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TAN 055 - WATER SUPPLY AND SANITATION DEVELOPMENT KIGOMA REGION. TANZANIA

Hydrological Investigations in Kigoma Region 1987-88

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Sammendrag/Abstract

The report describes the results of the hydrological investigations connected to water supply carried out in Kigoma Region, Tanzania, during the 1987-1988 dry season.

A number of recommendations for water sources for some villages have been made. Alternative gravity sources for Kasulu and also for Kigoma Town are discussed.

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1. INTRODUCTION

This report briefly describes the results of the hydrological investigation connected to water supply which had been carried out in Kigoma region during the 1987/1988 dry season. See location map figure 1.1.

Some recommendations for the proposed water sources for some villages have been made. Alternative additional gravity sources for Kasulu have been analyzed and are briefly described. Possible alternative gravity sources for Kigoma Town Water Supply have been briefly discussed.

This report being a continuation of earlier reports prepared by the Advisory Hydrologist, makes previous reports reference necessary. The same is true for WMP report Volumes 3,4 and 5.

For villages where no water quality data exist, it is recommended to carry out water quality tests.

A work program for 1988/1989 dry season and hydrological activities has also been appended. If possible it should be followed as closely as possible.

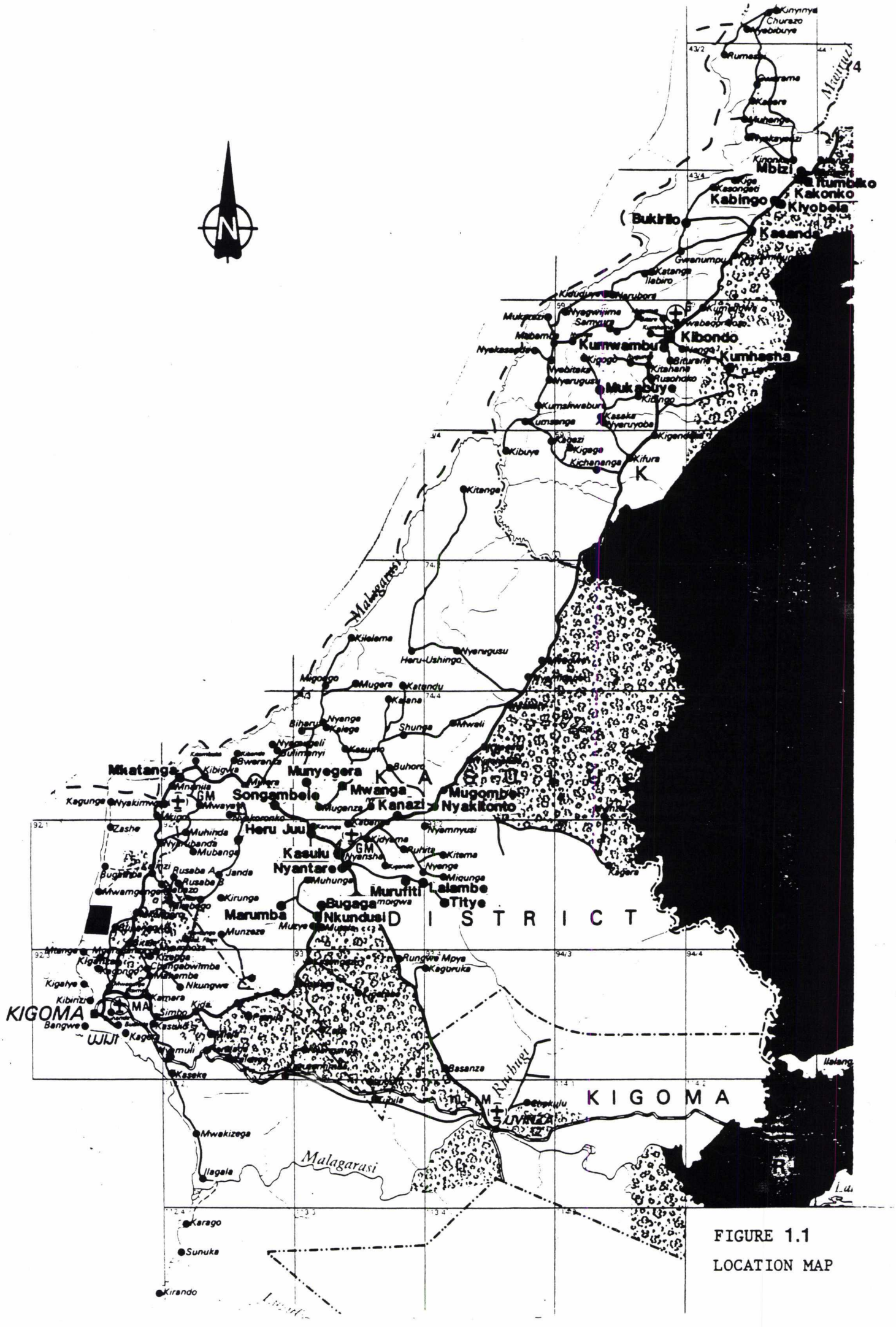


FIGURE 1.1

LOCATION MAP

2. RAINFALL 1987/1988

Rainfall distribution during 1987/88 hydrological year over the region can be seen by comparing the selected stations in fig. 2.1. On the whole Kigoma, Kibondo and Heri Mission received lower rainfall compared to their averages. Comparing them to the other three stations, these stations recorded rather less rainfall, although Heri Mission had a higher value probably due to its geographical location. Kasulu, Matendo and Uvinza stations received rainfall which was above average. Monthly values have shown great spatial distribution of rainfall over the region. The central part of the region eastwards received high amounts of rainfall, while the western and northern part represented by Kigoma and Kibondo were relatively dry.

It should also be noted that rainfall started as early as August at most of the stations. Hence low flows taken during August and September 1988 could have been affected by rain. Confirmation of low flow observation should be taken next dry season.

Table 2.1 shows four stations with long records which have been used to compute probability parameters by lognormal distribution function (Kibondo Agriculture station has been analyzed by Gumbel distribution function). Low flow values are calculated from these values (see vol. 7, WMP table 7-5.2).

3. RUN-OFF ANALYSES AND RESULTS

Following is a summary of the analyses and proposals for each scheme.

1. Mkongoro

   Observations from Kaseke Stream shows there is sufficient water for the Mkongoro Group. Considering the scarcity of data, the Nyete River as the source for the whole Mkongoro Group Scheme is questionable.

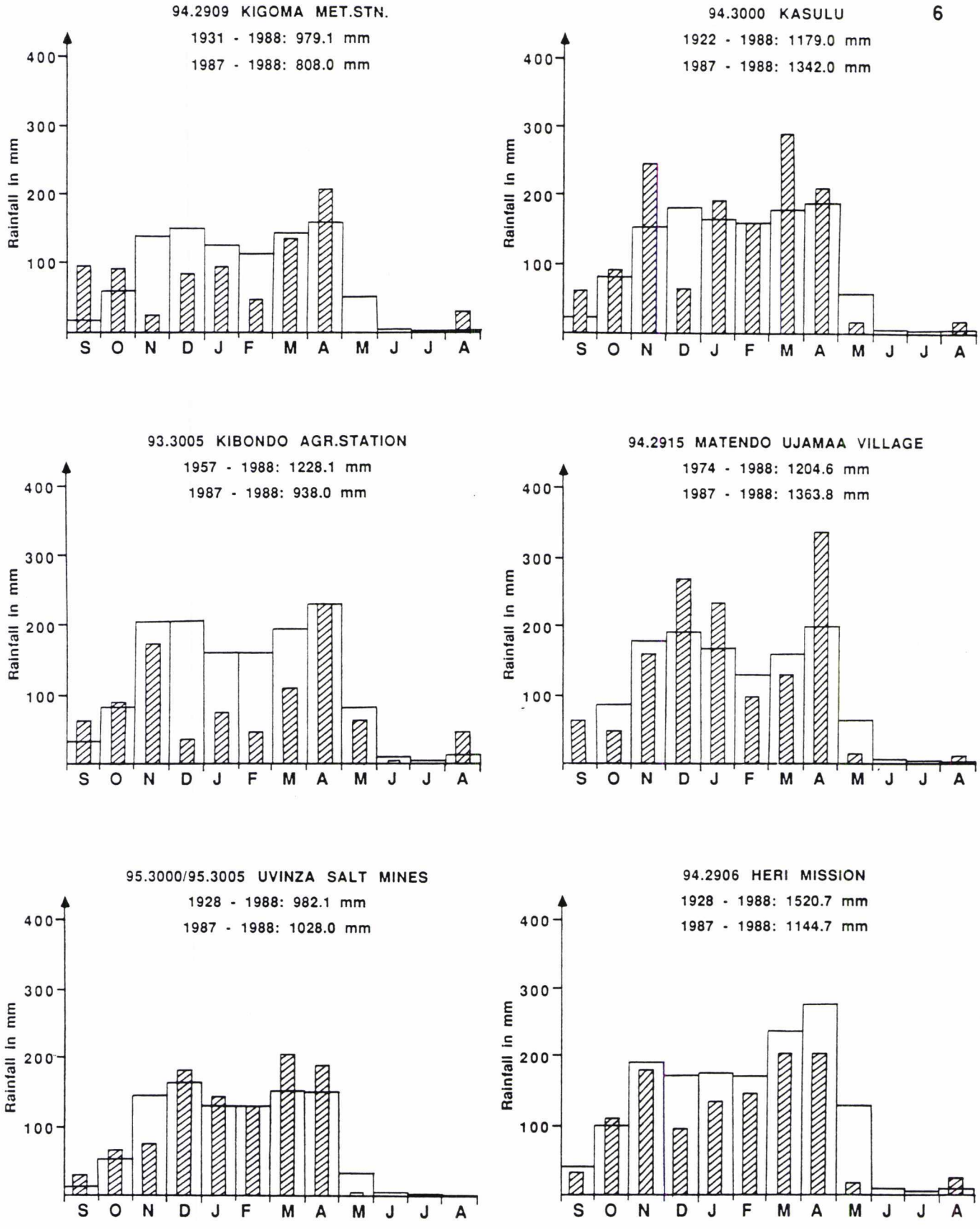


Figure 2.1 Rainfall in Kigoma

Table 2.1

Rainfall values at different return periods for selected stations (lognormal distribution), Gumbel for Kibondo.

No	Station	1987/88 Rainfall	Mean Rainfall	Estimated Rainfall at T_r 5	10	20
1	Kigoma	808.0	979.1	844.7	787.0	724.4
2	Kibondo Agr.	938.0	1228.1	997.1	919.8	863.1
3	Uvinza Salt Mine	1028.0	982.1	879.3	833.2	796.9
4	Kasulu	1342.0	1179.0	980.0	898.4	836.2

Note: The figure are annual values of hydrological year and are in mm.
: T_r is return period.

2. Nyantare
   The water yield of Mgandazi stream is quite sufficient and could probably also be used to supplement Kasulu town W/supply.

3. Kasulu
   Minimum flows in Kasulu area have shown some variations during the period of observation. Mgandazi river is the most reliable alternative source. As a first phase in improving the water supply to Kasulu Town is recommended a rehabilitation of the existing intake in Nyanka river, however. Continued monitoring of the low flow of the three rivers is recommended.

4. Muzye
   Although measurements from Kisuma Stream seem to be adequate, it is recommended that observations continue next dry season to have sufficient data. Muzye stream can also be considered as the source for this village.

5. Nyamnyusi/Ruhita Groups Scheme
   Need to continue low flow observations, next year. Measurements should be made at the proposed intake. Kisuma stream seems to be a reliable source.

6. Nyakitonto
   Observation by V-notch at intake should continue next dry season. This source is probably not sufficient for future demand. Janda stream should be investigated as an alternative/additional source.

7. Kabingo/Kiyobela
   Continuation of low flow observations for the three intakes, to confirm 1988 observations which seem to have been affected by rain.

8. Kasanda
   Lusenge at the proposed intake should be measured during next

dry season. Simultaneously a water engineer should select a suitable intake site for Lulalo stream, which is located west of Lusenge stream, and flow observations can be made at that point.

9. Kumhasha
   Observations by V-notch at intake should continue next dry season. This source is probably not sufficient for future demand. Infiltration/ground water investigations should be carried out in this area.

10. Kibondo
    Previous recommendations still valid.

11. Kigoma
    Alternative sources are analysed by interpolating available data, and recommendations made. Permanent V-notch to be installed at prop. intakes next dry season and observations to start thereafter for approx. two or three years.

