COMPUTERISATION OF WATER RESOURCES DEVELOPMENT ON WATER DISCHARGE MEASUREMENT

A CASE STUDY OF NIGER STATE WATER BOARD MINNA

BY

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CERTIFICATION

This is to certify that this project is an orginal work undertaken by me and has not been presented anywhere else for the award of any certificate.

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EXTERNAL EXAMINER

DEDICATION

This project in whole is heartily dedicated to the "ALMIGHTY GOD" for his endless mercies, never ending love, faithfulness over my life and his sustenance throughout my academic achievement in life.

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ABSTRACT

The project focuses on a general overview of water resources development and computer based water discharge measurement for Niger State Water Board, Minna, Niger State.

TABLE OF CONTENTS

INTRODUCTION TO DEVELOPMENT OF WATER RESOURCES

1.1 General background

Hydrology is the science which deals with the occurrence and
distribution of waters of the earths Reports of observed river
tage, rainfall, snow cover, temperature, etc, must be assembled
nd distributed by rapid communications to provide forecasts for
ter management. Development of forecasting procedures and
sign of hydraulic structures requires that the same data be
adily available for long periods of time. To meet these needs
e data should be processed and published on a routine basis.

The various types of hydrological and meteorological data
ing upon water management must be patterned to meet
equirements of forecasting and design. Discharge and water
vel data are hydrological in nature and are basic to the
lution of most design a operation problems. Water-levels in
kes and reservoirs are ndicative of the volumes of water in
orage - a basic factor the water budget synoptic reports of
age and/or discharge required in the preparation of river
recasts.

Rainfall, snowf and snow cover observations are
dispensable to wat source development and management such
ta are used to r available stream flow records, and
noptic reports o factors are used on the preparation of
ver and water-s forecasts.

Records of flow, precipitation, water quality and
her hydrologi meteorological factors are necessarily
mmarized and eted so that they can be used to evaluate
he available sources or flood or drought hazards. These

results, when published, become the basis for consideration of hydrological assets and deficits and for planning water resource development.

Hydrological forecasts serve a multitude of purposes by providing an improved basis for operational decisions. Thus, a farmer will plant less acreage if a seasonal shortage of irrigation water is expected; and prediction of a serious flood will signal a host of actions-evacuation of areas of potential inundation, elevation of moveable property, sandbagging of leaves, closing of flood gates, operation of flood-control dams, rerouting of rail and highway traffic etc. Shortrange prediction of lake levels, river levels and stream discharge undoubtedly constitutes the most important type of hydrological forecasting, with increased emphasis on multiple projects and regional development of water resources.

Studies pertaining to the detailed design of specific water resource projects involve economic and engineering considerations as well as those of a hydrological nature.

In countries having a research organisation with broad responsibilities in the earth and environmental sciences, other agencies are normally authorized to conduct research pertaining to their service responsibilities. Thus the water boards are usually responsible for research pertaining to the preparation and discemination of forecasts and warnings and the collection, interpretation, and publication of hydrological and meteorological data.

Like the other agencies of government, normal growth and

efficient operation of hydrological and meteorological services require that there be sufficient well trained personnel for the purpose.

1.2 Water demand

Demands for water-related services depend on the nature of the uses. For example, municipal and industrial demands tend to be fairly uniform throughout the year, whereas irrigation demands are very high during the growing season and usually negligible during the dormant season; demand for water based recreation is concentrated into the summer season, etc. The magnitude and time distribution of demands vary for different climatic zones as well as for different water management practices.

1.3 ESTIMATION OF WATER DEMANDS

1.3.1 PRELIMINARY ESTIMATES

Estimates of water requirements for preliminary planning purposes may sometimes be made on the basis of the experience at similar existing projects in the same general area. However estimates for final planning must be made on the basis of detailed studies of the presents and possible future requirements for each purpose.

1.3.2 PRE PROJECT REQUIREMENT

Demands existing prior to the construction of a project should be considered in the hydrological design of the project. Failure to consider these demands may cause economic losses and social as well as legal problems in the operation of a project.

1.3.3 NAVIGATION

Navigation demands are usually for regulation of flow to

maintain the minimum required water depth and the velocity below as safe maximum and for water volumes needed for passage through locks. In some cases navigation depth requirements have to met partially our entirely by channel dredging.

1.3.4 IRRIGATION

The quantity of irrigation water required to produce a crop depend on a number of factors such as the natural rainfall and other climatic conditions, type of crop, length of growing seasons method and scheduling of irrigation soil properties, etc. Several methods for estimating crop water requirements are in use in different in different countries, but they are usually suitable only for the conditions under which each was developed. Guidelines on this subject are available from the Food and Agriculture Organisation (FAO). The recent striving for efficient utilisation of irrigation water has led to a search for more efficient agricultural methods involving reduction of water demands and return flows, better water quality and reduction of monetary expenditures on irrigation while maintaining, or even increasing the level of crop production.

1.3.5 WATER POWER GENERATION

Power is generated at a rate which depends directly on the product of the discharge and a differential head of water. Hence water demand depends on the required power output and the available head. Power plants attached to large reservoirs can use the available supplies more efficiently than run-of-river plants since they can store surplus water in the reservoir which cannot only conserve water not needed immediately but also

creates the head and thus reduces the discharge required. Run-of river power plants can utilize only the discharge available at any specific time up to full turbine capacity.

1.3.6 FLOOD CONTROL

Flood control is not a water use but generally a demand for a more uniform time distribution of stream flow. This can be partly achieved by various land-use management practices such as afforestation of the basin, contour ploughing etc, but one of the most common means is the reduction of flood peaks by storing the excess water in reservoirs.

1.3.7 MUNICIPAL WATER SUPPLY

Water supply for municipalities is closely interrelated with problems of water quality. Quantitative municipal demand has usually little variation from season to season. However, a unique feature of this demand as the extremely high degree of dependability required owing to the potentially catastrophic consequences of shortages (epidemics, social disruption; etc).

1.3.8 POLLUTION ABATEMENT

Water quality in many rivers is less than desirable due to high concentration of pollutants. The situation is usually aggravated during dry periods when the ratio of effluent discharges to streamflow increases. Therefore, pollution abatement often requires low-flow augmentation of prevent the pollutants from exceeding a preset maximum revel of concentration occasional flushing-out of pollutants by surges of high flows from reservoirs is often desirable.

1.3.9 INDUSTRIAL USE

There are many rivers in the world where a specific flow regime is desirable because of science and recreational purposes, historical interest, religious activity or other intangible uses. Changes in flow regime in these rivers may provoke strong objections and must be planned and executed, carefully.

The recreational demand usually requires the water to have a reasonable quality, fairly constant level, constant low velocities and minor wave activity. Sudden changes in water level can be highly objectionable.

1.3.10 FISH AND WILDLIFE CONSERVATION

In considering fish and wildlife demands for water, it should be borne in mend that a change in regime may cause a change in the ecology of various species of fauna and flora. Evaluation of these changes is complicated and experts should be consulted whenever a change in the natural flow regime be is contemplated in order to mitigate adverse effects and strengthen the positive ones in the development of a project.

1.3.11 RECHARGE OF GROUNDWATER

In regions of high utilization of groundwater, surface water may serve as a source for groundwater recharge. This recharge is made through seepage from channels, reservoirs and recharge ponds or by injection of surface water into wells.

1.4 Purposes to be served by a water management project

In the usual scheme of development for a river basin, all flow which can be suitably regulated is utilized, purposes to be served by a project usually include a number of the following:-

a) Navigation;

b) Irrigation;

c) Power generation;

d) Flood control;

e) Municipal water supply;

f) Pollution abatement;

g) Industrial use;

h) Recreation, aesthetics and tradition;

i) Salinity and sediment control;

j) Fish and wildlife conservation;

k) Recharge of groundwater;

It is the objective of water resources management to seek an optimal balance between water supplies and demands by quantifying, to the extent possible, the consequences of trade offs between the conflicting tendencies on the basis of cost benefit studies and other considerations.

Estimation of available surface water supplies

A surface water suppply study involves an evaluation of the following basic factors:-

a) General quantitative characteristics of runoff, usually represented by the basic statistics of annual runoff such as the mean, variance, skewness and serial correlation.

b) Spatial variation of runoff, often represented by maps of average annual runoff.

c) Temporal variation of runoff within the year, usually represented by mean seasonal, monthly or daily flows.

d) Occurrences of low and high flows, usually

characterised by exceedence probabilities of events of different magnitudes.

1.5 Suitability of available records

Estimates of streamflow are based on stream ganging records obtained at or near the site of the proposed project or at a site on a nearby stream. These records are supplemented where necessary by synthetic streamflow data generated by correlations between streamflow and precipitations or by a regional analysis of streamflow.

1.6 Synthesis of water discharge data

Design and operation studies for water resources projects and systems rely on hydrological information derived from the historical records. Unfortunately, these records are often fragmentary, non-homogenous too short and sometimes they may not exist at all. For certain purposes, even a relatively long historic record is not sufficient its raw form and analytical methods must be used to extract from it the needed information.

Certain water discharge data can sometimes be derived or estimated for periods for which records of data for some other hydrological parameters exist. Two typical examples are the so called "filling in" of missing data and an "extension" of a hydrological record. This type of synthesis employs regression models and deterministic models. Another type of synthesis does not increase information on the given hydrological phenomenon but merely tries to make better use contained in the available data for planning and design purposes.

Where no stream flow records are available at the

development site, the required discharge data must be estimated from records obtained at gauging stations in the vicinity. If discharge records have been obtained at a nearby station on the same stream the required data can usually be estimated by assuming
that the runoff per unit area at the site is the same as that at the gauging station.

Regression methods

Regression of different kinds can be used for extending or estimating missing data in a streamflow record, for example a simple regression between data of two streamflow stations on the same stream or on two different streams; regression between the streamflow data and water level data of one station, or areally averaged precipitation for the whole basin above the flow measuring station where possible, linear regression is used or else the data are first linearized by suitable (e.g logarithmic, cube root, etc) transformations.

1.7 Water Discharge Measurements

River discharge is the rate at which water flows through a cross section, and is expressed as volume per unit time. Discharge at given time can be measured by several different methods and the choice of methods depends on the conditions encountered at a particular site. Most of these methods are based on the measurement of velocity and area in cross-section.

Continuous measurements of discharge are not yet feasible, so periodic measurements are made to determine the relation between stage and discharge at the stream gauging station. This relation could be used with a continuous record of stage to

develop a continuous record of discharge.

1.8 Measurement of Discharge by the velocity-area Method

For the purpose of this project work, we shall limit ourselves to the velocity-area method of measuring discharge which is the method being used by the Niger State Water Board to monitor the discharge from the rivers that falls under them.

Measurement of discharge by the velocity-area method is explained by the figure below.

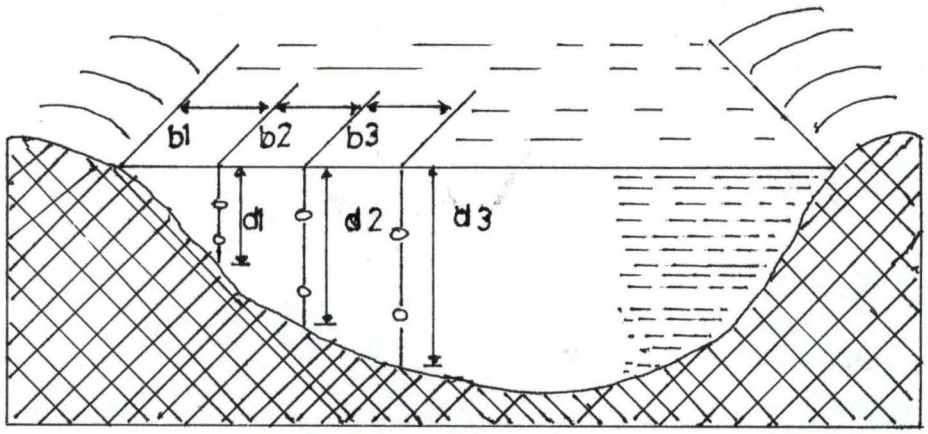


Fig. 1.6.1 View of a stream cross-section showing location of points of observation.

The depth of flow in the cross section is measured at verticals with a rod or sounding line. As the depth is measured, observations of velocity are obtained with the current meter at one or more points in the vertical. The measured widths, depths, and velocities permit computation of discharge for each segment of the cross section. The summation of these segment discharges is the total discharge.

1.9. Measurement of Cross Section

1.9.1 Measurement of width

Channel width and the distance between verticals should be

obtained by measuring from a fixed reference point (usually an initial point on the banked, which should be the same plane as the cross section. Normally, the distance between verticals is determined from a beaded wire temporarily stretched across the stream or from semi permanent marks painted on a bridge hand-rail or a suspension cable.

1.9.2 Measurement of depth

Depth are read directly on a graduated rod set on the stream bed if measurement is by wading. If the drum-wire weight system is used for measurement, meter and weight are lowered until the bottom of the weight just touches the water surface, and the depth dial reading is set at zero; the weight is there lowered until it rests on the stream bed, and the depth is read on the dial.

1.9.3 Measurement of Velocity

Velocity of flow at a point is usually measured by counting revolutions of a current meter rotor during a short time period measured with a stop watch velocity is observed at one or more points in the vertical, at each vertical by counting revolutions of the rotor during a period of not less than 60 seconds.

1.9.4 Determination of mean velocity in a vertical

The reduced (Two-point) method is used in determining the mean velocity. Velocity observations should be made at each vertical by exposing the current meter at 0.2 and 0.8 of the depth below the surface.

1.9.5 Computation of Discharge

Discharge many be computed either arithmetically (mid-section or mean section method) or graphically we shall limit

ourselves to the arithmetical methods.

a) Mean section method

The cross section (figure 1.1) is regarded as being made up of a number of panels, each bounded by two adjacent verticals. If V, is the mean velocity at the one vertical and V the mean velocity at the adjacent vertical, and if d and d are the total depths measured at verticals 1 and 2 respectively, and b is the horizontal distance between verticals, the discharge of the panel is taken to be:

$$q = * v + v * d1 + d2 \quad b. \qquad (1.7.1)$$

This is repeated for each panel and the total discharge obtained by adding the discharge from each panel.

b) Mid-section method

The discharge in each panel should be computed by multiplying vd by the corresponding width measured along the water surface line. This width is taken to be the sum of half the distances to adjacent verticals. The value of vd in the two half widths next to the banks can be estimated. Referring to figure 1.1 the total discharge Q is computed at:

$$Q = V1 \times d1 \times \frac{b1+b2}{2} + V2xd2 \times \frac{b2+b3}{2} + \ldots\ldots \qquad (1.7.2)$$

The computer allows the entry of the measured data and carries out all these computations automatically.

