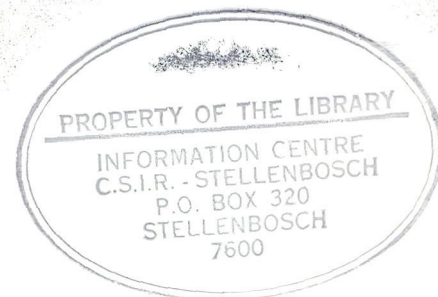


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**HYDROLOGICAL / HYDRAULIC STUDY
OF NATAL ESTUARIES**

**DATA REPORT NOS. 19 AND 20/21
MBOKODWENI NS 50
SIPINGO/MLAZI NS 51/52**



SEDIMENT DYNAMICS DIVISION
COASTAL ENGINEERING AND HYDRAULICS
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY
COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

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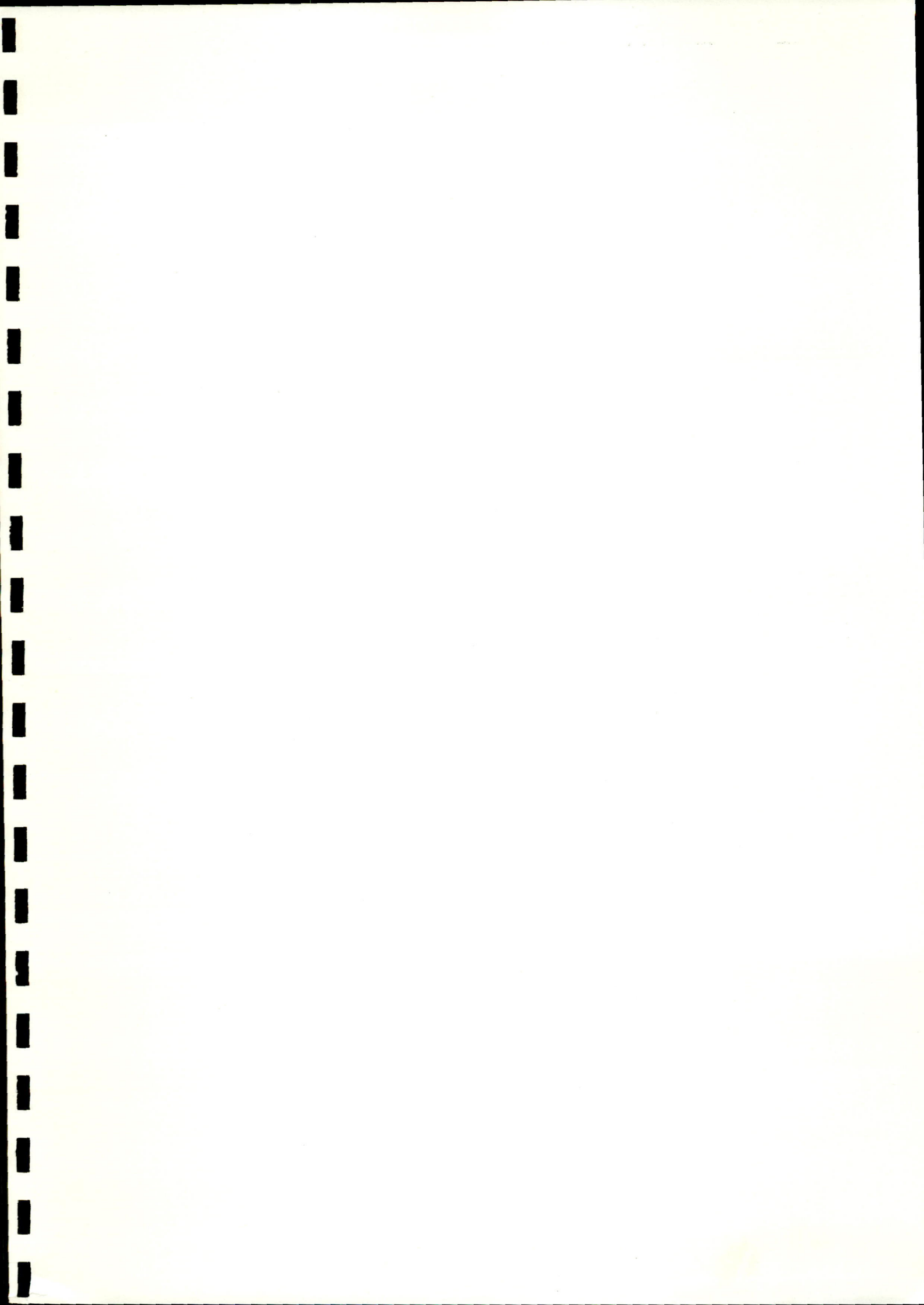
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FOREWORD

Run-off from the Mbokodweni (NS 50), Sipingo (NS 51) and Mlazi catchments is intertwined. A brief outline of the situation as it affects the discharge at the mouths of these rivers is given below.

- (i) Until 1951, the Sipingo and Mlazi rivers shared a common mouth, at what is now the Sipingo "estuary".
- (ii) In 1952, the lowest reaches of the Mlazi were diverted to a concrete-lined canal approximately 4 km ENE of the Sipingo "estuary" (see Frontispiece Photograph).
- (iii) Since 1969, floodwaters from the Sipingo R. have been diverted to the Mbokodweni R. along a grass-lined canal situated on the landward side of the railway line.

For ease of reference to the three river systems therefore, Data Reports 19 and 20/21 on the hydro-classification of the lower reaches of the Mbokodweni and the Sipingo/Mlazi are presented under one cover.

ACKNOWLEDGEMENTS : AERIAL PHOTOGRAPHY

Basic diapositives and orthophoto maps for this study were obtained from the following sources

- * The Chief Director, Surveys and Mapping, Mowbray
- ** The Air Survey Co. of Africa Pty Ltd., Durban

The asterisks given above are used in the Lists of Photographs to indicate the source.

DATA REPORT 19

HYDRO-CLASSIFICATION OF THE LOWER REACHES OF THE

MBOKODWENI NS 50

DATA REPORT 19

HYDRO-CLASSIFICATION OF THE LOWER REACHES OF THE

MBOKODWENI NS 50

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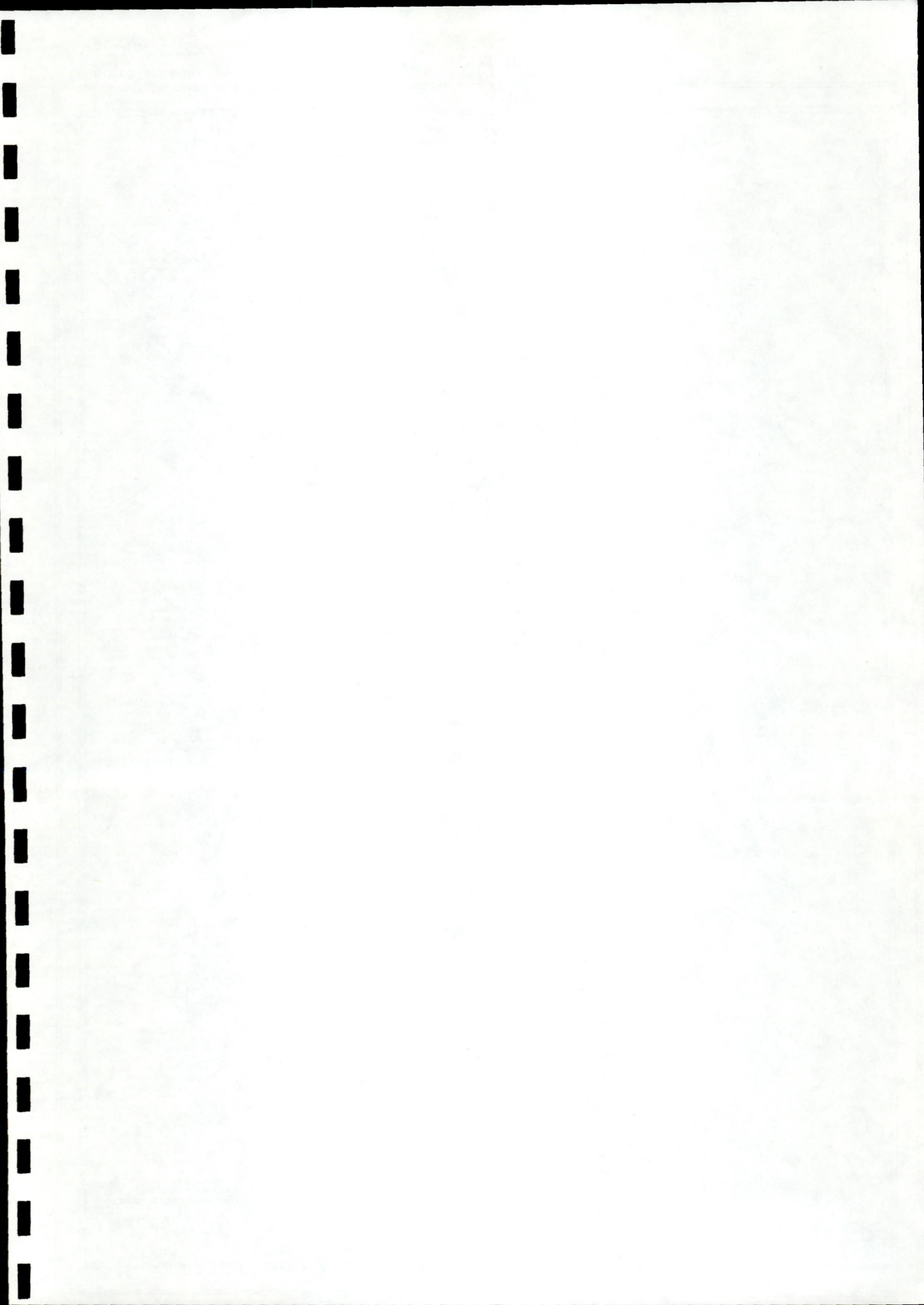
NS 50/I	Abstract, Mbokodweni NS 50
NS 50/II	Classification of the lower reaches of the Mbokodweni 1937
NS 50/III	Classification of the lower reaches of the Mbokodweni 1953
NS 50/IV	Classification of the lower reaches of the Mbokodweni 1959
NS 50/V	Classification of the lower reaches of the Mbokodweni 1967
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- * NS 50/3 July/August 1953 (11h15)
- * NS 50/4 6-6-59 (12h37)
- * NS 50/5 17-6-67 (13h07)
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- ** NS 50/7 6-2-84 (15h52)
- * NS 50/8 18-4-74 (Orthophoto)



BRIEF NOTESMBOKODWENI NS 50Location

The Mbokodweni discharges into the Indian Ocean on the Natal South Coast at 30°01'S, 30°56'E. The head of the reach under review is the railway bridge, 1,9 km from the mouth (Photograph NS 50/8).

Hydro Data

The M.A.R. from a catchment of 283 km² is 35,58 x 10⁶m³. Since 1969, flood flows from the Sipingo River have been diverted into the Mbokodweni, raising the M.A.R. to 36,02 x 10⁶m³. In view of this human intervention to the normal régime, two sets of tables and figures (the original and the "adjusted") are given regarding run-off: Tables NS 50/X and XI and Figures NS 50/2-7. In addition, Table NS 50/XII has been compiled to show the hypothetical case of the Mbokodweni receiving the assumed flood flows from the Sipingo (Table NS 51/XII from Data Report 20/21) over the period 1921-1975. In Table NS 50/XII one can see more clearly the effect of the additional Sipingo flood flows over a longer representative period of wet and dry phases: it shows that the M.A.R. is raised to 39,17 x 10⁶m³. More importantly it highlights the position during months of very high run-off: for example, if one compares Tables NS 51/X and NS 51/XII one sees the following run-off figures (in m³ x 10⁶);

	<u>Mbokodweni</u> <u>only</u>	<u>Mbokodweni and Sipingo</u> <u>flood flows</u>
March 1925	73,99	86,87
June 1935	39,89	46,88
April 1943	36,09	42,22
March 1976	32,03	37,35

The above differences are in themselves considerable and furthermore, if one considers the implied differences in flood-flow hydrographs, the comments on the new river mouth and stability in the relevant sections below are more clearly understood.

Of particular interest to this study is the erratic nature of the run-off. This is quantified by the high coefficients of variation (V%) for monthly run-off and the differences between the often far higher mean and median run-off values (monthly and annual) resulting from the occasional major flood flows to which the Mbokodweni is subject (Tables NS 50/X and XI). The wide spectrum of annual and monthly run-off is shown in Figures NS 50/2 and 3 and NS 50/4 and 5. Figures NS 50/6 and 7 show the trends in the annual run-off for the period 1921-1975. The aforementioned tables and figures are based upon simulated run-off data for tertiary catchments (Pitman et al. 1981).

For classification purposes, current and antecedent run-off conditions must be considered for each of the time slices covered by the aerial photographs. The following important facts emerge regarding the six relevant photographs:

1. 1939; below-average run-off within a dry phase.
2. 1953; below-average run-off within a dry phase.
3. 1959; above-average run-off, flood flows one month previous.
4. 1967; below-average run-off, average the previous month and above-average two to four months previous.
5. 1974; below-average run-off within a dry phase.
6. 1984; near/slightly above-average run-off, previous three months above-average following three years severe drought conditions.

River Mouth

Under natural conditions, the Mbokodweni is diverted at its mouth by a 500 m long, southerly-extending spit and discharges into the ocean alongside rocks on its right bank. The mouth position is variable, however, because following long periods of closure (to which the Mbokodweni is naturally subject) the bar is often breached mechanically (for example, Photograph NS 50/4) to alleviate flooding of the golf course. A ridge of calcareous sandstone, at -0,6 m to M.S.L. approximately, lies along the beach area. This restricted the entry of sea water prior to 1969 (Ward 1980). In 1969 an artificial mouth was created by blasting through this low ridge of sandstone near to the left bank. This was done to accommodate the additional flood-water flow from the Sipingo river. The artificial mouth is also subject to closure, and mechanical breaching continues. Begg (1983), during research within a dry phase, 1979-1982, found the mouth to be closed 93 per cent of the time.

Land-use

(a) Agriculture

Sugar cane was cultivated on the left valley side area (29%-88%) until 1966.

(b) Structures

At the head of the reach is a railway bridge which was built in 1932. 130 m downstream of this is the South Coast road bridge (1954). In 1970 a further road bridge was built, 240 m from the head of the reach, to connect Athlone Park residential area and Prospecton industrial area. Three footbridges have been built over the years further downstream for access to the golf course.

(c) Urbanization

In 1945 a golf course was built astride the lowest reaches of the Mbokodweni.

Mining for minerals in the sand has been carried out since 1956 in the Bluff Sandstone beds near the mouth on the left bank (Ward 1980).

The right valley side has seen the growth of the Athlone Park residential area since 1963 while on the left valley side there has been development of Prospecton industrial area since 1970.

Siltation

Begg (pers. comm.) regards the Mbokodweni as being moderately silted and Ward (1980) states that the Mbokodweni tends "to deposit a considerable amount of sand along its bank and flood plain". The aerial photography available confirms these viewpoints.

Stability

The Mbokodweni shows lateral instability particularly near the mouth. At the head of the reach, this instability is due to bridge building. Prior to construction of the artificial mouth, the river progressively cut into the hills on the left bank near the coast before being diverted in a southerly direction by the sandbar/spit. The position of the mouth itself used to be variable. When the artificial mouth was created in 1969, the mouth became "fixed" but the thalweg was shortened. This gives rise to higher flow velocities and bank erosion upstream of the "protected" lowest 300 m of the reach. The average lateral displacement of 79,8 m (210 per cent of the average river width) and average coefficient of variation of 47,3 per cent indicate unstable conditions. Table NS 50/IX gives full details of lateral stability.

The sinuosity of the reach was generally increased from 1937 to 1967, which is symptomatic of aggrading conditions. Sinuosity was abruptly reduced with the creation of the new mouth in 1969 and the river has yet to adjust fully to the new condition.

Even allowing for differing flow stages, the open water areas and river widths have decreased over the years. Long dry phases are partly responsible but, more importantly, the newly created mouth has resulted in the isolation, stagnation and reduction of the "lagoon area" near the mouth.

The Mbokodweni reflects considerable human influence. It shows moderate siltation and has been unstable for the period under review. Details of the classification may be found in Tables NS 50/II-VII and an abstract of results is given in Table NS 50/I.

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ABBREVIATIONS/SYMBOLS/TERMS USED

M.A.R.	Mean annual run-off
L.B.	Left bank
R.B.	Right bank
P	Perimeter
\bar{x}	Arithmetic mean
s	Standard deviation
V	Coefficient of variation $\frac{s}{\bar{x}}$
MSL	Mean sea level
R	River
d/s	Downstream
u/s	Upstream
—	Maximum value
---	Minimum value
N.R.	No record
Head of reach	An arbitrary control point selected at the first convenient place u/s of the maximum known limit of saline penetration/tidal influence where the R is confined (preferably a bridge, for example, to facilitate demarcation of flood plain areas).

BASIC DATA / CALCULATIONS

Lateral displacement (1937 - 1984) \bar{x} 79.8 m (210,0% R. width)
 Relative lateral stability (1937 - 1984) \bar{v} 47.3 km²
 Area of catchment 283 ha
 Area of flood plain 52.7 ha
 Area of envelope of mobility 15.4 ha
 Simulated M.A.R. \bar{x} 35.58 x 10⁶ m³ (including Sipingo Flood Plains from 1969)
 (1921 - 1975) \bar{s} 25.32 x 10⁶ m³
 \bar{v} 71.17

Dates of major floods: April 1856, Dec. 1921, March 1925, June 1935, Apr. Nov. 1943, March 1976

MEASUREMENTS/CALCULATIONS from PHOTOGRAPHS

Date	Jan/Aug	6-6-59	17-6-67	18-4-74	6-2-84
Thalweg (m)	1886	2225	2180	2104	1610
% Thalweg estuarine	?	?	?	53	?
Aerial D (m)	1270	1205	1239	1237	1353
Sinuosity	1.49	1.85	1.76	1.70	1.19
\bar{x} River width (m)	53.0	17.0	38.1	20.5	20.6
Open water area (ha)	11.0	4.1	8.4	4.5	3.1
% envelope of mobility	71.4	24.6	54.5	29.2	20.1
Bar/island area (ha)	0.4	0.6	0.8	0.7	0.2
River braided %thalweg	NIL	2.2	NIL	NIL	NIL
% Flood plain cultivated	NIL	NIL	NIL	NIL	NIL
Left valley side:					
% grass	65	65	NIL	96	50
% trees	6	6	6	4	NIL
% cultivated	29	29	88	NIL	NIL
% built up	NIL	NIL	6	NIL	50
Right valley side:					
% grass	NIL	NIL	NIL	NIL	NIL
% trees	100	100	100	80	80
% cultivated	NIL	NIL	NIL	NIL	NIL
% built up	NIL	NIL	NIL	20	20
L.B. % vegetated	20	33	5	10	30
R.B. % vegetated	20	40	15	10	20
Mouth open/closed o/c	0	c/o	0	c/o	0
Spit/bar:					
Direction (°)	227	229	228	227	224
Length (m)	391	573	485	456	144
\bar{x} width (m)	45	77	45	62	48

ABSTRACT

Within the Reach

1. Land-use

(a) Cultivation: Valley sides L.V.S. 29% - 88% sugar cane until 1966
 Flood plain Nil
 To channel edge Nil

(b) Bridge building and embankments

1. Railway Br. Position 0 Date of Construction 1932
2. S. Coast Road Br. Position 130 Date of Construction 1954
3. Road Br. (Athlone Park → Prosperon) Position 240 Date of Construction 1970

(c) Canals

Nil

(d) Urbanization/Industry

R.V.S. Growth of Athlone Park residential area 1963+
 L.V.S. Development of Prosperon industrial area 1970+

2. Breaching of sandbar

Mechanical breaching has occurred since 1945 to alleviate flooding of the Golf Course.

3. Others 1945 Golf Course built

1956 Mining for minerals in the sand
 1969 Artificial mouth created near L.B. by blasting through a low ridge of calcareous sandstone.

Upstream of Reach

(a) Dams in the catchment

Nil

Date of construction

(b) Building construction or canalization immediately upstream of reach

1969+ Flood waters from the Sipingo diverted along grass-lined canal to join Mbokodweni just ups of railway bridge.

(c) Land-use malpractices/silt supply

Deposition of sand/silt following flood flows shows ample supply from the catchment.

STABILITY FOR PERIOD UNDER REVIEW: 1937 - 1984

Unstable

RIVER MBOKODWENI, ? % ESTUARINE, REACH from Railway Bridge, 1.9 km from mouth. REF. DEA U 603g

AERIAL PHOTO DATE 30-4-37 SCALE 1:10 000 CATCHMENT AREA 283 km², M.A.R. 35,58 m³x10⁶, No. of DAMS Nil
 ↓ or 36,02 (see hydro notes)

RIVER VALLEY AND RIVER MOUTH FEATURES

General Description of the Terrain above the Valley			Valley Sides (Not Well-defined) ^{R.V.S. only}			
Terrain	Vegetation	Land-Use	Slumping	Vegetation and Land-Use	Left	Right
mountainous	almost none	none	none	coastal dune	<u>6</u>	<u>15</u> %
✓ hilly *	✓ grass	scattered cultivation	✓ occasional*	grass	<u>65</u>	%
undulating	sparsely forested (0-25%)	✓ partly cultivated	frequent	trees/bush		<u>85</u> %
✓ plains	✓ moderately forested (25-75%)	mainly cultivated		cultivated	<u>29</u>	%
	heavily forested (75-100%)	✓ scattered settlement		built-up		%
	swamp/bog	partly built-up				%
		urbanised				%

Comments * Bluff Bads R.V.S.
 ** Coastal dune hills

Valley Characteristics

Measurements	Terraces	Relation of Channel to Valley Bottom (Vertical)	Relation of Channel to Valley Sides or Resistant Terraces (Lateral)	Surface Geology
valley length <u>1350</u> m	none	not applicable	✓ not applicable (no valley or free)	bedrock
bottom width (av.) <u>424</u> m	indefinite	not obviously degrading	occasionally confined	lacustrine deposits
valley slope _____	fragmentary	or aggrading	frequently confined	✓ fluvial deposits
height at head _____	✓ continuous v.s.	partly entrenched	entrenched	aeolian
of reach _____ m to MSL		entrenched		sand covered _____ % area
		✓ aggrading		

Comments _____

River Mouth R. deflected to 225° over lowest 350 m

Characteristics	Measurements	Comments
✓ open/closed (joint!)	right bank breakwater length _____ m	
✓ natural/artificial	left bank breakwater length _____ m	
canalized	✓ rock sill level _____ m to MSL	
✓ sandy	cliffs on right bank: height _____ m to MSL	
rocks on right bank	cliffs on left bank: height _____ m to MSL	
rocks on left bank	spit/bar: direction of growth <u>227</u> °	
outer bar	length of spit/bar <u>391</u> m (to 165m from R.B.)	
silt plume (fluvial)	length stabilized <u>Nil</u> m	
✓ suspended sediment (marine)	width <u>45</u> m (to 50m ...)	

Comments _____

FLOOD PLAIN AND CHANNEL FEATURES

Description of Flood Plain		Vegetation	Forest Type	Land-Use
Presence	Extent			
none	none	almost none	not known/applicable	✓ not cultivated, not built-up
indefinite	average width <u>424</u> m	✓ grass	riverine:	cultivated _____ % area
fragmentary	maximum width <u>620</u> m	reed swamp ? % area	✓ main channel	cropland
✓ continuous	serial length <u>1270</u> m	✓ sparsely forested	tributaries	partly built-up
	area <u>52,7</u> ha	moderately forested	mangroves	mainly built-up
		heavily forested		

Comments _____

Channel Description N.B. Estimate of flow stage: LOW/~~NEAR LOW~~/~~NEAR~~/HIGH

Pattern	Measurements	Islands/Shoals	Type of Flow	Bar Type
straight	thalweg <u>1886</u> m	none	stagnant/still	none
sinuous	* sinuosity <u>1,49</u>	✓ occasional	✓ uniform water surface	channel side bars
irregular	* open water area <u>11,0</u> ha	frequent	uniform with rapid in reach	point bars
regular meanders	perimeter <u>4320</u> m	split	irregular	channel junction bars
✓ irregular meanders	lake/lagoon area _____ ha	braided	pool & riffle sequence	✓ mid-channel bars
tortuous meanders	river X-sections available		turbid	diamond bars
bifurcated	channel slope _____			diagonal bars
lake/s	channel width x _____ m			sand waves/large dunes
lagoon	river slope _____			
	river width x <u>53,0</u> m s = <u>33,2</u> m			

Comments *whole reach _____

Obstructions/Constructions

Natural	Degree	Man-made	Degree of Obstruction/Constriction for Each	Position (from head of reach)
✓ none	none	road bridge/s		
logs	minor	rail bridge/s		
boulders	major	causeway	<u>R. confined</u>	<u>head of reach</u>
vegetation		weir/dam		
		fish traps		
		embankment/s		
		groynes		
		canals		
		drainage furrows		
		others		

Comments _____

Lateral Channel Activity

Lateral Activity	Nature of Banks	Bank Vegetation	Lateral Stability
not detectable	✓ alluvium (silt/sand)	none	stable
✓ downstream progression	natural levées	✓ weak	slightly unstable
progression & cut-offs	rock/boulders	good	moderately unstable
mainly cut-offs	protected/stabilized	very strong	✓ unstable
entrenched loop development	cultivation to	left bank <u>20</u> %	highly unstable
irregular lateral activity	channel edge	right bank <u>20</u> %	
avulsion			

Comments _____

RIVER MBOKODWENI, ? % ESTUARINE, REACH from Railway Bridge, 2,2 km from mouth. REF. DEA U 603a
 AERIAL PHOTO DATE July/Aug '53 SCALE 1:10 000 CATCHMENT AREA 283 km², M.A.R. 35,58 m³x10⁶, No. of DAMS Nil
 at 36,02 - see hydro notes

RIVER VALLEY AND RIVER MOUTH FEATURES

General Description of the Terrain above the Valley			Valley Sides (Not Well-defined) ^{R.V.S. only}		
Terrain	Vegetation	Land-Use	Slumping	Vegetation and Land-Use	Left Right
mountainous	almost none	none	none	coastal dune	6 15 %
✓ hilly*	✓ grass	scattered cultivation	✓ occasional**	grass	65 %
undulating	sparse forested (0-25%)	✓ partly cultivated	✓ frequent	trees/bush	85 %
✓ plains	✓ moderately forested (25-75%)	mainly cultivated		cultivated	29 %
	heavily forested (75-100%)	✓ scattered settlement		built-up	%
	swamp/bog	partly built-up urbanised			

Comments * Bluff Beds R.V.S.
 ** Coastal dune hills

Valley Characteristics

Measurements	Terraces	Relation of Channel to Valley Bottom (Vertical)	Relation of Channel to Valley Sides or Resistant Terraces (Lateral)	Surface Geology
valley length <u>1350</u> m	none	not applicable	✓ not applicable (no valley or free)	bedrock
bottom width (av.) <u>424</u> m	indefinite	not obviously degrading or aggrading	occasionally confined	lacustrine deposits
valley slope _____	fragmentary	partly entrenched	frequently confined	✓ fluvial deposits
height at head _____	✓ continuous L.V.S.	entrenched	entrenched	aeolian
of reach _____ m to MSL		✓ aggrading		sand covered _____ % area

Comments _____

River Mouth R. deflected to 235° over lowest 510m

Characteristics	Measurements
✓ open/closed* <u>c/o</u>	right bank breakwater length _____ m
✓ natural/artificial canalized	left bank breakwater length _____ m
✓ sandy	✓ rock sill level _____ m to MSL
✓ rocks on right bank	cliffs on right bank: height _____ m to MSL
rocks on left bank	cliffs on left bank: height _____ m to MSL
outer bar	spit/bay: direction of growth <u>229</u> °
silt plume (fluvial)	length of spit/bay <u>573</u> m
suspended sediment (marine)	length stabilized <u>Nil</u> m
	width <u>77</u> m

Comments * open at high tide only

FLOOD PLAIN AND CHANNEL FEATURES

Description of Flood Plain	Presence	Extent	Vegetation	Forest Type	Land-Use
none	none	average width <u>424</u> m	almost none	not known/applicable	✓ not cultivated, not built-up
indefinite		maximum width <u>620</u> m	✓ grass	riverine:	cultivated _____ % area
fragmentary		aerial length <u>1205</u> m	reed swamp ? % area	✓ main channel	crop/s _____
✓ continuous		area <u>52,7</u> ha	✓ sparsely forested	tributaries	✓ partly built-up golf course
			moderately forested	mangroves	mainly built-up
			heavily forested		

Comments _____

Channel Description N.B. Estimate of flow stage: LOW/NEAR-LONG-TERM-MEAN/HIGH

Pattern	Measurements	Islands/Shoals*	Type of Flow	Bar Type
straight	thalweg <u>2225</u> m	none	stagnant/still	none
sinuous	* sinuosity <u>1,85</u>	occasional	uniform water surface	✓ channel side bars
irregular	* open water area <u>4,1</u> ha	frequent	uniform with rapid in reach	✓ point bars
regular meanders	perimeter <u>4658</u> m	split	irregular	channel junction bars
✓ irregular meanders	lake/lagoon area _____ ha	✓ braided (22%)	pool & riffle sequence	mid-channel bars
✓ tortuous meanders	river X-sections available _____		turbid	diamond bars
bifurcated	channel slope _____			diagonal bars
lake/s	channel width x _____ m s = _____ m			sand waves/large dunes
lagoon	river slope _____			
	river width x <u>17,0</u> m s = <u>16,4</u> m			

Comments * whole reach
 ** near mouth (a few)

Obstructions/Constructions

Natural	Degree	Man-made	Degree of Obstruction/Constriction for Each	Position (from head of reach)
✓ none	none	road bridge/s		
logs	minor	rail bridge/s		
boulders	major	causeways (2)	<u>R. confined across R. bed</u>	<u>head of reach 140m - 900m</u>
vegetation		weir/dam		
		fish traps		
		embankment/s		
		groynes		
		canals		
		drainage furrows		
		others	<u>1 footbridge</u>	<u>270m</u>

Lateral Channel Activity

Lateral Activity	Nature of Banks	Bank Vegetation	Lateral Stability
not detectable	✓ alluvium (silt/sand)	none	stable
downstream progression	natural levees	✓ weak	slightly unstable
✓ progression & cut-offs	rock/boulders	good	moderately unstable
mainly cut-offs	protected/stabilized	very strong	✓ unstable
entrenched loop development	cultivation to channel edge	left bank <u>33</u> %	highly unstable
irregular lateral activity		right bank <u>40</u> %	
avulsion			

Comments _____

RIVER MBOKODWENI, ? % ESTUARINE, REACH from Railway Bridge, 2.2 km from mouth. REF. DEA U 603a
 AERIAL PHOTO DATE 6-6-59 SCALE 1:10000 CATCHMENT AREA 283 km², M.A.R. 35,58 m³x10⁶, No. of DAMS Nil
 * 36,02 - see hydro notes

RIVER VALLEY AND RIVER MOUTH FEATURES

General Description of the Terrain above the Valley			Valley Sides (R.V.S. only Not Well-defined)			
Terrain	Vegetation	Land-Use	Slumping	Vegetation and Land-Use	Left	Right
mountainous	almost none	none	none	coastal dune	6	15
✓ hilly*	grass	scattered cultivation	✓ occasional*	grass		
undulating	sparsely forested (0-25%)	✓ partly cultivated	frequent	trees/bush		85
✓ plains	✓ moderately forested (25-75%)	mainly cultivated		cultivated	88	
	heavily forested (75-100%)	✓ scattered settlement		built-up	6	
	swamp/bog	partly built-up urbanised				

Comments * Bluff Reds R.V.S.
 ** coastal dune hills

Valley Characteristics

Measurements	Terraces	Relation of Channel to Valley Bottom (Vertical)	Relation of Channel to Valley Sides or Resistant Terraces (Lateral)	Surface Geology
valley length <u>1350</u> m	none	not applicable	✓ not applicable (no valley or free)	bedrock
bottom width (av.) <u>424</u> m	indefinite	not obviously degrading or aggrading	occasionally confined	lacustrine deposits
valley slope _____	fragmentary		frequently confined	✓ fluvial deposits
height at head _____	✓ continuous N.S.	partly entrenched	entrenched	aeolian
of reach _____ m to MSL		entrenched		✓ sand covered <u>7</u> % area
		✓ aggrading		

Comments _____

River Mouth R. deflected to 233° over lowest 450 m

Characteristics	Measurements	Comments
✓ open/ closed	right bank breakwater length _____ m	
✓ natural/ artificial	left bank breakwater length _____ m	
canalized	✓ rock sill level _____ m to MSL	
✓ sandy	cliffs on right bank: height _____ m to MSL	
rocks on right bank	cliffs on left bank: height _____ m to MSL	
rocks on left bank	spit/bar: direction of growth _____	
outer bar	length of spit/bar <u>228</u> m (75m from R.B.)	
silt plume (fluvial)	length stabilized <u>485</u> m	
✓ suspended sediment (marine)	width <u>Nil</u> m	
	<u>45</u> m (45m " ")	

Comments _____

FLOOD PLAIN AND CHANNEL FEATURES

Presence	Extent	Vegetation	Forest Type	Land-Use
none	none	almost none	not known/applicable	✓ not cultivated, not built-up
indefinite	average width <u>424</u> m	✓ grass	riverine:	cultivated _____ % area
fragmentary	maximum width <u>620</u> m	reed swamp ? % area	✓ main channel	crop/s
✓ continuous	aerial length <u>1239</u> m	✓ sparsely forested	tributaries	✓ partly built-up <u>golf course</u>
	area <u>52,7</u> ha	moderately forested	mangroves	mainly built-up
		heavily forested		

Comments _____

Channel Description N.B. Estimate of flow stage: ~~LOW/NEAR~~ LONG-TERM MEAN (HIGH) above ave.