12. Nyanganga
    To continue with observation this dry season in order to confirm last years low flow.

3. RUNOFF ANALYSES AND RESULTS

As in the previous years spot measurements continued to be carried out during the dry season. Measurements were carried out as had been planned by the Advisory Hydrologists and PP & P. High priority was given to establishment of recession curves for selected rivers in selected areas. Rainfall probability analysis has been used to estimate low flows of respective return period. Refer to table 3.1.

All these analysis were performed by computer facilities at NVE-Oslo, Norway. Other methods of estimating low flow were not looked into because of time constraint. Since this report was prepared while the updating report was also being prepared, no attempt has been made to use results of a report not yet finalized. Therefore recession curves might be used when this report is ready.

Below follows a brief description of the various water supply schemes where spot measurements were carried out. Measurements observed are included in Appendix 2.

3.1 Mkongoro g/s

A description of the Mkongoro Group Scheme was given in the 1985/86 Hydrological Investigation report by the Advisory Hydrologist and his travel report of April 11th 1985 (Travel Report from Kjell Repp, Norconsult A.S.). The map sketch was also included therein. It had been recommended to investigate Kaseke Stream for the heavily populated area downstream of the Kaseke and Nyete streams. As a follow up to the recommendation, spot measurements were taken during 1987/88 dry season. The estimated demand for the year 2005 for the Mkongoro is 42.3 l/sec. This scheme already takes 25 l/s from Nyete river. Lowest observed value measurement for Kaseke during 1987/88 was 109.2 l/s. This gives a 20%, 10% and 5% shortfall value of 114.2 l/s, 106.2 l/s and 100.3 l/s respectively. Kaseke as additional source is quite sufficient.

Table 3.1 Estimated low flow values for different return periods.

No.	Village	Stream	Observed flow (1988)	Estimated Demand (year)	Estimated low flow for T_r 5	10	20
1.	Mkongoro g/s	Kaseke	109.2 (Oct)	42.3 (2005)	114.2	106.2	100.3
2.	Nyantare	Mgandazi	69.2 (Sept)	10.4 (2008)	50.5	46.3	43.1
3.	Kasulu	Nyanka/ Miseno	-	47.0 (2005)	(See text)		
4.	Muzye	Kisuma	21.9 (Sept)	5.5 (2001) (incl. Mutale)	16.0	14.1	13.6
5.	Nyamnyusi	Kisuma	7.7 (Nov)	3.0 (2001)	5.6	5.2	4.8
6.	Nyakitonto	Chai	1.25 (Nov)	3.6 (2001)	0.91	0.84	0.78
7.	Kasanda	Lusenge	4.2 (Sept)	3.0 (2001)	4.5	4.1	3.9
8.	Kabingo/Kiyobela	Rusengi	5.9 (Sept)	5.0 (2006)	6.2	5.8	5.4
	"	Lusanga	9.2 (Aug)	5.0 (2006)	9.8	9.0	8.5
	"	Kiziguzigu	8.1 (July)	5.0 (2006)	8.6	7.9	7.5
9.	Nyanganga	Nyanganga	21.2 (Oct)	5.0 (2001) (incl. Kalenge and Zeze villages)	18.1	17.2	16.4

As mentioned before, the Mkongoro group is at present using Nyete stream for its water supply. While making an analysis of Kaseke stream data, it was decided to make some analysis of available data of Nyete stream also.

No more observations of Nyete stream have been carried out since 1980, and only some supplementary remarks may be added, based on the improved data-base for the Luiche River and some additional rivers in the area. Mean monthly specific runoff for the selected rivers are given in Table 3.2, based on varying length of records. Considering catchment characteristics, however, the most reasonable way is to transfer the data from Luiche at Jimbi, and use the same specific runoff at Nyete river.

Application of that simple method gives the mean monthly runoff as shown in Figure 3.1, while the dimensionless flow duration curve for Luiche is given in Figure 3.2. This curve may as well be used for the Nyete river, applying a mean annual flow of 251 l/sec.

The low flow of the Nyete river was measured in 1980 to 29 l/sec (5 September), which adjusted to the 10 years low flow by applying rainfall probability analyses from Kigoma and Kasulu, gives a 10 years low flow of approximately 28 l/sec.

It should be remembered, however, that the estimated low flow is based on only one discharge measurement, which compared to the Luiche river and other discharge measurements in the area seems to be ambiguous. The preliminary results from the ongoing updating of the WMP hydrology indicate an underestimation of the Nyete river flow, and it is strongly recommended to carry out some more investigations during the next dry season.

Table 3.2

Monthly specific runoff of various rivers in the Luiche Catchment, Kigoma Region.
l/sec/km^2

Station/River	Period	km^2 area	J	F	M	A	M	J	J	A	S	O	N	D	Annual
4BB1A KASEKE	1961-88	247	13.0	15.0	22.1	25.2	12.9	5.5	2.9	2.4	1.5	3.2	5.7	18.0	10.7
4B10 LUICHE (JIMBI)	1974-88	641	20.5	23.3	26.1	34.1	20.3	9.6	7.5	6.3	5.2	7.7	12.1	18.5	14.6
4B9 LUICHE (SIMBO)	1974-88	1682	15.0	15.0	20.2	27.6	16.6	8.0	5.9	4.8	4.2	5.3	10.3	15.1	11.5
4BA2A MUNGONYA	1974-88	128	12.1	9.5	19.1	31.5	18.7	8.5	5.2	3.0	2.7	3.0	5.0	23.3	11.2
4B11 MKUTI	1976-88	322	8.6	10.5	11.6	13.9	10.4	3.2	2.2	1.6	1.2	1.8	5.4	10.0	7.8

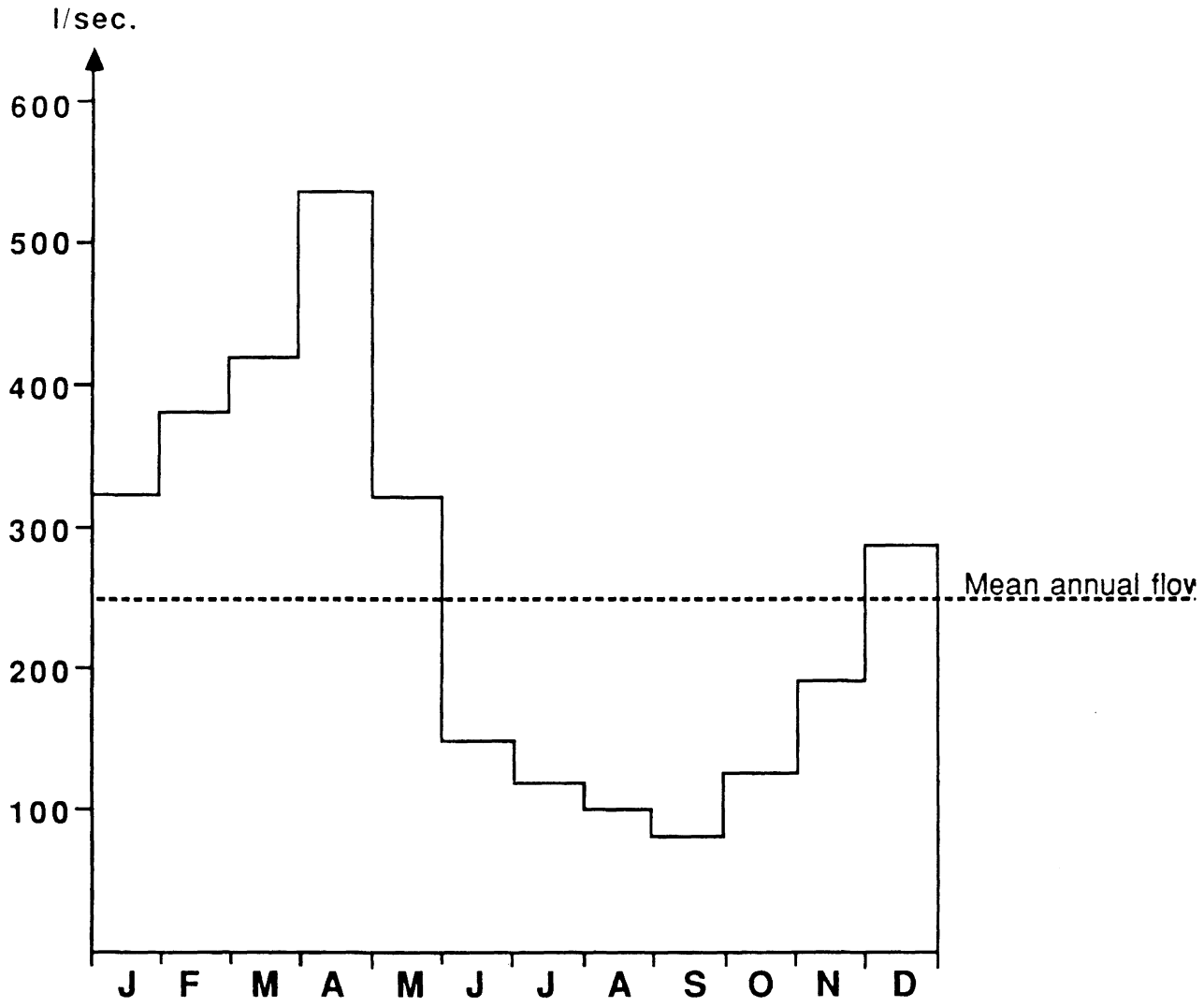
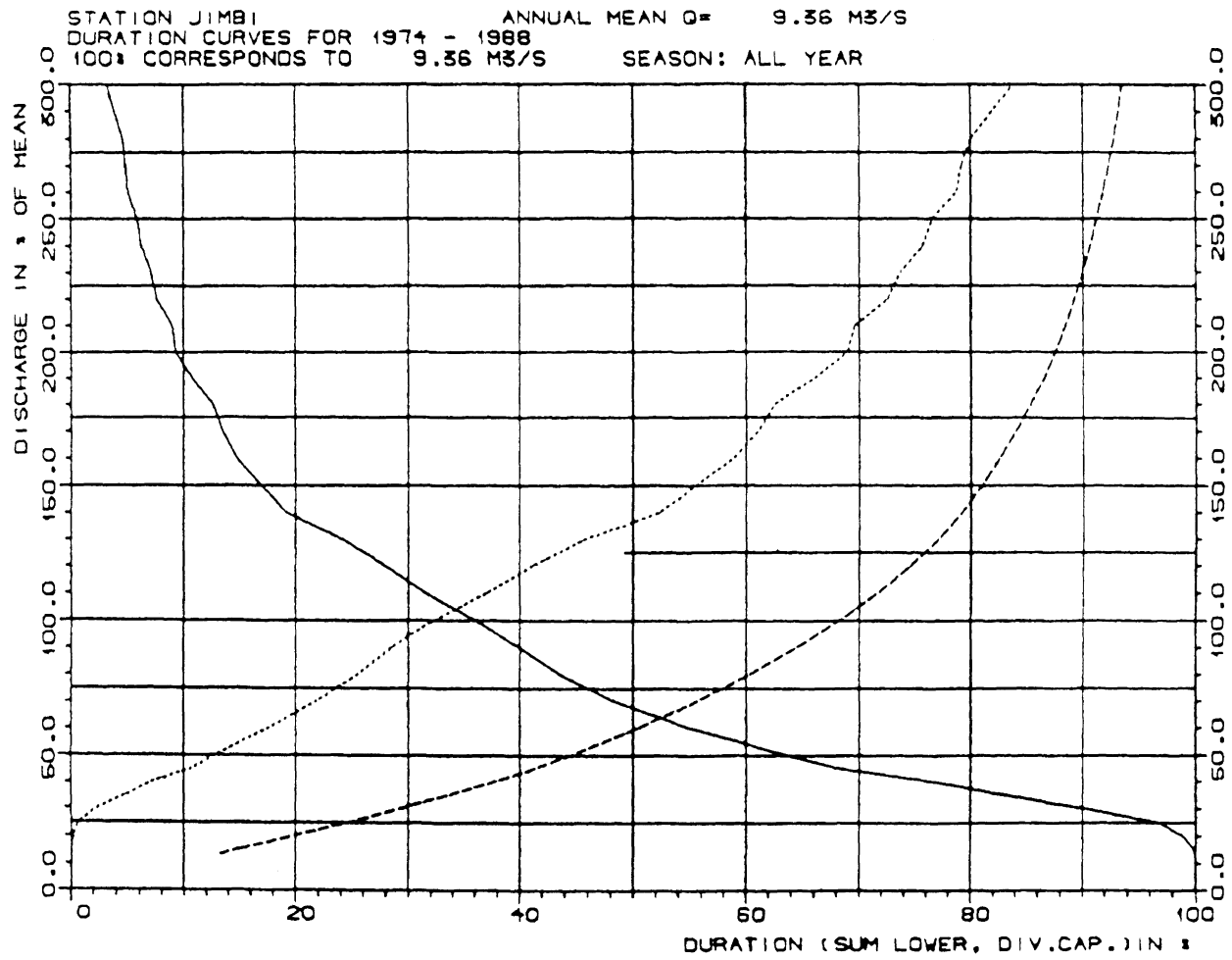


Figure **3.1**: Estimated monthly flow for the Nyete River at the existing water intake to the Mkongoro Group Scheme.

