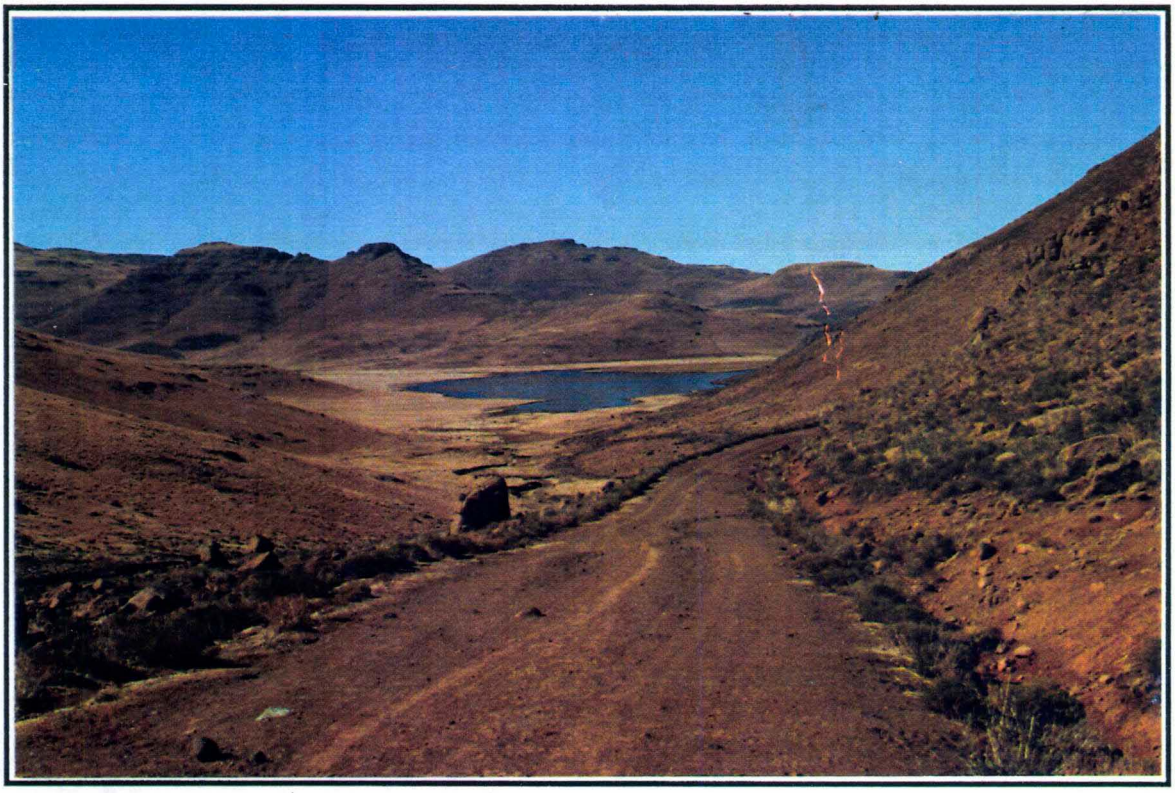
REPORT NO 01·90

NVE
NORWEGIAN
WATER RESOURCES AND
ENERGY ADMINISTRATION

Lars Evan Petterson

HYDROMETRIC STATIONS WITHIN QUTHING RIVER, LESOTHO

PROGRESS REPORT 1989



NVE
NORWEGIAN
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Division of development assistance

NORAD
NORWEGIAN AGENCY
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ASSISTANCE

DWA
DEPT. OF WATER AFFAIRS
LESOTHO

NVE
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Sammendrag/Abstract

A cooperation agreement between the Department of Water Affairs (DWA), Lesotho, and the Norwegian Water Resources and Energy Administration (NVE) was approved in early 1989.

In accordance with this cooperation agreement, representatives from NVE visited Lesotho in July 1989 to take part in the planning and establishment of hydrometric stations within Quthing river basin.

There are plans for a future water power plant in the upper part of the river, and since hydrometric data from the area are too sparse, there is a need to establish stations. This progress report summarises the work done in 1989 and gives recommendations for future work.

Emneord/Subject Terms

Lesotho
Quthing River
Hydrometric Stations

Ansvarlig underskrift/
Project Co-ordinator

Egil Skofteland
NVE/NORAD Coordinator

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1. INTRODUCTION

A possible cooperation agreement between Department of Water Affairs (DWA) in Lesotho and the Norwegian Water Resources and Energy Administration (NVE) within the sector of hydrology was discussed in 1988. In this connection, a representative from NVE visited Lesotho on a short-term mission 18.-22. April 1988, resulting in a mission report, "Establishment of hydrometric stations within Quthing river basin, Lesotho", report no. 2-88 published by NVE, [1].

A cooperation agreement was sanctioned by DWA and NVE in early 1989. See Appendix 1. The contribution from NVE will so far be an advisory role concerning hydrological investigations for a future water power plant in the Quthing river basin in the south-eastern part of Lesotho, and supply of some hydrometric equipment needed.

In July 1989 two representatives from NVE visited Lesotho on a two-week mission to assist DWA with the establishment of hydrometric stations. See Terms of Reference in Appendix 2.

This progress report summarises the work done so far and provides recommendations on future work on this project.

2. SUMMARY AND RECOMMENDATIONS

The existing network of hydrometric stations in south-eastern Lesotho is not sufficient as a basis for an estimation of the hydropower potential in the area. It is proposed to establish a number of hydrometric stations within the Quthing river basin.

The stream-gauging station SG 52 Hoko, in the lower part of Quthing river, was proposed to be rebuilt as a recording station. This construction work was carried out during the dry season 1989 and the station has been in operation since 27. september 1989. A site for a cableway should be picked out at high flow, while the construction work has to be done during low flow. A minor cableway for this purpose should be made available by NVE/NORAD.

A strem-gauging station should be established in the Letsie Dam. A rehabilitation of the dam is needed and will be rather expensive, depending on the order of the work. Additional funds are needed for the rehabilitation work. The station should be equipped with a Stevens recorder.

Three fully-equipped climatological stations should be established within the Quthing river basin or close to its water-divide. One of the stations could be a precipitation station only. The equipment for these stations could be part of the NVE contribution to the project.

A survey of the Letsie reservoir should be carried out as soon as possible to get a depth map of the lake. From another survey and mapping of the lake in a couple of years, the life time of the lake, due to sediment transport could be estimated.

As a part of the NVE assistance to the project, a new Ott current meter is bought to the DWA office in Quthing. The equipment was received by DWA in november 1989.

3. EXISTING HYDROMETRIC STATIONS

The Quthing river is a tributary to the Orange river (Senqu) in south-eastern Lesotho. See map in Figure 1. The upper part of Quthing river has been considered for hydropower development [2], [3]. Since the hydrology in the area is poorly known, any study of the hydropower potential in the area suffers from this lack of data. A short summary of the existing hydrometric stations in south-eastern Lesotho follows below. See also map in Figure 2.

SG 3 Seaka bridge:
The station gauges the Orange river close to the border where the river leaves Lesotho. The catchment area is 19.875 km^2.
Data are available since 1972.

SG 4 Whitehill:
The station gauges the Orange river and is situated to the north of Quthing river. The catchment area is 10.750 km^2. Data are available since 1965. The station SG 2 Rapose was situated very close to SG 4 with almost the same catchment and have observations in the period 1956-1967.

SG 7 Tsoelike bridge:
The station gauges Tsoelike river, a tributary to the Orange river about 80 km to the north-east of Quthing river. The catchment area is 797 km^2. Data are available since 1964.

SG 18 Semonkong:
The station gauges Maletsunyane river, a tributary to the Orange river about 50 km to the north of Quthing river. The catchment area is 219 km^2. Data are available since 1965.