Pattern	Measurements	Islands/Shoals	Type of Flow	Bar Type
straight	thalweg <u>2180</u> m	none	stagnant/still	none
sinuous	* sinuosity <u>1,76</u>	occasional	✓ uniform water surface	✓ channel side bars
irregular	* open water area <u>8,4</u> ha	frequent	uniform with rapid in reach	✓ point bars
regular meanders	perimeter <u>4905</u> m	split	irregular	channel junction bars
✓ irregular meanders	lake/lagoon area _____ ha	braided	pool & riffle sequence	mid-channel bars
tortuous meanders	river X-sections available _____		turbid	diamond bars
bifurcated	channel slope _____			diagonal bars
lake/s	channel width x _____ m s = _____ m			sand waves/large dunes
lagoon	river slope _____			
	river width x <u>38,1</u> m s = <u>28,6</u> m			

Comments *whole reach
 ** a few near mouth

Obstructions/Constructions

Natural	Degree	Man-made	Degree of Obstruction/Constriction for Each	Position (from head of reach)
✓ none	none	road bridge/s _____	R. confined	130 m
logs	minor	rail bridge/s _____	R. confined	head of reach
boulders	major	causeway? <u>bothies</u>		900 m
vegetation		weir/dam _____		
		<u>fish traps</u> <u>1 jetty</u>	minimal	2100 R.B.
		embankment/s _____		
		groynes _____		
		canals _____		
		drainage furrows _____		
		others <u>1 footbridge</u>		270 m

Comments _____

Lateral Channel Activity

Lateral Activity	Nature of Banks	Bank Vegetation	Lateral Stability	Comments
not detectable	✓ alluvium (silt/sand)	none	stable	
✓ downstream progression	natural levees	✓ weak	slightly unstable	
progression & cut-offs	rock/boulders	good	moderately unstable	
mainly cut-offs	protected/stabilized	very strong	✓ unstable	
entrenched loop development	cultivation to	left bank <u>5</u> %	highly unstable	
irregular lateral activity	channel edge	right bank <u>15</u> %		
avulsion				

Comments _____

RIVER MBOKODWENI, ? % ESTUARINE, REACH from Railway Bridge, 2.1 km from mouth. REF. DEA U 603a

AERIAL PHOTO DATE 17-6-67 SCALE 1:10 000 CATCHMENT AREA 283 km², M.A.R. 35,58 m³x10⁶, No. of DAMS Nil
 ↓ 36,02 - see hydro notes

RIVER VALLEY AND RIVER MOUTH FEATURES

General Description of the Terrain above the Valley			Valley Sides (RV.S. only Not Well-defined)		
Terrain	Vegetation	Land-Use	Slumping	Vegetation and Land-Use	Left Right
mountainous	almost none	none	none	coastal dune	4 15 %
hilly*	grass	scattered cultivation	occasional**	grass	96 65 %
undulating	sparsely forested (0-25%)	partly cultivated	frequent	trees/bush	65 %
plains	moderately forested (25-75%)	mainly cultivated		cultivated	20 %
	heavily forested (75-100%)	scattered settlement		built-up	
	swamp/bog	partly built-up urbanised			

Comments * Bluff Beds R.V.S.
 ** Coastal dune hills

Valley Characteristics

Measurements	Terraces	Relation of Channel to Valley Bottom (Vertical)	Relation of Channel to Valley Sides or Resistant Terraces (Lateral)	Surface Geology
valley length <u>1350</u> m	none	not applicable	not applicable (no valley or free)	bedrock
bottom width (av.) <u>424</u> m	indefinite	not obviously degrading or aggrading	not obviously confined	lacustrine deposits
valley slope	fragmentary	partly entrenched	frequently confined	fluvial deposits
height at head of reach ___ m to MSL	continuous V.S.	entrenched	entrenched	aeolian
		aggrading		sand covered ___ % area

Comments

River Mouth R. deflected to 233° over lowest 370m

Characteristics	Measurements
open/closed* <u>C/O</u>	right bank breakwater length ___ m
natural/artificial	left bank breakwater length ___ m
canalized	rock sill level ___ m to MSL
sandy	cliffs on right bank: height ___ m to MSL
rocks on right bank	cliffs on left bank: height ___ m to MSL
rocks on left bank	spit/bar: direction of growth <u>227°</u>
outer bar	length of spit/bar <u>456</u> m (710m from 2.B.)
silt plume (fluvial)	length stabilized <u>N:1</u> m
suspended sediment (marine)	width <u>62</u> m (780m ...)

Comments * open at high tide only

FLOOD PLAIN AND CHANNEL FEATURES

Description of Flood Plain

Presence	Extent	Vegetation	Forest Type	Land-Use
none	none	almost none	not known/applicable	not cultivated, not built-up
indefinite	average width <u>424</u> m	grass	riverine:	cultivated ___ % area
fragmentary	maximum width <u>620</u> m	reed swamp ? % area	main channel	crop/s
continuous	aerial length <u>1237</u> m	sparsely forested	tributaries	partly built-up golf course
	area <u>52,7</u> ha	moderately forested	mangroves	mainly built-up
		heavily forested		

Comments

Channel Description N.B. Estimate of flow stage: LOW/NEAR LOW/NEAR HIGH/HIGH

Pattern	Measurements	Islands/Shoals	Type of Flow	Bar Type
straight	thalweg <u>2104</u> m	none	stagnant/still	none
sinuous	* sinuosity <u>1,70</u>	occasional**	uniform water surface	channel side bars
irregular	* open water area <u>4,5</u> ha	frequent	uniform with rapid in reach	point bars
regular meanders	perimeter <u>4790</u> m	split	irregular	channel junction bars
irregular meanders	lake/lagoon area ___ ha	braided	pool & riffle sequence	mid-channel bars
tortuous meanders	river X-sections available		turbid	diamond bars
bifurcated	** channel slope = <u>(1:627)</u>			diagonal bars
lake/s	channel width x ___ m s = ___ m			sand waves/large dunes
lagoon	river slope ___			
	river width x <u>20,5</u> m s = <u>209</u> m			

Comments * whole reach ** bed level at head +3,35m to MSL near mouth

Obstructions/Constructions

Natural	Degree	Man-made	Degree of Obstruction/Constriction for Each	Position (from head of reach)
none	none	road bridge/s	R. confined	130m
logs	minor	rail bridge/s	R. confined	head of reach
boulders	major	causeway		
vegetation		weir/dam		
		fish-traps 1 <u>patrol</u>	minimal	2100m R.B.
		embankment/s		
		groynes (2)		1500 & 1545 L.B.
		canals		
		drainage furrows		
		others (2) <u>foot bridges</u>		300m & 900m

Lateral Channel Activity

Lateral Activity	Nature of Banks	Bank Vegetation	Lateral Stability
not detectable	alluvium (silt/sand)	none	stable
downstream progression	natural levées	weak	slightly unstable
progression & cut-offs	rock/boulders	good	moderately unstable
mainly cut-offs	protected/stabilized	very strong	unstable
entrenched loop development	cultivation to	left bank <u>10</u> %	highly unstable
irregular lateral activity	channel edge	right bank <u>10</u> %	
avulsion			

Comments

Station	Approx. distance along 1974 R. course (and old lagoon) from Rlwy. Br. (m)	River widths (m)							\bar{x}	s	V%
		Date									
		30.04.37	Jul/Aug 53	06.06.59	17.06.67	18.04.74	06.02.84				
1	0	45	4	22	16	13	16	19,3	13,9	71,8	
2	200	28	4	28	8	8	10	14,3	10,8	75,1	
3	400	25	4	30	5	8	12	14,0	10,9	78,1	
4	600	32	4	25	8	12	8	14,8	11,1	74,9	
5	800	34	4	20	6	18	24	17,7	11,3	63,8	
6	1 000	40	16	22	4	16	34	22,0	13,1	59,8	
7	1 200	60	20	26	10	28	28	28,7	16,8	58,6	
8	1 400	104	24	28	16	74	20	44,3	36,1	81,4	
9	1 600	92 (55+37)	36	56	54	**	**	59,5	23,5	39,4	
10	1 800	110	54	94	65	**	**	80,8	25,8	31,9	
11	2 000	60	30	96	42	**	**	57,0	28,8	50,5	
12	Mouth*	6 (1800m)	4 (2010m)	10 (2010m)	12 (1900m)	8 (1600m)	40	13,3	13,4	100,2	
\bar{x}		53,0	17,0	38,1	20,5	20,6	21,3	32,1			
s		33,2	16,4	28,6	20,9	21,0	11,1	28,4			
V%		62,6	96,7	75,2	102,1	102,1	52,0				

* Various positions over the years indicated e.g. (1600 m) approx.

** "Lagoon" area artificially cut off from main river: new river mouth position

Station	Approx. distance along 1974 river course from rlwy. bridge (m)	Distance from maximum observed L.B. position to mid-river (m)								Max - Min	\bar{x}	s	V%
		Date											
		30.04.37	Jul/Aug 53	06.06.59	17.06.67	18.04.74	06.02.84						
1	0	68	21	15	8	17	8		60	22,8	22,7	99,5	
2	200	14	30	37	38	44	28		30	31,8	10,5	32,9	
3	400	30	33	15	11	13	25		22	21,2	9,4	44,4	
4	600	16	25	30	22	28	28		14	24,8	5,2	20,8	
5	800	17	24	32	40	34	49		32	32,7	11,3	34,7	
6	1 000	35	24	30	27	27	17		18	26,7	6,0	22,6	
7	1 200	30	35	38	52	48	40		22	40,5	8,2	20,2	
8	1 400	80	24	14	8	98	77		90	50,2	39,2	78,1	
* 12	Mouth	280	450	377	345	35	20		430	251,2	181,8	72,4	
\bar{x}		63,3	74,0	65,3	61,2	38,2	32,4		79,8	55,7		47,3	
s		84,5	141,1	117,3	107,5	25,1	20,6		133,6			29,0	
V%		133,4	190,6	179,5	175,6	65,8	63,6		167,4			61,3	

Average lateral displacement 1937-1984 = 79,8 m
 Average coefficient of variation 1937-1984 = 47,3%

*Stations 9-11 not comparable for all years owing to deflection of river course by sand-spit

Station	Approx. distance along 1974 river course from rlwy. bridge (m)	Distance from maximum observed L.B. position to mid-river (m)								Max - Min	\bar{x}	s	V%
		Date											
		30.04.37	Jul/Aug 53	06.06.59	17.06.67	18.04.74	06.02.84						
1	0	<u>68</u>	21	15	<u>8</u>	17	<u>8</u>		60	22,8	22,7	99,5	
2	200	<u>14</u>	30	37	38	<u>44</u>	28		30	31,8	10,5	32,9	
3	400	30	<u>33</u>	15	<u>11</u>	13	25		22	21,2	9,4	44,4	
4	600	<u>16</u>	25	<u>30</u>	22	28	28		14	24,8	5,2	20,8	
5	800	<u>17</u>	24	32	40	34	<u>49</u>		32	32,7	11,3	34,7	
6	1 000	<u>35</u>	24	30	27	27	<u>17</u>		18	26,7	6,0	22,6	
7	1 200	<u>30</u>	35	38	<u>52</u>	48	40		22	40,5	8,2	20,2	
8	1 400	80	24	14	<u>8</u>	<u>98</u>	77		90	50,2	39,2	78,1	
* 12	Mouth	280	<u>450</u>	377	345	35	<u>20</u>		430	251,2	181,8	72,4	
\bar{x}		63,3	74,0	65,3	61,2	38,2	32,4		79,8	55,7		47,3	
s		84,5	141,1	117,3	107,5	25,1	20,6		133,6			29,0	
V%		133,4	190,6	179,5	175,6	65,8	63,6		167,4			61,3	

Average lateral displacement 1937-1984 = 79,8 m

Average coefficient of variation 1937-1984 = 47,3%

*Stations 9-11 not comparable for all years owing to deflection of river course by sand-spit

Station	Approx. distance along 1974 river course from rlwy. bridge (m)	Distance from maximum observed L.B. position to mid-river (m)						Max - Min	\bar{x}	s	V%
		Date									
		30.04.37	Jul/Aug 53	06.06.59	17.06.67	18.04.74	06.02.84				
1	0	<u>68</u>	21	15	<u>8</u>	17	<u>8</u>	60	22,8	22,7	99,5
2	200	<u>14</u>	30	37	38	<u>44</u>	28	30	31,8	10,5	32,9
3	400	30	<u>33</u>	15	<u>11</u>	13	25	22	21,2	9,4	44,4
4	600	<u>16</u>	25	<u>30</u>	22	28	28	14	24,8	5,2	20,8
5	800	<u>17</u>	24	32	40	34	<u>49</u>	32	32,7	11,3	34,7
6	1 000	<u>35</u>	24	30	27	27	<u>17</u>	18	26,7	6,0	22,6
7	1 200	<u>30</u>	35	38	<u>52</u>	48	40	22	40,5	8,2	20,2
8	1 400	80	24	14	<u>8</u>	<u>98</u>	77	90	50,2	39,2	78,1
12	Mouth	280	<u>450</u>	377	345	35	<u>20</u>	430	251,2	181,8	72,4
\bar{x}		63,3	74,0	65,3	61,2	38,2	32,4	79,8	55,7		47,3
s		84,5	141,1	117,3	107,5	25,1	20,6	133,6			29,0
V%		133,4	190,6	179,5	175,6	65,8	63,6	167,4			61,3

Average lateral displacement 1937-1984 = 79,8 m
 Average coefficient of variation 1937-1984 = 47,3%

*Stations 9-11 not comparable for all years owing to deflection of river course by sand-spit

TABLE NS 50/X SIMULATED RUN-OFF FOR MBOKODWENI NS 50 CATCHMENT AREA= 283.050 KM. *****

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL	\$M.A.R.
1921	1.24	13.64	31.32	10.93	1.84	1.07	.70	.84	1.18	1.11	1.03	.98	65.87	185.12
1922	1.93	9.58	4.62	2.36	2.63	2.31	1.78	1.13	.66	.54	.51	.40	28.45	79.97
1923	.35	.44	1.15	1.89	1.76	1.16	.82	.73	.60	.44	.36	.54	10.24	28.79
1924	.69	1.00	1.38	1.71	1.89	73.99	26.71	2.21	1.58	1.18	.90	1.09	114.34	321.35
1925	2.02	2.12	1.48	.89	.76	1.10	1.01	.61	.47	.44	.34	.37	11.63	32.67
1926	.64	.75	.71	.61	.59	4.65	3.22	1.45	.82	.58	.67	.71	15.40	43.29
1927	.76	.80	1.16	1.90	2.27	1.93	1.30	1.45	.55	.37	.31	.36	12.53	35.22
1928	.61	.82	.89	1.04	1.00	2.69	2.80	1.85	2.04	2.97	2.60	2.18	21.49	60.40
1929	2.44	2.49	2.28	7.46	4.19	2.35	2.04	1.35	.89	.75	.81	.96	28.02	78.75
1930	1.29	1.64	2.34	5.78	3.49	2.22	2.03	1.35	.74	.80	.92	.69	23.30	65.49
1931	.61	.72	.99	1.45	2.08	2.67	2.29	1.68	1.30	.91	.62	.48	15.81	44.42
1932	.90	1.52	2.15	2.16	1.69	1.45	1.22	.87	1.30	.91	.62	.48	15.81	44.42
1933	.29	.95	7.46	19.43	7.75	2.49	2.70	2.70	1.98	1.76	1.85	1.52	50.90	143.06
1934	1.21	1.21	3.42	4.14	5.31	3.75	2.57	2.33	39.89	15.37	2.16	1.39	82.75	232.57
1935	.95	.67	.49	.73	1.92	8.45	4.32	2.48	2.54	1.82	1.19	.88	26.45	74.35
1936	.88	15.71	7.06	2.07	2.26	1.97	1.17	.63	.44	.40	.38	.36	33.33	93.67
1937	.48	.67	1.41	2.20	21.36	8.57	2.12	1.92	1.26	1.05	1.05	.79	42.87	120.48
1938	1.17	1.93	3.40	3.39	11.68	5.88	2.26	1.74	1.40	1.02	.82	1.01	35.71	100.35
1939	1.55	2.36	2.96	2.49	1.87	1.62	1.93	11.99	6.57	2.80	1.71	1.20	38.45	108.07
1940	1.09	6.84	6.39	3.57	2.22	1.77	1.93	1.64	.98	.63	.48	.50	28.03	78.77
1941	.65	.96	1.15	1.80	2.69	18.43	8.18	2.68	1.98	1.33	1.21	1.31	42.37	119.09
1942	1.64	6.52	25.77	10.24	2.73	2.89	36.09	18.80	4.44	2.86	7.03	4.04	123.05	345.83
1943	21.58	35.37	15.84	3.94	2.16	5.61	3.52	1.59	.99	.76	.58	1.00	92.93	261.18
1944	1.84	2.00	1.46	1.08	1.27	17.17	7.41	1.68	1.07	.69	.46	.31	36.43	102.40
1945	.48	.57	.54	1.11	1.93	2.52	2.48	1.76	1.05	.66	.44	.33	13.87	38.98
1946	.42	.81	1.30	1.64	2.66	4.57	3.86	2.71	2.58	2.76	2.15	1.49	26.96	75.76
1947	1.22	2.02	3.03	5.13	5.44	3.69	3.28	2.73	1.64	.93	.57	.42	30.09	84.58
1948	1.02	1.96	2.36	2.42	2.57	2.35	1.90	1.42	.91	.63	.50	.57	18.59	52.24
1949	1.02	3.82	10.67	8.03	3.80	2.70	2.12	1.46	.99	.72	.78	.77	36.90	103.70
1950	.60	.49	.86	1.97	2.29	2.23	1.90	1.17	.68	.46	.88	1.40	14.93	41.95
1951	1.58	1.43	1.40	4.42	3.42	2.31	2.01	1.63	1.13	.82	.67	.55	21.36	60.04
1952	.50	.63	1.13	2.26	11.43	5.33	1.50	.86	.58	.45	.67	1.11	26.46	74.36
1953	1.49	1.66	2.52	2.89	2.50	2.02	1.53	1.27	1.07	.84	.65	.75	19.19	53.93
1954	1.98	2.91	2.28	18.68	13.04	8.04	4.06	2.09	1.24	.79	.55	.57	56.21	157.99
1955	.77	1.10	1.55	1.29	1.95	21.79	9.28	2.22	1.41	.93	.79	.81	43.88	123.32
1956	.90	1.29	21.90	11.70	3.78	2.98	15.79	6.96	1.71	1.01	.74	1.21	69.97	196.65
1957	2.23	2.91	2.78	2.81	17.88	7.70	8.95	4.58	1.59	.65	.65	.69	53.77	151.11
1958	.79	1.12	1.62	2.32	2.68	1.93	1.12	1.75	7.81	2.01	1.62	1.31	41.88	117.69
1959	1.17	1.25	1.34	1.28	1.25	1.53	1.78	1.44	.88	.57	.42	.40	13.31	37.40
1960	.61	1.32	7.24	4.80	2.74	2.50	24.81	10.08	2.10	1.62	1.12	1.12	60.17	169.11
1961	1.16	1.11	1.10	1.52	1.93	2.49	2.53	1.79	1.07	.65	.58	.55	16.46	46.26
1962	.54	1.20	1.72	2.13	2.06	2.11	2.06	1.37	.82	1.28	1.62	1.14	18.06	50.75
1963	.85	.79	.92	4.12	3.28	2.10	1.81	1.40	.95	.78	.61	.60	18.22	51.22
1964	1.21	1.59	1.82	1.94	1.63	1.03	.55	.52	1.05	1.47	1.61	1.72	16.15	45.38
1965	1.87	2.31	2.49	9.71	5.11	1.76	.95	.87	.90	.75	.61	.57	27.89	78.39
1966	.58	1.04	1.42	2.01	8.37	14.30	6.40	2.57	1.50	.95	.65	.44	40.22	113.04
1967	.62	1.27	1.46	2.20	2.53	2.00	1.35	.79	.49	.36	.48	.80	14.35	40.34
1968	1.03	1.01	.84	.64	.66	1.50	2.15	2.31	2.00	1.45	1.11	1.08	15.78	44.35
1969	2.10	3.06	3.24	3.19	2.34	1.25	.70	.61	.70	.71	.89	1.45	20.26	56.94
1970	10.52	9.27	4.33	2.77	2.37	2.70	3.05	13.16	6.03	2.16	2.47	2.40	61.23	172.10
1971	1.90	1.54	1.81	1.99	2.43	2.33	1.56	1.31	1.29	1.10	.83	.58	18.68	52.49
1972	.58	.91	1.18	1.53	1.86	1.69	1.33	.94	.57	.41	.69	1.67	13.35	37.51
1973	2.25	2.67	2.52	6.20	4.34	3.10	2.56	2.25	1.90	1.39	.98	.67	30.83	86.65
1974	.61	.78	1.09	3.53	13.54	5.87	1.71	1.24	.82	.56	.44	.91	31.09	87.39
1975	1.37	1.35	1.77	5.49	4.13	32.03	17.42	4.34	1.82	1.13	.94	.99	72.77	204.53
MEAN	1.65	3.02	3.95	3.91	4.06	5.94	4.58	2.92	2.26	1.32	1.02	.95	35.58	95
S	185.90	179.18	154.76	101.60	104.70	184.91	150.79	134.56	237.70	154.92	96.77	66.05	71.17	66.05
V%	1.02	1.29	1.72	2.26	2.43	2.49	2.06	1.63	1.07	.82	.69	.79	27.89	27.89
MEDIAN	1.02	1.29	1.72	2.26	2.43	2.49	2.06	1.63	1.07	.82	.69	.79	27.89	27.89

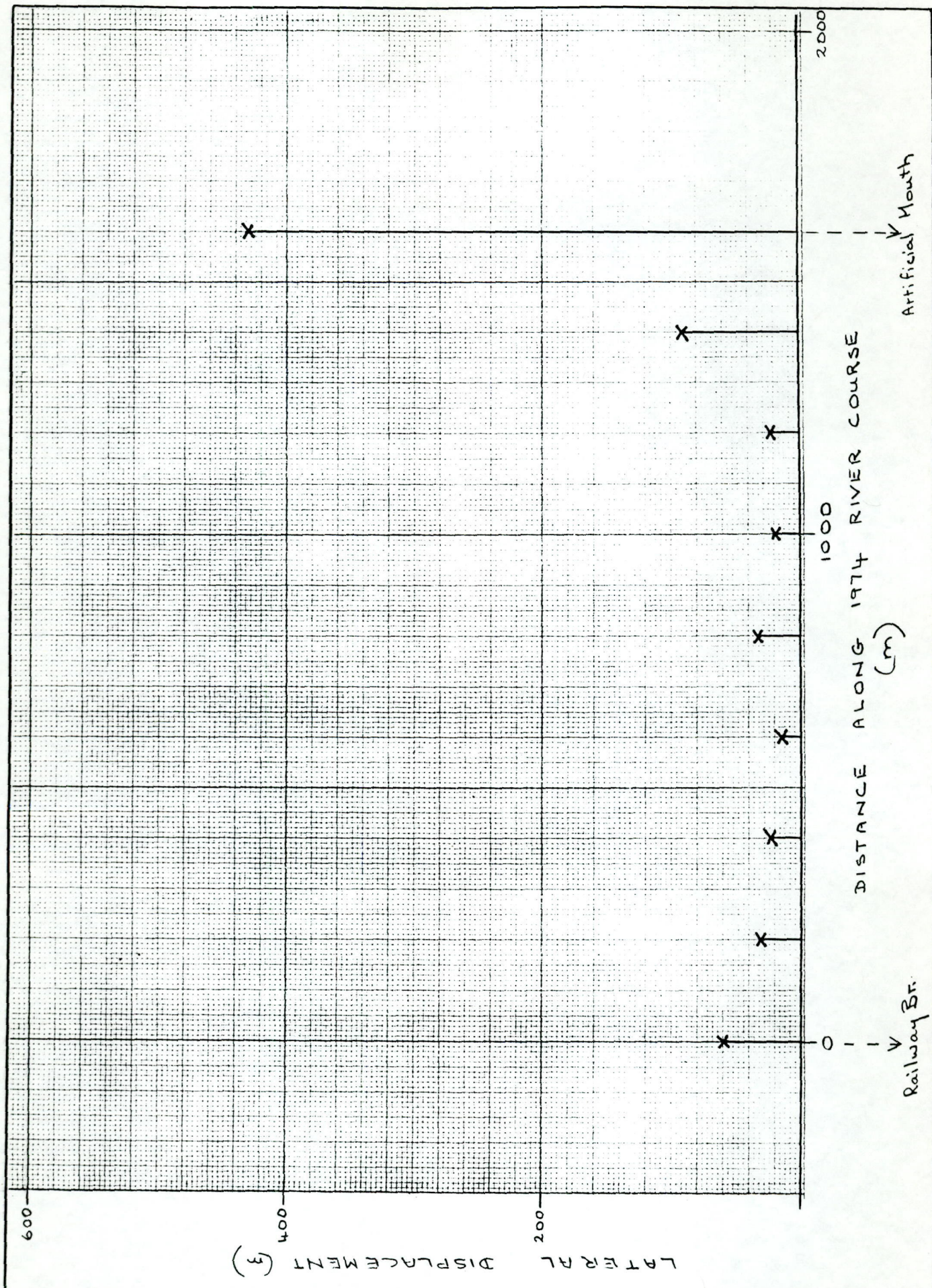
TABLE NS 50/SI ADJUSTED RUN-OFF FOR MBOKODWENI NS 50 CATCHMENT AREA= 283.050 Q.KM. M.A.R.

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
1921	1.24	13.64	31.32	10.93	1.84	1.07	.70	.84	1.18	1.11	1.03	.98	65.87
1922	1.93	9.58	4.62	2.36	2.31	2.31	1.78	1.13	.66	.54	.51	.40	28.45
1923	.35	.44	1.15	1.89	1.76	1.16	.82	.73	.60	.44	.36	.54	10.24
1924	.69	1.00	1.38	1.71	1.89	73.99	26.71	2.21	1.58	1.18	.90	1.09	114.34
1925	2.02	2.12	1.48	.89	.76	1.10	1.01	.61	.47	.44	.34	.37	11.63
1926	.64	.75	.71	.61	.59	4.65	3.22	1.45	.82	.58	.67	.71	15.40
1927	.76	.80	1.16	1.90	2.27	1.93	1.30	.84	.55	.37	.31	.36	12.53
1928	.61	.82	.89	1.04	1.00	2.69	2.80	1.85	2.04	2.97	2.60	2.18	21.49
1929	2.44	2.49	2.28	7.46	3.19	2.35	2.04	1.35	.89	.75	.81	.96	28.02
1930	1.29	1.64	2.34	5.78	3.49	2.22	2.03	1.35	.74	.80	.92	.69	23.30
1931	.61	.72	.99	1.45	2.08	2.67	2.29	1.68	1.30	.91	.62	.48	15.81
1932	.90	1.52	2.15	2.16	1.69	1.45	1.22	.87	.57	.46	.40	.32	13.71
1933	.29	.95	7.46	19.43	7.75	2.49	2.70	2.70	1.98	1.76	1.85	1.52	50.90
1934	1.21	1.21	3.42	4.14	5.31	3.75	2.57	2.33	39.89	15.37	2.16	1.39	82.75
1935	.95	.67	.49	.73	1.92	8.45	4.32	2.48	2.54	1.82	1.19	.88	26.45
1936	.88	15.71	7.06	2.07	2.26	1.97	1.17	.63	.44	.40	.38	.36	33.33
1937	.48	.67	1.41	2.20	21.36	8.57	2.12	1.92	1.26	1.05	1.05	.79	42.87
1938	1.17	1.93	3.40	3.39	11.88	5.88	2.26	1.74	1.40	1.02	.82	1.01	35.71
1939	1.55	2.36	2.96	2.49	1.87	1.62	1.32	11.99	6.57	2.80	1.71	1.20	38.45
1940	1.09	6.84	6.39	3.57	2.22	1.77	1.93	1.64	.98	.63	.48	.50	28.03
1941	.65	.96	1.15	1.80	2.69	18.43	8.18	2.68	1.98	1.33	1.21	1.31	42.37
1942	1.64	6.52	25.77	10.24	2.73	2.89	36.09	18.80	4.44	2.86	7.03	4.04	123.05
1943	21.58	35.37	15.84	3.94	2.16	5.61	3.52	1.59	.99	.76	.58	1.00	92.93
1944	1.84	2.00	1.46	1.08	1.27	17.17	7.41	1.68	1.07	.69	.46	.31	36.43
1945	.48	.57	.54	1.11	1.93	2.52	2.48	1.76	1.05	.66	.44	.33	13.87
1946	.42	.81	1.30	1.64	2.66	4.57	3.86	2.71	2.58	2.76	2.15	1.49	26.96
1947	1.22	2.02	3.03	5.13	5.44	3.69	3.28	2.73	1.64	.93	.57	.42	30.09
1948	1.02	1.96	2.36	2.42	2.57	2.35	1.90	1.42	.91	.63	.50	.57	18.59
1949	1.02	3.82	10.67	8.03	3.80	2.70	2.12	1.46	.99	.72	.79	.77	36.90
1950	.60	.49	.86	1.97	2.29	2.23	1.90	1.17	.68	.46	.88	1.40	14.93
1951	1.58	1.43	1.40	4.42	3.42	2.31	2.01	1.63	1.13	.82	.67	.55	21.36
1952	.50	.63	1.13	2.26	11.43	5.33	1.50	.86	.45	.45	.67	1.11	26.46
1953	1.49	1.66	2.52	2.89	2.50	2.02	1.53	1.27	1.07	.84	.65	.75	19.19
1954	1.98	2.91	2.28	18.68	13.04	8.04	4.06	2.09	1.24	.79	.55	.57	56.21
1955	.77	1.10	1.55	1.29	1.95	21.79	9.28	2.22	1.41	.93	.79	.81	43.88
1956	.90	1.29	2.190	11.70	3.78	2.98	15.79	6.96	1.71	1.01	.74	1.21	69.97
1957	2.23	2.91	2.78	2.82	17.88	7.70	8.95	4.58	1.59	.99	.65	.69	53.77
1958	1.17	1.12	1.62	2.32	2.68	1.93	1.12	17.55	7.81	2.01	1.62	1.31	41.88
1959	1.17	1.25	1.34	4.80	1.25	1.53	1.78	1.44	.88	.57	.42	.40	13.31
1960	.61	1.32	7.24	4.80	2.74	2.50	24.81	10.08	2.10	1.62	1.22	1.12	60.17
1961	1.16	1.11	1.10	1.52	1.93	2.49	2.53	1.79	1.07	.65	.58	.55	16.46
1962	.54	1.20	1.72	2.13	2.06	2.11	2.06	1.37	.82	1.28	1.62	1.14	18.06
1963	.85	.79	.92	4.12	3.28	2.10	1.81	1.40	.82	.78	.61	.60	18.22
1964	1.21	1.59	1.82	1.94	1.63	1.03	.55	.52	1.05	1.47	1.61	1.72	16.15
1965	1.87	2.31	2.49	9.71	5.11	1.76	.95	.87	.90	.75	.61	.57	27.89
1966	.58	1.04	1.42	2.01	8.37	14.30	6.40	2.57	1.50	.95	.65	.44	40.22
1967	.62	1.27	1.46	2.20	2.53	2.00	1.35	.79	.49	.36	.48	.80	14.35
1968	1.03	1.01	.84	.64	.66	1.50	2.15	2.31	2.00	1.45	1.11	1.08	15.78
1969	2.30	3.38	3.51	3.36	2.34	1.25	.70	.61	.70	.71	.93	1.57	21.38
1970	12.23	10.71	4.80	2.86	2.37	2.74	3.23	15.24	6.93	2.40	2.80	2.69	69.00
1971	2.06	1.59	1.83	1.99	2.43	2.33	1.56	1.31	1.33	1.15	.86	.58	19.03
1972	.58	.91	1.18	1.53	1.86	1.69	1.33	.94	.41	.57	.69	1.83	13.51
1973	2.47	2.92	2.66	6.91	4.68	3.21	2.65	2.37	2.05	1.49	1.04	.67	33.12
1974	.61	.78	1.09	3.76	15.54	6.48	1.71	1.24	.86	.56	.44	.93	33.99
1975	1.44	1.36	1.78	6.07	4.43	37.35	20.19	4.83	1.96	1.18	.99	1.03	82.60
MEAN	1.69	3.05	3.97	3.94	4.11	6.05	4.64	2.97	2.28	1.32	1.03	.97	36.02
S	3.17	5.44	6.12	3.98	4.34	11.24	7.01	4.04	5.38	2.04	1.00	.65	25.75
V% MEDIAN	187.11	178.08	154.10	101.08	105.69	185.73	151.22	136.12	235.84	154.13	96.83	67.23	71.49
	1.02	1.29	1.72	2.26	2.43	2.49	2.06	1.63	1.07	.82	.69	.79	27.89

TABLE NS 50 / XVII HYPOTHETICAL SIMULATED RUN-OFF FOR MBOKODWENI + STIPINGO FLOOD FLOWS OVER 55 YEARS.