Fig. **3.2** Flow duration curve for the Luiche River at Jimbi.



3.2 Nyantare

The Nyansha/Nyantare WSS has been described in earlier reports. It had been recommended to use Mgandazi River as source to these villages for their water supply. Earlier measurements have confirmed this recommendation. The demand for these villages is estimated to 10.4 l/sec for the year 2008. The lowest measurement made during 1988 dry season gave a value of 69.2 l/sec which gives a 20%, 10%, 5% shortfall of 50.5 l/sec, 46.3 l/sec, 43.1 l/sec respectively. This evidently shows sufficient amount of water, the remainder of which could be used to supplement the water shortage in Kasulu Township.

3.3 Kasulu Urban

Earlier reports from the Advisory Hydrologist have stated the necessity of a thorough analysis of the runoff conditions in the Kasulu area. More or less regular observations have been carried out in the three rivers Miseno, Nyanka and Mgandazi since 1985, but still the reliability of the observations is uncertain.

The ambiguity of the data is clearly shown in Table 3.3, where the observed minimum flow each year for the various rivers is shown, together with an estimated design flow of ten years return interval.

Table 3.3 Minimum flows in the Kasulu Area

River/Place	Month/year	Flow, l/sec	10 yrs low flow
Nyanka, exist int.	Oct. 1985	**16.9**	12.3
	Oct. 1986	20.9	16.9
	Sept. 1987	19.6	13.7
	Sept. 1988	19.5	13.1
Miseno, prop. int.	Oct. 1985	28.5	20.5
	Oct. 1986	28.7	23.2
	Sept. 1987	33.0 (25.4)	23.2 (17.8)
Mgandazi	Oct. 1985	28.7	21.0
	Oct. 1986	35.7	28.9
	Sept. 1987	42.9	30.0
	Sept. 1988	69.2	46.3

Obviously, the most reliable water source is the Mgandazi river, which is probably also supposed to serve the two villages Nyansha and Nyantare, however.

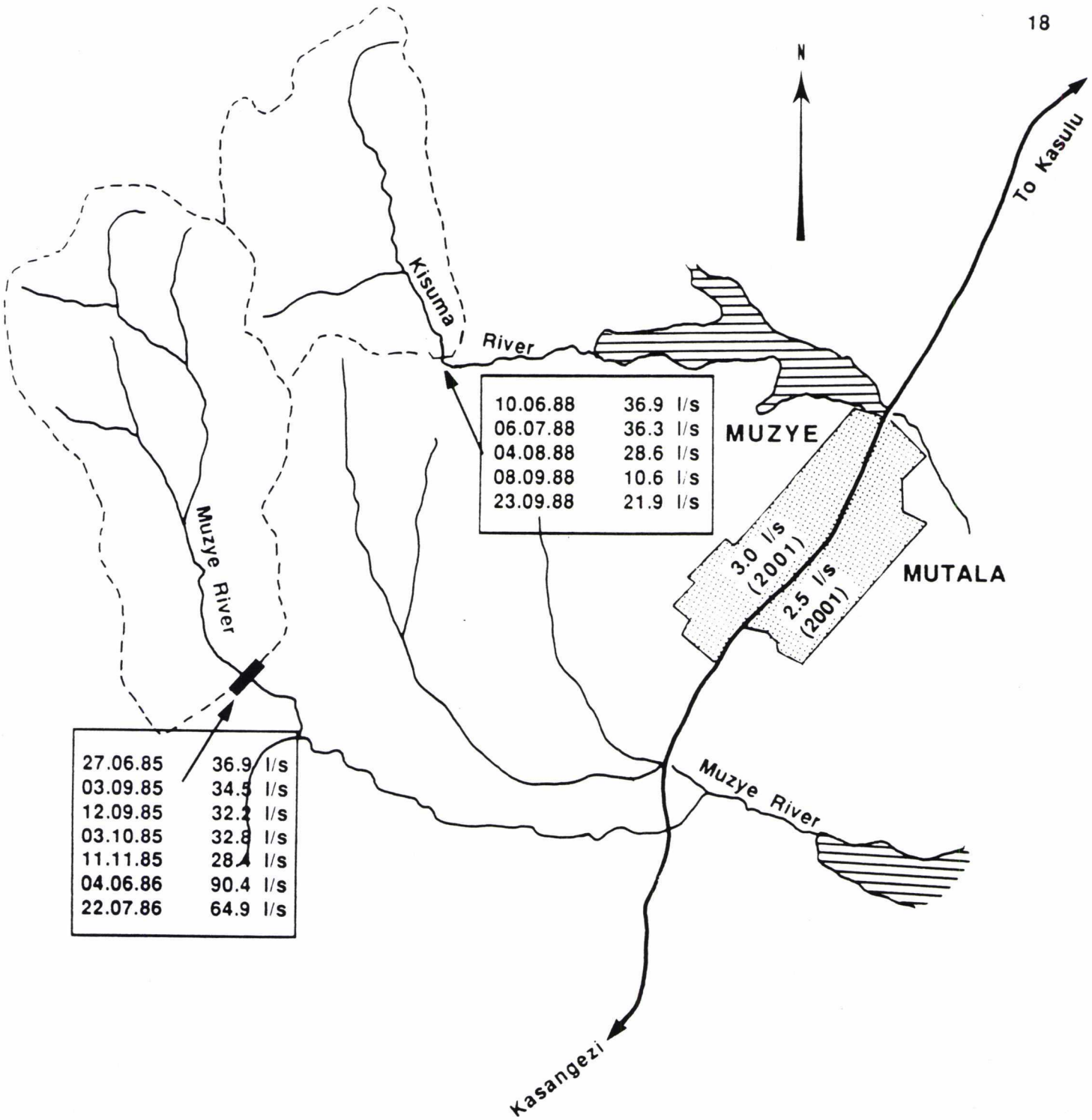
As seen in the table, the 10 years low flow, which is estimated from rainfall probability analyses, varies quite a lot for the same river, which indicate errors in the data base. On the other hand, the specific low flow in the area is quite high, and considering the total runoff in the three rivers, there should be a surplus of water in the area.

With the present knowledge of the catchment characteristics and the areal runoff, it is therefore proposed a rehabilitation of the existing intake in the Nyanka river, in order to minimize the leakages.
The proposed intake in Mgandazi should be constructed to serve Nyansha/Nyantare, while the dimension of the gravity main should be large enough, if necessary, later to be extended to serve parts of Kasulu Town.

As the population and the water demand increase, it may be considered to establish a new water intake in Miseno river. The monitoring of the low flow of the three rivers should continue, however, as the water demand might increase due to rural development/irrigation. With the present data base, it would be a waste of time to carry out more sophisticated low flow analyses.

3.4 Muzye (Fig 3.3)

Muzye village like other villages faces a water problem. Investigations started last year by taking spot measurement at Kisuma stream. Adjacent to this village there is Mutala village. Nkundusi is a few kilometers away on the way to Kasulu. Water demand for both Muzye and Mutala for 2001 is 5.5 l/sec. Several spot measurements for the Kisuma stream have been made. The lowest value being 21.9 l/sec. The 10.6 l/sec value was ignored as the instrument was not tested. Estimating the values by probability analysis with shortfall of 20%, 10%, 5% gives 16.0 l/sec, 14.1 l/sec, 13.6 l/sec respectively. It is evident



LEGEND

- Catchment Border
- Proposed Water Intake (WMP)
- Existing Water Intake
- Alternative Water Intake/measuring site
- 6.1 l/sec. (2008) — Village
- Estimated water Demand in The Year 2008

Figure 3.3 Alternative water Source to Muzye WSS

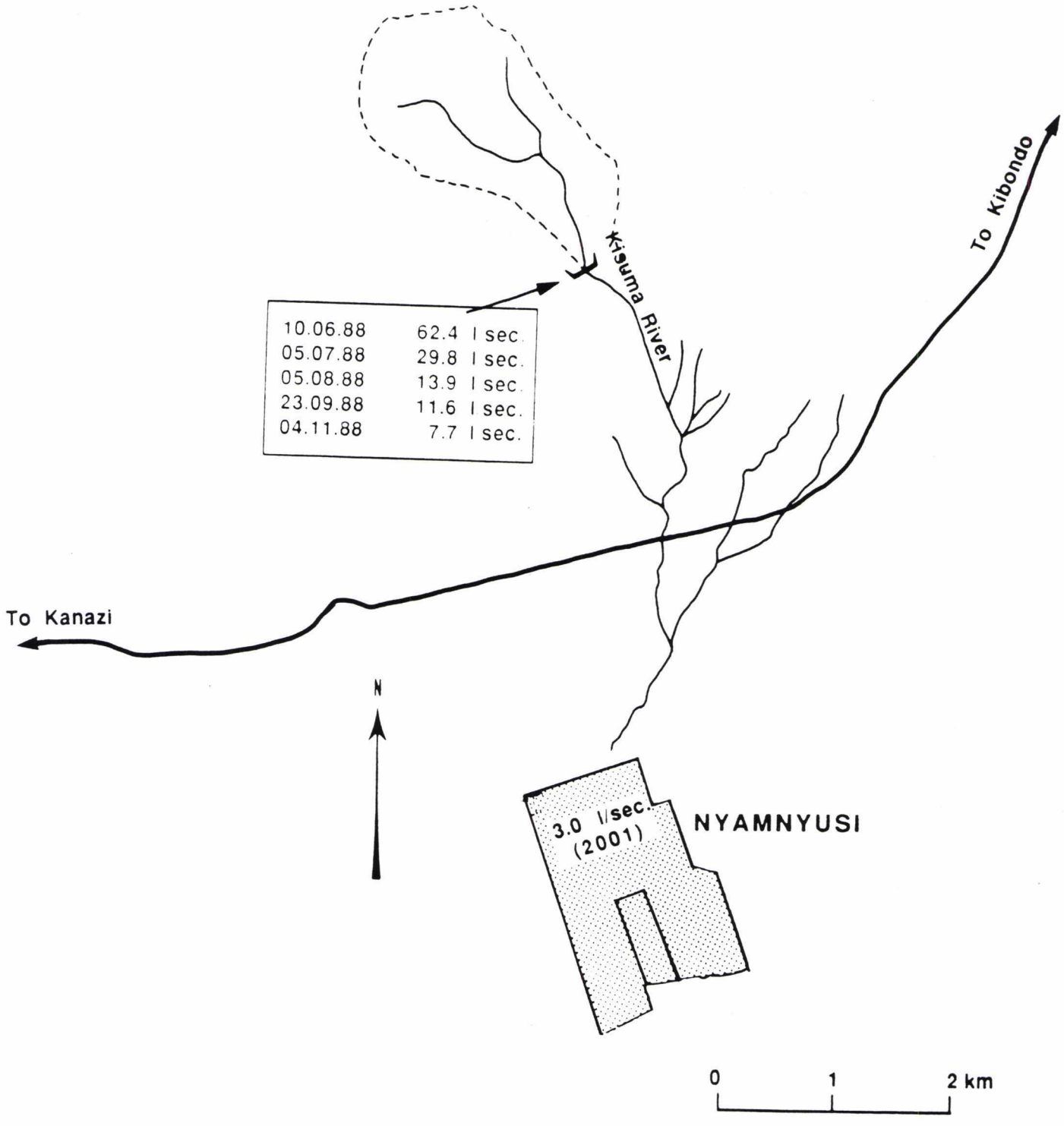
that this source is sufficient for the both Muzye and Mutala. Even Nkundusi could be added to this scheme. North West of this village there is Muzye stream which is also probably sufficient. While making a selection of a source for this village both streams could be considered. Observations made in Kisuma are by no means sufficient, it is therefore recommended to continue observations next dry season.

3.5 Nyanmnyusi/Ruhita Group Scheme (fig. 3.4)

The stream observed for this village is Kisuma. The name is similar to that stream near Muzye Village. They are different streams in different locations. During the entire dry period, measurements were taken at two different places. One being the proposed intake and another downstream of the proposed intake where observations have normally been taken.
At the latter site, where water quality is poor, the discharge was measured to 29.8 l/sec, while at the proposed intake it was only 7.7 l/sec. The probability analysis at the proposed intake with shortfalls of 20%, 10% and 5% gives values of 5.6 l/sec, 5.2 l/sec, 4.8 l/sec respectively. The demand for this village is 3.0 l/sec by 2001. Comparing supply and demand, water is probably sufficient. Data should continue to be observed particularly at the proposed intake.