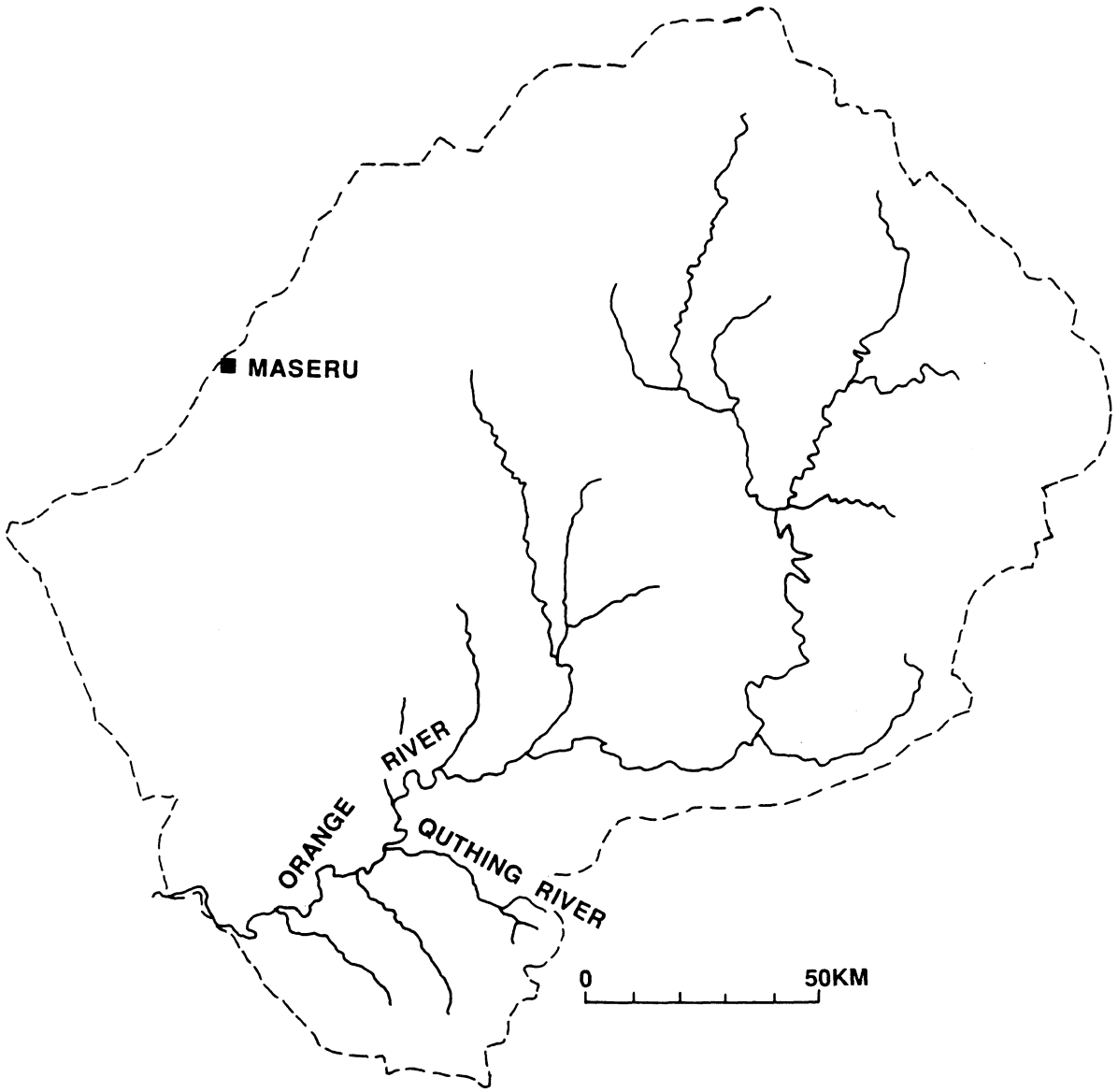


Fig. 1. Lesotho

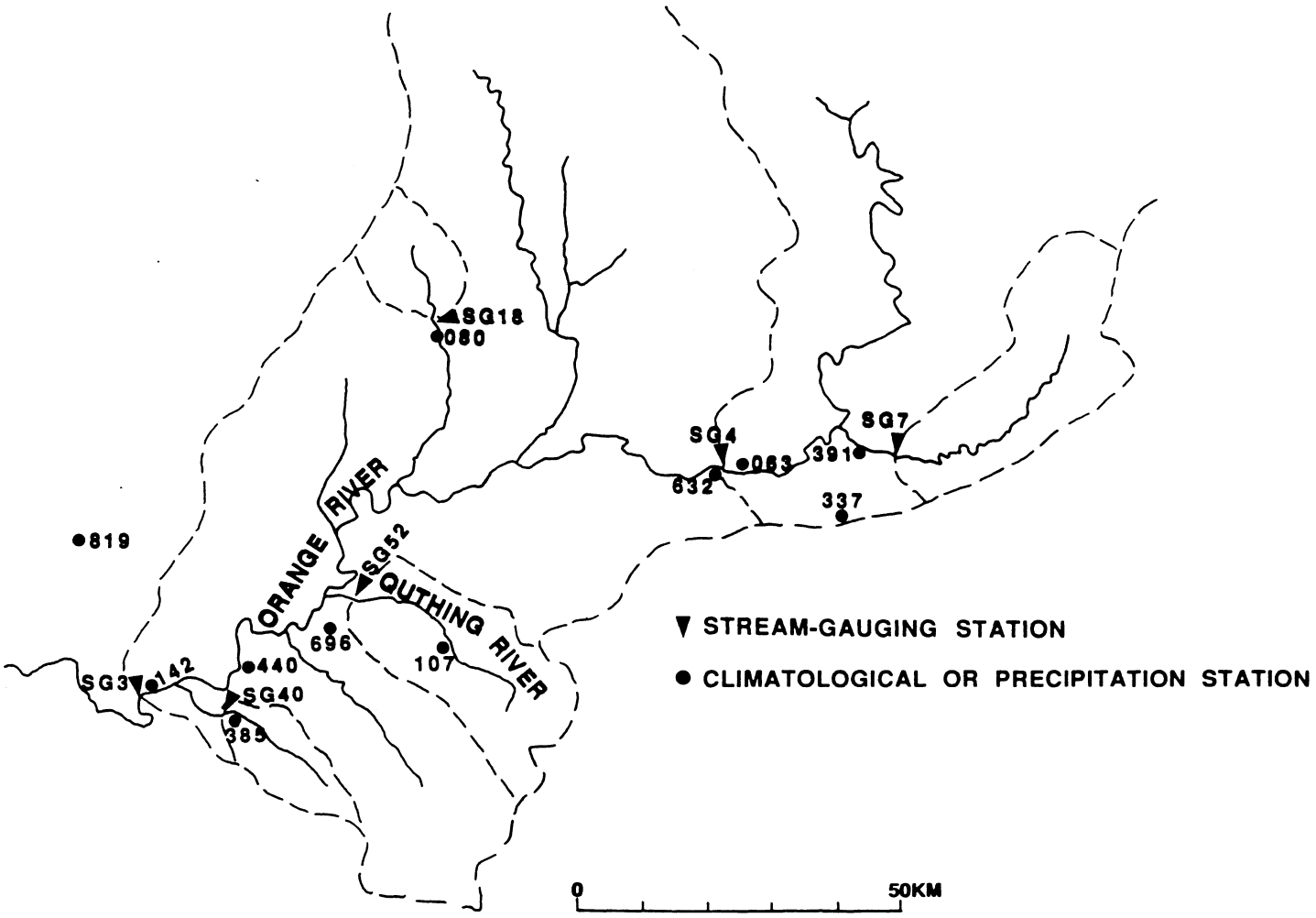


Fig. 2. Hydrometric stations in south-eastern Lesotho

SG 40 Quthing:
The station, situated in the little town Quthing, gauges Qomoqomong river, a tributary to the Orange river about 30 km to the south-west of Quthing river. The catchment area is 208 km^2.
Data are available since 1972.

In addition to these stations, there was for a period a station in Quthing river called SG 52 Hoko. This station, established in 1979, was gauging the whole Quthing river with a catchment area of 614 km^2. The station consisted of a staff gauge and was closed in 1986 when there was no observer available any longer. The data from the observation period has to be checked for their quality.

Besides the stream-gauging stations, several precipitation stations exist in the area, and a couple of climatological stations, which are all listed in table 1, with positions given by the map in Figure 2.