CHAPTER TWO

WATER RESOURCES DATA ANALYSIS

2.1 INTRODUCTION

Data hold the key to the orderly and efficient development and control of water resources.

a) STREAM FLOW DATA ANALYSIS

A continuous record of flow at gauging station is computed from a record of stage heights. This computed record is further analyzed to provide tabulations of the mean discharge for each day, month and annual period.

In addition the tabulation should include a list of the momentary peak discharges.

b) TYPES OF DATA COLLECTED.

The types of data collected include:

i. gauge heights

ii. Velocity of flow

iii. Width of the river

iv. Depth of the river.

The discharge (Q) can be computed using this sets of data.

2.2 DISCHARGE MEASUREMENT NOTES

The discharge measurement notes comprises of two pages.

a) Page one is used in taking the initial readings on the site. (Sometimes called field notes), and it contain such informations as:

i. Angle coefficient

ii. Distance from initial point

iii. Width.

iv. Depth.

v. Observation depth.

vi. Revolutions

vii. Time in seconds.

viii. Velocity (a) at point (b) mean in vertical.

ix. Adjusted for horizontal angle.

x. Area

xi. Discharge.

b) Page two is used for presenting the initial output of data computed from page one. Such informations include:

i. Width

ii. Area

iii. Velocity

iv. Gauge Height G.H.

v. Discharge.

vi. Date

vii. Number of sections.

viii. Name of river.

c) FORM DESIGN

A format of the discharge measurement notes is shown below:

PAGE 2

MINISTRY OF WORKS AND WATER RESOURCES

WATER RESOURCES DIVISION

DISCHARGE MEASUREMENT NOTES

NAME OR RIVER.....

DATE.....19.....Party.....

Width.....Area.....Vel.....G.H.....Disch.....

Method.....No.secs.....G.H.change.....Susp.....

PAGE 1

2.3 DISCHARGE CALCULATION

DATE OF OPERATION: 01/04/96: GAUGE HEIGHT: 4.3m

	VELOCITY	WIDTH	DEPTH	DISCHARGE m3/sec
PANEL 1	0.32	2.0m	1.20m	0.77
PANEL 2	0.55	2.0m	1.20m	1.32
PANEL 3	0.99	2.0m	1.40m	1.98
PANEL 4	0.95	2.0m	1.60m	3.04
PANEL 5	0.95	2.0m	1.40m	2.66
			Total =	9.73m^3/sec

DISCHARGE, Q = Vbd.

FOR PANEL 1

q1 = v1b1d1

= 0.32x2.0x1.2 = 0.768m^3/sec

FOR PANEL 2

$q2 = V_2b_2d_2$

= 0/55x2.0x1.2 = 1.32m_3/s

FOR PANEL 3

$q3 = V_3b_3d_3$

= 0.99x2.0x1.4 = 1.98m^3/s

FOR PANEL 4

q4 = 0.95x2x1.6 = 3.04m^3/s

FOR PANEL 5

$q5 = 0.95x2.2x1.4 = 2.66m^3/s$

Total discharge Q - q1+q2+q3+q4+q5 =

0.77+1.32+1.98+3.04+2.66

$Q = 9.73m^3/s$

2.3.1 DISCHARGE CALCULATION EXPLAINED

1. The rate of flow (discharge) is calculated for each panel. The entire sections of the river is divided into paels in order to aid calculations. The formula for calculating the discharge is q + bx dxv

where q = the discharge in panel

b = breadth of panel

v = velocity of flow through the panel

The discharge is calculated for each of the panels.

2. The discharge q is summed together in order to the total discharge or the quantity of water flowing through the river ie Q = q1+q2+q3+q4q5+q6+....qn

where Q = Total or discharge sum

q1 = discharge in first panel

q2 = discharge in second panel

q3 = discharge in n (number) of panel

2.4 HISTORY OF NIGER STATE WATER BOARD

OBJECTIVES AND DUTIES OF THE BOARD

The Niger State water board was established by Edict No. 6 of 1976 which came into force on 1st day of Arpil, 1976. This edict charged the board with the following responsibilities.

a) To establish the control, manage and develop new water works and to control, manage and develop the existing water supply facilities for the purpose of providing water to meet the

industrial and domestic needs of the people of the state.

b) To conduct such researches as are necessary for the fulfilment of water management.

c) To ensure, that adequate and portable water is supplied to the consumers at reasonable charges.

2.5 ORGANISATION SET UP

The Niger State Water Board is governed by a board of governors consisting of one chairman and eleven members. The board is run by the General Manager as the Chief Executive and is assisted by the following divisional heads.

1. Assistant General Manager Personnel and Secretary in-charge of administration.

2. Assistant General Manager Operations and Maintenance - in-charge of the operation and maintenance of all the existing water works in the state, so as to keep the services running all the time and construction of minor works relating to Govt. and other organisations.

3. Assistant General Manager Planning Research and Statistics - In-charge of planning of future projects both minor and major with liaison consultants whenever necessary and construction of minor projects. Also in charge of collection and consolidation of information relating to the water resources of the state, both surface and ground.

4. Assistant General Manager Finance and Supply and Commercial - In charge of accounts, purchasing and store.

5. Internal Audit and Public Relation - Coming under General Manager's bureau.

The board has about 1200 staff strength of which about 500

are permanent in both Senior and junior cadres of various grades.

For quicker development in water supply venture in the State, Divisions and Area Offices were created under AG Operations and maintenance as seen in the organisation chart) and they are headed by an Area Manager.

a) PERSONNEL SECTION

The board has about 80% junior staffs (mostly different professions, but a good number of junior officers were employed as revenue collectors and Bill writers.

b) ACCOUNTS SECTION

The section consists of finance, finance, Revenue salary and wages units each headed by an officer.

c) INTERNAL AUDIT DEPARTMENT

The Audit department make very useful recommendations to the management which helped the board in conserving funds. This section checks the of activities of following:-

1. STOCK CHECKING
2. GENERAL LEDGER
3. STAFF LIST
4. PAYMENTS
5. STATEMENT OF ACCOUNTS
6. REVENUE
7. STORES

d) PUBLIC RELATIONS SECTION

The section inform the management of the board the happenings of the water operations in and outside the state through cuttings of newspaper reports, public opinion and public

comments. The section coordinates its activities with other departments such as the operations and maintenance, revenue, section etc, to enhance better results. Press releases were from time to time issued while press conferences highlighting progress achieved, problems and plans of the Board for more and better water supply to the public were made.

e) SERVICES SECTIONS

This section is responsible for water connections to Educational Institutions all over the state. It also executes some small works such as extension of water pipe networks especially in the new development areas in and around the state capital.

f) AREA OFFICES

The board had ten Area offices at Chanchaga, Kontagora, Bida, Suleja, Kagara, Lapai, Kutigi, Rijau and Zungeru. These offices are responsible to the operations and maintenance manager.

g) CENTRAL WATER DEPOT

This section is reponsible for maintenance of boreholes all over the state and the maintenance of Dams.

h) CHEMICAL SECTION

The chemical section is responsible for the supply of good quality water to its consumers. The following chemicals are used by the Board.

1. ALUM
2. SODA
3. T.C.L.
4. H.T.H.

5. HYDRATED LIME

6. T.C.L.

These chemicals are used in various quantities.

(i) HYDROLOGICAL SECTION

This section is responsible for the collection and analysis of hydrological data of the streams, rivers and reservoirs in the state. Niger State is being drained by two rivers, the river Kaduna and the gurara which both flow into River Niger some few kilometres away south of the State Capital.

The Board has 32 discharge measurement stations throughout the state. The periodic discharge measurements were carried out by the Board's observation team. There are 36 operational Gauging stations and 16 non-operational ones in the state. These stations are divided into 2 zones ie Minna and Bida. The Minna zone comprises of Minna, Kuta, Kagara, Kontagora, Rijau and Suleja while Bida zone comprises of Bida, Agaie and Lapai. The Board has 47 gauging stations all over the state.

2.6 HYDROLOGIC SITES.

The importance of hydrologic data collection at various sites manually or automatically within the state Rivers catchment areas for varying observational hydrological events towards ease in feasibility studies cannot be over emphasized.

The 47 hydrological sites in the state are outlined below.

S/No.	STREAM AND LOCATION		CATCHMENT AREA AND STATE STREAM.
1.	Bakogi	Agari	290.00 km_2 Perennial
2.	Bankogi	T/kawo	188.2 " Seasonal
3.	Bakogi RlyBrdy	Bakogi	7,424.00 Perennial
4.	Beri	Beri	181.86 " Seasonal
5.	C/chaga	Minna W/Ws.	1,114.00 " Perennial
6.	Ebba	Ebba Rly Brd	88.00 "
7.	Egbe	Egbe Ezhi	39.00 "
8.	Ekulaye	Zugurma	401.61 "
9.	Elu	Gulu	69.72 "
10.	Ejikopata	Edozhigi	2424 "
11.	Esse	Ekopata	6.53 Seasonal
12.	Emi	Mutun Dayi	24.53 "
13.	"	Loguma	181.86 Perennial
14.	Etswan	Lapai	22.73 "
15.	Gbako	Badeggi	5,480.00 Seasonal
16.	Gbette	Kpuki	0.94 "
17.	Gurara	Izon	7,649.00 Perennial
18.	Iku	Suleja	168.00 "
19.	"	Pai	1,392.68 "
20.	Jatau	T/Mallam	190.62 Seasonal
21.	Jibwa	Kuta	3072 "
22.	Kaduna	Gurmana	1,333.00 Perennial
23.	Kaduna	Wuya	59,182.50 "
24.	Kaduna	Gusoro	1,318.50 "
25.	Koriga	Magami	201.45 Seasonal
26.	"	Allawa	104.98 "
27.	Kulako	Bosso Dam	45.65 "
28.	Kuka	Kuta	111.37 "
29.	Kuroko	Zungeru	230.50 "
30.	Liyogi	Liyoji	272.79 "
31.	Mariga	Marigo	12,556.80 "

32.	Malendo	Makudo	651.00	"
33.	Mofogi	Magogi	4.74	Perennial
34.	Mussa	Chanchaga	14.19	Biennial
35.	Mera'a	Kafinkoro	5.68	Perennial
36.	R. Gora	K/chimarko	5.95	"
37.	Bobo	Kwaita	212.17	Seasonal
38.	S/Pawa	S/Pawa	670.02	Perennial
39.	Tagwayi	Tagwai Dam	53.04	Seasonal
40.	Tagwayi	Paiko	19.00	"
41.	Tekpa	Tekpagi	13.64	"
	Toro	Batati	40.92	Perennial
43.	Osma	Gwagwalada	287.95	"
44.	Usubu	Usubu	25.19	"
45.	Tanko	Takoman	58.88	"
46.	Yiko	Guzan	524.80	"
47.	Zhibi	Labozi	6.53	"

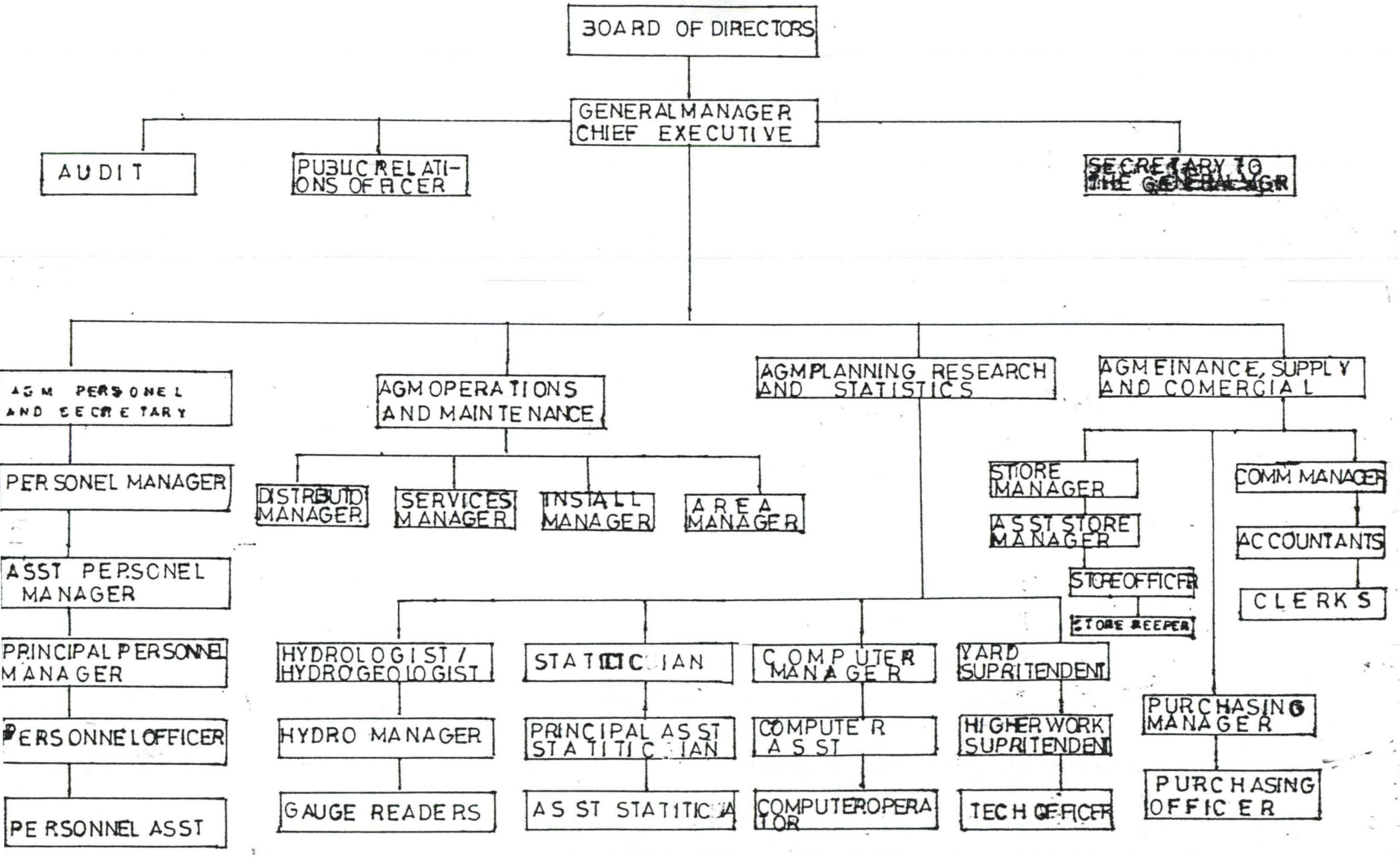

BOARD OF DIRECTORS
GENERAL MANAGER CHIEF EXECUTIVE
AUDIT
PUBLIC RELATIONS OFFICER
SECRETARY TO THE GENERAL MGR
AGM PERSONEL AND SECRETARY
AGM OPERATIONS AND MAINTENANCE
AGM PLANNING RESEARCH AND STATISTICS
AGM FINANCE, SUPPLY AND COMERCIAL
PERSONEL MANAGER
DISTRIBUTD MANAGER
SERVICES MANAGER
INSTALL MANAGER
AREA MANAGER
STORE MANAGER
ASST STORE MANAGER
STOREOFFICER
STORE KEEPER
COMM MANAGER
ACCOUNTANTS
CLERKS
ASST PERSONEL MANAGER
PRINCIPAL PERSONNEL MANAGER
PERSONNEL OFFICER
PERSONNEL ASST
HYDROLOGIST / HYDROGEOLOGIST
STATISTICIAN
COMPUTER MANAGER
YARD SUPRITENDENT
HYDRO MANAGER
PRINCIPAL ASST STATITICIAN
COMPUTER ASST
HIGHER WORK SUPRITENDENT
PURCHASING MANAGER
GAUGE READERS
ASST STATITICIAN
COMPUTER OPERATOR
TECH OFFICER
PURCHASING OFFICER

FIG 2.1

CHAPTER THREE

WATER DISCHARGE MEASUREMENT

3.1 SYSTEM DESIGN

The system design stage is based upon the findings obtained from the feasibility study conducted. In designing the new system, several criteria were considered. Major considerations was given to the requirements of the end user.