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL	%A.A.R.
1921	1.24	15.86	16.65	12.49	1.84	1.07	1.70	.84	1.20	1.14	1.09	1.01	75.18	191.93
1922	2.09	11.07	5.14	2.38	2.67	2.31	1.78	1.13	.66	.54	.40	.40	30.68	78.34
1923	.35	.44	1.15	1.89	1.75	1.16	.82	1.75	.60	.54	.54	.54	10.24	26.15
1924	.69	1.00	1.38	1.71	1.89	86.87	31.15	2.32	1.67	1.25	.94	1.14	132.02	337.04
1925	2.20	2.27	1.48	.89	.76	1.10	1.01	.47	.44	.34	.37	.37	11.96	30.52
1926	.64	.75	.71	.61	.59	5.04	3.43	1.45	.82	.54	.71	.71	16.00	40.86
1927	.76	.80	1.16	1.90	2.27	1.93	1.30	.84	.55	.37	.31	.36	12.53	32.00
1928	.61	.82	.89	1.04	1.00	2.73	2.04	1.89	2.21	3.35	2.94	2.43	22.85	58.34
1929	2.70	2.71	2.38	8.40	4.51	2.35	2.04	1.35	.89	.75	.83	.99	29.91	76.36
1930	1.34	1.70	2.45	6.41	3.68	2.22	2.03	1.35	.74	.80	.96	.69	24.38	62.25
1931	.61	.72	.99	1.45	2.08	2.70	2.33	1.69	1.34	.93	.62	.48	15.95	40.71
1932	.90	1.56	2.23	2.16	1.69	1.45	1.22	.87	.57	.46	.40	.32	13.83	35.30
1933	.29	.95	8.49	22.52	8.71	2.49	2.82	2.89	2.14	1.93	2.06	1.65	56.96	145.43
1934	1.25	1.21	3.73	4.48	5.83	3.98	2.66	2.46	46.88	17.99	2.43	1.50	94.40	241.01
1935	.95	.67	.49	.73	1.92	9.52	4.73	2.63	2.81	2.00	1.28	.80	28.64	73.12
1936	.88	18.31	8.02	2.07	2.26	1.97	1.17	.63	.44	.40	.38	.35	36.89	94.18
1937	.48	.67	1.41	2.20	24.77	9.67	2.13	1.97	1.30	1.09	1.11	.79	47.58	121.46
1938	1.20	2.05	3.70	3.59	13.35	6.49	2.30	1.76	1.46	1.06	.84	1.05	38.86	99.20
1939	1.64	2.55	3.18	2.53	1.87	1.62	1.32	13.86	7.56	3.16	1.89	1.27	42.46	108.41
1940	1.10	7.84	7.23	3.81	2.22	1.77	1.93	1.64	.98	.63	.48	.50	30.12	76.89
1941	.65	.96	1.15	1.80	2.74	21.30	9.28	2.87	2.14	1.42	1.30	1.40	47.01	120.03
1942	1.75	7.46	30.10	11.68	2.78	2.96	42.22	21.89	5.05	3.23	8.17	4.63	141.92	362.32
1943	25.28	41.51	18.38	4.24	2.16	6.17	3.74	1.59	.99	.76	.58	1.04	106.47	271.82
1944	1.99	2.13	1.46	1.08	1.27	19.81	8.37	1.69	1.07	.69	.46	.31	40.32	102.95
1945	.48	.57	.54	1.11	1.93	2.53	2.56	1.78	1.05	.66	.44	.33	13.98	35.69
1946	.42	.81	1.30	1.64	2.70	4.94	4.18	2.91	1.85	3.11	2.41	1.62	28.90	73.77
1947	1.26	2.15	3.27	5.65	5.98	3.91	3.50	2.93	1.74	.95	.57	.42	32.32	82.52
1948	1.02	2.08	2.47	2.45	2.59	2.35	1.90	1.42	.91	.63	.50	.57	18.87	48.17
1949	1.02	4.28	12.28	9.07	4.05	2.74	2.13	1.46	.99	.72	.81	.77	40.33	102.95
1950	.68	.49	.86	1.97	2.29	2.23	1.90	1.17	.68	.46	.91	1.51	15.07	38.46
1951	1.68	1.45	1.40	4.81	3.60	2.31	2.01	1.63	1.14	.82	.67	.55	22.06	56.33
1952	.50	.63	1.13	2.26	13.05	5.84	1.50	.86	.58	.45	.67	1.17	28.65	73.14
1953	1.58	1.73	2.66	3.00	2.51	2.02	1.53	1.27	1.07	.84	.65	.75	19.61	50.06
1954	2.15	3.20	2.38	21.64	14.95	9.04	4.42	2.17	1.27	.79	.55	.57	63.11	161.13
1955	.77	1.10	1.55	1.29	1.95	25.27	10.58	2.33	1.47	.95	.81	.81	48.87	124.76
1956	.90	1.29	25.54	13.40	4.02	3.07	18.26	7.92	1.83	1.04	.75	1.29	79.31	202.48
1957	2.45	3.20	2.97	2.91	20.66	8.64	10.19	5.11	1.68	1.02	.65	.69	60.18	153.63
1958	.79	1.12	1.62	2.33	2.72	1.93	1.12	20.42	9.02	2.22	1.79	1.40	46.48	118.65
1959	1.20	1.25	1.34	1.28	1.25	1.53	1.78	1.44	.88	.57	.42	.40	13.34	34.05
1960	.61	1.33	8.23	5.26	2.79	2.50	28.91	11.60	2.29	1.76	1.32	1.18	67.79	173.07
1961	1.18	1.11	1.10	1.52	1.93	2.49	2.61	1.82	1.07	.65	.58	.55	16.59	42.35
1962	.54	1.20	1.72	2.13	2.06	2.11	2.06	1.37	.82	1.36	1.79	1.20	18.37	46.89
1963	.85	.79	.92	4.46	3.43	2.10	1.81	1.40	.95	.78	.61	.60	18.71	47.78
1964	1.24	1.64	1.84	1.94	1.63	1.76	.55	.52	1.05	1.59	1.78	1.89	16.71	42.65
1965	2.02	2.49	2.63	11.05	5.59	1.76	.95	.87	.90	.75	.61	.57	30.18	77.06
1966	.58	1.04	1.42	2.01	9.44	16.43	7.18	2.74	1.58	.97	.65	.44	44.47	113.53
1967	.62	1.27	1.46	2.20	2.55	2.00	1.35	.74	.49	.36	.48	.80	14.37	36.70
1968	1.03	1.01	.84	.64	.66	1.50	2.17	2.43	2.17	1.56	1.19	1.13	16.33	41.69
1969	2.30	3.38	3.51	3.35	2.34	1.25	.70	.61	.70	.71	.93	1.57	21.38	54.59
1970	12.23	10.71	4.80	2.86	2.37	2.74	3.23	15.24	6.92	2.40	2.79	2.69	68.98	176.12
1971	2.06	1.58	1.83	1.99	2.43	2.33	1.56	1.31	1.33	1.15	.86	.58	19.02	48.55
1972	.58	.91	1.18	1.53	1.86	1.69	1.33	.94	.57	.41	.69	1.83	13.51	34.48
1973	2.47	2.92	2.67	6.91	4.68	3.21	2.65	2.36	2.05	1.49	1.03	.67	33.11	84.53
1974	.61	.78	1.09	3.76	15.54	6.48	1.71	1.24	.82	.56	.44	.93	33.95	86.69
1975	1.43	1.36	1.78	6.07	4.44	37.35	20.19	4.83	1.96	1.19	.90	1.03	82.61	210.92

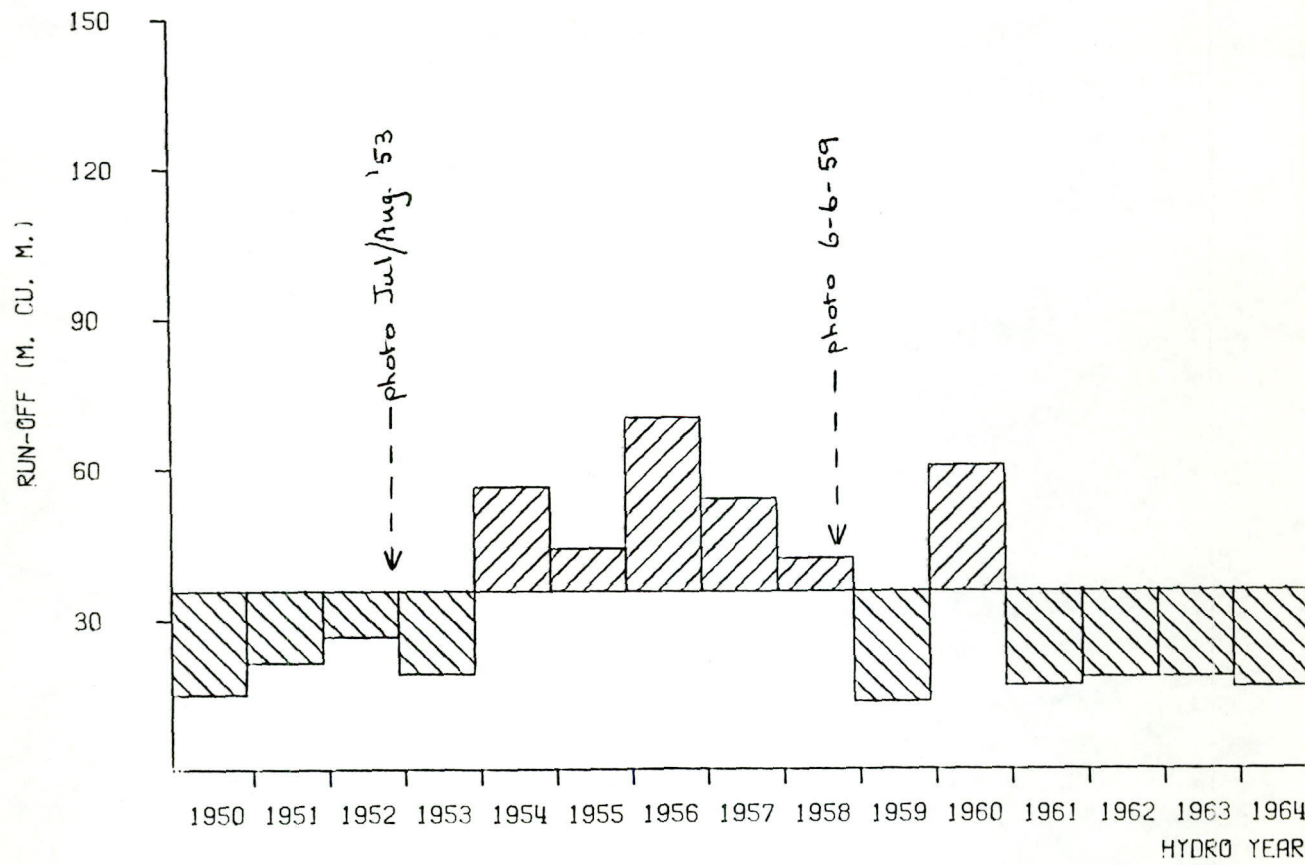
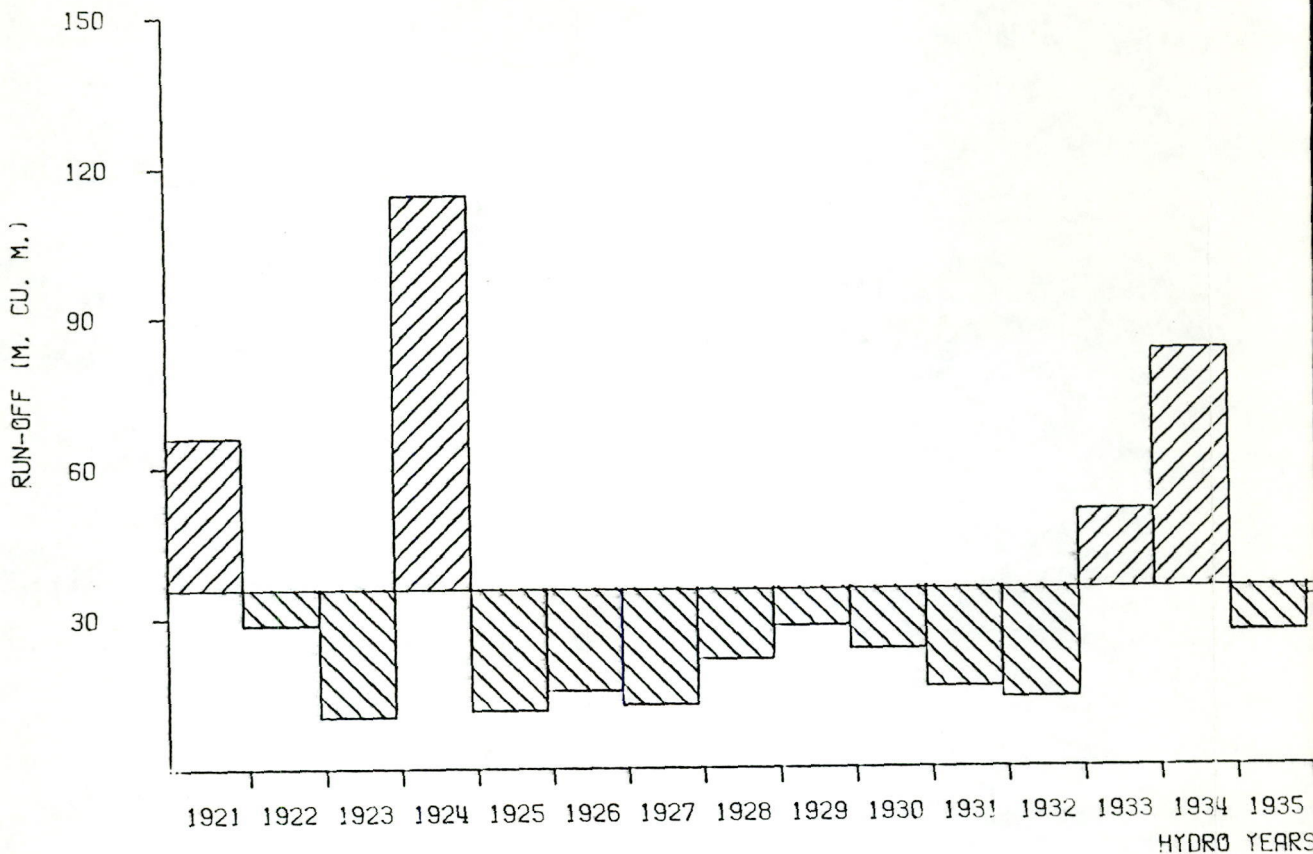
MEAN 1.80 3.36 4.40 4.26 4.41 6.62 5.09 3.20 2.50 1.42 1.10 1.01 39.17
 S 3.61 6.36 7.20 4.65 4.98 12.94 8.13 4.61 4.61 6.33 2.40 1.16 .73 29.67
 V 200.91 189.32 103.42 108.95 112.94 195.47 159.65 144.14 253.34 168.32 105.70 72.10 75.74
 MEDIAN 1.02 1.29 1.72 2.26 2.43 2.49 2.06 1.63 1.07 .82 .69 .79 29.91
 MEAN ANNUAL RUN-OFF = 39.17 MILLION CURIC METRES. COMPILED FROM HRU REPORT NO.9/81 DATA



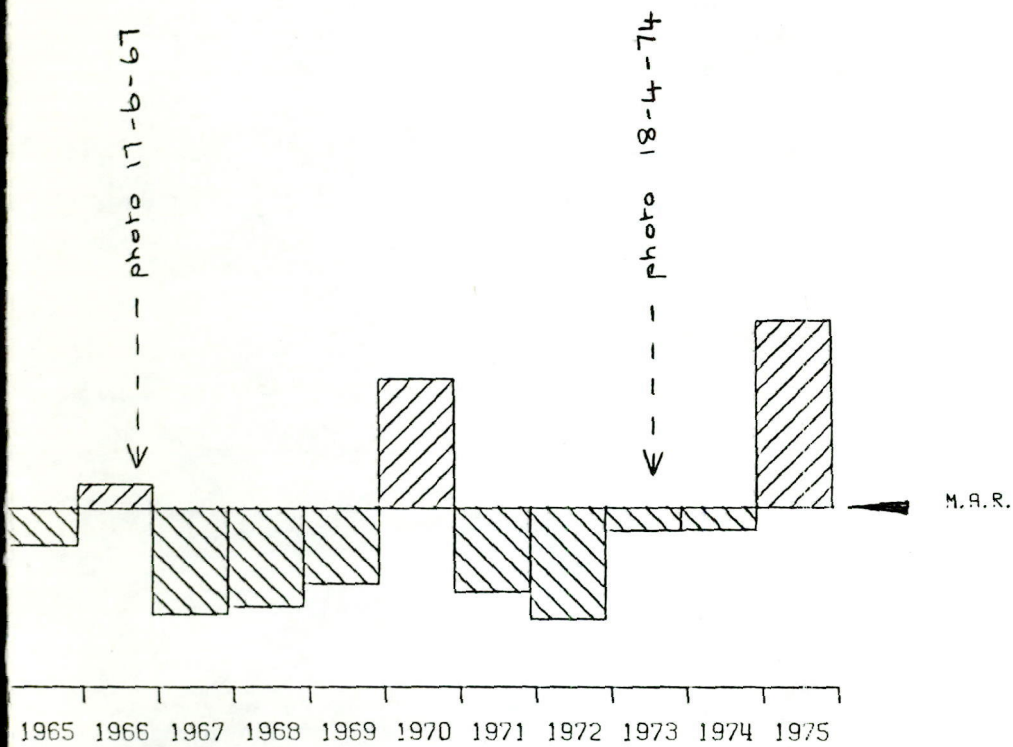
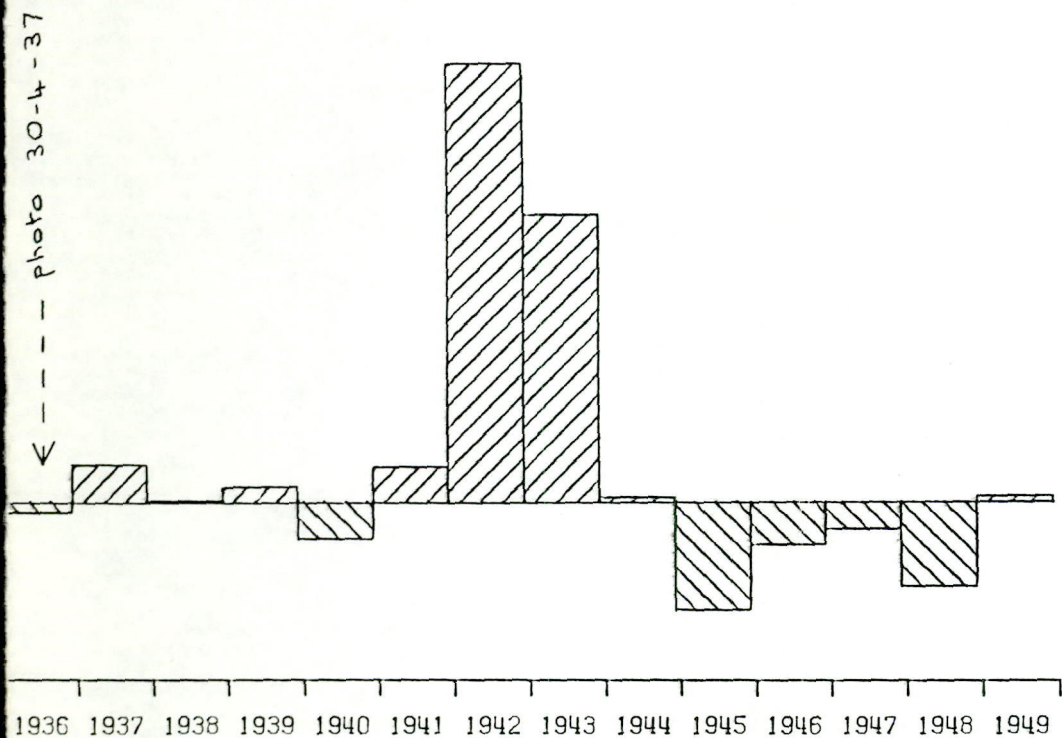
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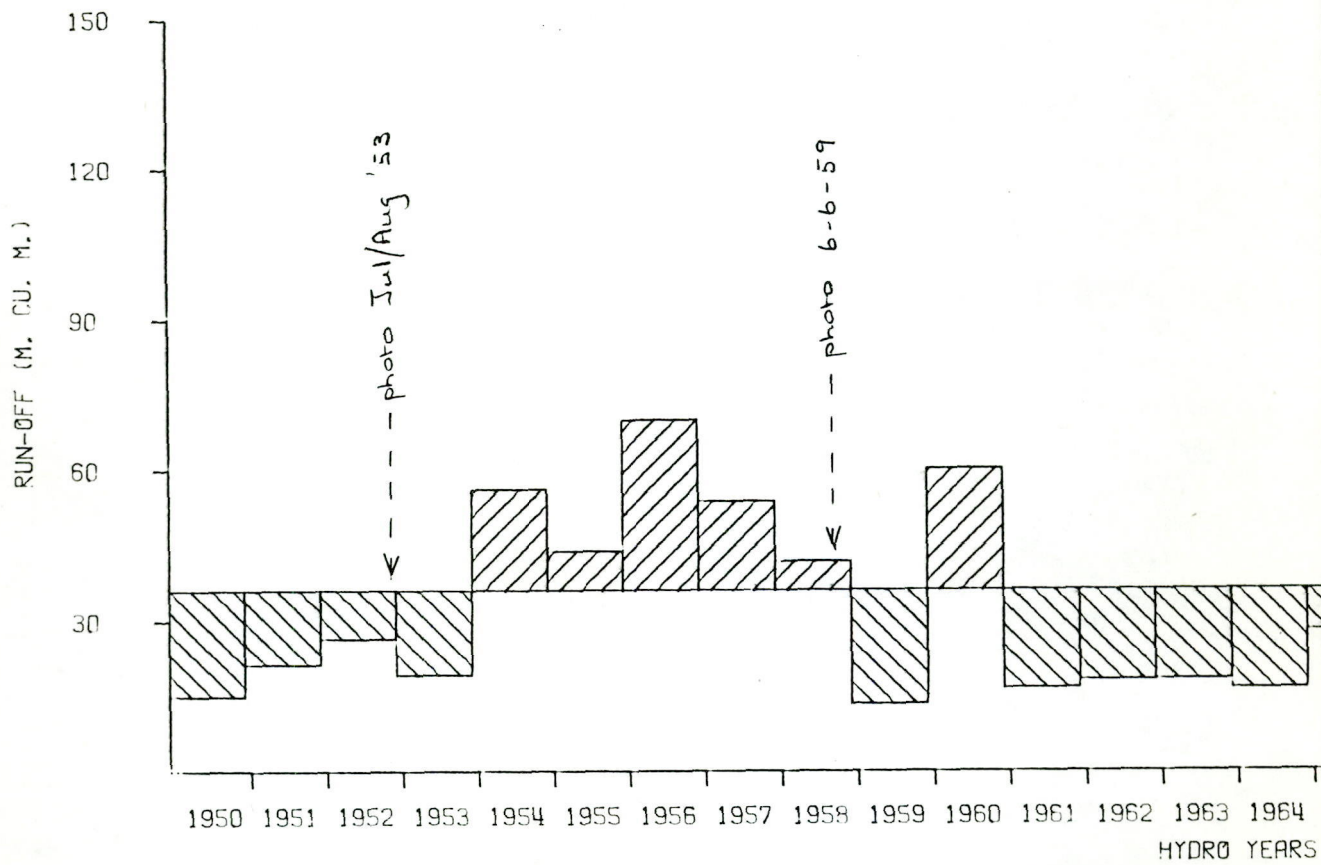
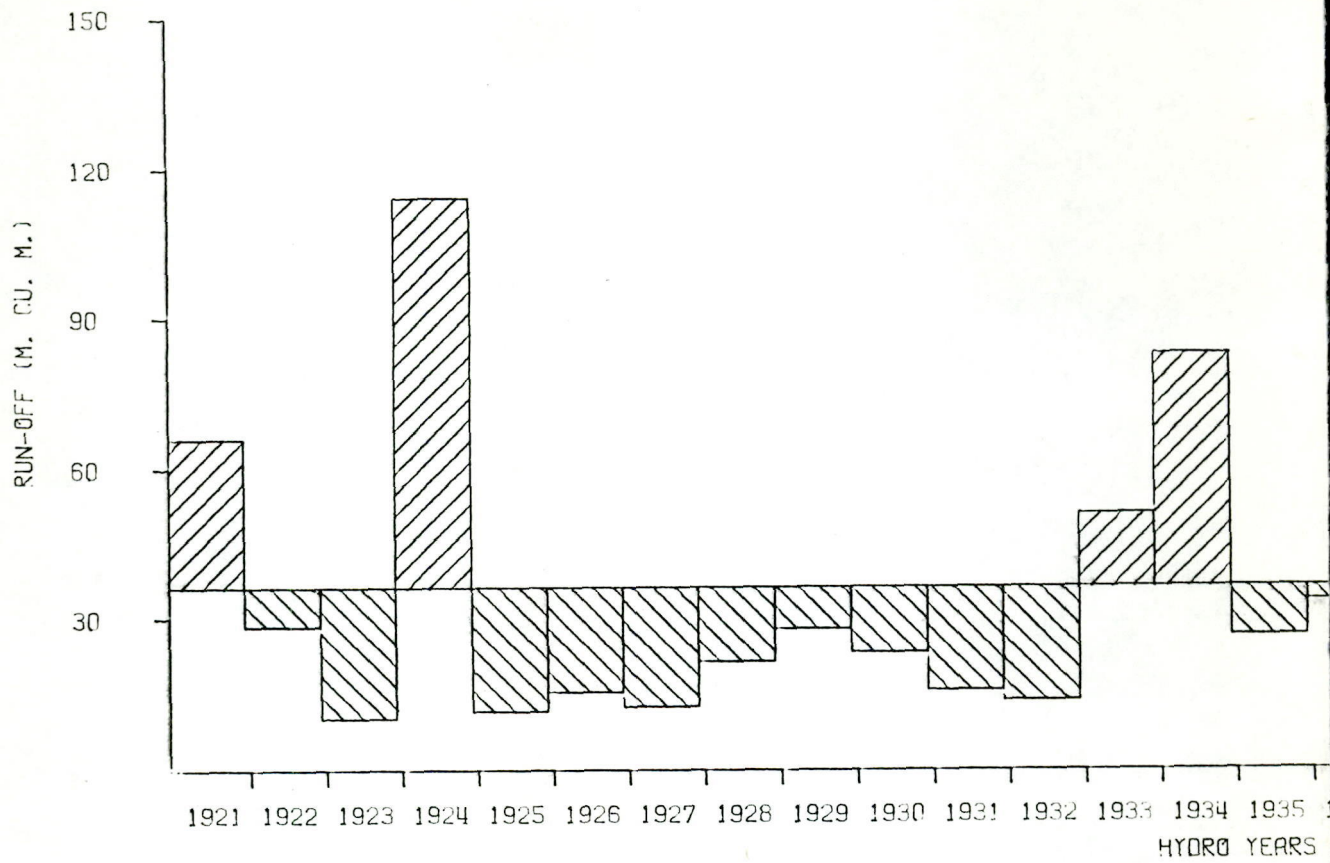
NATAL ESTUARIES: MBOKODWENI
 THALWEG DISPLACEMENT
 (1937 - 1984)

FIGURE
 NS 50/1



TRACED : COMPILOT CHECKED : DATE : REF. :	NATAL ESTUARIES : MBOKODWENI SIMULATED ANNUAL RUN-OFF 1921-1975	FIGURE NS 50/2
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY		





TRACED : COMPLETE
 CHECKED :
 DATE :
 REF. :

NATAL ESTUARIES : MBOKODWENI
 ADJUSTED SIMULATED ANNUAL RUN-OFF
 1921-1975

FIGURE
 NS 50/3

photo 30-4-37

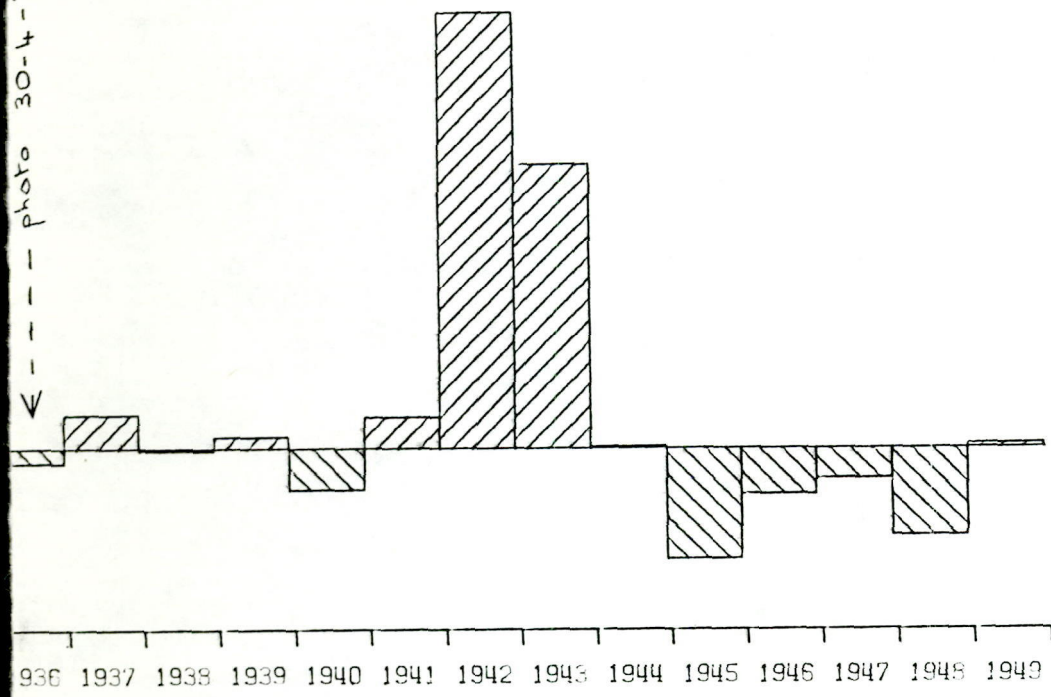
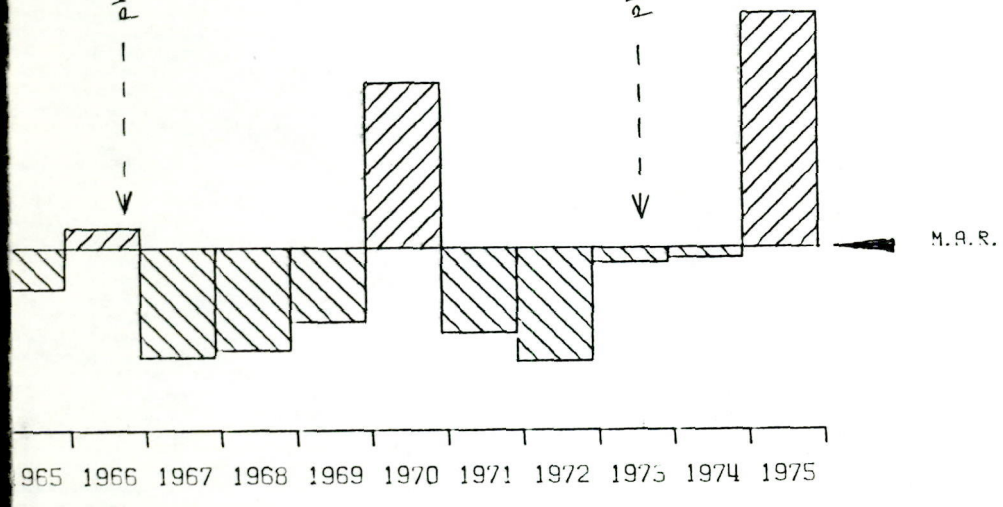
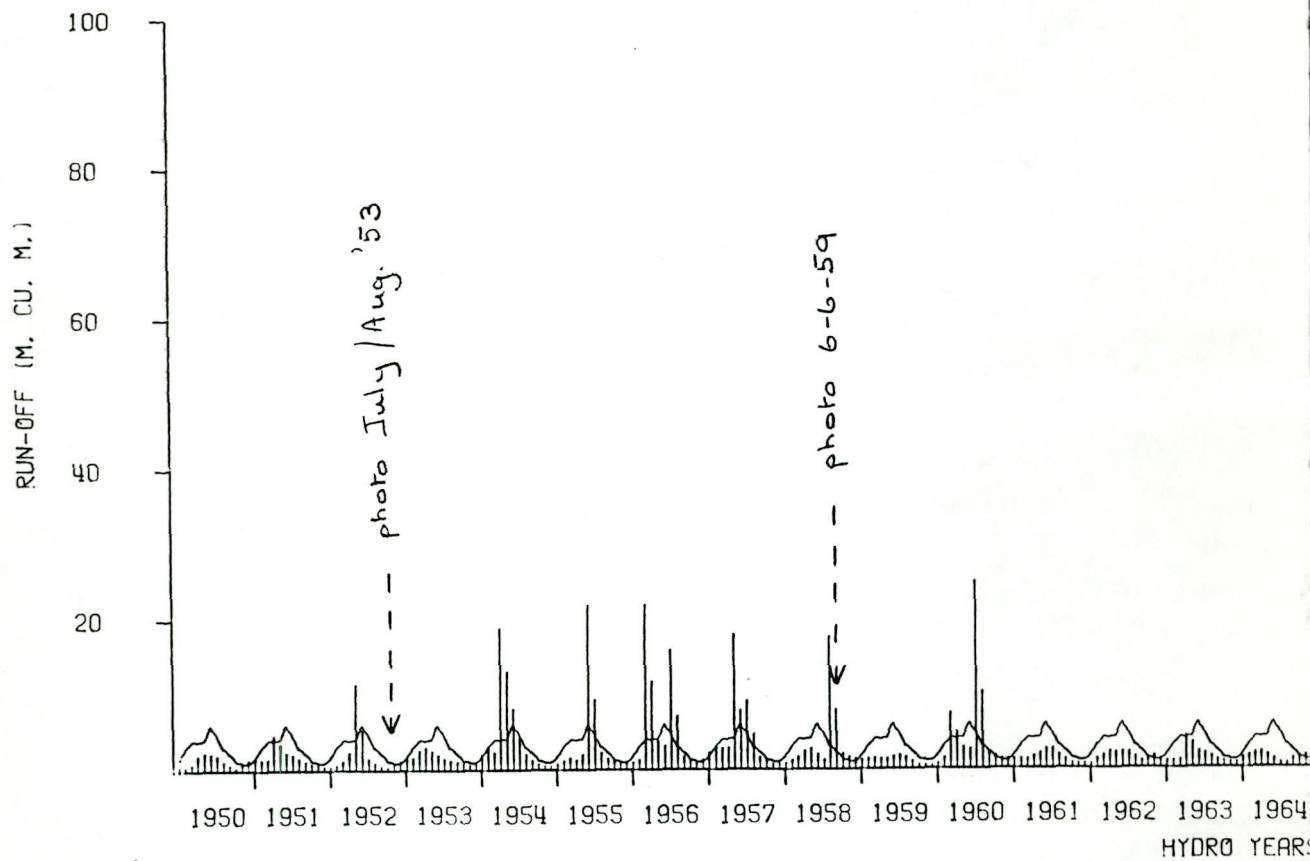
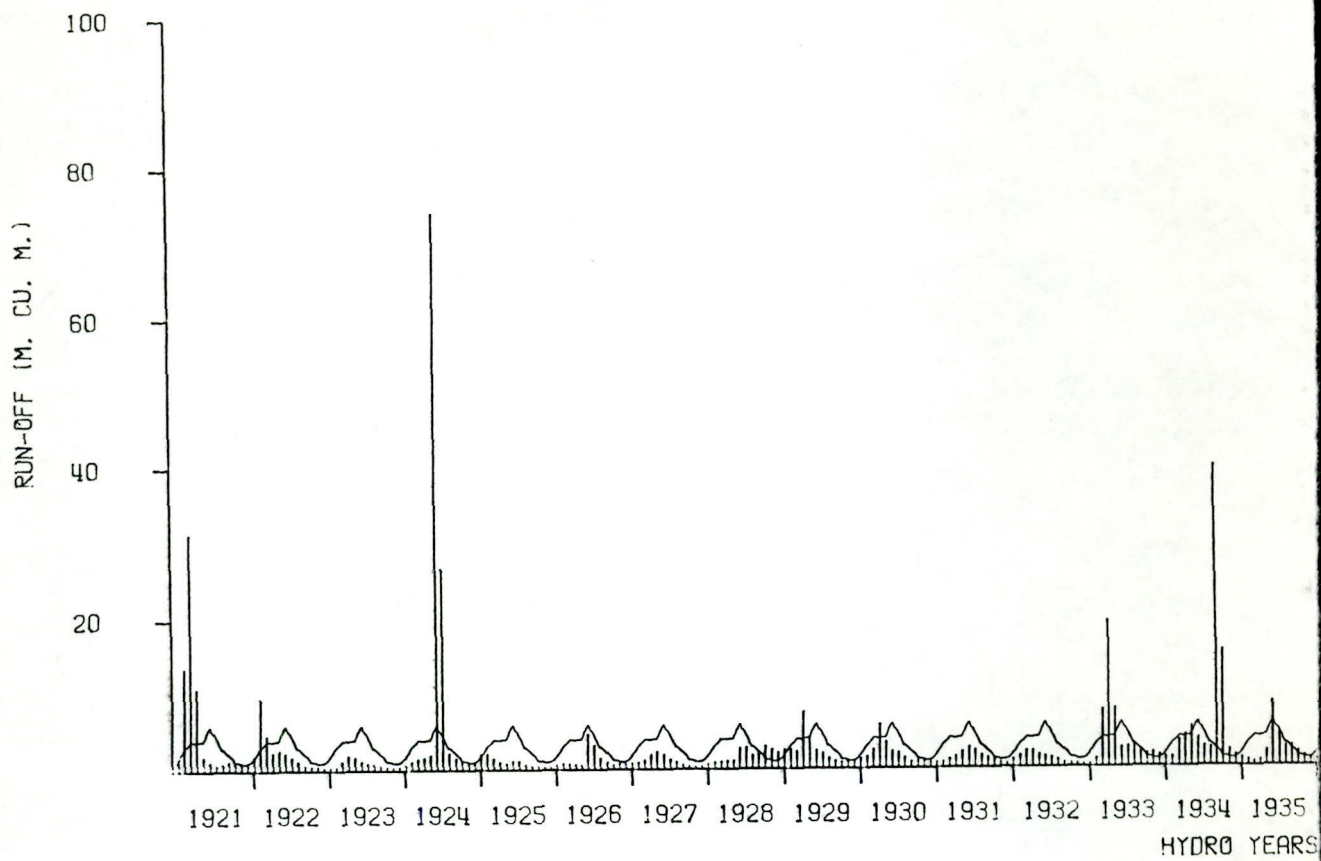


photo 17-6-67

photo 18-4-74





TRACED : COMPLIT
CHECKED:
DATE :
REF. :

