoW through its WSDP and other donors make available additional funds to enable revisiting, testing and revision of rating curves on all major rivers in order to ensure higher confidence in the flow measurements.

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## APPENDICES

### Appendix 1: Check survey data

#### 1. Ruvu River at Kibungo, 1H5

| BS    | IS    | FS    | IH     | RL (m) | Error (m) | Remarks/ Gauge Range (m) | Reduced Level after adjustment of plates (m) |
|-------|-------|-------|--------|--------|-----------|--------------------------|--|
| 2.249 |       |       | 10.532 | 8.283  |           | BM                       |  |
|       | 1.532 |       |        | 9.000  | 0.00      | 8-9                      | 9.0  |
|       | 2.525 |       |        | 8.007  | 0.007     | 7-8                      | 8.0  |
|       | 3.528 |       |        | 7.004  | 0.004     | 6-7                      | 7.0  |
|       | 4.530 |       |        | 6.002  | 0.002     | 5-6                      | 6.0  |
| 0.489 |       | 4.565 | 6.456  | 5.967  |           | CP                       |  |
|       | 1.506 |       |        | 4.950  | 0.05      | 4-5                      | 5.0  |
|       | 2.538 |       |        | 3.918  | 0.082     | 3-4                      | 4.0  |
|       | 3.585 |       |        | 2.871  | 0.13      | 2-3                      | 3.0  |
|       | 4.505 |       |        | 1.951  | 0.049     | 1-2                      | 2.0  |
| 2.682 |       | 4.971 | 4.167  | 1.485  |           | CP                       |  |
|       |       | 3.149 |        | 1.018  | 0.018     | 0-1                      | 1.0  |

#### 2. Mgeta River at Mgeta, 1HB2

| BS    | IM    | FS | IH    | RL (m) | Error (m) | Remarks/ Gauge Range (m) | Reduced Level after adjustment of plates (m) |
|-------|-------|----|-------|--------|-----------|--------------------------|--|
| 1.127 |       |    | 5.277 | 4.150  |           | BM                       |  |
|       | 0.278 |    |       | 4.999  | 0.001     | 4-5                      | 5.0  |
|       | 1.281 |    |       | 3.996  | 0.004     | 3-4                      | 4.0  |
|       | 2.278 |    |       | 2.999  | 0.001     | 2-3                      | 3.0  |
|       | 3.278 |    |       | 1.999  | 0.001     | 1-2                      | 2.0  |
|       | 4.278 |    |       | 0.999  | 0.001     | 0-1                      | 1.0  |

#### 3. Mgeta River at Duthumi, IHB1411

| BS    | IS    | FS    | IH    | RL (m) | Error (m) | Remarks/ Gauge Range (m) | Reduced Level after adjustment of plates (m) |
|-------|-------|-------|-------|--------|-----------|--------------------------|--|
| 3.798 |       | 4.749 | 5.726 | 5.573  |           | BM                       |  |
|       | 4.73  |       |       | 0.996  | 0.004     | 0-1                      | 1.0  |
|       | 3.73  |       |       | 1.996  | 0.004     | 1-2                      | 2.0  |
|       | 2.724 |       |       | 3.002  | 0.002     | 2-3                      | 3.0  |
|       | 1.718 |       |       | 4.008  | 0.008     | 3-4                      | 4.0  |
|       | 0.718 |       |       | 5.008  | 0.008     | 4-5                      | 5.0  |
| 2.627 |       | 1.677 |       |        |           |                          |  |

## 4. Ngerengere River at Konga, 1HA9A

| BS    | IS    | FS    | IH    | RL (m) | Error (m) | Remarks/ Gauge Range (m) | Reduced Level after adjustment of plates (m) |
|-------|-------|-------|-------|--------|-----------|--------------------------|--|
| 0.835 |       |       | 6.435 | 5.600  |           | TBM                      |  |
|       | 0.394 |       |       | 6.041  | 0.041     | 5-6                      | 5.5  |
|       | 1.392 |       |       | 5.043  | 0.043     | 4-5                      | 5.0  |
|       | 2.433 |       |       | 4.002  | 0.002     | 3-4                      | 4.0  |
|       | 3.418 |       |       | 3.017  | 0.017     | 2-3                      | 3.0  |
|       | 4.508 |       |       | 1.927  | 0.073     | 1-2                      | 2.0  |
| 3.245 |       | 4.880 | 4.800 | 1.555  |           | CP                       |  |
|       | 3.755 |       |       | 1.045  | 0.045     | 0-1                      | 1.0  |

## 5. Ngerengere River at Mgude, 1HA15

| BS    | IS    | FS    | IH    | RL (m) | Error (m) | Remarks/ Gauge Range (m) | Reduced Level after adjustment of plates (m) |
|-------|-------|-------|-------|--------|-----------|--------------------------|--|
| 0.224 |       |       | 6.489 | 6.265  |           | BM                       |  |
|       | 1.490 |       |       | 4.999  | 0.001     | 4-5                      | 5.0  |
|       | 2.490 |       |       | 3.999  | 0.001     | 3-4                      | 4.0  |
|       | 3.490 |       |       | 2.999  | 0.001     | 2-3                      | 3.0  |
| 3.652 |       | 4.861 | 5.280 | 1.628  |           | cp                       |  |
|       | 3.280 |       |       | 2.000  | 0.000     | 1-2                      | 2.0  |
|       |       | 4.280 |       | 1.000  | 0.000     | 0-1                      | 1.0  |

## 6. Ruvu River at Morogoro-Dar es Salaam Bridge, 1H8

| BS    | IS    | FS    | IH    | RL (m) | Error (m) | Remarks/ Gauge Range (m)              | Reduced Level after adjustment of plates (m) |
|-------|-------|-------|-------|--------|-----------|---------------------------------------|--|
| 0.36  |       |       | 7.13  | 6.77   |           | BM                                    |  |
|       | 0.03  |       |       | 7.1    | 0.1       | 6-7                                   | 7.0  |
|       | 1.089 |       |       | 6.041  | 0.041     | 5-6                                   | 6.0  |
| 0.478 |       | 2.07  | 5.538 | 5.06   | 0.06      | 4-5/CP                                | 5.0  |
|       | 1.479 |       |       | 4.059  | 0.059     | 3-4                                   | 4.0  |
|       | 2.484 |       |       | 3.054  | 0.054     | 2-3                                   | 3.0  |
| 3.482 |       | 3.478 | 5.542 | 2.06   | 0.06      | 1-2                                   | 2.0  |
|       |       |       |       |        |           | Gauge plate no. 1 overtopped by water |  |

**Appendix 2: River cross sections survey data**

## 1. Ruvu River at Kibungo, 1H5

| BS    | I/S   | FS    | HI     | RL    | Chainage (m) | REMARKS        |
|-------|-------|-------|--------|-------|--------------|----------------|
| 0.106 |       |       | 10.106 | 10    | 0            | TBM            |
|       | 0.478 |       |        | 9.628 | 2            |                |
|       | 0.938 |       |        | 9.168 | 4            |                |
|       | 1.638 |       |        | 8.468 | 6            |                |
|       | 2.292 |       |        | 7.814 | 8            |                |
|       | 2.855 |       |        | 7.251 | 10           |                |
|       | 3.715 |       |        | 6.391 | 12           |                |
|       | 4.450 |       |        | 5.656 | 14           |                |
| 0.23  |       | 4.492 | 5.844  | 5.614 | 16           | ON CONCRETE CP |
|       | 1.378 |       |        | 4.466 | 18           |                |
|       | 2.902 |       |        | 2.942 | 20           |                |
|       | 3.665 |       |        | 2.179 | 21           | WER/B          |
|       | 4.782 |       |        | 1.062 | 22           |                |
|       | 4.211 |       |        | 1.633 | 23           |                |
|       | 4.232 |       |        | 1.612 | 24           |                |
|       | 4.266 |       |        | 1.578 | 25           |                |
|       | 4.132 |       |        | 1.712 | 26           |                |
|       | 3.865 |       |        | 1.979 | 27           |                |
|       | 3.804 |       |        | 2.040 | 28           |                |
|       | 3.731 |       |        | 2.113 | 29           |                |
| 3.852 |       | 3.758 | 5.938  | 2.086 | 30           | CP             |
|       | 3.805 |       |        | 2.133 | 31           |                |
|       | 3.802 |       |        | 2.136 | 32           |                |
|       | 3.852 |       |        | 2.086 | 33           |                |
|       | 3.900 |       |        | 2.038 | 34           |                |
|       | 4.028 |       |        | 1.910 | 35           | CENTRE         |
|       | 4.102 |       |        | 1.836 | 36           |                |
|       | 4.121 |       |        | 1.817 | 37           |                |
|       | 4.140 |       |        | 1.798 | 38           |                |
|       | 4.180 |       |        | 1.758 | 39           |                |
|       | 4.205 |       |        | 1.733 | 40           |                |
|       | 4.261 |       |        | 1.677 | 41           |                |
|       | 4.610 |       |        | 1.328 | 42           |                |
|       | 4.422 |       |        | 1.516 | 43           |                |
|       | 4.362 |       |        | 1.576 | 44           |                |
|       | 4.480 |       |        | 1.458 | 45           |                |
|       | 4.580 |       |        | 1.358 | 46           |                |



|       |       |       |       |       |      |    |
|-------|-------|-------|-------|-------|------|----|
|       | 4.660 |       |       | 1.278 | 47   |    |
|       | 4.661 |       |       | 1.277 | 48   |    |
| 4.761 |       | 4.668 | 6.031 | 1.270 | 49   | CP |
|       | 4.782 |       |       | 1.249 | 50   |    |
|       | 4.744 |       |       | 1.287 | 51   |    |
|       | 4.695 |       |       | 1.336 | 52   |    |
|       | 4.499 |       |       | 1.532 | 52.5 |    |
|       | 3.848 |       |       | 2.183 | 54   |    |
|       | 3.652 |       |       | 2.379 | 56   |    |
|       | 2.382 |       |       | 3.649 | 58   |    |
| 2.068 |       | 0.365 |       | 5.666 | 60   |    |
| 2.02  |       | 0.305 |       | 5.726 | 62   |    |
|       |       | 0.295 |       | 5.736 | 64   |    |

## 2. Mgeta River at Mgeta, 1HB2

| BS    | I/S   | FS    | HI    | RL    | DST  | REMARKS |
|-------|-------|-------|-------|-------|------|---------|
| 0.558 |       |       | 8.058 | 7.5   | 0    | TBM     |
|       | 0.866 |       |       | 7.192 | 1    |         |
|       | 1.010 |       |       | 7.048 | 2    |         |
|       | 1.215 |       |       | 6.843 | 3    |         |
|       | 1.434 |       |       | 6.624 | 4    |         |
|       | 1.118 |       |       | 6.940 | 5    |         |
|       | 2.145 |       |       | 5.913 | 6    |         |
|       | 2.695 |       |       | 5.363 | 7    |         |
|       | 3.268 |       |       | 4.790 | 8    |         |
|       | 3.516 |       |       | 4.542 | 9    |         |
|       | 4.300 |       |       | 3.758 | 10   |         |
|       | 4.275 |       |       | 3.783 | 11   |         |
|       | 4.444 |       |       | 3.614 | 11.5 | WER/B   |
|       | 4.521 |       |       | 3.537 | 12   |         |
|       | 4.722 |       |       | 3.336 | 12.5 |         |
|       | 4.460 |       |       | 3.598 | 13   |         |
|       | 4.885 |       |       | 3.173 | 13.5 |         |
|       | 4.825 |       |       | 3.233 | 14   |         |
|       | 4.735 |       |       | 3.323 | 14.5 |         |
|       | 4.646 |       |       | 3.412 | 15   |         |
| 4.264 |       | 4.547 | 7.775 | 3.511 | 15.5 |         |
|       | 4.168 |       |       | 3.607 | 16   |         |
|       | 4.125 |       |       | 3.650 | 16.5 |         |
|       | 4.142 |       |       | 3.633 | 17   |         |
|       | 4.170 |       |       | 3.605 | 17.5 |         |

|       |       |       |       |       |      |  |
|-------|-------|-------|-------|-------|------|--|
|       | 4.174 |       |       | 3.601 | 18   |  |
|       | 4.185 |       |       | 3.590 | 18.5 |  |
|       | 4.214 |       |       | 3.561 | 19   |  |
|       | 3.994 |       |       | 3.781 | 19.5 |  |
|       | 4.015 |       |       | 3.760 | 20   |  |
|       | 3.975 |       |       | 3.800 | 20.5 |  |
|       | 3.735 |       |       | 4.040 | 21   |  |
|       | 3.695 |       |       | 4.080 | 21.5 |  |
|       | 3.586 |       |       | 4.189 | 22   |  |
|       | 3.612 |       |       | 4.163 | 22.5 |  |
|       | 3.625 |       |       | 4.150 | 23   |  |
|       | 3.648 |       |       | 4.127 | 23.5 |  |
|       | 3.052 |       |       | 4.723 | 24   |  |
| 2.420 |       | 3.565 | 6.630 | 4.210 | 24.5 |  |
|       | 1.622 |       |       | 5.008 | 25   |  |
|       | 1.318 |       |       | 5.312 | 25.5 |  |
|       | 1.225 |       |       | 5.405 | 26   |  |
|       | 1.018 |       |       | 5.612 | 27   |  |
| 3.934 |       | 1.182 | 9.382 | 5.448 | 28   |  |
|       | 3.642 |       |       | 5.740 | 29   |  |
|       | 3.360 |       |       | 6.022 | 30   |  |
|       | 2.940 |       |       | 6.442 | 31   |  |
|       |       | 2.110 |       | 7.272 | 32   |  |

## 3. Mgeta River at Duthumi, IHB1411

| BS    | I/S   | FS    | HI     | RL     | Chainage (m) | REMARKS |
|-------|-------|-------|--------|--------|--------------|---------|
| 0.715 |       |       | 19.827 | 19.112 | 0            | TBM     |
|       | 0.760 |       |        | 19.067 | 2            |         |
|       | 0.785 |       |        | 19.042 | 4            |         |
|       | 1.078 |       |        | 18.749 | 5            |         |
|       | 2.162 |       |        | 17.665 | 7            |         |
|       | 2.432 |       |        | 17.395 | 8            |         |
|       | 2.889 |       |        | 16.938 | 9            |         |
|       | 3.275 |       |        | 16.552 | 10           |         |
|       | 3.935 |       |        | 15.892 | 11           |         |
|       | 4.516 |       |        | 15.311 | 12           |         |
| 1.14  |       | 4.988 | 15.979 | 14.839 |              | CP      |
| 1.252 |       | 1.692 | 15.539 | 14.287 | 12.5         |         |
|       | 1.779 |       |        | 13.760 | 12.5         | WE L/B  |
|       | 1.966 |       |        | 13.573 | 12.5         |         |
|       | 2.460 |       |        | 13.079 | 13.5         |         |

|       |       |       |        |        |      |            |
|-------|-------|-------|--------|--------|------|------------|
|       | 2.678 |       |        | 12.861 | 14   |            |
|       | 2.850 |       |        | 12.689 | 14.5 |            |
|       | 2.700 |       |        | 12.839 | 15   |            |
|       | 2.702 |       |        | 12.837 | 15.5 |            |
|       | 2.879 |       |        | 12.660 | 16   | CENTRE     |
| 2.921 |       | 2.882 | 15.578 | 12.657 | 16.5 | CP         |
|       | 2.898 |       |        | 12.680 | 17   |            |
|       | 2.965 |       |        | 12.613 | 17.5 |            |
|       | 2.980 |       |        | 12.598 | 18   |            |
|       | 3.025 |       |        | 12.553 | 18.5 |            |
|       | 2.895 |       |        | 12.683 | 19   |            |
|       | 0.960 |       |        | 14.618 | 19.5 |            |
|       | 0.382 |       |        | 15.196 | 20   |            |
| 1.969 |       | 0.07  | 17.477 | 15.508 | 20.5 | CP         |
|       | 1.725 |       |        | 15.752 | 21   |            |
|       | 1.285 |       |        | 16.192 | 21.5 |            |
|       | 1.078 |       |        | 16.399 | 22   |            |
|       | 1.010 |       |        | 16.467 | 22.5 |            |
|       | 0.942 |       |        | 16.535 | 23   |            |
|       | 0.701 |       |        | 16.776 | 23.5 |            |
|       |       | 0.245 |        | 17.232 | 24   | LAST POINT |

## 4. Ngerengere River at Konga, 1HA9A

| BS    | I/S   | FS    | HI     | RL     | Chainage (m) | REMARKS |
|-------|-------|-------|--------|--------|--------------|---------|
| 0.715 |       |       | 10.715 | 10.000 | 0            | TBM     |
|       | 0.760 |       |        | 9.955  | 1            |         |
|       | 0.785 |       |        | 9.930  | 2            |         |
|       | 1.078 |       |        | 9.637  | 3            |         |
|       | 2.162 |       |        | 8.553  | 4            |         |
|       | 2.432 |       |        | 8.283  | 5            |         |
|       | 2.889 |       |        | 7.826  | 6            |         |
|       | 3.275 |       |        | 7.440  | 7            |         |
|       | 3.935 |       |        | 6.780  | 8            |         |
|       | 4.516 |       |        | 6.199  | 9            |         |
| 1.140 |       | 4.988 | 6.867  | 5.727  | 10           |         |
| 1.252 |       | 1.692 | 6.427  | 5.175  | 10.5         |         |
|       | 1.779 |       |        | 4.648  | 11           |         |
|       | 1.966 |       |        | 4.461  | 11.5         |         |
|       | 2.460 |       |        | 3.967  | 12           |         |
|       | 2.678 |       |        | 3.749  | 12.5         |         |
|       | 2.850 |       |        | 3.577  | 13           |         |

|       |       |       |       |       |      |        |
|-------|-------|-------|-------|-------|------|--------|
|       | 2.700 |       |       | 3.727 | 13.5 |        |
|       | 2.702 |       |       | 3.725 | 14   |        |
|       | 2.879 |       |       | 3.548 | 14.5 |        |
| 2.921 |       | 2.882 | 6.466 | 3.545 | 15   |        |
|       | 2.898 |       |       | 3.568 | 15.5 |        |
|       | 2.965 |       |       | 3.501 | 16   |        |
|       | 2.980 |       |       | 3.486 | 16.5 |        |
|       | 3.025 |       |       | 3.441 | 17   |        |
|       | 2.895 |       |       | 3.571 | 17.5 |        |
|       | 0.860 |       |       | 5.606 | 18   |        |
|       | 0.382 |       |       | 6.084 | 18.5 |        |
| 1.009 |       | 0.070 | 7.405 | 6.396 | 19   | WE R/B |
|       | 1.725 |       |       | 5.680 | 19.5 |        |
|       | 1.285 |       |       | 6.120 | 20   |        |
|       | 1.078 |       |       | 6.327 | 20.5 |        |
|       | 1.010 |       |       | 6.395 | 21   |        |
|       | 0.942 |       |       | 6.463 | 21.5 |        |
|       | 0.701 |       |       | 6.704 | 22   |        |
|       |       | 0.245 |       | 7.160 | 22.5 |        |

## 5. Ngerengere River at Mgude, 1HA15

| BS   | I/S   | FS    | HI    | RL    | Chainage (m) | REMARKS |
|------|-------|-------|-------|-------|--------------|---------|
| 0.52 |       |       | 10.52 | 10    | 0            | TBM     |
|      | 0.602 |       |       | 9.918 | 2            |         |
|      | 0.665 |       |       | 9.855 | 4            |         |
|      | 1.030 |       |       | 9.490 | 6            |         |
|      | 1.283 |       |       | 9.237 | 7            |         |
|      | 1.410 |       |       | 9.110 | 10           |         |
|      | 1.868 |       |       | 8.652 | 12           |         |
|      | 2.049 |       |       | 8.471 | 14           |         |
|      | 2.210 |       |       | 8.310 | 16           |         |
|      | 2.633 |       |       | 7.887 | 18           |         |
|      | 2.801 |       |       | 7.719 | 20           |         |
|      | 3.149 |       |       | 7.371 | 22           |         |
|      | 3.464 |       |       | 7.056 | 24           |         |
|      | 4.510 |       |       | 6.010 | 26           |         |
|      | 4.800 |       |       | 5.720 | 28           |         |
| 2.66 |       | 4.973 | 8.207 | 5.547 | 29           |         |
|      | 2.758 |       |       | 5.449 | 30           |         |
|      | 2.747 |       |       | 5.460 | 31           |         |
|      | 2.800 |       |       | 5.407 | 32           |         |

|       |       |       |        |        |    |        |
|-------|-------|-------|--------|--------|----|--------|
|       | 3.002 |       |        | 5.205  | 33 |        |
| 3.39  |       | 3.22  | 8.377  | 4.987  | 34 | CP     |
|       | 3.512 |       |        | 4.865  | 35 | WE L/B |
|       | 3.675 |       |        | 4.702  | 36 |        |
|       | 3.962 |       |        | 4.415  | 37 |        |
|       | 4.001 |       |        | 4.376  | 38 | CENTRE |
|       | 3.976 |       |        | 4.401  | 39 |        |
|       | 3.990 |       |        | 4.387  | 40 |        |
|       | 3.879 |       |        | 4.498  | 41 |        |
|       | 3.829 |       |        | 4.548  | 42 |        |
|       | 3.710 |       |        | 4.667  | 43 |        |
|       | 3.700 |       |        | 4.677  | 44 |        |
|       | 3.508 |       |        | 4.869  | 45 |        |
|       | 3.493 |       |        | 4.884  | 46 |        |
|       | 3.555 |       |        | 4.822  | 47 |        |
|       | 3.058 |       |        | 5.319  | 48 |        |
| 4.302 |       | 2.612 | 10.067 | 5.765  | 49 |        |
|       | 4.123 |       |        | 5.944  | 50 |        |
|       | 3.720 |       |        | 6.347  | 51 |        |
|       | 3.108 |       |        | 6.959  | 52 |        |
|       | 2.635 |       |        | 7.432  | 53 |        |
| 1.042 |       | 1.872 | 9.237  | 8.195  | CP |        |
| 2.282 |       | 0.42  | 11.099 | 8.817  | 54 |        |
|       | 1.688 |       |        | 9.411  | 55 |        |
| 1.485 |       | 1.66  | 10.924 | 9.439  | CP |        |
|       | 1.122 |       |        | 9.802  | 56 |        |
|       | 1.002 |       |        | 9.922  | 58 |        |
|       | 0.56  |       |        | 10.364 | 60 |        |
|       |       |       | 0.772  | 10.152 | 64 |        |

## 6. Ruvu River at Morogoro –Dar es Salaam Bridge, 1H8

| BS    | I/S   | FS | HI    | RL    | Chainage (m) | REMARKS |
|-------|-------|----|-------|-------|--------------|---------|
| 0.190 |       |    | 9.890 | 9.7   | 0            | BM      |
|       | 0.712 |    |       | 9.178 | 2            |         |
|       | 0.926 |    |       | 8.964 | 4            |         |
|       | 1.052 |    |       | 8.838 | 6            |         |
|       | 1.139 |    |       | 8.751 | 8            |         |
|       | 1.169 |    |       | 8.721 | 10           |         |
|       | 1.315 |    |       | 8.575 | 12           |         |
|       | 1.419 |    |       | 8.471 | 14           |         |
|       | 1.375 |    |       | 8.515 | 16           |         |

| BS    | I/S   | FS    | HI    | RL    | Chainage (m) | REMARKS |
|-------|-------|-------|-------|-------|--------------|---------|
|       | 1.448 |       |       | 8.442 | 18           |         |
|       | 1.512 |       |       | 8.378 | 20           |         |
|       | 1.586 |       |       | 8.304 | 22           |         |
|       | 1.649 |       |       | 8.241 | 24           |         |
|       | 1.683 |       |       | 8.207 | 26           |         |
|       | 1.775 |       |       | 8.115 | 28           |         |
|       | 1.725 |       |       | 8.165 | 30           |         |
|       | 1.828 |       |       | 8.062 | 32           |         |
|       | 1.898 |       |       | 7.992 | 34           |         |
|       | 1.861 |       |       | 8.029 | 36           |         |
|       | 1.779 |       |       | 8.111 | 38           |         |
| 1.908 |       | 1.925 | 9.873 | 7.965 | 40           | CP      |
|       | 1.870 |       |       | 8.003 | 42           |         |
|       | 1.941 |       |       | 7.932 | 44           |         |
|       | 2.002 |       |       | 7.871 | 46           |         |
|       | 1.899 |       |       | 7.974 | 48           |         |
|       | 2.001 |       |       | 7.872 | 50           |         |
|       | 2.049 |       |       | 7.824 | 52           |         |
|       | 2.070 |       |       | 7.803 | 54           |         |
|       | 2.170 |       |       | 7.703 | 56           |         |
|       | 2.084 |       |       | 7.789 | 58           |         |
|       | 1.971 |       |       | 7.902 | 60           |         |
|       | 1.872 |       |       | 8.001 | 62           |         |
|       | 1.868 |       |       | 8.005 | 64           |         |
|       | 1.989 |       |       | 7.884 | 66           |         |
|       | 1.985 |       |       | 7.888 | 68           |         |
|       | 1.900 |       |       | 7.973 | 70           |         |
|       | 1.902 |       |       | 7.971 | 72           |         |
|       | 2.038 |       |       | 7.835 | 74           |         |
|       | 2.061 |       |       | 7.812 | 76           |         |
| 0.215 |       | 2.072 | 8.016 | 7.801 | 78           | CP      |
|       | 1.122 |       |       | 6.894 | 80           |         |
|       | 2.212 |       |       | 5.804 | 82           |         |
|       | 3.059 |       |       | 4.957 | 84           |         |
|       | 3.825 |       |       | 4.191 | 84.5         |         |
| 1.84  |       | 2.233 | 7.623 | 5.783 | 85           |         |
|       | 2.712 |       |       | 4.911 | 86           |         |
|       | 3.348 |       |       | 4.275 | 87           |         |
|       | 3.938 |       |       | 3.685 | 88           |         |
|       | 4.184 |       |       | 3.439 | 89           |         |
|       | 3.667 |       |       | 3.956 | 90           |         |

| BS   | I/S   | FS    | HI     | RL    | Chainage (m) | REMARKS |
|------|-------|-------|--------|-------|--------------|---------|
|      | 3.016 |       |        | 4.607 | 91           |         |
|      | 2.902 |       |        | 4.721 | 92           |         |
|      | 2.989 |       |        | 4.634 | 93           |         |
|      | 3.070 |       |        | 4.553 | 94           |         |
|      | 3.082 |       |        | 4.541 | 95           |         |
|      | 3.172 |       |        | 4.451 | 96           |         |
|      | 3.342 |       |        | 4.281 | 97           |         |
|      | 3.469 |       |        | 4.154 | 98           |         |
| 3.74 |       | 3.68  | 7.683  | 3.943 | 99           |         |
|      | 3.803 |       |        | 3.880 | 101          | CP      |
|      | 3.888 |       |        | 3.795 | 102          |         |
|      | 3.799 |       |        | 3.884 | 103          |         |
|      | 3.755 |       |        | 3.928 | 104          |         |
|      | 3.798 |       |        | 3.885 | 105          |         |
|      | 3.799 |       |        | 3.884 | 106          |         |
|      | 3.768 |       |        | 3.915 | 107          |         |
|      | 3.835 |       |        | 3.848 | 108          |         |
|      | 3.871 |       |        | 3.812 | 109          |         |
|      | 3.948 |       |        | 3.735 | 110          |         |
|      | 3.919 |       |        | 3.764 | 111          |         |
|      | 3.872 |       |        | 3.811 | 112          |         |
|      | 3.402 |       |        | 4.281 | 113          |         |
|      | 2.821 |       |        | 4.862 | 114          |         |
|      | 1.920 |       |        | 5.763 | 115          |         |
|      | 1.189 |       |        | 6.494 | 116          | WE R/B  |
| 3.32 |       | 0.88  | 10.123 | 6.803 | 117          |         |
|      | 1.753 |       |        | 8.370 | 118          | CP      |
|      | 1.938 |       |        | 8.185 | 119          |         |
|      | 1.345 |       |        | 8.778 | 120          |         |
|      | 1.321 |       |        | 8.802 | 121          |         |
|      | 1.415 |       |        | 8.708 | 122          |         |
|      | 1.190 |       |        | 8.933 | 123          |         |
|      | 1.040 |       |        | 9.083 | 124          |         |
|      |       | 0.941 |        | 9.182 | 125          |         |