Station no.	Station name	Station type	Altitude m.a.s.	Length of record years
204/819	Mohales Hoek	Climatological	1620	94
205/142	Seaka	Precipitation	1440	11
205/385	Quthing	Climatological	1620	84
205/440	Fort Hartley	Precipitation	1480	26
205/696	Mount Moorosi	Precipitation	≈ 1650	9
206/107	Makoae	Precipitation	1667	12
206/632	White HilÆ	Precipitation	≈ 1700	52
207/063	Rapase	Precipitation	1630	49
207/337	Qachas Nek	Climatological	1970	94
207/391	Tsoelike	Precipitation	1940	52
235/080	Semonkong	Precipitation	2160	18

Table 1. Meteorological stations in south-eastern Lesotho.

4. PROPOSED HYDROMETRIC STATIONS

Considering the large variations in runoff pattern in south-eastern Lesotho, the existing network of hydrometric stations is not sufficient as a basis for an estimation of the hydropower potential in the area. Stream-gauging stations far away will not give a sufficient picture of the runoff conditions in upper Quthing river, where the projected hydropower plant will be located. Furthermore, the existing stations have much bigger catchments than the proposed hydro-power project area, and e.g. extreme runoff conditions -important as a basis for estimation of design floods -can not be transposed from the existing stations to small catchments in upper Quthing river.

To obtain representative hydrometric data, it is proposed to establish two automatic gauging stations in the Quthing river. One of them should be at almost the same site as the old staff gauge SG 52 at Hoko. This seems to be the best site to gauge the whole Quthing river catchment, even if there may be shifting conditions at the control at low flows. This site is easy to reach in rainy weather, while the access to other parts of the river may be difficult.

After a visit to Quthing river, NVE prepared a description of the proposed gauging station at Hoko, with detailed drawings. See Appendix 3. This description would serve as a support to the DWA team, when constructing the station during the dry season 1989.

The other gauging station is proposed to be established in the Letsie Dam. See map in Figure 3. This is the intake reservoir for the proposed hydropower station and therefore the most important site for a stream gauging station in Quthing river. It will be easy to establish a station in the reservoir, since a stilling pipe can be mounted to the dam construction. The station should be equipped with a Stevens recorder.

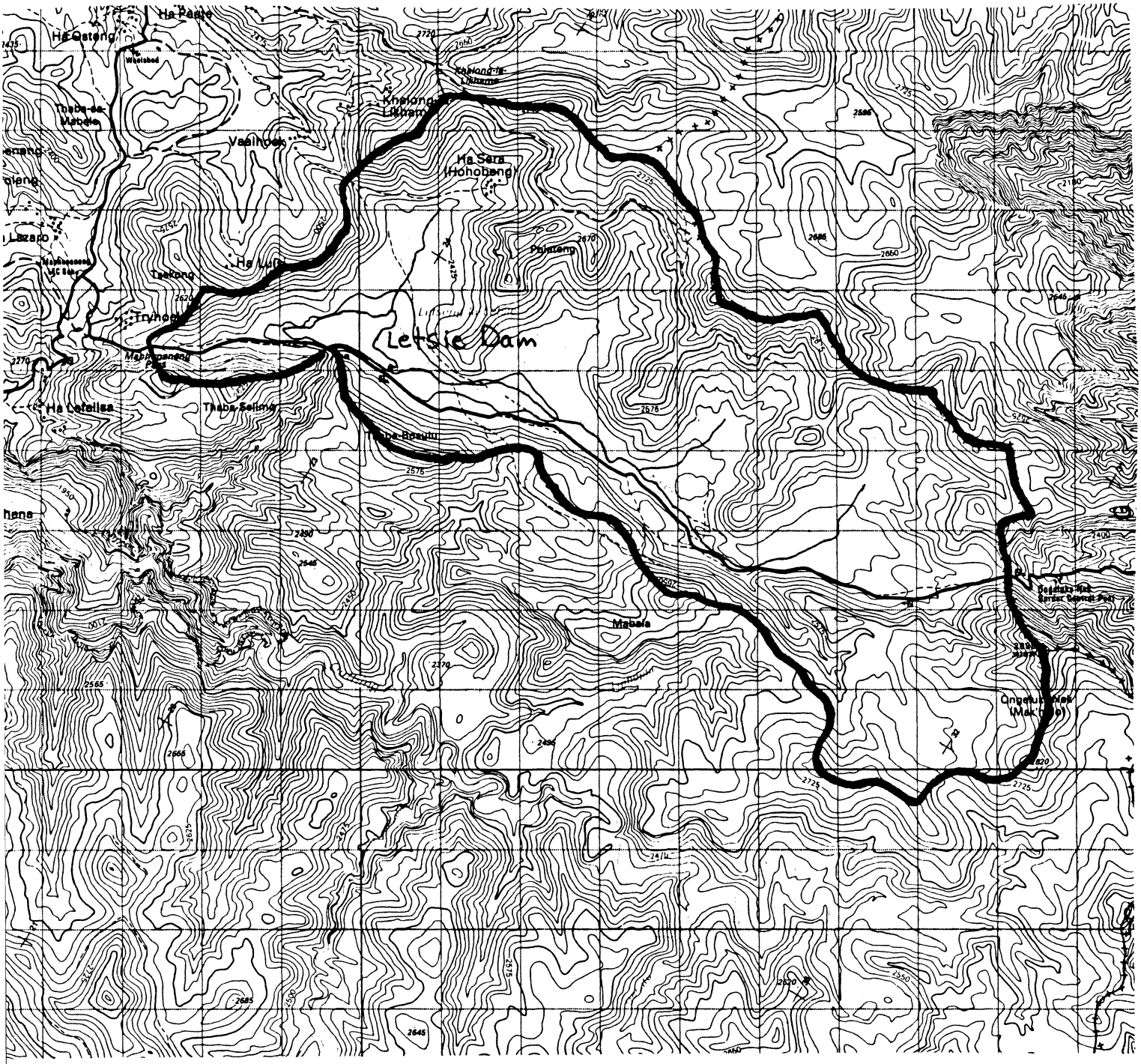


Fig. 3. Letsie Dam Basin

The problem of this site is the dam construction itself, since there are considerable leakages. Furthermore a remote station like this will be difficult to visit most of the rainy season, and there will probably be some problems to get discharge measurements at high flow. The dam construction should therefore have such a shape that the discharge can be calculated theoretically from the water stage. The dam has to be repaired and adjusted to make it suitable as a control for gauging. The contractor NOREMCO have prepared a cost estimate for the rehabilitation of the dam, see Appendix 4.

An alternative to rehabilitate the dam is to use the existing dam as a control as it is, or perhaps just carry out a minor rehabilitation. The control is perhaps more stable than at many other stations due to the dam construction. But there is a risk that the control can be changing, and the leakages may increase. With the existing dam, including some leakage and a dam crest not perfectly levelled, a theoretical calculation of the stage-discharge relationship will be of a poor quality.

Discharge measurements can be carried out in the river downstream the dam either by dilution methods or by cableway.

Any rehabilitation work on the dam will need a permission from concerned government authorities. Besides changing the dam construction itself a rehabilitation work will involve emptying the lake during the working period and perhaps a constant change of future water level.

It seems to be impossible to establish any stream-gauging station in the remote areas where the projected transfer of water will take place, since the operation of such a station will suffer from difficult accessibility. The best way to get an idea of the contribution of water from this area will be to measure the rainfall distribution throughout the Quthing river basin. A couple of villages in the area should be picked out as sites for climatological stations.

A precipitation station already exists in the Quthing river basin, Makoae. This station should be modernized and equipped as a complete climatological station.

Right outside the eastern part of the Letsie Dam catchment there is a border control post, Ongeluks Nek. This would be a good site for another climatological station, probably most representative for the whole Letsie Dam basin.

To get a good picture of the east-west gradient in climate, a third climatological station, or at least a precipitation station, should be established in the western part of the Letsie Dam catchment, where there is a village.

Sediment transport is heavy in rivers in Lesotho. Since the Letsie reservoir probably is a rather shallow lake, there would be of interest for a water power project involving the lake as a reservoir, to measure the sediment yield to the lake. Out of such measurements it would be possible to estimate the lifetime of the lake as a reservoir before it is filled up with sediments. A simple way of measuring this sediment yield is to survey the lake by sounding from boat completed by landsurveying the shores. This work should be done as soon as possible and a second time in about four or five years.