3.6 Nyakitonto (fig. 3.5)

Measurements from Chai stream, the recommended source for this village continued during last year's dry season. Two measuring sites exist for this source, one being downstream of intake while the second one is at the proposed intake. Lowest flow at the normal measuring site was 6.5 l/sec and 2.3 l/sec at proposed intake. However, using V-notch method on the proposed intake gave a discharge of 1.25. The V-notch however, is more reliable compared to Pigmy method. The data taken on 8.9.88 is also doubtful as the instrument was not spin tested. Demand for this village is 3.6 l/sec by the year 2001. When the rainfall proba-



LEGEND

RUHITA

5 l/sec (2001)

Catchment Border

Proposed Water Intake (WMP)

Existing Water Intake

Alternative Water Intake/measuring site

6.1 l/sec. (2008)

Village

Estimated water Demand in The Year 2008

Figure **3.4** Proposed water Source to Nyamnyusi WSS

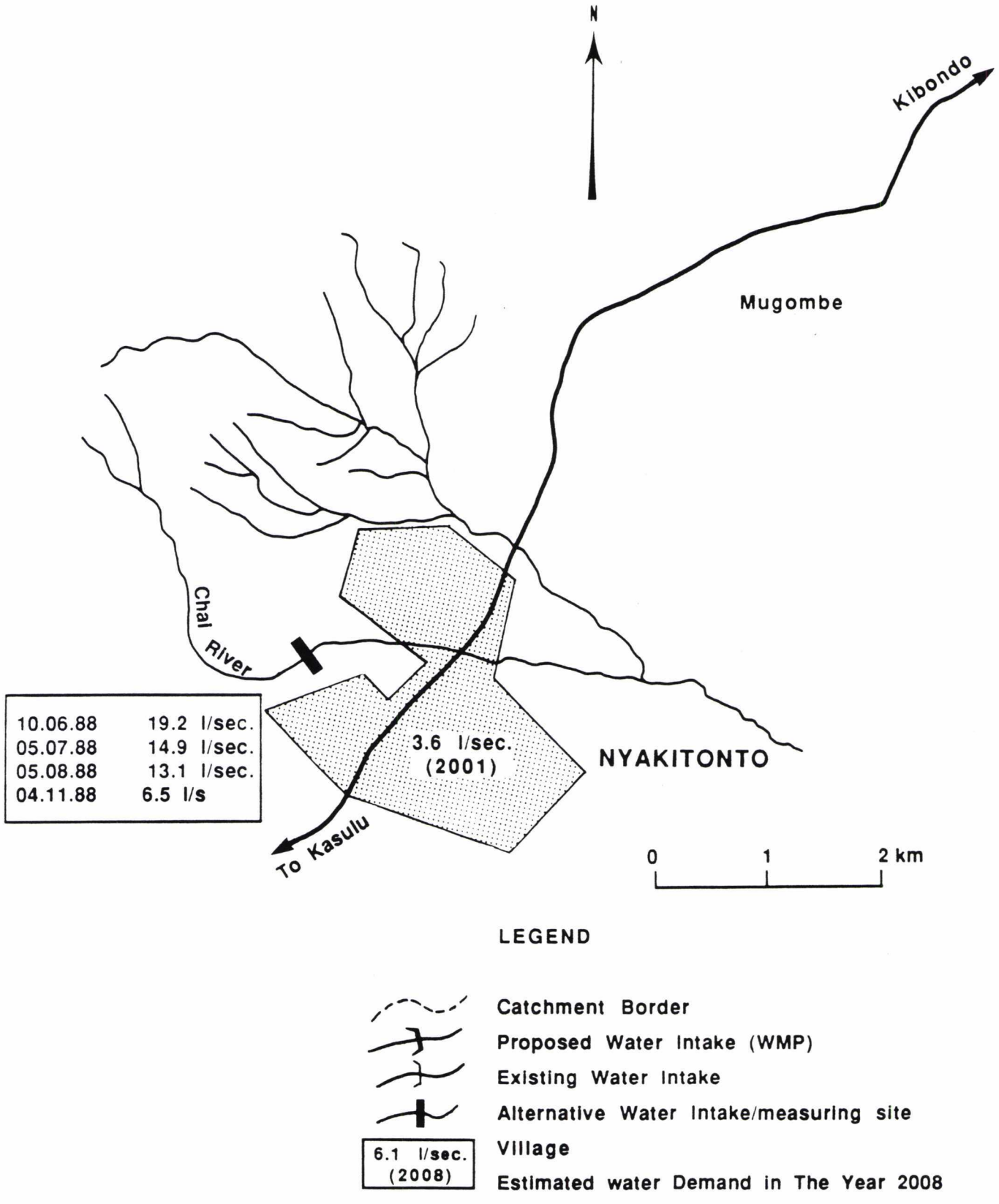


Figure **3.5** Proposed water Source to Nyakitonto WSS

bility analysis method is used for the lowest discharge, Chai stream is probably not a good source for this village. Results show values for 20%, 10%, 5% shortfall of 0.91 l/sec, 0.84 l/sec, and 0.78 l/sec. These observations, however, need to be confirmed by 1989 dry season observations, particularly at the proposed intake. Alternatively Janda Stream could be used as an additional source to the village.

3.7 Kabingo/Kiyobela

The flow values observed during the 1987 dry season caused some confusion presumably because values were higher than those of previous years, although it was a dry year. Observations during the past dry season have maintained even higher flow. This year was also relatively dry. Low flow at Rusengi/Ngoma stream of 5.9 l/s seems to be comparable to previous years. The data observed in August at Kiziguzigu also compares well with 1987 August observations. September observation seems to have been affected by rainfall. Choosing the July value as the lowest for the 1988 dry season is probably wrong. The value of Lusange falls under similar influences as that of Kiziguzigu. It is therefore recommended to take measurements during the driest time, probably mid-September during 1988/89 dry season.

The only data which has been analysed is that of Rusengi/Ngoma. The values for the 20%, 10%, 5% shortfall are 6.2, 5.8 and 5.4 l/s respectively. The demand for Kabingo/Kiyobela by the year 2008 is 5 l/s, hence making this stream probably sufficient as a source. However, it is necessary that measurements are taken during the 1989 dry season so that observations in the other streams can be confirmed.

3.8 Kasanda (Fig. 3.6)

As recommended in the last report, measurements were taken a bit downstream of the proposed Lusenge intake. The lowest value observed at this station was 4.2. The probability analysis at shortfall of 5% gives a value of 3.9 l/s. Based on this analysis

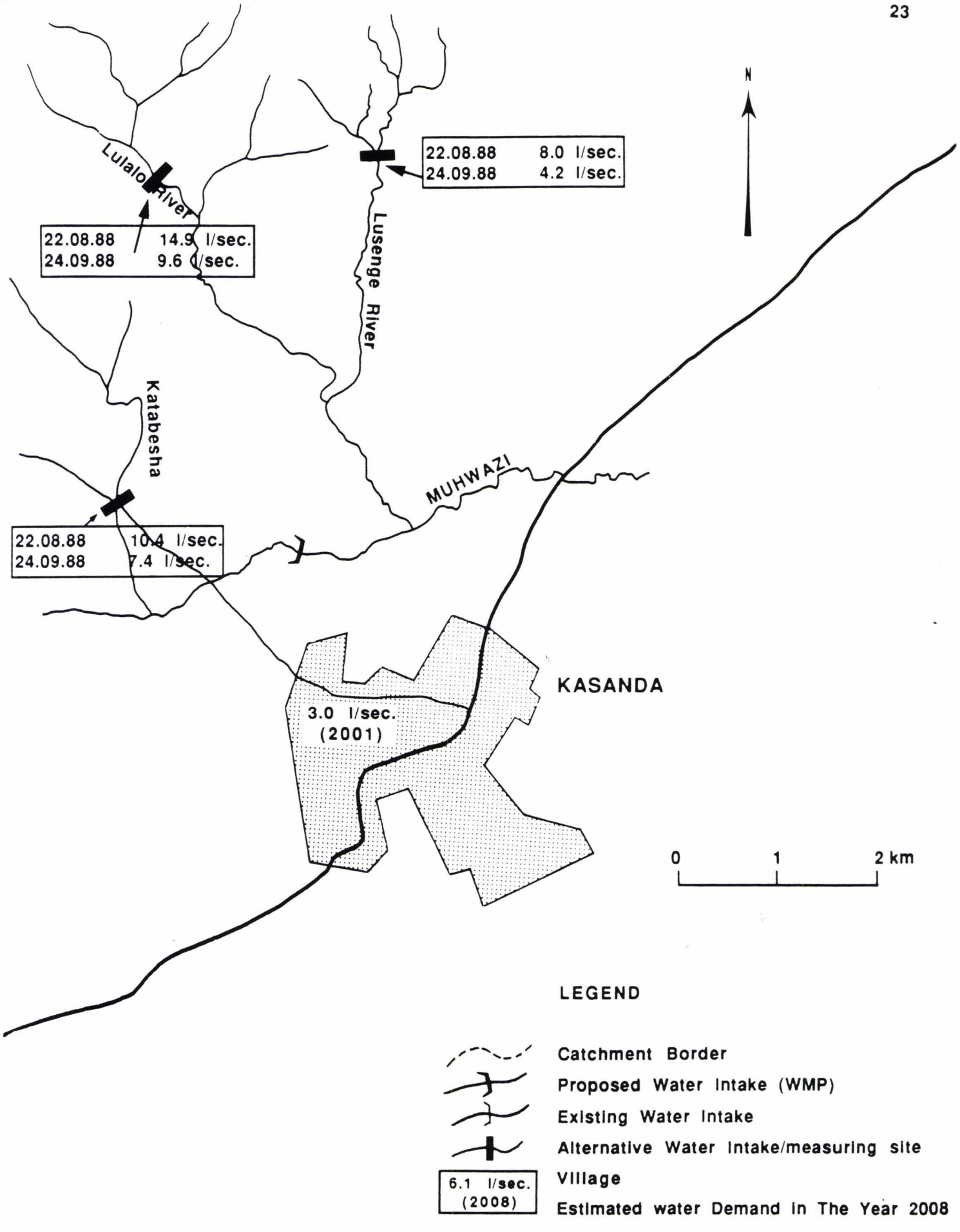


Figure 3.6 Alternative water Source to Kasanda WSS

and observations, the stream is probably adequate, since the water demand is only 3.0 l/sec. Other streams to the west are Lulalo and Katabesha. The names and streams should be checked at the site. Although observed discharges are much higher, these observations were made at arbitrary sites, just to have a feeling of how much water the stream had. Intake sites therefore for both streams should be selected by a Water Engineer before further measurements for these streams can continue. Lulalo is probably another possible source, and Lusenge should continue to be observed next dry season.

3.9 Kumhasha

Discharge measurements taken at proposed intake for the Chigazule stream have evidently ruled out a possibility of a surface gravity water scheme in the area. Therefore recommendations made in an earlier report are still valid.

3.10 Kibondo

Since nothing was done during 1987/1988 dry season, the recommendation given in the previous report is still valid. The need for a thorough investigation of a water source for Kibondo Town can not be overemphasized.

3.11 Kigoma Town W/Supply

The present source for Kigoma town W/Supply is Lake Tanganyika. Water is pumped from the lake intake to the several tanks around the town. Maintenance and operational costs have kept on rising, especially the electricity bill. This caused some concern. An alternative possible cheaper method had to be considered. Water can be supplied to residence in several ways. This study looks at the possibility of supplying the town with gravity supply.

When selecting the source two factors had to be kept in mind, i.e. the elevation of the tanks and the peak demand of the town. The Vamia Tank in Kigoma is located approx. 942 m.a.s.l. As most of

the water consumption is below the high level tank at elevation 886 m.a.s.l., the gravity main might end up in this tank. The minor Vamia Level Tank at elevation 942 m.a.s.l. The estimated future water demand by the year 2005 is 817 l/s according to feasibility study of October 1981, which is the latest figure.

Three streams have been considered and analysed using available information. These are Mungonya, Kaseke and Luiche (see attached maps). All three have several years of daily observation. Only Luiche, however, can have an intake near the gauging station and so data is used directly. Mungonya and Kaseke intakes have to be much higher (upstream) at proper elevations. Therefore data for these streams has to be interpolated. This has been done by relating the catchment above the proposed intake to the total catchment at the hydrometric station, and assuming same specific run off. Since in most cases specific run off is bigger upstream these values for Kaseke and Mungonya can be treated as minimum values.