**Appendix 3: Recent discharge measurements****1. Ruvu at Kibungo, 1H5**

| No. | Date       | Gauge Height<br>(m) | Width<br>(m) | Area<br>(m <sup>2</sup> ) | Velocity<br>(m/s) | Discharge<br>(m <sup>3</sup> /s) | Source       | Method/measurement tool used  |
|-----|------------|---------------------|--------------|---------------------------|-------------------|----------------------------------|--------------|-------------------------------|
| 1   | 20/12/2012 | 0.48                | 30.3         | 16.341                    | 0.42              | 7.691                            | This study   | Large propeller current meter |
| 2   | 20/12/2012 | 0.48                | 29           | 18.49                     | 0.398             | 7.357                            | This study   | Pigmy current meter           |
| 3   | 22/12/2012 | 0.44                |              | 15.918                    | 0.404             | 6.434                            | This study   | Large propeller current meter |
| 4   | 15/01/2013 | 0.48                | 30           | 18.125                    | 0.447             | 8.096                            | This study   | Large propeller current meter |
| 5   | 28/02/2013 | 0.34                | 29           | 5.896                     | 0.508             | 2.995                            | This study   | Pigmy current meter           |
| 6   | 13/04/2013 | 1.04                | 34           | 44.81                     | 0.62              | 27.78                            | This study   | Q-Liner Digital currentmeter  |
| 7   | 13/04/2013 | 1.1                 | 34           | 49.81                     | 0.66              | 32.87                            | This study   | Q-Liner Digital currentmeter  |
| 8   | 14/04/2013 | 0.85                | 30           | 33.87                     | 0.54              | 18.29                            | This study   | Q-Liner Digital currentmeter  |
| 9   | 20/05/2013 | 0.65                | 30.6         | 22.32                     | 0.684             | 15.27                            | This study   | Large propeller current meter |
| 10  | 21/05/2013 | 0.65                | 34           | 24.53                     | 0.558             | 13.682                           | This study   |                               |
| 11  | 09-01-2007 | 0.8                 |              | 32.156                    | 0.666             | 21.416                           | JICA/Hydata  |                               |
| 12  | 27-03-2007 | 0.655               |              | 22.098                    | 0.642             | 14.187                           | JICA/Hydata  |                               |
| 13  | 01-05-2007 | 0.696               |              | 17.813                    | 1.372             | 24.440                           | JICA/Hydata  |                               |
| 14  | 01-12-2007 | 0.54                |              | 19.663                    | 0.617             | 12.132                           | JICA/Hydata  |                               |
| 15  | 02-05-2008 | 1.78                |              | 32.387                    | 1.436             | 46.508                           | JICA/Hydata  |                               |
| 16  | 03-05-2008 | 1.49                |              | 30.041                    | 1.413             | 42.448                           | JICA/Hydata  |                               |
| 17  | 22-01-2009 | 0.32                |              | 18.961                    | 0.255             | 4.835                            | JICA/Hydata  |                               |
| 18  | 28-01-2010 | 0.38                |              | 12.434                    | 0.742             | 9.226                            | JICA/Hydata  |                               |
| 19  | 22-12-2010 | 0.4                 |              | 18.860                    | 0.314             | 5.926                            | JICA/Hydata  |                               |
| 20  | 15-07-2011 | 0.47                |              | 18.512                    | 0.437             | 8.081                            | JICA/Hydata  |                               |
| 21  | 09-10-2011 | 0.81                |              | 28.540                    | 0.660             | 18.824                           | JICA/Hydata  |                               |
| 22  | 10-11-2011 | 0.39                |              | 14.229                    | 0.414             | 5.897                            | JICA/Hydata  |                               |
| 23  | 02-12-2011 | 0.417               |              | 15.912                    | 0.395             | 6.287                            | JICA/Hydata  |                               |
| 24  | 17-01-2012 | 0.595               |              | 18.590                    | 0.637             | 11.841                           | JICA/Hydata  |                               |
| 25  | 10-01-2010 | 0.31                |              |                           |                   | 4.09                             | Kassambili   |                               |
| 26  | 31-03-2010 | 0.55                |              |                           |                   | 11.078                           | Kassambili   |                               |
| 27  | 09-06-2010 | 0.3                 |              |                           |                   | 3.479                            | Kassambili   |                               |
| 28  | 10-10-2010 | 0.297               |              |                           |                   | 3.63                             | Kassambili   |                               |
| 29  | 31-10-2010 | 0.45                |              |                           |                   | 9.038                            | Kassambili   |                               |
| 30  | 16-11-2010 | 0.43                |              |                           |                   | 8.61                             | Kassambili   |                               |
| 31  | 26-6-2011  | 0.46                |              |                           |                   | 16.659                           | Kassambili   |                               |
| 32  | 13-8-2011  | 0.45                |              |                           |                   | 6.219                            | Kassambili   |                               |
| 33  | 10-09-2011 | 0.78                |              |                           |                   | 18.225                           | Kassambili   |                               |
| 34  | 03-05-2012 | 0.46                | 30.5         | 13.828                    | 0.495             | 6.845                            | WetseasonEFA |                               |
| 35  | 03-05-2012 | 0.44                | 30.5         | 13.168                    | 0.486             | 6.406                            | WetseasonEFA |                               |
| 36  | 03-05-2012 | 0.46                | 30.5         | 13.728                    | 0.522             | 7.163                            | WetseasonEFA |                               |

**2. Mgeta at Mgeta, 1HB2**

| Sno | Date       | Gauge Height<br>(m) | Width<br>(m) | Area<br>(m <sup>2</sup> ) | Velocity<br>(m/s) | Discharge<br>(m <sup>3</sup> /s) | Source      | Method/measurement tool used |
|-----|------------|---------------------|--------------|---------------------------|-------------------|----------------------------------|-------------|------------------------------|
| 1   | 04-02-2010 | 0.5                 |              | 3.219                     | 0.374             | 1.204                            | JICA/Hydata |                              |
| 2   | 06-05-2008 | 0.71                |              | 5.687                     | 1.109             | 6.307                            | JICA/Hydata |                              |
| 3   | 12-01-2007 | 0.712               |              | 6.191                     | 0.968             | 5.993                            | JICA/Hydata |                              |
| 4   | 05-05-2008 | 0.74                |              | 5.848                     | 1.183             | 6.918                            | JICA/Hydata |                              |



|    |            |       |       |       |       |  |       |            |                                     |
|----|------------|-------|-------|-------|-------|--|-------|------------|-------------------------------------|
| 5  | 13-08-2011 | 0.47  |       |       |       |  | 1.129 |            |                                     |
| 6  | 04-02-2010 | 0.5   |       |       |       |  | 1.204 |            |                                     |
| 7  | 18/12/2012 | 0.43  | 7.1   | 1.718 | 0.834 |  | 1.432 | This study | Pigmy current meter                 |
| 8  | 18/12/2012 | 0.43  | 7.1   | 1.792 | 0.812 |  | 1.454 | This study | Acoustic Digital Currentmeter (ADC) |
| 9  | 20/02/2013 | 0.438 | 7.4   | 1.962 | 0.767 |  | 1.505 | This study | Pigmy current meter                 |
| 10 | 12/1/2013  | 0.44  | 6.9   | 1.87  | 0.712 |  | 1.332 | This study | Large propeller current meter       |
| 11 | 12/1/2013  | 0.44  | 6.9   | 1.989 | 0.72  |  | 1.433 | This study | Pigmy current meter                 |
| 12 | 19/02/2013 | 0.44  | 7.4   | 1.97  | 0.508 |  | 1.539 | This study | Pigmy current meter                 |
| 13 | 21/02/2013 | 0.44  | 7.5   | 1.97  | 1.587 |  | 1.539 | This study | Pigmy current meter                 |
| 14 | 19/02/2013 | 0.45  | 7.5   | 2.005 | 0.789 |  | 1.582 | This study | Large propeller current meter       |
| 15 | 21/02/2013 | 0.51  | 7.5   | 2.684 | 0.883 |  | 2.369 | This study | Large propeller current meter       |
| 16 | 21/02/2013 | 0.51  | 7.5   | 2.854 | 0.926 |  | 2.643 | This study | Acoustic Digital Currentmeter (ADC) |
| 17 | 28/04/2013 | 0.54  | 11.55 | 3.866 | 0.926 |  | 3.578 | This study | Large propeller current meter       |
| 18 | 27/04/2013 | 0.55  | 11.9  | 3.889 | 0.936 |  | 3.639 | This study | Large propeller current meter       |
| 19 | 26/04/2013 | 0.57  | 11.6  | 4.368 | 0.948 |  | 4.143 | This study | Large propeller current meter       |
| 20 | 30/05/2013 | 0.51  | 11.3  | 3.553 | 0.913 |  | 3.245 | This study | Large propeller current meter       |
| 21 | 1/6/2013   | 0.5   | 11.3  | 3.2   | 0.849 |  | 2.716 | This study | Large propeller current meter       |

### 3. Mgeta at Duthumi

|    | Date       | Gauge Height (m) | Width (m) | Area (m <sup>2</sup> ) | Velocity (m/s) | Discharge (m <sup>3</sup> /s) | Useful pts  | Method/measurement tool used  |
|----|------------|------------------|-----------|------------------------|----------------|-------------------------------|-------------|-------------------------------|
| 1  | 12-08-2011 | 0.28             |           |                        |                | 2.884                         |             |                               |
| 2  | 30-07-2011 | 0.38             |           |                        |                | 4.227                         |             |                               |
| 3  | 09-10-2011 | 0.5              |           |                        |                | 4.293                         |             |                               |
| 4  | 15-07-2011 | 0.5              |           | 13.75                  | 0.202          | 2.76                          | JICA/HYDATA | DDCA (Qliner)                 |
| 5  | 09-10-2011 | 0.5              |           | 10.149                 | 0.437          | 4.435                         | JICA/HYDATA | DDCA (ADC)                    |
| 6  | 10-11-2011 | 0.312            |           | 3.568                  |                | 1.553                         | JICA/HYDATA | WRBWB (ADC)                   |
| 7  | 02-12-2011 | 0.819            |           | 6.212                  |                | 2.628                         | JICA/HYDATA | WRBWB (ADC)                   |
| 8  | 17-01-2012 | 0.68             |           | 22.872                 | 0.361          | 8.256                         | JICA/HYDATA | WRBWB (Qliner)                |
| 9  | 6/3/2012   | 0.55             | 20.30     | 9.915                  | 0.618          | 6.131                         |             |                               |
| 10 | 6/3/2012   | 0.50             | 20.30     | 9.01                   | 0.636          | 5.739                         |             |                               |
| 11 | 6/3/2012   | 0.43             | 28.00     | 11.14                  | 0.505          | 5.628                         |             |                               |
| 12 | 6/3/2012   | 0.70             | 19.00     | 12.495                 | 0.503          | 6.291                         |             |                               |
| 13 | 21/12/2012 | 0.8              | 15.2      | 14.816                 | 0.516          | 7.675                         | This study  | Large propeller current meter |
| 14 | 22/12/2012 | 0.57             | 15.09     | 10.383                 | 0.559          | 5.813                         | This study  | Large propeller current meter |
| 15 | 16/01/2013 | 0.72             | 15.2      | 13.251                 | 0.433          | 5.741                         | This study  | Large propeller current meter |
| 16 | 27/02/2013 | 0.28             | 13.3      | 6.673                  | 0.529          | 3.533                         | This study  | Large propeller current meter |
| 17 | 15/04/2013 | 3.78             | 28        | 97.83                  | 0.69           | 67.5                          | This study  | Q-Liner Digital currentmeter  |
| 18 | 15/04/2013 | 3.74             | 28        | 83.94                  | 0.52           | 43.65                         | This study  | Q-Liner Digital currentmeter  |
| 19 | 16/04/2013 | 4.25             | 30        | 102.4                  | 0.7            | 71.68                         | This study  | Q-Liner Digital currentmeter  |
| 20 | 22/05/2013 | 1.35             | 25        | 20.834                 | 0.695          | 14.49                         | This study  | Large propeller current meter |
| 21 | 22/05/2013 | 1.355            | 30        | 21.986                 | 0.727          | 15.976                        | This study  | Large propeller current meter |
| 22 | 25/05/2013 | 1.33             | 27        | 20.06                  | 0.782          | 15.681                        | This study  |                               |

## 4. Ngerengere at Mgude

| Sno. | Date       | Gauge Height (m) | Width (m) | Area (m <sup>2</sup> ) | Velocity (m/s) | Discharge (m <sup>3</sup> /s) | Source      | Method/measurement tool used  |
|------|------------|------------------|-----------|------------------------|----------------|-------------------------------|-------------|---|
| 1    | 11/1/2013  | 0.46             | 8.5       | 2.488                  | 0.537          | 1.337                         | This study  | Large propeller current meter<br>Pigmy current meter<br><br>Qliner Digital Current meter<br>Large propeller current meter<br>Qliner Digital Current meter<br>Qliner Digital Current meter |
| 2    | 11/1/2013  | 0.46             | 8.5       | 2.368                  | 0.556          | 1.317                         | This study  |   |
| 3    | 26/02/2013 | 0.5              | 8.1       | 1.79                   | 0.645          | 1.154                         | This study  |   |
| 4    | 13-06-2009 | 0.76             |           | 3.173                  | 0.502          | 1.593                         | JICA/HYDATA |   |
| 5    | 25/05/2013 | 1.17             | 10.6      | 6.256                  | 0.5113         | 3.199                         | This study  |   |
| 6    | 24/05/2013 | 1.21             | 15        | 5.085                  | 0.531          | 2.7                           | This study  |   |
| 7    | 10/4/2013  | 1.95             | 20.5      | 20.15                  | 0.39           | 7.86                          | This study  |   |
| 8    | 10/4/2013  | 1.98             | 19        | 17.07                  | 0.5            | 8.54                          | This study  |   |
| 9    | 11/4/2013  | 2.54             | 28        | 56.72                  | 0.59           | 33.46                         | This study  |   |
| 10   | 19-04-2008 | 3.161            |           | 41.224                 | 0.776          | 31.99                         | JICA/HYDATA |   |
| 11   | 18-04-2008 | 3.17             |           | 43.301                 | 0.794          | 34.381                        | JICA/HYDATA |   |

## 5. Ngerengere at Konga

| SN. | Date       | Gauge Height (m) | Width (m) | Area (m <sup>2</sup> ) | Velocity (m/s) | Discharge (m <sup>3</sup> /s) | Source      | Method/measurement tool used |
|-----|------------|------------------|-----------|------------------------|----------------|-------------------------------|-------------|------------------------------|
| 1   | 14/01/2013 | 0.12             | 3         | 0.351                  | 0.529          | 0.186                         | This study  | Pigmy Current meter          |
| 2   | 19/12/2012 | 0.19             | 2.92      | 0.578                  | 0.386          | 0.223                         | This study  | Pigmy Current meter          |
| 3   | 19/12/2012 | 0.19             | 2.95      | 0.514                  | 0.399          | 0.205                         | This study  | Pigmy Current meter          |
| 4   | 24/02/2013 | 0.22             | 2.9       | 0.545                  | 0.483          | 0.263                         | This study  | Large current meter          |
| 5   | 23/02/2013 | 0.23             | 2.7       | 0.708                  | 0.556          | 0.394                         | This study  | Large current meter          |
| 6   | 22/02/2013 | 0.24             | 3.3       | 1.037                  | 0.631          | 0.654                         | This study  | Large current meter          |
| 7   | 28/04/2013 | 0.55             | 3.7       | 1.614                  | 0.559          | 0.903                         | This study  | Large current meter          |
| 8   | 27/04/2013 | 0.58             | 4.1       | 1.807                  | 0.51           | 0.922                         | This study  | Large current meter          |
| 9   | 31/05/2013 | 0.6              | 3.62      | 1.357                  | 0.437          | 0.593                         | This study  |                              |
| 10  | 26/04/2013 | 0.62             | 3.84      | 1.914                  | 0.483          | 0.924                         | This study  |                              |
| 11  | 23-12-2008 | 0.64             |           | 0.389                  | 0.419          | 0.163                         | This study  | Large current meter          |
| 12  | 26-03-2008 | 0.645            |           | 0.468                  | 0.434          | 0.203                         | JICA/HYDATA |                              |
| 13  | 26-03-2009 | 0.66             |           | 0.435                  | 0.517          | 0.225                         | JICA/HYDATA |                              |
| 14  | 29-07-2009 | 0.67             |           | 0.38                   | 0.476          | 0.181                         | JICA/HYDATA | Large current meter          |
| 15  | 24-01-2008 | 0.69             |           | 0.878                  | 0.509          | 0.447                         | JICA/HYDATA |                              |
| 16  | 18-12-2007 | 0.699            |           | 0.533                  | 0.478          | 0.255                         | JICA/HYDATA |                              |
| 17  | 22-04-2009 | 0.71             |           | 0.655                  | 0.704          | 0.461                         | JICA/HYDATA |                              |
| 18  | 24-06-2009 | 0.71             |           | 0.604                  | 0.614          | 0.371                         | JICA/HYDATA |                              |
| 19  | 08-10-2008 | 0.715            |           | 0.557                  | 0.564          | 0.314                         | JICA/HYDATA |                              |
| 20  | 09-06-2009 | 0.76             |           | 1.699                  | 0.439          | 0.746                         | JICA/HYDATA |                              |
| 21  | 19-06-2008 | 0.77             |           | 0.934                  | 0.955          | 0.892                         | JICA/HYDATA |                              |
| 22  | 2/2/2013   | 0.8              | 3.8       | 2.029                  | 0.487          | 0.989                         | JICA/HYDATA |                              |
| 23  | 23-02-2009 | 0.91             |           | 5.744                  | 0.18           | 1.034                         | JICA/HYDATA |                              |
| 24  | 12-01-2007 | 1                |           | 2.035                  | 0.579          | 1.178                         | JICA/HYDATA |                              |
| 25  | 12-06-2007 | 1                |           | 2.035                  | 0.579          | 1.178                         | JICA/HYDATA |                              |
| 26  | 13-05-2008 | 1.155            |           | 1.748                  | 0.798          | 1.395                         | JICA/HYDATA |                              |
| 27  | 07-11-2008 | 1.165            |           | 2.421                  | 0.906          | 2.193                         | JICA/HYDATA |                              |
| 28  | 07-05-2009 | 1.215            |           | 3.099                  | 0.715          | 2.216                         | JICA/HYDATA |                              |
| 29  | 05-05-2009 | 1.495            |           | 4.413                  | 0.477          | 2.105                         | JICA/HYDATA |                              |
| 30  | 22-04-2008 | 1.5              |           | 4.365                  | 0.587          | 2.562                         | JICA/HYDATA |                              |
| 31  | 16-11-2007 | 1.58             |           | 5.575                  | 0.838          | 4.672                         |             |                              |
| 32  | 15-04-2008 | 1.92             |           | 8.277                  | 0.636          | 5.264                         |             |                              |

## 6. Ruvu at Morogoro-Dar Bridge

| Sno | Date       | Gauge Height (m) | Width (m) | Area (m <sup>2</sup> ) | Velocity (m/s) | Discharge (m <sup>3</sup> /s) | Source      | Method/measurement tool used  |
|-----|------------|------------------|-----------|------------------------|----------------|-------------------------------|-------------|-------------------------------|
| 1   | 01-02-2009 | 1.090            |           | 16.135                 | 0.407          | 6.567                         | JICA/HYDATA |                               |
| 2   | 11-06-2009 | 2.340            |           | 49.751                 | 0.510          | 25.373                        | JICA/HYDATA |                               |
| 3   | 12-05-2009 | 5.610            |           | 176.610                | 0.963          | 170.075                       | JICA/HYDATA |                               |
| 4   | 13-05-2009 | 5.670            |           | 180.959                | 0.731          | 132.281                       | JICA/HYDATA |                               |
| 5   | 14-05-2009 | 5.700            |           | 173.963                | 0.845          | 146.999                       | JICA/HYDATA |                               |
| 6   | 16-04-2008 | 6.485            |           | 185.588                | 0.899          | 166.844                       | JICA/HYDATA |                               |
| 7   | 17-04-2008 | 6.590            |           | 220.090                | 0.796          | 175.192                       | JICA/HYDATA |                               |
| 8   | 24/12/2013 | 1.750            | 30.700    | 29.330                 | 0.543          | 15.933                        | This study  | Large propeller current meter |
| 9   | 25/02/2013 | 1.790            | 32.000    | 34.705                 | 0.469          | 16.292                        | This study  | Large propeller current meter |
| 10  | 10/1/2013  | 2.190            | 34.300    | 45.912                 | 0.562          | 25.278                        | This study  | Large propeller current meter |
| 11  | 29/05/2013 | 2.874            | 34.000    | 92.100                 | 0.416          | 38.271                        | This study  |                               |
| 12  | 4/4/2013   | 5.540            | 82.000    | 288.900                | 0.480          | 138.410                       | This study  | Q-Liner Digital currentmeter  |
| 13  | 5/4/2013   | 5.650            | 82.000    | 275.500                | 0.560          | 154.280                       | This study  | Q-Liner Digital currentmeter  |
| 14  | 6/4/2013   | 5.780            | 90.000    | 286.800                | 0.620          | 177.820                       | This study  | Q-Liner Digital currentmeter  |
| 15  | 7/4/2013   | 5.950            | 92.000    | 278.300                | 0.680          | 189.260                       | This study  | Q-Liner Digital currentmeter  |
| 16  | 7/4/2013   | 5.980            | 94.000    | 375.600                | 0.540          | 202.800                       | This study  | Q-Liner Digital currentmeter  |

**Appendix 3: Historical discharge measurements since 1950s**

## 1. Ruvu River at Kibungo

| SNo. | Date       | Stage (metres) | Velocity (m/s) | Area (m <sup>2</sup> ) | Measured (cumecs) |
|------|------------|----------------|----------------|------------------------|-------------------|
| 1    | 05-03-1960 | 1.189          | 0.919          | 31.121                 | 28.6              |
| 2    | 10-03-1960 | 0.61           | 0.37           | 10.208                 | 3.777             |
| 3    | 01-08-1960 | 0.61           | 0.38           | 10.037                 | 3.814             |
| 4    | 04-10-1960 | 1.814          | 1.173          | 46.471                 | 54.51             |
| 5    | 12-05-1961 | 1.128          | 0.747          | 35.596                 | 26.59             |
| 6    | 02-01-1962 | 1.006          | 0.654          | 28.231                 | 18.463            |
| 7    | 05-03-1962 | 1.905          | 1.176          | 53.865                 | 63.345            |
| 8    | 10-10-1962 | 0.762          | 0.42           | 17.193                 | 7.221             |
| 9    | 01-03-1963 | 0.975          | 0.66           | 25.914                 | 17.103            |
| 10   | 10-05-1963 | 0.594          | 0.349          | 10.871                 | 3.794             |
| 11   | 06-08-1963 | 0.847          | 0.58           | 20.428                 | 11.848            |
| 12   | 03-04-1964 | 0.829          | 0.557          | 20.336                 | 11.327            |
| 13   | 03-05-1964 | 0.823          | 0.533          | 19.424                 | 10.353            |
| 14   | 03-08-1964 | 0.957          | 0.632          | 24.437                 | 15.444            |
| 15   | 12-08-1964 | 0.735          | 0.387          | 19.318                 | 7.476             |
| 16   | 05-01-1965 | 1.073          | 0.699          | 33.907                 | 23.701            |
| 17   | 05-02-1965 | 1.045          | 0.722          | 32.514                 | 23.475            |
| 18   | 05-03-1965 | 1.027          | 0.689          | 32.591                 | 22.455            |
| 19   | 05-05-1965 | 0.991          | 0.651          | 30.665                 | 19.963            |
| 20   | 05-07-1965 | 1.052          | 0.744          | 31.97                  | 23.786            |
| 21   | 05-10-1965 | 0.957          | 0.573          | 29.058                 | 16.65             |
| 22   | 05-11-1965 | 1.122          | 0.812          | 33.617                 | 27.297            |
| 23   | 05-04-1966 | 1.134          | 0.748          | 34.128                 | 25.528            |
| 24   | 05-04-1966 | 1.134          | 0.764          | 34.139                 | 26.082            |
| 25   | 05-04-1966 | 1.131          | 0.696          | 34.411                 | 23.95             |
| 26   | 05-05-1966 | 1.289          | 0.88           | 39.722                 | 34.955            |
| 27   | 05-05-1966 | 1.298          | 0.868          | 39.726                 | 34.482            |
| 28   | 05-05-1966 | 1.28           | 0.261          | 132.184                | 34.5              |
| 29   | 05-06-1966 | 1.128          | 0.796          | 34.168                 | 27.198            |
| 30   | 05-06-1966 | 1.128          | 0.79           | 34.858                 | 27.538            |
| 31   | 05-06-1966 | 1.122          | 0.764          | 33.505                 | 25.598            |
| 32   | 05-07-1966 | 1.097          | 0.736          | 32.848                 | 24.176            |
| 33   | 05-07-1966 | 1.097          | 0.746          | 32.543                 | 24.277            |
| 34   | 06-07-1966 | 1.097          | 0.756          | 32.874                 | 24.853            |
| 35   | 05-09-1966 | 1.058          | 0.709          | 31.116                 | 22.061            |
| 36   | 05-09-1966 | 1.061          | 0.686          | 31.917                 | 21.895            |
| 37   | 06-09-1966 | 1.061          | 0.684          | 31.886                 | 21.81             |
| 38   | 05-10-1966 | 1.036          | 0.658          | 32.302                 | 21.255            |
| 39   | 05-10-1966 | 1.036          | 0.645          | 32.31                  | 20.84             |
| 40   | 05-10-1966 | 1.036          | 0.648          | 32.293                 | 20.926            |

| SNo. | Date       | Stage (metres) | Velocity (m/s) | Area (m <sup>2</sup> ) | Measured (cumecs) |
|------|------------|----------------|----------------|------------------------|-------------------|
| 41   | 04-01-1967 | 0.695          | 0.403          | 18.015                 | 7.26              |
| 42   | 04-02-1967 | 0.64           | 0.374          | 15.781                 | 5.902             |
| 43   | 04-03-1967 | 1.253          | 1.048          | 32.609                 | 34.174            |
| 44   | 05-05-1967 | 1.442          | 0.988          | 49.913                 | 49.314            |
| 45   | 05-05-1967 | 2.234          | 0.118          | 83.797                 | 9.888             |
| 46   | 05-06-1967 | 1.615          | 1.055          | 56.426                 | 59.529            |
| 47   | 04-07-1967 | 0.869          | 0.58           | 23.841                 | 13.828            |
| 48   | 05-07-1967 | 1.783          | 0.987          | 69.68                  | 68.774            |
| 49   | 04-08-1967 | 1.5            | 1.15           | 47.189                 | 54.267            |
| 50   | 06-09-1967 | 1.189          | 0.842          | 37.816                 | 31.841            |
| 51   | 05-10-1967 | 1.524          | 0.956          | 55.915                 | 53.455            |
| 52   | 05-12-1967 | 1.28           | 0.907          | 45.169                 | 40.968            |
| 53   | 12-05-1968 | 1.03           | 0.674          | 28.951                 | 19.513            |
| 54   | 03-06-1968 | 0.951          | 0.708          | 24.85                  | 17.594            |
| 55   | 12-05-1969 | 0.823          | 0.46           | 22.843                 | 10.508            |
| 56   | 10-08-1969 | 0.777          | 0.44           | 19.523                 | 8.59              |
| 57   | 04-11-1969 | 1.183          | 0.79           | 36.811                 | 29.081            |
| 58   | 02-10-1971 | 0.835          | 0.539          | 20.2                   | 10.888            |
| 59   | 08-10-1971 | 0.73           | 0.225          | 16.716                 | 3.761             |
| 60   | 03-08-1974 | 0.62           | 0.306          | 13.82                  | 4.229             |
| 61   | 10-09-1976 | 0.725          | 0.418          | 18.443                 | 7.709             |
| 62   | 05-02-1977 | 1.13           | 0.737          | 42.887                 | 31.608            |
| 63   | 05-05-1977 | 1.18           | 0.719          | 45.152                 | 32.464            |
| 64   | 05-06-1977 | 1              | 0.649          | 36.029                 | 23.383            |
| 65   | 06-06-1977 | 0.85           | 0.47           | 29.77                  | 13.992            |
| 66   | 06-07-1977 | 0.84           | 0.457          | 30.002                 | 13.711            |
| 67   | 05-09-1977 | 0.955          | 0.603          | 37.496                 | 22.61             |
| 68   | 05-11-1977 | 0.89           | 0.514          | 34.204                 | 17.581            |
| 69   | 09-10-1978 | 0.62           | 0.345          | 14.809                 | 5.109             |
| 70   | 03-03-1979 | 1.015          | 0.633          | 34.821                 | 22.042            |
| 71   | 03-05-1979 | 0.97           | 0.585          | 32.882                 | 19.236            |
| 72   | 04-05-1979 | 1.495          | 0.98           | 53.542                 | 52.471            |
| 73   | 03-08-1979 | 1              | 0.618          | 35.906                 | 22.19             |
| 74   | 03-10-1979 | 1.365          | 0.953          | 44.721                 | 42.619            |
| 75   | 04-10-1979 | 1.84           | 1.028          | 67.78                  | 69.678            |
| 76   | 04-11-1979 | 1.82           | 1.042          | 65.421                 | 68.169            |
| 77   | 03-12-1979 | 1.14           | 0.755          | 38.805                 | 29.298            |
| 78   | 04-04-1981 | 0.88           | 0.53           | 27.774                 | 14.72             |
| 79   | 04-08-1981 | 0.985          | 0.484          | 28.622                 | 13.853            |
| 80   | 04-09-1981 | 1.375          | 1.023          | 43.224                 | 44.218            |
| 81   | 03-11-1981 | 0.71           | 0.416          | 20.481                 | 8.52              |
| 82   | 03-12-1981 | 0.7            | 0.379          | 19.499                 | 7.39              |
| 83   | 03-12-1981 | 0.7            | 0.382          | 19.346                 | 7.39              |
| 84   | 04-12-1981 | 2.4            | 1.229          | 89.862                 | 110.441           |
| 85   | 09-01-2007 | 0.8            | 0.666          | 32.156                 | 21.416            |

| SNo. | Date       | Stage (metres) | Velocity (m/s) | Area (m <sup>2</sup> ) | Measured (cumecs) |
|------|------------|----------------|----------------|------------------------|-------------------|
| 86   | 27-03-2007 | 0.655          | 0.642          | 22.098                 | 14.187            |
| 87   | 01-05-2007 | 0.696          | 1.372          | 17.813                 | 24.44             |
| 88   | 01-12-2007 | 0.54           | 0.617          | 19.663                 | 12.132            |
| 89   | 02-05-2008 | 1.78           | 1.436          | 32.387                 | 46.508            |
| 90   | 03-05-2008 | 1.49           | 1.413          | 30.041                 | 42.448            |
| 91   | 22-01-2009 | 0.32           | 0.255          | 18.961                 | 4.835             |
| 92   | 28-01-2010 | 0.38           | 0.742          | 12.434                 | 9.226             |
| 93   | 22-12-2010 | 0.4            | 0.314          | 18.86                  | 5.926             |
| 94   | 31-03-2011 |                | 0.593          | 24.075                 | 14.271            |
| 95   | 26-06-2011 | 2.01           | 0.992          | 16.801                 | 16.659            |
| 96   | 15-07-2011 | 0.47           | 0.437          | 18.512                 | 8.081             |
| 97   | 30-07-2011 |                | 0.378          | 18.339                 | 6.928             |
| 98   | 09-10-2011 | 0.81           | 0.66           | 28.54                  | 18.824            |
| 99   | 10-11-2011 | 0.39           | 0.414435       | 14.229                 | 5.897             |
| 100  | 02-12-2011 | 0.417          | 0.395111       | 15.912                 | 6.287             |
| 101  | 17-01-2012 | 0.595          | 0.6365         | 18.5895                | 11.8405           |