A complete investigation of the sediment transport and its influence on the hydropower project involves, besides estimation of lifetime of the reservoir, also measurements of total yield and analysies of types of suspended material that will toil the turbines, and measurements of bedload that can fill up transfer tunnels.

5. THE FUTURE DWA/NVE COOPERATION

In general terms, the future cooperation between DWA and NVE will follow the agreement referred to in chapter 1. However, there was a need to define a more detailed work program including a time schedule for 1989 and 1990. Such a program, which also settles down the responsibilities of the DWA and NVE, was mutually agreed upon in a meeting in Maseru, Lesotho, 17. July 1989, with the following participants:

Mr. Makhoalibe, Director, DWA, Lesotho
Mr. Tau, Head of Hydrology Section, DWA, Lesotho
Mr. Pettersson, Senior Hydrologist, NVE, Norway
Mr. Repp, Senior Hydrologist, NVE, Norway

The workprogram and time schedule is shown in Appendix 5.

It should be noted that parts of the work program and time schedule will depend on additional funds from NORAD, since a rehabilition of the Letsie Dam will be rather expensive.

In addition there is a need for hydrological and meteorological equipment, like a portable cableway and 2 or 3 fully equipped climatological stations, to an amount of approximately 100 000 NOK.

6. STATUS DES. 1989.

The construction work of the first automatic stream-gauging station in Quthing river, SG 52 could not be started while the representatives from NVE were in Lesotho in July 1989. But later on during the dry season, materials and equipment were brought to the Quthing river and the construction work was carried out. The automatic recorder was operative 27. September. See Appendix 6 for report from the construction work.

A cableway for discharge measurements at SG 52 has not yet been installed. The best site for a cableway should be picked out at high flow, but the construction has to been done during low flow.

The future work at the Letsie Dam depends on the way of construction that will be preferred.

As a part of the NVE assistance to the project, see Terms of Reference, a new Ott current meter was ordered to the DWA office in Quthing town. In November the equipment was received in Lesotho. See Appendix 7.

7. REFERENCES

[1] Establishment of Hydrometric Stations within Quthing River Basin, Lesotho. A Mission Report. NVE-Report 2 (1988).

[2] Small Hydro Power Project Quthing. Feasibility Study. Institute of Water Management, Universitet Fuer Bodenkultur, Vienna-Austria (August 1984).

[3] Hydroelectric Power in Lesotho, V-publication 3, NVE (1987).

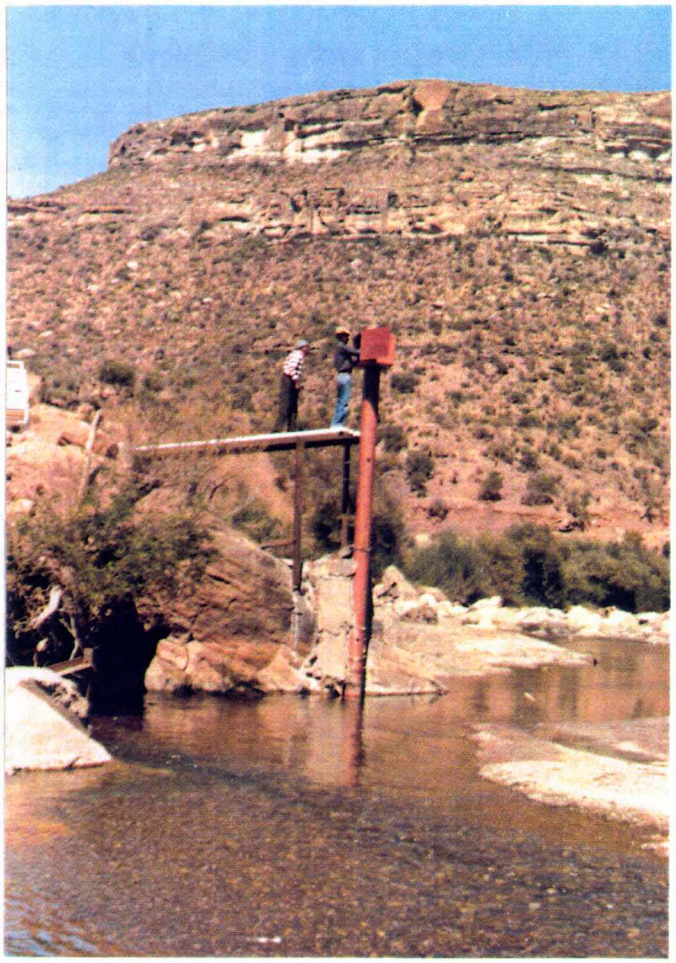


Fig. 4. The stream-gauging station SG 52, September 1989

Fig. 5. The dam construction at the Letsie reservoir, July 1989.

COOPERATION AGREEMENT BETWEEN THE DEPARTMENT OF WATER AFFAIRS (DWA), LESOTHO, AND THE NORWEGIAN WATER RESOURCES AND ENERGY ADMINISTRATION (NVE), NORWAY

General

NVE accepts to act as an advisory body to DWA on matters within the sector of hydrology and water resources. NVE shall only act on written or telex request from Water Affairs and the scope of NVE's tasks shall be mutually agreed upon in each case.

The agreement shall be valid for the 3 years 1988, 1989 and 1990. Further extension has to be agreed upon by both parties.

Salary expenses for NVE-personnel working on projects under this agreement will not be part of any project budget but will be covered through the general agreement between NVE and NORAD. Expenses connected to travelling and purchase of equipment, shall be included in the project budget.

This agreement shall be considered a part of the ongoing agreement between NORAD and Lesotho for Semonkong and Mantsonyane small hydropower projects. Projects will be defined under the Agreement; the first being described below.

****

1. **Project title:** Establishment of Hydrometric Stations within Quthing River Basin.

2. **Primary function:** Establishment of hydrometric stations within Quthing River Basin for the assessment and development of hydropower and water resources potential of the catchment area.

3. **Implementing Agency:** Hydrology Division/Department of Water Affairs. Ministry of Water, Energy and Mining.

4. **Project Start:** April 1988.

5. **Project Background**

An initial feasibility study on the Hydropower potential of the Quthing River Basin which was undertaken by the Institute of Water Management (Austria) has indicated that Quthing River has a high potential of hydropower production. But the hydrology of the catchment, which forms basic and

valuable information for the development and production of hydropower, is not well defined.

It is important that information on streamflow, water level, sediment transport and rainfall be collected and analyzed for reliability and accuracy in order to come up with a well planned hydropower plant for Quthing and surrounding areas like Mphaki; Qhoali etc.

6. **Objective:**

To define the hydrology of the catchment in order to obtain at least 5 year of basic data for the study area by:

a) Reassessing the hydrological study done by the Institute of Water management

b) Establishing hydrometric stations within Quthing catchment.

c) Assessing the quality of the rainfall stations.

d) Assessing the possibilities of measuring the sediment transport.

7. **Present Stage:**

- There exists a feasibility study report done by the Institute of Water Management (Austria)

- THe Hydrology Division of Water Affairs Department of WEMMIN has established a non-recording station (staff gauge) on Quthing river. There are approximately 5 years of records (water level/streamflow). Due to the change of the accessibility of the road system in Quthing area, the station was closed and has been relocated but it is still to be reestablished.

8. **NVE assistance:**

The NVE assistance to this project in 1988 will be to offer advise on the planning of the project and to supply some hydrometric equipment needed. The assistance in 1988 will be limited to a total of NOK 100 000.-.

The assistance in 1989 will be decided on at a later date.

Oslo 2. May 1989

NORGES VASSDRAGS- OG ENERGIVERK

Signed

S. MAKHOALIBE

MINISTRY OF WATER ENERGY & MINING
DIRECTOR
-5 APR 1989
WATER AFFAIRS
MASERU, LESOTHO

ESTABLISHMENT OF HYDROMETRIC STATIONS WITHIN QUTHING RIVER BASIN, LESOTHO
TERMS OF REFERENCE

BACKGROUND

In April 1988 a representative from Norwegian Water Resources and Energy Administration, NVE, visited the Quthing area in Lesotho on a short-term mission. The visit resulted in a report that gives recommendations on hydrometric investigations in the Quthing river basin and on possible future cooperation between The Department of Water Affairs, DWA, and NVE. Later on a cooperation agreement of April 1989 between DWA and NVE was accepted, involving a project description for the establishment of hydrometric stations within Quthing river basin.