NATAL ESTUARIES : MBOKODWENI
SIMULATED MONTHLY RUN-OFF
1921-1975

FIGURE
NS 50/4

photo 30-4-37

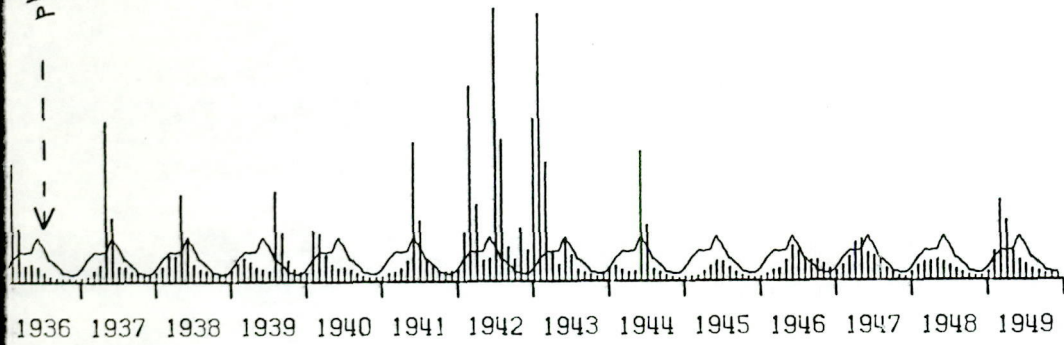
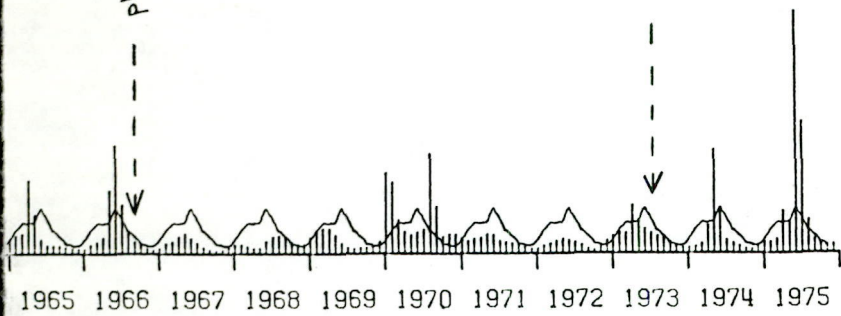
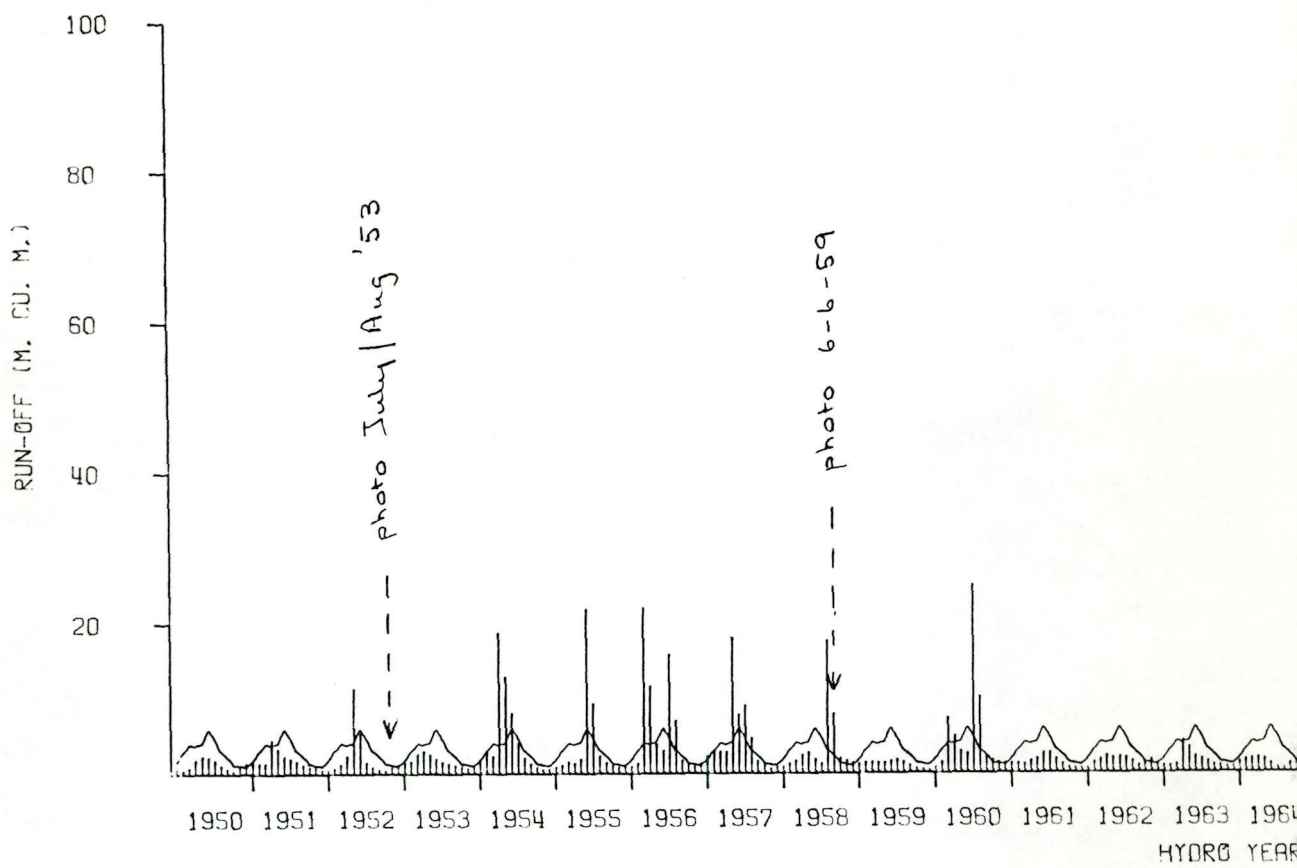
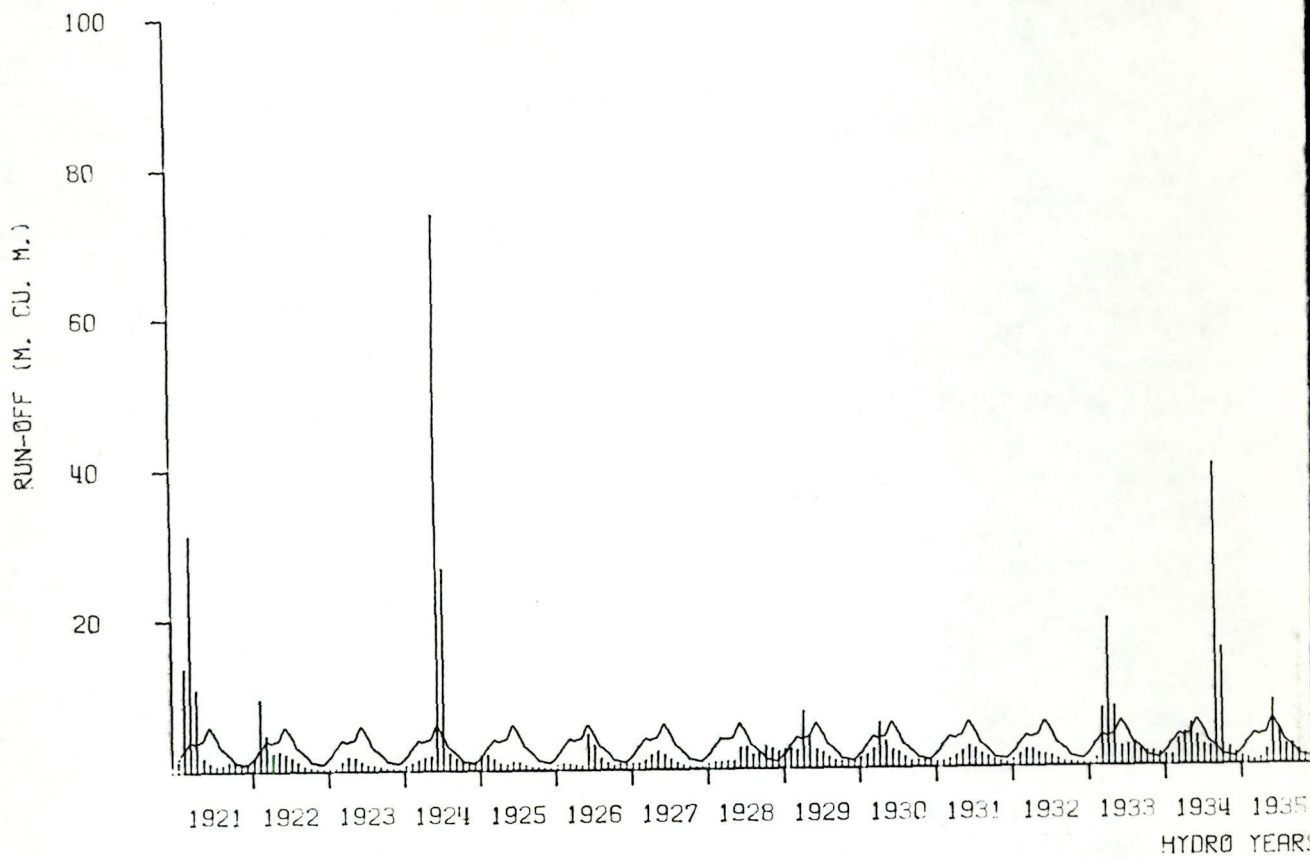


photo 17-6-67

photo 18-4-74



 MONTHLY MEANS



TRACED : COMPLETE
CHECKED :
DATE :
REF :

NATAL ESTUARIES : MBOKODWENT
ADJUSTED SIMULATED MONTHLY RUN-OFF
1921-1975

FIGURE
NS 50/5

photo 30-4-37

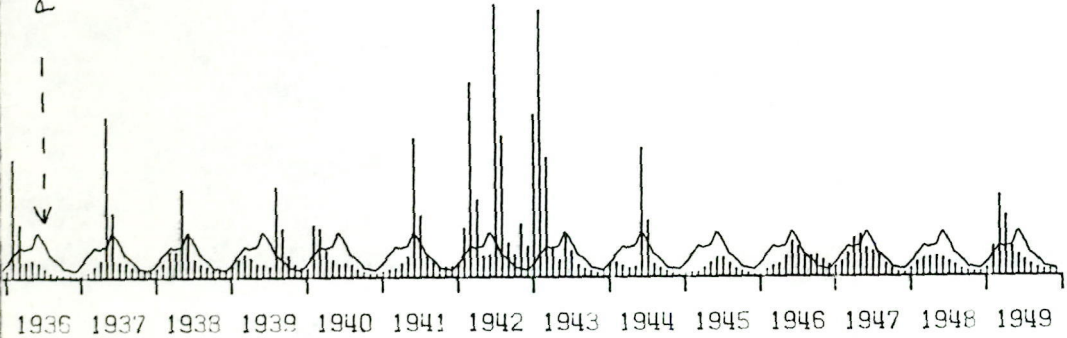
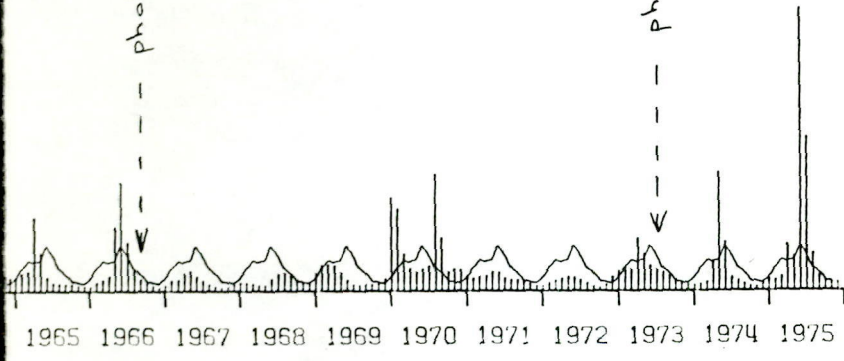

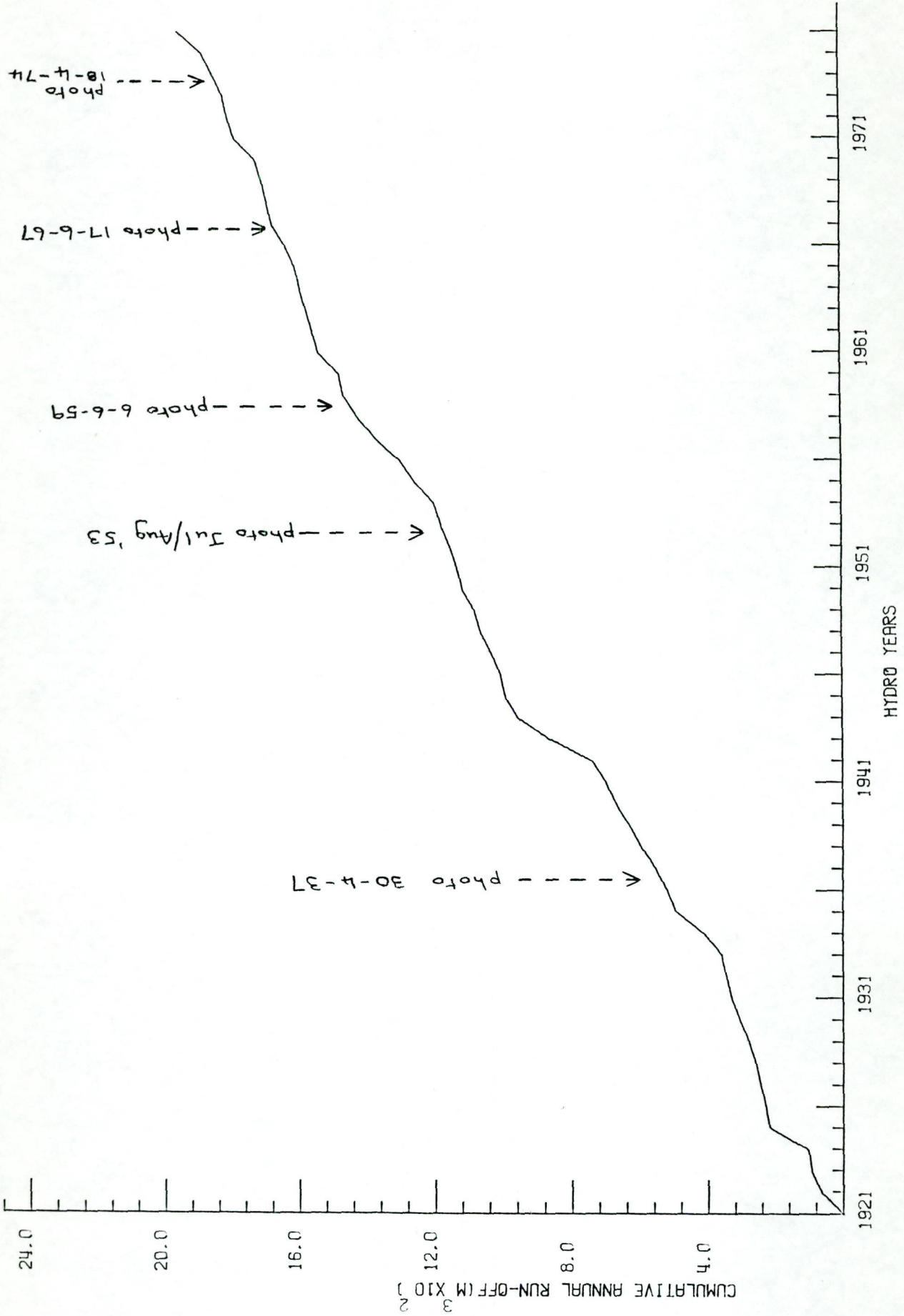


photo 17-6-67

photo 18-4-74



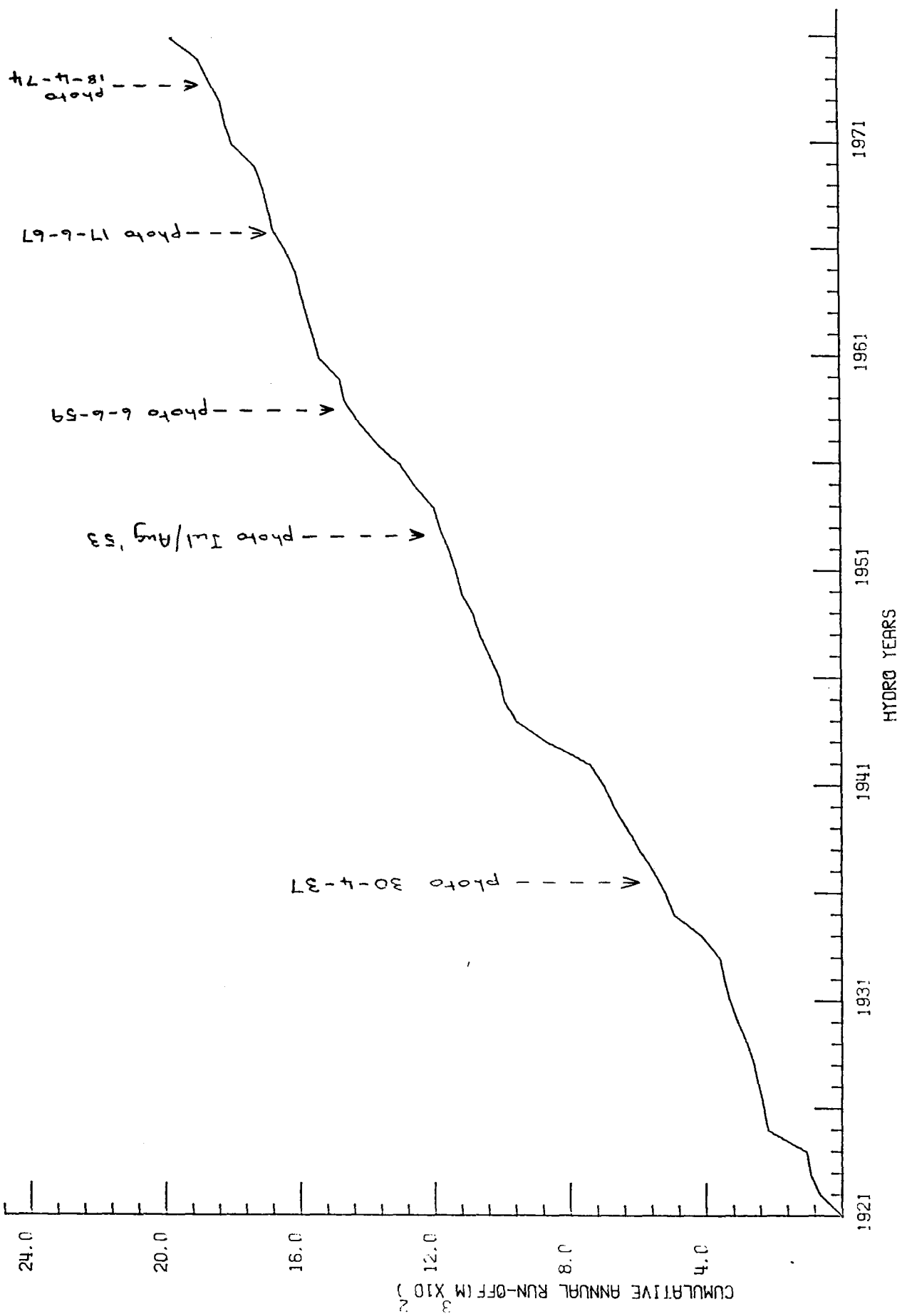
 MONTHLY MEANS



TRACED : COMPILOT
 CHECKED:
 DATE :
 REF. :

NATAL ESTUARIES: MBOKODWENI
 CUMULATIVE ANNUAL RUN-OFF

FIGURE
 NS 50/6



TRACED : COMPILOT
 CHECKED:
 DATE :
 REF. :

NATAL ESTUARIES: MBOKODWENI
CUMULATIVE ANNUAL RUN-OFF
 (ADJUSTED)

FIGURE
NS 50/7



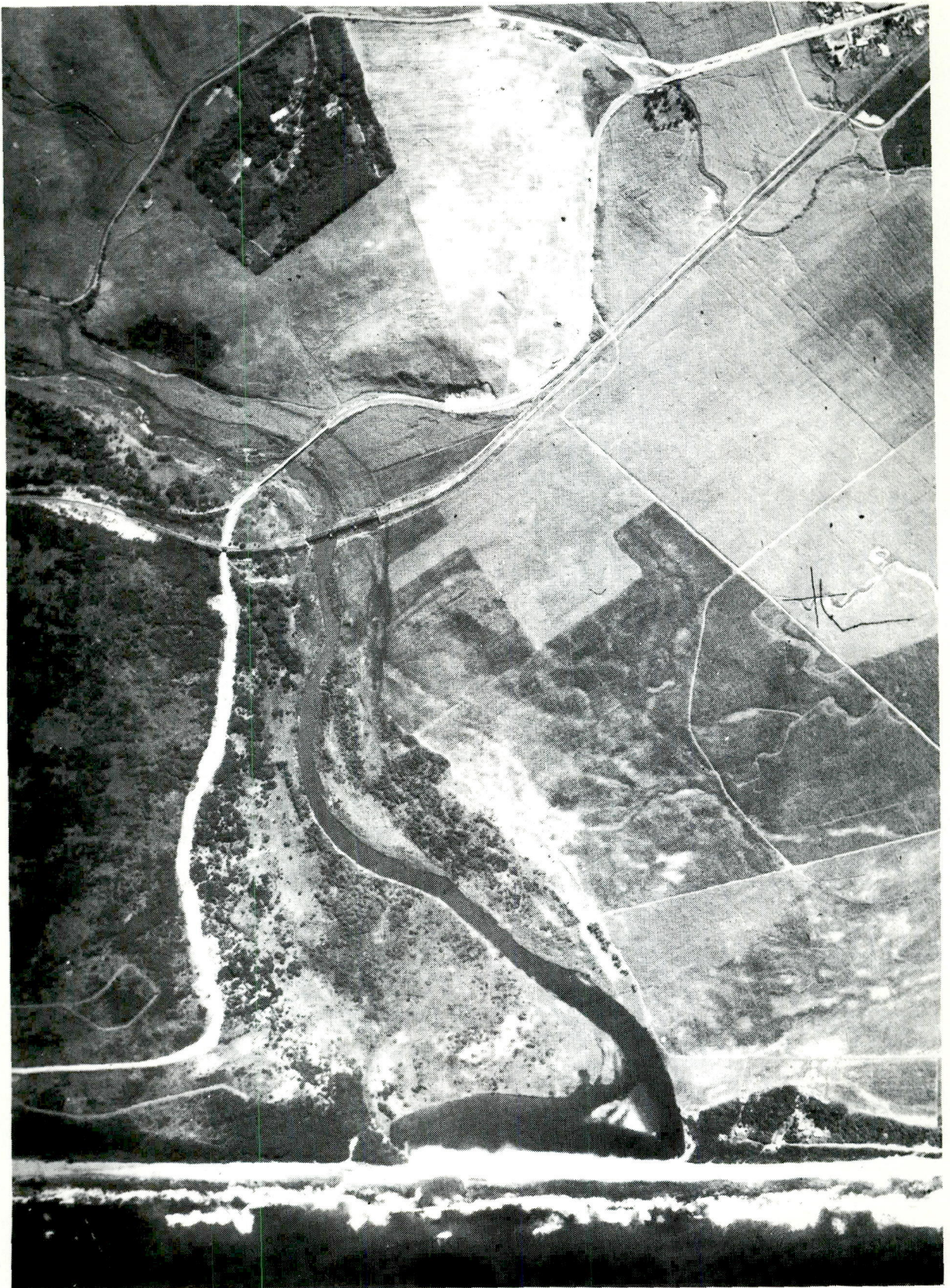
SCALE: 1 : 10 000 approx.

TRACED
CHECKED
DATE
REF

NATAL ESTUARIES : MBOKODWENI
6 - 2 - 84
(30 - 4 - 37 RIVER COURSE SUPERIMPOSED)

PHOTOGRAPH
NS 50/1

NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY



SCALE: 1:10 000 approx.

TRACED
CHECKED
DATE
REF

NATAL ESTUARIES: MBOKODWENI

30-4-37 (12 h 43)

PHOTOGRAPH

NS 50/2

NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY



SCALE: 1 : 10 000 approx.

TRACED
CHECKED
DATE
REF

NATAL ESTUARIES : MBOKODWENI

JULY / AUGUST 1953 (11 h 15)

PHOTOGRAPH
NS 50/3

NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY



SCALE: 1 : 10 000 approx.

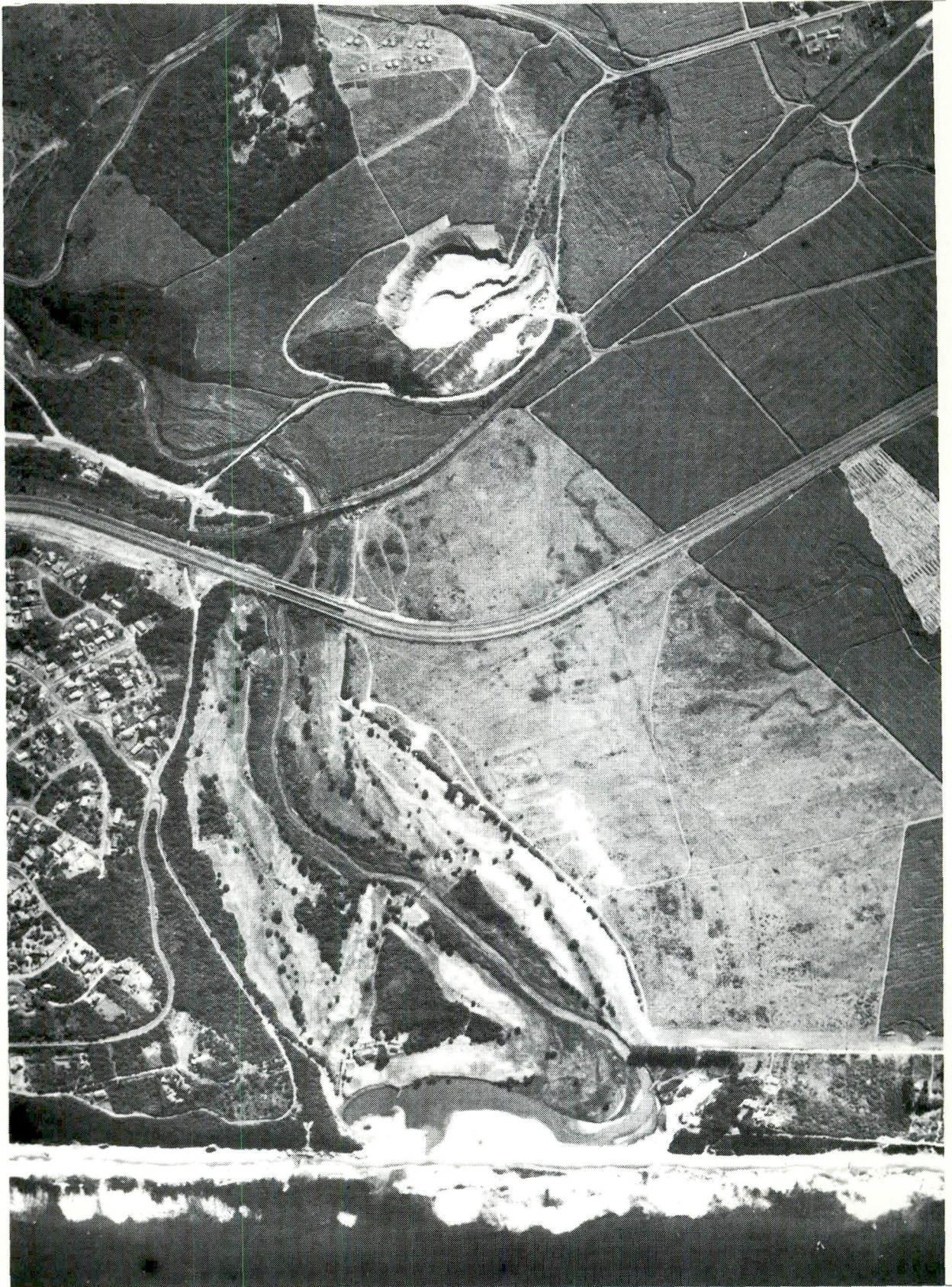
TRACED
CHECKED
DATE
REF

NATAL ESTUARIES : MBOKODWENI

6-6-59 (12 h 37)

PHOTOGRAPH
NS 50/4

NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY



SCALE: 1 : 10 000 approx.

TRACED
CHECKED
DATE
REF

NATAL ESTUARIES : MBOKODWENI

17-6-67 (13h07)

PHOTOGRAPH
NS 50/5

NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY



SCALE: 1 : 10 000 approx.

TRACED
CHECKED
DATE
REF

NATAL ESTUARIES : MBOKODWENI

18 - 4 - 74 (11h27)

PHOTOGRAPH
NS 50/6

NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY



SCALE: 1 : 10 000 approx.

TRACED
CHECKED
DATE
REF

NATAL ESTUARIES : MBOKODWENI

6 - 2 - 84 (15h52)

PHOTOGRAPH
NS 50/7

NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY



SCALE: 1:10 000 approx.