## 2. Mgeta River at Mgeta

| SNo. | Date       | Stage (metres) | Velocity (m/s) | Area (m <sup>2</sup> ) | Measured (cumecs) |
|------|------------|----------------|----------------|------------------------|-------------------|
| 1    | 22-06-1954 | 0.53           | 0.23           | 7.391                  | 1.7               |
| 2    | 04-09-1954 | 0.4            | 0.14           | 6.143                  | 0.86              |
| 3    | 02-10-1954 | 0.37           | 0.13           | 5.769                  | 0.75              |
| 4    | 23-01-1959 | 0.43           | 0.26           | 3.962                  | 1.03              |
| 5    | 26-04-1959 | 0.61           | 0.35           | 7.057                  | 2.47              |
| 6    | 03-01-1960 | 0.4            | 0.35           | 7.057                  | 2.47              |
| 7    | 09-03-1960 | 0.64           | 0.7            | 5.014                  | 3.51              |
| 8    | 13-05-1960 | 0.64           | 0.52           | 6.173                  | 3.21              |
| 9    | 10-09-1960 | 0.38           | 0.31           | 2.935                  | 0.91              |
| 10   | 02-11-1960 | 0.4            | 0.34           | 3.324                  | 1.13              |
| 11   | 02-03-1961 | 0.55           | 0.64           | 3.875                  | 2.48              |
| 12   | 05-06-1961 | 0.5            | 0.77           | 3.143                  | 2.42              |
| 13   | 26-08-1961 | 0.4            | 0.32           | 3.625                  | 1.16              |
| 14   | 31-01-1962 | 0.63           | 0.78           | 4.872                  | 3.8               |
| 15   | 06-03-1962 | 0.55           | 0.59           | 4.119                  | 2.43              |
| 16   | 26-04-1962 | 0.67           | 0.73           | 5.137                  | 3.75              |
| 17   | 25-07-1962 | 0.46           | 0.42           | 2.952                  | 1.24              |
| 18   | 22-08-1962 | 0.49           | 0.51           | 3.039                  | 1.55              |
| 19   | 17-09-1962 | 0.44           | 0.38           | 3.026                  | 1.15              |
| 20   | 13-12-1962 | 0.46           | 0.38           | 4.395                  | 1.67              |
| 21   | 27-12-1962 | 0.7            | 0.59           | 7.898                  | 4.66              |
| 22   | 30-05-1963 | 0.54           | 0.53           | 5.245                  | 2.78              |
| 23   | 19-07-1963 | 0.41           | 0.31           | 4.645                  | 1.44              |
| 24   | 14-08-1963 | 0.37           | 0.29           | 3.862                  | 1.12              |
| 25   | 27-09-1963 | 0.32           | 0.23           | 3.739                  | 0.86              |
| 26   | 27-09-1963 | 0.32           | 0.14           | 6.214                  | 0.87              |
| 27   | 19-11-1963 | 0.82           | 0.66           | 9.303                  | 6.14              |

| SNo. | Date       | Stage (metres) | Velocity (m/s) | Area (m2) | Measured (cumecs) |
|------|------------|----------------|----------------|-----------|-------------------|
| 28   | 21-11-1963 | 0.67           | 0.28           | 6.964     | 1.95              |
| 29   | 13-02-1964 | 0.47           | 0.4            | 3.975     | 1.59              |
| 30   | 22-05-1964 | 0.58           | 0.24           | 6.5       | 1.56              |
| 31   | 18-09-1964 | 0.33           | 0.21           | 4.238     | 0.89              |
| 32   | 18-09-1964 | 0.33           | 0.47           | 1.957     | 0.92              |
| 33   | 16-07-1965 | 0.41           | 0.3            | 4.067     | 1.22              |
| 34   | 13-01-1966 | 0.49           | 0.35           | 5.943     | 2.08              |
| 35   | 21-02-1966 | 0.73           | 0.76           | 6.789     | 5.16              |
| 36   | 29-10-1966 | 0.4            | 0.3            | 4.367     | 1.31              |
| 37   | 08-06-1967 | 0.69           | 0.49           | 8.469     | 4.15              |
| 38   | 21-03-1968 | 0.76           | 0.51           | 9.529     | 4.86              |
| 39   | 25-03-1968 | 0.67           | 0.46           | 8.326     | 3.83              |
| 40   | 26-03-1968 | 0.89           | 0.6            | 11.833    | 7.1               |
| 41   | 26-03-1968 | 0.85           | 0.63           | 10.698    | 6.74              |
| 42   | 31-03-1968 | 0.87           | 0.63           | 10.889    | 6.86              |
| 43   | 01-04-1968 | 0.81           | 0.58           | 9.948     | 5.77              |
| 44   | 02-04-1968 | 0.79           | 0.55           | 9.655     | 5.31              |
| 45   | 02-04-1968 | 0.81           | 0.6            | 9.95      | 5.97              |
| 46   | 03-04-1968 | 0.93           | 0.65           | 12.185    | 7.92              |
| 47   | 03-04-1968 | 0.91           | 0.65           | 11.615    | 7.55              |
| 48   | 03-04-1968 | 0.84           | 0.56           | 10.625    | 5.95              |
| 49   | 04-04-1968 | 0.8            | 0.53           | 10.208    | 5.41              |
| 50   | 05-04-1968 | 0.89           | 0.64           | 11.172    | 7.15              |
| 51   | 05-04-1968 | 0.85           | 0.59           | 10.492    | 6.19              |
| 52   | 06-04-1968 | 0.89           | 0.63           | 11.063    | 6.97              |
| 53   | 09-04-1968 | 0.95           | 0.7            | 11.671    | 8.17              |
| 54   | 10-04-1968 | 0.93           | 0.64           | 11.672    | 7.47              |
| 55   | 13-04-1968 | 1.08           | 0.99           | 11.051    | 10.94             |
| 56   | 13-04-1968 | 1.16           | 1              | 16.33     | 16.33             |
| 57   | 13-04-1968 | 1.17           | 1.03           | 17.709    | 18.24             |
| 58   | 13-04-1968 | 1.12           | 0.92           | 16.228    | 14.93             |
| 59   | 16-04-1968 | 0.97           | 0.75           | 13        | 9.75              |
| 60   | 16-04-1968 | 0.98           | 0.77           | 13.13     | 10.11             |
| 61   | 17-04-1968 | 1.01           | 0.8            | 13.188    | 10.55             |
| 62   | 17-04-1968 | 1.02           | 0.8            | 13.538    | 10.83             |
| 63   | 20-04-1968 | 1.03           | 0.8            | 13.25     | 10.6              |
| 64   | 20-04-1968 | 1.01           | 0.78           | 12.91     | 10.07             |
| 65   | 22-04-1968 | 1.04           | 0.65           | 17.6      | 11.44             |
| 66   | 23-04-1968 | 1.09           | 0.71           | 18.352    | 13.03             |
| 67   | 23-04-1968 | 1.11           | 0.71           | 16.845    | 11.96             |
| 68   | 02-05-1968 | 0.87           | 0.47           | 14.149    | 6.65              |
| 69   | 05-11-1968 | 0.33           | 0.19           | 4.737     | 0.9               |
| 70   | 07-12-1968 | 0.7            | 0.38           | 10.526    | 4                 |
| 71   | 14-10-1969 | 0.3            | 0.21           | 3.905     | 0.82              |
| 72   | 04-03-1970 | 0.64           | 0.75           | 4.96      | 3.72              |
| 73   | 14-07-1970 | 0.41           | 0.71           | 1.817     | 1.29              |
| 74   | 05-02-1971 | 0.66           | 0.9            | 4.522     | 4.07              |
| 75   | 11-08-1971 | 0.55           | 0.16           | 3.938     | 0.63              |
| 76   | 16-10-1971 | 0.51           | 0.22           | 3.977     | 0.875             |
| 77   | 26-09-1972 | 0.445          | 0.42           | 2.883     | 1.211             |
| 78   | 14-08-1973 | 0.57           | 0.2            | 3.26      | 0.652             |
| 79   | 29-08-1974 | 0.585          | 0.32           | 3.116     | 0.997             |
| 80   | 16-11-1974 | 0.565          | 0.18           | 4.139     | 0.745             |

| SNo. | Date       | Stage (metres) | Velocity (m/s) | Area (m2) | Measured (cumecs) |
|------|------------|----------------|----------------|-----------|-------------------|
| 81   | 16-10-1975 | 0.6            | 0.53           | 1.37      | 0.726             |
| 82   | 15-11-1975 | 0.6            | 0.99           | 0.842     | 0.834             |
| 83   | 05-10-1976 | 0.46           | 0.55           | 3.395     | 1.867             |
| 84   | 07-10-1976 | 0.445          | 0.52           | 2.912     | 1.514             |
| 85   | 14-11-1977 | 1.25           | 0.73           | 5.89      | 4.3               |
| 86   | 04-01-1978 | 1.36           | 0.84           | 6.07      | 5.099             |
| 87   | 06-12-1978 | 1.43           | 0.66           | 9.303     | 6.14              |
| 88   | 01-03-1979 | 1.25           | 0.55           | 5.995     | 3.297             |
| 89   | 03-03-1979 | 1.25           | 0.51           | 5.896     | 3.007             |
| 90   | 05-03-1979 | 1.22           | 0.49           | 5.614     | 2.751             |
| 91   | 08-03-1979 | 1.23           | 0.62           | 5.906     | 3.662             |
| 92   | 08-03-1979 | 1.58           | 0.86           | 10.37     | 8.918             |
| 93   | 09-03-1979 | 1.28           | 0.66           | 6.286     | 4.149             |
| 94   | 12-03-1979 | 1.31           | 0.62           | 7.095     | 4.399             |
| 95   | 13-03-1979 | 1.39           | 0.7            | 7.39      | 5.173             |
| 96   | 13-03-1979 | 1.47           | 0.74           | 9.055     | 6.701             |
| 97   | 15-03-1979 | 1.46           | 0.76           | 8.478     | 6.443             |
| 98   | 16-03-1979 | 1.52           | 0.79           | 9.448     | 7.464             |
| 99   | 17-03-1979 | 1.46           | 0.74           | 8.684     | 6.426             |
| 100  | 19-03-1979 | 1.56           | 0.79           | 10.782    | 8.518             |
| 101  | 21-03-1979 | 1.64           | 0.93           | 10.831    | 10.073            |
| 102  | 09-04-1979 | 1.72           | 1.09           | 10.82     | 11.794            |
| 103  | 11-04-1979 | 1.82           | 1.07           | 12.006    | 12.846            |
| 104  | 12-04-1979 | 1.83           | 1.09           | 12.155    | 13.249            |
| 105  | 14-04-1979 | 1.74           | 1.07           | 9.695     | 10.374            |
| 106  | 22-04-1979 | 1.77           | 1.39           | 8.437     | 11.727            |
| 107  | 24-04-1979 | 1.91           | 1.47           | 9.988     | 14.683            |
| 108  | 24-04-1979 | 1.72           | 1              | 9.894     | 9.894             |
| 109  | 24-04-1979 | 1.93           | 1.54           | 9.852     | 15.172            |
| 110  | 26-04-1979 | 1.61           | 1.37           | 6.799     | 9.315             |
| 111  | 27-04-1979 | 1.61           | 0.88           | 10.494    | 9.235             |
| 112  | 09-05-1979 | 1.52           | 0.96           | 7.745     | 7.435             |
| 113  | 10-05-1979 | 1.5            | 0.93           | 7.384     | 6.867             |
| 114  | 11-05-1979 | 1.48           | 0.92           | 7.218     | 6.641             |
| 115  | 14-05-1979 | 1.44           | 0.89           | 6.404     | 5.7               |
| 116  | 16-05-1979 | 1.4            | 0.9            | 6.044     | 5.44              |
| 117  | 28-01-1980 | 0.54           | 0.5            | 4.16      | 2.08              |
| 118  | 21-08-1982 | 0.26           | 0.45           | 4.171     | 1.877             |
| 119  | 24-02-1983 | 0.5            | 0.55           | 3.129     | 1.721             |
| 120  | 07-03-1983 | 0.48           | 0.56           | 2.852     | 1.597             |
| 121  | 15-03-1983 | 0.53           | 0.64           | 4         | 2.56              |
| 122  | 16-03-1983 | 0.51           | 0.52           | 3.442     | 1.79              |
| 123  | 17-03-1983 | 0.74           | 0.86           | 6.779     | 5.83              |
| 124  | 17-03-1983 | 0.72           | 0.86           | 6.2       | 5.332             |
| 125  | 17-03-1983 | 0.69           | 0.8            | 5.628     | 4.502             |
| 126  | 30-03-1983 | 0.815          | 0.87           | 7.562     | 6.579             |
| 127  | 30-03-1983 | 0.81           | 0.86           | 7.393     | 6.358             |
| 128  | 18-04-1983 | 0.56           | 0.64           | 4.023     | 2.575             |
| 129  | 28-04-1983 | 0.66           | 0.77           | 5.195     | 4                 |
| 130  | 28-04-1983 | 0.65           | 0.78           | 5.054     | 3.942             |
| 131  | 08-12-1989 | 0.457          | 0.55           | 5.115     | 2.813             |
| 132  | 12-01-2007 | 0.712          | 0.968          | 6.191     | 5.993             |
| 133  | 05-05-2008 | 0.74           | 1.183          | 5.848     | 6.918             |



| SNo.       | Date              | Stage (metres) | Velocity (m/s) | Area (m2)    | Measured (cumecs) |
|------------|-------------------|----------------|----------------|--------------|-------------------|
| 134        | 06-05-2008        | 0.71           | 1.109          | 5.687        | 6.307             |
| 135        | 23-01-2009        | 0.52           | 0.632          | 1.848        | 1.168             |
| 136        | 06-05-2009        | 0.632          | 0.396          | 5.28         | 2.091             |
| 137        | 16-06-2009        | 0.55           | 0.776          | 2.47         | 1.917             |
| 138        | 17-12-2009        | 0.515          | 0.676          | 1.553        | 1.05              |
| 139        | 04-02-2010        | 0.5            | 0.374          | 3.219        | 1.204             |
| <b>140</b> | <b>24-12-2010</b> | <b>0.57</b>    | <b>0.608</b>   | <b>1.968</b> | <b>1.196</b>      |
| 141        | 27-06-2011        | 0.515          |                |              | 1.552             |

### 3. Ngeregere River at Mgude

| SNo. | Date       | Stage (metres) | Velocity (m/s) | Area (m2) | Measured (cumecs) |
|------|------------|----------------|----------------|-----------|-------------------|
| 1    | 14-10-1968 | 0.54           | 0.363          | 1.242     | 0.451             |
| 2    | 14-10-1968 | 0.54           | 0.396          | 1.217     | 0.482             |
| 3    | 31-01-1969 | 0.61           | 0.582          | 2.256     | 1.313             |
| 4    | 01-02-1969 | 0.67           | 0.621          | 2.773     | 1.722             |
| 5    | 04-02-1969 | 1.22           | 0.679          | 8.583     | 5.828             |
| 6    | 09-04-1969 | 1.04           | 0.662          | 6.088     | 4.03              |
| 7    | 10-04-1969 | 1.04           | 0.687          | 6.336     | 4.353             |
| 8    | 11-04-1969 | 1.25           | 0.801          | 8.31      | 6.656             |
| 9    | 14-04-1969 | 1.58           | 0.822          | 11.369    | 9.345             |
| 10   | 15-04-1969 | 1.6            | 1.016          | 10.87     | 11.044            |
| 11   | 16-04-1969 | 1.58           | 1.112          | 10.823    | 12.035            |
| 12   | 17-04-1969 | 1.76           | 1.003          | 12.916    | 12.955            |
| 13   | 18-04-1969 | 1.83           | 1.03           | 13.471    | 13.875            |
| 14   | 19-04-1969 | 1.89           | 1.021          | 14.075    | 14.371            |
| 15   | 21-04-1969 | 2.13           | 1.054          | 17.598    | 18.548            |
| 16   | 22-04-1969 | 2.13           | 1.063          | 17.049    | 18.123            |
| 17   | 24-04-1969 | 2.15           | 1.069          | 16.953    | 18.123            |
| 18   | 24-04-1969 | 2.26           | 1.099          | 18.294    | 20.105            |
| 19   | 28-04-1969 | 1.98           | 1.151          | 15.007    | 17.273            |
| 20   | 29-04-1969 | 2.07           | 1.05           | 16.45     | 17.273            |
| 21   | 30-04-1969 | 2.53           | 1.03           | 22.763    | 23.446            |
| 22   | 05-05-1969 | 3.03           | 1.128          | 32.886    | 37.095            |
| 23   | 05-05-1969 | 3.08           | 1.073          | 50.934    | 54.652            |
| 24   | 08-05-1969 | 2.58           | 1.255          | 24.256    | 30.441            |
| 25   | 10-05-1969 | 2.3            | 1.19           | 19.981    | 23.777            |
| 26   | 12-05-1969 | 1.97           | 1.184          | 14.583    | 17.266            |
| 27   | 15-05-1969 | 1.65           | 0.796          | 11.562    | 9.203             |
| 28   | 16-05-1969 | 1.6            | 1.066          | 10.825    | 11.539            |
| 29   | 17-05-1969 | 1.52           | 0.991          | 10.358    | 10.265            |
| 30   | 21-05-1969 | 1.34           | 0.432          | 16.715    | 7.221             |
| 31   | 23-05-1969 | 1.25           | 0.775          | 8.659     | 6.711             |
| 32   | 28-05-1969 | 1.13           | 0.716          | 7.761     | 5.557             |
| 33   | 10-09-1969 | 0.54           | 0.825          | 2.015     | 1.662             |
| 34   | 12-09-1969 | 0.51           | 0.691          | 1.852     | 1.28              |
| 35   | 13-09-1969 | 0.56           | 0.758          | 2.266     | 1.718             |
| 36   | 16-09-1969 | 0.49           | 0.753          | 1.838     | 1.384             |
| 37   | 22-09-1969 | 0.41           | 0.622          | 1.654     | 1.029             |

| SNo. | Date       | Stage (metres) | Velocity (m/s) | Area (m <sup>2</sup> ) | Measured (cumecs) |
|------|------------|----------------|----------------|------------------------|-------------------|
| 38   | 24-09-1969 | 0.44           | 0.592          | 1.569                  | 0.929             |
| 39   | 25-09-1969 | 0.45           | 0.568          | 1.616                  | 0.918             |
| 40   | 27-09-1969 | 0.43           | 0.552          | 1.607                  | 0.887             |
| 41   | 27-09-1969 | 0.43           | 0.553          | 1.606                  | 0.888             |
| 42   | 01-10-1969 | 0.4            | 0.589          | 1.348                  | 0.794             |
| 43   | 01-10-1969 | 0.4            | 0.531          | 1.273                  | 0.676             |
| 44   | 23-12-1969 | 0.46           | 0.589          | 1.579                  | 0.93              |
| 45   | 27-04-1970 | 2.5            | 1.094          | 25.507                 | 27.905            |
| 46   | 28-04-1970 | 2.13           | 1.101          | 19.586                 | 21.564            |
| 47   | 28-04-1970 | 2.01           | 1.06           | 17.329                 | 18.369            |
| 48   | 29-04-1970 | 1.77           | 1.201          | 13.777                 | 16.546            |
| 49   | 30-04-1970 | 1.66           | 1.055          | 11.8                   | 12.449            |
| 50   | 07-05-1970 | 1.52           | 0.975          | 10.196                 | 9.941             |
| 51   | 08-05-1970 | 1.49           | 0.98           | 10.233                 | 10.028            |
| 52   | 11-05-1970 | 1.37           | 0.723          | 9.243                  | 6.683             |
| 53   | 12-05-1970 | 1.28           | 0.697          | 9.06                   | 6.315             |
| 54   | 13-05-1970 | 1.22           | 0.635          | 8.65                   | 5.493             |
| 55   | 19-05-1970 | 0.98           | 0.656          | 5.877                  | 3.855             |
| 56   | 22-05-1970 | 0.91           | 0.532          | 5.795                  | 3.083             |
| 57   | 23-05-1970 | 1.11           | 0.613          | 7.576                  | 4.644             |
| 58   | 24-05-1970 | 1.25           | 0.669          | 9.694                  | 6.485             |
| 59   | 28-05-1970 | 1.04           | 0.63           | 6.787                  | 4.276             |
| 60   | 01-06-1970 | 0.88           | 0.642          | 5.218                  | 3.35              |
| 61   | 04-06-1970 | 0.76           | 0.842          | 3.686                  | 3.104             |
| 62   | 11-10-1970 | 0.08           | 0.189          | 0.794                  | 0.15              |
| 63   | 16-10-1970 | 0.34           | 0.513          | 1.378                  | 0.707             |
| 64   | 17-10-1970 | 0.3            | 0.456          | 1.162                  | 0.53              |
| 65   | 02-02-1971 | 0.96           | 0.618          | 6.028                  | 3.725             |
| 66   | 11-02-1971 | 0.9            | 0.622          | 5.69                   | 3.539             |
| 67   | 12-02-1971 | 0.79           | 0.548          | 5.4                    | 2.959             |
| 68   | 21-07-1971 | 0.52           | 0.68           | 2.415                  | 1.642             |
| 69   | 22-07-1971 | 0.53           | 0.662          | 2.566                  | 1.699             |
| 70   | 24-07-1971 | 0.6            | 0.474          | 4.576                  | 2.169             |
| 71   | 12-10-1971 | 0.08           | 0.188          | 0.771                  | 0.145             |
| 72   | 09-02-1972 | 0.16           | 0.269          | 1.067                  | 0.287             |
| 73   | 11-02-1972 | 0.18           | 0.292          | 1.164                  | 0.34              |
| 74   | 14-02-1972 | 0.15           | 0.262          | 1.008                  | 0.264             |
| 75   | 09-03-1972 | 1.06           | 0.541          | 7.447                  | 4.029             |
| 76   | 11-03-1972 | 0.52           | 0.694          | 2.203                  | 1.529             |
| 77   | 07-04-1972 | 0.44           | 0.541          | 2.089                  | 1.13              |
| 78   | 08-04-1972 | 0.42           | 0.529          | 1.972                  | 1.043             |
| 79   | 11-04-1972 | 1.08           | 0.56           | 7.196                  | 4.03              |
| 80   | 18-04-1972 | 1.56           | 0.82           | 9.695                  | 7.95              |
| 81   | 20-04-1972 | 2.05           | 0.82           | 9.695                  | 7.95              |
| 82   | 22-04-1972 | 2.74           | 1.035          | 32.271                 | 33.4              |
| 83   | 24-04-1972 | 2.31           | 1.099          | 20.883                 | 22.95             |
| 84   | 25-04-1972 | 2.54           | 1.142          | 25.512                 | 29.135            |
| 85   | 02-05-1972 | 1.86           | 0.957          | 13.334                 | 12.761            |
| 86   | 03-05-1972 | 1.58           | 0.537          | 11.229                 | 6.03              |
| 87   | 05-05-1972 | 1.36           | 0.903          | 8.549                  | 7.72              |
| 88   | 06-05-1972 | 1.4            | 0.879          | 9.479                  | 8.332             |

| SNo. | Date       | Stage (metres) | Velocity (m/s) | Area (m <sup>2</sup> ) | Measured (cumecs) |
|------|------------|----------------|----------------|------------------------|-------------------|
| 89   | 08-05-1972 | 1.79           | 0.873          | 11.936                 | 10.42             |
| 90   | 15-05-1972 | 3.19           | 0.842          | 41.116                 | 34.62             |
| 91   | 16-05-1972 | 2.85           | 0.976          | 39.303                 | 38.36             |
| 92   | 19-05-1972 | 2.73           | 0.985          | 35.858                 | 35.32             |
| 93   | 20-05-1972 | 2.98           | 1.076          | 41.747                 | 44.92             |
| 94   | 22-05-1972 | 2.18           | 1.077          | 20.344                 | 21.91             |
| 95   | 05-06-1972 | 1.52           | 0.963          | 11.121                 | 10.71             |
| 96   | 06-06-1972 | 1.44           | 0.883          | 9.581                  | 8.46              |
| 97   | 07-06-1972 | 1.38           | 0.897          | 8.673                  | 7.78              |
| 98   | 08-06-1972 | 1.32           | 0.89           | 9.438                  | 8.4               |
| 99   | 14-06-1972 | 1.08           | 0.662          | 7.896                  | 5.227             |
| 100  | 16-06-1972 | 1.02           | 0.587          | 7.245                  | 4.253             |
| 101  | 17-06-1972 | 0.96           | 0.572          | 7.472                  | 4.274             |
| 102  | 19-06-1972 | 0.91           | 0.559          | 6.869                  | 3.84              |
| 103  | 20-06-1972 | 0.88           | 0.511          | 6.591                  | 3.368             |
| 104  | 21-06-1972 | 0.88           | 0.572          | 6.5                    | 3.718             |
| 105  | 22-06-1972 | 0.84           | 0.587          | 6.411                  | 3.763             |
| 106  | 23-06-1972 | 0.81           | 0.556          | 6.277                  | 3.49              |
| 107  | 04-09-1972 | 0.27           | 0.386          | 1.808                  | 0.698             |
| 108  | 08-09-1972 | 0.27           | 0.345          | 2.006                  | 0.692             |
| 109  | 09-09-1972 | 0.26           | 0.358          | 1.793                  | 0.642             |
| 110  | 12-09-1972 | 0.54           | 0.567          | 3.54                   | 2.007             |
| 111  | 14-11-1972 | 1.22           | 0.624          | 8.851                  | 5.523             |
| 112  | 15-11-1972 | 1.44           | 0.66           | 10.539                 | 6.956             |
| 113  | 18-12-1972 | 0.82           | 0.568          | 5.648                  | 3.208             |
| 114  | 19-12-1972 | 0.74           | 0.557          | 5.048                  | 2.812             |
| 116  | 12-08-1974 | 0.34           | 0.466          | 1.738                  | 0.81              |
| 117  | 15-08-1974 | 0.36           | 0.429          | 1.702                  | 0.73              |
| 118  | 28-03-1975 | 0.77           | 0.283          | 2.625                  | 0.743             |
| 119  | 29-03-1975 | 0.76           | 0.316          | 2.446                  | 0.773             |
| 120  | 31-03-1975 | 0.7            | 0.252          | 2.218                  | 0.559             |
| 121  | 01-04-1975 | 0.75           | 0.329          | 2.608                  | 0.858             |
| 122  | 12-04-1975 | 1.44           | 0.54           | 10.309                 | 5.567             |
| 123  | 13-04-1975 | 1.44           | 0.551          | 9.98                   | 5.499             |
| 124  | 21-04-1975 | 1.56           | 0.531          | 13.422                 | 7.127             |
| 125  | 22-04-1975 | 1.47           | 0.533          | 11.765                 | 6.271             |
| 126  | 23-04-1975 | 1.48           | 0.506          | 10.478                 | 5.302             |
| 127  | 24-04-1975 | 1.62           | 0.494          | 15.304                 | 7.56              |
| 128  | 03-05-1975 | 1.56           | 0.641          | 13.257                 | 8.498             |
| 129  | 05-05-1975 | 1.49           | 0.561          | 12.594                 | 7.065             |
| 130  | 06-05-1975 | 1.52           | 0.574          | 11.063                 | 6.35              |
| 131  | 07-05-1975 | 1.4            | 0.545          | 10.062                 | 5.484             |
| 132  | 08-05-1975 | 1.39           | 0.536          | 9.062                  | 4.857             |
| 133  | 09-05-1975 | 1.31           | 0.548          | 8.487                  | 4.651             |
| 134  | 12-05-1975 | 1.23           | 0.512          | 7.371                  | 3.774             |
| 135  | 13-05-1975 | 1.49           | 0.566          | 11.77                  | 6.662             |
| 136  | 15-05-1975 | 0.66           | 0.269          | 2.286                  | 0.615             |
| 137  | 19-05-1975 | 1.59           | 0.543          | 13.786                 | 7.486             |
| 138  | 22-05-1975 | 1.44           | 0.542          | 10.838                 | 5.874             |
| 140  | 14-08-1975 | 0.65           | 0.398          | 2.239                  | 0.891             |
| 141  | 18-03-1976 | 0.59           | 0.322          | 0.991                  | 0.319             |