SCOPE OF WORK

NVE's contribution to the cooperation will in 1989 include a two weeks visit to Lesotho by the two hydrologists, Mr. Kjell Repp and Mr. Lars-Evan Pettersson, to offer assistance connected with the hydrological investigations in Quthing river basin. Furthermore, NVE will make available for the DWA-office in Quthing a new Ott current meter and a Stevens recorder for the use at a hydrometric station in Quthing river.

In the context of the recommendations of the report on the 1988-mission the hydrologists shall, in agreement with the DWA-office, carry out the work described below:

- Give detailed recommendations for the rehabilitation and assist in the construction of the hydrometric station SG 52.
- Give detailed recommendations for the establishment of a gauging station in Letseng-la-Letsie. This involves investigations of the existing dam and of the need to change the spillway into a better control.
- Investigate sites for possible gauging stations elsewhere in the Quthing river basin.
- Visit gauging stations in near-by rivers.
- Visit meteorological stations in the area to check their quality.
- Investigate the need and possibilities to measure sediment transport.
- Check all accesible meteorological and hydrological data from the Quthing area. Part of this work can be carried out after the visit to Lesotho is finished.
- Make an detailed agreement on the future DWA/NVE cooperation, including a proposed time-schedule.

REPORTING

A report in English shall be prepared before the 1. of November.

29. June 1989

Egil Skofteland
Norwegian Water Resources
and Energy Administration

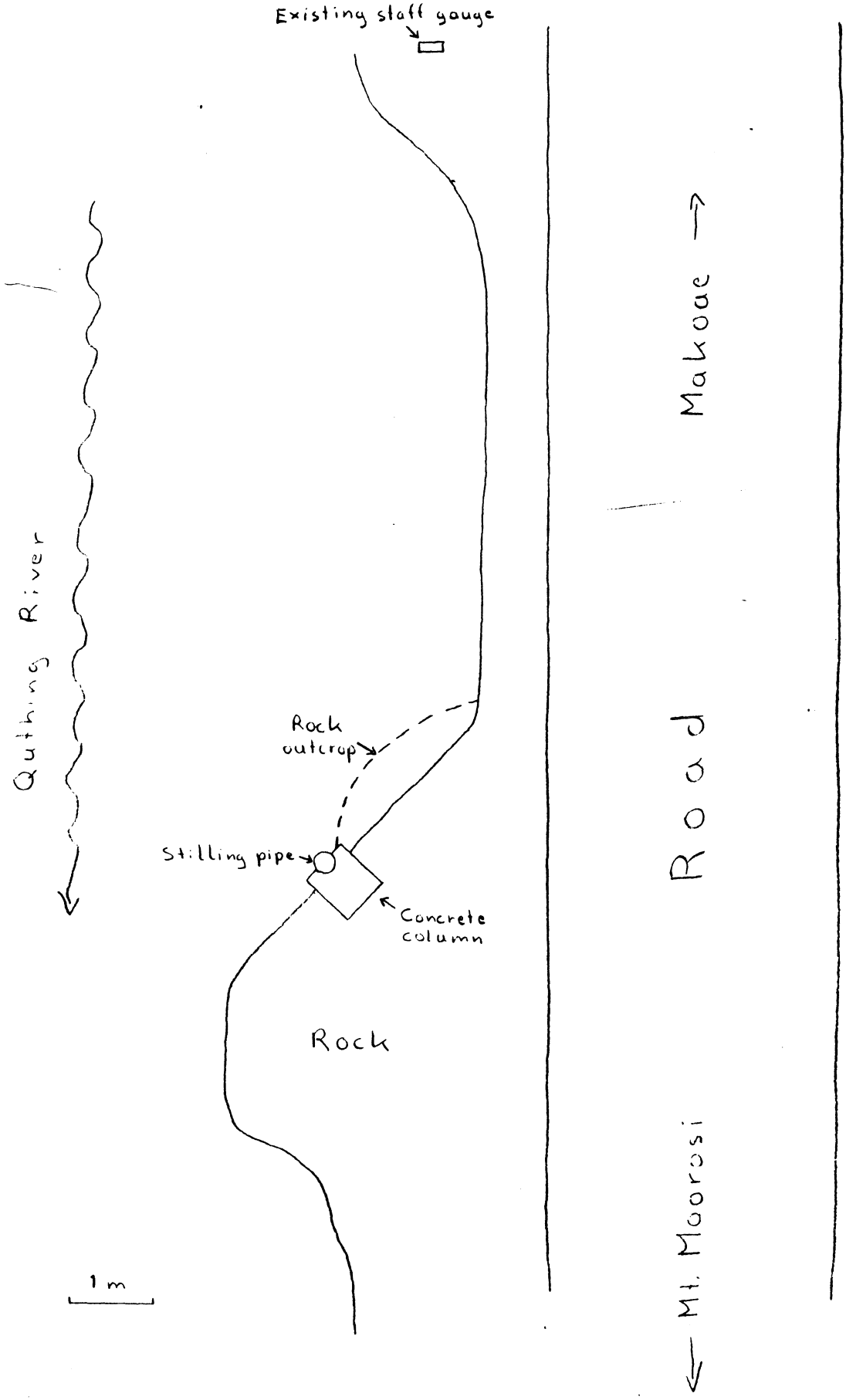
APPENDIX 3

RECORDING STATION AT SG 52 HOKO, QUTHING RIVER

The station consists of a stilling pipe embedded in a concrete column, situated 10-15 m downstream the old staff gauge. The stilling pipe, a 6 m long steel pipe with a conical end section, is mounted approximately 0.6 m above the deepest part of the river bottom and where the rock is almost vertical for over 1 m. Two pairs of bolts, drilled into the rock, and flat iron clamps hold the lower part of the steel pipe, while clamps for appr. each meter hold the upper part of the pipe to the concrete column. The concrete column is 4-5 m high and reinforced with 6 iron, Ø 32 mm, to the top. The water enters the pipe through a bottom hole in the conical end-section and through 4-5 mm - holes that are situated each 25 centimeter at a vertical line and at an angle of 40 ^{0} against the main flow.

On top of the stilling pipe there is a casing for the Stevens recorder. The staff gauges are mounted to the concrete column so that they are easily read at any water stage.