Apart from considering the end users requirements detailed specification such as flexibility, user friendliness, ease of maintenance and efficiency of the system were bourne in mind.

3.2 SYSTEM DESIGN LIFE CYCLE

The emphasis of system design is to develop a new system that helps to achieve the goals and objectives of the organisation and overcomes some of the short-comings and limitation of the existing system.

Every system consit of a number of inter-related components. In order for the system to function properly, these component must work in harmony.

Developing a detialed plan for a computer-based system include going through the following stages:-

PROBLEM DEFINITION

SYSTEM ANALYSIS

FUNCTIONAL DESIGN

TECHNICAL DESIGN

IMPLEMENTATION

TESTING

EVALUATION

PROBLEM DEFINITION: Here the exact problem is determined. Tools used include personnel interviews with the affected people a study of the existing system was made. The problem definition stage, points out the lapses involved in the existing system.

SYSTEM ANALYSIS: Here a number of possible solutions to the problem were made, with rough estimates of cost and benefit were developed.

FUNCTIONAL DESIGN: The furnished system is considered as whether it is going to be functional or not, inclusive technical design ensuring that the system design is feasible.

IMPLEMENTATION STAGE: The program is actually coded and

debugged. The analyst then spent time preparing operating procedure, security procedures, backups procedures and a solid test plan for the system.

TESTING: A test plan is made, the system is tested under realistic conditions.

EVALUATION: The system is evaluated, found to be reliable and useful.

3.3 INPUT OF DATA

In data input process the user works with a certain screen based image of a form. This has blanks in which data can be entered. It is for the user to enter data at any point on the form.

3.4 DATA BASE

The system is a complete data base system. A data base is a collection of data usually files, arranged in such a way that its is independent of an particular program or application. The arrangement eliminates data redundancy. Access to file is provided by a database management system.

A database management system is an organised collection of interrelated data and the set of programs to access that data. The aim of a database management system is to create an environment that is efficient and convenient for retrieving information from stored database.

3.4.1 OBJECTIVES OF DATABASE SYSTEM

1. To reduce data duplication, inconsistency and increase its shareability.
2. To reduce or eliminate data redundancy
3. To achieve data integration.

4. Provide a management view of the organisation.

5. Increase the speed in implementing system.

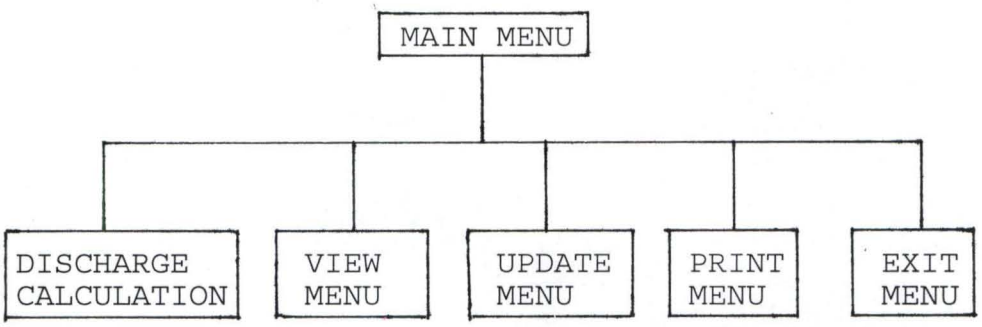
3.5 DATABASE FILE DESCRIPTION

One database file is in use, namely discharge database file (DISCH.DBF) Below is the data base structure of the file.

Table 3.1 DISCH.DBF.

FIELD NO.	FIELD DESCRIPTION	FIELD NAME	FIELD TYPE	WID.	DEC.
1.	WATER STATE	STAGE	NUMERIC	6	2
2.	DISCHARGE	DISCHARGE	"	6	2
3.	VELOCITY	VELOCITY	"	6	2
4.	DEPTH	DEPTH	"	6	2
5.	WIDTH	WIDTH	"	6	2
6.	NUMBER OF PANEL	NUMBER	"	2	-
7.	HYDRO YEAR	YEAR	MEMO	-	-
8.	DATE OF OPERATION	DATE	DATE	8	-
9.	NAME OF RIVER	RIVER	CHARACTER	15	-

3.6 MODULAR PROGRAM STRUCTURE OF THE NEW SYSTEM



3.7 ALGORITHM OF THE MODULAR PROGRAM

Algorithm is a finite set or sequence of instructions or operations for carrying out specific task or solving a specific problem. The algorithm used here is both the pseudocode and the flowcharts.

3.7.1 PSEUDOCODE OF THE MAIN PROGRAM

(Algorithm for the computerisation of water discharge measurement)

START.

DECLARE

VELOCITY, DEPTH, WIDTH, DISCHARGE, SUM: REAL -

NUMBER, K, INTEGER.

EXECUTE

DISPLAY MAIN MENU

SELECT OPTION

CASE OPTIONS "DISCAL"

```
     EXECUTE DISCAL MENU
END CASE
RETURN
CASE OPTION = "VIEW"
     EXECUTE VIEW MENU
END CASE
RETURN
CASE OPTION = "UPDATE"
     EXECUTE UPDATE MENU
END CASE
RETURN
CASE OPTION = "PRINT"
     EXECUTE PRINT MENU
END CASE
RETURN
CASE OPTION = "EXIT"
     EXECUTE EXIT MENU
END CASE
RETURN
(PSEUDOCODE FOR DISMAL PROGRAM)
OUTPUT          NAME OF RIVER:
INPUT           RIVER
OUTPUT          NUMBER OF PANEL:
INPUT           NUMBER:
OUTPUT          WATER STAGE:
INPUT           STAGE
OUTPUT          DATE OF OPERATION:
INPUT           DATE:
```

```
Sum         =     0
FOR K       =     I TO NUMBER
OUTPUT            VELOCITY OF FLOW:
INPUT             VELOCITY
OUTPUT            DEPTH OF STREAM:
INPUT             DEPTH
OUTPUT            WIDTH OF STREAM:
INPUT             WIDTH
DISCHARGE =       VELOCITY * DEPTH * WIDTH
SUM         =     SUM + DISCHARGE
OUTPUT            Sum
END FOR
     Sum    =     I DISCHAR.
     (PSEUDOCODE FOR VIEW PROGRAM
     CASE OPTION = "DISPLAY"
     DISPLAY RIVER, DATE, DISCHARGE, STAGE
END CASE
RETURN.
CASE OPTION = "EDIT"
     DO ED FILE
     IF EOF (    )
          DEACTIVATE MENU
          RETURN
     ENDIF
     OUTPUT            NAME OF RIVER:
     INPUT             RIVER
     OUTPUT            DATE OF OPERATION:
     INPUT             DATE
```

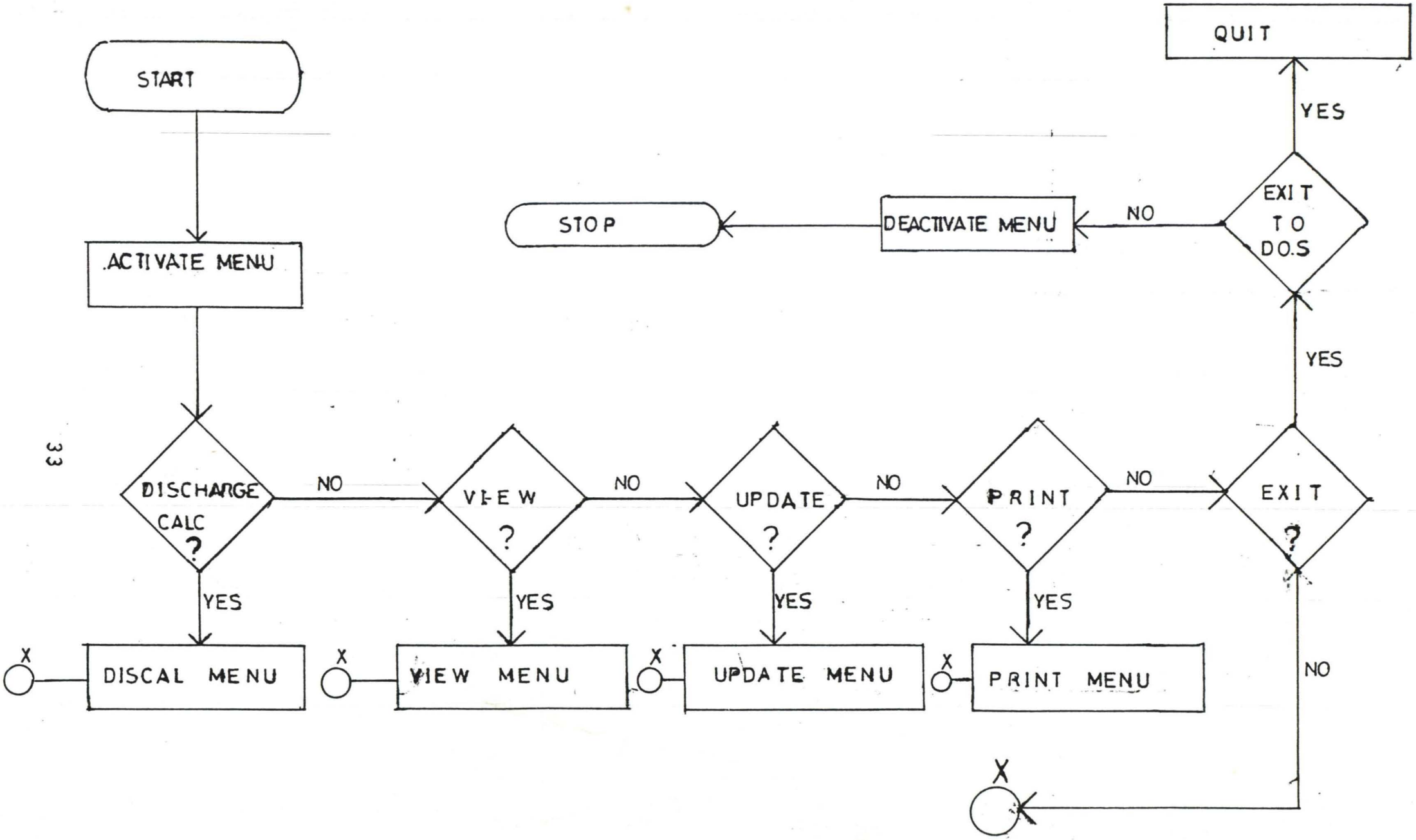
```
        OUTPUT          WATER STAGE
        INPUT           STAGE
        OUTPUT          DISCHARGE
        INPUT           DISCHARGE
        END DO
END CASE
RETURN
(PSEUDOCODE FOR ADD RECORD PROGRAM)
CASE OPTION = "ADD RECORD"
        APPEND BLANK
        OUTPUT          NAME OF RIVER:
        INPUT           RIVER
        OUTPUT          WATER STAGE:
        INPUT           STAGE
        OUTPUT          DISCHARGE:
        INPUT           DISCHARGE:
END CASE
RETURN
(PSEUDOCODE FOR DELETE RECORD PROGRAM)
CASE OPTION = "DELETE DISCHARGE".
        OUTPUT          NAME OF RIVER:
        INPUT           RIVER
        OUTPUT          DATE OF OPERATION:
        INPUT           DATE
        OUTPUT          WATER STAGE
        INPUT           STAGE
        OUTPUT          DISCHARGE
        INPUT           DISCHARGE
```

```
     OUTPUT          DELETE THIS RECORD?
     INPUT           CONFIRM
     IF CONFIRM = 'Y'
     DELETE
     PACK
END IF
DEACTIVATE MENU
END CASE
RETURN
(PSEUDOCODE FOR PRINT PROGRAM)
CASE OPTION = "PRINTINT PARTICULAR DATE"
     OUTPUT          DATE OF OPERATION:
     INPUT           DATE
     LOCATE FOR DATE
     DISPLAY RIVER, DISCHARGE, DATE, STATE
END CASE
RETURN
CASE OPTION = "PRINT ALL"
     DISPLAY RIVER, STAGE, DATE, DISCHARGE ALL
END CASE
RETURN
(PSEUDOCODE FOR EXIT PRGRAME)
CASE OPTION = "EXIT TO DOS"
END CASE
CASE OPTION = "EXIT"
     DEACTIVATE MENU
END CASE
RETURN
```