| SNo. | Date       | Stage (metres) | Velocity (m/s) | Area (m <sup>2</sup> ) | Measured (cumecs) |
|------|------------|----------------|----------------|------------------------|-------------------|
| 139  | 23-05-1975 | 1.53           | 0.479          | 12.658                 | 6.063             |
| 176  | 21-05-1976 | 1.6            | 0.629          | 13.488                 | 8.484             |
| 142  | 19-03-1976 | 0.58           | 0.317          | 0.981                  | 0.311             |
| 143  | 20-03-1976 | 0.52           | 0.333          | 0.661                  | 0.22              |
| 144  | 22-03-1976 | 0.98           | 0.495          | 5.149                  | 2.549             |
| 145  | 23-03-1976 | 0.92           | 0.452          | 4.735                  | 2.14              |
| 146  | 24-03-1976 | 0.91           | 0.441          | 4.791                  | 2.113             |
| 147  | 25-03-1976 | 0.97           | 0.364          | 6.214                  | 2.262             |
| 148  | 29-03-1976 | 0.94           | 0.459          | 5.386                  | 2.472             |
| 149  | 30-03-1976 | 0.95           | 0.518          | 4.998                  | 2.589             |
| 150  | 01-04-1976 | 1.16           | 0.504          | 8.321                  | 4.194             |
| 151  | 02-04-1976 | 1.08           | 0.589          | 6.229                  | 3.669             |
| 152  | 03-04-1976 | 1              | 0.584          | 5.139                  | 3.001             |
| 153  | 06-04-1976 | 0.87           | 0.47           | 4.151                  | 1.951             |
| 154  | 07-04-1976 | 0.82           | 0.436          | 3.573                  | 1.558             |
| 155  | 08-04-1976 | 0.78           | 0.409          | 3.357                  | 1.373             |
| 156  | 09-04-1976 | 0.74           | 0.514          | 2.381                  | 1.224             |
| 157  | 10-04-1976 | 0.72           | 0.511          | 2.258                  | 1.154             |
| 158  | 12-04-1976 | 0.72           | 0.517          | 2.329                  | 1.204             |
| 159  | 13-04-1976 | 0.89           | 0.392          | 5.145                  | 2.017             |
| 160  | 14-04-1976 | 0.9            | 0.471          | 4.896                  | 2.306             |
| 161  | 15-04-1976 | 0.86           | 0.479          | 3.998                  | 1.915             |
| 162  | 17-04-1976 | 0.81           | 0.424          | 3.651                  | 1.548             |
| 163  | 20-04-1976 | 1.2            | 0.452          | 9.529                  | 4.307             |
| 164  | 21-04-1976 | 1.28           | 0.497          | 10.706                 | 5.321             |
| 165  | 22-04-1976 | 1.31           | 0.575          | 9.814                  | 5.643             |
| 166  | 23-04-1976 | 1.42           | 0.558          | 11.303                 | 6.307             |
| 167  | 24-04-1976 | 1.43           | 0.587          | 11.334                 | 6.653             |
| 168  | 07-05-1976 | 1.82           | 0.674          | 19.51                  | 13.15             |
| 169  | 10-05-1976 | 1.72           | 0.696          | 14.375                 | 10.005            |
| 170  | 11-05-1976 | 1.73           | 0.674          | 16.708                 | 11.261            |
| 171  | 12-05-1976 | 1.67           | 0.651          | 13.515                 | 8.798             |
| 172  | 13-05-1976 | 1.55           | 0.65           | 12.4                   | 8.06              |
| 173  | 14-05-1976 | 1.46           | 0.704          | 10.467                 | 7.369             |
| 174  | 15-05-1976 | 1.39           | 0.586          | 10.846                 | 6.356             |
| 175  | 17-05-1976 | 1.32           | 0.59           | 9.573                  | 5.648             |
| 177  | 22-05-1976 | 1.47           | 3.367          | 1.87                   | 6.296             |
| 178  | 24-05-1976 | 1.32           | 0.57           | 8.686                  | 4.951             |
| 179  | 25-05-1976 | 1.27           | 0.569          | 8.615                  | 4.902             |
| 180  | 27-05-1976 | 1.18           | 0.625          | 7.058                  | 4.411             |
| 181  | 01-06-1976 | 1.02           | 0.568          | 5.222                  | 2.966             |
| 182  | 02-06-1976 | 1              | 0.547          | 5.124                  | 2.803             |
| 183  | 03-06-1976 | 0.99           | 0.565          | 4.701                  | 2.656             |
| 184  | 04-06-1976 | 0.98           | 0.543          | 4.7                    | 2.552             |
| 185  | 19-06-1976 | 1.77           | 0.67           | 14.533                 | 9.737             |
| 186  | 17-08-1976 | 0.66           | 0.402          | 1.493                  | 0.6               |
| 187  | 13-03-1977 | 0.8            | 0.567          | 3.102                  | 1.759             |
| 188  | 15-03-1977 | 0.78           | 0.364          | 2.94                   | 1.07              |
| 189  | 16-03-1977 | 0.87           | 0.466          | 4.028                  | 1.877             |
| 190  | 18-03-1977 | 0.77           | 0.516          | 2.63                   | 1.357             |
| 191  | 19-03-1977 | 0.76           | 0.484          | 2.762                  | 1.337             |

| SNo. | Date       | Stage (metres) | Velocity (m/s) | Area (m <sup>2</sup> ) | Measured (cumecs) |
|------|------------|----------------|----------------|------------------------|-------------------|
| 192  | 21-03-1977 | 0.68           | 0.553          | 1.62                   | 0.896             |
| 193  | 22-03-1977 | 0.69           | 0.508          | 1.74                   | 0.884             |
| 194  | 23-03-1977 | 1.3            | 0.376          | 11.835                 | 4.45              |
| 195  | 24-03-1977 | 0.76           | 0.523          | 2.707                  | 1.416             |
| 196  | 25-03-1977 | 0.68           | 0.539          | 1.77                   | 0.954             |
| 197  | 26-03-1977 | 0.67           | 0.536          | 1.791                  | 0.96              |
| 198  | 29-03-1977 | 1.05           | 0.435          | 7.637                  | 3.322             |
| 199  | 30-03-1977 | 1.15           | 0.407          | 8.835                  | 3.596             |
| 200  | 31-03-1977 | 1.19           | 0.453          | 8.755                  | 3.966             |
| 201  | 01-04-1977 | 1.16           | 0.473          | 7.753                  | 3.667             |
| 202  | 02-04-1977 | 1.15           | 0.513          | 7.156                  | 3.671             |
| 203  | 04-04-1977 | 1.02           | 0.527          | 5.702                  | 3.005             |
| 204  | 06-04-1977 | 0.98           | 0.522          | 4.697                  | 2.452             |
| 205  | 07-04-1977 | 0.96           | 0.551          | 4.702                  | 2.591             |
| 206  | 12-04-1977 | 1.2            | 0.575          | 7.224                  | 4.154             |
| 207  | 13-04-1977 | 1.25           | 0.509          | 8.68                   | 4.418             |
| 208  | 15-04-1977 | 1.36           | 0.452          | 10.409                 | 4.705             |
| 209  | 17-04-1977 | 1.24           | 0.544          | 7.943                  | 4.321             |
| 210  | 19-04-1977 | 1.05           | 0.553          | 5.707                  | 3.156             |
| 211  | 20-04-1977 | 1.01           | 0.558          | 5.916                  | 3.301             |
| 212  | 22-04-1977 | 1.03           | 0.487          | 5.632                  | 2.743             |
| 213  | 01-05-1977 | 1.2            | 0.55           | 7.704                  | 4.237             |
| 214  | 07-05-1977 | 1.41           | 0.53           | 10.081                 | 5.343             |
| 215  | 09-05-1977 | 1.28           | 0.542          | 8.852                  | 4.798             |
| 216  | 10-05-1977 | 1.28           | 0.516          | 8.804                  | 4.543             |
| 217  | 16-05-1977 | 1.06           | 0.53           | 5.83                   | 3.09              |
| 218  | 19-05-1977 | 0.98           | 0.55           | 4.989                  | 2.744             |
| 219  | 21-05-1977 | 0.92           | 0.572          | 4.168                  | 2.384             |
| 220  | 23-05-1977 | 1.02           | 0.538          | 5.855                  | 3.15              |
| 221  | 04-06-1977 | 1.31           | 0.621          | 7.404                  | 4.598             |
| 222  | 03-10-1977 | 1.1            | 1.543          | 3.563                  | 5.498             |
| 223  | 06-10-1977 | 0.96           | 1.708          | 2.584                  | 4.414             |
| 224  | 14-02-1978 | 0.99           | 0.522          | 3.42                   | 1.785             |
| 225  | 14-02-1978 | 0.98           | 0.529          | 2.694                  | 1.425             |
| 226  | 16-02-1978 | 0.94           | 0.406          | 2.734                  | 1.11              |
| 227  | 19-02-1978 | 0.88           | 0.506          | 1.802                  | 0.912             |
| 228  | 21-02-1978 | 0.86           | 0.54           | 1.846                  | 0.997             |
| 229  | 23-02-1978 | 0.97           | 0.496          | 2.827                  | 1.402             |
| 230  | 28-02-1978 | 1.34           | 0.517          | 5.882                  | 3.041             |
| 231  | 01-03-1978 | 1.23           | 0.523          | 4.258                  | 2.227             |
| 232  | 02-03-1978 | 1.16           | 0.512          | 3.154                  | 1.615             |
| 233  | 03-03-1978 | 1.1            | 0.487          | 2.984                  | 1.453             |
| 234  | 04-03-1978 | 1.06           | 0.503          | 3.074                  | 1.546             |
| 235  | 06-03-1978 | 0.98           | 0.478          | 2.444                  | 1.168             |
| 236  | 07-03-1978 | 0.95           | 0.484          | 2.376                  | 1.15              |
| 237  | 09-03-1978 | 0.98           | 0.445          | 3.106                  | 1.382             |
| 238  | 12-03-1978 | 0.93           | 0.448          | 2.299                  | 1.03              |
| 239  | 14-03-1978 | 1.02           | 0.421          | 2.589                  | 1.09              |
| 240  | 15-03-1978 | 1              | 0.435          | 2.811                  | 1.223             |
| 241  | 16-03-1978 | 0.97           | 0.454          | 2.242                  | 1.018             |
| 242  | 17-03-1978 | 0.97           | 0.371          | 3.48                   | 1.291             |

| SNo. | Date       | Stage (metres) | Velocity (m/s) | Area (m <sup>2</sup> ) | Measured (cumecs) |
|------|------------|----------------|----------------|------------------------|-------------------|
| 243  | 18-03-1978 | 2.17           | 0.456          | 26.134                 | 11.917            |
| 244  | 03-04-1978 | 1.46           | 0.466          | 7.107                  | 3.312             |
| 245  | 04-04-1978 | 1.58           | 0.448          | 9.063                  | 4.06              |
| 246  | 12-04-1978 | 2.35           | 0.736          | 30.458                 | 22.417            |
| 247  | 13-04-1978 | 2.23           | 0.693          | 35.851                 | 24.845            |
| 248  | 16-04-1978 | 1.3            | 0.511          | 15.89                  | 8.12              |
| 249  | 17-04-1978 | 1.78           | 0.589          | 11.983                 | 7.058             |
| 250  | 19-04-1978 | 2              | 0.671          | 14.833                 | 9.953             |
| 251  | 20-04-1978 | 2.12           | 0.608          | 27.536                 | 16.742            |
| 252  | 21-04-1978 | 2.1            | 0.513          | 23.082                 | 11.841            |
| 253  | 22-04-1978 | 2.1            | 0.555          | 21.429                 | 11.893            |
| 254  | 23-04-1978 | 2.45           | 0.608          | 27.536                 | 16.742            |
| 255  | 01-05-1978 | 2.52           | 0.655          | 25.519                 | 16.715            |
| 256  | 11-05-1978 | 1.72           | 0.44           | 21.257                 | 9.353             |
| 257  | 12-05-1978 | 1.84           | 0.486          | 28.27                  | 13.739            |
| 258  | 02-06-1978 | 1.38           | 0.466          | 9.562                  | 4.456             |
| 259  | 03-06-1978 | 1.39           | 0.468          | 10.011                 | 4.685             |
| 260  | 05-06-1978 | 1.34           | 0.517          | 8.919                  | 4.611             |
| 261  | 06-06-1978 | 1.36           | 0.5            | 7.954                  | 3.977             |
| 262  | 07-06-1978 | 1.33           | 0.499          | 8.585                  | 4.284             |
| 263  | 08-06-1978 | 1.3            | 0.452          | 7.619                  | 3.444             |
| 264  | 02-08-1978 | 0.75           | 0.488          | 1.658                  | 0.809             |
| 265  | 02-08-1978 | 0.75           | 0.49           | 1.824                  | 0.894             |
| 266  | 03-08-1978 | 0.76           | 0.465          | 1.828                  | 0.85              |
| 267  | 03-08-1978 | 0.76           | 0.484          | 1.884                  | 0.912             |
| 268  | 05-08-1978 | 0.74           | 0.47           | 1.785                  | 0.839             |
| 269  | 07-08-1978 | 0.72           | 0.477          | 1.633                  | 0.779             |
| 270  | 08-08-1978 | 0.74           | 0.52           | 1.74                   | 0.905             |
| 271  | 10-08-1978 | 0.72           | 0.463          | 1.635                  | 0.757             |
| 272  | 12-08-1978 | 0.7            | 0.483          | 1.489                  | 0.719             |
| 273  | 15-01-1979 | 1.78           | 0.499          | 23.986                 | 11.969            |
| 274  | 17-01-1979 | 1.62           | 0.454          | 20.729                 | 9.411             |
| 275  | 21-01-1979 | 1.5            | 0.147          | 18.272                 | 2.686             |
| 276  | 22-01-1979 | 1.42           | 0.422          | 11.396                 | 4.809             |
| 277  | 23-01-1979 | 1.91           | 0.382          | 13.319                 | 5.088             |
| 278  | 24-01-1979 | 1.78           | 0.633          | 30.641                 | 19.396            |
| 279  | 12-02-1979 | 1.53           | 0.493          | 11.777                 | 5.806             |
| 280  | 14-02-1979 | 1.49           | 0.468          | 11.321                 | 5.298             |
| 281  | 15-02-1979 | 1.51           | 0.552          | 12.462                 | 6.879             |
| 282  | 16-02-1979 | 1.46           | 0.511          | 10.924                 | 5.582             |
| 283  | 17-02-1979 | 1.56           | 0.552          | 14.036                 | 7.748             |
| 284  | 23-02-1979 | 2.32           | 0.717          | 30.841                 | 22.113            |
| 285  | 23-02-1979 | 2.3            | 0.668          | 30.545                 | 20.404            |
| 286  | 24-02-1979 | 2.02           | 0.663          | 25.528                 | 16.925            |
| 287  | 24-02-1979 | 2.04           | 0.583          | 25.907                 | 15.104            |
| 288  | 28-02-1979 | 1.95           | 0.647          | 25.649                 | 16.595            |
| 289  | 03-03-1979 | 1.52           | 0.095          | 12.505                 | 1.188             |
| 290  | 04-03-1979 | 1.48           | 0.482          | 11.151                 | 5.375             |
| 291  | 05-03-1979 | 1.4            | 0.477          | 10.333                 | 4.929             |
| 292  | 06-03-1979 | 1.36           | 0.496          | 9.665                  | 4.794             |
| 293  | 07-03-1979 | 1.32           | 0.474          | 9.165                  | 4.344             |

| SNo. | Date       | Stage (metres) | Velocity (m/s) | Area (m <sup>2</sup> ) | Measured (cumecs) |
|------|------------|----------------|----------------|------------------------|-------------------|
| 294  | 09-03-1979 | 1.3            | 0.517          | 8.404                  | 4.345             |
| 295  | 10-03-1979 | 1.3            | 0.449          | 9.189                  | 4.126             |
| 296  | 11-03-1979 | 1.24           | 0.519          | 8.295                  | 4.305             |
| 297  | 12-03-1979 | 1.28           | 0.527          | 8.898                  | 4.689             |
| 298  | 13-03-1979 | 1.34           | 0.51           | 9.373                  | 4.78              |
| 299  | 14-03-1979 | 1.42           | 0.557          | 10.522                 | 5.861             |
| 300  | 16-03-1979 | 2.04           | 0.826          | 21.093                 | 17.423            |
| 301  | 17-03-1979 | 2.28           | 0.914          | 23.992                 | 21.929            |
| 302  | 20-03-1979 | 2.38           | 0.793          | 30.566                 | 24.239            |
| 303  | 21-03-1979 | 3.54           | 0.885          | 65.719                 | 58.161            |
| 304  | 22-03-1979 | 3.24           | 0.946          | 64.225                 | 60.757            |
| 305  | 23-03-1979 | 2.41           | 0.678          | 35.497                 | 24.067            |
| 306  | 24-03-1979 | 2.09           | 0.617          | 28.833                 | 17.79             |
| 307  | 25-03-1979 | 2.97           | 0.955          | 54.381                 | 51.934            |
| 308  | 25-03-1979 | 2.99           | 1.008          | 55.406                 | 55.849            |
| 309  | 26-03-1979 | 2.83           | 1.071          | 45.236                 | 48.448            |
| 310  | 26-03-1979 | 2.82           | 1.02           | 45.807                 | 46.723            |
| 311  | 30-03-1979 | 2.44           | 0.897          | 39.796                 | 35.697            |
| 312  | 30-03-1979 | 2.43           | 0.937          | 39.099                 | 36.636            |
| 313  | 03-04-1979 | 1.87           | 0.639          | 21.628                 | 13.82             |
| 314  | 03-04-1979 | 1.85           | 0.698          | 21.223                 | 14.814            |
| 315  | 04-04-1979 | 1.94           | 0.659          | 23.388                 | 15.413            |
| 316  | 04-04-1979 | 1.96           | 0.667          | 23.706                 | 15.812            |
| 317  | 06-04-1979 | 2.24           | 0.777          | 30.933                 | 24.035            |
| 318  | 07-04-1979 | 2.28           | 0.84           | 27.958                 | 23.485            |
| 319  | 09-04-1979 | 2.35           | 0.928          | 32.894                 | 30.526            |
| 320  | 09-04-1979 | 2.37           | 0.874          | 32.926                 | 28.777            |
| 321  | 10-04-1979 | 2.4            | 0.69           | 35.178                 | 24.273            |
| 322  | 11-04-1979 | 2.38           | 0.869          | 33.284                 | 28.924            |
| 323  | 16-04-1979 | 2.84           | 1.021          | 50.767                 | 51.833            |
| 324  | 14-05-1979 | 1.92           | 0.601          | 26.747                 | 16.075            |
| 325  | 21-04-1980 | 2.5            | 0.894          | 41.213                 | 36.844            |
| 326  | 30-09-1980 | 0.4            | 0.274          | 0.989                  | 0.271             |
| 327  | 06-12-1980 | 0.98           | 0.439          | 5.911                  | 2.595             |
| 328  | 08-12-1980 | 1.22           | 0.526          | 10.633                 | 5.593             |
| 329  | 09-12-1980 | 1.24           | 0.542          | 11.076                 | 6.003             |
| 330  | 10-12-1980 | 1.16           | 0.489          | 10.313                 | 5.043             |
| 331  | 11-12-1980 | 1.02           | 0.505          | 7.873                  | 3.976             |
| 332  | 12-12-1980 | 0.99           | 0.508          | 5.835                  | 2.964             |
| 333  | 13-12-1980 | 0.82           | 0.478          | 4.933                  | 2.358             |
| 334  | 17-12-1980 | 0.9            | 0.538          | 5.359                  | 2.883             |
| 335  | 03-10-1981 | 0.38           | 0.29           | 0.721                  | 0.209             |
| 336  | 10-03-1982 | 0.34           | 0.442          | 0.466                  | 0.206             |
| 337  | 11-03-1982 | 0.32           | 0.252          | 0.302                  | 0.076             |
| 338  | 12-03-1982 | 0.3            | 0.407          | 0.241                  | 0.098             |
| 339  | 13-03-1982 | 0.28           | 0.383          | 0.188                  | 0.072             |
| 340  | 13-03-1982 | 0.28           | 0.343          | 0.204                  | 0.07              |
| 341  | 14-03-1982 | 0.3            | 0.406          | 0.207                  | 0.084             |
| 342  | 15-03-1982 | 0.28           | 0.313          | 0.16                   | 0.05              |
| 343  | 16-03-1982 | 0.3            | 0.403          | 0.201                  | 0.081             |
| 344  | 18-03-1982 | 0.26           | 0.232          | 0.185                  | 0.043             |

| SNo. | Date       | Stage (metres) | Velocity (m/s) | Area (m <sup>2</sup> ) | Measured (cumecs) |
|------|------------|----------------|----------------|------------------------|-------------------|
| 345  | 22-03-1982 | 0.37           | 0.531          | 0.397                  | 0.211             |
| 346  | 23-03-1982 | 0.39           | 0.433          | 0.554                  | 0.24              |
| 347  | 24-03-1982 | 0.38           | 0.431          | 0.522                  | 0.225             |
| 348  | 25-03-1982 | 0.36           | 0.42           | 0.462                  | 0.194             |
| 349  | 26-03-1982 | 0.34           | 0.36           | 0.397                  | 0.143             |
| 350  | 27-03-1982 | 0.36           | 0.37           | 0.53                   | 0.196             |
| 351  | 31-03-1982 | 0.48           | 0.487          | 1.06                   | 0.516             |
| 352  | 02-04-1982 | 0.37           | 0.312          | 0.641                  | 0.2               |
| 353  | 03-04-1982 | 0.41           | 0.37           | 0.741                  | 0.274             |
| 354  | 05-04-1982 | 0.48           | 0.447          | 1.427                  | 0.638             |
| 355  | 06-04-1982 | 0.98           | 0.414          | 8.942                  | 3.702             |
| 356  | 07-04-1982 | 0.9            | 0.565          | 5.958                  | 3.366             |
| 357  | 08-04-1982 | 0.94           | 0.576          | 6.122                  | 3.526             |
| 358  | 10-04-1982 | 1              | 0.539          | 7.297                  | 3.933             |
| 359  | 12-04-1982 | 0.93           | 0.562          | 6.11                   | 3.434             |
| 360  | 13-04-1982 | 0.88           | 0.553          | 6.016                  | 3.327             |
| 361  | 14-04-1982 | 0.83           | 0.535          | 4.791                  | 2.563             |
| 362  | 15-04-1982 | 0.75           | 0.49           | 4.245                  | 2.08              |
| 363  | 16-04-1982 | 0.7            | 0.452          | 3.874                  | 1.751             |
| 364  | 17-04-1982 | 0.7            | 0.469          | 3.832                  | 1.797             |
| 365  | 18-04-1982 | 0.74           | 0.337          | 6.065                  | 2.044             |
| 366  | 20-04-1982 | 0.76           | 0.481          | 4.497                  | 2.163             |
| 367  | 22-04-1982 | 0.93           | 0.556          | 6.108                  | 3.396             |
| 368  | 23-04-1982 | 0.88           | 0.575          | 5.563                  | 3.199             |
| 369  | 24-04-1982 | 0.96           | 0.508          | 6.949                  | 3.53              |
| 370  | 26-04-1982 | 0.89           | 0.503          | 6.322                  | 3.18              |
| 371  | 29-04-1982 | 0.91           | 0.47           | 6.436                  | 3.025             |
| 372  | 02-05-1982 | 0.84           | 0.481          | 5.694                  | 2.739             |
| 373  | 08-05-1982 | 1.4            | 0.468          | 15.944                 | 7.462             |
| 374  | 17-05-1982 | 1.34           | 0.58           | 12.493                 | 7.246             |
| 375  | 18-05-1982 | 1.26           | 0.598          | 10.201                 | 6.1               |
| 376  | 19-05-1982 | 1.16           | 0.607          | 8.733                  | 5.301             |
| 377  | 20-05-1982 | 1.09           | 0.611          | 7.957                  | 4.862             |
| 378  | 21-05-1982 | 1.02           | 0.592          | 7.316                  | 4.331             |
| 379  | 22-05-1982 | 0.97           | 0.59           | 6.646                  | 3.921             |
| 380  | 24-05-1982 | 1.16           | 0.585          | 9.174                  | 5.367             |
| 381  | 25-05-1982 | 1.18           | 0.436          | 9.615                  | 4.192             |
| 382  | 26-05-1982 | 1.08           | 0.588          | 8.085                  | 4.754             |
| 383  | 27-05-1982 | 1.02           | 0.621          | 6.692                  | 4.156             |
| 384  | 29-05-1982 | 0.98           | 0.58           | 6.693                  | 3.882             |
| 385  | 21-11-1983 | 0.34           | 0.234          | 0.936                  | 0.219             |
| 386  | 26-11-1983 | 0.38           | 0.546          | 4.524                  | 2.47              |
| 387  | 11-08-1984 | 0.63           | 0.595          | 2.103                  | 1.251             |
| 388  | 13-08-1984 | 0.62           | 0.395          | 2.962                  | 1.17              |
| 389  | 10-04-1985 | 0.96           | 0.089          | 5.09                   | 0.453             |
| 390  | 11-04-1985 | 0.71           | 0.458          | 4.926                  | 2.256             |
| 391  | 12-04-1985 | 0.64           | 0.452          | 4.54                   | 2.052             |
| 392  | 13-04-1985 | 0.7            | 0.455          | 5.233                  | 2.381             |
| 393  | 15-04-1985 | 0.99           | 0.482          | 5.12                   | 2.468             |
| 394  | 17-04-1985 | 1.3            | 0.757          | 13.458                 | 10.188            |
| 395  | 17-04-1985 | 1.32           | 1.008          | 10.853                 | 10.94             |



| SNo. | Date       | Stage (metres) | Velocity (m/s) | Area (m <sup>2</sup> ) | Measured (cumecs) |
|------|------------|----------------|----------------|------------------------|-------------------|
| 398  | 22-04-1985 | 1.53           | 0.863          | 14.156                 | 12.217            |
| 399  | 23-04-1985 | 1.89           | 0.736          | 12.906                 | 9.499             |
| 400  | 23-04-1985 | 1.62           | 0.853          | 11.352                 | 9.683             |
| 401  | 23-04-1985 | 1.46           | 0.82           | 13.174                 | 10.803            |
| 402  | 24-04-1985 | 1.36           | 0.661          | 12.451                 | 8.23              |
| 403  | 24-04-1985 | 1.36           | 0.793          | 12.006                 | 9.521             |
| 404  | 24-04-1985 | 1.45           | 0.827          | 13.388                 | 11.072            |
| 405  | 26-04-1985 | 1.26           | 0.792          | 12.701                 | 10.059            |
| 406  | 29-04-1985 | 1.14           | 0.683          | 12.728                 | 8.693             |
| 407  | 25-05-1985 | 1.37           | 0.703          | 10.989                 | 7.725             |
| 408  | 25-05-1985 | 1.35           | 0.661          | 11.383                 | 7.524             |
| 409  | 25-11-1985 | 0.58           | 0.36           | 1.353                  | 0.487             |
| 410  | 30-11-1985 | 0.62           | 0.278          | 3.335                  | 0.927             |
| 411  | 01-12-1985 | 0.58           | 0.191          | 3.576                  | 0.683             |
| 412  | 02-12-1985 | 0.56           | 0.286          | 2.252                  | 0.644             |
| 413  | 03-12-1985 | 0.7            | 0.344          | 4.488                  | 1.544             |
| 414  | 04-12-1985 | 0.79           | 0.489          | 4.738                  | 2.317             |
| 415  | 07-12-1985 | 0.78           | 0.264          | 3.966                  | 1.047             |
| 416  | 09-12-1985 | 0.6            | 0.376          | 2.957                  | 1.112             |
| 417  | 10-03-1986 | 0.58           | 0.355          | 0.944                  | 0.335             |
| 418  | 13-03-1986 | 0.68           | 0.281          | 1.907                  | 0.536             |
| 419  | 15-03-1986 | 0.84           | 0.469          | 3.61                   | 1.693             |
| 420  | 18-03-1986 | 0.9            | 0.561          | 5.998                  | 3.365             |
| 421  | 19-03-1986 | 0.9            | 0.555          | 3.27                   | 1.815             |
| 422  | 20-03-1986 | 0.94           | 0.483          | 4.772                  | 2.305             |
| 423  | 28-03-1986 | 0.8            | 0.389          | 2.9                    | 1.128             |
| 424  | 31-03-1986 | 1.12           | 0.505          | 8.046                  | 4.063             |
| 425  | 03-04-1986 | 1.47           | 0.714          | 11.667                 | 8.33              |
| 426  | 04-04-1986 | 1.68           | 0.836          | 13.361                 | 11.17             |
| 427  | 05-04-1986 | 1.62           | 0.853          | 11.464                 | 9.779             |
| 428  | 28-04-1986 | 1.48           | 0.937          | 10.171                 | 9.53              |
| 429  | 29-04-1986 | 1.52           | 0.742          | 13.205                 | 9.798             |
| 430  | 29-04-1986 | 1.52           | 0.791          | 11.293                 | 8.933             |
| 431  | 09-11-1987 | 0.58           | 0.808          | 0.333                  | 0.269             |
| 432  | 10-11-1987 | 0.54           | 0.338          | 0.538                  | 0.182             |
| 433  | 12-11-1987 | 0.5            | 0.222          | 0.5                    | 0.111             |
| 434  | 13-11-1987 | 0.52           | 0.307          | 0.57                   | 0.175             |
| 435  | 16-11-1987 | 0.6            | 0.372          | 0.551                  | 0.205             |
| 436  | 17-11-1987 | 0.4            | 0.303          | 0.667                  | 0.202             |
| 437  | 27-11-1987 | 0.46           | 0.293          | 0.099                  | 0.029             |
| 438  | 28-11-1987 | 0.47           | 0.102          | 0.304                  | 0.031             |
| 439  | 30-11-1987 | 0.35           | 0.203          | 0.453                  | 0.092             |
| 440  | 01-12-1987 | 0.34           | 0.217          | 0.396                  | 0.086             |
| 441  | 16-11-1988 | 1.4            | 0.444          | 2.655                  | 1.179             |
| 442  | 28-11-1988 | 1.64           | 0.62           | 6.01                   | 3.726             |
| 443  | 29-11-1988 | 1.6            | 0.573          | 5.845                  | 3.349             |
| 444  | 30-11-1988 | 1.58           | 0.548          | 4.195                  | 2.299             |
| 445  | 01-12-1988 | 1.54           | 0.586          | 3.341                  | 1.958             |
| 446  | 02-03-1989 | 1.26           | 0.561          | 1.597                  | 0.896             |
| 447  | 03-03-1989 | 1.24           | 0.533          | 1.552                  | 0.827             |
| 448  | 04-03-1989 | 1.22           | 0.524          | 1.494                  | 0.783             |

| SNo. | Date       | Stage (metres) | Velocity (m/s) | Area (m <sup>2</sup> ) | Measured (cumecs) |
|------|------------|----------------|----------------|------------------------|-------------------|
| 449  | 06-03-1989 | 1.21           | 0.501          | 1.451                  | 0.727             |
| 450  | 07-03-1989 | 1.2            | 0.494          | 1.421                  | 0.702             |
| 451  | 08-03-1989 | 1.2            | 0.475          | 1.442                  | 0.685             |
| 452  | 22-03-1989 | 1.52           | 0.542          | 3.426                  | 1.857             |
| 453  | 28-03-1989 | 1.4            | 0.436          | 3.163                  | 1.379             |
| 454  | 01-04-1989 | 1.54           | 0.564          | 3.089                  | 1.742             |
| 455  | 07-04-1989 | 1.6            | 0.599          | 5.97                   | 3.576             |
| 456  | 27-04-1989 | 1.64           | 0.945          | 12.322                 | 11.644            |
| 457  | 04-05-1989 | 1.47           | 0.516          | 3.273                  | 1.689             |
| 458  | 08-05-1989 | 1.63           | 0.619          | 6.181                  | 3.826             |
| 459  | 19-05-1989 | 1.58           | 0.602          | 4.364                  | 2.627             |
| 460  | 19-05-1990 | 1.98           | 0.891          | 9.23                   | 8.224             |
| 461  | 20-05-1990 | 1.9            | 0.967          | 8.421                  | 8.143             |
| 462  | 22-05-1990 | 1.82           | 0.924          | 7.429                  | 6.864             |
| 463  | 24-05-1990 | 1.76           | 0.857          | 6.564                  | 5.625             |
| 464  | 26-05-1990 | 1.68           | 0.693          | 6.358                  | 4.406             |
| 465  | 27-05-1990 | 1.64           | 0.693          | 7.01                   | 4.858             |
| 466  | 28-05-1990 | 1.62           | 0.781          | 5.822                  | 4.547             |
| 467  | 29-05-1990 | 1.6            | 0.674          | 5.519                  | 3.72              |
| 468  | 30-05-1990 | 1.85           | 0.716          | 14.432                 | 10.333            |
| 469  | 30-05-1991 | 1.8            | 0.658          | 13.398                 | 8.816             |
| 470  | 31-05-1991 | 1.84           | 0.731          | 13.345                 | 9.755             |
| 471  | 31-05-1991 | 1.84           | 0.578          | 14.73                  | 8.514             |
| 472  | 17-06-1991 | 1.38           | 0.537          | 5.02                   | 2.696             |
| 473  | 17-06-1991 | 1.37           | 0.469          | 4.896                  | 2.296             |
| 474  | 18-06-1991 | 1.34           | 0.519          | 4.753                  | 2.467             |
| 475  | 18-06-1991 | 1.34           | 0.472          | 4.809                  | 2.27              |
| 476  | 19-06-1991 | 1.36           | 0.479          | 4.401                  | 2.108             |
| 477  | 19-06-1991 | 1.36           | 0.484          | 4.725                  | 2.287             |
| 478  | 30-01-1992 | 0.28           | 0.37           | 1.078                  | 0.399             |
| 479  | 30-01-1992 | 0.28           | 0.446          | 0.998                  | 0.445             |
| 480  | 29-05-1992 | 1.7            | 0.681          | 11.467                 | 7.809             |
| 481  | 30-05-1992 | 1.68           | 0.658          | 9.384                  | 6.175             |
| 482  | 31-05-1992 | 1.66           | 0.703          | 8.361                  | 5.878             |
| 483  | 01-06-1992 | 1.64           | 0.622          | 6.965                  | 4.332             |
| 484  | 02-06-1992 | 1.68           | 0.651          | 9.353                  | 6.089             |
| 485  | 03-06-1992 | 1.66           | 0.696          | 8.236                  | 5.732             |
| 486  | 04-06-1992 | 1.67           | 0.626          | 9.219                  | 5.771             |