Mean monthly flows for the period of observation of the three stations was calculated and a mean annual flow obtained. Values for Mungonya and Kaseke were reduced accordingly as shown in table 3.4.

From the table only Luiche can supply water adequately to Kigoma. This is further shown on the duration curve in fig. 3.2. Kaseke on the other hand has an annual mean flow, which is less than the peak demand. Mean annual flow of 424 l/sec flows only 30% of the time as shown in fig. 3.9. Mungonya on the other hand has a mean annual flow of 255 l/sec which flows about 27% of the time as shown in fig. 3.8.

The above analyses give a picture of the alternative gravity sources around Kigoma. But these are only estimates which need to be confirmed by observations during dry season. It is proposed to build permanent V-notches at the proposed intakes, and daily observations should continue for at least two years.

From the foregone Lake Tanganyika remains, and may remain, a reliable source of water for Kigoma town for some time to come. Some consideration could be given on combining several intakes from streams to satisfy demand, or let the two systems co-exist i.e. gravity and pumping.

Rough estimates of pipe line costs have been made by Consultant Water Engineer to Kigoma W/supply for the three intakes, and have been appended. It is included here to serve as an indicator to the feasibility and evaluation of the proposal.

Table 3.4 Mean monthly flow in the rivers Mgonya, Kaseke and Luiche

Place/ Location	Period Records	Catchm area km^2	Mean monthly - l/sec J	F	M	A	M	J	J	A	S	O	N	D	Mean
Mgonya (prop.intake)	1974-88	21.6	262	206	412	681	403	184	111	66	59	64	108	503	255
Kaseke (prop. intake)	1961-88	40.0	520	598	884	1006	517	220	115	94	60	128	227	719	424
Luiche at Janda (m^3/sec)	1975-88	641.0	13.2	14.9	16.8	21.9	13.0	6.2	4.8	4.0	3.4	5.0	7.8	11.9	9.4

Fig. **3.8** Flow duration curve for the Mungonya River.

0.255 m^3/sec

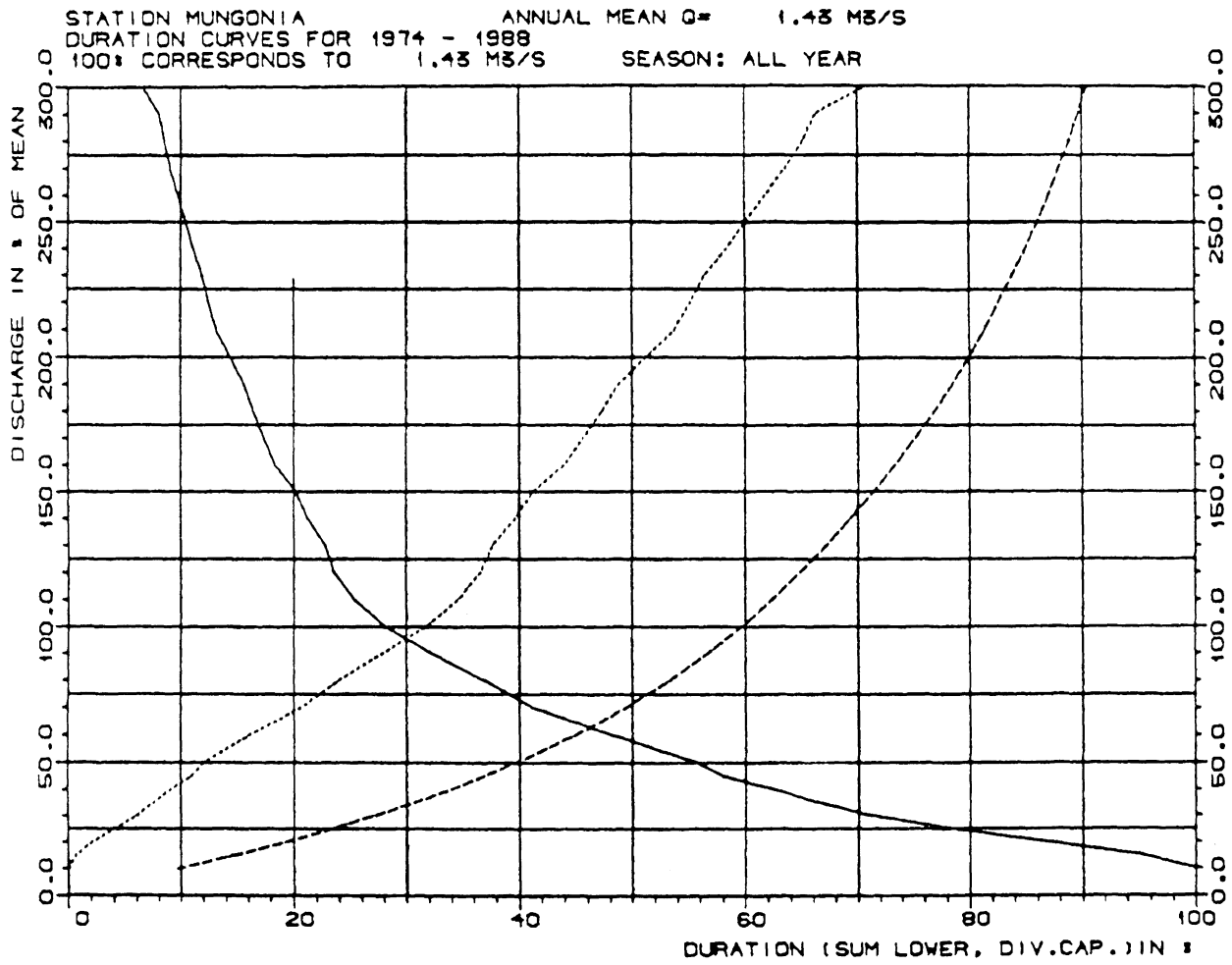
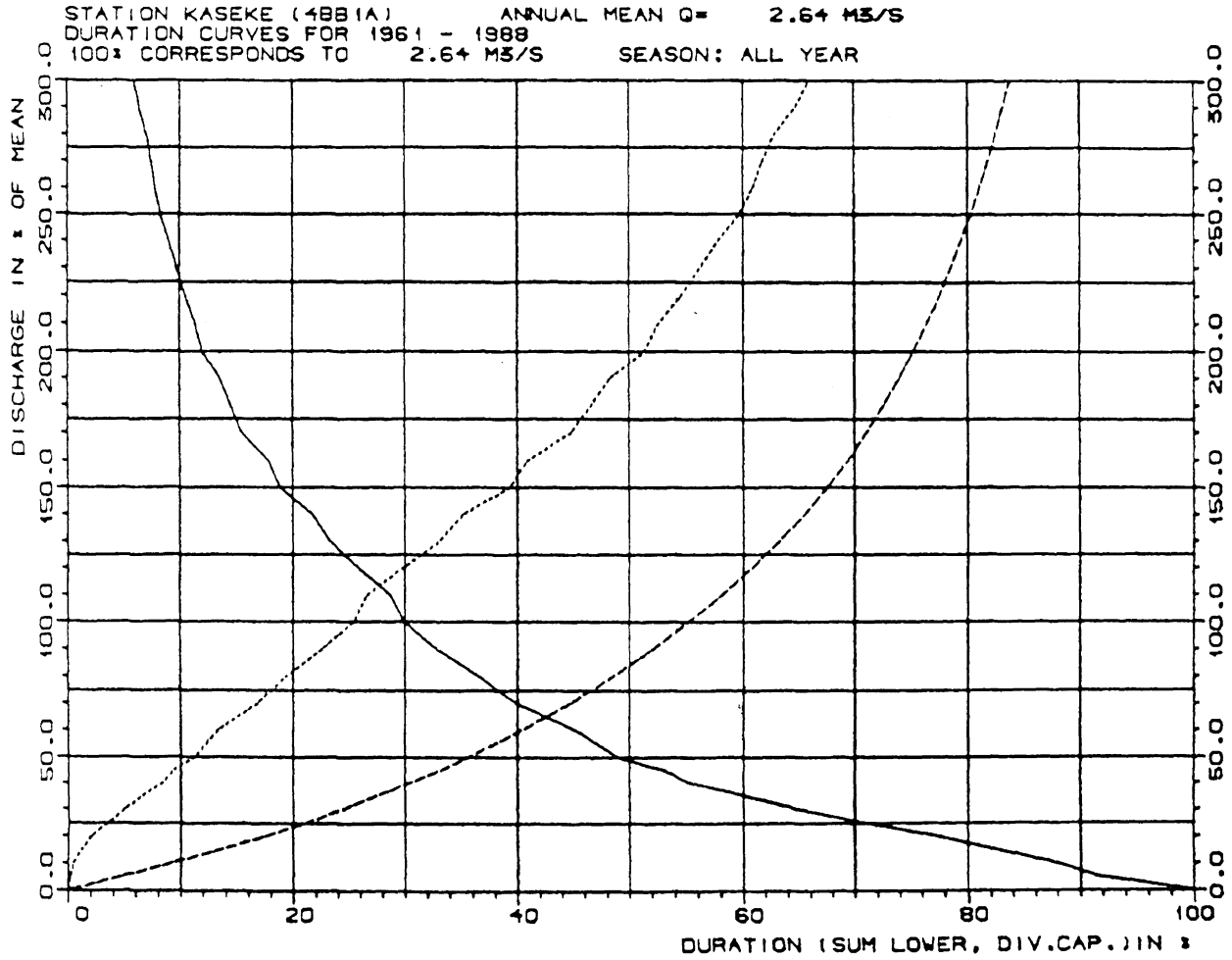


Fig. **3.9** . Flow duration curve for the Kaseke River.

0.424 m^3/sec



3.12 Nyanganga (figure 3.7)

Nyanganga village with an estimated demand of 5.0 l/s (including Kalenge/Zeze villages) by the year 2001 has Nyanganga River as a possible water source for the village. Observations show that the discharge was quite sufficient. During this time it is possible to have an influence of early rains. Therefore data should be confirmed during next dry season.

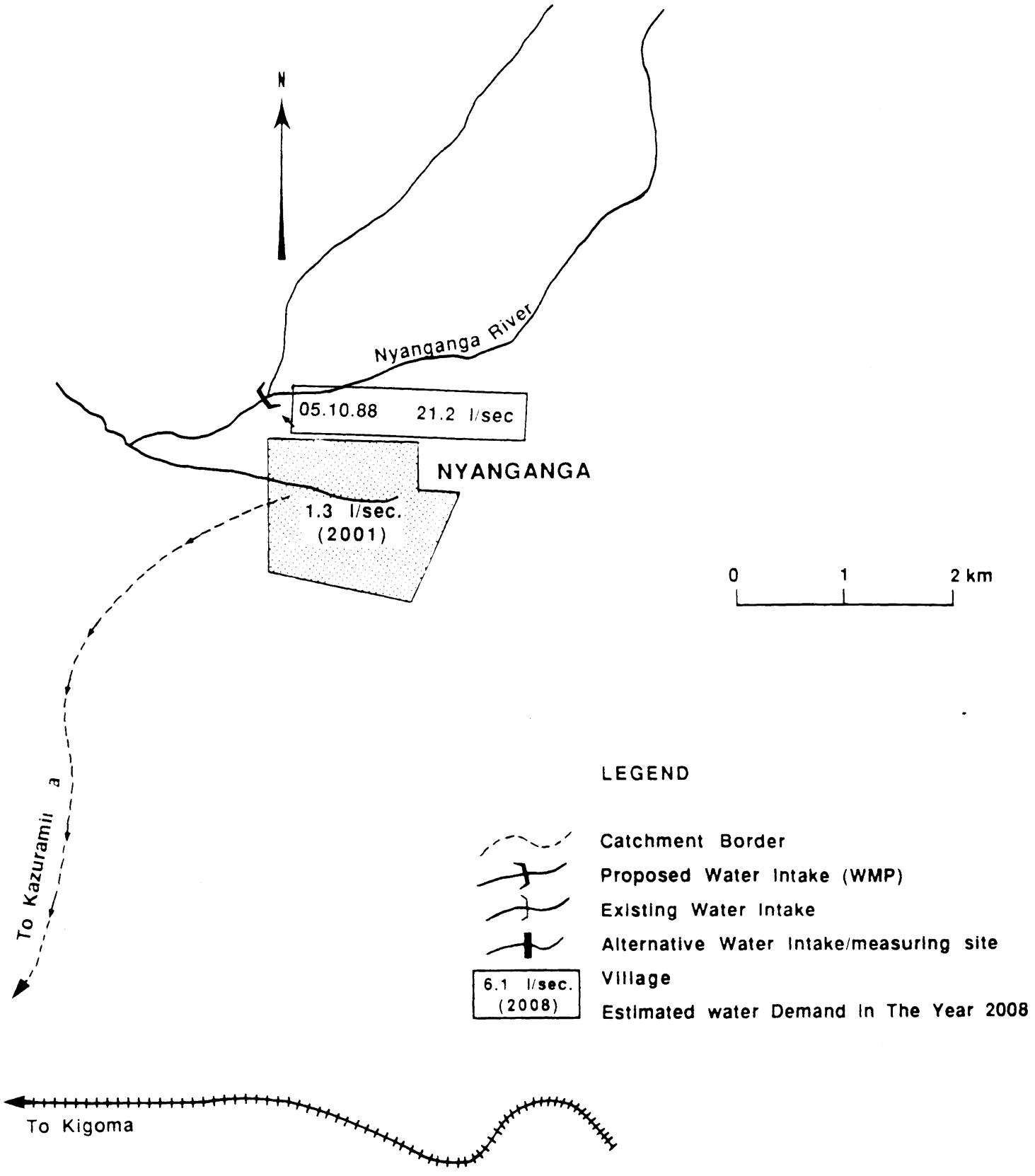


Figure 3.7 Proposed water Source to Nyanganga Village

KIGOMA-UJIJI URBAN WATER SUPPLY

Alternative Surface Water Sources

April 1989

Table of contents

1. INTRODUCTION

Due to the increasing energy cost of the existing pumped water supply to Kigoma/Ujiji from Lake Tanganyika, it is necessary to look into the possibilities of supplying the area by gravitated water from nearby rivers.