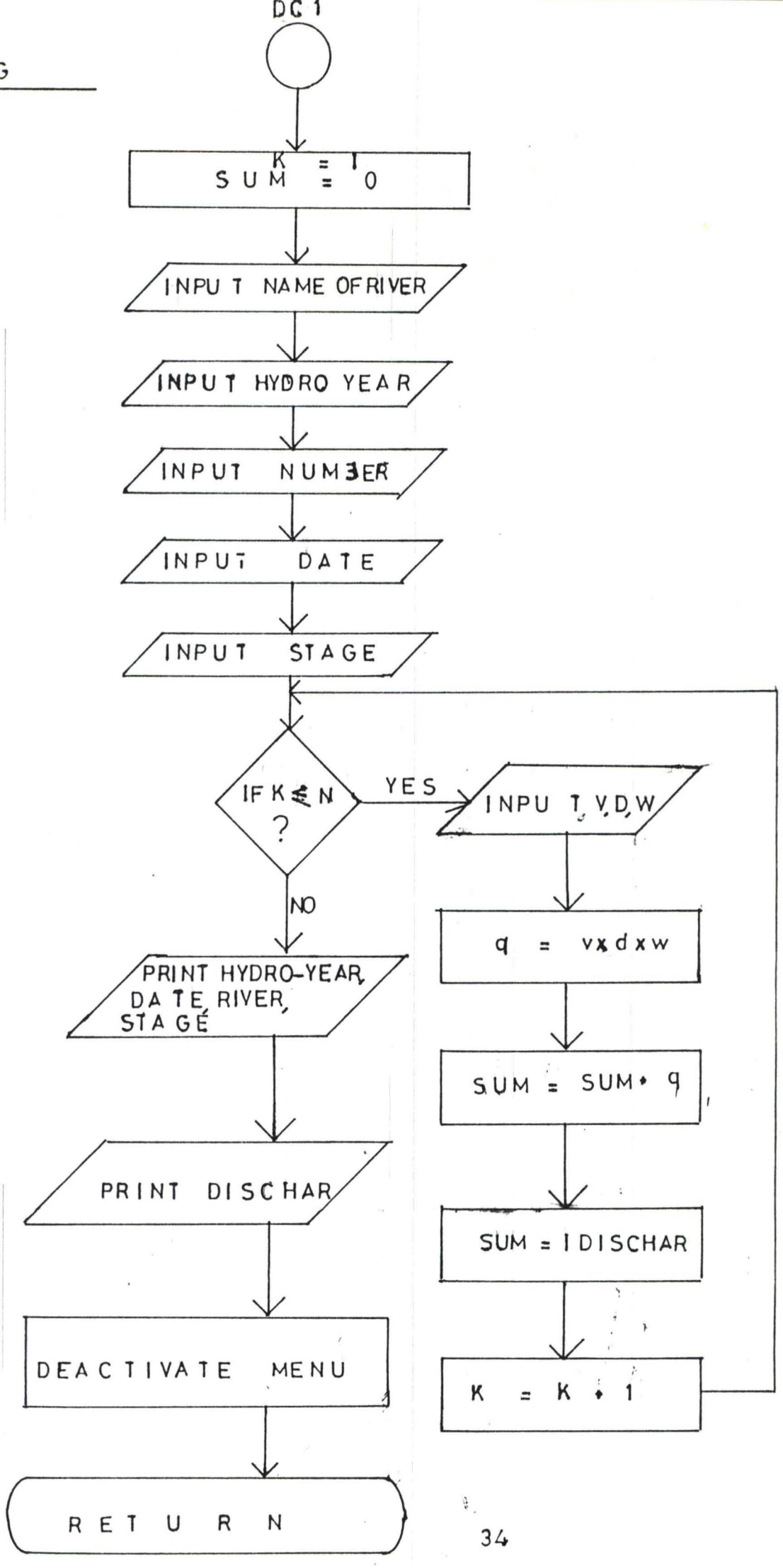
3.7.2 FLOW CHART

INTRODUCTION

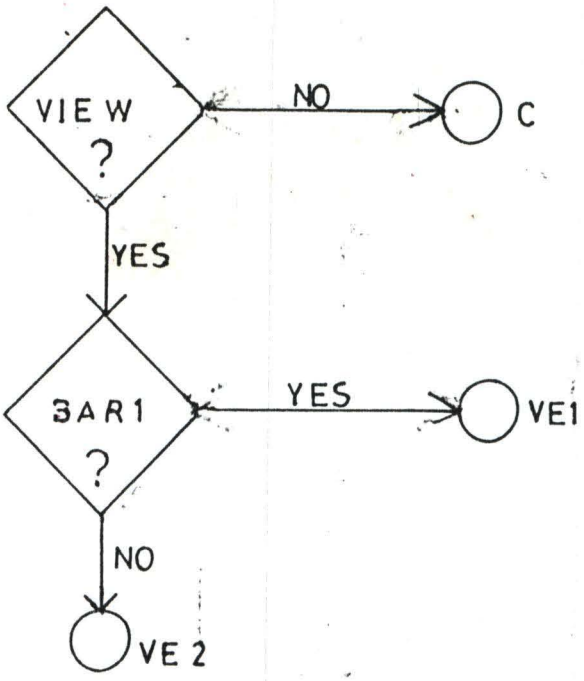
The flow chart shows the relationship between inputs, process and output according to discharge menu. It makes and also gives a clear insignt of the discharge menus and subminus of the modular structure program. Below is the entire body of the program.


START
ACTIVATE MENU
DISCHARGE CALC ?
NO
VIEW ?
NO
UPDATE ?
NO
PRINT ?
NO
EXIT ?
YES
YES
YES
YES
NO
X
DISCAL MENU
X
VIEW MENU
X
UPDATE MENU
X
PRINT MENU
X
EXIT TO DOS
NO
YES
DEACTIVATE MENU
STOP
QUIT

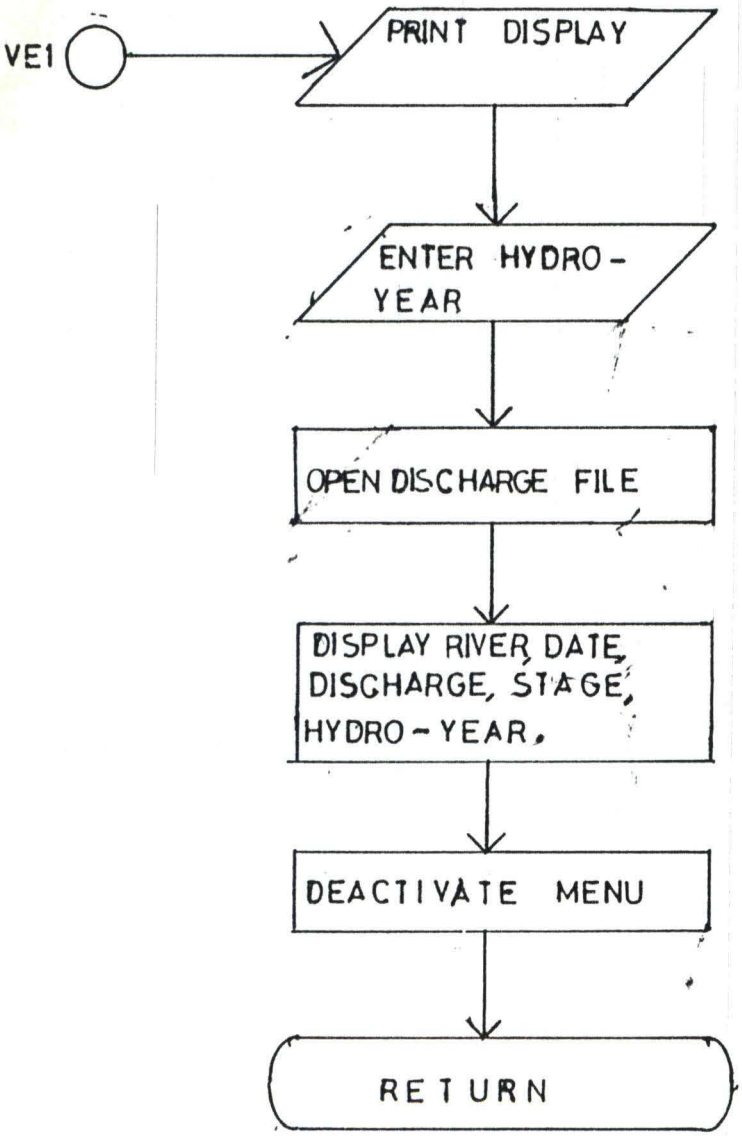
DIS CAL . PRG


DC1
K = 1
SUM = 0
INPUT NAME OFRIVER
INPUT HYDRO YEAR
INPUT NUMBER
INPUT DATE
INPUT STAGE
IF K ≤ N ?
YES
INPUT V,D,W
NO
q = v x d x w
SUM = SUM + q
K = K + 1
PRINT HYDRO-YEAR, DATE, RIVER, STAGE
PRINT DISCHAR
SUM = I DISCHAR
DEACTIVATE MENU
RETURN