#### 4. Ngerengere River at Konga

| SNo. | Date       | Stage (metres) | Velocity (m/s) | Area (m <sup>2</sup> ) | Measured (cumecs) |
|------|------------|----------------|----------------|------------------------|-------------------|
| 1    | 08-11-1962 | 0.18           | 0.09           | 2.444                  | 0.22              |
| 2    | 01-06-1963 | 0.29           | 0.16           | 3.75                   | 0.6               |
| 3    | 15-08-1963 | 0.24           | 0.1            | 3.1                    | 0.31              |
| 4    | 28-08-1963 | 0.25           | 0.11           | 3.091                  | 0.34              |
| 5    | 28-09-1963 | 0.25           | 0.12           | 2.75                   | 0.33              |
| 6    | 18-05-1964 | 0.27           | 0.15           | 5.267                  | 0.79              |
| 7    | 12-01-1966 | 0.12           | 0.09           | 4.333                  | 0.39              |

|    |            |      |      |        |      |
|----|------------|------|------|--------|------|
| 8  | 28-10-1966 | 0.14 | 0.24 | 2.167  | 0.52 |
| 9  | 14-03-1967 | 0.05 | 0.06 | 2.667  | 0.16 |
| 10 | 03-04-1967 | 0.11 | 0.09 | 4      | 0.36 |
| 11 | 09-04-1967 | 0.32 | 0.2  | 8.05   | 1.61 |
| 12 | 12-04-1967 | 0.24 | 0.18 | 6.444  | 1.16 |
| 13 | 14-04-1967 | 0.38 | 0.4  | 5.05   | 2.02 |
| 14 | 15-04-1967 | 0.25 | 0.17 | 6.824  | 1.16 |
| 15 | 21-04-1967 | 0.18 | 0.15 | 5.6    | 0.84 |
| 16 | 01-05-1967 | 0.34 | 0.13 | 13.385 | 1.74 |
| 17 | 02-05-1967 | 0.26 | 0.22 | 5.909  | 1.3  |
| 18 | 03-05-1967 | 0.26 | 0.21 | 5.667  | 1.19 |
| 19 | 04-05-1967 | 0.25 | 0.22 | 5.545  | 1.22 |
| 20 | 05-05-1967 | 0.54 | 0.29 | 9.966  | 2.89 |
| 21 | 05-05-1967 | 0.45 | 0.26 | 9.5    | 2.47 |
| 22 | 06-05-1967 | 0.76 | 0.27 | 16.778 | 4.53 |
| 23 | 07-05-1967 | 0.62 | 0.25 | 14.24  | 3.56 |
| 24 | 07-05-1967 | 0.87 | 0.4  | 15.2   | 6.08 |
| 25 | 08-05-1967 | 0.52 | 0.22 | 12.455 | 2.74 |
| 26 | 08-05-1967 | 0.46 | 0.25 | 10.32  | 2.58 |
| 27 | 08-05-1967 | 0.45 | 0.23 | 10.913 | 2.51 |
| 28 | 09-05-1967 | 0.72 | 0.27 | 16.667 | 4.5  |
| 29 | 09-05-1967 | 0.52 | 0.23 | 12.478 | 2.87 |
| 30 | 10-05-1967 | 0.51 | 0.24 | 11.292 | 2.71 |
| 31 | 25-03-1968 | 0.21 | 0.26 | 3.385  | 0.88 |
| 32 | 26-03-1968 | 0.32 | 0.4  | 4.775  | 1.91 |
| 33 | 26-03-1968 | 0.29 | 0.37 | 4.135  | 1.53 |
| 34 | 27-03-1968 | 0.21 | 0.34 | 2.971  | 1.01 |
| 35 | 28-03-1968 | 0.38 | 0.42 | 5.429  | 2.28 |
| 36 | 29-03-1968 | 0.23 | 0.35 | 3.286  | 1.15 |
| 37 | 30-03-1968 | 0.56 | 0.46 | 7.957  | 3.66 |
| 38 | 03-04-1968 | 0.64 | 0.51 | 8.275  | 4.22 |
| 39 | 03-04-1968 | 0.46 | 0.45 | 6.067  | 2.73 |
| 40 | 09-04-1968 | 0.48 | 0.46 | 6.543  | 3.01 |
| 41 | 10-04-1968 | 0.55 | 0.5  | 6.76   | 3.38 |
| 42 | 12-04-1968 | 0.59 | 0.52 | 7.308  | 3.8  |
| 43 | 14-04-1968 | 0.72 | 0.51 | 9.627  | 4.91 |
| 44 | 14-04-1968 | 0.65 | 0.53 | 8.453  | 4.48 |
| 45 | 19-04-1968 | 0.73 | 0.49 | 10.204 | 5    |
| 46 | 22-04-1968 | 0.61 | 0.4  | 8.775  | 3.51 |
| 47 | 26-04-1968 | 0.62 | 0.44 | 8.659  | 3.81 |
| 48 | 27-04-1968 | 0.54 | 0.41 | 8.098  | 3.32 |
| 49 | 28-04-1968 | 0.49 | 0.38 | 7.605  | 2.89 |
| 50 | 03-05-1968 | 0.34 | 0.33 | 5.364  | 1.77 |
| 51 | 06-05-1968 | 0.3  | 0.31 | 5.065  | 1.57 |
| 52 | 07-05-1968 | 0.41 | 0.48 | 5.625  | 2.7  |
| 53 | 08-05-1968 | 0.53 | 0.43 | 6.93   | 2.98 |
| 54 | 07-12-1968 | 0.46 | 0.21 | 14.286 | 3    |
| 55 | 15-10-1969 | 0.06 | 0.06 | 4.5    | 0.27 |
| 56 | 08-04-1971 | 0.23 | 0.17 | 5.588  | 0.95 |
| 57 | 09-04-1971 | 0.3  | 0.2  | 7.65   | 1.53 |
| 58 | 13-04-1971 | 0.32 | 0.21 | 7.667  | 1.61 |
| 59 | 14-04-1971 | 0.29 | 0.2  | 7.25   | 1.45 |
| 60 | 19-04-1971 | 0.39 | 0.25 | 9.92   | 2.48 |

|     |            |       |       |        |       |
|-----|------------|-------|-------|--------|-------|
| 61  | 22-04-1971 | 0.6   | 0.32  | 13.375 | 4.28  |
| 62  | 23-04-1971 | 0.53  | 0.3   | 13.4   | 4.02  |
| 63  | 24-04-1971 | 0.43  | 0.28  | 9.214  | 2.58  |
| 64  | 29-04-1971 | 0.34  | 0.22  | 8.455  | 1.86  |
| 65  | 03-05-1971 | 0.23  | 0.15  | 6.733  | 1.01  |
| 66  | 18-05-1971 | 0.24  | 0.18  | 5.722  | 1.03  |
| 67  | 21-05-1971 | 0.69  | 0.53  | 9.849  | 5.22  |
| 68  | 03-06-1971 | 0.19  | 0.22  | 3.091  | 0.68  |
| 69  | 19-08-1972 | 0.11  | 0.36  | 0.658  | 0.237 |
| 70  | 12-09-1975 | 0.115 | 0.2   | 1.835  | 0.367 |
| 71  | 16-10-1975 | 0.085 | 0.32  | 0.406  | 0.13  |
| 72  | 09-07-1976 | 0.125 | 0.21  | 1.695  | 0.356 |
| 73  | 31-07-1976 | 0.09  | 0.22  | 1.323  | 0.291 |
| 74  | 24-09-1976 | 0.155 | 0.69  | 0.826  | 0.57  |
| 75  | 08-10-1976 | 0.085 | 0.16  | 1.806  | 0.289 |
| 76  | 27-10-1976 | 0.072 | 0.12  | 1.683  | 0.202 |
| 77  | 14-07-1978 | 0.1   | 0.18  | 1.422  | 0.256 |
| 78  | 25-01-1980 | 0.07  | 0.4   | 0.465  | 0.186 |
| 80  | 25-09-1990 | 0.02  | 0.25  | 0.572  | 0.143 |
| 81  | 12-01-2007 | 1     | 0.579 | 2.035  | 1.178 |
| 82  | 05-06-2007 | 1.24  | 0.461 | 2.931  | 1.351 |
| 83  | 12-06-2007 | 1     | 0.579 | 2.035  | 1.178 |
| 84  | 16-11-2007 | 1.58  | 0.838 | 5.575  | 4.672 |
| 85  | 18-12-2007 | 0.699 | 0.478 | 0.533  | 0.255 |
| 86  | 24-01-2008 | 0.69  | 0.509 | 0.878  | 0.447 |
| 87  | 21-02-2008 | 0.61  | 0.423 | 0.414  | 0.175 |
| 88  | 26-03-2008 | 0.645 | 0.434 | 0.468  | 0.203 |
| 89  | 15-04-2008 | 1.92  | 0.636 | 8.277  | 5.264 |
| 90  | 22-04-2008 | 1.5   | 0.587 | 4.365  | 2.562 |
| 91  | 13-05-2008 | 1.155 | 0.798 | 1.748  | 1.395 |
| 92  | 19-06-2008 | 0.77  | 0.955 | 0.934  | 0.892 |
| 94  | 22-08-2008 | 0.695 | 0.415 | 0.47   | 0.195 |
| 95  | 08-10-2008 | 0.715 | 0.564 | 0.557  | 0.314 |
| 96  | 07-11-2008 | 1.165 | 0.906 | 2.421  | 2.193 |
| 97  | 23-12-2008 | 0.64  | 0.419 | 0.389  | 0.163 |
| 98  | 19-01-2009 | 0.605 | 0.274 | 0.303  | 0.083 |
| 100 | 23-02-2009 | 0.91  | 0.18  | 5.744  | 1.034 |
| 101 | 26-03-2009 | 0.66  | 0.517 | 0.435  | 0.225 |
| 102 | 22-04-2009 | 0.71  | 0.704 | 0.655  | 0.461 |
| 103 | 05-05-2009 | 1.495 | 0.477 | 4.413  | 2.105 |
| 104 | 07-05-2009 | 1.215 | 0.715 | 3.099  | 2.216 |
| 105 | 09-06-2009 | 0.76  | 0.439 | 1.699  | 0.746 |
| 106 | 24-06-2009 | 0.71  | 0.614 | 0.604  | 0.371 |
| 107 | 02-07-2009 | 0.75  | 0.486 | 0.553  | 0.269 |
| 108 | 23-07-2009 | 0.74  | 0.377 | 0.523  | 0.197 |
| 109 | 29-07-2009 | 0.67  | 0.476 | 0.38   | 0.181 |
| 110 | 04-02-2010 | 0.6   | 0.374 | 0.099  | 0.037 |
| 111 | 23-12-2010 | 0.6   | 0.164 | 0.549  | 0.09  |

## 5. Ruvu River at Morogoro-Dar Es Salaam Bridge

| SNo. | Date       | Stage (metres) | Velocity (m/s) | Area (m <sup>2</sup> ) | Measured (cumecs) |
|------|------------|----------------|----------------|------------------------|-------------------|
| 1    | 30-12-1958 | 2.32           | 0.618          | 63.186                 | 39.049            |
| 2    | 07-04-1959 | 1.78           | 0.646          | 41.248                 | 26.646            |
| 3    | 10-04-1959 | 1.71           | 0.638          | 35.019                 | 22.342            |
| 4    | 27-05-1959 | 2.44           | 0.62           | 59.923                 | 37.152            |
| 5    | 07-07-1959 | 1.62           | 0.609          | 32.688                 | 19.907            |
| 6    | 26-07-1959 | 1.19           | 0.457          | 22.926                 | 10.477            |
| 7    | 29-10-1959 | 1.05           | 0.454          | 18.026                 | 8.184             |
| 8    | 21-12-1959 | 1.33           | 0.543          | 26.179                 | 14.215            |
| 9    | 02-03-1960 | 1.4            | 0.544          | 32.116                 | 17.471            |
| 10   | 12-03-1960 | 2.71           | 0.719          | 63.605                 | 45.732            |
| 11   | 26-04-1960 | 6.58           | 0.113          | 262.115                | 29.619            |
| 12   | 06-05-1960 | 6.13           | 0.798          | 247.01                 | 197.114           |
| 13   | 11-05-1960 | 5.61           | 0.659          | 217.64                 | 143.425           |
| 14   | 16-08-1960 | 1.46           | 0.318          | 48.264                 | 15.348            |
| 15   | 10-12-1960 | 0.75           | 0.185          | 20.816                 | 3.851             |
| 16   | 24-02-1961 | 4.23           | 0.539          | 159.605                | 86.027            |
| 17   | 05-05-1961 | 5.52           | 0.682          | 201.166                | 137.195           |
| 18   | 13-11-1961 | 6.55           | 0.995          | 273.606                | 272.238           |
| 19   | 21-11-1961 | 6.48           | 0.749          | 343.507                | 257.287           |
| 20   | 29-11-1961 | 6.57           | 0.099          | 331.798                | 32.848            |
| 21   | 04-12-1961 | 6.12           | 0.703          | 296.663                | 208.554           |
| 22   | 18-12-1961 | 6.18           | 0.765          | 293.162                | 224.269           |
| 23   | 01-03-1962 | 3.72           | 0.464          | 175.272                | 81.326            |
| 24   | 14-03-1962 | 6.18           | 0.921          | 282.369                | 260.062           |
| 25   | 30-03-1962 | 5.47           | 0.646          | 254.37                 | 164.323           |
| 26   | 02-06-1962 | 2.93           | 0.416          | 121.026                | 50.347            |
| 27   | 28-06-1962 | 2.29           | 0.328          | 92.375                 | 30.299            |
| 28   | 30-07-1962 | 1.71           | 0.282          | 66.876                 | 18.859            |
| 29   | 08-08-1962 | 1.66           | 0.291          | 65.88                  | 19.171            |
| 30   | 09-11-1962 | 1.62           | 0.372          | 57.852                 | 21.521            |
| 31   | 01-04-1963 | 5.98           | 0.769          | 251.796                | 193.631           |
| 32   | 30-05-1963 | 3.21           | 0.389          | 148.499                | 57.766            |
| 33   | 13-07-1963 | 2.2            | 0.323          | 93.892                 | 30.327            |
| 34   | 21-07-1963 | 1.99           | 0.304          | 84.484                 | 25.683            |
| 35   | 18-09-1963 | 1.24           | 0.202          | 51.446                 | 10.392            |
| 36   | 30-11-1963 | 6.91           | 0.015          | 426.667                | 6.4               |
| 37   | 15-12-1963 | 4.63           | 0.502          | 234.432                | 117.685           |
| 38   | 02-01-1964 | 6              | 0.756          | 323.134                | 244.289           |
| 39   | 09-02-1964 | 2.72           | 0.426          | 120.115                | 51.169            |
| 40   | 28-04-1964 | 6.43           | 1.054          | 395.495                | 416.852           |
| 41   | 04-06-1964 | 2.95           | 0.385          | 134.377                | 51.735            |
| 42   | 16-12-1964 | 1.01           | 0.295          | 26.203                 | 7.73              |

| SNo. | Date       | Stage<br>(metres) | Velocity<br>(m/s) | Area<br>(m <sup>2</sup> ) | Measured<br>(cumecs) |
|------|------------|-------------------|-------------------|---------------------------|----------------------|
| 43   | 08-01-1965 | 1.65              | 0.463             | 52.168                    | 24.154               |
| 44   | 08-01-1965 | 1.65              | 0.448             | 52.525                    | 23.531               |
| 45   | 09-01-1965 | 1.6               | 0.442             | 50.676                    | 22.399               |
| 46   | 05-03-1965 | 1.46              | 0.456             | 42.412                    | 19.34                |
| 47   | 20-04-1965 | 5.76              | 0.782             | 260.464                   | 203.683              |
| 48   | 13-10-1965 | 1.59              | 0.499             | 49.03                     | 24.466               |
| 49   | 24-12-1965 | 3.02              | 0.596             | 103.018                   | 61.399               |
| 50   | 17-02-1966 | 3.24              | 0.614             | 106.064                   | 65.123               |
| 51   | 23-02-1966 | 3.11              | 0.906             | 99.883                    | 90.494               |
| 52   | 26-02-1966 | 2.71              | 0.712             | 80.118                    | 57.044               |
| 53   | 29-03-1966 | 4.58              | 0.075             | 172.467                   | 12.935               |
| 54   | 30-03-1966 | 4.8               | 0.076             | 186.013                   | 14.137               |
| 55   | 07-04-1966 | 5.62              | 0.809             | 218.03                    | 176.386              |
| 56   | 08-04-1966 | 5.84              | 0.817             | 241.438                   | 197.255              |
| 57   | 09-04-1966 | 5.92              | 0.77              | 246.43                    | 189.751              |
| 58   | 10-04-1966 | 5.95              | 0.851             | 246.051                   | 209.389              |
| 59   | 11-04-1966 | 6.05              | 0.826             | 258.251                   | 213.315              |
| 60   | 12-04-1966 | 6.22              | 0.886             | 276.786                   | 245.232              |
| 61   | 13-04-1966 | 6.28              | 0.869             | 285.395                   | 248.008              |
| 62   | 14-04-1966 | 6.39              | 0.787             | 392.729                   | 309.078              |
| 63   | 15-04-1966 | 6.45              | 0.837             | 419.262                   | 350.922              |
| 64   | 16-04-1966 | 6.45              | 0.814             | 415.708                   | 338.386              |
| 65   | 17-04-1966 | 6.4               | 0.794             | 410.583                   | 326.003              |
| 66   | 18-04-1966 | 6.37              | 0.748             | 415.587                   | 310.859              |
| 67   | 19-04-1966 | 6.37              | 0.749             | 417.004                   | 312.336              |
| 68   | 20-04-1966 | 6.37              | 0.738             | 417.885                   | 308.399              |
| 69   | 22-04-1966 | 6.36              | 0.726             | 425.455                   | 308.88               |
| 70   | 23-04-1966 | 6.27              | 0.682             | 400.579                   | 273.195              |
| 71   | 24-04-1966 | 6.17              | 0.659             | 379.844                   | 250.317              |
| 72   | 25-04-1966 | 5.81              | 0.621             | 321.407                   | 199.594              |
| 73   | 26-04-1966 | 5.49              | 0.581             | 273.609                   | 158.967              |
| 74   | 27-04-1966 | 5.05              | 0.576             | 245.314                   | 141.301              |
| 75   | 30-04-1966 | 5.15              | 0.63              | 248.59                    | 156.612              |
| 76   | 01-05-1966 | 5.21              | 0.633             | 253.336                   | 160.362              |
| 77   | 02-05-1966 | 5.22              | 0.646             | 250.158                   | 161.602              |
| 78   | 03-05-1966 | 5.11              | 0.626             | 241.879                   | 151.416              |
| 79   | 04-05-1966 | 4.79              | 0.594             | 222.291                   | 132.041              |
| 80   | 05-05-1966 | 4.37              | 0.544             | 203.156                   | 110.517              |
| 81   | 06-05-1966 | 4.21              | 0.586             | 189.666                   | 111.144              |
| 82   | 07-05-1966 | 4.24              | 0.534             | 188.29                    | 100.547              |
| 83   | 08-05-1966 | 4.35              | 0.614             | 189.041                   | 116.071              |
| 84   | 09-05-1966 | 4.42              | 0.606             | 207.003                   | 125.444              |
| 85   | 10-05-1966 | 4.47              | 0.618             | 194.709                   | 120.33               |
| 86   | 11-05-1966 | 4.4               | 0.667             | 188.51                    | 125.736              |
| 87   | 12-05-1966 | 4.32              | 0.613             | 185.561                   | 113.749              |

| SNo. | Date       | Stage<br>(metres) | Velocity<br>(m/s) | Area<br>(m <sup>2</sup> ) | Measured<br>(cumecs) |
|------|------------|-------------------|-------------------|---------------------------|----------------------|
| 88   | 13-05-1966 | 4.15              | 0.611             | 171.245                   | 104.631              |
| 89   | 14-05-1966 | 3.93              | 0.575             | 161.12                    | 92.644               |
| 90   | 15-05-1966 | 3.89              | 0.597             | 158.442                   | 94.59                |
| 91   | 18-10-1966 | 1.13              | 0.375             | 21.389                    | 8.021                |
| 92   | 30-10-1966 | 2.02              | 0.535             | 62.021                    | 33.181               |
| 93   | 18-11-1966 | 1.4               | 0.438             | 35.95                     | 15.746               |
| 94   | 04-05-1967 | 6.23              | 0.745             | 364.573                   | 271.607              |
| 95   | 05-05-1967 | 6.21              | 0.702             | 371.637                   | 260.889              |
| 96   | 06-05-1967 | 6.18              | 0.685             | 353.39                    | 242.072              |
| 97   | 07-05-1967 | 6.2               | 0.659             | 363.517                   | 239.558              |
| 98   | 09-05-1967 | 6.14              | 0.653             | 358.74                    | 234.257              |
| 99   | 10-05-1967 | 6.16              | 0.72              | 350.976                   | 252.703              |
| 100  | 11-05-1967 | 6.17              | 0.73              | 355.342                   | 259.4                |
| 101  | 12-05-1967 | 6.15              | 0.685             | 357.772                   | 245.074              |
| 102  | 13-05-1967 | 6.19              | 0.733             | 373.918                   | 274.082              |
| 103  | 14-05-1967 | 6.22              | 0.69              | 386.629                   | 266.774              |
| 104  | 15-05-1967 | 6.26              | 0.731             | 397.044                   | 290.239              |
| 105  | 16-05-1967 | 6.28              | 0.739             | 390.778                   | 288.785              |
| 106  | 17-05-1967 | 6.27              | 0.721             | 398.732                   | 287.486              |
| 107  | 18-05-1967 | 6.27              | 0.72              | 409.399                   | 294.767              |
| 108  | 19-05-1967 | 6.24              | 0.719             | 400.955                   | 288.287              |
| 109  | 20-05-1967 | 6.15              | 0.676             | 378.339                   | 255.757              |
| 110  | 21-05-1967 | 5.98              | 0.622             | 358.947                   | 223.265              |
| 111  | 22-05-1967 | 5.62              | 0.566             | 311.62                    | 176.377              |
| 112  | 23-05-1967 | 5.04              | 0.499             | 274.265                   | 136.858              |
| 113  | 24-05-1967 | 4.72              | 0.508             | 246.12                    | 125.029              |
| 114  | 25-05-1967 | 4.69              | 0.496             | 248.619                   | 123.315              |
| 115  | 26-05-1967 | 4.69              | 0.485             | 246.616                   | 119.609              |
| 116  | 27-05-1967 | 4.51              | 0.538             | 214.797                   | 115.561              |
| 117  | 28-05-1967 | 4.33              | 0.556             | 205.392                   | 114.198              |
| 118  | 29-05-1967 | 4.27              | 0.52              | 202.838                   | 105.476              |
| 119  | 30-05-1967 | 4.32              | 0.511             | 202.413                   | 103.433              |
| 120  | 31-05-1967 | 4.36              | 0.509             | 202.919                   | 103.286              |
| 121  | 01-06-1967 | 4.63              | 0.636             | 202.904                   | 129.047              |
| 122  | 02-06-1967 | 4.88              | 0.628             | 230.057                   | 144.476              |
| 123  | 30-08-1967 | 2.13              | 0.554             | 61.982                    | 34.338               |
| 124  | 31-08-1967 | 2.07              | 0.555             | 58.51                     | 32.473               |
| 125  | 31-08-1967 | 2.07              | 0.594             | 57.305                    | 34.039               |
| 126  | 01-09-1967 | 2.07              | 0.573             | 56.515                    | 32.383               |
| 127  | 01-09-1967 | 2.06              | 0.544             | 56.467                    | 30.718               |
| 128  | 02-09-1967 | 2.04              | 0.543             | 56.565                    | 30.715               |
| 129  | 03-09-1967 | 2.01              | 0.578             | 54.066                    | 31.25                |
| 130  | 04-09-1967 | 2.27              | 0.597             | 65.157                    | 38.899               |
| 131  | 04-09-1967 | 2.38              | 0.617             | 72.16                     | 44.523               |
| 132  | 05-09-1967 | 2.44              | 0.6               | 74.862                    | 44.917               |

