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SARAWAK

MIRI-BINTULU REGIONAL PLANNING STUDY

REPORT

ON

SPECIAL VISIT BY HYDROLOGIST

Binnie & Partners  
London

CONTENTS

Chapter

1 SUMMARY

Purpose **SARAWAK**

Itinerary and programme

Immediate hydrological studies

Second visit to Sarawak

Special studies

**MIRI-BINTULU REGIONAL PLANNING STUDY**

2 PRESENT AVAILABILITY OF HYDROLOGICAL DATA

Climate

Evaporation

Rainfall

River records

**REPORT**

Chemical quality **ON**

Sediment

**INITIAL VISIT BY HYDROLOGIST**

Water supply

3 THE HYDROLOGICAL NETWORK IN RELATION TO REGIONAL PLANNING

General

Climate

Rainfall

River records

Chemical quality

Sediment

Instruments and equipment

**Binnie & Partners**  
**London**

1. SUMMARY

Introduction  
Statement of the problem  
Scope of the study  
Methodology  
Organization of the study

2. REVIEW OF LITERATURE

Concepts  
Literature  
Review  
Methodology  
Statement of the problem  
Scope of the study  
Organization of the study

3. THE ECONOMIC NETWORK IN INDIA  
TO ECONOMIC REFORMS

General  
Economic  
Development  
Economic reforms  
Economic growth  
Economic development  
Economic growth  
Economic development