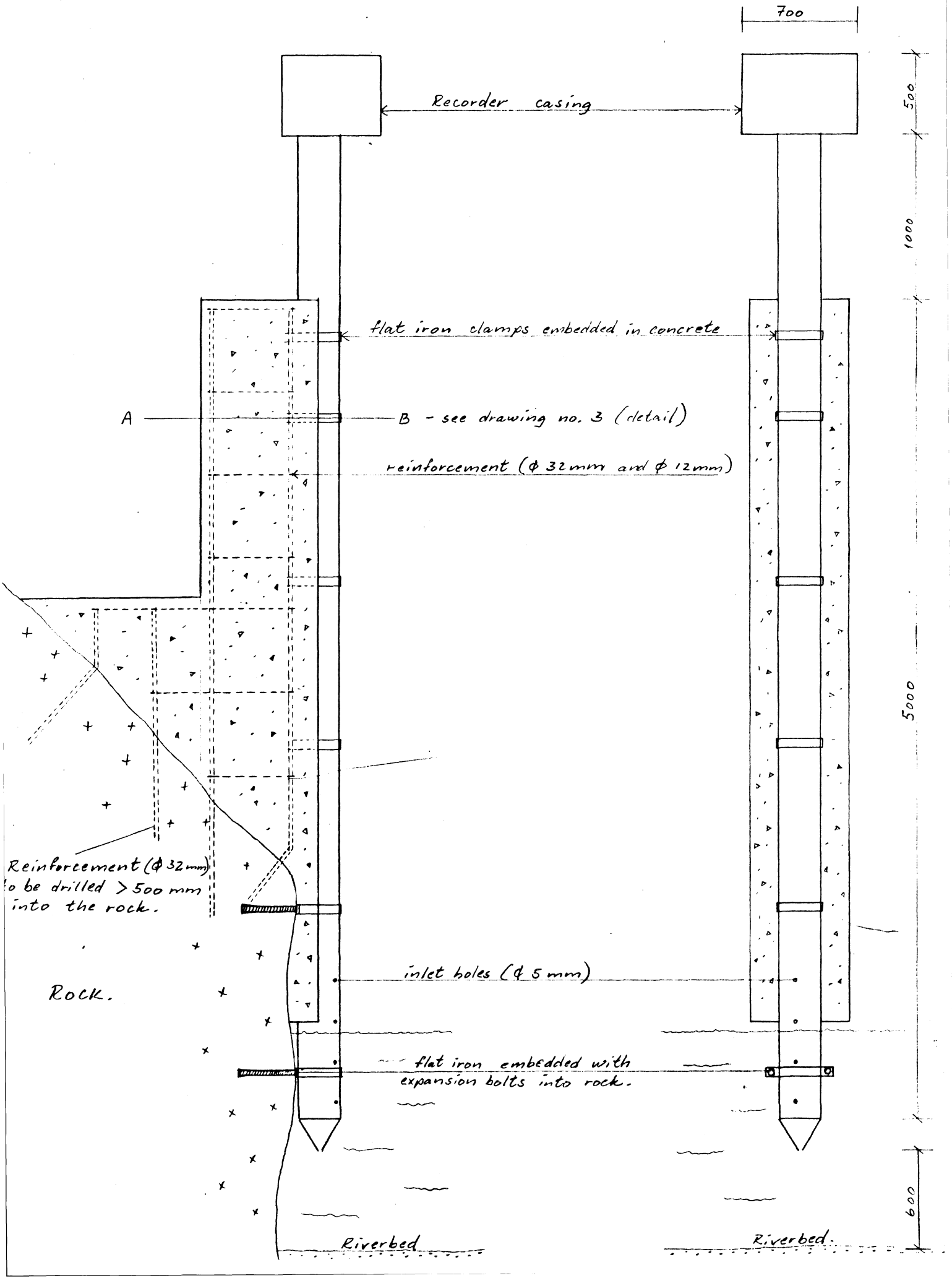
The new staff gauge must be levelled towards the existing B.M, in order to establish the relationship between the old and the new staff gauge.



Drawing no. 1. **Location map** of the recording station at SG52 Mt. Moorosi, Quthing river.

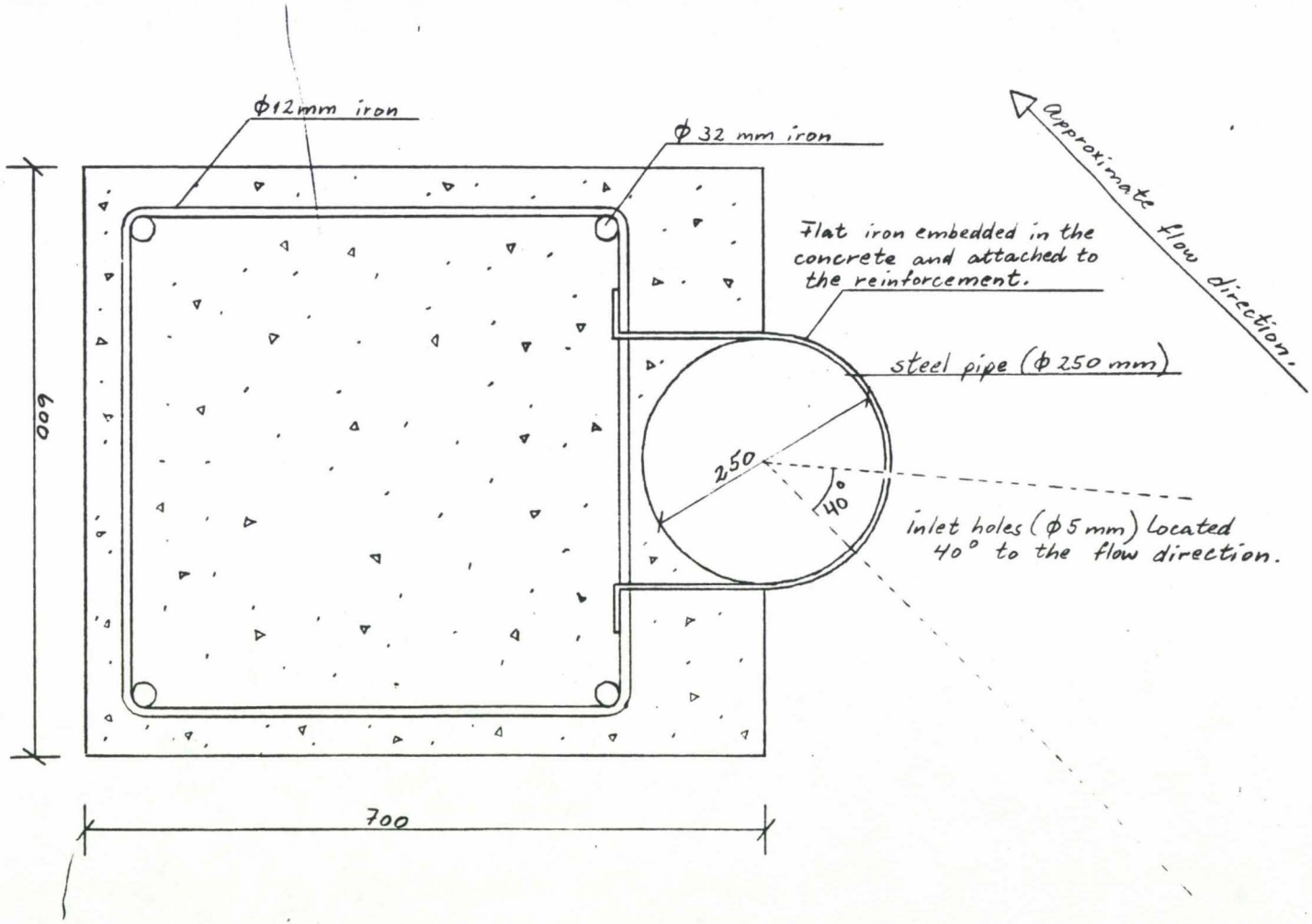
DRAWING NO. 2.

STATION SG 52, QUTHING RIVER.
STILLING PIPE



DRAWING NO. 3.

DETAIL OF STILLING PIPE WITH FOUNDATION (CROSS-SECTION A-B, DRAWING NO. 2)



APPENDIX 4

LETSIE DAM, QUTHING RIVER
Possible rehabilitation of the dam.

A temporary cost estimate for the rehabilitation of the Letsie Dam was prepared by NOREMCO in september 1989. It was based on a visit to the dam in july 1989 and on some ideas of the future spillway design, given by NVE. The cost estimate was given in norwegian and therefore it is summarized in english by NVE.