This is a part of the ongoing work with rehabilitation of the existing supply system. Based on the census of August 1988, new population and water consumption figures will be calculated. As these figures not yet are available, for the following the figures from "Kigoma-Ujiji Town Water Supply Feasibility Study Report of October 1981" will be used.

When the new and revised consumption figures are available the following calculations probably have to be revised accordingly.

Population and Water Demand m^3/d	1980	1995	2005
Total population	74,000	192,000	364,000
Domestic demand	4,100	16,300	32,800
Institutional demand	615	2,445	4,920
Industrial demand	472	3,749	7,544
Losses	1,037	4,499	9,053
Average day demand	6,224	26,993	54,317
Peak day demand	8,090	35,090	70,612

Population and water consumption. Figures of October 1981.

As a gravity supply the mains are sized for 24 hours duty per day. The peak day demand of 70 612 m^3 2005 means approx 817 l/sec accordingly.

In the following hydrological item the rivers Luiche, Kaseke and Mungonia are considered to be the only realistic raw water sources.

2. HYDROLOGY

Refer to text.

3. ALTERNATIVE WATER SOURCES

3.1 General

So far three alternative rivers have been considered to be possible future gravity raw water sources to the Kigoma-Ujiji Urban Water Supply

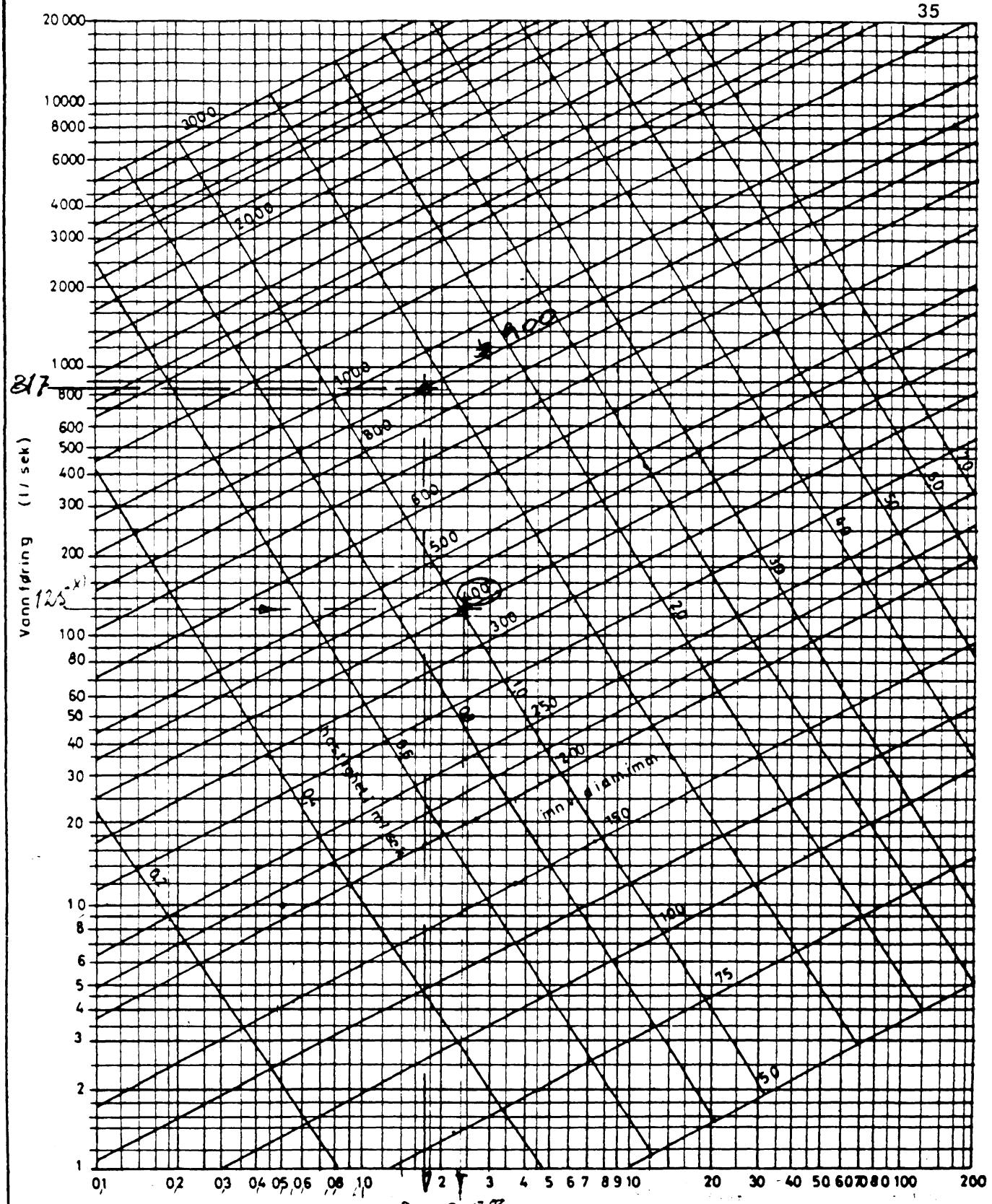
- Luiche River
- Kaseke River
- Mungonia River

Accordingly to item 2 "Hydrology", Luiche is the only river which has capacity to supply the area.

Utilizing both Kaseke and Mungonia Rivers only a part of the consumption will be supplied by gravity. This means the low level pumping station near Lake Tanganyika has to supply the difference.

It is however, recommended to see these figures in connection with the 1989 revised future consumption estimates.

Further analyses and Jar-tests should be carried out for the rivers as it might be doubtful to send raw water through the long gravity mains without a great danger of clogging the pipes.



Kobbelt
Støpejern &
støpejern

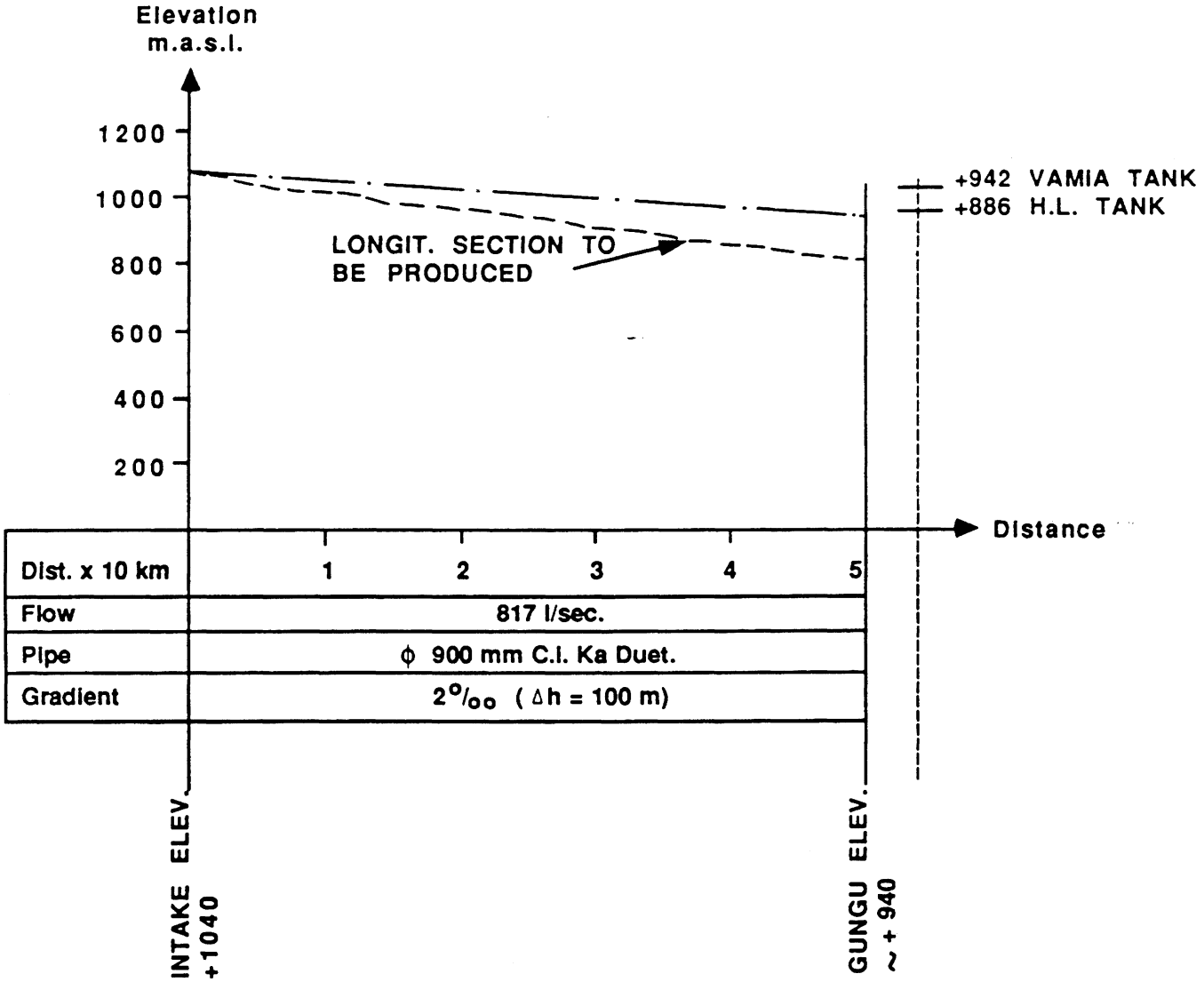
Trykktapsdiagram for rørledninger
ved transport av vann 10°C
(Prandtl - Colebrooke) k = 0,2 mm