TRACED
CHECKED
DATE
REF

NATAL ESTUARIES: MBOKODWENI

18 - 4 - 74 (ORTHOGRAPHO)

PHOTOGRAPH

NS 50/8

NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY

DATA REPORT 20/21

HYDRO-CLASSIFICATION OF THE LOWER REACHES OF THE

SIPINGO NS 51
(and MLAZI NS 52)

CONTENTS

DATA REPORT 20/21

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NS 51/III	Classification of the lower reaches of the Sipingo 1953
NS 51/IV	Classification of the lower reaches of the Sipingo 1959
NS 51/V	Classification of the lower reaches of the Sipingo 1967
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NS 51/IX	Lateral stability: 1937-1984
NS 51/X	Simulated run-off: 1921-1975
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- * NS 51/5 17-6-67 (13h07)
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- ** NS 51/7 6-2-84 (15h52)
- * NS 51/8 18-4-74 (Orthophoto)

APPENDIX

- | | | |
|--------------------------|--|---------|
| Table NS 52/I | Simulated run-off: 1921-1975 |] Mlazi |
| Figure NS 52/1 | Simulated annual run-off: 1921-1975 | |
| Figure NS 52/2 | Simulated monthly run-off: 1921-1975 | |
| Figure NS 52/3 | Cumulative annual run-off: 1921-1975 | |
| ** Photograph NS 50/51/1 | Mbokodweni and Sipingo (10/11/66
13h03) | |

BRIEF NOTESSIPINGO/MLAZI (NS 51/52)Location

The Sipingo discharges into the Indian Ocean on the Natal South Coast at 30°00'S, 30°57'E. The Mlazi shared a common mouth with the Sipingo at this position until 1952 but now discharges into the ocean along a concrete lined canal further ENE (see Frontispiece Photograph and the Foreword). The head of the reach under review is the Avenue East road bridge, 1,5 km from the mouth (Photograph NS 51/8).

Hydro Data

The M.A.R. from the Sipingo catchment (51 km²) is 6,41 x 10⁶m³. However, this does not reflect the run-off conditions near the mouth where until 1952 the Sipingo joined the much larger Mlazi river. The M.A.R. for the Mlazi alone from a catchment of 972 km² is 91 x 10⁶m³. Furthermore, since 1969, floodwaters from the Sipingo have been diverted to the Mbokodweni. In order to give a more representative picture of conditions at the mouth of the Sipingo, the simulated run-off data for Tertiary catchments (Pitman et al. 1981) have been "adjusted" in the following manner:

- (a) 1921-1951; the run-off from the Sipingo and the Mlazi have been added (M.A.R. 102, 16 x 10⁶m³).
- (b) 1952-1968; Sipingo alone (M.A.R. 5,85 x 10⁶m³).
- (c) 1969-1975; for the portion of the catchment of the Sipingo upstream of the railway bridge, the difference between the total and median run-off has been subtracted from the run-off figures (Table NS 51/XII). The negligible remaining run-off has been added to a 90 per cent run-off/rainfall estimate from the Prospection Industrial area of the remainder of the catchment (M.A.R. 2,60 x 10⁶m³).

Although these "adjustments" are estimates only, they allow a comparison to be made of run-off conditions from 1921-1975 to show the marked impact of human intervention on the hydro-conditions of the Sipingo estuary. Full details are clearly seen in the Tables and Figures as follows:

1. Simulated virgin run-off from the Sipingo catchment alone (Table NS 51/X and Figures NS 51/2, 4 and 6).
2. Simulated virgin run-off from the Mlazi catchment alone (Appendix Table NS 52/I and Figures NS 52/1, 2 and 3).
3. "Adjusted" run-off for the Sipingo as itemized above (Table NS 51/XI and Figures NS 51/3, 5 and 7).

For classification purposes, current and antecedent run-off conditions must be considered for each of the time slices covered by the aerial photographs. The following important facts emerge regarding the six relevant photographs:

1. 1937; below-average run-off within a dry phase.
2. 1953; below-average run-off within a dry phase.
3. 1959; slightly above-average, flood flows one month previous.
4. 1967; below-average run-off, above-average two to four months previous.
5. 1974; below-average run-off within a dry phase.
6. 1984; near/slightly above-average run-off, previous three months above-average following three years severe drought conditions.

River Mouth

The 300 m long sand-spit at the mouth is southerly-extending. The Sipingo/Mlazi rivers prior to 1952 and occasionally since then the Sipingo alone, discharge into the ocean against rocks and over a rock sill towards the right bank. This rock sill, unlike the one at the Mbokodweni, is not continuous and therefore is not a barrier to tidal exchange. In former years a tidal influence was noted as far upstream as Sipingo rail (Ward, 1980).

With the marked reduction in run-off from $102,16 + 5,85 + 2,60 \times 10^6 \text{m}^3$ as noted in the section above on Hydro-data, the mouth became increasingly liable to closure. During research within a dry phase, Begg (1983) found the mouth to be closed 99 per cent of the time. Initially when the mouth became blocked, an attempt was made to clear the bar mechanically. This was followed in 1955 by the installation of a metal pipe which in turn was replaced by a pair of concrete pipes in 1961. The landward base of these pipes is 30 cm above MSL (Ward, 1980). Generally, tidal exchange is restricted by these pipes but sometimes the bar is breached mechanically in a position near to the right bank. However, the mouth only remains open for a short while afterwards.

Land-use

(a) Agriculture

Sugar cane was cultivated on the left valley side area (40 per cent) until the middle 1970s.

(b) Structures

There is a road bridge at the head of the reach and a small road bridge across the southern lagoon area.

A 275 m long wall lies along the right bank of the mouth area.

From 1906-1927 there was a boating canal which linked the main river course (at 650 m from the head of the reach) with the southern lagoon area. In 1952, the Mlazi was diverted to a concrete-lined canal 4 km ENE of the Sipingo mouth. From 1966-1969 the Sipingo upstream of the present estuarine reach, was straightened and canalized. Its tributaries were also canalized. Since 1969 flood waters from the Sipingo have been diverted to the Mbokodweni along a grass-lined canal on the landward side of the railway line to alleviate flooding of the Prospecton industrial area. Photograph NS 50/51/1 in the Appendix was taken in 1966, just prior to these canalization works: it is a print direct from a diapositive, showing open water areas starkly in black and riverine vegetation in white. Sugar cane fields on the Sipingo flats are clearly seen and the position of the 1969 diversion of the flood waters of the Sipingo is indicated. It is interesting to compare this photograph with the Frontispiece photograph (1974) which shows the Prospecton industrial area, with its canalization, fully developed.

There are no dams on the Sipingo but the Shongweni dam on the Mlazi was built in 1927.

Urbanization

There has been a hotel complex on the flood plain for the whole period and a general residential build-up since the 1970s.

From 1929-1939 there was a golf course on the right bank of the Mlazi. The area became a wartime aerodrome from 1939 to 1945.

Construction for Louis Botha airport commenced in 1946.

In 1961 two concrete pipes were installed (see River Mouth section above).

In the same year sand mining near the mouth commenced, and it is still in operation.

Immediately upstream of the estuarine reach lies the Prospecton industrial area. For this, from 1966 onwards, large areas were drained of swamps, vegetation cleared and the land infilled to a height of approximately 3,5 m above MSL from a former 1-1,5 m above MSL (Ward, 1980).

Siltation

Begg (pers. comm.) regards the Sipingo as being only slightly silted and Ward (1980) states that the Sipingo catchment area yields little silt. However, the Mlazi carries a considerable silt load during major floods. Evidence of a silt plume deposited by the Mlazi in the "Sipingo estuary" may be seen in Photograph NS 51/2 taken in 1937. Ward (1980) reports that when the boating canal was open (1906-1927) the Mlazi would deposit such a large quantity of silt during a major flood as to block off the lowest reach of the Sipingo and force the main flow through the southerly lagoon area. Since the last major flood flows of April and November 1943, however, the siltation has probably been minimal. Channel side-bar areas are now small but note should be made of the siltation build-up, since the mid-1970s, on building rubble dumped into the river alongside the hotel complex. This should not be allowed to block the channel, especially in view of the present greatly reduced flow of the Sipingo.

Stability

The average lateral displacement of 31,7 m with an average coefficient of variation of 22,5 per cent reflects slightly unstable conditions. The only position where the lateral shift is marked is on either side of the hotel complex: here, in the main channel there has been a slight shift and in 1953 there was an extension of the area of vegetation growth (?as a result of siltation) thereby narrowing the southerly lagoon area. Full details

of the lateral stability are given in Table NS 51/IX. The differing open water areas and river widths (Table NS 51/VIII) reflect different flow stages. The changes in sinuosity do not reflect a general lateral instability - only different mouth conditions.

Although not represented by the six time slices of aerial photography selected, the southerly lagoon area may, at times of very low flow, lose its connection with the main channel which it normally maintains just inland of the sandbar across the mouth.

The lower reaches of the Sipingo reflect marked human influence for the period under review. Since 1952, the "estuarine area" has had a struggle to survive, hydrologically, because of markedly reduced river flow and restricted tidal exchange. The Sipingo shows slight siltation and is laterally slightly unstable. Details of the classification may be found in Tables NS 51/II-VII and an abstract of results is given in Table NS 51/I.

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PITMAN, W.V., MIDDLETON, B.J. and MIDGLEY, D.C. 1981. Surface
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ABBREVIATIONS/SYMBOLS/TERMS USED

M.A.R.	Mean annual run-off
L.B.	Left bank
R.B.	Right bank
P	Perimeter
\bar{x}	Arithmetic mean
s	Standard deviation
V	Coefficient of variation $\frac{s}{\bar{x}}$
MSL	Mean sea level
R	River
d/s	Downstream
u/s	Upstream
—	Maximum value
---	Minimum value
N.R.	No record
Head of reach	An arbitrary control point selected at the first convenient place u/s of the maximum known limit of saline penetration/tidal influence where the R is confined (preferably a bridge, for example, to facilitate demarcation of flood plain areas).

BASIC DATA / CALCULATIONS

Lateral displacement (1937 - 1984) \bar{x} 31.7 m (53, 4% R. width)
 Relative lateral stability (1937 - 1984) \bar{v} 22.5 %
 Area of catchment 51 km²
 Area of flood plain 51.1 ha
 Area of envelope of mobility 12.3 ha
 Simulated H.A.R. (1921-1975) \bar{x} 59.72 m (Mlazi til 1952)
 1921-51 102.16 x 10⁶ m³
 1952-68 5.85 x 10⁸ m³ at mouth (x)
 1969-75 2.60 x 10⁸ m³
 Dates of major floods: April 1856, Dec. 1921, March 1925, June 1935, April/Nov. 1943

MEASUREMENTS/CALCULATIONS from PHOTOGRAPHS

Date	Thalweg (m)	% Thalweg estuarine	Aerial D (m)	Sinuosity	\bar{x} River width (m)	Open water area (ha)	% envelope of mobility	Bar/island area (ha)	River braided %thalweg	% Flood plain cultivated	Left valley side:	Right valley side:	L.B. % vegetated	R.B. % vegetated	Mouth open/closed o/c	Spit/bar:	Direction (°)	Length (m)	\bar{x} width (m)
30-4-37	1452	1496	17-6-59	1055	1019	968	1033	1016	1016	1016	1016	1016	1016	1016	1016	1016	1016	1016	1016
1658	1452	1480	1480	1655	1489	1489	1489	1489	1489	1489	1489	1489	1489	1489	1489	1489	1489	1489	1489
?	300	?	?	100	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
1055	1019	1008	968	1033	1016	1016	1016	1016	1016	1016	1016	1016	1016	1016	1016	1016	1016	1016	1016
1.57	1.42	1.48	1.53	1.60	1.47	1.47	1.47	1.47	1.47	1.47	1.47	1.47	1.47	1.47	1.47	1.47	1.47	1.47	1.47
61.9	54.9	66.1	66.9	57.0	49.6	49.6	49.6	49.6	49.6	49.6	49.6	49.6	49.6	49.6	49.6	49.6	49.6	49.6	49.6
9.1	7.6	8.7	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
74.0	61.8	70.7	63.4	63.4	59.3	59.3	59.3	59.3	59.3	59.3	59.3	59.3	59.3	59.3	59.3	59.3	59.3	59.3	59.3
6.7	6.5	4.0	2.9	0.9	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL
NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL
4.4	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL
4.9	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
7	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL
NIL	NIL	NIL	10	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL
100	70	60	50	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL
NIL	30	40	40	40	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
70	100	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
90	80	75	45	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
0	C	C	C	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
214	214	214	217	219	218	218	218	218	218	218	218	218	218	218	218	218	218	218	218
217	295	295	290	260	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255
120	115	85	113	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

ABSTRACT

Within the Reach

1. Land-use

(a) Cultivation: Valley sides NIL at present: up to 40% formerly
 Flood plain NIL

To channel edge NIL

(b) Bridge building and embankments

1. Avenue East Road Br. at head of reach: built ?
2. Small Road Br. across southern lagoon

(c) Canals The Mlazi R., with which the Sipingo used to share a common mouth, has been canalized: since 1952 it discharges into the ocean \pm 4 km E.N.E. of the Sipingo mouth.

(d) Urbanization/Industry

1. Hotel complex: whole period
2. Residential build-up since 1970s

2. Breaching of sandbar

Mechanical breaching became necessary 1952-61 (Begg, 1978)

It has been undertaken again in 1984

3. Others 1929-39, R.B. Mlazi - golf course: 1939-45 this area was an aerodrome
 1961 two concrete pipes installed to improve tidal exchange
 1961 sand mining commenced near mouth

Upstream of Reach

(a) Dams in the catchment

Date of construction

None on the Sipingo

Shongweni dam on the Mlazi 1927

(b) Building construction or canalization immediately upstream of reach

1. Construction for Louis Botha Airport commenced 1946
2. Prospection Industrial area 1966. For this, Sipingo straightened & canalized vegetation cleared, drainage of swamps & large areas infilled.
3. 1964 flood waters from Sipingo diverted to Mbokodweni.

(c) Land-use malpractices/silt supply

1. Sugar cane grown extensively on Isipingo Flats until 1960s.
 Silt supply from Sipingo minimal but from Mlazi very great: this affected present Sipingo "estuary" until early 1940s.

STABILITY FOR PERIOD UNDER REVIEW:

1937-1984 Slightly Unstable

RIVER SIPINGO, ? 300^o/₂ ESTUARINE, REACH from Avenue East Br., 1,7 km from mouth. REF. DEA U 603b
 AERIAL PHOTO DATE 30-4-37 SCALE 1:10000 CATCHMENT AREA 51 km², M.A.R. 641/5972 m³x10⁶, No. of DAMS Nil*
 see hydro notes

RIVER VALLEY AND RIVER MOUTH FEATURES

General Description of the Terrain above the Valley			Valley Sides (Not Well-defined)			
Terrain	Vegetation	Land-Use	Slumping	Vegetation and Land-Use	Left	Right
mountainous	almost none	none	✓ none	coastal dune	19	— %
✓ hilly**	grass	scattered cultivation	occasional	grass (GOLF course)	44	— %
undulating	✓ sparsely forested (0-25%)	✓ partly cultivated	frequent	trees/bush	30	100 %
✓ plains	moderately forested (25-75%)	mainly cultivated		cultivated	7	— %
	heavily forested (75-100%)	scattered settlement		built-up		— %
	swamp/bog	✓ partly built-up urbanised				— %

Comments * 1 on Mlazi (1927)
 ** Bluff beds R.V.S. near coast

Valley Characteristics

Measurements	Terraces	Relation of Channel to Valley Bottom (Vertical)	Relation of Channel to Valley Sides or Resistant Terraces (Lateral)	Surface Geology
valley length <u>1290</u> m	none	not applicable	✓ not applicable (no valley or free)	bedrock
bottom width (av.) <u>400</u> m	indefinite	not obviously degrading or aggrading	occasionally confined	lacustrine deposits
valley slope	fragmentary	partly entrenched	frequently confined	✓ fluvial deposits
height at head of reach <u>10</u> m to MSL approx.	continuous	entrenched	entrenched	aeolian
	✓ aggrading			sand covered ___ % area

Comments _____

River Mouth R. deflected to 251° over lowest 100 m

Characteristics	Measurements	Comments
✓ open/closed	right bank breakwater length _____ m	
✓ natural/artificial	left bank breakwater length _____ m	
canalized	✓ rock sill level _____ m to MSL	
✓ sandy	cliffs on right bank: height _____ m to MSL	
✓ rocks on right bank	cliffs on left bank: height _____ m to MSL	
rocks on left bank	spit/bar: direction of growth <u>214</u> °	
outer bar	length of spit/bar <u>217</u> m	
silt plume (fluvial)	length stabilized <u>85</u> m	
✓ suspended sediment (marine)	width <u>120</u> m	

Comments _____

FLOOD PLAIN AND CHANNEL FEATURES

Description of Flood Plain	Presence	Extent	Vegetation	Forest Type	Land-Use
none	none	none	almost none	not known/applicable	✓ not cultivated, not built-up
✓ indefinite	fragmentary	average width <u>400</u> m	grass	✓ riverine:	cultivated ___ % area
continuous	continuous	maximum width* <u>500</u> m	reed swamp <u>NIL</u> % area	main channel	prop/s
		serial length <u>1055</u> m	sparsely forested	tributaries	✓ partly built-up hotel
		area <u>51,1</u> ha	✓ moderately forested	✓ mangroves	mainly built-up
			heavily forested		Comments _____

Channel Description N.B. Estimate of flow stage: LOW / ~~near low stage~~ / ~~high~~

Pattern	Measurements	Islands/Shoals**	Type of Flow	Bar Type
straight	thalweg <u>1657</u> m	none	stagnant/still	none
sinuous	* sinuosity <u>1,57</u>	occasional	✓ uniform water surface	✓ channel side bars
irregular	* open water area <u>9,1</u> ha	frequent	uniform with rapid in reach	point bars
regular meanders	perimeter <u>5347</u> m	split	irregular	✓ channel junction bars
✓ irregular meanders	S. lake/lagoon area <u>3,5</u> ha	braided	pool & riffle sequence	mid-channel bars
tortuous meanders	river X-sections available		✓ turbid	diamond bars
bifurcated	channel slope _____			diagonal bars
lake/s	channel width x _____ m s = _____ m			sand waves/large dunes
✓ lagoon	river slope _____			Comments *whole reach
	river width x <u>61,9</u> m s = <u>42,7</u> m			** near mouth

Obstructions/Constructions

Natural	Degree	Man-made	Degree of Obstruction/Constriction for Each	Position (from head of reach)
✓ none	none	road bridge/s	<u>Ave E.</u>	<u>R. constricted</u>
logs	minor	weir bridge/s	<u>(1 small footbridge + 1 road bridge</u>	<u>head of reach</u>
boulders	major	conveyer	<u>across southern lagoon)</u>	
vegetation		weir/dam		
		fish traps		
		embankment/s		
		groynes		
		canals		
		drainage furrows		
		others		

Comments _____

Lateral Channel Activity

Lateral Activity	Nature of Banks	Bank Vegetation	Lateral Stability
not detectable	✓ alluvium (<u>muddy silt/sand</u>)	none	stable
downstream progression	natural levées	weak	✓ slightly unstable
✓ progression & cut-offs	rock/boulders	✓ good	moderately unstable
mainly cut-offs	protected/stabilized	very strong	unstable
entrenched loop development	cultivation to channel edge	left bank <u>70</u> %	highly unstable
irregular lateral activity		right bank <u>90</u> %	Comments _____
avulsion			

RIVER SIPINGO, ?300^b ESTUARINE, REACH from Avenue East Br., 1.7 km from mouth. REF. DEA U 603b
 AERIAL PHOTO DATE July/Aug 53 SCALE 1:10 000 CATCHMENT AREA 51 km², M.A.R. 641/59,72 m³x10⁶, No. of DAMS Nil
 ↓ see hydro notes

RIVER VALLEY AND RIVER MOUTH FEATURES

General Description of the Terrain above the Valley

Valley Sides (Not Well-defined)

Terrain	Vegetation	Land-Use	Slumping	Vegetation and Land-Use	Left	Right
mountainous	almost none	none	none	coastal dune	16	%
✓ hilly*	grass	scattered cultivation	occasional	grass		%
undulating	✓ sparsely forested (0-25%)	✓ partly cultivated	frequent	trees/bush	44	70 %
✓ plains	moderately forested (25-75%)	mainly cultivated		cultivated	40	%
	heavily forested (75-100%)	scattered settlement		built-up		30 %
	swamp/bog	✓ partly built-up				
		urbanised				

Comments * Bluff beds R.V.S. near coast

Valley Characteristics

Measurements	Terraces	Relation of Channel to Valley Bottom (Vertical)	Relation of Channel to Valley Sides or Resistant Terraces (Lateral)	Surface Geology
valley length <u>1290</u> m	✓ none	not applicable	✓ not applicable (no valley or free)	bedrock
bottom width (av.) <u>2400</u> m	indefinite	not obviously degrading or aggrading	occasionally confined	lacustrine deposits
valley slope _____	fragmentary	partly entrenched	frequently confined	✓ fluvial deposits
height at head of reach <u>+1.0</u> m to MSL approx.	continuous	entrenched	entrenched	aeolian sand covered _____ % area
		✓ aggrading		Comments _____

River Mouth R. deflected to 238° out lowest 130 m

Characteristics	Measurements	Comments
✓ open/closed (just)	right bank breakwater length _____ m	
natural/artificial	left bank breakwater length _____ m	
canalized	✓ rock sill level _____ m to MSL	
✓ sandy	cliffs on right bank: height _____ m to MSL	
✓ rocks on right bank	cliffs on left bank: height _____ m to MSL	
rocks on left bank	spot/bar: direction of growth <u>214</u> °	
outer bar	length of spot/bar <u>295</u> m	
silt plume (fluvial)	length stabilized <u>90</u> m	
suspended sediment (marine)	width <u>115</u> m	

FLOOD PLAIN AND CHANNEL FEATURES

Description of Flood Plain

Presence	Extent	Vegetation	Forest Type	Land-Use
none	none	almost none	not known/applicable	✓ not cultivated, not built-up
✓ indefinite	average width (±80) m	grass	✓ riverine:	cultivated _____ % area
fragmentary	maximum width (<u>200</u>) m	reed swamp = <u>2</u> % area	main channel	crop/s
continuous	aerial length <u>1019</u> m	sparsely forested	tributaries	✓ partly built-up hotel
	* area 1937 <u>511</u> ha	✓ moderately forested	✓ mangroves	mainly built-up
	(± 10 ha)	heavily forested		Comments _____

Channel Description N.B. Estimate of flow stage: LOW/~~HEAD LOW~~ ~~FROM HEAD~~ ~~TO REACH~~

Pattern	Measurements	Islands/Shoals**	Type of Flow	Bar Type
straight	thalweg <u>1452</u> m	none	stagnant/still	none
sinuous	* sinuosity <u>1.42</u>	occasional	✓ uniform water surface	✓ channel side bars
irregular	* open water area <u>7.6</u> ha	frequent	uniform with rapid in reach	point bars
regular meanders	perimeter <u>4910</u> m	split	irregular	✓ channel junction bars
✓ irregular meanders	S. lake/lagoon area <u>3.4</u> ha	braided	pool & riffle sequence	mid-channel bars
tortuous meanders	river X-sections available _____		✓ turbid	diamond bars
bifurcated	channel slope _____ m s = _____ m			diagonal bars
lake/s	channel width <u>x</u> _____ m			sand waves/large dunes
✓ lagoon	river slope _____			
	river width <u>x</u> <u>54.9</u> m s = <u>33.9</u> m			Comments * whole reach

Obstructions/Constructions

Natural	Degree	Man-made	Degree of Obstruction/Constriction for Each	Position (from head of reach)
✓ none	none	road bridge/s	<u>Ave. E. R. constructed</u>	head of reach
logs	minor	✓ road bridge/s	<u>(1 small road br across S. lagoon)</u>	
boulders	major	causeway		
vegetation		veir/dam		
		fish traps		
		embankment/s		
		groynes		
		canals		
		drainage furrows		
		others		

Lateral Channel Activity

Lateral Activity	Nature of Banks	Bank Vegetation	Lateral Stability
not detectable	✓ alluvium (<u>muddy</u>)	none	stable
downstream progression	natural levées	weak	✓ slightly unstable
✓ progression & cut-offs	rock/boulders	✓ good	moderately unstable
mainly cut-offs	protected/stabilized	very strong	unstable
entrenched loop development	cultivation to	left bank <u>100</u> %	highly unstable
irregular lateral activity	channel edge	right bank <u>80</u> %	Comments _____
avulsion			

RIVER SIPINGO, 300% ESTUARINE, REACH from Avenue East Br., 1.7 km from mouth. REF. DEA U6036
 AERIAL PHOTO DATE 6-6-59 SCALE 1:10 000 CATCHMENT AREA 51 km², M.A.R. 6.41/59.72 m³x10⁶, No. of DAMS Nil
 ↓ see hydro notes

RIVER VALLEY AND RIVER MOUTH FEATURES

General Description of the Terrain above the Valley

Terrain	Vegetation	Land-Use
mountainous	almost none	none
✓ hilly	grass	scattered cultivation
undulating	✓ sparsely forested (0-25%)	✓ partly cultivated
✓ plains	moderately forested (25-75%)	mainly cultivated
	heavily forested (75-100%)	scattered settlement
	swamp/bog	✓ partly built-up urbanised

Valley Sides (Not Well-defined)

Slumping	Vegetation and Land-Use	Left	Right
✓ none	coastal dune	13	%
occasional	grass		%
frequent	trees/bush	47	60 %
	cultivated	40	%
	built-up		40 %

Comments *Bluff beds R.V.S. near coast

Valley Characteristics

Measurements	Terraces	Relation of Channel to Valley Bottom (Vertical)	Relation of Channel to Valley Sides or Resistant Terraces (Lateral)	Surface Geology
valley length <u>1290</u> m	✓ none	not applicable	✓ not applicable (no valley or free)	bedrock
bottom width (av.) <u>400</u> m	indefinite	✓ not obviously degrading or aggrading	occasionally confined	lacustrine deposits
valley slope	fragmentary	partly entrenched	frequently confined	✓ fluvial deposits
height at head of reach <u>+1.0</u> m to MSL	continuous approx.	entrenched	entrenched	aeolian
		aggrading		sand covered _____ % area

River Mouth R. deflected to 214° over lowest 100m

Characteristics

Measurements

✓ open/closed	right bank breakwater length _____ m
natural/artificial	left bank breakwater length _____ m
canalized	✓ rock sill level _____ m to MSL
✓ sandy	cliffs on right bank: height _____ m to MSL
rocks on right bank	cliffs on left bank: height _____ m to MSL
rocks on left bank	spot/bar: direction of growth <u>214</u> °
outer bar	length of spot/bar <u>295</u> m
silt plume (fluvial)	length stabilized <u>85</u> m
✓ suspended sediment (marine)	width <u>85</u> m

Comments _____

FLOOD PLAIN AND CHANNEL FEATURES

Description of Flood Plain

Presence	Extent	Vegetation	Forest Type	Land-Use
none	none	almost none	not known/applicable	✓ not cultivated, not built-up
✓ indefinite	average width (<u>± 80</u>) m	grass	✓ riverine:	cultivated _____ % area
fragmentary	maximum width (<u>200</u>) m	reed swamp = <u>2</u> % area	main channel	crop/s
continuous	aerial length <u>1008</u> m	✓ sparsely forested	tributaries	✓ partly built-up hotel
	area 1937 <u>51.1</u> ha	✓ moderately forested	✓ mangroves	mainly built-up
	(<u>± 10</u> ha)	heavily forested		

Comments _____

Channel Description N.B. Estimate of flow stage: ~~LOW~~/NEAR LONG-TERM MEAN/~~HIGH~~ (slightly above June av. for Sipingo)

Pattern	Measurements	Islands/Shoals ^{xx}	Type of Flow	Bar Type
straight	thalweg <u>1496</u> m	none	stagnant/still	none
sinuous	*sinuosity <u>1.48</u>	occasional	✓ uniform water surface	✓ channel side bars
irregular	*open water area <u>8.7</u> ha	frequent	uniform with rapid in reach	point bars
regular meanders	perimeter <u>5032</u> m	split	irregular	✓ channel junction bars
✓ irregular meanders	S. lake/lagoon area <u>3.8</u> ha	braided	pool & riffle sequence	mid-channel bars
tortuous meanders	river X-sections available		turbid	diamond bars
bifurcated	channel slope _____			diagonal bars
lake/s	channel width x _____ m s = _____ m			sand waves/large dunes
✓ lagoon	river slope _____			
	river width x <u>66.1</u> m s = <u>34.4</u> m			

Comments *whole reach

xx near mouth

Obstructions/Constructions

Natural	Degree	Man-made	Degree of Obstruction/Constriction for Each	Position (from head of reach)
✓ none	none	road bridge/s	Ave E. R. culverted	Lead of reach
logs	minor	ret bridge/s	(1 small road br. across S. lagoon)	
boulders	major	causeway		
vegetation		weir/dam		
		fish traps		
		embankment/s		
		groynes		
		canals		
		drainage furrows		
		others		

Lateral Channel Activity

Lateral Activity	Nature of Banks	Bank Vegetation	Lateral Stability
not detectable	✓ alluvium (muddy silt/sand)	none	stable
downstream progression	natural levees	weak	✓ slightly unstable
✓ progression & cut-offs	rock/boulders	✓ good	moderately unstable
mainly cut-offs	protected/stabilized	very strong	unstable
entrenched loop development	cultivation to	left bank <u>90</u> %	highly unstable
irregular lateral activity	channel edge	right bank <u>75</u> %	
avulsion			Comments _____

RIVER SIPINGO, ? % ESTUARINE, REACH from Avenue East Br., km from mouth. REF. DEA U 603 b
 AERIAL PHOTO DATE 17-6-67 SCALE 1:10 000 CATCHMENT AREA 51 km², M.A.R. 6,41/59,72 m³x10⁶, No. of DAMS Nil
 ↓
 see hydro notes

RIVER VALLEY AND RIVER MOUTH FEATURES

General Description of the Terrain above the Valley

Terrain	Vegetation	Land-Use
mountainous	almost none	none
✓ hilly	grass	scattered cultivation
undulating	✓ sparsely forested (0-25%)	✓ partly cultivated
✓ plains	moderately forested (25-75%)	mainly cultivated
	heavily forested (75-100%)	scattered settlement
	swamp/bog	✓ partly built-up
		urbanised

Valley Sides (Not Well-defined) ✓

Slumping	Vegetation and Land-Use	Left	Right	%
✓ none	coastal dune	13		%
occasional	grass		10	%
frequent	trees/bush	47	50	%
	cultivated	40		%
	built-up		40	%

Comments Bluff heads R.V.S. near coast

Valley Characteristics

Measurements	Terraces	Relation of Channel to Valley Bottom (Vertical)	Relation of Channel to Valley Sides or Resistant Terraces (Lateral)	Surface Geology
valley length <u>1290</u> m	✓ none	not applicable	✓ not applicable (no valley or free)	bedrock
bottom width (av.) <u>2400</u> m	indefinite	✓ not obviously degrading	occasionally confined	lacustrine deposits
valley slope <u>?</u>	fragmentary	or aggrading	frequently confined	✓ fluvial deposits
height at head of reach <u>+2/3</u> m to MSL approx.	continuous	partly entrenched	entrenched	aeolian
		entrenched		sand covered <u> </u> % area
		aggrading		Comments <u>infilled</u>

River Mouth R. deflected to 247° over lowest 110 m

Characteristics	Measurements	Comments
open/closed	right bank breakwater length <u> </u> m	
natural/artificial	left bank breakwater length <u> </u> m	
canalized	✓ rock sill level <u> </u> m to MSL	
✓ sandy	cliffs on right bank: height <u> </u> m to MSL	
✓ rocks on right bank	cliffs on left bank: height <u> </u> m to MSL	
rocks on left bank	spit/bar: direction of growth <u>217</u> °	
outer bar	length of spit/bar <u>290</u> m	
silt plume (fluvial)	length stabilized <u>80</u> m	
✓ suspended sediment (marine)	width <u>113</u> m	

FLOOD PLAIN AND CHANNEL FEATURES

Description of Flood Plain

Presence	Extent	Vegetation	Forest Type	Land-Use
none	none	almost none	not known/applicable	✓ not cultivated, <u>not</u> built-up
✓ indefinite	average width (<u>± 80</u>) m	grass	✓ riverine:	cultivated <u> </u> % area
fragmentary	maximum width (<u>200</u>) m	reed swamp <u>± 2</u> % area	main channel	crop/s
continuous	aerial length <u>968</u> m	✓ sparsely forested	tributaries	✓ partly built-up <u>hote</u>
	area 1937 <u>51.1</u> ha	moderately forested	✓ mangroves	mainly built-up
	(<u>± 10 ha</u>)	heavily forested		Comments <u> </u>

Channel Description N.B. Estimate of flow stage: LOW/ NEAR-TIDE/ HIGH

Pattern	Measurements	Islands/Shoals**	Type of Flow	Bar Type
straight	thalweg <u>1480</u> m	none	stagnant/still	none
sinuous	* sinuosity <u>1.53</u>	occasional	✓ uniform water surface	✓ channel side bars
irregular	* open water area <u>7.8</u> ha	frequent	uniform with rapid in reach	point bars
regular meanders	perimeter <u>4924</u> m	split	irregular	✓ channel junction bars
✓ irregular meanders	S. <u>lake/lagoon</u> areas <u>2.9</u> ha	braided	pool & riffle sequence	mid-channel bars
tortuous meanders	river X-sections available		turbid	diamond bars
bifurcated	channel slope <u> </u>			diagonal bars
lake/s	channel width <u> </u> m			sand waves/large dunes
✓ lagoon	river slope <u> </u>			
	river width <u>66.9</u> m			Comments *whole reach
	river width <u>37.7</u> m			** <u>near mouth</u>

Obstructions/Constructions

Natural	Degree	Man-made	Degree of Obstruction/Constriction for Each	Position (from head of reach)
✓ none	none	road bridge/s	<u>Ave. E.</u> <u>R. constricted</u>	<u>head of reach</u>
logs	minor	road bridge/s	<u>(1 small road br. across S. lagoon)</u>	
boulders	major	causeway		
vegetation		weir/dam		
		fish traps		
		embankment/s		
		groynes		
		canals		
		drainage furrows		
		others		

Lateral Channel Activity

Lateral Activity	Nature of Banks	Bank Vegetation	Lateral Stability	Comments
not detectable	alluvium (<u>muddy</u> <u>silt/sand</u>)	none	stable	
downstream progression	natural levées	✓ weak R & B	✓ slightly unstable	
✓ progression & cut-offs	rock/boulders	✓ good L & B	moderately unstable	
mainly cut-offs	protected/stabilized	very strong	unstable	
entrenched loop development	cultivation to	left bank <u>90</u> %	highly unstable	
irregular lateral activity	channel edge	right bank <u>45</u> %		
avulsion				