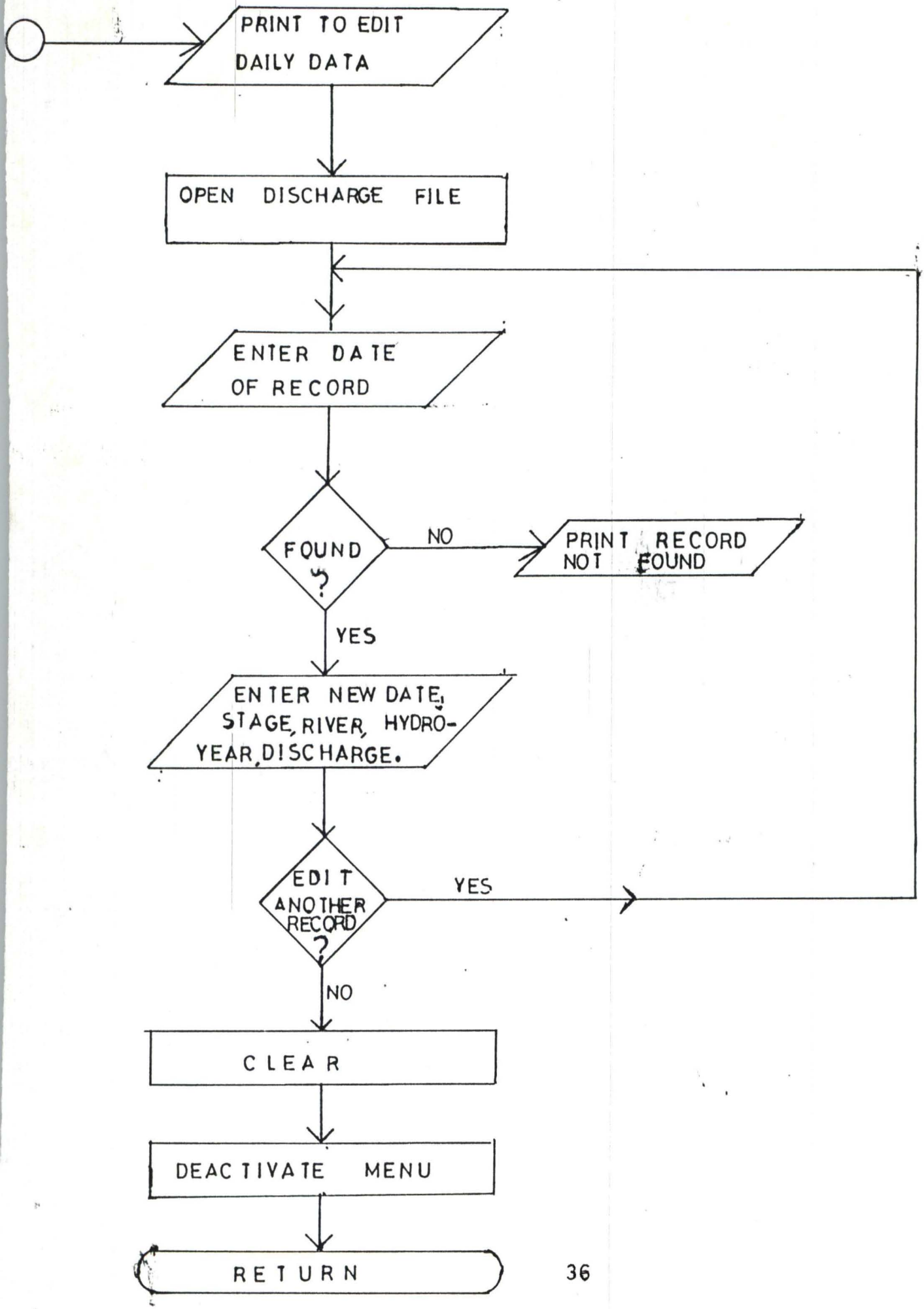
VIEW PROCE DURE



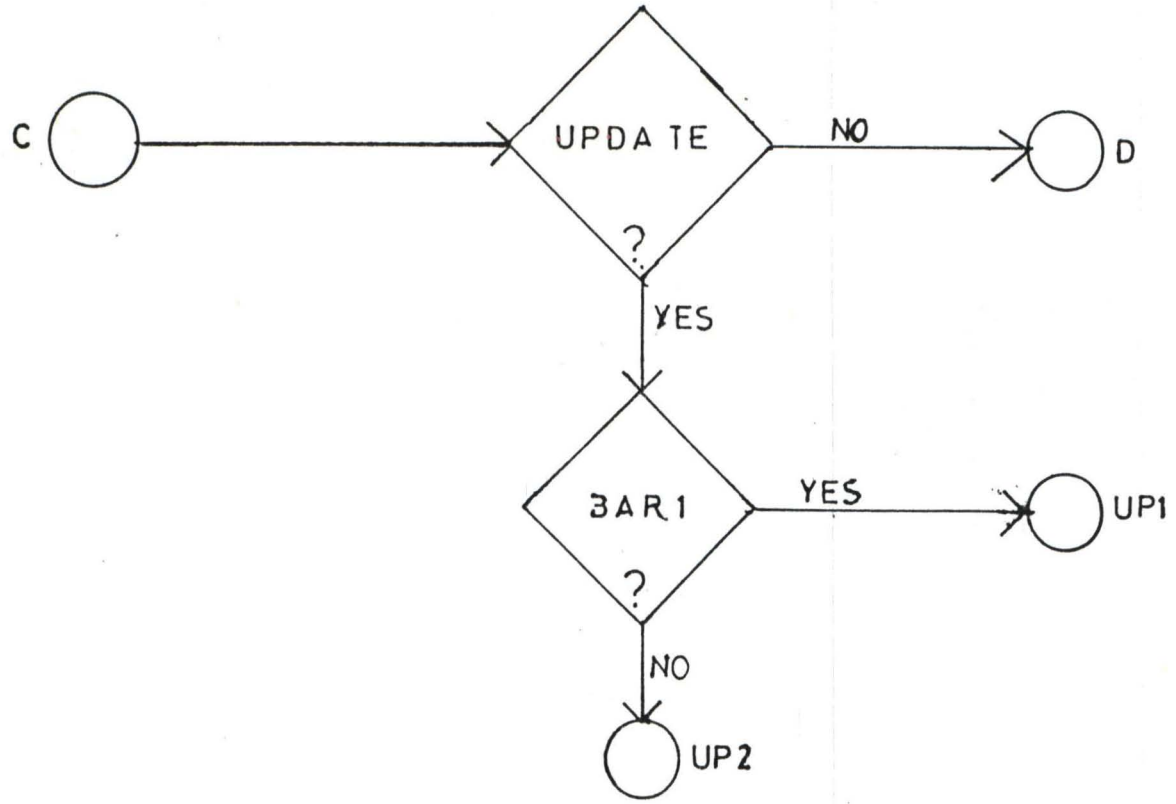
MVIEW. PRG



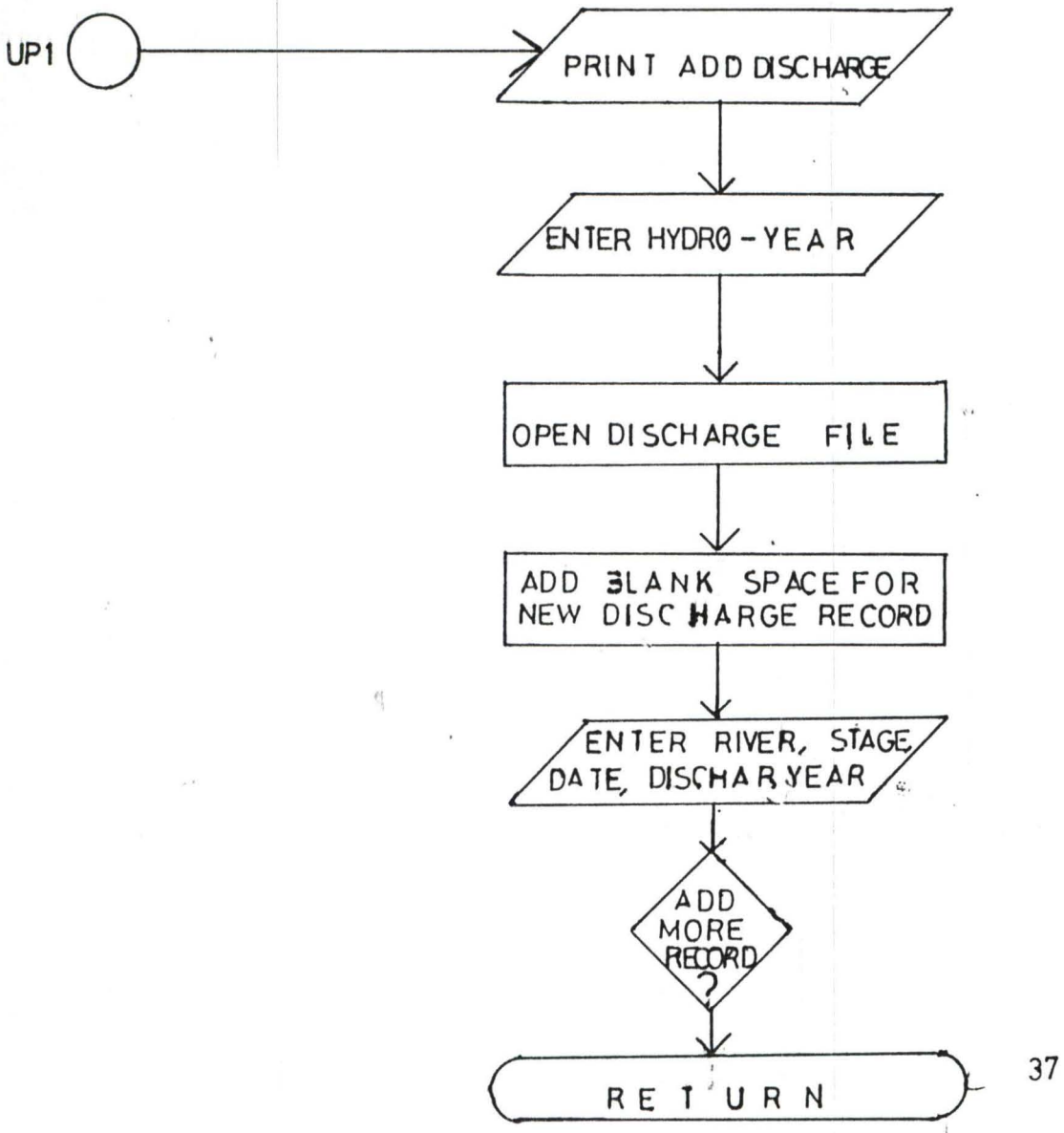
MEDIT. PRG


PRINT TO EDIT DAILY DATA
OPEN DISCHARGE FILE
ENTER DATE OF RECORD
FOUND ?
NO
PRINT RECORD NOT FOUND
YES
ENTER NEW DATE, STAGE, RIVER, HYDRO-YEAR, DISCHARGE.
EDIT ANOTHER RECORD ?
YES
NO
CLEAR
DEACTIVATE MENU
RETURN

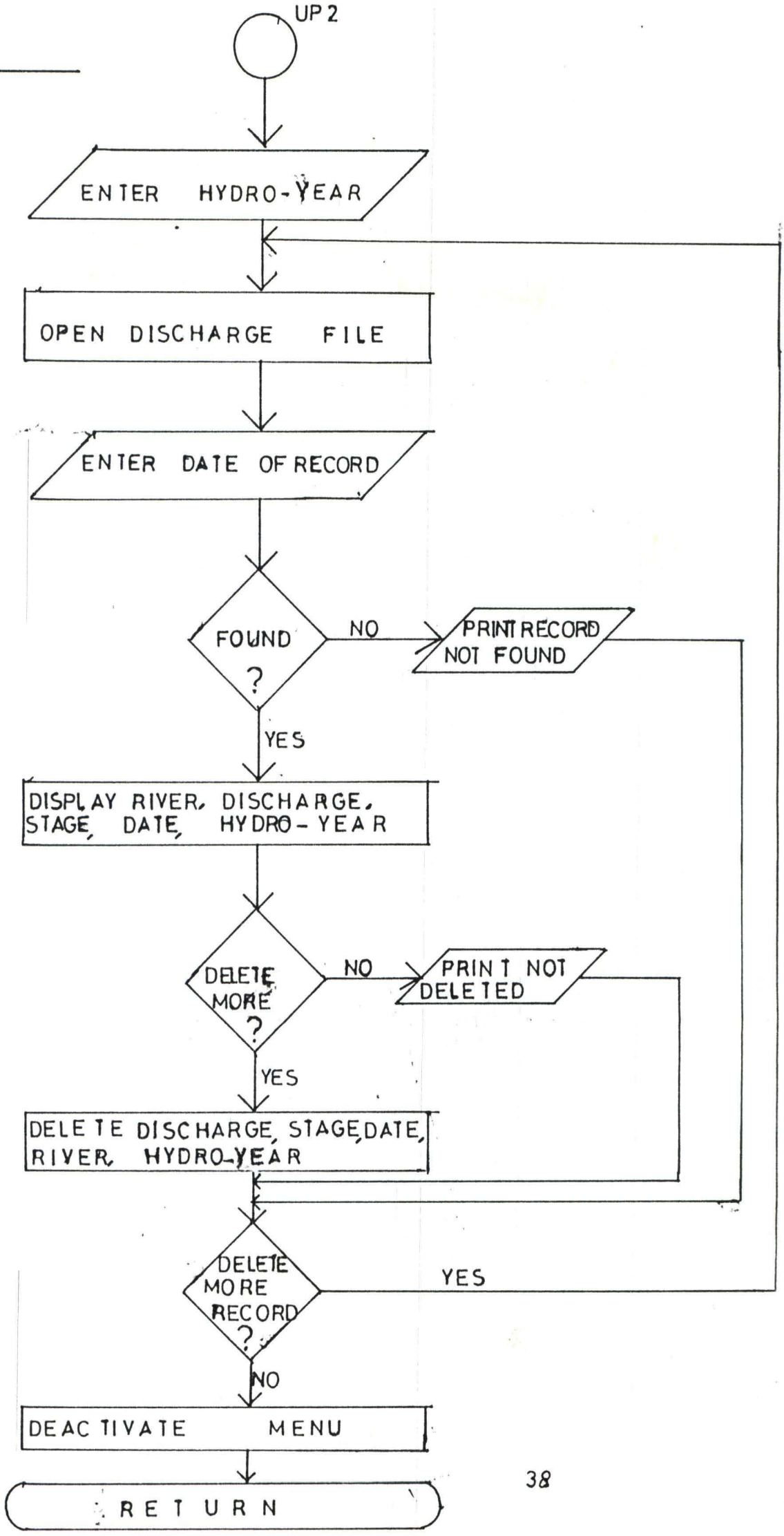
UPDATE PROCEDURE



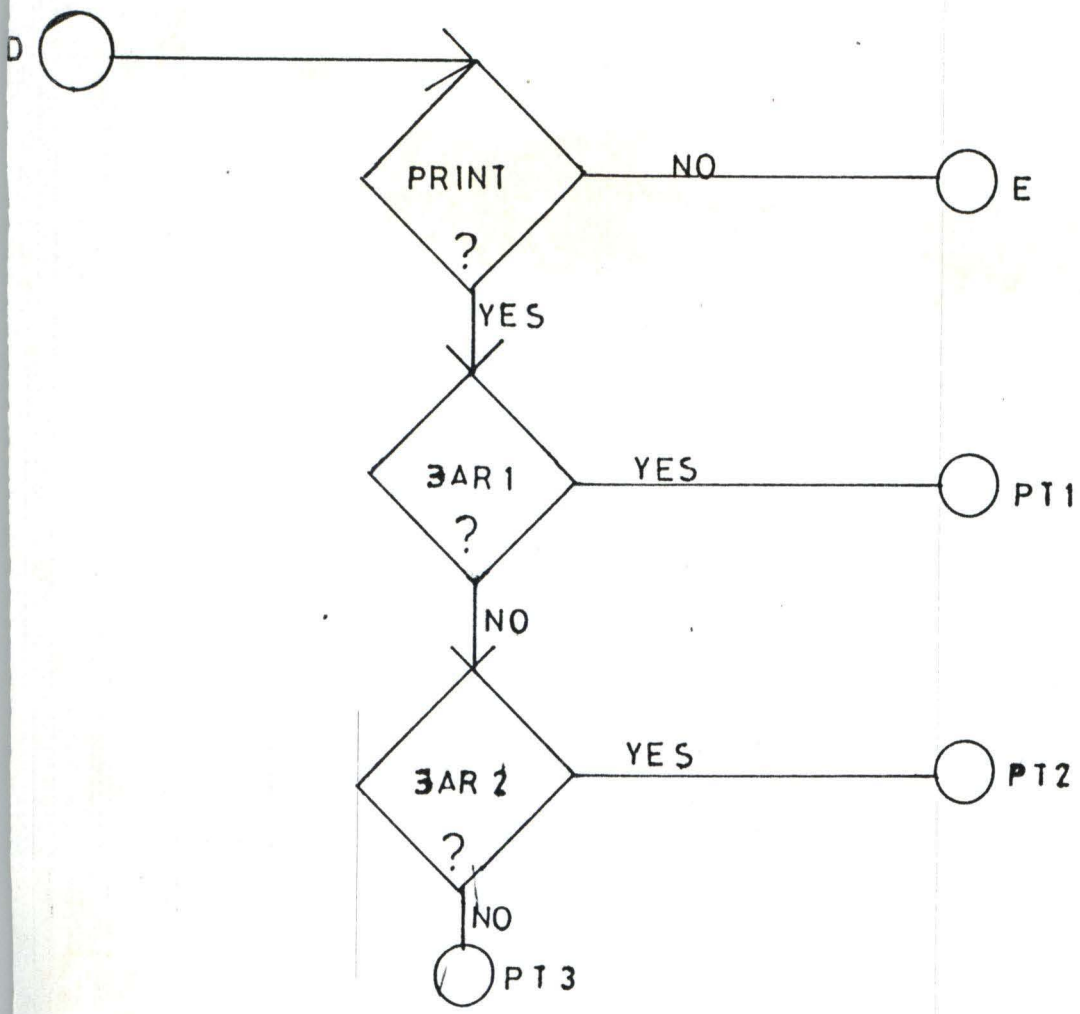
MADD.PRG



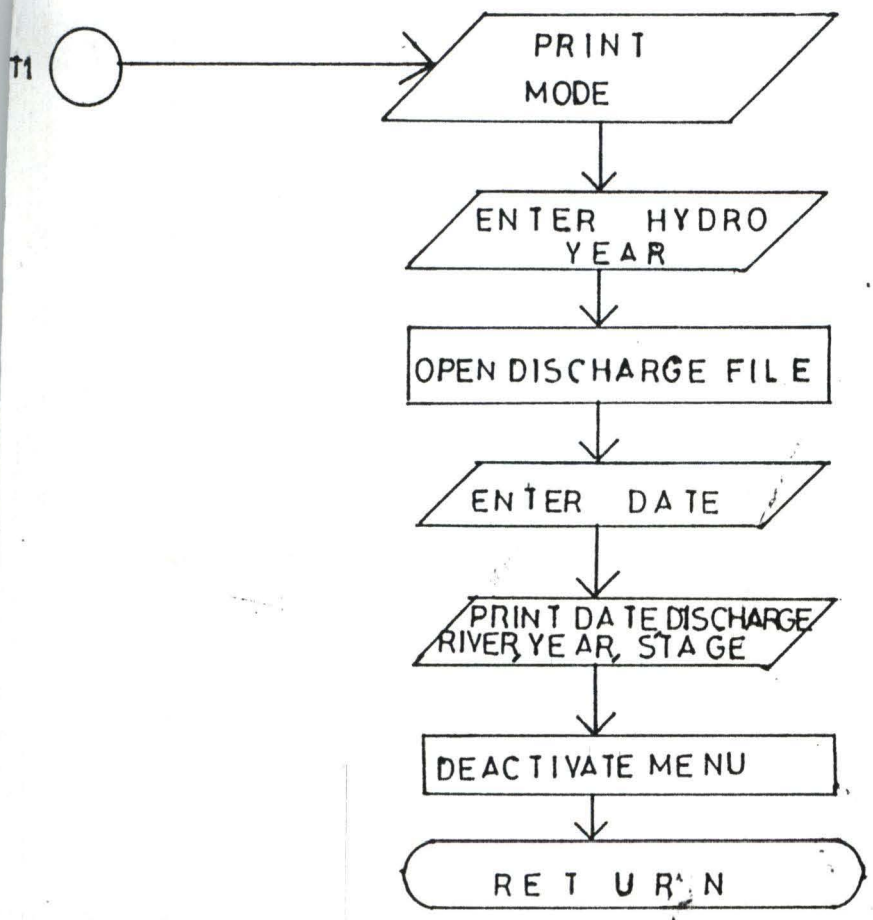
MDEL.PRG


UP 2
ENTER HYDRO-YEAR
OPEN DISCHARGE FILE
ENTER DATE OF RECORD
FOUND ?
NO
PRINT RECORD NOT FOUND
YES
DISPLAY RIVER, DISCHARGE, STAGE, DATE, HYDRO-YEAR
DELETE MORE ?
NO
PRINT NOT DELETED
YES
DELETE DISCHARGE, STAGE, DATE, RIVER, HYDRO-YEAR
DELETE MORE RECORD ?
YES
NO
DEACTIVATE MENU
RETURN