x) Karube & Matsunaga

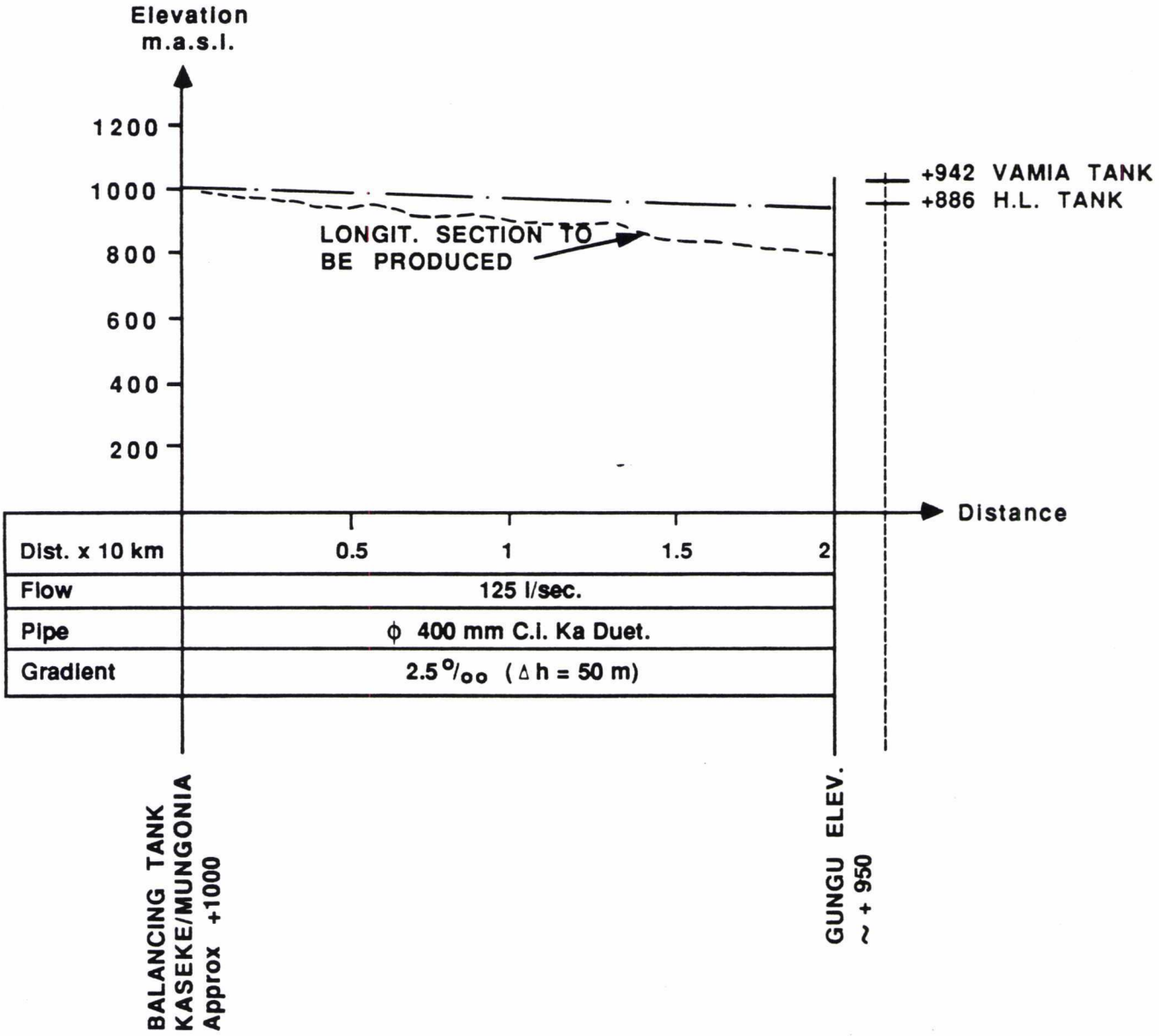
3.2 Luiche River

Ref. no. (see attached maps).

Intake Luiche River 817 l/s x 24 l/d
= 70612 m^3/d



Capacity 125 l/sec 60% of the time
approx 11000 m^3/d.
The pumping station at low level to be maintained and used for the rest of the water consumption.



3.3 Kaseke and Mungonia Rivers

Kaseke and Mungonia to supply 60% of the duration time

Kaseke: 35 % of mean
35% x 424 l/s = 150 l/sec

Mungonia: 40% of mean
40% x 255 l/s = 100 l/sec

Total available approx 250 l/s

of which 50% to be used for gravity supply to Kigoma/Ujiji i.e. 125 l/sec.

COMPONENT	INTAKE LUICHE RIVER DETAILS	MILL. NOK	INTAKES KASEKE & MUNGONIA RIV. DETAILS	MILL. NOK
CONCRETE INTAKE STRUCTURE	L.S	0.5	2 NOS L.S	0.5
SUPPLY OF GRAVITY MAIN F.O.B. EUROPE ESTIMATE FROM SUPPLIER	o900 mm D.I.K9 L = 50 000 m each NOK 2 200.-	110.0	o400 mm D.I K9 L = 27 000 m each NOK 600.-	16.2
SUPPLY OF VALVES AND FITTINGS F.O.B. EUROPE	ADDITIONAL 5% OF ABOVE	5.5		0.8
SEA TRANSPORT EUROPE TO DAR ES SALAAM ESTIMATE TRANSP. AGENCY	55 000 m^3 each USD 50.- Approx. NOK 350.-	17.5	7500 m^3	2.6
TRANSPORT DAR-KIGOMA	TO BE CALCULATED IN KIGOMA			
PIPE LAYING ROUGH ESTIMATE/EDUR. GUESS	50 000 m each NOK 400.-	20.0	27000 m each NOK 200.-	5.4
NECESSARY TREATMENT	P.T. UNKNOWN		P.T. UNKNOWN	
ACCESS ROADS AND ELECTRICITY SUPPLY	L.S.	1.0	2 nos L.S.	1.5
PRESENT VALUE O & M CHEMICAL & ELECTR. COST	TO BE CALCULATED ACCORDINGLY TO KIND OF TREATMENT			
TEMPORARY PART-SUM	ABOVE MISSING ITEMS TO BE CALCULATED AND ADDED	154.5		27.0

Appendix 2

LOW FLOW MEASUREMENTS/KIGOMA REGION

Village	Demand, l/sec Q_{24}	Q_{pd}	Year	River/Spring	Date/ Year	Qobs, l/sec	Catchment area, km^2	Qspes. l/sec.km^2	Remarks
KASANGEZI	3.6	5.4	2007	Karenge R.	Sept.80	0.5	0.8	0.63	V-notch. Exist int.
					11.06.81	9.0			Bucket
					17.06.81	7.0			"
					30.06.81	5.5			"
					17.07.81	10.0			
					31.07.81	9.0			
					13.08.81	7.0			
					27.08.81	5.0			
					09.09.81	5.0			
					24.09.81	3.0			
					09.10.81	3.0		3.75	
					30.10.81	4.0			
					05.06.85	0.7		0.88	
					11.10.85	0.75			
					17.07.87	3.5			
					22.09.87	1.8			
				Muzye R.	27.06.85	44.0	7.8		V-notch. Prop. int. (RWE)
					03.09.85	34.5			Pygmee-Ott
					12.09.85	32.2			V-notch
					03.10.85	23.8		3.05	"
					11.11.85	28.4			Pygmee-Ott.
					04.06.86	90.4			
					22.07.86	64.9			
RUSESA g/s	12.7	15.9	2006	Kasangezi R.	04.09.80	9.0	7.1	1.27	Pygmee-Ott. Old int.
					11.06.81	65.0			
					17.06.81	59.0			
					30.06.81	56.0			
					17.07.81	55.0			
					12.08.81	51.0			
					27.08.81	47.0			
					09.09.81	41.0			
					29.10.81	37.0	5.21		

Village	Demand, l/sec Q_{24}	Q_{pd}	Year	River/Spring	Date/ Year	Qobs, l/sec	Catchment area, km^2	Qspes. l/sec.km^2	Remarks
RUSESA (cont'd)					29.09.84	3.6		0.51	V-notch (fixed)
					03.10.85	5.3		0.75	" "
					03.10.85	2.2	4.03	0.55	Bucket, before confluence
				Nyabagole R.	17.06.81	31.0	2.59		At new intake
					17.07.81	25.0			
					13.08.81	19.0			
					27.08.81	18.0			
					24.09.81	10.0			
					30.10.81	14.0			
					20.10.84	1.9			V-notch (fixed, new int.)
					03.10.85	4.3			" " "
BUGAGA g/s	10.0	15.0	2007	Mushori R.	04.09.80	14.0	1.66		At intake.
					12.09.85	12.9			V-notch. At intake.
					03.10.85	10.4		6.27	" " "
					11.10.85	11.4			" " "
					03.04.86	20.2			
					01.10.86	15.7			
				Nyabushish R.	03.10.85	9.4	1.22	7.71	Bucket. Opposite to intake.
					11.10.85	12.6		10.33	" " "
					03.04.86	21.0			
NKUNDUZI	2.1	3.1	2006	Mubanga R.	17.06.80	3.5			Exact position unknown.
				Rundugu R.	17.06.80	2.5			" "
				Mubanga R.	13.09.85	8.1	1.5	5.40	Bucket. After confluence.
					05.10.85	8.0			" "
					05.10.85	3.3	0.54	6.11	Bucket. Before confluence.
					04.06.86	9.7			
					02.10.86	4.5			V-notch (portable).
				Rundugu R.	04.06.86	21.9			
					02.10.86	5.7			V-notch (portable).

Village	Demand, l/sec Q_{24}	Q_{pd}	Year	River/Spring	Date/ Year	Qobs, l/sec	Catchment area, km^2	Qspes. l/sec.km^2	Remarks
MARUMBA	4.2	6.2	2001	Kaligamba R.	04.10.85	2.33	<1	>2.33	Bucket.
					03.10.86	4.49			V-notch (portable) d/s of pond.
				Nyakivuba R.	27.06.80	5.0			Proposed int. WMP.
					13.09.85	4.5			
					05.06.86	13.5			
					03.10.86	4.7			
				Kisito R.	04.10.85	4.26	< 1	>4.26	Bucket.
					05.06.86	27.10			After confluence w/Kaligamba R.
					03.10.86	5.7			V-notch, portable
MURUFITI g/s	6.4	9.6	2007	Mgandazi R.	17.06.80	1500	61.9		Old Intake.
					04.10.85	11.5	61.0	0.19	Pygmee-Ott. Inflow to pond.
					04.10.85	4.0	61.5	0.07	V-notch. After pond.
					04.10.85	26.7	61.9	0.43	Pygmee-Ott. Old intake.
					06.11.85	44.4			
					22.07.86	87.0			Midway between pond & old int.
					01.10.86	54.6			
KASULU	47.0	56.0	2005	Miseno R.	05.10.85	28.1	5.13	5.48	Pygmee-Ott.
					24.12.85	33.5			
					06.06.86	77.6			
					02.10.86	28.7			V-notch (fixed).
					24.09.87	33.0			" and Pygmee-Ott.
				Nyanka R.	07.10.85	16.9	1.52	11.12	V-noth (fixed). Exist intake.
					24.12.85	25.4			
					06.06.86	25.4			
					02.10.86	20.9			
					23.09.87	19.6			
HERU JUU g/s	7.5	9.8	2007	Ghogo R.	23.09.85	11.2			V-noth and bucket.
					06.10.85	14.7			Pygmee-Ott & bucket.
					03.10.86	13.9			V-notch (fixed).
SONGAMBELE g/s	8.9	11.6	2007	Nyanfizi R.	04.10.86	36.6			Pygmee-Ott.
					14.06.88	89.4			" (Above intake)

Village	Demand, l/sec Q_{24}	Q_{pd}	Year	River/Spring	Date/ Year	Qobs, l/sec	Catchment area, km^2	Qspes. $l/sec.km^2$	Remarks
NYANTARE g/s	10.4	13.5	2008	Mgandazi R.	31.08.85	34.1	11.45	2.98	V-notch (fixed)
					07.10.85	28.7			
					06.11.85	44.5			
					24.12.85	69.8			
					06.06.86	101.0			
					02.10.86	35.7			
					17.07.87	70.4			Pygmee Ott.
					24.09.87	42.9			" "
					20.05.88	258.0	11.45		" "
					28.05.88	242.7			" "
					05.07.88	147.0			" "
					04.08.88	107.5			" "
					06.09.88	69.2			" "
MUNYEGERA	3.4	5.1	2001	Lugambwa R.	07.10.85	10.4	4.12	2.52	V-notch, at alt. intake
					05.06.86	64.7			
					03.10.86	9.0			
MWANGA	4.7	7.0	2007	Nyanzanze R.	11.06.80	5.0			?
					07.10.75	1.52	0.74	2.05	Bucket, just u/s waterfall
					05.06.86	3.5			
				Kigombe R.	07.10.85	6.00	1.92	3.13	Bucket, at alt. intake.
					05.06.86	29.50			
					03.10.86	7.08			V-notch (portable)
BUKUBA	4.4	6.6	2001	Nyanzogoro	12.10.80	6.00			?
					07.10.85	5.3	4.18	1.27	Bucket, at prop. intake.
MSAMBARA	4.3	5.4	2006	Muganga R.	31.10.84	2.6	3.6	0.72	V-notch (fixed). Exist int.
					05.11.84	12.0			
					14.05.86	59.4			
KALELA	2.9	4.3	2004	Kunde R.	09.10.85	5.1			