# CONTENTS

## Chapter

### 1 SUMMARY

Purpose

Itinerary and meetings

Immediate hydrological studies

Second visit to Sarawak

Special studies

### 2 PRESENT AVAILABILITY OF HYDROLOGICAL DATA

Climate

Evaporation

Rainfall

River records

Chemical quality

Sediment

Water supplies

### 3 THE HYDROLOGICAL NETWORK IN RELATION TO REGIONAL PLANNING

General

Climate

Rainfall

River records

Chemical quality

Sediment

Instruments and equipment

Chapter 4. SUMMARY AND CONCLUSIONS

5. SUMMARY AND CONCLUSIONS

6. SUMMARY AND CONCLUSIONS

7. SUMMARY AND CONCLUSIONS

8. SUMMARY AND CONCLUSIONS

9. SUMMARY AND CONCLUSIONS

10. SUMMARY AND CONCLUSIONS

11. SUMMARY AND CONCLUSIONS

12. SUMMARY AND CONCLUSIONS

13. SUMMARY AND CONCLUSIONS

14. SUMMARY AND CONCLUSIONS

15. SUMMARY AND CONCLUSIONS

16. SUMMARY AND CONCLUSIONS

17. SUMMARY AND CONCLUSIONS

18. SUMMARY AND CONCLUSIONS

19. SUMMARY AND CONCLUSIONS

20. SUMMARY AND CONCLUSIONS

21. SUMMARY AND CONCLUSIONS

22. SUMMARY AND CONCLUSIONS

23. SUMMARY AND CONCLUSIONS

24. SUMMARY AND CONCLUSIONS

25. SUMMARY AND CONCLUSIONS

26. SUMMARY AND CONCLUSIONS

27. SUMMARY AND CONCLUSIONS

28. SUMMARY AND CONCLUSIONS

29. SUMMARY AND CONCLUSIONS

30. SUMMARY AND CONCLUSIONS

31. SUMMARY AND CONCLUSIONS

32. SUMMARY AND CONCLUSIONS

33. SUMMARY AND CONCLUSIONS

34. SUMMARY AND CONCLUSIONS

35. SUMMARY AND CONCLUSIONS

36. SUMMARY AND CONCLUSIONS

37. SUMMARY AND CONCLUSIONS

38. SUMMARY AND CONCLUSIONS

39. SUMMARY AND CONCLUSIONS

40. SUMMARY AND CONCLUSIONS

41. SUMMARY AND CONCLUSIONS

42. SUMMARY AND CONCLUSIONS

43. SUMMARY AND CONCLUSIONS

44. SUMMARY AND CONCLUSIONS

45. SUMMARY AND CONCLUSIONS

46. SUMMARY AND CONCLUSIONS

47. SUMMARY AND CONCLUSIONS

48. SUMMARY AND CONCLUSIONS

49. SUMMARY AND CONCLUSIONS

50. SUMMARY AND CONCLUSIONS

51. SUMMARY AND CONCLUSIONS

52. SUMMARY AND CONCLUSIONS

53. SUMMARY AND CONCLUSIONS

54. SUMMARY AND CONCLUSIONS

55. SUMMARY AND CONCLUSIONS

56. SUMMARY AND CONCLUSIONS

57. SUMMARY AND CONCLUSIONS

58. SUMMARY AND CONCLUSIONS

59. SUMMARY AND CONCLUSIONS

60. SUMMARY AND CONCLUSIONS

61. SUMMARY AND CONCLUSIONS

62. SUMMARY AND CONCLUSIONS

63. SUMMARY AND CONCLUSIONS

64. SUMMARY AND CONCLUSIONS

65. SUMMARY AND CONCLUSIONS

66. SUMMARY AND CONCLUSIONS

67. SUMMARY AND CONCLUSIONS

68. SUMMARY AND CONCLUSIONS

69. SUMMARY AND CONCLUSIONS

70. SUMMARY AND CONCLUSIONS

71. SUMMARY AND CONCLUSIONS

72. SUMMARY AND CONCLUSIONS

73. SUMMARY AND CONCLUSIONS

74. SUMMARY AND CONCLUSIONS

75. SUMMARY AND CONCLUSIONS

76. SUMMARY AND CONCLUSIONS

77. SUMMARY AND CONCLUSIONS

78. SUMMARY AND CONCLUSIONS

79. SUMMARY AND CONCLUSIONS

80. SUMMARY AND CONCLUSIONS

81. SUMMARY AND CONCLUSIONS

82. SUMMARY AND CONCLUSIONS

83. SUMMARY AND CONCLUSIONS

84. SUMMARY AND CONCLUSIONS

85. SUMMARY AND CONCLUSIONS

86. SUMMARY AND CONCLUSIONS

87. SUMMARY AND CONCLUSIONS

88. SUMMARY AND CONCLUSIONS

89. SUMMARY AND CONCLUSIONS

90. SUMMARY AND CONCLUSIONS

91. SUMMARY AND CONCLUSIONS

92. SUMMARY AND CONCLUSIONS

93. SUMMARY AND CONCLUSIONS

94. SUMMARY AND CONCLUSIONS

95. SUMMARY AND CONCLUSIONS

96. SUMMARY AND CONCLUSIONS

97. SUMMARY AND CONCLUSIONS

98. SUMMARY AND CONCLUSIONS

99. SUMMARY AND CONCLUSIONS

100. SUMMARY AND CONCLUSIONS

PRESENT AVAILABILITY OF HYDROLOGICAL DATA

Climate

Evaporation

Rainfall

River records

Chemical quality

Sediment

Water supplies

THE HYDROLOGICAL NETWORK IN RELATION TO REGIONAL PLANNING

General

Climate

Rainfall

River records

Chemical quality

Sediment

Instruments and equipment

APPENDICES

Miri-Sarawak Regional Planning Study

Initial visit by hydrologist

- A ITINERARY
- B MEETINGS AND VISITS
- C MALAYSIAN METEOROLOGICAL SERVICE STANDARD EQUIPMENT AND OBSERVING HOURS
- D RIVER DATA 4TH DIVISION
- E HYDROLOGICAL EQUIPMENT ORDERED
- F GOVERNMENT ANALYTICAL LABORATORY KUCHING STANDARD REPORTING FORM

Itinerary and meetings

1.3 Mr. Stowell left London on the afternoon of 30 May and returned on the afternoon of 25 June. His itinerary is given in Appendix A and details of meetings and visits in Appendix B.