RIVER SIPINGO, 100% ESTUARINE, REACH from Avenue East Br., 1.7 km from mouth. REF. DEA U 603 b
 AERIAL PHOTO DATE 18-4-74 SCALE 1:10 000 CATCHMENT AREA 51 km², M.A.R. 6.41/59.72 m³x10⁶, No. of DAMS Nil
 (Orthophoto) see hydro notes

RIVER VALLEY AND RIVER MOUTH FEATURES

General Description of the Terrain above the Valley

Terrain	Vegetation	Land-Use
mountainous	almost none	none
✓ hilly ^x	grass	scattered cultivation
✓ undulating	✓ sparsely forested (0-25%)	✓ partly cultivated
✓ plains	moderately forested (25-75%)	mainly cultivated
	heavily forested (75-100%)	scattered settlement
	swamp/bog	✓ partly built-up
		urbanised up stream

Valley Sides (Not Well-defined)

Slumping	Vegetation and Land-Use	Left	Right
✓ none	coastal dune	10	
occasional	grass		
frequent	trees/bush	50	40
	cultivated	40	
	built-up		60

Comments * Bluff beds R.V.S. near coast

Valley Characteristics

Measurements	Terraces	Relation of Channel to Valley Bottom (Vertical)	Relation of Channel to Valley Sides or Resistant Terraces (Lateral)	Surface Geology
valley length <u>1290</u> m	✓ none	not applicable	✓ not applicable (no valley or free)	bedrock
bottom width (av.) <u>2400</u> m	indefinite	✓ not obviously degrading or aggrading	occasionally confined	lacustrine deposits
valley slope <u>1:516</u>	fragmentary		frequently confined	✓ fluvial deposits
height at head of reach <u>+2.3</u> m to MSL	continuous	partly entrenched	entrenched	aeolian
		entrenched		sand covered _____ % area
		aggrading		

Comments

* infilled

River Mouth R. deflected to 248° over lowest 130m

Characteristics

- ✓ open/closed (just)
- ✓ natural/artificial
- canalized
- ✓ sandy
- ✓ rocks on right bank
- rocks on left bank
- outer bar
- silt plume (fluvial)
- ✓ suspended sediment (marine)

Measurements

right bank breakwater length	_____ m
left bank breakwater length	_____ m
✓ rock sill level	_____ m to MSL
cliffs on right bank: height	_____ m to MSL
cliffs on left bank: height	_____ m to MSL
spit/bar: direction of growth	<u>219</u> °
length of spit/bar	<u>260</u> m
length stabilized	<u>Nil</u> m
width	<u>100</u> m

Comments

Shoreline Orientation
50°/230° → N
45°/225° → S

FLOOD PLAIN AND CHANNEL FEATURES

Description of Flood Plain

Presence	Extent	Vegetation	Forest Type	Land-Use
none	none	almost none	not known/applicable	✓ not cultivated, not built-up
✓ indefinite	average width (<u>±80</u>) m	grass	✓ riverine:	cultivated _____ % area
fragmentary	maximum width (<u>200</u>) m	reed swamp <u>< 2</u> % area	main channel	crop/s _____
continuous	aerial length <u>1033</u> m	✓ sparsely forested	tributaries	✓ partly built-up <u>total + lower</u>
	area 1937 <u>51.1</u> ha	moderately forested	✓ mangroves	mainly built-up
	(<u>±10 ha</u>)	heavily forested		

Comments

Channel Description N.B. Estimate of flow stage: LOW/NEAR-LONG-TERM-MEAN/HIGH

Pattern	Measurements	Islands/Shoals ^x	Type of Flow	Bar Type
straight	thalweg <u>1655</u> m	none	stagnant/still	none
sinuous	*sinuosity <u>1.60</u>	occasional	✓ uniform water surface	✓ channel side bars
irregular	*open water area <u>7.8</u> ha	frequent	uniform with rapid in reach	point bars
regular meanders	perimeter <u>5170</u> m	split	irregular	channel junction bars
✓ irregular meanders	S. lake/lagoon area <u>3.6</u> ha	braided	pool & riffle sequence	mid-channel bars
cortuous meanders	river X-sections available		✓ turbid	diamond bars
bifurcated	channel slope _____			diagonal bars
lake/s	channel width <u>_____</u> m s = _____ m			sand waves/large dunes
✓ lagoon	river slope _____			
	river width <u>_____</u> m s = <u>39.3</u> m			

Comments *whole reach

** near mouth.

Obstructions/Constructions

Natural	Degree	Man-made	Degree of Obstruction/Constriction for Each	Position (from head of reach)
none	none	road bridge/s <u>Ave. E</u>	<u>R. constricted</u>	<u>head of reach</u>
logs	✓ minor	road bridge/s <u>(small road br. across S. lagoon)</u>		
boulders	major	causeway _____		
✓ vegetation		weir/dam _____		
		fish traps _____		
		embankment/s _____		
		groynes _____		
		canals _____		
		drainage furrows _____		
		others <u>building rubble (+ silt) 1/2 way across channel</u>		<u>1 km</u>

Lateral Channel Activity

Lateral Activity	Nature of Banks	Bank Vegetation	Lateral Stability
not detectable	✓ alluvium (<u>muddy silt/sand</u>)	none	stable
downstream progression	natural levees	✓ weak R.B.	✓ slightly unstable
✓ progression & cut-offs	rock/boulders	✓ good L.B.	moderately unstable
mainly cut-offs	protected/stabilized	very strong	unstable
entrenched loop development	cultivation to channel edge	left bank <u>90</u> %	highly unstable
irregular lateral activity		right bank <u>50</u> %	
avulsion			

Comments

RIVER SIPINGO, ? % ESTUARINE, REACH from Avenue East Br., 1.5 km from mouth. REF. DEA U 603b
 AERIAL PHOTO DATE 6-2-84 SCALE 1:10 000 CATCHMENT AREA 51 km², M.A.R. 6.4/5972 m³x10⁶, No. of DAMS N:1

See hydro notes

RIVER VALLEY AND RIVER MOUTH FEATURES

General Description of the Terrain above the Valley

Terrain	Vegetation	Land-Use
mountainous	almost none	none
✓ hilly	grass	scattered cultivation
undulating	✓ sparsely forested (0-25%)	partly cultivated
✓ plains	moderately forested (25-75%)	mainly cultivated
	heavily forested (75-100%)	scattered settlement
	swamp/bog	✓ partly built-up
		urbanised w/s of reach

Valley Sides (Not Well-defined)

Slumping	Vegetation and Land-Use	Left	Right
none	coastal dune	<u>5</u>	<u>0</u> %
occasional	grass		<u>0</u> %
✓ frequent	trees/bush	<u>95</u>	<u>40</u> %
	cultivated		<u>0</u> %
	built-up		<u>60</u> %

Comments * Bluff beds R.V.S. near coast

Valley Characteristics

Measurements	Terraces	Relation of Channel to Valley Bottom (Vertical)	Relation of Channel to Valley Sides or Resistant Terraces (Lateral)	Surface Geology
valley length <u>1290</u> m	✓ none	not applicable	✓ not applicable (no valley or free)	bedrock
bottom width (av.) <u> </u> m	indefinite	✓ not obviously degrading or aggrading	occasionally confined	lacustrine deposits
valley slope <u> </u> %	fragmentary		frequently confined	✓ fluvial deposits
× height at head of reach <u>+2/3</u> m to MSL	continuous	partly entrenched	entrenched	aeolian
		entrenched		sand covered <u> </u> % area
		aggrading		

Comments

* infilled

River Mouth R. deflected to 206° over lowest 100m

Characteristics	Measurements	Comments
✓ open/closed	right bank breakwater length <u> </u> m	
✓ natural/artificial	left bank breakwater length <u> </u> m	
canalized	✓ rock sill level <u> </u> m to MSL	
✓ sandy	cliffs on right bank: height <u> </u> m to MSL	
✓ rocks on right bank	cliffs on left bank: height <u> </u> m to MSL	
rocks on left bank	spit/bar: direction of growth <u>218</u> °	
outer bar	length of spit/bar <u>255</u> m	
silt plume (fluvial)	length stabilized <u>Nil</u> m	
✓ suspended sediment (marine)	width <u>100</u> m	

FLOOD PLAIN AND CHANNEL FEATURES

Description of Flood Plain

Presence	Extent	Vegetation	Forest Type	Land-Use
none	none	almost none	not known/applicable	✓ not cultivated, not built-up
✓ indefinite	average width <u> </u> m	grass	✓ riverine:	cultivated <u> </u> % area
fragmentary	maximum width <u> </u> m	reed swamp <u>≈ 2</u> % area	main channel	crop/s
continuous	aerial length <u>1016</u> m	✓ sparsely forested	tributaries	✓ partly built-up hotels, houses
	area <u>1937</u> <u>51.1</u> ha	moderately forested	✓ mangroves	mainly built-up
	(<u>≈ 10</u> ha)	heavily forested		

Comments

Channel Description N.B. Estimate of flow stage: LOW/NEAR LONG-TERM MEAN/HIGH

Pattern	Measurements	Islands/Shoals ^{xx}	Type of Flow	Bar Type
straight	thalweg <u>1489</u> m	none	stagnant/still	none
sinuous	*sinuosity <u>1.47</u>	occasional	✓ uniform water surface	✓ channel side bars
irregular	*open water area <u>7.3</u> ha	frequent	uniform with rapid in reach	point bars
regular meanders	perimeter <u>4725</u> m	split	irregular	channel junction bars
✓ irregular meanders	S. bank/lagoon area <u>3.4</u> ha	braided	pool & riffle sequence	mid-channel bars
tortuous meanders	river X-sections available		✓ turbid	diamond bars
bifurcated	channel slope <u> </u>			diagonal bars
lake/s	channel width <u> </u> m			sand waves/large dunes
✓ lagoon	river slope <u> </u>			
	river width <u>49.6</u> m			

Comments *whole reach

xx near mouth

Obstructions/Constructions

Natural	Degree	Man-made	Degree of Obstruction/Constriction for Each	Position (from head of reach)
none	none	road bridge/s	<u>Ave. E.</u>	<u>R. confined</u>
logs	✓ minor	rail bridge/s		<u>head of reach</u>
boulders	major	causeway		
✓ vegetation		weir/dam		
		fish traps		
		embankment/s		
		groynes		
		canals		
		drainage furrows		
		others	<u>building rubble (+ silt)</u>	<u>1 km</u>

Lateral Channel Activity

Lateral Activity	Nature of Banks	Bank Vegetation	Lateral Stability	Comments
not detectable	✓ alluvium (<u>silt/sand</u>)	none	stable	
downstream progression	natural levées	✓ weak R.B	✓ slightly unstable	
✓ progression & cut-offs	rock/boulders	✓ good L.B	moderately unstable	
mainly cut-offs	protected/stabilized	very strong	unstable	
entrenched loop development	cultivation to	left bank <u>90</u> %	highly unstable	
irregular lateral activity	channel edge	right bank <u>50</u> %		
avulsion				

TABLE NS 51/VIII

RIVER WIDTHS

SIPINGO NS 51

Station	Approx. distance along 1974 river course from the Avenue E. Rd. Br. (m)	River widths (m)								\bar{x}	s	V%
		Date										
		30.04.37	Jul/Aug 53	06.06.59	17.06.67	18.04.74	06.02.84					
1	0	44	44	40	38	8	12	31,0	16,5	53,2		
2	200	44	39	39	30	38	36	37,7	4,6	12,2		
3	400	38	30	30	26	40	36	33,3	5,5	16,4		
4	600	101 (46+55)	70 (25+45)	61 (17+44)	66 (20+44)	87 (27+60)	99 (34+65)	80,7	17,4	21,5		
5	800	134 (38+96)	126 (30+96)	126 (29+97)	126 (30+96)	114 (16+98)	110 (20+90)	122,7	8,9	7,3		
6	1 000	94 (30+64)	40 (28+12)	92 (34+58)	92 (40+52)	80 (20+60)	60 (12+48)	76,3	21,9	28,7		
7	1 200	32 (22+10)	35 (17+18)	75 (25+50)	90 (30+60)	84 (26+58)	36 (20+16)	58,7	27,1	46,2		
8	1 400 - 1 600 (mouth)	8	N.R.	N.R.	N.R.	5	8	7,0	1,7	24,7		
\bar{x}		61,9	54,9	66,1	66,9	57,0	49,6	55,9				
s		42,7	33,9	34,4	37,7	39,9	37,6	59,4				
V%		69,0	61,8	51,9	56,4	70,1	75,8					

Station	Approx. distance along 1974 river course from the Avenue E. Rd. Br. (m)	Distance from maximum observed L.B. position to mid-river (m)							Max - Min	\bar{x}	s	V%
		Date										
		30.04.37	Jul/Aug 53	06.06.59	17.06.67	18.04.74	06.02.84					
1	0	22,0	22,0	20,0	19,0	20,0	17,0	5,0	20,0	1,9	9,5	
2	200	22,0	20,0	28,0	26,0	19,0	20,0	9,0	22,5	3,7	16,3	
3	400	28,0	30,0	34,0	34,0	20,0	22,0	14,0	28,0	5,9	21,2	
4	600	125,9	145,2	167,7	160,2	155,5	146,1	41,8	150,1	14,6	9,7	
5	800	252,0	264,4	268,0	265,0	293,4	276,7	41,4	269,9	14,0	5,2	
6	1 000	155,9	84,5	147,3	133,9	168,3	178,8	94,3	144,8	33,4	23,1	
7	1 200	72,3	90,1	107,7	105,0	104,1	75,4	35,4	92,4	15,7	17,0	
8	1 400 - 1 600 (mouth)	4,0	N.R.	N.R.	N.R.	6,0	17,0	13,0	9,0	7,0	77,8	
\bar{x}		85,3	93,7	110,4	106,2	98,3	94,1	31,7	92,1		22,5	
s		86,6	88,1	91,6	89,6	102,4	97,2	29,3	98,0		23,2	
V%		101,6	93,9	82,9	84,4	104,1	103,3	92,4			103,1	

Average lateral displacement 1937-1984 = 31,7 m
 Average coefficient of variation 1937-1984 = 22,5%

TABLE NS 51/1 SIMULATED RUN-OFF FOR SIPPINGO NS 51 CATCHMENT AREA = 51.050 SQ. KM. \$M.A.R.

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
1921	.22	2.46	5.64	1.97	.33	.19	.13	.15	.21	.20	.19	.07	11.87
1922	.35	1.73	.83	.43	.47	.42	.32	.20	.12	.10	.09	.07	5.13
1923	.06	.08	.34	.31	.34	.32	.48	.13	.11	.08	.06	.10	1.85
1924	.12	.18	.25	.31	.34	13.33	4.81	.40	.28	.21	.16	.20	20.60
1925	.36	.38	.27	.16	.20	.84	.58	.11	.09	.08	.06	.07	2.09
1926	.12	.13	.13	.11	.11	.84	.20	.26	.15	.10	.12	.13	2.78
1927	.14	.14	.21	.34	.41	.35	.23	.15	.10	.07	.06	.09	2.26
1928	.11	.15	.16	.19	.18	.48	.51	.33	.37	.53	.47	.39	3.87
1929	.44	.45	.41	1.34	.76	.42	.37	.24	.16	.15	.17	.17	5.05
1930	.23	.30	.42	1.04	.63	.40	.37	.24	.13	.14	.17	.12	4.20
1931	.11	.13	.18	.26	.37	.48	.41	.30	.23	.16	.11	.09	2.85
1932	.16	.16	.39	.39	.30	.26	.22	.16	.10	.08	.07	.06	2.47
1933	.05	.17	1.34	3.50	1.40	.45	.49	.36	.36	.32	.33	.27	9.17
1934	.22	.22	.62	.75	.96	.68	.46	.42	7.19	2.77	.39	.25	14.91
1935	.17	.12	.09	.13	.35	1.52	.78	.45	.46	.33	.21	.16	4.77
1936	.16	2.83	1.27	.37	.37	.41	.21	.11	.08	.07	.07	.06	6.00
1937	.09	.12	.25	.40	3.85	1.54	.38	.35	.23	.19	.19	.14	7.72
1938	.21	.35	.61	.61	2.10	1.06	.41	.18	.25	.15	.15	.18	6.43
1939	.28	.43	.53	.45	.34	.29	.24	2.16	1.18	.51	.22	.22	6.93
1940	.20	1.23	1.15	.64	.40	.32	.35	.30	.18	.11	.09	.09	5.05
1941	.12	.17	.21	.32	.49	3.32	1.47	.48	.36	.24	.22	.24	7.63
1942	.30	1.17	4.64	1.85	.49	.52	6.50	3.39	.80	1.27	.10	.73	22.17
1943	3.89	6.37	2.85	.71	.39	1.01	.63	.29	.18	.14	.10	.18	16.74
1944	.33	.36	.26	.19	.23	3.09	1.34	.30	.19	.12	.08	.06	6.56
1945	.09	.10	.10	.20	.35	.45	.45	.32	.47	.50	.08	.06	2.50
1946	.08	.15	.23	.30	.48	.82	.70	.49	.30	.17	.10	.07	5.42
1947	.22	.36	.55	.92	.98	.66	.59	.49	.30	.17	.10	.07	84.58
1948	.18	.35	.42	.44	.46	.42	.34	.26	.16	.11	.09	.14	3.35
1949	.18	.69	1.92	1.45	.68	.49	.38	.26	.18	.14	.14	.14	6.65
1950	.11	.09	.15	.35	.41	.40	.34	.21	.12	.08	.16	.25	2.69
1951	.29	.26	.25	.80	.62	.42	.36	.29	.20	.15	.12	.20	3.85
1952	.09	.11	.20	.41	2.06	.96	.27	.25	.11	.08	.12	.20	4.77
1953	.27	.30	.45	.52	.45	.36	.28	.23	.19	.15	.12	.13	3.46
1954	.36	.52	.41	3.36	2.35	1.45	.73	.38	.22	.14	.10	.10	10.13
1955	.14	.20	.28	.23	.35	3.93	1.67	.40	.25	.17	.13	.15	7.91
1956	.16	.23	3.95	2.11	.68	.54	2.84	1.25	.31	.18	.13	.22	12.61
1957	.40	.52	.50	.51	3.22	1.39	1.61	.83	.29	.18	.12	.12	9.69
1958	.14	.20	.29	.42	.48	.35	.20	3.16	1.41	.36	.29	.24	7.54
1959	.21	.23	.24	.23	.23	.28	.32	.26	.16	.10	.08	.07	2.40
1960	.11	.20	1.30	.27	.49	.45	4.47	1.82	.38	.29	.22	.20	10.84
1961	.21	.20	.20	.27	.45	.45	.46	.32	.19	.12	.10	.10	2.97
1962	.10	.22	.31	.38	.37	.38	.37	.25	.15	.23	.29	.21	3.25
1963	.15	.14	.17	.74	.59	.38	.33	.25	.17	.14	.11	.11	3.28
1964	.22	.29	.33	.35	.29	.19	.10	.09	.17	.29	.29	.31	2.91
1965	.34	.42	.45	1.75	.92	.32	.17	.16	.16	.13	.11	.10	5.03
1966	.10	.19	.26	.36	1.51	2.58	1.15	.46	.27	.17	.12	.08	7.25
1967	.11	.23	.26	.40	.46	.36	.24	.14	.09	.06	.09	.14	2.59
1968	.19	.18	.12	.12	.12	.27	.39	.42	.36	.26	.20	.19	2.84
1969	.38	.55	.58	.58	.42	.23	.13	.11	.13	.16	.16	.26	3.65
1970	1.89	1.67	.78	.50	.49	.49	.55	2.37	1.09	.39	.45	.43	11.03
1971	.34	.28	.33	.36	.44	.42	.28	.24	.23	.20	.15	.11	3.36
1972	.10	.16	.21	.28	.33	.30	.24	.17	.10	.07	.12	.30	2.40
1973	.40	.48	.45	1.12	.78	.56	.46	.41	.15	.25	.18	.12	5.55
1974	.11	.14	.20	.64	2.44	1.06	.31	.22	.15	.10	.08	.16	5.60
1975	.25	.24	.32	.99	.74	5.77	3.14	.78	.33	.20	.17	.18	13.11
MEAN	.30	.54	.71	.70	.73	1.07	.83	.53	.41	.24	.18	.17	6.41
S	.55	.97	1.10	.72	.77	1.98	1.24	.71	.97	.37	.18	.11	4.56
V%	185.90	179.18	154.76	101.60	104.70	184.91	150.79	134.56	237.70	154.92	96.77	66.05	71.17
MEDIAN	.18	.23	.31	.41	.44	.45	.37	.29	.19	.15	.12	.14	5.03

TABLE NS 51/11 ADJUSTED RUN-OFF FOR SIPINGO NS 51 CATCHMENT AREA= 1023.0SQ.KM. \$M.A.R.

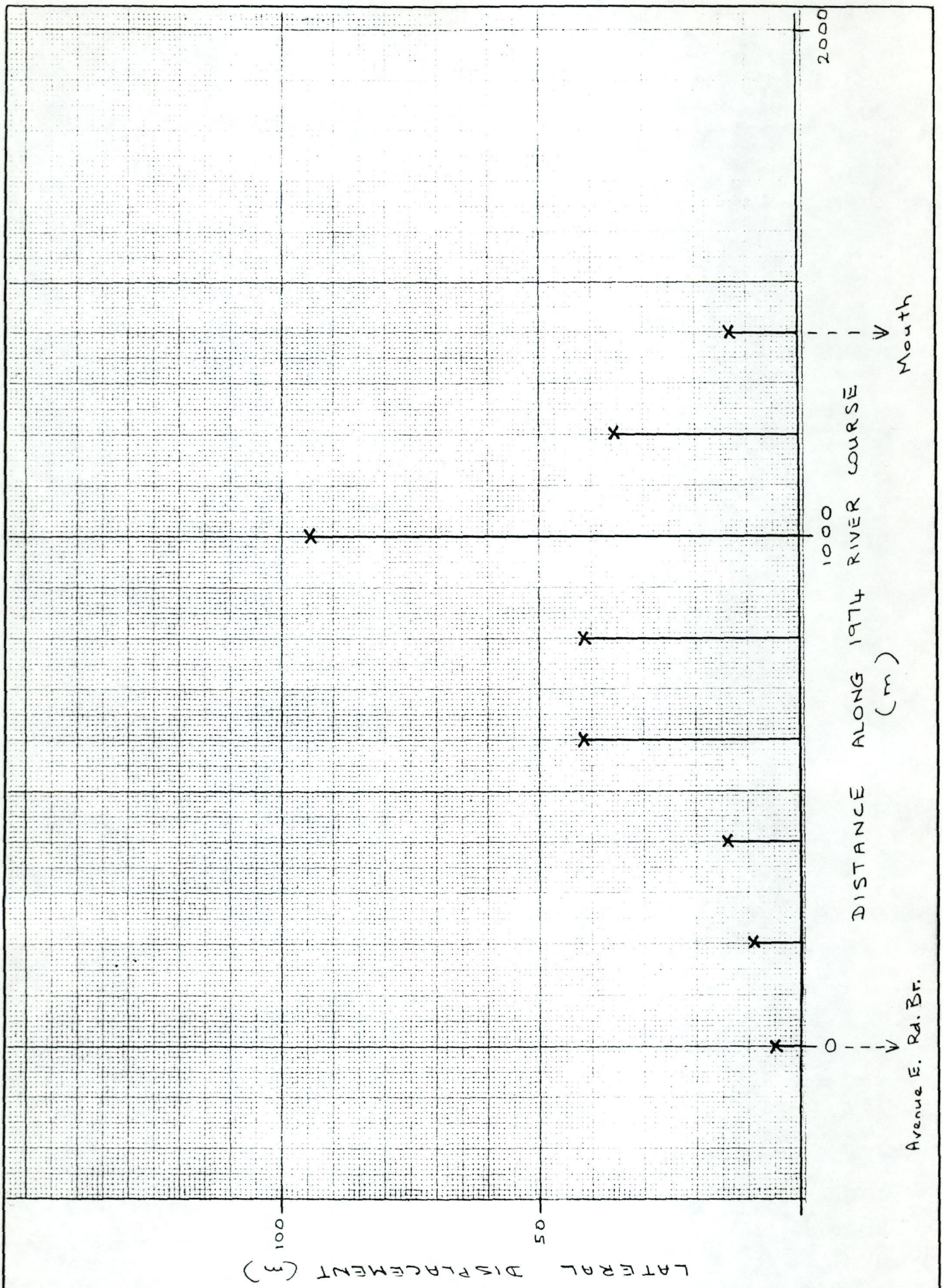
YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
1921	3.40	37.33	85.74	29.92	5.03	2.92	1.91	2.31	3.22	3.05	2.81	2.68	180.33
1922	5.28	26.24	12.65	6.46	7.21	6.33	4.87	3.09	1.82	1.47	1.38	1.10	77.90
1923	.96	1.20	3.16	5.17	4.81	3.19	2.24	2.00	1.65	1.21	.98	1.47	28.05
1924	1.88	2.75	3.78	4.68	5.18	202.57	73.12	6.06	4.32	3.24	2.48	2.99	313.03
1925	5.53	5.81	4.05	2.44	2.08	3.01	2.77	1.68	1.29	1.19	.94	1.03	524.16
1926	1.75	2.05	1.67	1.67	1.62	12.74	8.82	3.97	2.25	1.58	1.83	1.94	53.30
1927	2.08	2.18	3.17	5.19	6.21	5.28	3.55	2.97	1.50	1.02	.85	.99	70.61
1928	1.67	2.25	2.43	2.86	2.75	7.36	7.68	5.06	5.58	8.12	7.12	5.97	34.31
1929	6.68	6.82	6.23	20.43	11.48	6.44	5.58	3.69	2.45	2.05	2.20	1.89	58.84
1930	3.54	4.50	6.40	15.81	9.56	6.09	5.55	3.70	2.04	2.19	2.52	1.89	76.71
1931	1.67	1.97	2.71	3.98	5.69	7.31	6.27	4.61	3.55	2.50	1.70	1.32	128.44
1932	2.45	4.17	5.88	5.92	4.61	3.96	3.35	2.38	1.56	1.27	1.11	.87	63.80
1933	3.32	2.60	20.43	53.20	21.22	6.83	7.38	7.40	5.43	4.82	5.08	4.17	72.46
1934	2.59	1.84	1.34	11.33	14.53	10.26	7.03	6.39	109.21	42.07	5.93	3.81	37.53
1935	2.41	4.30	19.33	5.68	6.19	5.40	3.19	1.73	6.96	4.98	3.27	2.41	233.36
1936	1.30	1.83	3.86	6.02	58.47	23.46	5.80	5.27	3.46	1.08	1.04	.98	379.36
1937	1.30	5.30	9.31	9.29	31.97	16.10	6.20	4.76	3.82	2.79	2.24	2.16	121.27
1938	4.23	6.47	8.10	6.82	5.13	4.44	3.62	32.83	17.99	1.74	1.31	1.36	152.79
1939	2.97	18.72	17.48	9.76	6.09	4.84	5.30	4.49	2.68	1.82	1.22	.89	91.25
1940	1.78	2.63	3.14	4.92	7.37	50.47	22.41	7.33	5.41	3.64	3.32	3.60	126.49
1941	4.49	17.84	70.54	28.04	7.48	7.92	98.80	51.48	12.15	7.83	19.24	11.05	194.26
1942	59.09	96.84	43.36	10.79	5.91	15.36	9.63	4.34	2.70	2.09	1.58	2.74	564.09
1943	5.04	5.47	4.00	2.95	3.48	47.01	20.30	4.59	2.93	1.88	1.25	.86	166.03
1944	1.31	1.55	1.48	3.05	5.28	6.90	6.79	4.81	2.87	1.82	1.22	.89	427.03
1945	1.15	2.21	3.57	4.50	7.29	12.51	10.56	7.42	7.07	7.55	5.88	4.09	97.75
1946	3.33	5.53	8.29	14.04	14.89	10.11	8.98	7.49	4.49	2.53	1.57	1.14	128.28
1947	2.79	10.46	29.21	21.98	10.41	7.38	5.81	4.01	2.70	1.72	1.36	1.55	137.96
1948	1.65	1.34	2.34	5.38	6.27	6.11	5.19	3.20	1.87	1.98	2.16	2.12	85.22
1949	4.33	3.90	3.85	12.10	9.36	6.33	5.49	4.46	3.08	1.27	2.41	3.83	169.15
1950	.09	.11	.20	.41	2.06	.96	.27	.15	.11	.08	1.84	1.50	40.86
1951	.27	.30	.45	.52	.45	.36	.28	.23	.19	.08	.12	.20	97.93
1952	.36	.52	.28	3.36	2.35	1.45	.73	.38	.22	.15	.10	.13	4.77
1953	.14	.20	.28	.23	.35	3.93	1.67	.40	.25	.14	.10	.10	3.46
1954	.16	.23	3.95	2.11	.68	.54	2.84	1.25	.31	.18	.13	.22	10.13
1955	.40	.52	.50	.51	3.22	1.39	1.61	3.16	.29	.18	.12	.12	7.91
1956	.14	.20	.29	.42	.48	.35	.20	3.16	1.41	.36	.29	.24	12.61
1957	.21	.23	.24	.23	.23	.28	.32	.26	.16	.10	.08	.07	9.69
1958	.11	.24	1.30	.87	.49	.45	4.47	1.82	.38	.29	.22	.20	7.54
1959	.21	.20	.20	.27	.35	.45	.46	.32	.19	.12	.10	.10	2.40
1960	.10	.22	.31	.38	.37	.38	.36	.32	.15	.23	.29	.21	10.84
1961	.15	.14	.17	.74	.59	.38	.33	.25	.17	.14	.11	.11	2.97
1962	.22	.29	.33	.35	.29	.19	.10	.09	.16	.13	.11	.10	3.25
1963	.34	.42	.45	1.75	.92	.32	.17	.16	.16	.13	.11	.10	2.91
1964	.10	.19	.26	.36	1.51	2.58	1.15	.46	.27	.17	.12	.08	4.87
1965	.11	.23	.26	.40	.46	.36	.24	.14	.09	.06	.09	.14	5.03
1966	.19	.23	.15	.12	.12	.27	.39	.42	.36	.26	.20	.19	7.25
1967	.15	.23	.24	.23	.17	.09	.05	.05	.05	.05	.07	.11	2.59
1968	.77	.68	.32	.20	.17	.20	.22	.97	.44	.16	.18	.18	4.76
1969	.14	.11	.13	.15	.14	.17	.10	.10	.09	.08	.06	.04	1.49
1970	.04	.07	.09	.11	.14	.12	.10	.07	.04	.03	.05	.12	4.50
1971	.16	.20	.19	.46	.32	.23	.19	.14	.14	.10	.07	.05	1.37
1972	.04	.06	.08	.26	.99	.43	.13	.09	.06	.04	.03	.07	.98
1973	.04	.06	.08	.26	.99	.43	.13	.09	.06	.04	.03	.07	2.26
1974	.04	.06	.08	.26	.99	.43	.13	.09	.06	.04	.03	.07	3.79
1975	.10	.10	.13	.40	.30	2.35	1.28	.32	.13	.08	.07	.07	2.28
MEAN	2.73	6.17	7.54	6.14	5.76	10.12	7.14	4.11	4.28	2.46	1.77	1.50	59.72
S	7.93	15.13	16.00	9.45	9.26	28.22	16.31	8.03	14.75	5.84	2.94	1.93	77.04
V%	290.39	245.18	212.31	153.79	160.67	278.94	228.34	195.57	344.47	237.69	165.89	128.40	129.00
MEDIAN	1.15	1.55	2.34	2.86	3.22	3.93	3.19	2.29	1.50	1.19	.98	.89	34.31

TABLE NS 61/XII ASSUMED SIPINGO FLOOD FLOWS

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
1921	.04	2.22	5.33	1.56	.00	.00	.00	.00	.02	.05	.06	.03	9.31
1922	.16	1.43	.52	.02	.04	.00	.00	.00	.00	.00	.00	.00	2.23
1923	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
1924	.00	.00	.00	.00	.00	12.88	4.44	.11	.09	.07	.04	.05	17.68
1925	.18	.15	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.33
1926	.00	.00	.00	.00	.00	.39	.21	.00	.00	.00	.00	.00	.60
1927	.00	.00	.00	.00	.00	.04	.13	.04	.17	.39	.34	.25	1.36
1928	.00	.00	.10	.94	.32	.00	.00	.00	.00	.00	.02	.03	1.89
1929	.26	.22	.11	.63	.19	.00	.00	.00	.00	.00	.04	.00	1.08
1930	.05	.06	.11	.00	.00	.03	.04	.01	.04	.02	.00	.00	.14
1931	.00	.00	.08	.00	.00	.00	.00	.00	.00	.00	.00	.00	.12
1932	.00	.04	.00	.00	.96	.00	.12	.19	.16	.17	.21	.13	6.06
1933	.00	.00	1.03	3.09	.52	.23	.09	.13	6.99	2.62	.27	.11	11.65
1934	.04	.00	.31	.34	.00	.00	.41	.15	.27	.18	.09	.02	2.19
1935	.00	.00	.96	.00	.00	.00	.00	.00	.00	.00	.00	.00	3.56
1936	.00	2.60	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	4.71
1937	.00	.00	.00	.00	3.41	1.10	.01	.05	.04	.04	.02	.04	3.15
1938	.03	.12	.30	.20	1.67	.61	.04	.02	.06	.36	.18	.07	4.01
1939	.09	.19	.22	.04	.00	.00	.00	1.87	.99	.00	.00	.00	2.09
1940	.01	1.00	.84	.24	.00	.00	.00	.00	.00	.00	.00	.00	4.64
1941	.00	.00	.00	.00	.05	2.87	1.10	.19	.16	.09	.09	.09	4.64
1942	.11	.94	4.33	1.44	.05	.07	6.13	3.09	.61	.37	1.14	.59	18.87
1943	3.70	6.14	2.54	.30	.00	.56	.26	.00	.00	.00	.00	.04	13.54
1944	.15	.13	.00	.00	.00	2.64	.96	.01	.00	.00	.00	.00	3.89
1945	.00	.00	.00	.00	.00	.01	.08	.02	.00	.00	.00	.00	.11
1946	.00	.00	.00	.00	.04	.37	.32	.20	.27	.35	.26	.13	1.94
1947	.04	.13	.24	.52	.54	.22	.22	.20	.10	.02	.00	.00	2.23
1948	.00	.12	.11	.03	.02	.00	.00	.00	.00	.00	.00	.00	.28
1949	.00	.46	1.61	1.04	.25	.04	.01	.00	.00	.00	.02	.00	3.43
1950	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.03	.11	.14
1951	.10	.02	.00	.39	.18	.00	.00	.00	.01	.00	.00	.00	.70
1952	.00	.07	.14	.11	1.62	.51	.00	.00	.00	.00	.00	.06	2.19
1953	.17	.29	.10	2.96	1.91	1.00	.36	.08	.03	.00	.00	.00	.42
1954	.00	.00	.00	.00	.24	3.48	1.30	.08	.06	.02	.02	.08	6.90
1955	.00	.00	3.64	1.70	.09	.94	2.47	.96	.12	.03	.01	.08	9.34
1956	.00	.29	.19	.10	2.78	.00	1.24	.53	.09	.03	.00	.00	6.41
1957	.22	.29	.00	.01	.04	.00	.00	2.87	1.21	.21	.17	.09	4.60
1958	.03	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.03
1959	.00	.00	.00	.46	.05	.00	4.10	1.52	.19	.14	.10	.06	7.62
1960	.00	.01	.99	.00	.00	.00	.08	.03	.00	.00	.00	.00	.13
1961	.02	.00	.00	.00	.00	.00	.00	.00	.00	.08	.17	.06	.31
1962	.00	.00	.00	.34	.15	.00	.00	.00	.00	.00	.00	.00	.49
1963	.03	.05	.02	.00	.00	.00	.00	.00	.00	.12	.17	.17	.56
1964	.15	.14	.14	1.34	.48	.00	.00	.00	.00	.00	.00	.00	2.29
1965	.00	.00	.00	.00	1.07	2.13	.78	.17	.08	.02	.00	.00	4.25
1966	.00	.00	.00	.00	.02	.00	.00	.00	.00	.00	.00	.00	.02
1967	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.05
1968	.00	.00	.00	.00	.00	.00	.02	.12	.17	.11	.08	.05	.55
1969	.20	.32	.27	.17	.00	.00	.00	.00	.00	.00	.04	.12	1.12
1970	1.71	1.44	.47	.09	.00	.00	.18	2.08	.89	.24	.32	.29	7.75
1971	.16	.04	.02	.00	.00	.04	.00	.00	.04	.05	.03	.00	.34
1972	.00	.00	.00	.00	.00	.00	.00	.00	.00	.10	.05	.00	.16
1973	.22	.25	.15	.71	.34	.00	.00	.11	.15	.10	.05	.00	2.28
1974	.00	.00	.00	.23	2.00	.61	.00	.00	.00	.00	.00	.02	2.86
1975	.06	.01	.01	.58	.31	5.32	2.77	.49	.14	.06	.05	.04	9.84

MEAN ANNUAL RUN-OFF FOR CATCHMENT = 3.59 MILLION CURIC METRES.