Village	Demand, l/sec Q_{24}	Q_{pd}	Year	River/Spring	Date/ Year	Qobs, l/sec	Catchment area, km^2	Qspes. $l/sec.km^2$	Remarks
MKONGORO g/s	42.3	48.7	2006	Nyete R.	05.06.80	30.0			
					05.09.80	29.0	15.8	1.8	Pygmee-Ott 200m u/s of intake
					19.09.80	48.0			?
					09.10.80	43.0			?
				Kaseke R.	18.08.81	232.0	40.0		U/s of road bridge to Mkongoro
					01.09.81	83.0			
					15.09.81	145.0			
					22.09.81	98.0			
					16.10.81	105.0			
					07.11.81	83.0			
					09.10.85	67.4	22.6		Pygmee-Ott. Alt.int. (RWE)
					13.05.88	232.0	40.0		Pygmee-Ott.
					28.06.88	186.1			" "
					01.08.88	129.7			" "
					25.08.88	116.0			" "
					04.10.88	109.2			" "
MGARANGANZA g/s	7.5	11.2	2004	Muanda R.	26.09.79	9.0			At intake.
					30.08.80	6.0			V-notch, intake.
					19.09.80	(3.9)			
					14.10.80	4.5			
					Apr. 81	6.0			
					18.06.84	3.6			
					12.07.84	3.4			
					30.07.84	3.2			
					10.09.84	2.6			
					24.09.84	(2.3)			
					05.11.84	(1.9)			

Village	Demand, l/sec Q_{24}	Q_{pd}	Year	River/Spring	Date/ Year	Qobs, l/sec	Catchment area, km^2	Qspes. l/sec.km^2	Remarks
NYAKITONTO	(3.6)		2001	Chai R.	19.02.86	7.3			Bucket
					14.05.86	19.6			
					10.06.88	19.2			Pygmee-Ott.
					05.07.88	14.9			" "
					05.08.88	13.1			" "
					04.11.88	6.5			" "
					08.09.88	1.5			" " Prop. intake
					23.09.88	2.6			" " "
					04.11.88	2.3			" " "
					04.11.88	1.25			" " (Prop.intake)
MUGOMBE	(2.6)		2001	Janda R.	19.02.86	7.7			
KUMWAMBO	(6.5)		2001	Kibingo R.	06.09.86	2.0			V-notch
KABINGO g/s	5.0	6.5	2006	Kiziguzigu R.	18.09.80	4.3			Prop.int.
					07.11.80	5-10			Estimated
					01.02.85	3.0			
					20.09.85	2.1			Bucket, d/s of confluence.
					18.12.85	2.5			
					18.02.86	4.42			
					18.10.86	2.99			V-notch, portable
					12.08.87	7.3			Pygmee Ott d/s of confluence
					30.09.87	5.4			" " "
					03.06.88	9.5			Pygmee Ott
					20.07.88	8.1			" "
					21.08.88	8.3			" "
					25.09.88	9.1			" "

Village	Demand, l/sec Q_{24}	Q_{pd}	Year	River/Spring	Date/ Year	Qobs, l/sec	Catchment area, km^2	Qspes. l/sec.km^2	Remarks
KABINGO g/s (cont'd)				Lusange R.	01.02.85	0.44			Bucket, inflow to storage tank
				(Kange R.)	18.09.85	1.61			Exist. intake
					18.09.85	(0.22)			
					18.12.85	1.72			
					18.02.86	3.72			Alt. intake + inflow to storage
					08.10.86	3.88			tank (Bucket).
					13.08.87	7.2			V-notch (portable)
					30.09.87	7.0			
					03.06.88	9.6			Bucket (Incl. tank flow)
					20.07.88	12.45			" "
					21.08.88	9.2			" "
					25.09.88	11.0			" "
				Rusengi R.	09.10.86	3.95			
				(Ngomo R.)	13.08.87	9.50			
					30.09.87	6.60			
					03.06.88	34.1			Pygmee-Ott.
					20.07.88	14.8			" "
					21.08.88	12.5			" "
					25.09.88	5.9			" "
KAKONKO g/s	8.5	11.0	2009	Nyakaviro R.	08.10.80	1.3			
				(exist. int)	01.02.85	1.0			?
					19.09.85	0.69			Bucket, u/s intake.
					18.12.85	0.52			
					05.09.86	0.8			V-notch (portable).
					08.10.86	0.45			V-notch (portable).
				Kanyaga R.	19.09.85	1.1			Bucket, upper Mbizi.
					19.09.85	1.53			Bucket, lower Mbizi.
					01.10.87	0.70			Bucket, lower Mbizi.
					05.09.86	3.0			At small bridge.
					08.10.86	2.0			Estimate.
				Mihigo Spring	03.06.88	1.5			V-notch

Village	Demand, l/sec Q_{24}	Q_{pd}	Year	River/Spring	Date/ Year	Qobs, l/sec	Catchment area, km^2	Qspes. l/sec.km^2	Remarks
CHURAZO g/s	2.6	3.9	2006	Kifunza R.	15.10.80	3.0	16.9	0.18	
					17.12.85	2.6			Fixed V-notch.
BUKIRILO	3.4	5.0	2001	Kavumu R.	20.09.85	1.1	1.9	0.6	Bucket, prop. int.
					04.09.86	2.6			
					15.08.87	4.0			V-notch, portable.
					01.10.87	2.77			
				Kumjigojigo R.20	20.09.85	0.54			Bucket
				Kumgogo R.	01.10.87	1.68			V-notch, portable, alt.int.
BUKIRILO g/s	4.6	7.0	2001						
KUMHASHA	1.5	2.2	2007	Chigazule R.	20.11.80	1.0			
					20.09.85	0.62			Bucket, d/s of prop. intake.Farming, irr. est. 2-3 l/sec.
					04.09.86	1.0			V-notch, at prop. int.
					15.08.87	3.0			V-notch, portable
					03.10.87	2.0			
					02.06.88	5.7			V-notch
					21.07.88	1.84			"
					20.08.88	0.88			"
					25.09.88	0.61			"
				Nyamavuye	02.06.88	1.28			"
					20.08.88	0.17			"
KASEKE	4.3	6.4	2007	Nyamponda R.	16.08.84	10.8			
					29.08.84	5.7			
					28.08.85	31.5	73.4		V-notch (fixed).
					23.09.85	21.5			" "
					08.10.85	14.5			" "
					08.10.85	12.5	50.4	0.25	Bucket, 150 m d/s of int.

Village	Demand, l/sec Q_{24}	Q_{pd}	Year	River/Spring	Date/ Year	Qobs, l/sec	Catchment area, km^2	Qspes. $l/sec.km^2$	Remarks
NYAMOLI	2.0	3.0	2007				2.0		
KASANDA	(3.0)		2001	Lusenge R.	18.02.86	54.2			
					04.09.86	1.3			
					14.08.87	2.6			V-notch, portable
					02.10.87	3.5			
					22.08.88	8.0			V-notch
					24.09.88	4.2			Pygmee
				Lulalo R.	22.08.88	10.4			"
					24.09.88	7.4			"
				Katabesha R.	22.08.88	14.9			"
					24.09.88	9.6			
MLELA	3.2	4.8	2006	Spring	01.09.84	5.8			Pygmee-Ott.
					31.05.85	12.4			Near village.
					31.05.85	7.1			Upper reaches of the stream/spring.
					31.05.85	2.6			
					18.11.85	3.4			
MUKABUYE	(3.2)		2001	Kumnywa	06.09.86	12.4			
				Mpanga R.	16.08.87	14.5			V-notch, portable.
					03.10.87	28.2			
MKATANGA g/s (MANYOVU)	(14.0)			Kivuruga R.	17.06.86	17.7	1.41		
					04.10.86	6.1		4.3	
KIBONDO TOWN				Kumwambo R.	19.02.86	17.1			
					05.09.86	3.0			V-notch (portable).
					02.10.87	12.6			

Village	Demand, l/sec Q_{24}	Q_{pd}	Year	River/Spring	Date/ Year	Qobs, l/sec	Catchment area, km^2	Qspes. l/sec.km^2	Remarks
KANAZI	4.2	5.9	2007	Maurwbezi R.	02.08.80	3-4	1.11	3.15	At prop. int.
				Spring I	04.05.85	2.3			Bucket
					30.08.85	2.1			
					09.09.85	2.0			
					16.09.85	2.0			
					16.11.85	1.7			
					08.03.86	2.9			
					14.03.86	2.9			
					24.03.86	2.9			
					03.04.86	2.9			
					11.04.86	2.9			
					18.04.86	3.3			
					25.04.86	3.3			
					12.05.86	3.3			
					14.06.86	2.9			
					26.06.86	2.9			
				Spring II	30.08.85	2.3			
					09.09.85	2.1			
					16.09.85	2.0			
					06.11.85	1.5			
					08.03.86	6.7			
					14.03.86	8.0			
					24.03.86	10.0			
					03.04.86	10.0			
					11.04.86	10.0			
					18.04.86	10.0			
					25.04.86	10.0			
					13.05.86	8.0			
					14.06.86	6.7			
					26.06.86	5.0			

Village	Demand, l/sec Q_{24}	Q_{pd}	Year	River/Spring	Date/ Year	Qobs, l/sec	Catchment area, km^2	Qspes. $l/sec.km^2$	Remarks
KANAZI (cont'd)				Spring III	30.08.85	2.6			
					09.09.85	2.5			
					16.09.85	2.4			
					06.11.85	1.5			
					08.03.86	8.0			
					14.03.86	8.0			
					24.03.86	8.0			
					03.04.86	8.0			
					11.04.86	6.7			
					18.04.86	8.0			
					25.04.86	8.0			
					13.05.86	8.0			
					14.06.86	5.7			
					26.06.86	5.0			
					01.10.86	2.3			
				Spring I+II	01.10.86	3.2			
				Mgurubezi R.	30.08.85	13.2			V-notch, d/s of 3 springs.
MUZYE	3 l/sec		2001	Kisuma	10.06.88	36.9			Pygmee-Ott - Above Muzye intake
					06.07.88	36.3			"
					04.08.88	28.6			
					08.09.88	10.6			
					23.9.88	21.9			
NYAMNYUSI	3 l/sec		2001	Kisuma	10.06.88	62.4			Pygmee-Ott.
					05.07.88	29.8			100 m above
					05.08.88	29.8			(Nyamnuysui intake)
					08.09.88	13.9			
					23.09.88	11.6			
					04.11.88	7.7			

Village	Demand, l/sec Q_{24}	Q_{pd}	Year	River/Spring	Date/ Year	Qobs, l/sec	Catchment area, km^2	Qspes. $l/sec.km^2$	Remarks
SHUNGA				Mugera	17.06.88	24.3			
					05.08.88	17.9			
NYANGANGA g/s				Nyanganga	05.10.88	21.2			
MWAMILA				Lugufu	08.03.88	1960.0			

Appendix 3

RWE — KIGOMA
HYDROLOGY

WORK PLAN

HYDROMET STATIONS

JANUARY — JUNE 1989

No	STATION	RIVER	D	J	F	M	A	M	J
A1	LAKE TANGANYIKA								
4A5	TARAGI	MALAGARASI							
4AB1	MAKERE	MAKERE							
4AA2	PWAGA	RUCHUGI		—					
4A9	MBELAGULE	MALAGARASI	—		—			—	
4B10	JIMBI	LUICHE				—			
4B11	MKUTI	MKUTI							
4B9	SIMBO	LUICHE					—		
4BA2A	MUNGONYA	MUNGONYA							
4D1	LUBALISI	LUEGELE							—
4BB1A	KASEKE	KASEKE							

NB. Each trip is 2 wks

WORK PROGRAM

METEOROLOGICAL STATIONS

JANUARY — JUNE 1989

No	STATION	J	F	M	A	M	J
93-3007	KIBONDO		●				
95-3008	UVINZA			●			
95-3105	NGURUKA				●		
94-3006	KAGERA					●	

● Visit — Make any repairs
— Collection of data

Appendix 4

SPOT MEASUREMENTS 1989 DRY SEASON

NO	VILLAGE	STREAM	MAY	JUN	JULY	AUG	SEPT	OCT						
1.	MUZYE	KISUMA (K.S.L.)												
2.	NYAMNYUSI	KISUMA (K.S.L.)												
3.	NYAKITONTO	CHAI (K.S.L.)												
4.	KABINGO / KIYOBELA	RUSENGI / NGOMA (K.B.D.)												
5	KABINGO/ KIYOBELA	KAGE/KASSANGE/LUSSANGE (K.B.D.)												
6.	KABINGO/ KIYOBELA	KIZIGUZIGU (K.B.D.)												
7.	KASANDA	LUSENGE (K.B.D.)												
8	KASANDA	KATABESHA (K B D)												
9	KASANDA	LULALO (K.B.D.)												
10.	NYANGANGA / ZEZE / KALENGE	NYANGANGA (K.G.M.)												
11	KITEMA	MIGESIBIRI (K.S.L.)												

1. DISCHARGE MEASUREMENTS TO BE TAKEN ONCE PER MONTH
2. DATES OF TRAVEL WILL DEPEND ON TRANSPORT AVAILABILITY

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