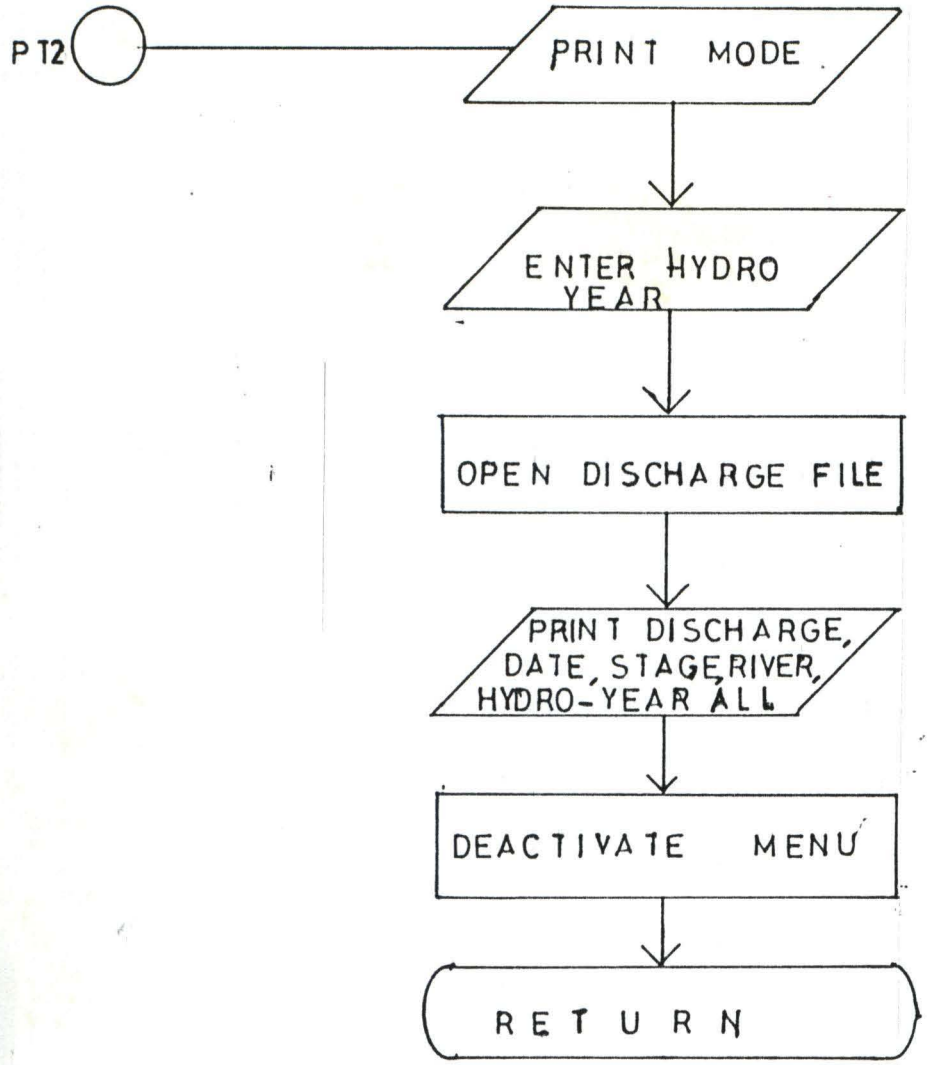
PRINT PROCEDURE



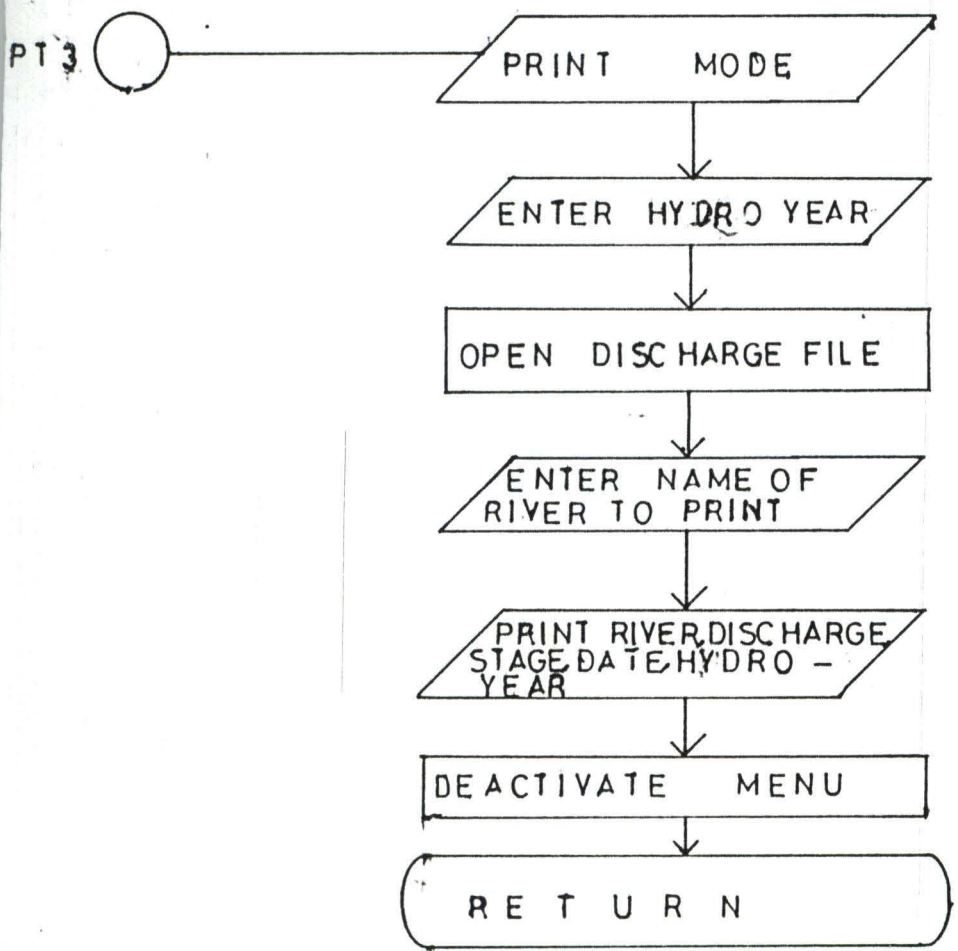
MPRINT.PRG



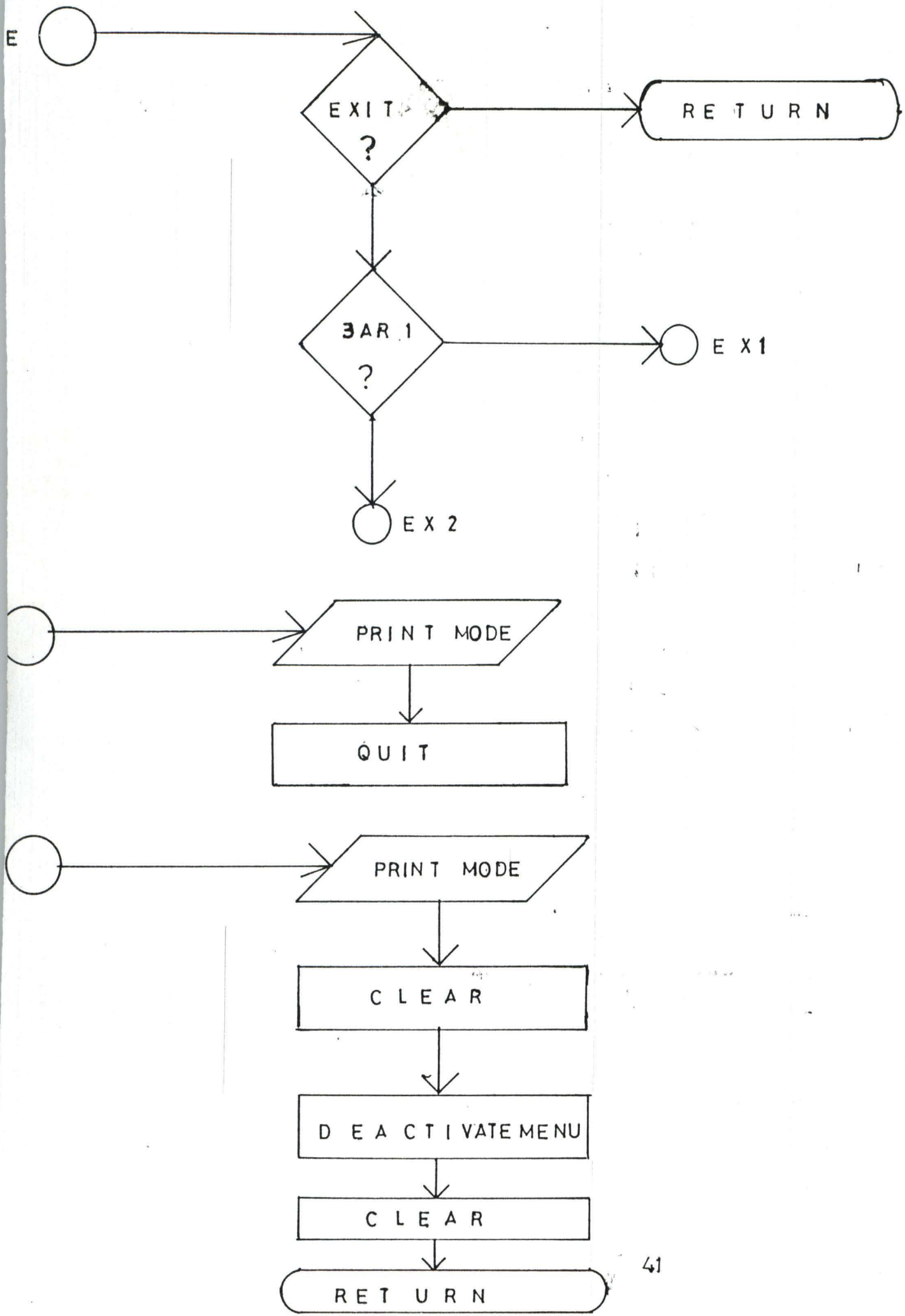
MPT 2. PRG



MPT 3. PRG



EXIT PROCEDURE



3.7.3 NARRATIVE PROCEDURE OF THE MODULAR PROGRAM

MODULE I ROTIMI.PRG.

This program is the first thing a user encounter. It introduces user to the package and displays such information such as the name of the programmer and purpose of the project.

MODULE 2. MENU PRG.

This is the program informing using on the various options available within the main program from which a user can select.

MODULE 3. DISCALC.PRG.

This is the program that accepts datas such as the velocity, width, and depth from which the discharge can be calculated is q = vxdxw.

MODULE 4. M VIEW.PRG.

This is the program that allows user to view the records available in the database file and to perform some modification through the edit.

MODULE MADD.PRG.

This is the program that allows new records to be added to the database file.

MOULE 6. MDEL.PRG.

This is the program that allow data or records to be deleted.

MODULE 7. MPRINT.PRG.

This is the program that allows the contents of the file to be printed on a hardcopy.

CHAPTER FOUR

SYSTEM EXPERIMENTATION

4.1 INTRODUCTION

The final step in the system process is system experimentation or implementation. Here programs are written and tested to ensure their correctness. Any existing data are taken from the old system and converted to the new system.

4.2 TESTING

The DbaseIV is loaded in the hard disk or is contained in floppy diskettes. After booting the system will get to the C prompt ie C\>

1. Type

   C\> CD dbase (press return key)

   C\> dbase

When the assist menu is shown on the screen you will,

2. Press the escape key to take you to the Dot prompt.
3. Put the diskette containing the system A and type:

   SET DEFAULT TO A.

   And type DO MENU

   A message will appear on the screen as shown below:

PROJECT: COMPUTERISATION OF WATER RESOURCE DEVELOPMENT.

A CASE STUDY OF NIGER STATE

WATER BOARD, MINNA.

4.3 CONVERSION

The change over from the old to the new system is known as conversion. The three general methods of conversion are parallel. Conversion, direct conversion and phase in conversion.

The phase in conversion is chosen for this system, since it is the most effective method of changing over to a new system. Gradual change over can be achieved by operating the new system with increasing larger volumes of data and/or introducing parts of new system and replacing the corresponding part in the old system by the new system as they are checked out under actual operating conditions.

4.4 TRAINING

The training of the personnel that will be responsible for the system has to be done according to the level of training needed for each personnel that are involved are the computer operators and the data entry personnel.

The computer operator will be trained using the in-service method while the Data entry personnel in-house method.