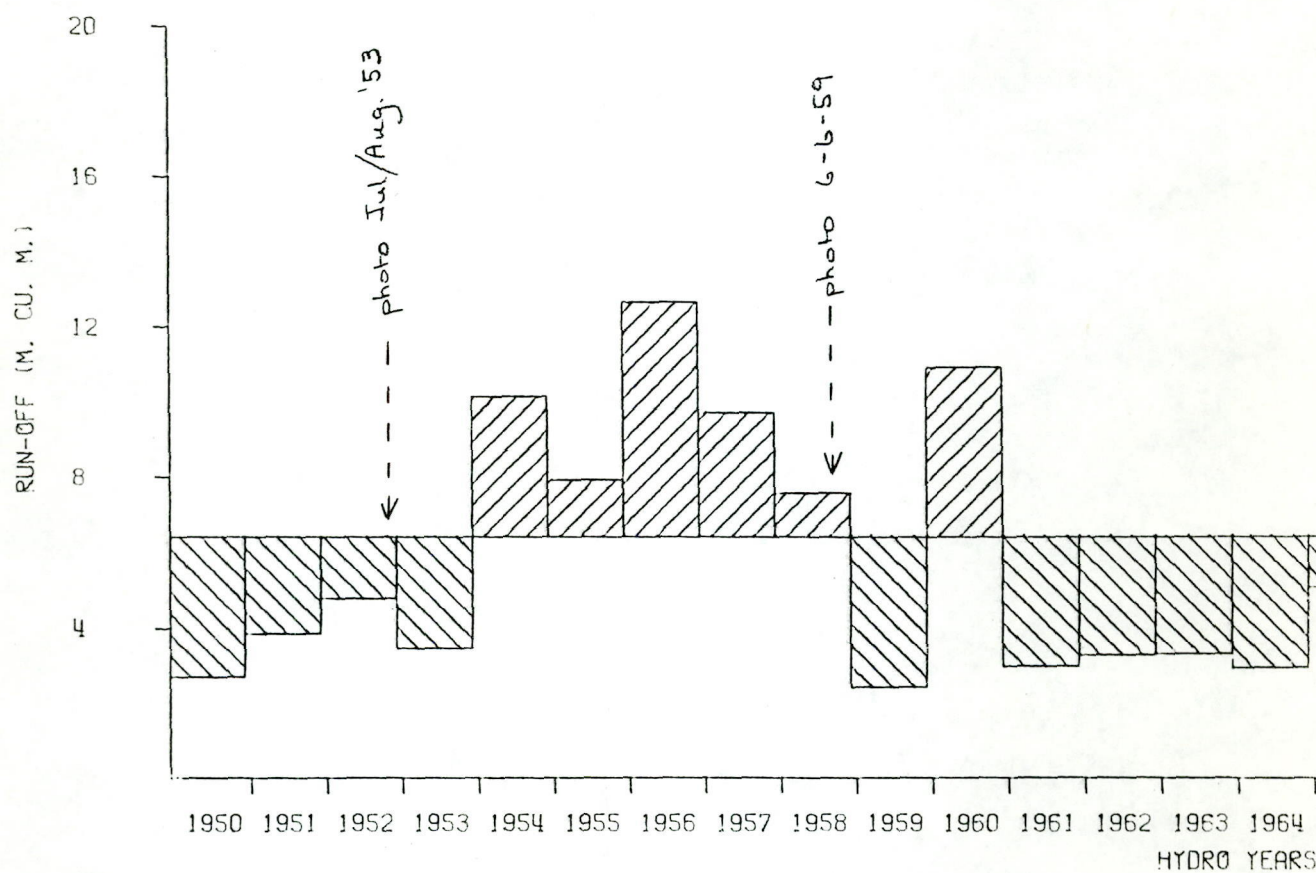
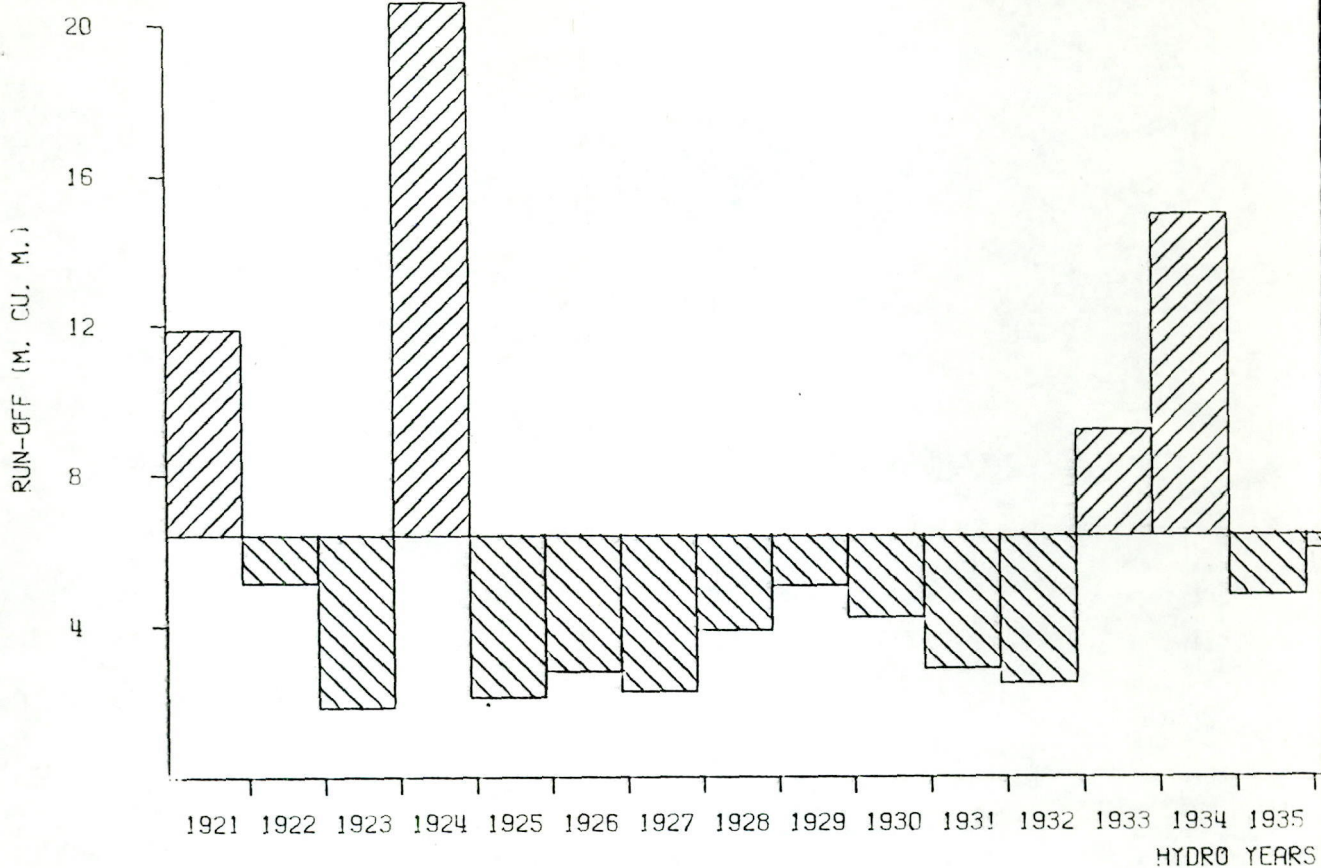
CATCHMENT AREA 51.0 SQ. KM.



TRACED
 CHECKED
 DATE
 REF

NATAL ESTUARIES: SIPINGO
 THALWEG DISPLACEMENT
 (1937-1984)

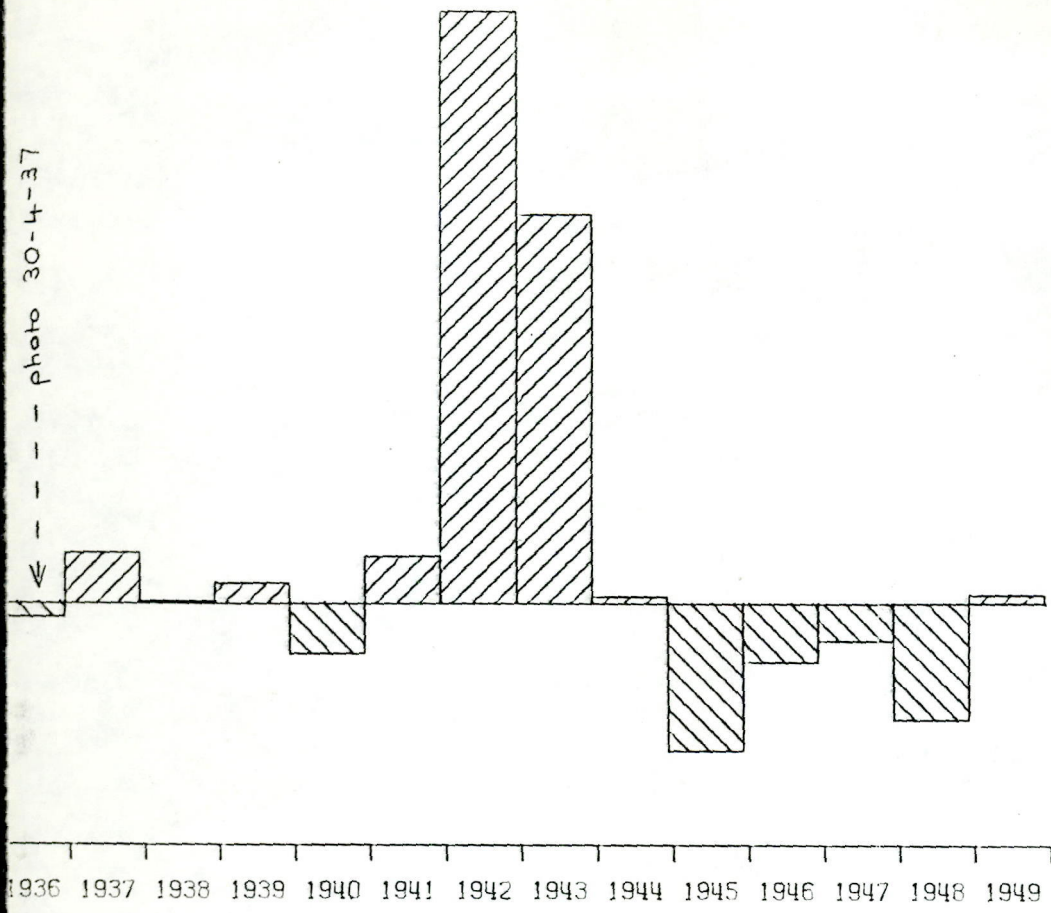
FIGURE
 NS 51/1



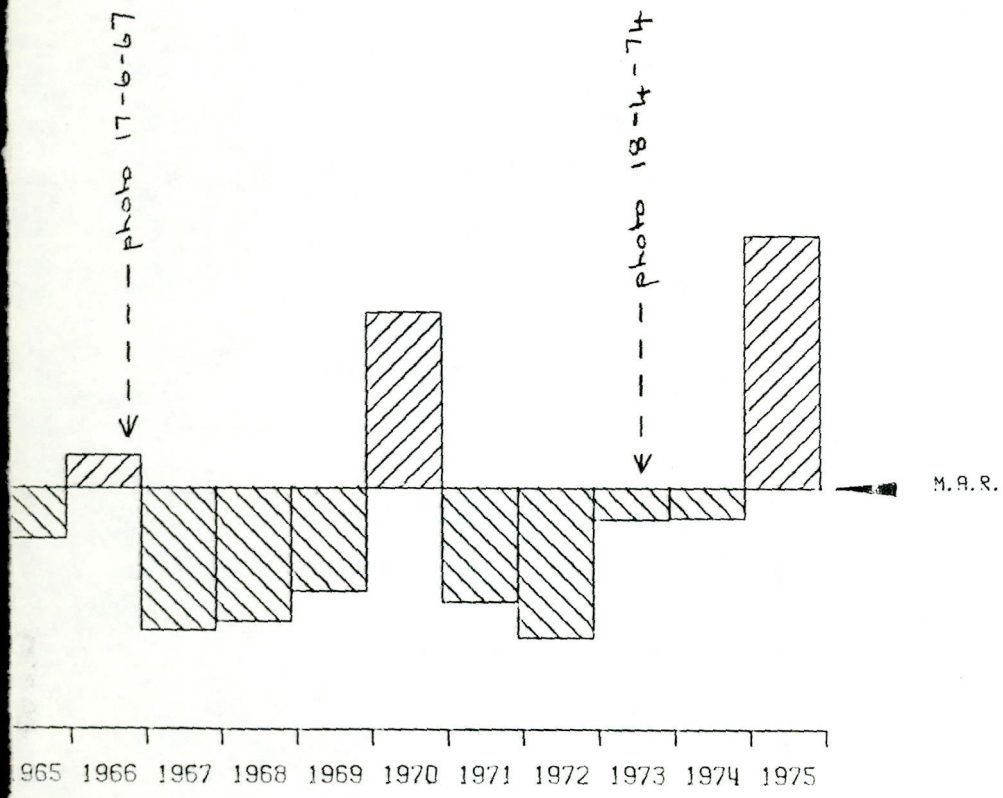
TRACED : COMPILOT
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NATAL ESTUARIES : SIPINGO
 SIMULATED ANNUAL RUN-OFF
 1921-1975

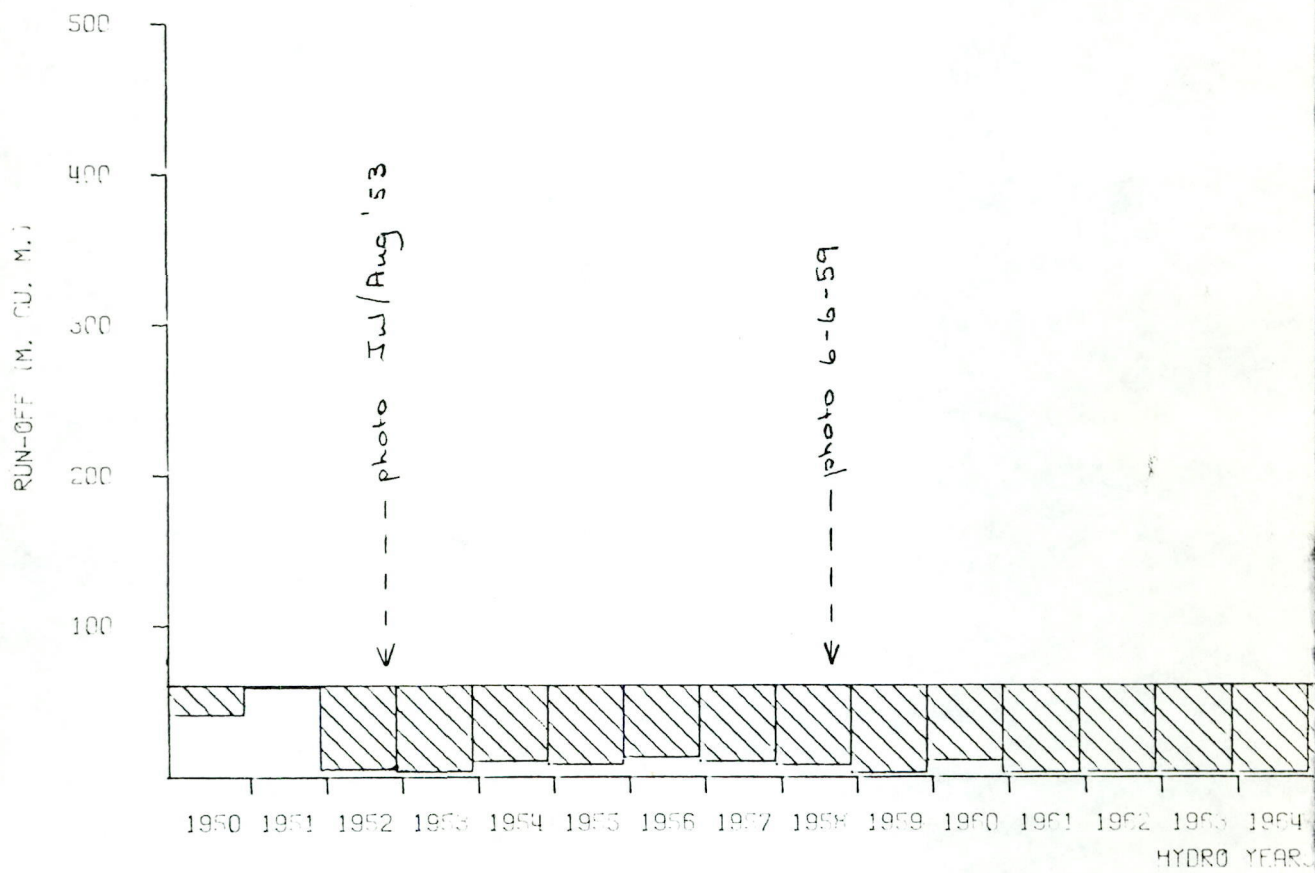
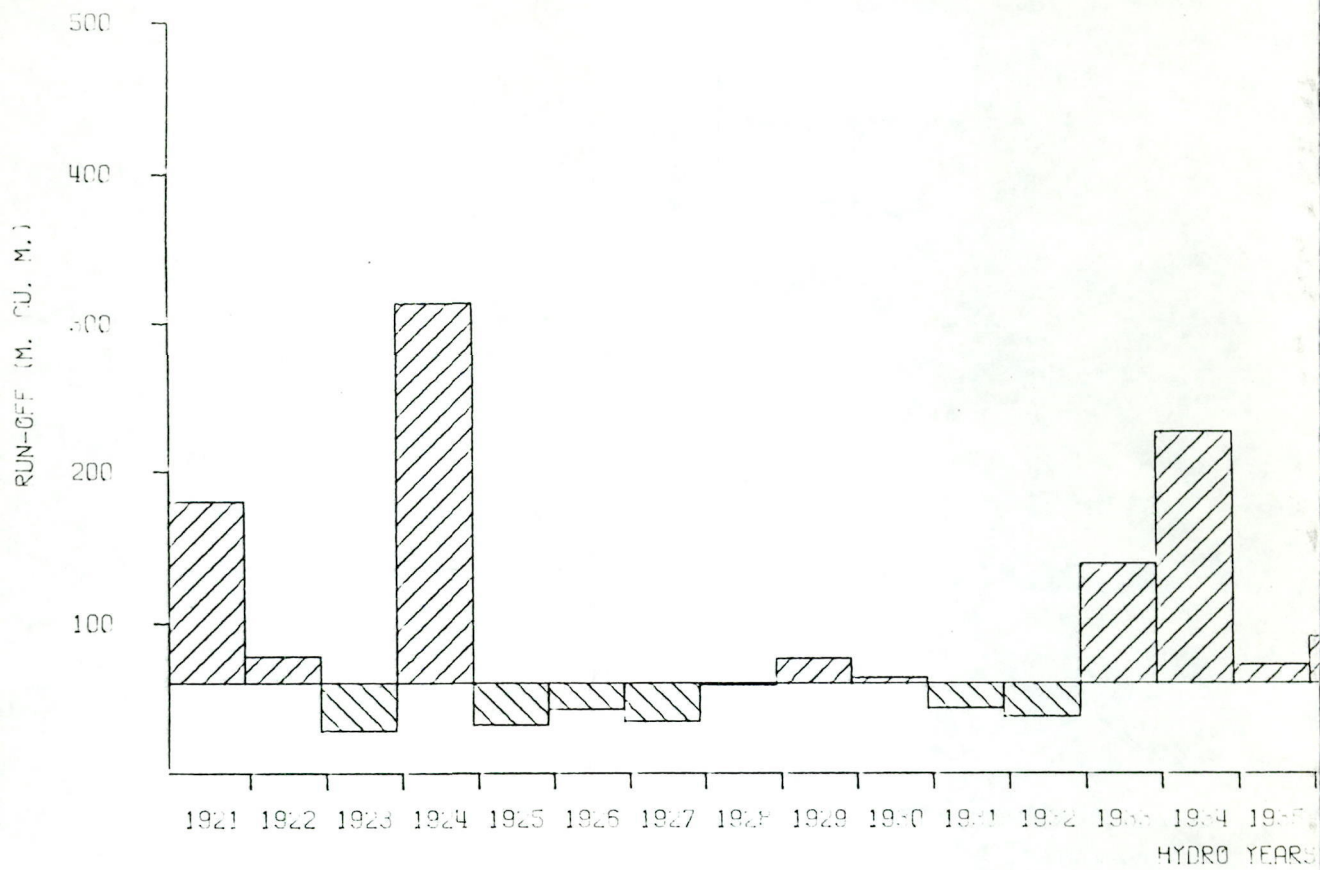
FIGURE
 NS 51/2



1936 1937 1938 1939 1940 1941 1942 1943 1944 1945 1946 1947 1948 1949



1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975



GRADED - COMPLETE CHECKED DATE REF	NATAL ESTUARIES - WIPINGO ADJUSTED SIMULATED ANNUAL RUN-OFF 1921-1975 NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY	FIGURE NS 51/3
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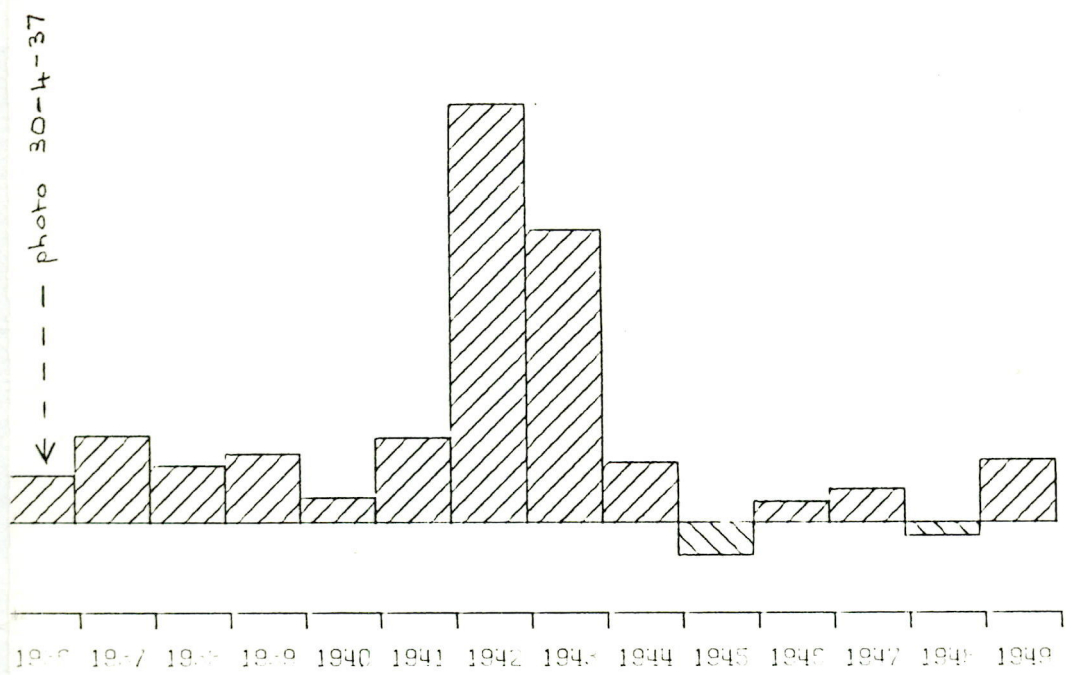
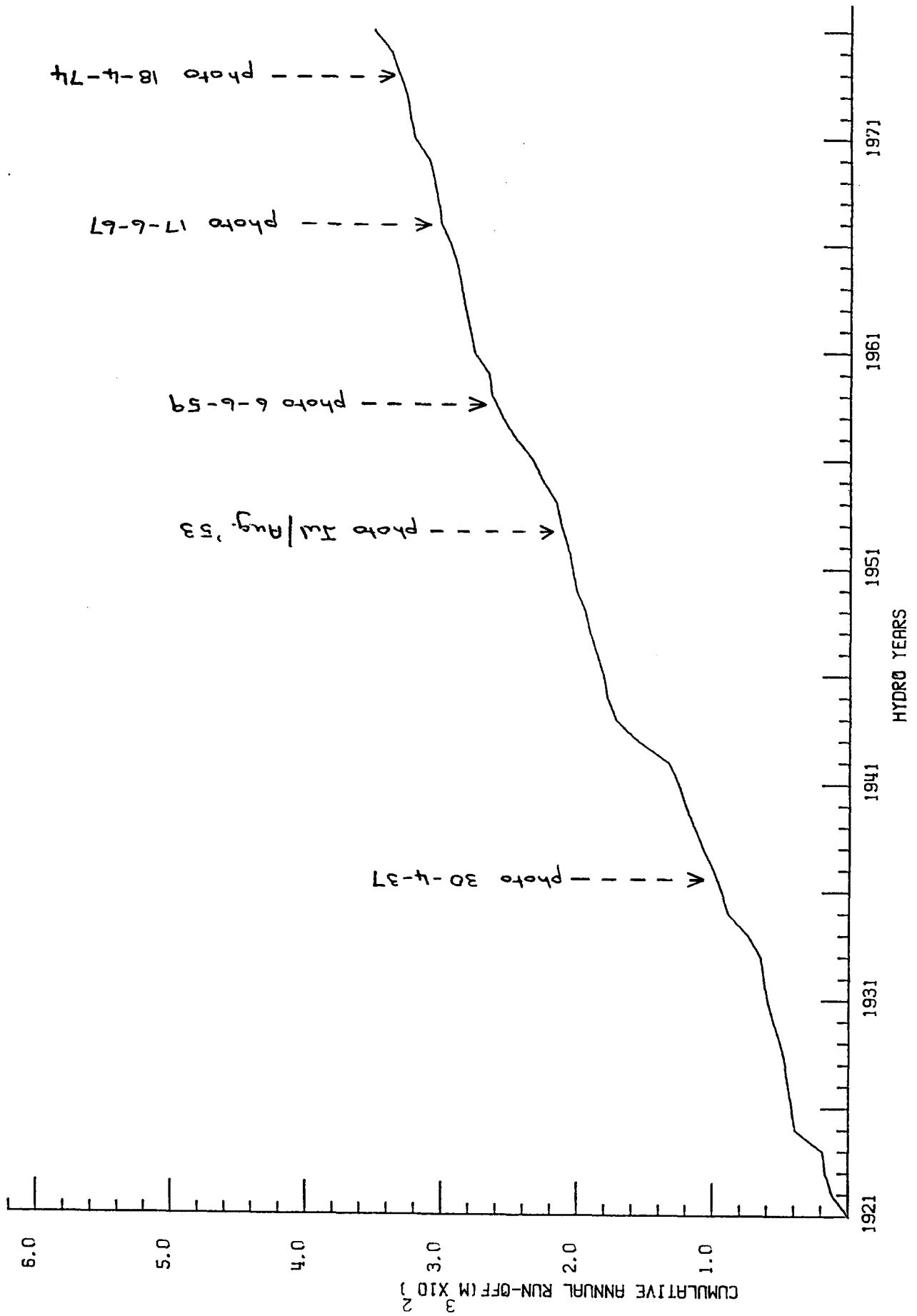


photo 17-6-67

photo 18-4-74

M.P.R.

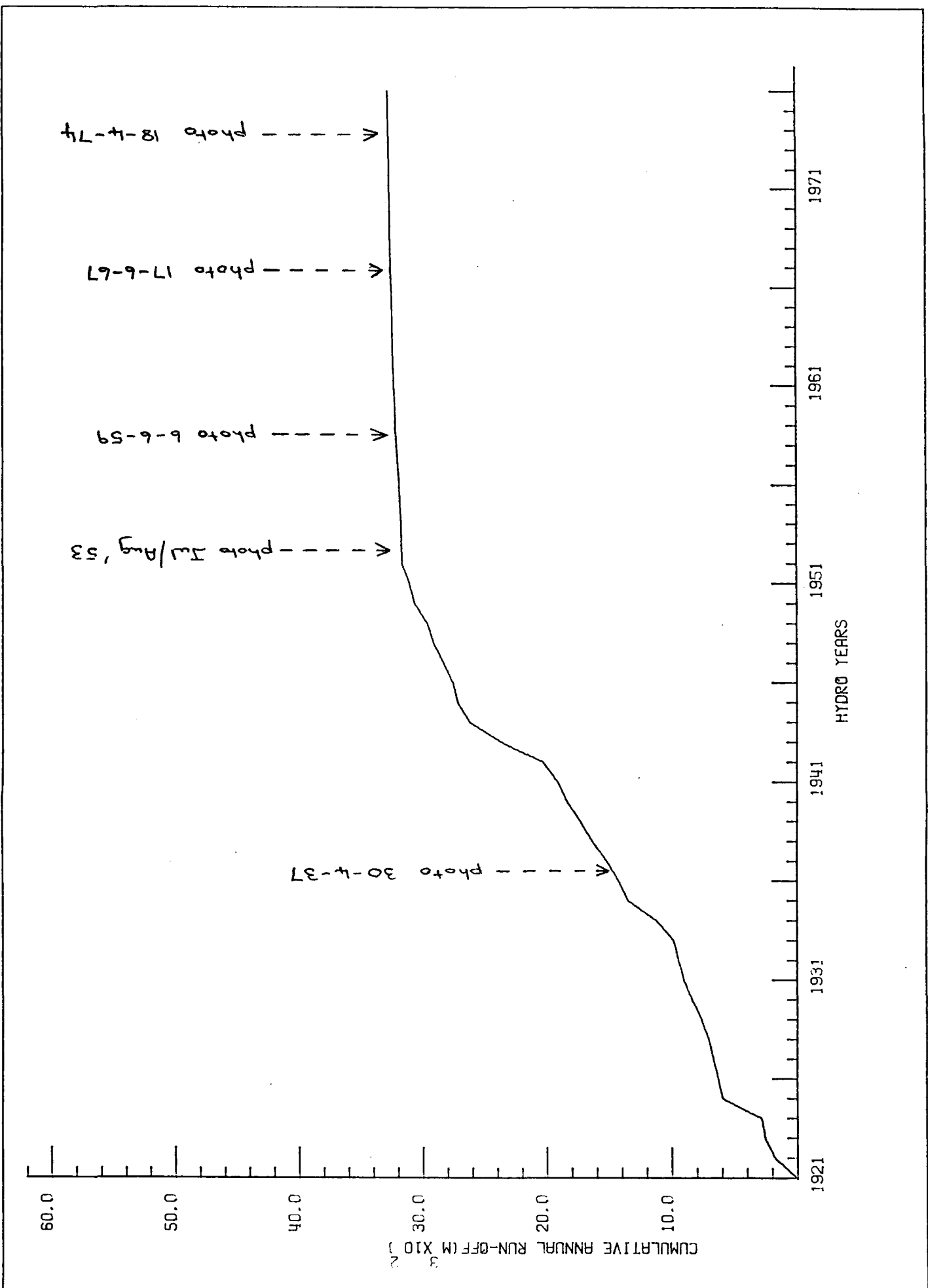
TRACE	CHECK	DATE	REF.
		1965	
		1966	
		1967	
		1968	
		1969	
		1970	
		1971	
		1972	
		1973	
		1974	
		1975	



TRACED : COMLOT
 CHECKED :
 DATE :
 REF. :

NATAL ESTUARIES: SIPINGO
CUMULATIVE ANNUAL RUN-OFF

FIGURE
 NS 51/6



TRACED : COMPTON
 CHECKED :
 DATE :
 REF. :

NATAL ESTUARIES: SIPINGO
CUMULATIVE ANNUAL RUN-OFF
 (ADJUSTED)

FIGURE
NS 51/7



SCALE: 1 : 10 000 approx.