Immediate hydrological studies

1.3 Immediate work to be concluded before Mr. Stowell's next visit to Sarawak will concentrate on collating the data which have been gathered, examining their consistency and filling gaps where possible. Station locations will be mapped and available records summarized and tabulated. Hydrological studies will then be directed towards extracting a generalized picture of immediately relevant parameters, as described more fully below.

a) Meteorology

Available climate data will be studied and analyzed to produce, for the project area, estimates of:

- monthly potential evapotranspiration (Penman E<sub>0</sub>)
- monthly USWB Class A pan evaporation
- mean annual rainfall (isohyets)
- reliability of monthly rainfall
- frequency and duration of rainless periods.

APPENDICES

APPENDIX A - RIVER DATA 4TH DIVISION

Initial visit for the first trial

ITINERARY

SUMMARY AND VISITS

APPENDIX B - METEOROLOGICAL SERVICE STANDARD

EQUIPMENT AND OBSERVING HOURS

The purpose of the initial trial was:

RIVER DATA 4TH DIVISION

1) Review of project and initial discussion of hydrological

HYDROLOGICAL EQUIPMENT

2) Review of equipment and procedures for

GOVERNMENT APPROPRIATE LABORATORY RECORDS

3) Review of laboratory records and reports

4) Review of meteorological service standard

5) Review of equipment and procedures for

6) Review of meteorological service standard

Initial visit and meeting

1. The initial visit to the station on the afternoon of 28 May and returned

on the afternoon of 29 May. The itinerary is given in Appendix A and details

of results and data in Appendix B.

Initial visit to the station

2. The initial visit to the station was conducted during the afternoon of 28 May

and was a 10 hour visit on collecting the data which has been gathered

at the station. The equipment and filling gaps were possible. Station location

was not typical of other stations because of the nature of the site. Hydrological

data was collected during the visit and a generalised picture of

the station was obtained. The following were fully below.

a) Meteorology

1. Meteorological data will be recorded and analysed

to provide the project with the following:

1. Daily maximum and minimum temperature (10 min)

2. Daily maximum and minimum relative humidity

3. Daily maximum and minimum wind speed

4. Daily maximum and minimum wind direction

5. Daily maximum and minimum cloud cover

Miri-Bintulu Regional Planning Study

Initial visit by hydrologist

1. SUMMARY

Purpose

- 1.1 The purposes of this initial visit were :
- a) liaison with Project staff in Miri, discussion of hydrological requirements of the Zonation and Perspective Plans.
  - b) collection of available hydrological records and relevant background information for Sarawak and adjacent areas of Borneo
  - c) liaison with DID, Kuching concerning planning of field and other work to be undertaken as special studies.

Itinerary and meetings

- 1.2 Mr. Stowell left London on the afternoon of 30 May and returned on the afternoon of 25 June. His itinerary is given in Appendix A and details of meetings and visits in Appendix B.

Immediate hydrological studies

- 1.3 Immediate work to be concluded before Mr. Stowell's next visit to Sarawak will concentrate on collating the data which have been gathered, examining their consistency and filling gaps where possible. Station locations will be mapped and available records summarised and tabulated. Hydrological studies will then be directed towards extracting a generalised picture of immediately relevant parameters, as described more fully below.

a) Meteorology

Available climate data will be studied and analysed to produce, for the project area, estimates of:

- monthly potential evapotranspiration (Penman E<sub>o</sub>)
- monthly USWB Class A pan evaporation
- mean annual rainfall (isohyets)
- reliability of monthly rainfall
- frequency and duration of rainless periods.



b) River flows

Available river flow data for the project and other comparable areas will be analysed to produce preliminary estimates of :

low flow frequencies

flood peaks

Second visit to Sarawak

1.4 Mr. Stowell's second visit to Sarawak will start at the end of August. Initially, the results of the preliminary hydrological studies will be coordinated with the draft Zonation and Perspective plans, and the hydrological contribution to these plans finalised. Subsequently, fieldwork will be started together with the seconded Engineering Assistant from the Drainage and Irrigation Department and other locally recruited staff. A brief outline of the proposals for this work is given in the section on Special Studies below.