| SNo. | Date       | Stage<br>(metres) | Velocity<br>(m/s) | Area<br>(m <sup>2</sup> ) | Measured<br>(cumecs) |
|------|------------|-------------------|-------------------|---------------------------|----------------------|
| 133  | 05-09-1967 | 2.44              | 0.598             | 75.758                    | 45.303               |
| 134  | 06-09-1967 | 2.37              | 2.464             | 17.603                    | 43.373               |
| 135  | 02-12-1967 | 5.49              | 0.653             | 278.727                   | 182.009              |
| 136  | 03-12-1967 | 5.75              | 0.667             | 287.69                    | 191.889              |
| 137  | 04-12-1967 | 5.9               | 0.632             | 302.883                   | 191.422              |
| 138  | 09-12-1967 | 5.07              | 0.658             | 223.652                   | 147.163              |
| 139  | 21-12-1967 | 6.36              | 0.938             | 325.342                   | 305.171              |
| 140  | 29-12-1967 | 6.46              | 0.982             | 354.826                   | 348.439              |
| 141  | 30-12-1967 | 6.45              | 0.877             | 364.82                    | 319.947              |
| 142  | 29-03-1968 | 6.22              | 4.135             | 301.871                   | 1248.235             |
| 143  | 30-03-1968 | 6.43              | 1.188             | 252.849                   | 300.385              |
| 144  | 02-04-1968 | 6.43              | 0.918             | 342.393                   | 314.317              |
| 145  | 03-04-1968 | 6.41              | 1.063             | 325.124                   | 345.607              |
| 146  | 05-04-1968 | 6.4               | 0.85              | 356.459                   | 302.99               |
| 147  | 06-04-1968 | 6.39              | 0.828             | 349.207                   | 289.143              |
| 148  | 08-04-1968 | 6.41              | 0.99              | 347.596                   | 344.12               |
| 149  | 09-04-1968 | 6.42              | 0.915             | 343.804                   | 314.581              |
| 150  | 10-04-1968 | 6.52              | 0.957             | 338.501                   | 323.945              |
| 151  | 11-04-1968 | 6.65              | 1.214             | 329.446                   | 399.947              |
| 152  | 12-04-1968 | 7                 | 1.411             | 425.455                   | 600.317              |
| 153  | 14-04-1968 | 6.96              | 1.38              | 462.509                   | 638.262              |
| 154  | 16-04-1968 | 6.89              | 1.31              | 419.544                   | 549.602              |
| 155  | 16-04-1968 | 6.89              | 1.285             | 416.462                   | 535.154              |
| 156  | 18-04-1968 | 6.3               | 1.355             | 399.508                   | 541.333              |
| 157  | 19-04-1968 | 6.93              | 1.374             | 455.481                   | 625.831              |
| 158  | 20-04-1968 | 6.91              | 2.101             | 213.891                   | 449.384              |
| 159  | 21-04-1968 | 6.9               | 1.293             | 448.514                   | 579.929              |
| 160  | 22-04-1968 | 7.08              | 1.291             | 512.818                   | 662.048              |
| 161  | 22-04-1968 | 7.08              | 1.412             | 464.661                   | 656.101              |
| 162  | 23-04-1968 | 6.91              | 1.588             | 378.105                   | 600.43               |
| 163  | 24-04-1968 | 6.84              | 1.377             | 355.76                    | 489.881              |
| 164  | 25-04-1968 | 6.84              | 1.297             | 427.656                   | 554.67               |
| 165  | 27-04-1968 | 6.83              | 1.307             | 427.353                   | 558.55               |
| 166  | 28-04-1968 | 6.87              | 1.389             | 459.104                   | 637.695              |
| 167  | 29-04-1968 | 6.79              | 1.38              | 416.135                   | 574.266              |
| 168  | 02-05-1968 | 6.64              | 1.328             | 351.828                   | 467.228              |
| 169  | 03-05-1968 | 6.61              | 1.192             | 416.675                   | 496.677              |
| 170  | 05-05-1968 | 6.54              | 1.032             | 416.768                   | 430.105              |
| 171  | 05-05-1968 | 6.53              | 1.06              | 212.723                   | 225.486              |
| 172  | 06-05-1968 | 6.51              | 1.11              | 323.118                   | 358.661              |
| 173  | 07-05-1968 | 6.47              | 0.973             | 409.765                   | 398.701              |
| 174  | 09-05-1968 | 6.52              | 0.948             | 338.339                   | 320.745              |
| 175  | 10-05-1968 | 6.28              | 0.898             | 379.44                    | 340.737              |
| 176  | 11-05-1968 | 6.19              | 0.78              | 290.51                    | 226.598              |
| 177  | 12-05-1968 | 6.12              | 0.691             | 349.146                   | 241.26               |



| SNo. | Date       | Stage<br>(metres) | Velocity<br>(m/s) | Area<br>(m <sup>2</sup> ) | Measured<br>(cumecs) |
|------|------------|-------------------|-------------------|---------------------------|----------------------|
| 178  | 13-05-1968 | 6.07              | 0.711             | 378.633                   | 269.208              |
| 179  | 14-05-1968 | 6.04              | 0.332             | 690.777                   | 229.338              |
| 180  | 17-05-1968 | 5.16              | 0.488             | 321.35                    | 156.819              |
| 181  | 18-05-1968 | 4.89              | 0.537             | 284.75                    | 152.911              |
| 182  | 18-05-1968 | 4.96              | 0.488             | 340.904                   | 166.361              |
| 183  | 19-05-1968 | 4.85              | 0.537             | 260.81                    | 140.055              |
| 184  | 20-05-1968 | 4.6               | 0.52              | 275.229                   | 143.119              |
| 185  | 21-05-1968 | 4.53              | 0.443             | 278.693                   | 123.461              |
| 186  | 22-05-1968 | 4.5               | 0.448             | 279.138                   | 125.054              |
| 187  | 22-05-1968 | 4.51              | 0.556             | 235.04                    | 130.682              |
| 188  | 23-05-1968 | 4.56              | 0.472             | 284.218                   | 134.151              |
| 189  | 24-05-1968 | 4.69              | 0.507             | 283.448                   | 143.708              |
| 190  | 24-05-1968 | 4.64              | 0.834             | 281.811                   | 235.03               |
| 191  | 25-05-1968 | 4.74              | 0.523             | 283.547                   | 148.295              |
| 192  | 27-05-1968 | 4.35              | 0.409             | 138.469                   | 56.634               |
| 193  | 06-06-1968 | 5.8               | 0.614             | 312.593                   | 191.932              |
| 194  | 07-06-1968 | 5.92              | 0.624             | 383.003                   | 238.994              |
| 195  | 08-06-1968 | 5.95              | 0.588             | 403.139                   | 237.046              |
| 196  | 09-06-1968 | 5.91              | 0.691             | 325.767                   | 225.105              |
| 197  | 10-06-1968 | 5.78              | 0.663             | 339.119                   | 224.836              |
| 198  | 11-06-1968 | 5.53              | 0.659             | 310.325                   | 204.504              |
| 199  | 12-06-1968 | 5.21              | 1.302             | 245.326                   | 319.414              |
| 200  | 13-06-1968 | 5.11              | 0.63              | 263.71                    | 166.137              |
| 201  | 15-06-1968 | 4.73              | 0.541             | 260.767                   | 141.075              |
| 202  | 16-06-1968 | 4.45              | 0.485             | 259.231                   | 125.727              |
| 203  | 17-06-1968 | 4.22              | 0.477             | 242.801                   | 115.816              |
| 204  | 18-06-1968 | 4.02              | 0.478             | 237.672                   | 113.607              |
| 205  | 20-06-1968 | 3.83              | 0.432             | 224.699                   | 97.07                |
| 206  | 21-06-1968 | 3.7               | 0.435             | 214.818                   | 93.446               |
| 207  | 22-06-1968 | 3.61              | 0.43              | 207.437                   | 89.198               |
| 208  | 23-06-1968 | 3.49              | 0.38              | 203.434                   | 77.305               |
| 209  | 24-06-1968 | 3.43              | 0.44              | 176.336                   | 77.588               |
| 210  | 25-06-1968 | 3.35              | 0.428             | 172.217                   | 73.709               |
| 211  | 18-02-1969 | 1.79              | 0.468             | 54.859                    | 25.674               |
| 212  | 19-02-1969 | 1.73              | 0.441             | 57.642                    | 25.42                |
| 213  | 20-02-1969 | 1.66              | 0.399             | 52.586                    | 20.982               |
| 214  | 21-02-1969 | 1.6               | 0.409             | 50.335                    | 20.587               |
| 215  | 22-02-1969 | 1.56              | 0.405             | 49.758                    | 20.152               |
| 216  | 23-02-1969 | 1.52              | 0.414             | 44.258                    | 18.323               |
| 217  | 24-02-1969 | 1.49              | 0.395             | 46.833                    | 18.499               |
| 218  | 25-02-1969 | 1.49              | 0.387             | 45.804                    | 17.726               |
| 219  | 28-04-1969 | 5.52              | 0.354             | 498.506                   | 176.471              |
| 220  | 28-04-1969 | 5.44              | 0.434             | 455.157                   | 197.538              |
| 221  | 02-05-1969 | 6.15              | 0.414             | 622.012                   | 257.513              |
| 222  | 07-05-1969 | 6.36              | 0.923             | 360.48                    | 332.723              |

| SNo. | Date       | Stage<br>(metres) | Velocity<br>(m/s) | Area<br>(m <sup>2</sup> ) | Measured<br>(cumecs) |
|------|------------|-------------------|-------------------|---------------------------|----------------------|
| 223  | 12-05-1969 | 6.44              | 0.452             | 785.292                   | 354.952              |
| 224  | 12-05-1969 | 6.44              | 0.044             | 792.864                   | 34.886               |
| 225  | 13-05-1969 | 6.44              | 0.456             | 783.991                   | 357.5                |
| 226  | 14-05-1969 | 6.45              | 0.455             | 800.341                   | 364.155              |
| 227  | 27-12-1969 | 1.93              | 0.604             | 55.421                    | 33.474               |
| 228  | 29-12-1969 | 1.69              | 0.563             | 43.21                     | 24.327               |
| 229  | 29-03-1970 | 4.36              | 0.722             | 154.213                   | 111.342              |
| 230  | 30-03-1970 | 4.59              | 0.757             | 169.452                   | 128.275              |
| 231  | 31-03-1970 | 4.83              | 0.828             | 190.831                   | 158.008              |
| 232  | 02-04-1970 | 4.75              | 0.845             | 176.938                   | 149.513              |
| 233  | 03-04-1970 | 4.81              | 0.865             | 184.895                   | 159.934              |
| 234  | 04-04-1970 | 5                 | 0.889             | 193.982                   | 172.45               |
| 235  | 05-04-1970 | 5.43              | 0.885             | 205.258                   | 181.653              |
| 236  | 06-04-1970 | 5.18              | 0.854             | 206.574                   | 176.414              |
| 237  | 08-04-1970 | 4.54              | 0.852             | 167.276                   | 142.519              |
| 238  | 09-04-1970 | 4.19              | 0.836             | 148.359                   | 124.028              |
| 239  | 10-04-1970 | 4.07              | 0.826             | 146.863                   | 121.309              |
| 240  | 12-04-1970 | 3.7               | 0.776             | 127.718                   | 99.109               |
| 241  | 13-04-1970 | 3.65              | 2.566             | 33.393                    | 85.687               |
| 242  | 24-04-1970 | 5.28              | 0.888             | 215.565                   | 191.422              |
| 243  | 25-04-1970 | 5.36              | 0.886             | 218.289                   | 193.404              |
| 244  | 07-05-1970 | 3.34              | 0.787             | 104.093                   | 81.921               |
| 245  | 08-05-1970 | 3.4               | 0.827             | 106.831                   | 88.349               |
| 246  | 10-05-1970 | 3.43              | 0.822             | 106.964                   | 87.924               |
| 247  | 12-05-1970 | 3.23              | 0.824             | 97.597                    | 80.42                |
| 248  | 13-05-1970 | 3.09              | 0.768             | 92.914                    | 71.358               |
| 249  | 14-05-1970 | 3                 | 0.766             | 90.569                    | 69.376               |
| 250  | 15-05-1970 | 2.9               | 0.799             | 79.741                    | 63.713               |
| 251  | 16-05-1970 | 2.82              | 0.799             | 75.31                     | 60.173               |
| 252  | 17-05-1970 | 2.76              | 0.805             | 71.513                    | 57.568               |
| 253  | 19-05-1970 | 2.65              | 0.836             | 65.033                    | 54.368               |
| 254  | 21-05-1970 | 2.56              | 0.698             | 63.45                     | 44.288               |
| 255  | 23-05-1970 | 2.52              | 0.655             | 63.032                    | 41.286               |
| 256  | 24-05-1970 | 2.6               | 0.674             | 66.969                    | 45.137               |
| 257  | 25-05-1970 | 2.58              | 0.703             | 62.917                    | 44.231               |
| 258  | 26-05-1970 | 2.54              | 0.631             | 67.314                    | 42.475               |
| 259  | 27-05-1970 | 2.69              | 0.66              | 74.439                    | 49.13                |
| 260  | 29-05-1970 | 2.48              | 0.576             | 70.792                    | 40.776               |
| 261  | 31-05-1970 | 2.38              | 0.605             | 60.846                    | 36.812               |
| 262  | 02-06-1970 | 2.29              | 0.643             | 52.846                    | 33.98                |
| 263  | 03-06-1970 | 2.26              | 0.646             | 51.724                    | 33.414               |
| 264  | 04-06-1970 | 2.23              | 0.639             | 47.416                    | 30.299               |
| 265  | 28-10-1970 | 1.3               | 0.277             | 31.906                    | 8.838                |
| 266  | 29-10-1970 | 1.26              | 0.302             | 31.235                    | 9.433                |
| 267  | 01-02-1971 | 2.42              | 0.682             | 71.328                    | 48.646               |

| SNo. | Date       | Stage<br>(metres) | Velocity<br>(m/s) | Area<br>(m <sup>2</sup> ) | Measured<br>(cumecs) |
|------|------------|-------------------|-------------------|---------------------------|----------------------|
| 268  | 20-02-1971 | 1.71              | 0.582             | 38.328                    | 22.307               |
| 269  | 22-02-1971 | 1.71              | 0.582             | 38.447                    | 22.376               |
| 270  | 24-04-1971 | 5.79              | 0.904             | 232.299                   | 209.998              |
| 271  | 25-04-1971 | 5.99              | 0.851             | 246.167                   | 209.488              |
| 272  | 30-04-1971 | 6.33              | 0.793             | 302.095                   | 239.561              |
| 273  | 05-05-1971 | 6.16              | 0.845             | 288.865                   | 244.091              |
| 274  | 15-05-1971 | 3.76              | 0.717             | 132.785                   | 95.207               |
| 275  | 19-05-1971 | 3.26              | 0.702             | 101.085                   | 70.962               |
| 276  | 20-05-1971 | 3.19              | 0.788             | 90.657                    | 71.438               |
| 277  | 21-05-1971 | 3.47              | 0.812             | 103.615                   | 84.135               |
| 278  | 22-05-1971 | 3.56              | 0.785             | 109.329                   | 85.823               |
| 279  | 24-05-1971 | 3.51              | 0.753             | 111.673                   | 84.09                |
| 280  | 25-05-1971 | 3.75              | 0.749             | 126.764                   | 94.946               |
| 281  | 29-05-1971 | 3.24              | 0.673             | 114.655                   | 77.163               |
| 282  | 01-06-1971 | 2.91              | 0.767             | 78.106                    | 59.907               |
| 283  | 02-06-1971 | 2.82              | 0.778             | 73.377                    | 57.087               |
| 284  | 03-06-1971 | 2.74              | 0.753             | 68.83                     | 51.829               |
| 285  | 04-06-1971 | 2.64              | 0.762             | 66.395                    | 50.593               |
| 286  | 06-06-1971 | 2.59              | 0.685             | 65.326                    | 44.748               |
| 287  | 07-06-1971 | 2.47              | 0.7               | 58.143                    | 40.7                 |
| 288  | 17-07-1971 | 1.86              | 0.582             | 40.577                    | 23.616               |
| 289  | 19-07-1971 | 1.83              | 0.55              | 40.865                    | 22.476               |
| 290  | 04-08-1971 | 1.8               | 0.557             | 42.553                    | 23.702               |
| 291  | 08-10-1971 | 1.15              | 0.319             | 21.68                     | 6.916                |
| 292  | 09-10-1971 | 1.14              | 0.309             | 22.078                    | 6.822                |
| 293  | 03-02-1972 | 1.63              | 0.533             | 28.882                    | 15.394               |
| 294  | 13-02-1972 | 1.62              | 0.463             | 30.281                    | 14.02                |
| 295  | 17-02-1972 | 1.64              | 0.527             | 30.009                    | 15.815               |
| 296  | 19-02-1972 | 1.58              | 0.492             | 27.868                    | 13.711               |
| 297  | 03-03-1972 | 1.63              | 0.535             | 28.852                    | 15.436               |
| 298  | 13-03-1972 | 2.37              | 0.66              | 58.97                     | 38.92                |
| 299  | 06-04-1972 | 3.82              | 0.731             | 126.389                   | 92.39                |
| 300  | 13-04-1972 | 3.72              | 0.483             | 190.161                   | 91.848               |
| 301  | 17-04-1972 | 4.48              | 0.93              | 135.72                    | 126.22               |
| 302  | 24-04-1972 | 2.48              | 0.459             | 153.394                   | 70.408               |
| 303  | 24-04-1972 | 2.48              | 0.386             | 107.334                   | 41.431               |
| 304  | 27-04-1972 | 6.76              | 0.843             | 376.096                   | 317.049              |
| 305  | 02-05-1972 | 6.78              | 0.685             | 394.53                    | 270.253              |
| 306  | 11-05-1972 | 5.86              | 0.661             | 313.398                   | 207.156              |
| 307  | 12-05-1972 | 5.65              | 0.631             | 293.002                   | 184.884              |
| 308  | 14-05-1972 | 6.13              | 0.694             | 337.643                   | 234.324              |
| 309  | 25-05-1972 | 6.46              | 0.729             | 401.868                   | 292.962              |
| 310  | 26-05-1972 | 6.45              | 0.714             | 391.116                   | 279.257              |
| 311  | 27-05-1972 | 6.47              | 0.75              | 389.251                   | 291.938              |
| 312  | 02-06-1972 | 6.25              | 0.668             | 363.069                   | 242.53               |

| SNo. | Date       | Stage<br>(metres) | Velocity<br>(m/s) | Area<br>(m <sup>2</sup> ) | Measured<br>(cumecs) |
|------|------------|-------------------|-------------------|---------------------------|----------------------|
| 313  | 09-06-1972 | 3.96              | 0.526             | 192.559                   | 101.286              |
| 314  | 18-09-1972 | 1.44              | 0.473             | 37.304                    | 17.645               |
| 315  | 21-09-1972 | 1.45              | 0.504             | 39.688                    | 20.003               |
| 316  | 22-09-1972 | 1.49              | 0.447             | 40.152                    | 17.948               |
| 317  | 25-09-1972 | 1.58              | 0.476             | 49.914                    | 23.759               |
| 318  | 29-09-1972 | 1.37              | 0.454             | 33.359                    | 15.145               |
| 319  | 17-11-1972 | 2.96              | 0.67              | 104.11                    | 69.754               |
| 320  | 18-11-1972 | 2.781             | 0.655             | 98.362                    | 64.427               |
| 321  | 19-11-1972 | 2.781             | 0.652             | 92.431                    | 60.265               |
| 322  | 08-12-1972 | 2.438             | 0.662             | 80.15                     | 53.059               |
| 323  | 09-12-1972 | 2.344             | 0.636             | 75.648                    | 48.112               |
| 324  | 11-12-1972 | 2.841             | 0.678             | 99.947                    | 67.764               |
| 325  | 26-12-1972 | 2.505             | 0.694             | 77.291                    | 53.64                |
| 326  | 27-12-1972 | 2.432             | 0.66              | 76.003                    | 50.162               |
| 327  | 28-12-1972 | 2.326             | 0.653             | 71.083                    | 46.417               |
| 328  | 30-01-1973 | 4.078             | 0.774             | 144.309                   | 111.695              |
| 329  | 01-02-1973 | 3.44              | 0.831             | 106.043                   | 88.122               |
| 330  | 02-02-1973 | 3.29              | 0.984             | 82.055                    | 80.742               |
| 331  | 03-02-1973 | 3.11              | 0.751             | 89.281                    | 67.05                |
| 332  | 04-02-1973 | 3.04              | 0.761             | 87.512                    | 66.597               |
| 333  | 05-02-1973 | 2.8               | 0.786             | 81.095                    | 63.741               |
| 334  | 06-02-1973 | 2.79              | 0.747             | 80.621                    | 60.224               |
| 335  | 07-02-1973 | 2.68              | 0.816             | 71.463                    | 58.314               |
| 336  | 08-02-1973 | 2.62              | 0.754             | 71.353                    | 53.8                 |
| 337  | 09-02-1973 | 2.53              | 0.679             | 70.081                    | 47.585               |
| 338  | 10-02-1973 | 2.48              | 0.696             | 66.51                     | 46.291               |
| 339  | 12-02-1973 | 2.4               | 0.622             | 65.215                    | 40.564               |
| 340  | 14-02-1973 | 2.29              | 0.643             | 57.698                    | 37.1                 |
| 341  | 16-02-1973 | 3.493             | 0.778             | 118.332                   | 92.062               |
| 342  | 19-02-1973 | 3.267             | 0.81              | 96.196                    | 77.919               |
| 343  | 22-02-1973 | 3.06              | 0.782             | 94.875                    | 74.192               |
| 344  | 23-02-1973 | 3.12              | 0.794             | 102.024                   | 81.007               |
| 345  | 05-03-1973 | 5.096             | 0.811             | 206.054                   | 167.11               |
| 346  | 07-03-1973 | 3.52              | 0.813             | 113.522                   | 92.293               |
| 347  | 08-03-1973 | 3.115             | 0.798             | 94.051                    | 75.053               |
| 348  | 09-03-1973 | 2.954             | 0.82              | 84.002                    | 68.882               |
| 349  | 28-03-1973 | 3.6               | 0.778             | 129.229                   | 100.54               |
| 350  | 29-03-1973 | 3.65              | 0.758             | 131.044                   | 99.331               |
| 351  | 05-04-1973 | 3.14              | 0.713             | 104.424                   | 74.454               |
| 352  | 06-04-1973 | 3.53              | 0.773             | 124.07                    | 95.906               |
| 353  | 07-04-1973 | 3.79              | 0.702             | 153.574                   | 107.809              |
| 354  | 19-04-1973 | 6.68              | 0.88              | 299.261                   | 263.35               |
| 355  | 21-04-1973 | 6.16              | 0.809             | 312.225                   | 252.59               |
| 356  | 24-04-1973 | 6.05              | 0.583             | 370.117                   | 215.778              |
| 357  | 28-04-1973 | 5.21              | 0.732             | 223.402                   | 163.53               |

| SNo. | Date       | Stage (metres) | Velocity (m/s) | Area (m <sup>2</sup> ) | Measured (cumecs) |
|------|------------|----------------|----------------|------------------------|-------------------|
| 358  | 06-05-1973 | 7.1            | 0.892          | 436.929                | 389.741           |
| 359  | 07-05-1973 | 7.03           | 0.914          | 446.138                | 407.77            |
| 360  | 08-05-1973 | 7.12           | 0.887          | 448.407                | 397.737           |
| 361  | 09-05-1973 | 7.25           | 0.931          | 468.12                 | 435.82            |
| 362  | 10-05-1973 | 7.21           | 0.953          | 454.622                | 433.255           |
| 363  | 11-05-1973 | 7.16           | 0.917          | 466.017                | 427.338           |
| 364  | 12-05-1973 | 7.09           | 0.887          | 431.003                | 382.3             |
| 365  | 11-08-1973 | 1.69           | 0.469          | 43.642                 | 20.468            |
| 366  | 12-08-1973 | 1.58           | 0.438          | 43.502                 | 19.054            |
| 367  | 18-08-1973 | 1.77           | 0.476          | 48.5                   | 23.086            |
| 368  | 26-08-1973 | 1.86           | 0.443          | 48.777                 | 21.608            |
| 369  | 27-08-1973 | 1.77           | 0.492          | 42.561                 | 20.94             |
| 370  | 29-08-1973 | 1.65           | 0.447          | 39.128                 | 17.49             |
| 371  | 31-08-1973 | 1.68           | 0.534          | 37                     | 19.758            |
| 372  | 01-09-1973 | 1.62           | 0.471          | 40.828                 | 19.23             |
| 373  | 21-11-1973 | 1.67           | 0.513          | 44.52                  | 22.839            |
| 374  | 24-11-1973 | 2.68           | 0.632          | 95.5                   | 60.356            |
| 375  | 26-11-1973 | 2.93           | 0.6            | 113.187                | 67.912            |
| 376  | 27-11-1973 | 2.59           | 0.587          | 88.957                 | 52.218            |
| 377  | 03-12-1973 | 1.48           | 0.436          | 38.39                  | 16.738            |
| 378  | 04-12-1973 | 1.565          | 0.482          | 43.272                 | 20.857            |
| 379  | 11-12-1973 | 2.65           | 0.584          | 92.772                 | 54.179            |
| 380  | 14-12-1973 | 1.92           | 0.559          | 56.953                 | 31.837            |
| 381  | 18-12-1973 | 1.81           | 0.478          | 55.753                 | 26.65             |
| 382  | 10-01-1974 | 1.33           | 0.344          | 37.483                 | 12.894            |
| 383  | 02-02-1974 | 2.34           | 0.593          | 81.121                 | 48.105            |
| 384  | 04-02-1974 | 2.28           | 0.601          | 69.947                 | 42.038            |
| 385  | 14-02-1974 | 1.36           | 0.497          | 23.974                 | 11.915            |
| 386  | 29-03-1974 | 2.293          | 0.532          | 74.955                 | 39.876            |
| 387  | 21-04-1974 | 4.54           | 0.738          | 182.913                | 134.99            |
| 388  | 22-04-1974 | 4.42           | 0.717          | 185.941                | 133.32            |
| 389  | 23-04-1974 | 4.015          | 0.735          | 154.952                | 113.89            |
| 390  | 24-04-1974 | 3.75           | 0.711          | 133.066                | 94.61             |
| 391  | 27-04-1974 | 3.73           | 0.752          | 134.348                | 101.03            |
| 392  | 29-04-1974 | 4.61           | 0.804          | 188.619                | 151.65            |
| 393  | 30-04-1974 | 5.41           | 0.773          | 235.912                | 182.36            |
| 394  | 01-05-1974 | 5.64           | 0.73           | 268.438                | 195.96            |
| 395  | 04-05-1974 | 6.605          | 0.812          | 369.803                | 300.28            |
| 396  | 07-05-1974 | 6.72           | 0.734          | 397.875                | 292.04            |
| 397  | 10-05-1974 | 7.125          | 0.782          | 492.468                | 385.11            |
| 398  | 11-05-1974 | 7              | 0.884          | 443.326                | 391.9             |
| 399  | 12-05-1974 | 6.18           | 0.76           | 439.658                | 334.14            |
| 400  | 29-05-1974 | 3.63           | 0.538          | 173.792                | 93.5              |
| 401  | 14-06-1974 | 2.77           | 0.313          | 100.16                 | 31.35             |
| 402  | 15-06-1974 | 2.7            | 0.305          | 98.931                 | 30.174            |

| SNo. | Date       | Stage<br>(metres) | Velocity<br>(m/s) | Area<br>(m <sup>2</sup> ) | Measured<br>(cumecs) |
|------|------------|-------------------|-------------------|---------------------------|----------------------|
| 403  | 17-06-1974 | 2.63              | 0.565             | 96.775                    | 54.678               |
| 404  | 18-06-1974 | 2.58              | 0.568             | 87.026                    | 49.431               |
| 405  | 20-08-1974 | 1.48              | 0.474             | 35.295                    | 16.73                |
| 406  | 21-08-1974 | 1.46              | 0.466             | 34.871                    | 16.25                |
| 407  | 23-08-1974 | 1.42              | 0.481             | 31.476                    | 15.14                |
| 408  | 24-08-1974 | 1.4               | 0.451             | 31.353                    | 14.14                |
| 409  | 11-10-1974 | 1.93              | 0.599             | 54.925                    | 32.9                 |
| 410  | 14-10-1974 | 1.51              | 0.515             | 39.089                    | 20.131               |
| 411  | 15-03-1975 | 1.9               | 0.806             | 36.514                    | 29.43                |
| 412  | 25-03-1975 | 3.36              | 0.698             | 110.185                   | 76.909               |
| 413  | 02-04-1975 | 2.13              | 0.656             | 74.396                    | 48.804               |
| 414  | 02-04-1975 | 2.13              | 0.656             | 74.396                    | 48.804               |
| 415  | 03-04-1975 | 2.65              | 0.766             | 62.59                     | 47.944               |
| 416  | 04-04-1975 | 2.94              | 0.816             | 80.293                    | 65.519               |
| 417  | 09-04-1975 | 4.36              | 1.179             | 116.641                   | 137.52               |
| 418  | 10-04-1975 | 4.475             | 0.805             | 159.104                   | 128.079              |
| 419  | 11-04-1975 | 4.41              | 0.839             | 162.813                   | 136.6                |
| 420  | 12-04-1975 | 4.71              | 0.808             | 139.532                   | 112.742              |
| 421  | 14-04-1975 | 5.26              | 0.703             | 252.723                   | 177.664              |
| 422  | 15-04-1975 | 4.97              | 0.8               | 175.9                     | 140.72               |
| 423  | 17-04-1975 | 4.95              | 0.833             | 172.761                   | 143.91               |
| 424  | 19-04-1975 | 5.25              | 0.929             | 183.027                   | 170.032              |
| 425  | 21-04-1975 | 5.08              | 0.938             | 143.977                   | 135.05               |
| 426  | 22-04-1975 | 5.1               | 0.905             | 176.508                   | 159.74               |
| 427  | 23-04-1975 | 5.31              | 0.904             | 189.978                   | 171.74               |
| 428  | 24-04-1975 | 5.47              | 0.862             | 201.677                   | 173.846              |
| 429  | 27-04-1975 | 6.05              | 0.91              | 259.501                   | 236.146              |
| 430  | 30-04-1975 | 5.4               | 0.871             | 216.303                   | 188.4                |
| 431  | 03-05-1975 | 5.33              | 0.765             | 220.562                   | 168.73               |
| 432  | 05-05-1975 | 4.97              | 0.803             | 198.418                   | 159.33               |
| 433  | 06-05-1975 | 4.98              | 0.828             | 197.536                   | 163.56               |
| 434  | 08-05-1975 | 4.42              | 0.769             | 161.691                   | 124.34               |
| 435  | 10-05-1975 | 3.62              | 0.665             | 120.168                   | 79.912               |
| 436  | 20-05-1975 | 4.68              | 0.636             | 216.204                   | 137.506              |
| 437  | 22-05-1975 | 5.255             | 1.015             | 173.645                   | 176.25               |
| 438  | 23-05-1975 | 5.33              | 0.896             | 205.922                   | 184.506              |
| 439  | 24-05-1975 | 5.24              | 0.854             | 204.496                   | 174.64               |
| 440  | 27-05-1975 | 5.02              | 0.851             | 185.805                   | 158.12               |
| 441  | 07-06-1975 | 3.295             | 0.73              | 106.618                   | 77.831               |
| 442  | 09-06-1975 | 3.02              | 0.741             | 90.818                    | 67.296               |
| 443  | 18-08-1975 | 1.43              | 0.284             | 51.218                    | 14.546               |
| 444  | 18-03-1976 | 2.49              | 0.703             | 71.882                    | 50.533               |
| 445  | 19-03-1976 | 2.8               | 0.681             | 74.449                    | 50.7                 |
| 446  | 20-03-1976 | 3.36              | 0.713             | 120.045                   | 85.592               |
| 447  | 22-03-1976 | 3.64              | 0.799             | 115.829                   | 92.547               |