PROJECT
COMPUTERISATION OF WATER RESOURCE DEVELOPMENT

A CASE STUDY OF NIGER STATE WATER BOARD,MINNA

BY

ADEKANMBI ROTIMI . O.

PGD/MCS/025/96

ss any key to continue...

```
ENTER HYDROYEAR: 92/93
ENTER NAME OF RIVER: BAKOGI
NUMBER OF PANEL:  1
ENTER STAGE: 120.00
ENTER DATE: 01/04/93
ENTER VELOCITY:   3.00
ENTER DEPTH:   6.00
ENTER WIDTH:   3.00
```

ROYEAR: 92/93

RIVER	DATE	DISCHARGE	STAGE
BAKOGI	01/04/92	20.00	120.00

PRESS ANY KEY TO RETURN TO THE PREVIOUS MENU....

R	DATE	DISCHAR	STAGE	HYDRO_YEAR
GI	04/01/92	0.21	25.00	92/93
GI	04/02/92	0.20	24.00	92/93
GI	05/04/92	0.20	24.00	92/93
	04/05/92	0.20	37.00	92/93
	04/05/92	0.25	31.00	92/93
	04/06/92	0.21	27.00	92/93
	04/07/92	0.24	43.00	92/93
	04/08/92	0.23	12.00	93/93
	04/09/92	0.23	25.00	92/93
	04/10/92	0.22	34.00	92/93
I	04/11/92	0.34	33.00	92/93
I	04/12/92	0.21	45.00	92/93
I	04/10/92	0.33	34.00	92/93
I	04/12/92	0.65	12.00	92/93
I	13/04/92	0.34	23.00	92/93
I	14/04/92	0.34	26.00	92/93
RI	15/04/92	0.21	28.00	92/93
RI	16/04/92	0.35	23.00	92/93
RI	17/04/92	0.54	33.00	92/93
RI	18/04/92	0.54	35.00	92/93
RI	19/04/92	0.43	29.00	92/93
RI	20/04/92	0.56	23.00	92/93
RI	21/02/92	0.44	46.00	92/93

ss any key to continue...

```
              22/04/92    0.57   37.00 92/93
              23/04/92    0.24   61.00 92/93
              24/04/92    0.43    0.26 92/93
              26/04/92    0.45   16.00 92/93
              27/04/92    0.28   22.00 92/93
              28/04/92   20.00   14.00 92/93
              29/04/92    0.33   25.00 92/93
              29/04/92    2.00   33.00 92/93
              30/04/92    0.66   20.00 92/93
              01/05/92    0.54   24.00 92/93
              01/05/92    0.32   33.00 92/93
              02/05/92    0.56   43.00 92/93
              03/05/92   24.00   41.00 92/93
              04/05/92    0.99   13.00 92/93
              06/05/92   15.00   16.00 92/93
              05/05/92    0.56   22.00 92/93
              07/05/92    0.87   35.00 92/93
              07/05/92    0.86   12.00 92/93
              09/05/92    0.88   34.00 92/93
              09/05/92    0.67   27.00 92/93
              10/05/92    0.65   14.00 92/93
              11/05/92    0.55   36.00 92/93
              12/05/92    0.85   43.00 92/93
              13/05/92    0.76   23.00 92/93
ss any key to continue...
```

```
              14/05/92    0.45   32.00 92/93
              15/05/92    4.00    0.45 92/93
              16/05/92   45.00   67.00 92/93
              16/05/92   33.00   39.00 92/93
              16/05/92    3.00   23.00 92/93
              17/05/92    4.00   34.00 92/93
              17/05/92    5.00   24.00 92/93
              18/05/92    6.00   34.00 92/93
              18/05/92    3.00   14.00 92/93
              19/05/92    3.00   33.00 92/93
              20/05/92    2.00   44.00 92/93
              21/05/92    5.00   34.00 92/93
              22/05/92    3.00   36.00 92/93
              23/05/92    6.00   26.00 92/93
              24/05/92    3.00   44.00 92/93
              25/05/92    4.00   44.00 92/93
              26/05/92    4.00   55.00 92/93
              27/05/92    5.00   33.00 92/93
              28/05/92    5.00   33.00 92/93
              29/05/92    7.00   44.00 92/93
              29/05/92    4.00   33.00 92/93
              30/05/92    9.00   60.00 92/93
              01/06/92   21.00   34.00 92/93
              12/06/92    3.00   33.00 92/93
ss any key to continue...
```

```
                02/06/92    8.00   23.00 92/93
                03/06/92   24.00   34.00 92/93
                04/06/92    3.00   34.00 92/93
                05/06/92    4.00   23.00 92/93
                06/06/92   24.00   34.00 92/93
                07/06/92    5.00   34.00 92/93

                08/06/92    2.00   23.00 92/93
                08/06/92    0.98   12.00 92/93
                09/06/92    2.60   16.00 92/93
                10/06/92    4.70   23.00 92/93
                11/06/92    2.90    5.30 92/93
                12/06/92    3.80    3.70 92/93
                13/06/92    2.65   25.00 92/93
                13/06/92    2.86   34.00 92/93
                14/06/92    0.54   23.00 92/93
                15/06/92    2.87   24.00 92/93
                14/06/92    2.48   28.00 92/93
                17/06/92    2.89   34.00 92/93
                18/06/92    4.90   23.00 92/93
                19/06/92    2.67   43.00 92/93
                19/06/92    3.80   32.00 92/93
                20/06/92    2.90   34.00 92/93
                  /  /                 92/93
ss any key to continue...
```

DISCHARGE RECORD FILE

ENTER DATE OF RECORD: 01/04/92

ERROR,NO RECORD FOUND.PRESS ANY KEY TO RETURN TO MENU

ss any key to continue...

TO EDIT DAILY DATA

```
ENTER HYDROYEAR: 92/93

ENTER NAME OF RIVER:  BAKOGI

ENTER DATE: 04/01/92

ENTER DISCHARGE:     0.21

ENTER STAGE:  25.00
```

TO ADD DISCHARGE RECORD

```
        ENTER HYDROYEAR: 92/93

        ENTER NAME OF THE RIVER: BERI

        ENTER STAGE: 123.00

        ENTER DATE: 17/08/92

        ENTER DISCHARGE:  178.00
```

DELETE DISCHARGE RECORD FILE

HYDROYEAR: 92/93

DATE: 02/06/92

RIVER: ESSE

STAGE: 23.00

DISCHARGE: 8.00

DELETE THIS RECORD ? (Y/N).....

```
ENTER DATE TO PRINT DATA 12/04/92



RECORD NOT FOUND!


ss any key to continue...
```

```
E      RIVER              DISCHAR   STAGE HYDRO_YEAR
06/92 ESSE                  24.00   34.00 92/93
06/92 BAKOGI                22.00   33.00 92/93
E      RIVER              DISCHAR   STAGE HYDRO_YEAR
06/92 ESSE                  24.00   34.00 92/93
06/92 BAKOGI                22.00   33.00 92/93


E      RIVER              DISCHAR   STAGE HYDRO_YEAR
06/92 ESSE                  24.00   34.00 92/93
06/92 BAKOGI                22.00   33.00 92/93



ss any key to continue...
```

ER	DATE	DISCHAR	STAGE	HYDRO_YEAR
OGI	04/01/92	0.21	25.00	92/93
OGI	04/02/92	0.20	24.00	92/93
OGI	05/04/92	0.20	24.00	92/93
I	04/05/92	0.20	37.00	92/93
I	04/05/92	0.25	31.00	92/93
I	04/06/92	0.21	27.00	92/93
I	04/07/92	0.24	43.00	92/93
I	04/08/92	0.23	12.00	93/93
I	04/09/92	0.23	25.00	92/93
I	04/10/92	0.22	34.00	92/93
I	04/11/92	0.34	33.00	92/93
I	04/12/92	0.21	45.00	92/93
I	04/10/92	0.33	34.00	92/93
RI	04/12/92	0.65	12.00	92/93
RI	13/04/92	0.34	23.00	92/93
RI	14/04/92	0.34	26.00	92/93
RI	15/04/92	0.21	28.00	92/93
RI	16/04/92	0.35	23.00	92/93
RI	17/04/92	0.54	33.00	92/93
RI	18/04/92	0.54	35.00	92/93
RI	19/04/92	0.43	29.00	92/93
RI	20/04/92	0.56	23.00	92/93
RI	21/02/92	0.44	46.00	92/93
RI	22/04/92	0.57	37.00	92/93
RI	23/04/92	0.24	61.00	92/93
RI	24/04/92	0.43	0.26	92/93
RI	26/04/92	0.45	16.00	92/93
RI	27/04/92	0.28	22.00	92/93
RI	28/04/92	20.00	14.00	92/93
RI	29/04/92	0.33	25.00	92/93
RI	29/04/92	2.00	33.00	92/93
RI	30/04/92	0.66	20.00	92/93
RI	01/05/92	0.54	24.00	92/93
U	01/05/92	0.32	33.00	92/93
U	02/05/92	0.56	43.00	92/93
U	03/05/92	24.00	41.00	92/93
U	04/05/92	0.99	13.00	92/93
U	06/05/92	15.00	16.00	92/93
U	05/05/92	0.56	22.00	92/93
U	07/05/92	0.87	35.00	92/93
U	07/05/92	0.86	12.00	92/93
U	09/05/92	0.88	34.00	92/93
U	09/05/92	0.67	27.00	92/93
U	10/05/92	0.65	14.00	92/93
U	11/05/92	0.55	36.00	92/93
U	12/05/92	0.85	43.00	92/93
U	13/05/92	0.76	23.00	92/93
U	14/05/92	0.45	32.00	92/93
U	15/05/92	4.00	0.45	92/93
U	16/05/92	45.00	67.00	92/93
U	16/05/92	33.00	39.00	92/93
U	16/05/92	3.00	23.00	92/93
U	17/05/92	4.00	34.00	92/93
U	17/05/92	5.00	24.00	92/93
U	18/05/92	6.00	34.00	92/93
U	18/05/92	3.00	14.00	92/93
U	19/05/92	3.00	33.00	92/93
U	20/05/92	2.00	44.00	92/93
U	21/05/92	5.00	34.00	92/93
U	22/05/92	3.00	36.00	92/93
U	23/05/92	6.00	26.00	92/93
U	24/05/92	3.00	44.00	92/93

	25/05/92	4.00	44.00	92/93
	26/05/92	4.00	55.00	92/93
	27/05/92	5.00	33.00	92/93
	28/05/92	5.00	33.00	92/93
	29/05/92	7.00	44.00	92/93
	29/05/92	4.00	33.00	92/93
	30/05/92	9.00	60.00	92/93
E	01/06/92	21.00	34.00	92/93
E	12/06/92	3.00	33.00	92/93
E	02/06/92	8.00	23.00	92/93
E	03/06/92	24.00	34.00	92/93
E	04/06/92	3.00	34.00	92/93
E	05/06/92	4.00	23.00	92/93
E	06/06/92	24.00	34.00	92/93
E	07/06/92	5.00	34.00	92/93
SE	08/06/92	2.00	23.00	92/93
SE	08/06/92	0.98	12.00	92/93
SE	09/06/92	2.60	16.00	92/93
SE	10/06/92	4.70	23.00	92/93
SE	11/06/92	2.90	5.30	92/93
SE	12/06/92	3.80	3.70	92/93
SE	13/06/92	2.65	25.00	92/93
SE	13/06/92	2.86	34.00	92/93
SE	14/06/92	0.54	23.00	92/93
SE	15/06/92	2.87	24.00	92/93
SE	14/06/92	2.48	28.00	92/93
SE	17/06/92	2.89	34.00	92/93
SE	18/06/92	4.90	23.00	92/93
SE	19/06/92	2.67	43.00	92/93
SE	19/06/92	3.80	32.00	92/93
SE	20/06/92	2.90	34.00	92/93
SE32	/ /			92/93
SE	21/06/92	2.70	34.00	92/93
SE	22/06/92	33.00	37.00	92/93
SE	23/06/92	2.10	34.00	92/93
SE	24/06/92	3.70	35.00	92/93
SE	24/06/92	2.67	34.00	92/93
SE	24/06/92	33.00	38.00	92/93
SE	25/06/92	4.98	34.00	92/93
SE	27/06/92	3.50	45.00	92/93
SE	28/06/92	35.00	34.00	92/93
SE	28/06/92	44.00	36.00	92/93
SE	29/06/92	2.89	23.00	92/93
SE	30/06/92	4.60	24.00	92/93
SE	01/07/92	3.70	34.00	92/93
AKOGI	01/06/92	21.00	32.00	92/93
AKOGI	02/06/92	21.00	44.00	92/93
AKOGI	03/06/92	22.00	33.00	92/93
AKOGI	04/06/92	22.00	33.00	92/93
AKOGI	05/06/92	2.00	24.00	92/93
AKOGI	06/06/92	24.00	44.00	92/93
AKOGI	07/06/92	23.00	45.00	92/93
AKOGI	08/06/92	25.00	46.00	92/93
AKOGI	09/06/92	24.00	33.00	92/93
AKOGI	10/06/92	2.98	44.00	92/93
AKOGI	11/06/92	21.00	36.00	92/93
AKOGI	12/06/92	27.00	33.00	92/93
AKOGI	13/06/92	21.00	43.00	92/93
AKOGI	14/06/92	38.00	44.00	92/93
AKOGI	16/06/92	33.00	55.00	92/93
AKOGI	17/06/92	28.00	39.00	92/93
AKOGI	18/06/92		24.00	92/93
AKOGI	19/06/92	4.00	34.00	92/93

DISCHARGE RECORD FILE

ENTER THE NAME OF RIVER TO PRINT: BAKOGI

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 SUMMARY

The aim of this project is to effectively design and develop a computerised system that will reduce data redundancy and inefficiency.

This piece of work focused on the feasibility of computer application to water discharge calculation in water resource development. In doing this the researcher enumerated the prospect of using computer and checked the availability of software packages that are useful for water board management.

Chapter one describes the background information on water resource development and the function and concepts of water resource development.

The second chapter gave the data analysis of the water discharge measurement as well as the case study of the Niger State water Board.

Chapter three gave a full description of overall computerised system within the scope of the computerisation.

Chapter four is all about the result of the computerised system, testing of the new system and the steps required to change over from the old system to the new system.

5.2 SYSTEM MAINTENANCE

The maintenance of the system is taken care of by making sure that the system is working perfectly. Once this has been proven, the user of the system makes sure that any irregularity with the system is recorded and rectified as quickly as possible.