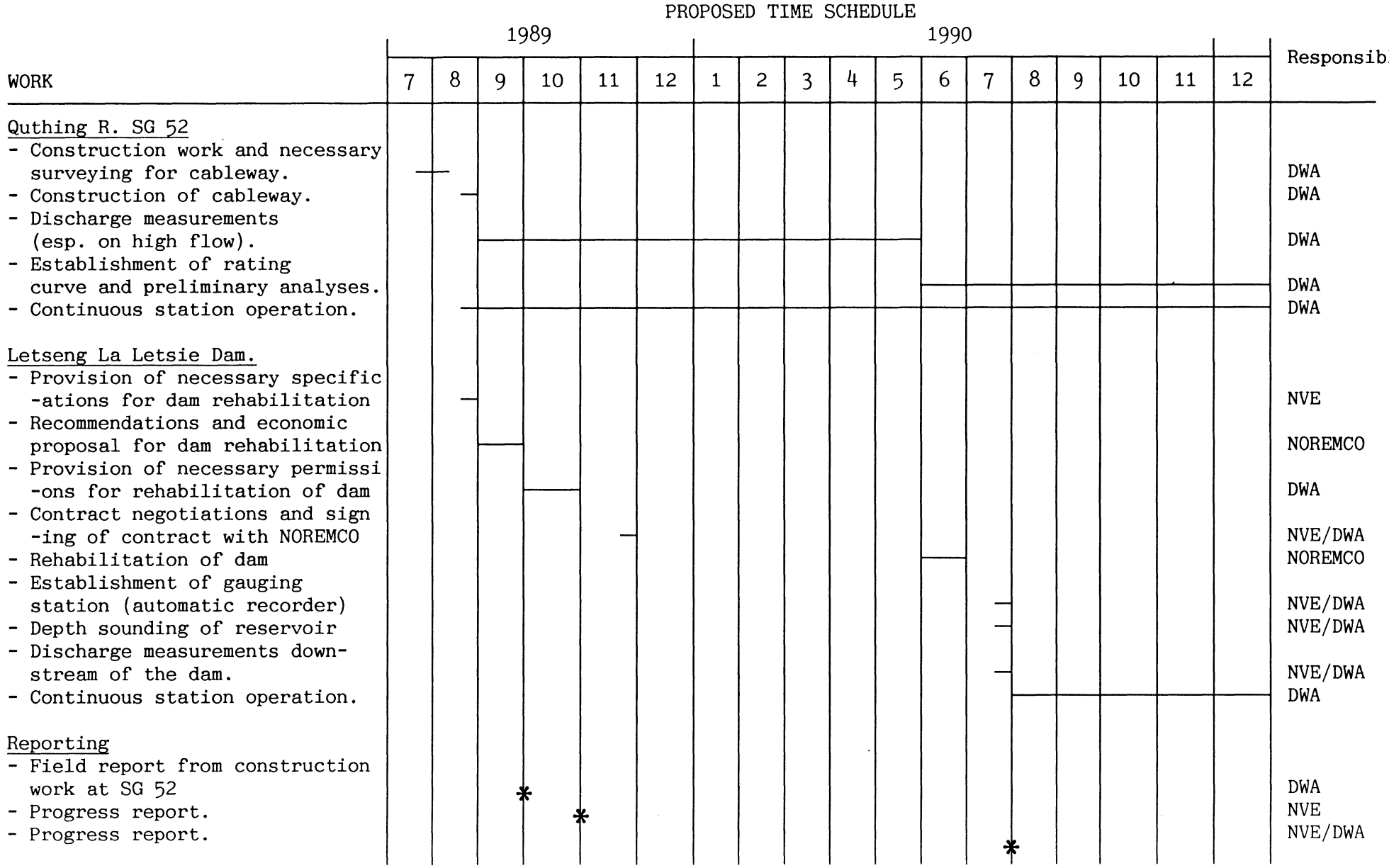
Four alternatives of the spillway design are estimated. The length of the spillway is supposed to be intact, while the height should be increased to 0.5 m or 1.0 m. The existing height is approximately 0.2 m. This might be obtained in two ways, either by raising the existing dam crest or by lowering the spillway. The cost differences between the alternatives are estimated. Lowering the spillway to a height of 0.5 m, existing height is approximately 0.2 m, is cheapest. Lowering it to 1.0 m will cost appr. 500 Maluti extra, while raising the crest to a height 0.5 m or 1.0 m will cost appr. 4500 Maluti or appr. 20 000 Maluti extra compared to the cheapest alternative.

The reservoir has to be emptied during the rehabilitation work. That will take some time, but meanwhile the work on the crest and on the spillway can be carried out. When the water stage is low enough a ditch can be dug on the water-side of the dam. The leakages can be stopped either by filling up with masses and then compressing them or by use of concrete.

Some work has to be done with the road downstream the dam, if it shall survive extreme floods.

A rough estimate ends in costs for the work of NOK 500 000 - 800 000. The uncertainty depends to a great deal on the ground conditions below the dam.

PROPOSED TIME SCHEDULE



APPENDIX 5

MINISTRY OF WATER, ENERGY AND MINING

DEPARTMENT OF WATER AFFAIRS

QUTHING RIVER NEAR MOUNT MOOROSI : SG.52

1. CONSTRUCTION:

The construction of the hydrometric station on the Quthing river near Mt. Moorosi went beyond the work schedule as programmed by the NVE hydrologists. The construction of the recorder house and the steel pipe stilling well did not advance as quickly as anticipated. These took 3 weeks to construct.

The equipment, materials and camping equipment also had some delays of 2-3 weeks before transport was available to the site due to other projects undertaken by the Department utilising the only available truck in the department.

The construction team at site was composed of one artisan, and seven labourers (two of which are regular DWA employees with years of experience in hydrometric stations' construction; while the rest were local casual labourers). Frequent visits were made by one or two more senior technical personnel from the Head office to supervise the works, while fortnightiy progress monitoring visits were made by the professional personnel of the DWA.

The construction design was maintained as far as possible to that prepared by the NVE personnel and agreed to by DWA authorities. The concrete column does not go 4-5 m high. Instead the recorder housing is reached by the walkway detached from the steel pipe tower, hence the walk way can be washed away leaving the tower behind during heavy floods. Secondly, the river channel configuration was disturbed to a minimum.

One downstream side the steel pipe tower is anchor-supported with approximately 1.5-2.0 m iron beam welded onto the tower and embedded into the rock some 2 m away.

Two staff gauges were installed upstream of the tower at positions where they are easily readat any water level; and hence the river rise can be read manually to a level of 3 m just about a metre or so before the road and the walkway are flooded.

2. STATION DESCRIPTION

2.1. Access:

The station is easily accessible from the Mt. Moorosi-Mphaki tarmac road. Branch off about 1 km from Mt. Moorosi Village and take a dirt road to Letseng-La-Letsie through Ha Makoae until you reach the Quthing river, about 1 km upstream Mundia bridge on the main tarmac road.

2.2. Location:

Lat. 30° 14' S and Long. 27° 52' E. The altitude is 1524 m.a.m.s.l.

2.3. Characteristics:

Area = 614 km^2 ; Length of main channel = 45 km; Highest point within the basin = 2940 m.a.m.s.l.; and river channel slope = 3.1%.

The river basin is composed of the basalt (headwaters) underlain by the sandstone at approximately 40% and 60% respectively in area.

2.4. Equipment:

(a) Recorder: Leupold & Stevens type A.35 and spring driven, model 71 and serial no.105384-82

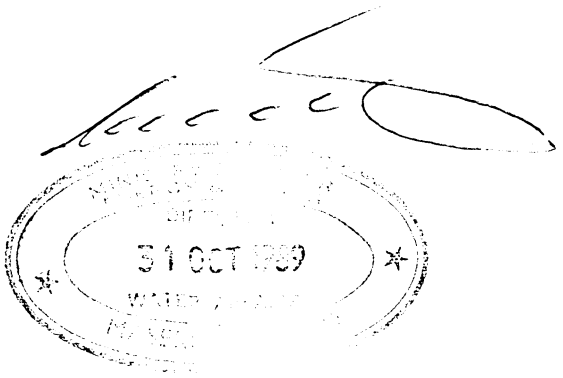
2.5. Control:

A fairly stable natural control of rock boulders about 20-30 m downstream. For high flows the channel itself acts as control

2.6. River reach:

The station has a fairly straight approach channel reach for a distance of some 200 m with a bed material composition of mainly sand - gravel grain size. For the reach downstream see 2.5 above.

The right bank is rather heavily vegetated with mainly big trees and banks are not very steep. The left bank is less vegetated while it is well defined with height of about 2 m before reaching the small floodpain on which the road runs. There are several gauging stations available for wading, but not so succesful with high flow measuring. The road prohibits cableways installations within the river reach referred to above. However, possible sites above Mundia bridge exist although susceptible to backwater and flooding by the Senqu (Orange) river.