| SNo. | Date       | Stage<br>(metres) | Velocity<br>(m/s) | Area<br>(m <sup>2</sup> ) | Measured<br>(cumecs) |
|------|------------|-------------------|-------------------|---------------------------|----------------------|
| 448  | 31-03-1976 | 4.48              | 0.797             | 168.9                     | 134.613              |
| 449  | 01-04-1976 | 4.64              | 0.819             | 171.188                   | 140.203              |
| 450  | 05-04-1976 | 3.97              | 0.799             | 130.776                   | 104.49               |
| 451  | 07-04-1976 | 3.93              | 0.797             | 133.915                   | 106.73               |
| 452  | 08-04-1976 | 3.85              | 0.771             | 127.567                   | 98.354               |
| 453  | 10-04-1976 | 3.33              | 0.76              | 101.48                    | 77.125               |
| 454  | 14-04-1976 | 3.08              | 0.888             | 82.332                    | 73.111               |
| 455  | 22-04-1976 | 4.04              | 0.768             | 139.193                   | 106.9                |
| 456  | 23-04-1976 | 4.29              | 0.773             | 155.618                   | 120.293              |
| 457  | 26-04-1976 | 5.03              | 0.857             | 176.399                   | 151.174              |
| 458  | 27-04-1976 | 5.14              | 0.8               | 192.645                   | 154.116              |
| 459  | 29-04-1976 | 5.33              | 0.851             | 197.899                   | 168.412              |
| 460  | 30-04-1976 | 5.35              | 0.813             | 199.287                   | 162.02               |
| 461  | 03-05-1976 | 4.92              | 0.87              | 187.141                   | 162.813              |
| 462  | 05-05-1976 | 5.26              | 0.805             | 196.186                   | 157.93               |
| 463  | 06-05-1976 | 5.45              | 0.881             | 201.487                   | 177.51               |
| 464  | 07-05-1976 | 5.64              | 0.9               | 221.888                   | 199.699              |
| 465  | 08-05-1976 | 5.92              | 0.878             | 236.761                   | 207.876              |
| 466  | 09-05-1976 | 6.05              | 0.897             | 262.637                   | 235.585              |
| 467  | 10-05-1976 | 6.09              | 0.915             | 272.689                   | 249.51               |
| 468  | 12-05-1976 | 5.86              | 0.835             | 250.795                   | 209.414              |
| 469  | 13-05-1976 | 5.59              | 0.759             | 238.366                   | 180.92               |
| 470  | 15-05-1976 | 4.41              | 0.745             | 170.698                   | 127.17               |
| 471  | 17-05-1976 | 3.87              | 0.716             | 140.489                   | 100.59               |
| 472  | 18-05-1976 | 3.81              | 0.718             | 132.632                   | 95.23                |
| 473  | 19-05-1976 | 3.85              | 0.754             | 143.21                    | 107.98               |
| 474  | 21-05-1976 | 4.16              | 0.736             | 159.573                   | 117.446              |
| 475  | 22-05-1976 | 4.1               | 0.747             | 153.253                   | 114.48               |
| 476  | 24-05-1976 | 3.68              | 0.713             | 122.259                   | 87.171               |
| 477  | 26-05-1976 | 3.29              | 0.693             | 107.489                   | 74.49                |
| 478  | 29-05-1976 | 2.93              | 0.643             | 92.784                    | 59.66                |
| 479  | 31-05-1976 | 2.82              | 0.668             | 81.841                    | 54.67                |
| 480  | 01-06-1976 | 2.72              | 0.613             | 82.445                    | 50.539               |
| 481  | 02-06-1976 | 2.66              | 0.671             | 78.733                    | 52.83                |
| 482  | 07-06-1976 | 2.42              | 0.588             | 74.398                    | 43.746               |
| 483  | 09-06-1976 | 2.37              | 0.721             | 60.57                     | 43.671               |
| 484  | 11-06-1976 | 2.29              | 0.518             | 74.237                    | 38.455               |
| 485  | 16-06-1976 | 2.7               | 0.641             | 82.574                    | 52.93                |
| 486  | 11-08-1976 | 1.43              | 0.448             | 31.589                    | 14.152               |
| 487  | 24-08-1976 | 1.326             | 0.441             | 26.488                    | 11.681               |
| 488  | 24-03-1977 | 3.115             | 0.696             | 99.04                     | 68.932               |
| 489  | 25-03-1977 | 1.93              | 0.565             | 54.984                    | 31.066               |
| 490  | 26-03-1977 | 2.315             | 0.61              | 69.07                     | 42.133               |
| 491  | 30-03-1977 | 3.6               | 0.666             | 126.356                   | 84.153               |
| 492  | 31-03-1977 | 3.56              | 0.626             | 121.173                   | 75.854               |

| SNo. | Date       | Stage<br>(metres) | Velocity<br>(m/s) | Area<br>(m <sup>2</sup> ) | Measured<br>(cumecs) |
|------|------------|-------------------|-------------------|---------------------------|----------------------|
| 493  | 01-04-1977 | 3.06              | 0.66              | 95.464                    | 63.006               |
| 494  | 02-04-1977 | 2.72              | 0.682             | 76.098                    | 51.899               |
| 495  | 03-04-1977 | 2.63              | 0.648             | 79.4                      | 51.451               |
| 496  | 05-04-1977 | 2.48              | 0.636             | 70.781                    | 45.017               |
| 497  | 07-04-1977 | 2.73              | 0.655             | 82.687                    | 54.16                |
| 498  | 14-04-1977 | 2.82              | 0.563             | 85.08                     | 47.9                 |
| 499  | 22-04-1977 | 2.38              | 0.622             | 68.473                    | 42.59                |
| 500  | 23-04-1977 | 2.61              | 0.638             | 76.746                    | 48.964               |
| 501  | 26-04-1977 | 3.765             | 0.681             | 125.85                    | 85.704               |
| 502  | 28-04-1977 | 4.21              | 0.722             | 148.364                   | 107.119              |
| 503  | 30-04-1977 | 4.93              | 0.708             | 195.016                   | 138.071              |
| 504  | 02-05-1977 | 5.415             | 0.74              | 226.332                   | 167.486              |
| 505  | 06-05-1977 | 5.405             | 0.75              | 216                       | 162                  |
| 506  | 07-05-1977 | 4.825             | 0.689             | 182.231                   | 125.557              |
| 507  | 09-05-1977 | 3.69              | 0.725             | 110.566                   | 80.16                |
| 508  | 16-05-1977 | 2.595             | 0.553             | 74.79                     | 41.359               |
| 509  | 26-05-1977 | 2.54              | 0.606             | 77.611                    | 47.032               |
| 510  | 27-05-1977 | 2.675             | 0.563             | 84.075                    | 47.334               |
| 511  | 28-05-1977 | 3.325             | 0.648             | 105.519                   | 68.376               |
| 512  | 20-03-1978 | 2.72              | 0.635             | 88.346                    | 56.1                 |
| 513  | 21-03-1978 | 3.19              | 0.677             | 101.507                   | 68.72                |
| 514  | 22-03-1978 | 2.85              | 0.623             | 88.299                    | 55.01                |
| 515  | 30-03-1978 | 6.06              | 0.726             | 237.92                    | 172.73               |
| 516  | 03-04-1978 | 6.17              | 0.709             | 277.504                   | 196.75               |
| 517  | 04-04-1978 | 6.085             | 0.734             | 293.719                   | 215.59               |
| 518  | 06-04-1978 | 5.785             | 0.701             | 252.753                   | 177.18               |
| 519  | 10-04-1978 | 5.53              | 0.672             | 220.833                   | 148.4                |
| 520  | 11-04-1978 | 5.72              | 0.628             | 254.029                   | 159.53               |
| 521  | 12-04-1978 | 5.78              | 0.708             | 258.39                    | 182.94               |
| 522  | 17-04-1978 | 4.59              | 0.616             | 194.075                   | 119.55               |
| 523  | 19-04-1978 | 4.75              | 0.651             | 202.949                   | 132.12               |
| 524  | 20-04-1978 | 5.15              | 0.662             | 222.598                   | 147.36               |
| 525  | 23-04-1978 | 5.99              | 0.546             | 368.297                   | 201.09               |
| 526  | 24-04-1978 | 6.11              | 0.694             | 281.153                   | 195.12               |
| 527  | 28-04-1978 | 6.255             | 1.021             | 259.589                   | 265.04               |
| 528  | 29-04-1978 | 6.225             | 0.801             | 311.124                   | 249.21               |
| 529  | 09-05-1978 | 4.03              | 0.543             | 179.355                   | 97.39                |
| 530  | 10-05-1978 | 3.76              | 0.539             | 165.343                   | 89.12                |
| 531  | 11-05-1978 | 3.58              | 0.523             | 155.679                   | 81.42                |
| 532  | 13-05-1978 | 3.83              | 0.568             | 163.574                   | 92.91                |
| 533  | 15-05-1978 | 3.61              | 0.58              | 147.5                     | 85.55                |
| 534  | 16-05-1978 | 3.42              | 0.544             | 138.879                   | 75.55                |
| 535  | 17-05-1978 | 3.3               | 0.558             | 130.932                   | 73.06                |
| 536  | 18-05-1978 | 3.205             | 0.534             | 128.652                   | 68.7                 |
| 537  | 19-05-1978 | 3.115             | 0.523             | 123.518                   | 64.6                 |



| SNo. | Date       | Stage<br>(metres) | Velocity<br>(m/s) | Area<br>(m <sup>2</sup> ) | Measured<br>(cumecs) |
|------|------------|-------------------|-------------------|---------------------------|----------------------|
| 538  | 20-05-1978 | 3.02              | 0.525             | 120.019                   | 63.01                |
| 539  | 22-05-1978 | 2.9               | 0.513             | 114.581                   | 58.78                |
| 540  | 23-05-1978 | 2.84              | 0.544             | 111.801                   | 60.82                |
| 541  | 24-05-1978 | 3.15              | 0.612             | 121.699                   | 74.48                |
| 542  | 25-05-1978 | 3.18              | 0.615             | 124.358                   | 76.48                |
| 543  | 26-05-1978 | 2.99              | 0.584             | 116.61                    | 68.1                 |
| 544  | 30-05-1978 | 2.81              | 0.536             | 105.28                    | 56.43                |
| 545  | 31-05-1978 | 2.715             | 0.599             | 95.292                    | 57.08                |
| 546  | 06-06-1978 | 2.49              | 0.622             | 71.929                    | 44.74                |
| 547  | 07-06-1978 | 2.48              | 0.645             | 70.822                    | 45.68                |
| 548  | 10-06-1978 | 2.34              | 0.601             | 65.541                    | 39.39                |
| 549  | 13-06-1978 | 2.22              | 0.601             | 61.431                    | 36.92                |
| 550  | 15-06-1978 | 2.18              | 0.621             | 61.884                    | 38.43                |
| 551  | 05-12-1978 | 4.74              | 0.591             | 154.966                   | 91.585               |
| 552  | 06-12-1978 | 5.02              | 0.69              | 152.099                   | 104.948              |
| 553  | 07-12-1978 | 5.38              | 0.738             | 178.027                   | 131.384              |
| 554  | 08-12-1978 | 5.53              | 0.653             | 231.466                   | 151.147              |
| 555  | 09-12-1978 | 5.6               | 0.788             | 231.939                   | 182.768              |
| 556  | 10-12-1978 | 5.68              | 0.748             | 226.222                   | 169.214              |
| 557  | 11-12-1978 | 5.81              | 0.774             | 255.293                   | 197.597              |
| 558  | 13-12-1978 | 5.62              | 0.734             | 249.405                   | 183.063              |
| 559  | 14-12-1978 | 5.37              | 0.723             | 229.562                   | 165.973              |
| 560  | 15-12-1978 | 5.3               | 0.652             | 229.649                   | 149.731              |
| 561  | 16-12-1978 | 5.42              | 0.737             | 230.064                   | 169.557              |
| 562  | 17-12-1978 | 5.45              | 0.687             | 240.255                   | 165.055              |
| 563  | 18-12-1978 | 5.93              | 0.776             | 275.369                   | 213.686              |
| 564  | 19-12-1978 | 6.19              | 0.75              | 307.02                    | 230.265              |
| 565  | 20-12-1978 | 6.37              | 0.77              | 335.174                   | 258.084              |
| 566  | 29-12-1978 | 6.12              | 0.677             | 369.886                   | 250.413              |
| 567  | 30-12-1978 | 6.04              | 0.637             | 365.95                    | 233.11               |
| 568  | 01-01-1979 | 5.32              | 0.591             | 272.222                   | 160.883              |
| 569  | 02-01-1979 | 4.95              | 0.6               | 244.308                   | 146.585              |
| 570  | 03-01-1979 | 4.9               | 0.921             | 132.099                   | 121.663              |
| 571  | 15-02-1979 | 4.29              | 0.806             | 149.64                    | 120.61               |
| 572  | 16-02-1979 | 4.7               | 0.801             | 173.38                    | 138.877              |
| 573  | 17-02-1979 | 5.015             | 0.781             | 207.006                   | 161.672              |
| 574  | 18-02-1979 | 5.04              | 0.791             | 197.671                   | 156.358              |
| 575  | 20-02-1979 | 5.1               | 0.791             | 203.049                   | 160.612              |
| 576  | 21-02-1979 | 5.55              | 0.855             | 226.175                   | 193.38               |
| 577  | 22-02-1979 | 5.7               | 0.822             | 226.046                   | 185.81               |
| 578  | 23-02-1979 | 5.69              | 0.766             | 231.971                   | 177.69               |
| 579  | 24-02-1979 | 5.78              | 0.802             | 251.683                   | 201.85               |
| 580  | 26-02-1979 | 6.15              | 0.771             | 307.553                   | 237.123              |
| 581  | 27-02-1979 | 6.3               | 0.79              | 328.329                   | 259.38               |
| 582  | 28-02-1979 | 6.4               | 0.801             | 334.808                   | 268.181              |

| SNo. | Date       | Stage (metres) | Velocity (m/s) | Area (m <sup>2</sup> ) | Measured (cumecs) |
|------|------------|----------------|----------------|------------------------|-------------------|
| 583  | 01-03-1979 | 6.405          | 0.784          | 343.236                | 269.097           |
| 584  | 08-03-1979 | 3.73           | 0.52           | 180.638                | 93.932            |
| 585  | 09-03-1979 | 3.52           | 0.494          | 165.387                | 81.701            |
| 586  | 10-03-1979 | 3.64           | 0.522          | 167.487                | 87.428            |
| 587  | 13-03-1979 | 3.81           | 0.56           | 181.109                | 101.421           |
| 588  | 14-03-1979 | 3.89           | 0.565          | 176.991                | 100               |
| 589  | 18-03-1979 | 4.9            | 0.685          | 225.915                | 154.752           |
| 590  | 20-03-1979 | 5.57           | 0.709          | 269.763                | 191.262           |
| 591  | 21-03-1979 | 5.74           | 0.701          | 291.763                | 204.526           |
| 592  | 23-03-1979 | 5.98           | 0.686          | 323.891                | 222.189           |
| 593  | 25-03-1979 | 6              | 0.575          | 341.437                | 196.326           |
| 594  | 26-03-1979 | 6.02           | 0.583          | 344.962                | 201.113           |
| 595  | 27-03-1979 | 6.06           | 0.628          | 348.763                | 219.023           |
| 596  | 28-03-1979 | 6.17           | 0.652          | 347.817                | 226.777           |
| 597  | 29-03-1979 | 6.32           | 1.08           | 247.222                | 267               |
| 598  | 30-03-1979 | 6.46           | 0.594          | 378.367                | 224.75            |
| 599  | 02-04-1979 | 6.65           | 0.663          | 403.192                | 267.316           |
| 600  | 09-04-1979 | 6.48           | 0.692          | 376.13                 | 260.282           |
| 601  | 08-05-1979 | 6.77           | 1.049          | 418.341                | 438.84            |
| 602  | 09-05-1979 | 6.675          | 0.908          | 436.637                | 396.466           |
| 603  | 10-05-1979 | 6.775          | 0.974          | 442.811                | 431.298           |
| 604  | 11-05-1979 | 6.78           | 0.988          | 408.62                 | 403.717           |
| 605  | 12-05-1979 | 6.5            | 0.593          | 383.592                | 227.47            |
| 606  | 15-05-1979 | 6.41           | 0.835          | 375.104                | 313.212           |
| 607  | 16-05-1979 | 6.33           | 0.879          | 271.019                | 238.226           |
| 608  | 17-05-1979 | 6.205          | 0.782          | 353.63                 | 276.539           |
| 609  | 06-10-1979 | 1.27           | 0.448          | 36.882                 | 16.523            |
| 610  | 08-10-1979 | 1.24           | 0.355          | 41.885                 | 14.869            |
| 611  | 10-10-1979 | 1.22           | 0.409          | 45.533                 | 18.623            |
| 612  | 11-10-1979 | 1.28           | 0.439          | 42.285                 | 18.563            |
| 613  | 26-05-1980 | 3.49           | 0.649          | 109.778                | 71.246            |
| 614  | 27-05-1980 | 3.36           | 0.705          | 97.756                 | 68.918            |
| 615  | 27-05-1980 | 3.31           | 0.719          | 94.238                 | 67.757            |
| 616  | 03-12-1980 | 1.635          | 0.531          | 49.55                  | 26.311            |
| 617  | 04-12-1980 | 2.18           | 0.582          | 68.43                  | 39.826            |
| 618  | 05-12-1980 | 2.52           | 0.694          | 71.916                 | 49.91             |
| 619  | 05-02-1981 | 2.8            | 0.628          | 92.76                  | 58.253            |
| 620  | 06-02-1981 | 2.435          | 0.624          | 77.994                 | 48.668            |
| 621  | 07-02-1981 | 2.24           | 0.699          | 61.096                 | 42.706            |
| 622  | 09-02-1981 | 2.04           | 0.725          | 53.411                 | 38.723            |
| 623  | 10-02-1981 | 1.94           | 0.609          | 57.054                 | 34.746            |
| 624  | 11-02-1981 | 1.88           | 0.598          | 53.562                 | 32.03             |
| 625  | 12-02-1981 | 1.82           | 0.551          | 52.474                 | 28.913            |
| 626  | 13-02-1981 | 1.78           | 0.559          | 49.369                 | 27.597            |
| 627  | 14-02-1981 | 1.78           | 0.586          | 48.208                 | 28.25             |

| SNo. | Date       | Stage<br>(metres) | Velocity<br>(m/s) | Area<br>(m <sup>2</sup> ) | Measured<br>(cumecs) |
|------|------------|-------------------|-------------------|---------------------------|----------------------|
| 628  | 16-02-1981 | 2.5               | 0.622             | 84.1                      | 52.31                |
| 629  | 17-02-1981 | 2.44              | 0.673             | 74.661                    | 50.247               |
| 630  | 18-02-1981 | 2.44              | 0.617             | 79.825                    | 49.252               |
| 631  | 19-02-1981 | 2.54              | 0.652             | 78.917                    | 51.454               |
| 632  | 20-02-1981 | 2.32              | 0.648             | 71.162                    | 46.113               |
| 633  | 21-02-1981 | 2.2               | 0.641             | 63.027                    | 40.4                 |
| 634  | 23-02-1981 | 2.68              | 0.712             | 80.732                    | 57.481               |
| 635  | 24-02-1981 | 2.4               | 0.669             | 69.297                    | 46.36                |
| 636  | 03-03-1981 | 1.75              | 0.565             | 47.485                    | 26.829               |
| 637  | 10-03-1981 | 1.52              | 0.536             | 43.547                    | 23.341               |
| 638  | 11-03-1981 | 1.48              | 0.504             | 36.244                    | 18.267               |
| 639  | 16-03-1981 | 1.405             | 0.524             | 34.21                     | 17.926               |
| 640  | 20-03-1981 | 1.48              | 0.465             | 43.314                    | 20.141               |
| 641  | 21-03-1981 | 1.46              | 0.443             | 34.745                    | 15.392               |
| 642  | 23-03-1981 | 2.23              | 0.598             | 63.744                    | 38.119               |
| 643  | 24-03-1981 | 2.43              | 0.671             | 73.323                    | 49.2                 |
| 644  | 25-03-1981 | 2.61              | 0.625             | 82.602                    | 51.626               |
| 645  | 26-03-1981 | 2.28              | 0.589             | 70.569                    | 41.565               |
| 646  | 04-04-1981 | 3.89              | 0.806             | 113.252                   | 91.281               |
| 647  | 06-04-1981 | 2.92              | 0.781             | 83.169                    | 64.955               |
| 648  | 13-04-1981 | 3.1               | 0.686             | 82.054                    | 56.289               |
| 649  | 14-04-1981 | 4.2               | 0.749             | 153.324                   | 114.84               |
| 650  | 17-04-1981 | 3.98              | 0.808             | 129.401                   | 104.556              |
| 651  | 20-04-1981 | 4.67              | 0.863             | 190.171                   | 164.118              |
| 652  | 21-04-1981 | 4.75              | 0.625             | 202.485                   | 126.553              |
| 653  | 22-04-1981 | 4.73              | 0.76              | 199.721                   | 151.788              |
| 654  | 25-04-1981 | 4.6               | 0.871             | 188.037                   | 163.78               |
| 655  | 05-05-1981 | 5.75              | 0.872             | 278.407                   | 242.771              |
| 656  | 06-05-1981 | 5.68              | 0.861             | 265.496                   | 228.592              |
| 657  | 07-05-1981 | 5.71              | 0.883             | 284.085                   | 250.847              |
| 658  | 08-05-1981 | 5.81              | 0.852             | 284.487                   | 242.383              |
| 659  | 09-05-1981 | 5.91              | 1.211             | 226.733                   | 274.574              |
| 660  | 12-05-1981 | 6.18              | 0.959             | 332.425                   | 318.796              |
| 661  | 13-05-1981 | 6.36              | 0.943             | 343.001                   | 323.45               |
| 662  | 14-05-1981 | 6.65              | 0.887             | 389.317                   | 345.324              |
| 663  | 18-05-1981 | 6.39              | 0.87              | 416.711                   | 362.539              |
| 664  | 21-05-1981 | 7                 | 0.924             | 437.592                   | 404.335              |
| 665  | 22-07-1981 | 2.36              | 0.669             | 66.952                    | 44.791               |
| 666  | 11-03-1982 | 1.44              | 0.267             | 36.663                    | 9.789                |
| 667  | 12-03-1982 | 1.49              | 0.248             | 35.468                    | 8.796                |
| 668  | 17-03-1982 | 1.22              | 0.205             | 33.039                    | 6.773                |
| 669  | 18-03-1982 | 1.45              | 0.23              | 41.53                     | 9.552                |
| 670  | 19-03-1982 | 1.81              | 0.252             | 53.921                    | 13.588               |
| 671  | 20-03-1982 | 1.9               | 0.277             | 57.029                    | 15.797               |
| 672  | 21-03-1982 | 1.92              | 0.275             | 58.618                    | 16.12                |

| SNo. | Date       | Stage<br>(metres) | Velocity<br>(m/s) | Area<br>(m <sup>2</sup> ) | Measured<br>(cumecs) |
|------|------------|-------------------|-------------------|---------------------------|----------------------|
| 673  | 22-03-1982 | 1.88              | 0.282             | 56.667                    | 15.98                |
| 674  | 23-03-1982 | 1.78              | 0.282             | 48.177                    | 13.586               |
| 675  | 24-03-1982 | 1.89              | 0.283             | 47.057                    | 13.317               |
| 676  | 25-03-1982 | 1.84              | 0.275             | 51.273                    | 14.1                 |
| 677  | 26-03-1982 | 1.68              | 0.277             | 40.419                    | 11.196               |
| 678  | 30-03-1982 | 1.4               | 0.241             | 36.021                    | 8.681                |
| 679  | 01-04-1982 | 1.34              | 0.237             | 36.076                    | 8.55                 |
| 680  | 02-04-1982 | 1.41              | 0.257             | 34.918                    | 8.974                |
| 681  | 03-04-1982 | 1.57              | 0.26              | 40.546                    | 10.542               |
| 682  | 04-04-1982 | 1.72              | 0.279             | 51.276                    | 14.306               |
| 683  | 05-04-1982 | 1.93              | 0.276             | 55.435                    | 15.3                 |
| 684  | 07-04-1982 | 3.11              | 0.323             | 111.83                    | 36.121               |
| 685  | 07-04-1982 | 3.38              | 0.388             | 109.66                    | 42.548               |
| 686  | 07-04-1982 | 3.33              | 0.333             | 134.661                   | 44.842               |
| 687  | 08-04-1982 | 3.63              | 0.351             | 136.872                   | 48.042               |
| 688  | 09-04-1982 | 3.75              | 0.356             | 146.416                   | 52.124               |
| 689  | 14-04-1982 | 3.05              | 0.358             | 103.67                    | 37.114               |
| 690  | 15-04-1982 | 3.04              | 0.22              | 93.664                    | 20.606               |
| 691  | 16-04-1982 | 3.15              | 0.375             | 103.821                   | 38.933               |
| 692  | 19-04-1982 | 3.13              | 0.37              | 105.822                   | 39.154               |
| 693  | 20-04-1982 | 3.12              | 0.36              | 99.886                    | 35.959               |
| 694  | 21-04-1982 | 3.32              | 0.371             | 109.825                   | 40.745               |
| 695  | 22-04-1982 | 3.9               | 0.374             | 147.88                    | 55.307               |
| 696  | 22-04-1982 | 3.81              | 0.378             | 132.86                    | 50.221               |
| 697  | 23-04-1982 | 4.07              | 0.373             | 155.399                   | 57.964               |
| 698  | 24-04-1982 | 4.37              | 0.379             | 174.327                   | 66.07                |
| 699  | 25-04-1982 | 4.23              | 0.393             | 155.519                   | 61.119               |
| 700  | 28-04-1982 | 3.05              | 0.368             | 96.848                    | 35.64                |
| 701  | 30-04-1982 | 2.69              | 0.356             | 71.784                    | 25.555               |
| 702  | 01-05-1982 | 2.6               | 0.345             | 71.632                    | 24.713               |
| 703  | 02-05-1982 | 2.84              | 0.369             | 83.71                     | 30.889               |
| 704  | 05-05-1982 | 3.11              | 0.38              | 98.887                    | 37.577               |
| 705  | 06-05-1982 | 3.88              | 0.369             | 136.184                   | 50.252               |
| 706  | 06-05-1982 | 3.78              | 0.377             | 133.817                   | 50.449               |
| 707  | 07-05-1982 | 4.03              | 0.389             | 140.383                   | 54.609               |
| 708  | 08-05-1982 | 4.22              | 0.367             | 158.91                    | 58.32                |
| 709  | 10-05-1982 | 4.46              | 0.415             | 154.294                   | 64.032               |
| 710  | 11-05-1982 | 4.66              | 0.392             | 182.673                   | 71.608               |
| 711  | 12-05-1982 | 4.78              | 0.392             | 184.569                   | 72.351               |
| 712  | 13-05-1982 | 4.93              | 0.412             | 182.051                   | 75.005               |
| 713  | 14-05-1982 | 5.14              | 0.341             | 205.806                   | 70.18                |
| 714  | 15-05-1982 | 5.34              | 0.362             | 213.997                   | 77.467               |
| 715  | 16-05-1982 | 5.49              | 0.424             | 214.634                   | 91.005               |
| 716  | 19-05-1982 | 4.47              | 0.398             | 161.93                    | 64.448               |
| 717  | 20-05-1982 | 3.85              | 0.41              | 131.649                   | 53.976               |