TRACED
CHECKED
DATE:
REF

NATAL ESTUARIES : SIPINGO
6-2-84
(30-4-37 RIVER COURSE SUPERIMPOSED)

PHOTOGRAPH
NS 51/1

NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY



SCALE: 1 : 10 000 approx.

TRACED
CHECKED
DATE:
REF.

NATAL ESTUARIES : SIPINGO

30 - 4 - 37 (12 h 44)

PHOTOGRAPH
NS 51/2

NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY



SCALE: 1 : 10 000 approx.

TRACED
CHECKED
DATE:
REF:

NATAL ESTUARIES : SIPINGO

JULY / AUGUST 1953 (11 h 15)

PHOTOGRAPH
NS 51/3

NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY



SCALE: 1 : 10 000 approx.

TRACED
CHECKED
DATE:
REF

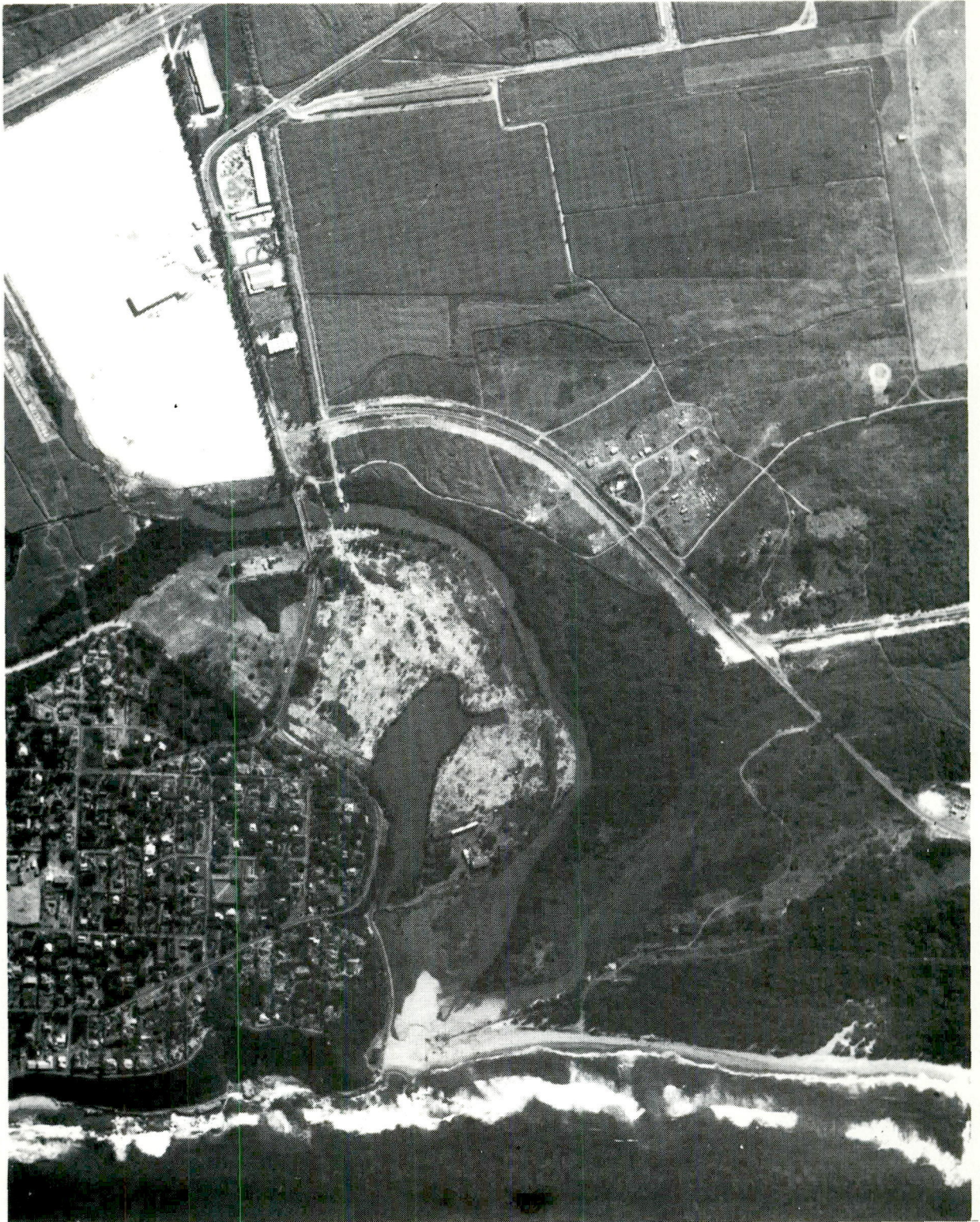
NATAL ESTUARIES : SIPINGO

6-6-59 (12 h 37)

PHOTOGRAPH

NS 51/4

NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY



SCALE: 1 : 10 000 approx.

TRACED
CHECKED
DATE.
REF

NATAL ESTUARIES : SIPINGO

17-6-67 (13h07)

PHOTOGRAPH
NS 51/5

NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY



SCALE: 1 : 10 000 approx.

TRACED
CHECKED
DATE
REF

NATAL ESTUARIES : SIPINGO

18 - 4 - 74 (11 h 27)

PHOTOGRAPH
NS 51/6

NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY



SCALE: 1 : 10 000 approx.

TRACED
CHECKED
DATE
REF

NATAL ESTUARIES : SIPINGO

6-2-84 (15h52)

PHOTOGRAPH
NS 51/7

NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY



SCALE: 1 : 10 000 approx.

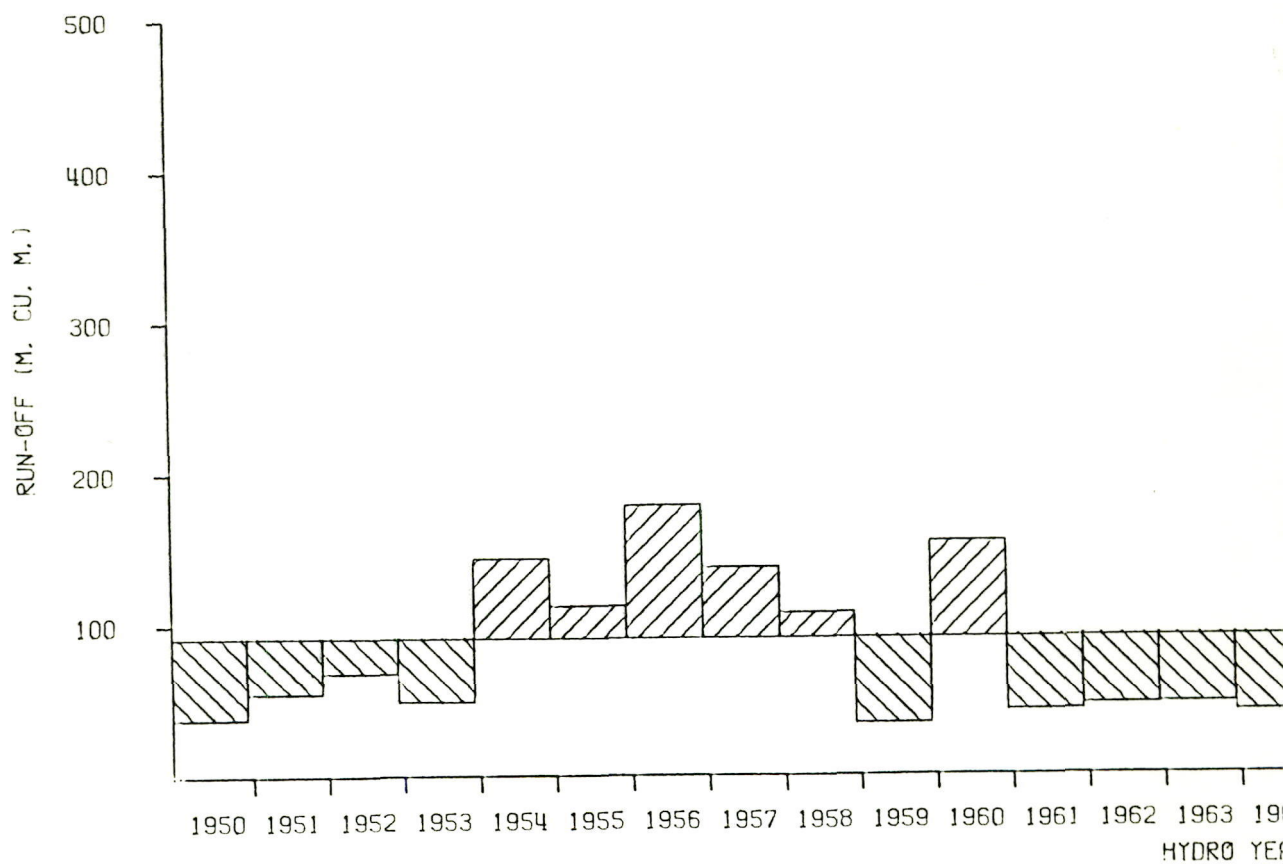
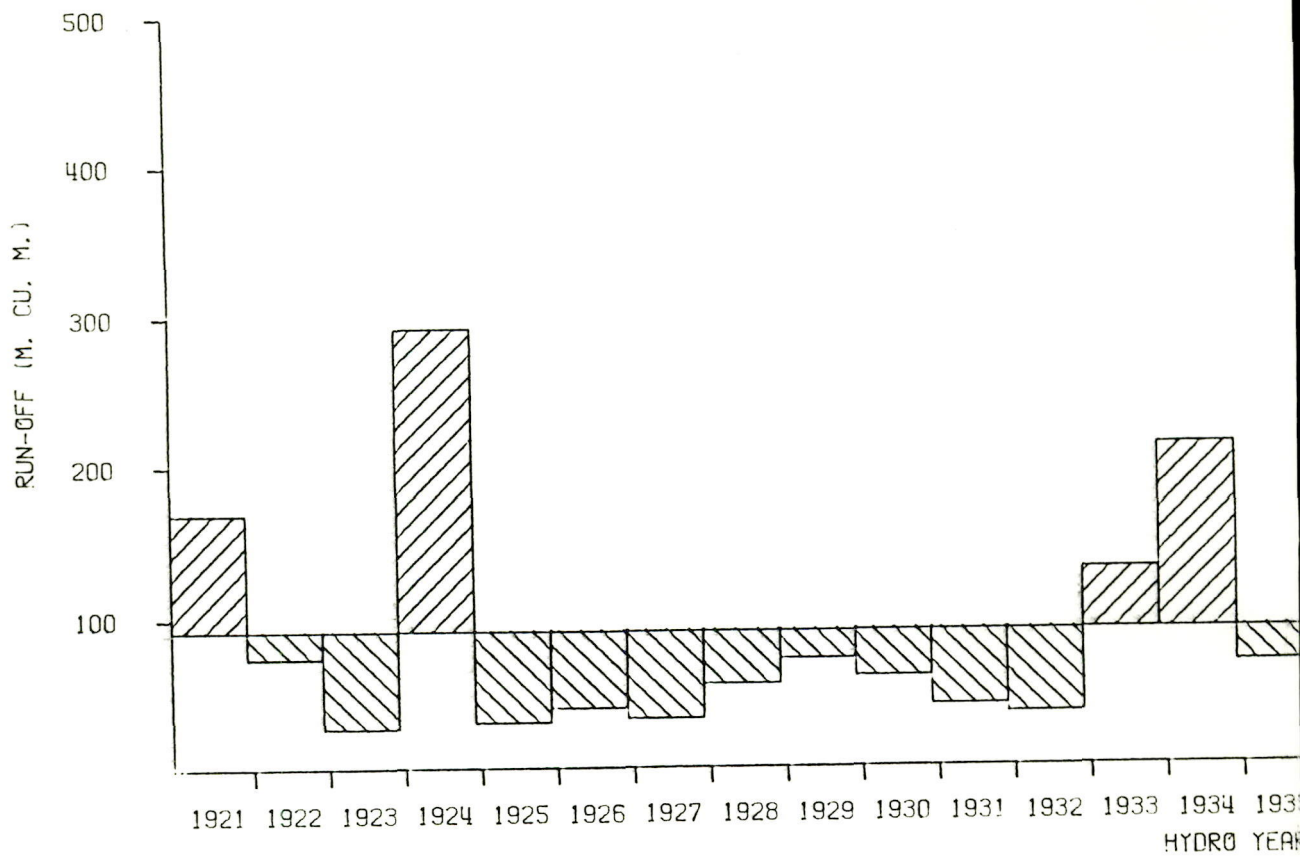
TRACED
 CHECKED :
 DATE:
 REF :

NATAL ESTUARIES : SIPINGO
 18-4-74 (ORTHOPHOTO)

PHOTOGRAPH
 NS 51/8

TABLE NS 52 I SIMULATED RUN-OFF FOR MLAZI NS 52 CATCHMENT AREA= 972.050.KM. %M.A.R.

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL	%M.A.R.
1921	3.18	34.87	40.10	27.95	4.70	2.73	1.79	2.16	3.01	2.85	2.63	2.50	168.46	185.12
1922	4.93	24.51	11.82	6.04	6.73	5.92	4.55	2.89	1.70	1.37	1.91	1.03	72.78	79.97
1923	.90	1.12	2.95	4.83	4.50	2.98	2.09	1.87	1.54	1.13	.91	1.37	26.20	28.79
1924	1.75	2.57	3.53	4.37	4.84	189.24	68.31	5.66	4.03	3.02	2.31	2.80	292.43	321.35
1925	5.17	5.43	3.78	2.28	1.94	2.82	2.59	1.57	1.21	1.12	.88	.96	29.73	32.67
1926	1.64	1.91	1.82	1.56	1.51	11.90	8.24	3.71	2.10	1.48	1.71	1.82	39.40	43.29
1927	1.94	2.04	2.96	4.85	5.81	4.93	3.31	2.14	1.40	.95	.80	.93	32.05	35.22
1928	1.56	2.10	2.27	2.67	2.57	6.88	7.17	4.73	5.22	7.59	6.65	5.58	54.97	60.40
1929	6.24	6.38	5.82	19.09	10.73	6.02	5.22	3.44	2.28	1.92	2.06	2.47	71.66	78.75
1930	3.30	4.21	5.98	14.77	8.93	5.69	5.19	3.45	1.90	2.05	2.36	1.77	59.60	65.49
1931	1.56	1.84	3.72	5.32	5.32	6.83	5.86	4.31	3.31	2.34	1.59	1.24	40.43	44.42
1932	2.29	3.89	5.49	5.53	4.31	3.70	3.13	2.22	1.46	1.19	1.03	.81	35.06	38.52
1933	.75	2.43	19.09	49.70	19.82	6.38	6.90	6.91	5.07	4.51	4.74	3.89	130.19	143.06
1934	3.10	3.10	8.74	10.59	13.57	9.59	6.57	5.97	102.03	39.30	5.54	3.56	211.64	232.57
1935	2.42	1.72	1.25	1.86	4.91	21.62	11.06	6.34	6.50	4.66	3.05	2.26	67.65	74.35
1936	2.26	40.17	18.06	5.31	5.78	5.05	2.98	1.61	1.12	1.01	.97	.92	85.24	93.67
1937	1.22	1.71	3.60	5.62	54.62	21.92	5.42	4.92	3.23	2.68	2.68	2.02	109.64	120.48
1938	3.00	4.95	8.69	6.38	29.86	15.04	5.79	4.45	3.57	2.61	2.09	2.58	91.32	100.35
1939	3.95	6.04	7.56	6.04	4.79	4.15	3.39	30.67	16.80	7.17	4.38	3.07	98.35	108.07
1940	2.78	17.49	16.33	9.12	5.69	4.52	4.95	4.19	2.50	1.62	1.22	1.27	71.68	78.77
1941	1.66	2.45	2.93	4.60	6.89	47.15	20.93	6.85	5.06	3.40	3.10	3.36	108.38	119.09
1942	4.20	16.66	65.90	26.20	6.99	7.40	92.30	48.09	11.35	7.32	17.98	10.33	314.71	345.83
1943	4.71	5.11	3.74	2.75	3.25	43.91	18.96	4.06	2.52	1.95	1.48	2.56	237.68	261.18
1944	1.44	1.45	1.38	2.85	4.93	6.44	6.35	4.29	2.73	1.76	1.16	.80	93.18	102.40
1945	1.23	2.06	3.33	4.20	6.81	11.69	6.94	6.94	6.61	7.05	1.14	.83	35.47	38.98
1946	1.08	5.17	7.74	13.12	13.91	9.44	8.39	6.99	4.20	2.37	1.47	1.06	76.97	84.58
1947	3.11	5.00	6.03	6.18	6.56	6.02	4.87	3.63	2.32	1.60	1.27	1.45	47.54	52.24
1948	2.61	9.78	27.29	20.53	9.72	6.90	5.43	3.75	2.52	1.85	2.02	1.98	94.37	103.70
1949	2.61	9.78	27.29	20.53	9.72	6.90	5.43	3.75	2.52	1.85	2.02	1.98	94.37	103.70
1950	1.54	1.25	2.19	5.03	5.86	5.70	4.85	2.99	1.74	1.19	2.25	3.58	38.17	41.95
1951	4.05	3.64	3.59	11.30	8.75	5.92	5.13	4.17	2.88	2.09	1.72	1.40	54.64	60.04
1952	1.29	1.62	2.88	6.45	5.78	29.24	3.84	4.17	1.49	1.15	1.71	2.85	67.67	74.36
1953	3.81	4.24	6.45	7.40	6.39	5.15	3.91	3.25	2.74	2.15	1.67	1.91	49.08	53.93
1954	5.06	7.44	5.83	47.77	33.34	20.56	10.39	5.34	3.17	2.02	1.40	1.46	143.77	157.99
1955	1.97	2.81	3.95	3.30	4.98	55.74	23.73	5.67	3.60	2.38	2.01	2.08	112.22	123.32
1956	2.31	3.31	56.02	29.91	9.67	7.61	40.37	17.81	4.37	2.57	1.90	3.10	178.95	196.65
1957	5.70	7.43	7.11	7.19	45.72	19.70	22.88	11.72	4.08	2.53	1.67	1.77	137.51	151.11
1958	2.02	2.86	4.13	5.93	6.84	4.95	2.86	4.88	19.97	5.14	4.15	3.35	107.10	117.69
1959	3.00	3.20	3.43	3.28	3.19	3.92	4.55	3.67	2.25	1.45	1.08	1.01	34.04	37.40
1960	1.57	3.39	18.52	12.29	7.00	6.39	63.44	25.79	5.38	4.14	3.11	2.86	153.89	169.11
1961	2.96	2.85	2.81	3.88	4.92	6.37	6.47	4.57	2.73	1.65	1.48	1.41	42.10	46.26
1962	1.37	3.08	4.40	5.45	5.27	5.40	5.26	3.52	2.09	3.28	4.15	2.92	46.18	50.75
1963	2.18	2.03	2.36	10.53	8.38	5.36	4.63	3.57	2.44	2.00	1.57	1.55	46.61	51.22
1964	3.09	4.07	4.66	4.97	4.18	2.63	1.40	1.32	2.69	3.76	4.12	4.41	41.30	45.38
1965	4.78	5.91	6.37	24.83	13.06	4.51	2.42	2.22	2.30	1.91	1.57	1.47	71.34	78.39
1966	1.48	2.65	3.63	5.13	21.41	36.57	16.37	6.57	3.84	2.43	1.67	1.12	102.86	113.04
1967	1.59	3.25	3.73	5.63	6.48	5.11	3.45	2.03	1.26	.91	1.24	2.05	36.71	40.34
1968	2.63	2.58	2.15	1.64	1.69	3.84	5.50	5.90	5.12	3.72	2.84	2.75	40.36	44.35
1969	5.38	7.84	8.29	8.17	5.98	3.20	1.80	1.57	1.80	1.82	2.27	3.71	51.82	56.94
1970	26.90	23.71	11.08	7.08	6.07	6.92	7.81	33.65	15.42	5.53	6.33	6.13	156.61	172.10
1971	4.87	3.93	4.63	5.08	6.22	5.94	4.00	3.34	3.29	2.82	2.13	1.49	47.77	52.49
1972	1.49	2.32	3.02	3.91	4.75	4.31	3.40	2.39	1.47	1.04	1.76	1.47	34.13	37.51
1973	5.74	6.82	6.46	15.85	11.10	7.92	6.55	5.76	4.87	3.55	2.51	1.71	78.85	86.65
1974	1.56	2.01	2.79	9.03	34.62	15.01	4.37	3.17	2.09	1.43	1.13	2.32	79.53	87.39
1975	3.52	3.45	4.52	14.03	10.57	81.92	44.54	11.10	4.66	2.88	2.40	2.54	186.13	204.53
MEAN	4.22	7.71	10.11	10.00	10.39	15.19	11.72	7.46	5.78	3.37	2.62	2.44	91.00	91.00
S	7.85	13.82	15.65	10.16	10.87	28.09	17.67	10.04	13.73	5.21	2.53	1.61	64.76	64.76
V%	185.90	179.18	154.76	101.60	104.70	184.91	150.79	134.56	237.70	154.92	96.77	66.05	71.17	71.17
MEDIAN	2.61	3.31	4.40	5.78	6.22	6.37	5.26	4.17	2.73	2.09	1.76	2.02	71.34	71.34

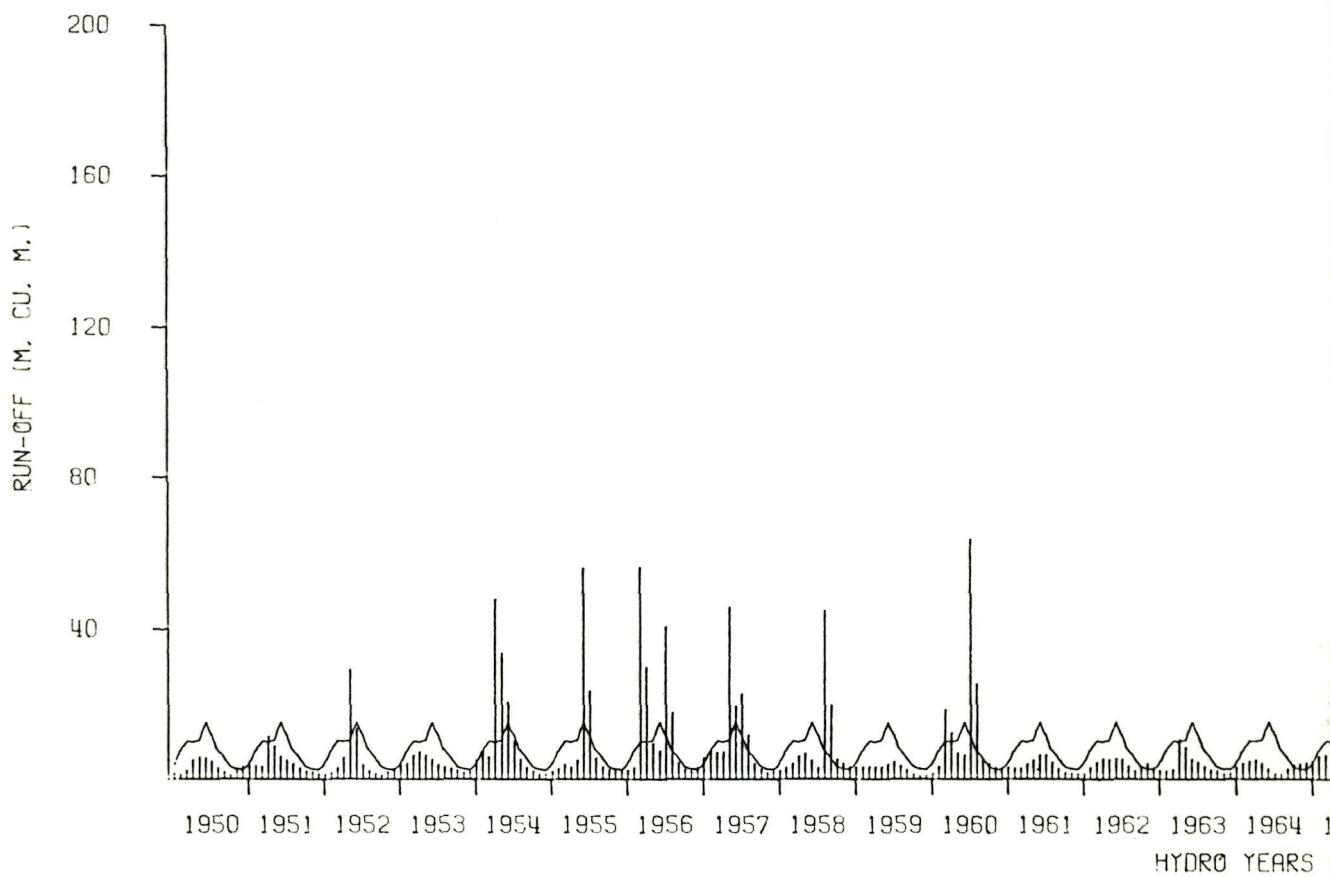
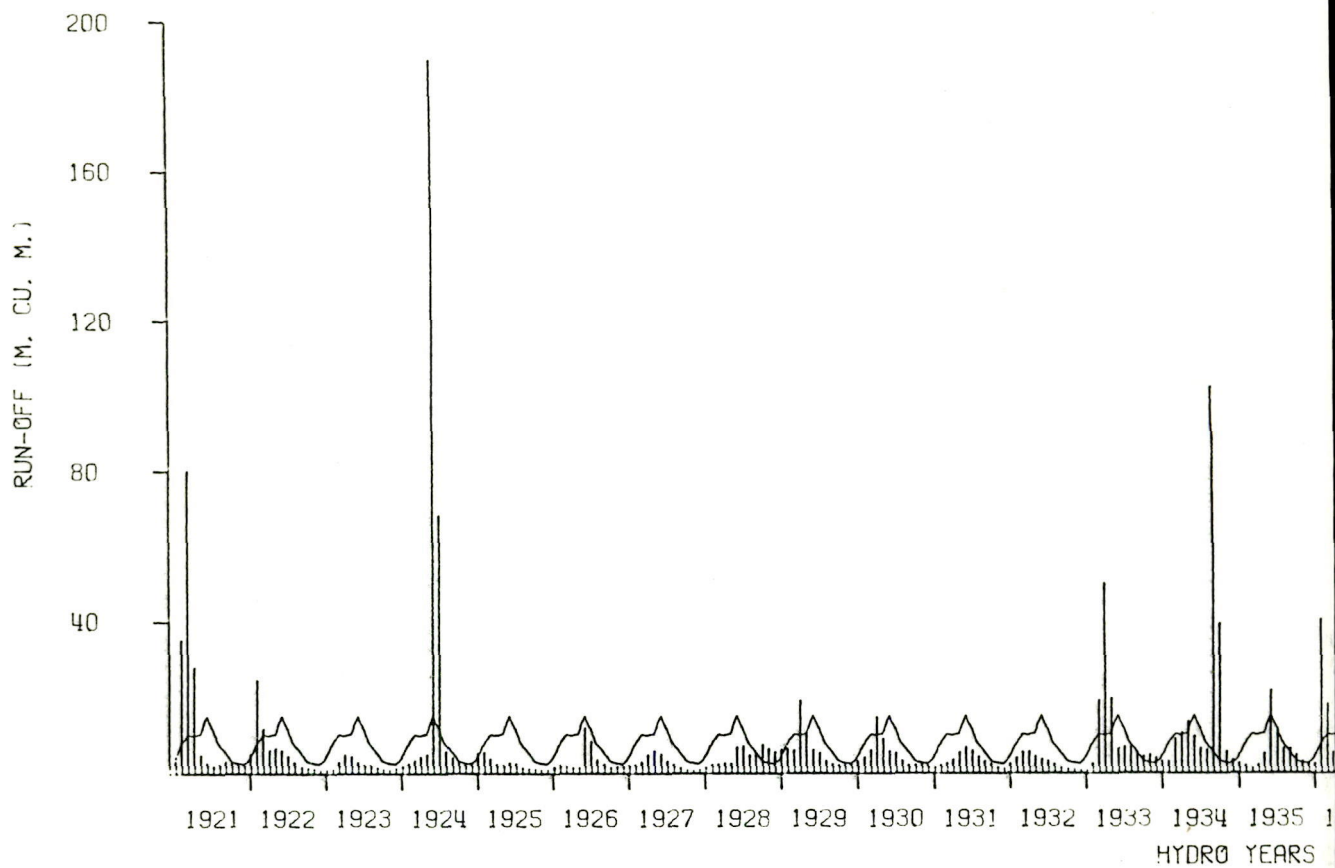


TRACED : COMPILOT
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 DATE :
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NATAL ESTUARIES : MLAZI

SIMULATED ANNUAL RUN-OFF
 1921-1975

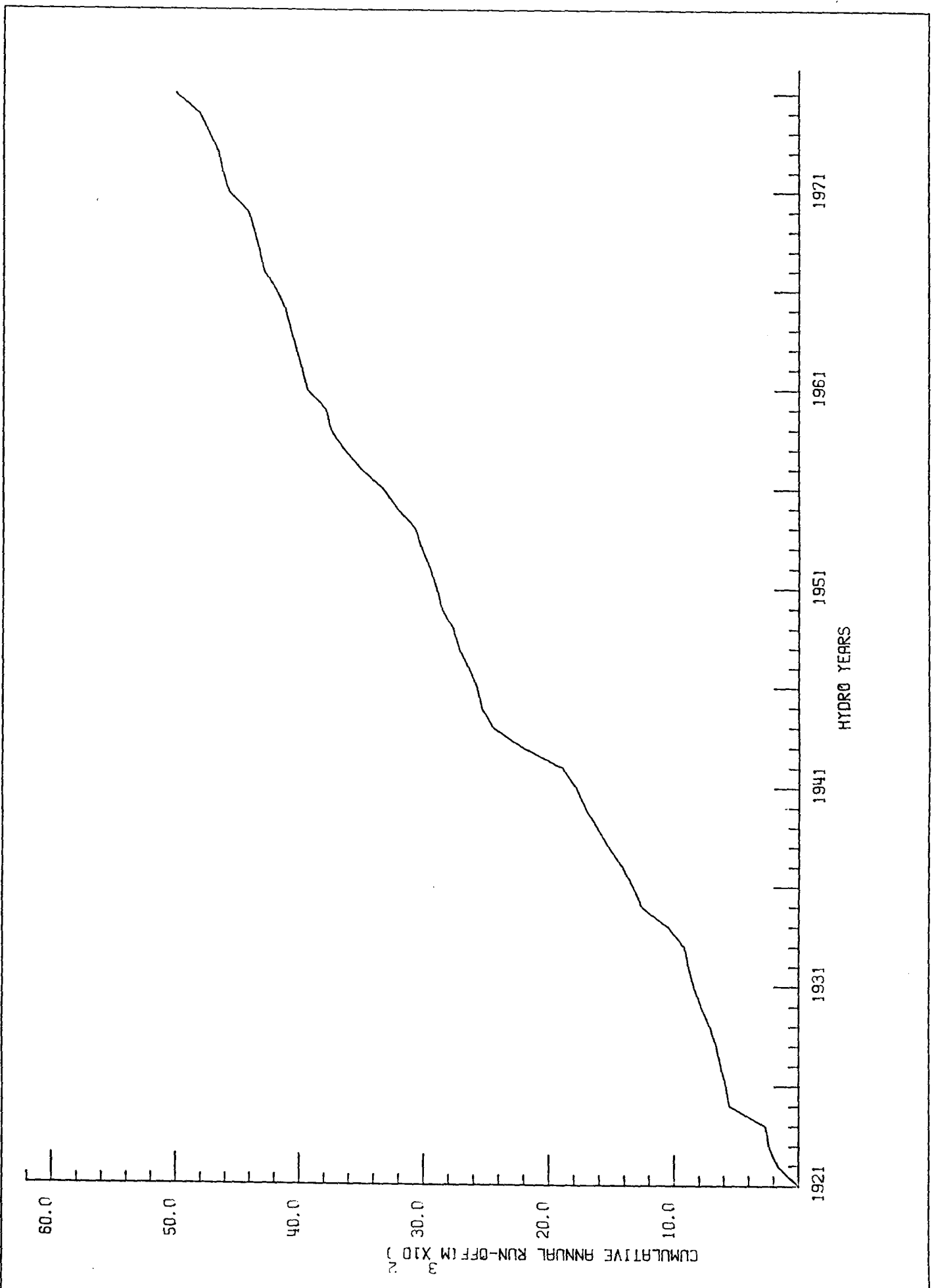
FIGURE
 NS 52/1



TRACED : COMPILOT
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NATAL ESTUARIES : MLAZI
 SIMULATED MONTHLY RUN-OFF
 1921-1975

FIGURE
 NS 52/2



TRACED : COMPLIT CHECKED: DATE : REF. :	NATAL ESTUARIES: MLAZI CUMULATIVE ANNUAL RUN-OFF	FIGURE NS 52/3
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SCALE: 1:14 000 approx.

TRACED
CHECKED
DATE
REF

NATAL ESTUARIES

MBOKODWENI + SIPINGO
(10-11-66 13h03)

PHOTOGRAPH

APPENDIX
NS 50/51/1

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