RIVER : QUTHING RIVER

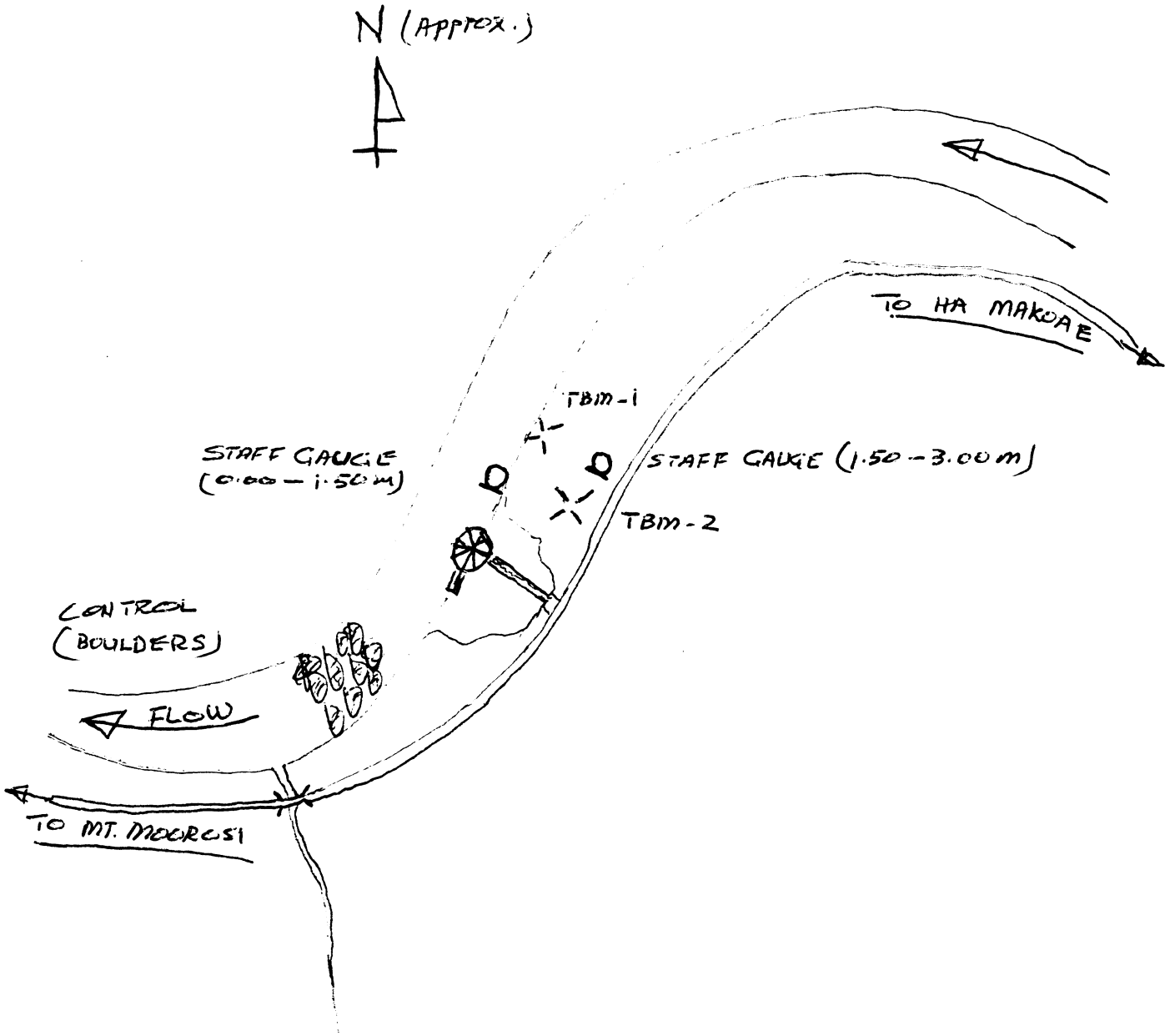
LOCALITY: NEAR MT MOOROSI (HA HOKO)

STN. NO : SG. 52

RECORDER NO : A-35 LEUPOLD & STEVENS SERIAL NO 105384-82
MODEL 71 SPRING DRIVEN

DATE INSTALLED : 27-9-1989 TIME: 11h25 BY: A.M. MOKEMANE

PARTY: F. MOSHECA, A.M. MOKEMANE & S. MAKHOALIBE



NOTE : SKETCH NOT TO SCALE

S. MAKHOALIBE

27/9/89

Department of Water Affairs
P.O. Box 772
MASERU 100
L E S O T H O
14/11/1989.
TELEX: 4431 or 4253

WEM/WA/A/1

Water Res. and Energy Adminstr
Boks 5091 Majorstua
N-0301 OSLO 3/Norwegen

Re: CURRENT METER

We have received the C31 universal current meter except 20 mm dia wading rods only.

We are highly appreciating your co-operation and assistance for developing the Hydrometric network in Lesotho.

I have enclosed a copy showing the equipment you sent.

Yours Faithfully

AZAEL M. MOKEMANE
Senior Technician.

A.OTT KEMPTEN

MESSTECHNIK HEEL

Heel GmbH & Co. Meßtechnik KG, Postfach 1745, D-8960 Kempten

Bistandskontoret,Norwegian
Water Res. and Energy Adminstr
Boks 5091 Majorstua

N-0301 Oslo3/NORWEGEN

Bestelldatum	AB-Datum	Bearbeiter	Vertreter	Ihr Kundencode	Auftragsnr.	Versandart	Datum
08.06.89	10.07.89	THOMA	Vetter	11318	89060302/15	Rechnung	09.10.89

L i e f e r s c h e i n Nr.: 89100042

Order No. 2383/VHO 89 LEP/MLO
Wir liefern auf der Basis unserer Verkaufs und Lieferbedingungen

We send today, by airfreight, CIF Maseru,Lesotho, through our agent
to: Ministry of Water, Energy & Mining
c/o Nordplan/Noremco
P.O.Box 7583
Maseru 100, Lesotho

1 Carton: OTT 89060302

Ident#	Bezeichnung	Bestellt Stück	Rückstand Stück	Geliefert (Heute)
60 053	Grundgerät Universalflügel C31 10.001.001.3.6 Universal current meter C31 Instr.Nr. 104818	1.00	1.00	0.00
21 235	Flügelschaufel Ms No.1-105064 10.001.027.4.2 Metal propeller No. 1 125 mm dia	1.00	1.00	0.00
21 409	Richtzeiger f. Flügelstange 20x2 16.000.025.4.2 Direction pointer for the rod	1.00	1.00	0.00
22 138	Kabel-DO v.Zählgerät z.C31 4m lang 17.150.035.4.2 Cable 111/110 4m long	1.00	1.00	0.00
60 006	Zählgerät Z30 12.010.001.2.0 Counter set Z30 with	1.00	1.00	0.00
52 207	Mignonzelle 1.5V 96.300.004.9.5 Baby cells 1.5 V	4.00	4.00	0.00

A.OTT KEMPTEN

MESSTECHNIK HEEL

Heel GmbH & Co. Meßtechnik KG, Postfach 17 45, D-8960 Kempten

Kunde: Bistandskontoret,Norwegian Auftragsnr.: 89060302 SEITE : 2

Artikel#	Bezeichnung	Bestellt Stück	Rückstand Stück	Geliefert (Heute)
21 361	Gerätekasten f. Stangenflügel 17.601.001.2.2 Instrument case	1.00	1.00	0.00
168	Prüfung Bargo an Stange 20 mm Calibration BARGO	1.00	1.00	0.00
21 362	Stange 3teilig, ø 20mm, 3m 16.000.128.9.7 Rod 20 mm dia, 3 m long, 3 sections	1.00	1.00	0.00
80 486	Bedienungsanleitung C31 10.001.001B.E.	1.00	1.00	0.00

Payment, please, let us have immediately
after receipt of invoice
net cash.

Wir bedanken uns für Ihren Auftrag.

A.OTT KEMPTEN

MESSTECHNIK HEEL

HYDRAULIC LABORATORY

Certificate of Calibration

for OTT Current Meter No. 104818 type C31 "10.001"

Method of calibration: BARGO

Type of support: 20 mm dia. rod

If ***n*** denotes the number of revolutions of the propeller per second and **v** the water velocity in metres per second, we have

Propeller diameter 125 mm, pitch 0.250 m, No. 1-105064

if $n <$ 0.71 **v** = 0.2488 n + 0.011

if $n \gtrless$ **v** =

if $n >$ 0.71 **v** = 0.2572 n + 0.005

Propeller diameter ____ mm, pitch ____ m, No. ____

if $n <$ ____ **v** = ____

if $n \gtrless$ **v** = ____

if $n >$ ____ **v** = ____

Propeller diameter ____ mm, pitch ____ m, No. ____

if $n <$ ____ **v** = ____

if $n \gtrless$ **v** = ____

if $n >$ ____ **v** = ____

Kempten, 06.10.1989 ✓

Heel GmbH & Co. Meßtechnik KG
Jägerstraße 4 – 12, D-8960 Kempten

Signature

p. t. o.