If opinion about the new system suggest any changes, then modification should be made to meet up with current expect action and changes.

To prevent over tasking of the computer, strict adherence to the rules guiding the use of computer and the new system should be observed. This helps in reducing abuse of the computer.

Furthermore, the new system is more maintenance since it does not involve much paper work. Almost all information need for documentation are stored in storage media such as the diskettes or the computer harddisk to avoid any misplacement of files or incorrect information. And the chances are that even if information is lost on a file there are always back up files stored in other diskettes called the father and grandfather diskettes and they are both kept in different places to avoid loses of some or all datas.

5.3 RECOMMENDATION

One would therefore recommend the use of computers in water resource development provided there is enough fund, proper planning and good sense of purpose.

However, the use of computer should not be limited to the area of water discharge measurement alone, other areas such as precipitation, evaporation/evapotranspiration, subsurface water should be computerised.

5.4 CONCLUSION

The computer is indeed a helpful tool. States water boards and water resources ministries stand to gain a lot from its use and should surely consider using computer knowing what problems and benefits they stand to get. The benefit derived from computation is far greater than the problems associated with it.

APPENDIX

```
  1

. OFF
REBOARD OFF
TUS OFF
TE TO BRITISH
.F. TO EXITDOS


SAY "                          PROJECT                                  "
SAY " COMPUTERISATION OF WATER RESOURCE DEVELOPMENT"
5 SAY " A CASE STUDY OF NIGER STATE WATER BOARD,MINNA"
5 SAY "                        BY                                       "
5 SAY "              ADEKANMBI ROTIMI . O.                                    "
5 SAY "                  PGD/MCS/025/96                                     "


SPACE(5)
 TO 16,60 DOUBLE
 SAY " ENTER PASSWORD OR Q TO QUIT: "
TE OFF
LOR TO B/B
 GET MPASS

LOR TO W/B
TE ON
 CLEAR TO 12,57
 SAY " "


SS = "Q"


SS <> "CIVIL"
,22 SAY " ACCESS DENIED "

R


SS = "CIVIL".OR.MPASS = "civil"



LE EXITDOS =.F.
F_MENS
 view OF MAIN ACTIVATE POPUP view_pop
 update OF MAIN ACTIVATE POPUP update_pop
 print OF MAIN ACTIVATE POPUP print_pop
 EXIT OF MAIN ACTIVATE POPUP exit_pop
LECTION PAD discal OF MAIN DO  discal
LECTION POPUP exit_pop do exit_pro
LECTION POPUP view_pop do view_pro
LECTION POPUP UPDATE_POP DO UPDATE_PRO
LECTION POPUP PRINT_POP DO PRINT_PRO
ATE MENU MAIN PAD VIEW
```

```
K ON

URE def_mens
menu MAIN
E MENU MAIN
E PAD discal OF MAIN PROMPT "DISCAL" at 2,5
E PAD view OF MAIN PROMPT "VIEW" AT 2,16
E PAD Update OF MAIN PROMPT "UPDATE" at 2,30
E PAD PRINT OF MAIN PROMPT  "PRINT"  at 2,50
E PAD EXIT OF MAIN PROMPT "EXIT" AT 2,70
pup view_pop
E POPUP VIEW_POP FROM 3,16
E BAR 1 OF VIEW_POP PROMPT "DISPLAY"
E BAR 2 OF VIEW_POP PROMPT "EDIT"
POPUP UPDATE_POP
E POPUP UPDATE_POP FROM 3,30
E BAR 1 OF UPDATE_POP PROMPT "ADD DISCHARGE"
E BAR 2 OF UPDATE_POP PROMPT "DELETE DISCHARGE"
popup print_pop
 POPUP PRINT_POP FROM 3,50
 BAR 1 OF PRINT_POP PROMPT "PRINT PARTICULAR DATE"
 BAR 2 OF PRINT_POP PROMPT "PRINT ALL"
 BAR 3 OF PRINT_POP PROMPT "PRINT PARTICULAR RIVER"
OPUP EXIT_POP
 POPUP EXIT_POP FROM 3,70
 BAR 1 OF EXIT_POP PROMPT "QUIT"
 BAR 2 OF EXIT_POP PROMPT "Exit to dot prompt"


URE EXIT_PRO
ASE
  CASE BAR()=1
          QUIT
  CASE BAR()=2
         STORE   .T.  TO   EXITDOS
         SET TALK ON
         SET HEADING ON
         SET STATUS ON
         SET PROCEDURE TO
         CLEAR
         DEACTIVATE MENU
         CLEAR
         RETURN
DCASE


URE VIEW_PRO
ASE
  CASE BAR()=1
          CLEAR
          USE DISCH
           DISPLAY OFF ALL  RIVER  , DATE,  DISCHAR,  STAGE,     HYDRO_Y
```

```
        WAIT
        CLEAR
        DEACTIVATE MENU
        CLEAR
        RETURN

CASE BAR()=2
        USE DISCH
        DO ED_FILE
        IF EOF()
        CLEAR
        DEACTIVATE MENU
        RETURN
        ENDIF
        DO WHILE .T.
        CLEAR
        @4,10 SAY "TO EDIT DAILY DATA"
        @5,5  TO 23,60 DOUBLE
        @6,10 say "ENTER HYDROYEAR:" GET HYDRO_YEAR
        @10,10 SAY "ENTER NAME OF RIVER: " GET RIVER
        @14,10 SAY "ENTER DATE:" GET DATE PICTURE  " DD/MM/YY"
        @18,10 SAY "ENTER DISCHARGE: " GET DISCHAR PICTURE "999.99"
        @21,10 SAY "ENTER STAGE:" GET STAGE PICTURE "999.99"
        READ
        IF LASTKEY()=18
          SKIP-1
        IF EOF()
         @18,18 SAY "TOP OF FILE ,PRESS ANY KEY TO RETURN"
         WAIT " "
         EXIT
        ENDIF
        LOOP
        ENDIF
          IF LASTKEY() =3
        SKIP
        IF EOF()
         @18,18 SAY "END OF FILE,PRESS ANY KEY TO CONTINUE..."
         WAIT
         EXIT
        ENDIF
        LOOP
        ENDIF
        STORE " " TO CONFIRM
        @23,22 SAY " EDIT ANOTHER RECORD (Y/N)...." GET CONFIRM
        READ
        IF UPPER(CONFIRM)="Y"
         CLEAR
        DO ED_FILE
        IF EOF()
         EXIT
        ENDIF
        LOOP
        ELSE
```

```
          EXIT
         ENDIF
         ENDDO
         CLEAR
         DEACTIVE MENU
   ENDCASE
N

DURE ED_FILE
         GO TOP
         CLEAR
         STORE {00/00/00} TO DATE1
         @4,22 SAY "DISCHARGE RECORD FILE"
         @5,10 TO 20,70 DOUBLE
         @10,11 SAY "ENTER DATE OF RECORD:" GET DATE1
         READ
         LOCATE FOR DATE=DATE1
         IF EOF()
            @6,11 CLEAR TO 6,69
            @18,11 SAY "ERROR,NO RECORD FOUND.PRESS ANY KEY TO RETURN T
            @ 22,10 SAY " "
            WAIT
            CLEAR
         ENDIF

URE UPDATE_PRO
E
SE BAR()=1
   USE DISCH
   CLEAR
   APPEND BLANK
 DO WHILE .T.
    @3,10  SAY "TO ADD DISCHARGE RECORD"
    @4,5  TO    20,60 DOUBLE
    @5,17 SAY "ENTER HYDROYEAR:" GET HYDRO_YEAR
    @8,17 SAY "ENTER NAME OF THE RIVER:" GET RIVER
    @11,17 SAY "ENTER STAGE:" GET STAGE PICTURE "999.99"
    @14,17 SAY "ENTER DATE:" GET DATE PICTURE "DD/MM/YY"
    @17,17 SAY "ENTER DISCHARGE: " GET DISCHAR PICTURE "999.99"
    READ
    STORE " " TO CONFIRM
    @22,22 SAY "ADD ANOTHER RECORD? (Y/N)....." GET CONFIRM
    READ
    IF UPPER(CONFIRM)="Y"
      CLEAR
      APPEND BLANK
      LOOP
    ELSE
      EXIT
    ENDIF
ENDDO

VATE MENU
```

```
E BAR()=2
 CLEAR
 USE DISCH
 DO ED_FILE
 IF EOF()
  CLEAR
  RETURN
 ENDIF
HILE .T.
 CLEAR
 @5,10 SAY " DELETE DISCHARGE RECORD FILE"
 @6,5 TO 22,60 DOUBLE
 @7,10 SAY "HYDROYEAR:" GET HYDRO_YEAR
 @11,10 SAY " DATE:" GET DATE PICTURE "DD/MM/YY"
 @14,10 SAY "RIVER:" GET RIVER
 @18,10 SAY "STAGE:" GET STAGE PICTURE "999.99"
 @21,10 SAY "DISCHARGE:" GET   DISCHAR  PICTURE "999.99"
 CLEAR GETS
 STORE " " TO CONFIRM
 @23,22 SAY "DELETE THIS RECORD ? (Y/N)....." GET CONFIRM
 READ
 IF UPPER(CONFIRM)="Y"
    DELETE
    PACK
 ENDIF
 IF LASTKEY()=18
   SKIP -1
F()
    @18,18 SAY "TOP OF FILE ,PRESS ANY KEY TO CONTINUE....."
    WAIT " "
    EXIT
    LOOP
 ENDIF
 LASTKEY()=3
     SKIP
 IF EOF()
    @18,18 SAY "END OF FILE,PRESS ANY KEY TO CONTINUE........"
    WAIT
    EXIT
 ENDIF
 LOOP
)IF

IT
F
)
R
TIVATE MENU

N
E
```

```
RE PRINT_PRO
SE
ASE BAR()=1
 CLEAR
 DATE1={00/00/00}
 USE DISCH
 GO TOP
 SET PRINTER ON
 @4,15 SAY "ENTER DATE TO PRINT DATA"  GET DATE1
 READ
 LOCATE FOR DATE=DATE1
 IF EOF()
  @15,12 SAY "RECORD NOT FOUND!"
  @22,12 SAY " "
  WAIT
 ELSE
     @2,10 SAY " "
     DISPLAY OFF ALL DATE,RIVER,DISCHAR,STAGE,HYDRO_YEAR FOR DATE =DATE1
     SET PRINTER OFF
     @23,12 SAY " "
     WAIT
 ENDIF
  CLEAR
  DEACTIVATE MENU
  CLEAR
  RETURN
ASE BAR()=2
  CLEAR
  USE DISCH
  SET PRINTER ON
  @4,15 SAY "TO PRINT ALL RESULT"
   DISPLAY OFF ALL RIVER  ,     DATE , DISCHAR, STAGE,HYDRO_YEAR
   SET PRINTER OFF
   WAIT
   CLEAR
   DEACTIVATE MENU
   CLEAR
   RETURN
SE BAR()=3
  CLEAR
  USE DISCH
  GO TOP
  SET PRINTER ON
  @4,15 SAY " TO PRINT PARTICULAR RIVER RECORD"
  CLEAR
  STORE SPACE(15)  TO  RIVER1
  @4,22 SAY " DISCHARGE RECORD FILE"
  @5,10 TO 20,70 DOUBLE
  @10,11 SAY "ENTER THE NAME OF RIVER TO PRINT:" GET RIVER1
  READ
  CLEAR
  LOCATE FOR RIVER =  RIVER1
```

```
   EOF()
   @19,11 SAY "ERROR,NO RECORD FOUND,PRESS ANY KEY TO RETURN TO MENU"
   @22,11 SAY " "
   WAIT
   CLEAR
ELSE
  DISPLAY OFF ALL RIVER,   DATE ,DISCHAR,STAGE,HYDRO_YEAR  FOR RIVER=RIVE
  WAIT
  SET PRINTER OFF
ENDIF
  CLEAR
ASE
IVATE MENU
N
```

```
  #    1

 TALK OFF
 SCOREBOARD OFF
  STATUS OFF
 : DATE TO BRITISH
ORE .F. TO EXITDOS
LEAR

,15 SAY "                          PROJECT                                "
,15 SAY " COMPUTERISATION OF WATER RESOURCE DEVELOPMENT"
2,15 SAY " A CASE STUDY OF NIGER STATE WATER BOARD,MINNA"
6,15 SAY "                        BY                                "
0,15 SAY "              ADEKANMBI ROTIMI . O.                                "
4,15 SAY "                  PGD/MCS/025/96                                "
IT
EAR
ASS=SPACE(5)
1,22 TO 16,60 DOUBLE
3,24 SAY " ENTER PASSWORD OR Q TO QUIT: "
 INTE OFF
 COLOR TO B/B
3,54 GET MPASS
AD
 COLOR TO W/B
 INTE ON
,30 CLEAR TO 12,57
,30 SAY " "
T
AR
MPASS = "Q"
UIT
IF
MPASS <> "CIVIL"
 20,22 SAY " ACCESS DENIED "
AIT
LEAR
UIT
IF
MPASS = "CIVIL".OR.MPASS = "civil"
IT
EAR
IF
WHILE EXITDOS =.F.
 DEF_MENS
 pad view OF MAIN ACTIVATE POPUP view_pop
 PAD update OF MAIN ACTIVATE POPUP update_pop
 PAD print OF MAIN ACTIVATE POPUP print_pop
 PAD EXIT OF MAIN ACTIVATE POPUP exit_pop
 SELECTION PAD discal OF MAIN DO  discal
 SELECTION POPUP exit_pop do exit_pro
 SELECTION POPUP view_pop do view_pro
 SELECTION POPUP UPDATE_POP DO UPDATE_PRO
 SELECTION POPUP PRINT_POP DO PRINT_PRO
TIVATE MENU MAIN PAD VIEW
```

REFERENCE

1. NANCY GORDON, BRIAN L. FINLAYSON, THOMAS .A. MCMAHON, "STREAM HYDROLOGY" JOHN WILEY & SONS LTD, FIRST EDITION 1993

2. RAUDKIUI A.J. "HYDROLOGY" PERGAMON PRESS FIRST EDITION, 1979.

3. SUDDESH DUGGAL "BUSINESS PROGRAMMING USING DBASEIV" MACMILLAN PUBLISHING COMPANY, FIRST EDITION, 1992.