| SNo. | Date       | Stage<br>(metres) | Velocity<br>(m/s) | Area<br>(m <sup>2</sup> ) | Measured<br>(cumecs) |
|------|------------|-------------------|-------------------|---------------------------|----------------------|
| 718  | 21-05-1982 | 3.45              | 0.357             | 112.417                   | 40.133               |
| 719  | 22-05-1982 | 3.19              | 0.35              | 101.266                   | 35.443               |
| 720  | 24-05-1982 | 3.17              | 0.349             | 102.453                   | 35.756               |
| 721  | 25-05-1982 | 3.03              | 0.314             | 93.615                    | 29.395               |
| 722  | 26-05-1982 | 2.87              | 0.345             | 82.38                     | 28.421               |
| 723  | 10-06-1982 | 1.33              | 0.353             | 44.584                    | 15.738               |
| 724  | 03-09-1982 | 1.405             | 0.397             | 45.295                    | 17.982               |
| 725  | 07-09-1982 | 1.385             | 0.387             | 47.163                    | 18.252               |
| 726  | 11-09-1982 | 1.31              | 0.353             | 42.411                    | 14.971               |
| 727  | 13-09-1982 | 1.29              | 0.352             | 40.804                    | 14.363               |
| 728  | 17-09-1982 | 1.38              | 0.385             | 44.143                    | 16.995               |
| 729  | 02-05-1983 | 4.64              | 0.811             | 175.568                   | 142.386              |
| 730  | 03-05-1983 | 4.9               | 0.807             | 197.914                   | 159.717              |
| 731  | 04-05-1983 | 5.15              | 0.868             | 211.063                   | 183.203              |
| 732  | 05-05-1983 | 5.33              | 0.841             | 219.954                   | 184.981              |
| 733  | 06-05-1983 | 5.4               | 0.863             | 230.977                   | 199.333              |
| 734  | 07-05-1983 | 5.48              | 0.858             | 228.49                    | 196.044              |
| 735  | 09-05-1983 | 5.55              | 0.881             | 231.264                   | 203.744              |
| 736  | 10-05-1983 | 5.62              | 0.851             | 229.096                   | 194.961              |
| 737  | 11-05-1983 | 5.7               | 0.887             | 236.207                   | 209.516              |
| 738  | 12-05-1983 | 5.86              | 0.911             | 241.212                   | 219.744              |
| 739  | 13-05-1983 | 5.88              | 0.879             | 250.053                   | 219.797              |
| 740  | 14-05-1983 | 5.72              | 0.885             | 233.401                   | 206.56               |
| 741  | 19-05-1983 | 5.76              | 0.881             | 251.472                   | 221.547              |
| 742  | 20-05-1983 | 5.8               | 0.885             | 251.637                   | 222.699              |
| 743  | 23-05-1983 | 5.76              | 0.846             | 236.725                   | 200.269              |
| 744  | 25-05-1983 | 5.65              | 0.824             | 247.443                   | 203.893              |
| 745  | 26-05-1983 | 5.5               | 0.794             | 241.136                   | 191.462              |
| 746  | 30-05-1983 | 5.16              | 0.771             | 216.612                   | 167.008              |
| 747  | 01-06-1983 | 5.42              | 0.834             | 228.159                   | 190.285              |
| 748  | 02-06-1983 | 5.64              | 0.841             | 226.875                   | 190.802              |
| 749  | 05-06-1983 | 5.72              | 0.84              | 264.021                   | 221.778              |
| 750  | 08-06-1983 | 5.05              | 0.734             | 217.549                   | 159.681              |
| 751  | 09-06-1983 | 4.6               | 0.734             | 184.627                   | 135.516              |
| 752  | 10-06-1983 | 4.25              | 0.693             | 165.719                   | 114.843              |
| 753  | 11-06-1983 | 3.88              | 0.672             | 140.207                   | 94.219               |
| 754  | 15-02-1984 | 2.04              | 0.48              | 64.956                    | 31.179               |
| 755  | 16-02-1984 | 1.89              | 0.486             | 57.012                    | 27.708               |
| 756  | 17-02-1984 | 2.96              | 0.67              | 94.212                    | 63.122               |
| 757  | 17-02-1984 | 1.86              | 0.482             | 58.581                    | 28.236               |
| 758  | 18-02-1984 | 1.98              | 0.571             | 64.497                    | 36.828               |
| 759  | 20-02-1984 | 2.91              | 0.703             | 109.073                   | 76.678               |
| 760  | 21-02-1984 | 2.96              | 0.662             | 118.322                   | 78.329               |
| 761  | 22-02-1984 | 3.02              | 0.73              | 112.279                   | 81.964               |
| 762  | 23-02-1984 | 2.96              | 0.695             | 97.45                     | 67.728               |

| SNo. | Date       | Stage<br>(metres) | Velocity<br>(m/s) | Area<br>(m <sup>2</sup> ) | Measured<br>(cumecs) |
|------|------------|-------------------|-------------------|---------------------------|----------------------|
| 763  | 24-02-1984 | 2.72              | 0.654             | 86.731                    | 56.722               |
| 764  | 25-02-1984 | 2.47              | 0.584             | 80.152                    | 46.809               |
| 765  | 27-02-1984 | 2.13              | 0.54              | 66.089                    | 35.688               |
| 766  | 28-02-1984 | 1.92              | 0.55              | 62.805                    | 34.543               |
| 767  | 01-03-1984 | 1.73              | 0.465             | 52.856                    | 24.578               |
| 768  | 02-03-1984 | 1.68              | 0.423             | 50.809                    | 21.492               |
| 769  | 03-03-1984 | 1.63              | 0.419             | 53.945                    | 22.603               |
| 770  | 05-03-1984 | 1.6               | 1                 | 22.495                    | 22.495               |
| 771  | 10-03-1984 | 1.46              | 0.361             | 42.396                    | 15.305               |
| 772  | 12-03-1984 | 1.42              | 0.351             | 42.593                    | 14.95                |
| 773  | 13-03-1984 | 1.4               | 0.33              | 40.739                    | 13.444               |
| 774  | 14-03-1984 | 1.44              | 0.395             | 41.248                    | 16.293               |
| 775  | 15-03-1984 | 1.74              | 0.47              | 52.289                    | 24.576               |
| 776  | 16-03-1984 | 2.62              | 0.633             | 87.15                     | 55.166               |
| 777  | 20-03-1984 | 2.54              | 0.618             | 81.482                    | 50.356               |
| 778  | 21-03-1984 | 2.55              | 0.643             | 82.432                    | 53.004               |
| 779  | 22-03-1984 | 2.585             | 0.63              | 83.921                    | 52.87                |
| 780  | 24-03-1984 | 2.35              | 0.58              | 76.636                    | 44.449               |
| 781  | 28-03-1984 | 2                 | 0.45              | 61.338                    | 27.602               |
| 782  | 02-04-1984 | 2.48              | 0.59              | 92.671                    | 54.676               |
| 783  | 04-04-1984 | 2.79              | 0.581             | 109.497                   | 63.618               |
| 784  | 13-04-1984 | 3.1               | 0.73              | 99.44                     | 72.591               |
| 785  | 16-04-1984 | 3.28              | 0.728             | 115.474                   | 84.065               |
| 786  | 18-04-1984 | 3.73              | 0.765             | 126.241                   | 96.574               |
| 787  | 19-04-1984 | 3.7               | 0.744             | 134.462                   | 100.04               |
| 788  | 21-04-1984 | 3.16              | 0.761             | 105.854                   | 80.555               |
| 789  | 24-04-1984 | 3.59              | 0.762             | 129.013                   | 98.308               |
| 790  | 25-04-1984 | 4.1               | 0.785             | 149.164                   | 117.094              |
| 791  | 28-04-1984 | 5.28              | 0.857             | 215.218                   | 184.442              |
| 792  | 28-09-1984 | 1.1               | 0.419             | 29.2                      | 12.235               |
| 793  | 04-10-1984 | 1.04              | 0.216             | 40.435                    | 8.734                |
| 794  | 09-10-1984 | 1.02              | 0.212             | 39.297                    | 8.331                |
| 795  | 11-10-1984 | 1.87              | 0.497             | 71.181                    | 35.377               |
| 796  | 12-10-1984 | 1.98              | 0.493             | 74.519                    | 36.738               |
| 797  | 13-10-1984 | 1.89              | 0.452             | 78.305                    | 35.394               |
| 798  | 15-10-1984 | 1.54              | 0.378             | 54.741                    | 20.692               |
| 799  | 19-10-1984 | 1.22              | 0.264             | 48.5                      | 12.804               |
| 800  | 20-10-1984 | 1.2               | 0.269             | 47.996                    | 12.911               |
| 801  | 22-10-1984 | 1.14              | 0.253             | 47.672                    | 12.061               |
| 802  | 16-05-1985 | 6.3               | 0.739             | 399.138                   | 294.963              |
| 803  | 17-05-1985 | 6.26              | 0.835             | 372.29                    | 310.862              |
| 804  | 18-05-1985 | 6.16              | 0.81              | 347.699                   | 281.636              |
| 805  | 19-05-1985 | 5.94              | 0.8               | 309.493                   | 247.594              |
| 806  | 20-05-1985 | 5.34              | 0.659             | 297.781                   | 196.238              |
| 807  | 21-05-1985 | 4.52              | 0.558             | 244.382                   | 136.365              |

| SNo. | Date       | Stage (metres) | Velocity (m/s) | Area (m <sup>2</sup> ) | Measured (cumecs) |
|------|------------|----------------|----------------|------------------------|-------------------|
| 808  | 22-05-1985 | 4.22           | 0.455          | 211.308                | 96.145            |
| 809  | 23-05-1985 | 3.86           | 0.506          | 208.318                | 105.409           |
| 810  | 24-05-1985 | 3.48           | 0.484          | 183.079                | 88.61             |
| 811  | 25-05-1985 | 3.38           | 0.475          | 166.425                | 79.052            |
| 812  | 26-05-1985 | 3.3            | 0.454          | 167.601                | 76.091            |
| 813  | 27-05-1985 | 3.16           | 0.462          | 156.89                 | 72.483            |
| 814  | 28-05-1985 | 3.06           | 0.443          | 151.108                | 66.941            |
| 815  | 29-05-1985 | 3              | 0.448          | 147.388                | 66.03             |
| 816  | 30-05-1985 | 2.88           | 0.432          | 141.856                | 61.282            |
| 817  | 31-05-1985 | 2.82           | 0.414          | 138.529                | 57.351            |
| 818  | 04-06-1985 | 2.55           | 0.375          | 119.411                | 44.779            |
| 819  | 05-06-1985 | 2.52           | 0.364          | 116.387                | 42.365            |
| 820  | 06-06-1985 | 2.48           | 0.381          | 117.793                | 44.879            |
| 821  | 07-06-1985 | 2.44           | 0.364          | 114.857                | 41.808            |
| 822  | 21-11-1985 | 1.9            | 1.895          | 15.991                 | 30.302            |
| 823  | 22-11-1985 | 1.72           | 0.454          | 29.401                 | 13.348            |
| 824  | 23-11-1985 | 1.62           | 0.478          | 52.849                 | 25.262            |
| 825  | 24-11-1985 | 1.53           | 0.428          | 47.748                 | 20.436            |
| 826  | 26-11-1985 | 1.22           | 0.59           | 90.085                 | 53.15             |
| 827  | 27-11-1985 | 2.73           | 0.614          | 108.264                | 66.474            |
| 828  | 28-11-1985 | 2.4            | 0.632          | 76.429                 | 48.303            |
| 829  | 29-11-1985 | 2.2            | 0.63           | 69.983                 | 44.089            |
| 830  | 04-12-1985 | 2.24           | 0.584          | 102.87                 | 60.076            |
| 831  | 05-12-1985 | 2.12           | 0.475          | 70.636                 | 33.552            |
| 832  | 06-12-1985 | 2.02           | 0.488          | 71.027                 | 34.661            |
| 833  | 12-12-1985 | 2.04           | 0.493          | 72.144                 | 35.567            |
| 834  | 19-12-1985 | 2.24           | 0.518          | 63.664                 | 32.978            |
| 835  | 20-02-1986 | 2.06           | 1.413          | 54.552                 | 77.082            |
| 836  | 24-02-1986 | 2.04           | 0.495          | 59.418                 | 29.412            |
| 837  | 25-02-1986 | 1.92           | 0.609          | 38.736                 | 23.59             |
| 838  | 26-02-1986 | 1.8            | 0.546          | 45.5                   | 24.843            |
| 839  | 27-02-1986 | 1.74           | 0.558          | 42.758                 | 23.859            |
| 840  | 28-02-1986 | 1.68           | 0.461          | 52.51                  | 24.207            |
| 841  | 03-03-1986 | 1.56           | 0.463          | 47.099                 | 21.807            |
| 842  | 05-03-1986 | 1.47           | 0.484          | 42.758                 | 20.695            |
| 843  | 07-03-1986 | 1.52           | 0.462          | 43.71                  | 20.194            |
| 844  | 10-03-1986 | 1.48           | 0.426          | 38.85                  | 16.55             |
| 845  | 01-04-1986 | 3.9            | 0.664          | 137.187                | 91.092            |
| 846  | 02-04-1986 | 4.1            | 0.71           | 138.815                | 98.559            |
| 847  | 03-04-1986 | 4.04           | 0.7            | 137.099                | 95.969            |
| 848  | 04-04-1986 | 3.94           | 0.686          | 139.554                | 95.734            |
| 849  | 06-04-1986 | 3.76           | 0.695          | 121.456                | 84.412            |
| 850  | 07-04-1986 | 4              | 0.678          | 140.77                 | 95.442            |
| 851  | 09-04-1986 | 5.02           | 0.7            | 196.106                | 137.274           |
| 852  | 11-04-1986 | 6.26           | 0.808          | 288.959                | 233.479           |

| SNo. | Date       | Stage<br>(metres) | Velocity<br>(m/s) | Area<br>(m <sup>2</sup> ) | Measured<br>(cumecs) |
|------|------------|-------------------|-------------------|---------------------------|----------------------|
| 853  | 12-04-1986 | 6.68              | 0.795             | 325.597                   | 258.85               |
| 854  | 13-04-1986 | 6.65              | 0.802             | 329.397                   | 264.176              |
| 855  | 14-04-1986 | 6.56              | 0.679             | 310.741                   | 210.993              |
| 856  | 15-04-1986 | 6.64              | 0.776             | 353.152                   | 274.046              |
| 857  | 17-04-1986 | 6.96              | 0.744             | 411.569                   | 306.207              |
| 858  | 21-04-1986 | 6.44              | 0.664             | 337.334                   | 223.99               |
| 859  | 22-04-1986 | 6.32              | 0.642             | 332.872                   | 213.704              |
| 860  | 23-04-1986 | 6.16              | 0.613             | 330.688                   | 202.712              |
| 861  | 29-04-1986 | 4.28              | 0.444             | 185.495                   | 82.36                |
| 862  | 02-05-1986 | 3.82              | 0.468             | 156.66                    | 73.317               |
| 863  | 05-05-1986 | 3.88              | 0.541             | 159.898                   | 86.505               |
| 864  | 03-06-1987 | 3.26              | 0.692             | 97.127                    | 67.212               |
| 865  | 04-06-1987 | 3.12              | 0.669             | 96.457                    | 64.53                |
| 866  | 05-06-1987 | 2.98              | 0.601             | 91.705                    | 55.115               |
| 867  | 06-06-1987 | 2.9               | 0.633             | 90.213                    | 57.105               |
| 868  | 08-06-1987 | 2.741             | 0.561             | 74.371                    | 41.722               |
| 869  | 09-06-1987 | 2.66              | 0.553             | 73.595                    | 40.698               |
| 870  | 10-06-1987 | 2.6               | 0.551             | 66.419                    | 36.597               |
| 871  | 11-06-1987 | 2.54              | 0.53              | 65.251                    | 34.583               |
| 872  | 12-06-1987 | 2.48              | 0.502             | 64.743                    | 32.501               |
| 873  | 14-06-1987 | 2.38              | 0.484             | 61.233                    | 29.637               |
| 874  | 16-06-1987 | 2.3               | 0.486             | 56.496                    | 27.457               |
| 875  | 18-06-1987 | 2.22              | 0.477             | 55.164                    | 26.313               |
| 876  | 20-06-1987 | 2.16              | 0.435             | 54.354                    | 23.644               |
| 877  | 22-06-1987 | 2.1               | 0.417             | 51.854                    | 21.623               |
| 878  | 15-02-1988 | 1.72              | 0.514             | 55.401                    | 28.476               |
| 879  | 16-02-1988 | 1.62              | 0.533             | 42.657                    | 22.736               |
| 880  | 18-02-1988 | 1.7               | 0.488             | 49.072                    | 23.947               |
| 881  | 19-02-1988 | 1.64              | 0.451             | 42.186                    | 19.026               |
| 882  | 23-02-1988 | 1.4               | 0.44              | 35.405                    | 15.578               |
| 883  | 25-02-1988 | 1.34              | 0.413             | 34.847                    | 14.392               |
| 884  | 02-03-1988 | 2.33              | 0.597             | 68.362                    | 40.812               |
| 885  | 03-03-1988 | 2.1               | 0.57              | 57.295                    | 32.658               |
| 886  | 05-04-1988 | 1.76              | 0.507             | 47.897                    | 24.284               |
| 887  | 01-05-1988 | 3.5               | 0.762             | 79.497                    | 60.577               |
| 888  | 01-05-1988 | 3.52              | 0.779             | 89.454                    | 69.685               |
| 889  | 02-05-1988 | 3.46              | 0.796             | 78.926                    | 62.825               |
| 890  | 02-05-1988 | 3.495             | 0.773             | 77.668                    | 60.037               |
| 891  | 03-05-1988 | 3.36              | 0.7               | 76.14                     | 53.298               |
| 892  | 04-05-1988 | 3.14              | 0.7               | 64.543                    | 45.18                |
| 893  | 04-05-1988 | 3.22              | 0.822             | 67.164                    | 55.209               |
| 894  | 05-05-1988 | 3.02              | 0.783             | 50.229                    | 39.329               |
| 895  | 05-05-1988 | 2.975             | 0.676             | 59.444                    | 40.184               |
| 896  | 06-05-1988 | 2.815             | 0.683             | 54.274                    | 37.069               |
| 897  | 19-05-1988 | 4.4               | 0.897             | 99.116                    | 88.907               |



| SNo. | Date       | Stage (metres) | Velocity (m/s) | Area (m <sup>2</sup> ) | Measured (cumecs) |
|------|------------|----------------|----------------|------------------------|-------------------|
| 898  | 01-03-1989 | 1.9            | 0.479          | 38.86                  | 18.614            |
| 899  | 02-03-1989 | 1.86           | 0.46           | 38.646                 | 17.777            |
| 900  | 03-03-1989 | 1.82           | 0.434          | 43.901                 | 19.053            |
| 901  | 06-03-1989 | 1.74           | 0.515          | 20.992                 | 10.811            |
| 902  | 08-03-1989 | 1.7            | 0.499          | 20.22                  | 10.09             |
| 903  | 24-03-1989 | 1.94           | 0.499          | 42.485                 | 21.2              |
| 904  | 02-04-1989 | 2.6            | 0.521          | 78.702                 | 41.004            |
| 905  | 03-04-1989 | 2.5            | 0.567          | 74.436                 | 42.205            |
| 906  | 04-04-1989 | 2.48           | 0.579          | 75.534                 | 43.734            |
| 907  | 05-04-1989 | 2.81           | 0.614          | 87.313                 | 53.61             |
| 908  | 06-04-1989 | 2.98           | 0.551          | 89.78                  | 49.469            |
| 909  | 07-04-1989 | 2.97           | 0.549          | 91.395                 | 50.176            |
| 910  | 12-04-1989 | 3.2            | 1.483          | 41.075                 | 60.914            |
| 911  | 13-04-1989 | 3.34           | 0.62           | 102.81                 | 63.742            |
| 912  | 14-04-1989 | 3.82           | 0.66           | 135.492                | 89.425            |
| 913  | 15-04-1989 | 4.08           | 0.723          | 124.382                | 89.928            |
| 914  | 18-04-1989 | 4.32           | 0.745          | 152.672                | 113.741           |
| 915  | 19-04-1989 | 4.46           | 0.716          | 156.105                | 111.771           |
| 916  | 20-04-1989 | 4.59           | 0.668          | 164.344                | 109.782           |
| 917  | 23-04-1989 | 5.46           | 0.761          | 192.742                | 146.677           |
| 918  | 24-04-1989 | 5.64           | 0.705          | 189.082                | 133.303           |
| 919  | 25-04-1989 | 5.76           | 0.731          | 205.521                | 150.236           |
| 920  | 26-04-1989 | 5.84           | 0.489          | 206.135                | 100.8             |
| 921  | 05-05-1989 | 6              | 0.656          | 265.102                | 173.907           |
| 922  | 09-05-1989 | 5.64           | 0.736          | 213.757                | 157.325           |
| 923  | 10-05-1989 | 5.52           | 0.667          | 182.421                | 121.675           |
| 924  | 12-05-1989 | 5.2            | 0.668          | 191.87                 | 128.169           |
| 925  | 13-03-1990 | 6.45           | 0.808          | 375.532                | 303.43            |
| 926  | 13-03-1990 | 6.46           | 0.797          | 380.981                | 303.642           |
| 927  | 14-03-1990 | 6.34           | 0.801          | 370.311                | 296.619           |
| 928  | 14-03-1990 | 6.3            | 0.644          | 384.071                | 247.342           |
| 929  | 16-03-1990 | 5.98           | 0.688          | 331.222                | 227.881           |
| 930  | 17-03-1990 | 6.14           | 0.711          | 334.706                | 237.976           |
| 931  | 19-03-1990 | 6.4            | 0.788          | 383.829                | 302.457           |
| 932  | 29-03-1991 | 1.43           | 0.28           | 17.211                 | 4.819             |
| 933  | 30-03-1991 | 1.44           | 0.371          | 16.07                  | 5.962             |
| 934  | 31-03-1991 | 1.48           | 0.427          | 15.384                 | 6.569             |
| 935  | 14-05-1991 | 3.72           | 1.27           | 102.506                | 130.182           |
| 936  | 15-05-1991 | 3.86           | 0.811          | 103.428                | 83.88             |
| 937  | 16-05-1991 | 4              | 1.01           | 112.376                | 113.5             |
| 938  | 19-05-1991 | 3.64           | 0.806          | 96.52                  | 77.795            |
| 939  | 20-05-1991 | 3.58           | 78.833         | 0.89                   | 70.161            |
| 940  | 22-05-1991 | 3.6            | 0.779          | 90.249                 | 70.304            |
| 941  | 24-05-1991 | 3.78           | 0.781          | 108.348                | 84.62             |
| 942  | 26-05-1991 | 3.96           | 0.816          | 110.571                | 90.226            |

| SNo. | Date       | Stage<br>(metres) | Velocity<br>(m/s) | Area<br>(m <sup>2</sup> ) | Measured<br>(cumecs) |
|------|------------|-------------------|-------------------|---------------------------|----------------------|
| 943  | 29-05-1991 | 3.73              | 0.796             | 103.754                   | 82.588               |
| 944  | 18-06-1991 | 2.19              | 0.779             | 50.049                    | 38.988               |
| 945  | 20-06-1991 | 2.12              | 0.511             | 42.002                    | 21.463               |
| 946  | 31-10-1991 | 1.18              | 0.303             | 17.125                    | 5.189                |
| 947  | 01-11-1991 | 1.22              | 0.304             | 22.674                    | 6.893                |
| 948  | 02-11-1991 | 1.16              | 0.31              | 18.8                      | 5.828                |
| 949  | 03-11-1991 | 1.16              | 0.328             | 19.939                    | 6.54                 |
| 950  | 04-11-1991 | 1.14              | 0.304             | 19.27                     | 5.858                |
| 951  | 06-11-1991 | 1.13              | 2.059             | 2.8                       | 5.765                |
| 952  | 19-11-1991 | 1.44              | 0.43              | 32.67                     | 14.048               |
| 953  | 20-11-1991 | 1.35              | 0.456             | 27.075                    | 12.346               |
| 954  | 05-02-1992 | 1.36              | 0.383             | 12.292                    | 4.708                |
| 955  | 06-02-1992 | 1.36              | 0.388             | 13.034                    | 5.057                |
| 956  | 07-02-1992 | 1.36              | 0.389             | 12.661                    | 4.925                |
| 957  | 08-02-1992 | 1.34              | 0.383             | 11.809                    | 4.523                |
| 958  | 09-02-1992 | 1.34              | 0.396             | 10.24                     | 4.055                |
| 959  | 10-02-1992 | 1.44              | 0.407             | 14.423                    | 5.87                 |
| 960  | 10-05-1992 | 1.44              | 0.465             | 14.482                    | 6.734                |
| 961  | 12-05-1992 | 5.97              | 0.667             | 381.877                   | 254.712              |
| 962  | 13-05-1992 | 5.98              | 0.635             | 356.953                   | 226.665              |
| 963  | 14-05-1992 | 5.98              | 0.709             | 363.633                   | 257.816              |
| 964  | 16-05-1992 | 6.01              | 0.668             | 368.942                   | 246.453              |
| 965  | 18-05-1992 | 5.84              | 0.621             | 288.831                   | 179.364              |
| 966  | 19-05-1992 | 5.54              | 0.605             | 301.241                   | 182.251              |
| 967  | 20-05-1992 | 5.24              | 0.554             | 274.413                   | 152.025              |
| 968  | 08-05-1993 | 6.85              | 0.97              | 430.472                   | 417.558              |
| 969  | 09-05-1993 | 6.74              | 0.831             | 420.752                   | 349.645              |
| 970  | 10-05-1993 | 6.64              | 0.791             | 406.142                   | 321.258              |
| 971  | 12-05-1993 | 6.72              | 0.778             | 432.023                   | 336.114              |
| 972  | 13-05-1993 | 6.65              | 0.799             | 415.335                   | 331.853              |
| 973  | 14-05-1993 | 6.57              | 0.797             | 373.073                   | 297.339              |
| 974  | 17-06-1994 | 2.3               | 0.485             | 49.672                    | 24.091               |
| 975  | 18-06-1994 | 2.27              | 0.4               | 44.865                    | 17.946               |
| 976  | 19-06-1994 | 2.3               | 0.419             | 50.272                    | 21.064               |
| 977  | 20-06-1994 | 2.25              | 0.453             | 46.464                    | 21.048               |
| 978  | 21-06-1994 | 2.2               | 0.427             | 45.747                    | 19.534               |
| 979  | 22-06-1994 | 2.06              | 0.402             | 43.955                    | 17.67                |
| 980  | 11-04-2003 | 2.96              | 0.27              | 104.696                   | 28.268               |
| 981  | 11-04-2003 | 2.88              | 0.295             | 97.193                    | 28.672               |
| 982  | 12-04-2003 | 2.88              | 0.92              | 30.895                    | 28.423               |
| 983  | 13-04-2003 | 2.76              | 0.296             | 87.132                    | 25.791               |
| 984  | 14-04-2003 | 2.55              | 0.327             | 83.031                    | 27.151               |
| 985  | 15-04-2003 | 2.39              | 0.313             | 76.843                    | 24.052               |
| 986  | 16-04-2003 | 2.31              | 0.3               | 74.23                     | 22.269               |
| 987  | 17-04-2003 | 2.45              | 0.309             | 79.259                    | 24.491               |

| SNo. | Date       | Stage (metres) | Velocity (m/s) | Area (m <sup>2</sup> ) | Measured (cumecs) |
|------|------------|----------------|----------------|------------------------|-------------------|
| 988  | 18-04-2003 | 2.4            | 0.382          | 73.081                 | 27.917            |
| 989  | 11-06-2003 | 1.75           | 0.537          | 36.97                  | 19.853            |
| 990  | 19-06-2003 | 1.48           | 0.153          | 45.065                 | 6.895             |
| 991  | 20-06-2003 | 1.45           | 0.225          | 42.96                  | 9.666             |
| 992  | 21-06-2003 | 1.45           | 0.176          | 46.352                 | 8.158             |
| 993  | 01-07-2003 | 1.45           | 0.209          | 44.378                 | 9.275             |
| 994  | 02-07-2003 | 1.42           | 0.197          | 42.33                  | 8.339             |
| 995  | 03-07-2003 | 1.41           | 0.2            | 40.81                  | 8.162             |
| 996  | 17-07-2003 | 1.37           | 0.183          | 35.929                 | 6.575             |
| 997  | 18-07-2003 | 1.29           | 0.177          | 31.475                 | 5.571             |
| 998  | 19-07-2003 | 1.28           | 0.185          | 35.265                 | 6.524             |
| 999  | 04-08-2003 | 1.15           | 0.188          | 18.601                 | 3.497             |
| 1000 | 05-08-2003 | 1.15           | 0.166          | 19.066                 | 3.165             |
| 1001 | 06-08-2003 | 1.13           | 0.174          | 18.931                 | 3.294             |
| 1002 | 07-08-2003 | 1.12           | 0.177          | 18.599                 | 3.292             |
| 1003 | 08-08-2003 | 1.11           | 0.181          | 18.575                 | 3.362             |
| 1004 | 09-08-2003 | 1.09           | 0.173          | 18.509                 | 3.202             |
| 1005 | 10-08-2003 | 1.13           | 0.186          | 18.882                 | 3.512             |
| 1006 | 11-08-2003 | 1.13           | 0.184          | 19.141                 | 3.522             |
| 1007 | 13-08-2003 | 1.1            | 0.177          | 18.051                 | 3.195             |
| 1008 | 17-03-2004 | 3.33           | 0.596          | 64.391                 | 38.377            |
| 1009 | 08-04-2004 | 4.625          | 0.743          | 148.851                | 110.596           |
| 1010 | 09-04-2004 | 4.37           | 0.741          | 141.501                | 104.852           |
| 1011 | 10-04-2004 | 4.05           | 0.718          | 121.812                | 87.461            |
| 1012 | 11-04-2004 | 4.1            | 0.767          | 121.695                | 93.34             |
| 1013 | 12-04-2004 | 3.995          | 0.756          | 126.901                | 95.937            |
| 1014 | 13-04-2004 | 4.26           | 0.72           | 144.389                | 103.96            |
| 1015 | 14-04-2004 | 4.625          | 0.872          | 148.165                | 129.2             |
| 1016 | 15-04-2004 | 5.155          | 0.732          | 178.264                | 130.489           |
| 1017 | 16-04-2004 | 4.845          | 0.732          | 162.709                | 119.103           |
| 1018 | 17-04-2004 | 5.645          | 0.592          | 254.988                | 150.953           |
| 1019 | 20-04-2004 | 5.895          | 0.669          | 277.664                | 185.757           |
| 1020 | 21-04-2004 | 6.14           | 0.69           | 284.677                | 196.427           |
| 1021 | 23-04-2004 | 6.21           | 0.652          | 298.845                | 194.847           |
| 1022 | 27-04-2004 | 5.67           | 0.585          | 260.851                | 152.598           |
| 1023 | 28-04-2004 | 5.56           | 0.585          | 258.267                | 151.086           |
| 1024 | 29-04-2004 | 5.51           | 0.623          | 268.125                | 167.042           |
| 1025 | 30-04-2004 | 5.46           | 0.612          | 256.292                | 156.851           |
| 1026 | 16-04-2008 | 6.485          | 0.899          | 185.588                | 166.844           |
| 1027 | 17-04-2008 | 6.59           | 0.796          | 220.09                 | 175.192           |
| 1028 | 01-02-2009 | 1.09           | 0.407          | 16.135                 | 6.567             |
| 1029 | 12-05-2009 | 5.61           | 0.963          | 176.61                 | 170.075           |
| 1030 | 13-05-2009 | 5.67           | 0.731          | 180.959                | 132.281           |
| 1031 | 14-05-2009 | 5.7            | 0.845          | 173.963                | 146.999           |
| 1032 | 11-06-2009 | 2.34           | 0.51           | 49.751                 | 25.373            |





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