Special Studies

1.5 Following discussion with the Director, Drainage and Irrigation Department, in Kuching, it was agreed by the Director that Mr. Then Thiat Khiong, the Engineering Assistant in charge of the D.I.D. Hydrology Branch, could be based in Miri for the year between Mr. Stowell's 2nd and final visits to Sarawak. This assistance from the D.I.D. will be most valuable to the Project as it enables a hydrological field programme to be carried out. Further personnel could not reasonably be provided by the D.I.D., and would need to be recruited and paid for out of Project funds.

1.6 As suitably qualified supervision is essential to the success of any field work, the size of the field effort must necessarily be confined to that which Mr. Then can reasonably supervise. It is therefore proposed to recruit one gauging team and the necessary office staff for data reduction, and to limit the new field installations to what can be serviced by one team. The proposed composition of the team is

Mr. Then (in charge)

Technical Assistant

3 labourers

1 driver

2 hydrological clerks (filing and office computations)

Available river flow data for the project and other comparable areas will be analysed to produce preliminary estimates of low flow frequencies and flood peaks.

Second visit to Sarawak

Mr. Stowell's second visit to Sarawak will involve the following: the results of the preliminary hydrological study will be discussed with the draft National and Federal plans, and the hydrological contribution to the plan finalized. Subsequently, fieldwork will be started together with the second Engineering Assistant from the District and Irrigation Department and other locally recruited staff. A list of the proposals for this work is given in the section on Special Studies below.

Special Studies

1.5 Following discussion with the Director, Drainage and Irrigation Department, in Kuching, it was agreed by the Director that Mr. Then Tait Khiong, the Engineering Assistant in charge of the D.I.D. Hydrology Branch, could be based in Miri for the year between Mr. Stowell's 2nd and final visits to Sarawak. This assistance from the D.I.D. will be most valuable to the Project as it enables a hydrological field programme to be carried out. Further personnel could not reasonably be provided by the D.I.D. and would need to be recruited and paid for out of Project funds.

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composition of the team is

- Mr. Then (in charge)
- Technical Assistant
- 3 labourers
- 1 driver
- 2 hydrological clerks (typing and office computations)

## PRESENT AVAILABILITY OF HYDROLOGICAL DATA

1.7 The major concentration of field work will be on making current meter discharge measurements. In addition to the four existing permanent discharge stations on the Baram and its major tributaries, it is proposed to gauge at 6 sites listed in Chapter 3, all accessible by road from either Miri or Bintulu. Regular samples will also be taken for analysis of chemical quality, and a limited number of samplings for suspended sediment will be made.

1.8 To provide climate data for a non-coastal site, a station will be established at the Agricultural Research Station at Kabuloh. Observations will be made by the staff of the research station. Assistance in operation and maintenance and periodic supervision will be given by the Miri-based team.

1.9 During Mr. Stowell's second visit, it is hoped to make surveys up the major rivers to obtain more detailed information on depths, cross-sections and flood levels. Use will be made of echo sounding apparatus recently purchased by the D. I. D.

### Evaporation

2.3 At the Miri and Bintulu meteorological stations, USWB Class A evaporation pans and totalising anemometers were installed in 1963 under an agreement between the Meteorological Service and the Drainage and Irrigation Department. The evaporation and wind records are returned to the DID, who publish daily evaporation figures in the Hydrological Yearbooks. The wind records are not published, but have been abstracted from the original records for the purposes of this study.

2.4 The only inland evaporation station in the Fourth Division is at Long Akah on the Batang Baram. The record from this station, which lies some distance outside the study area, is irregular.

2.5 The data available for Miri and Bintulu are sufficient to enable monthly Penman type open water or potential evapotranspiration estimates to be made for a period of about 7 years.

### Rainfall

2.6 Until the founding of the Hydrological Branch in the early 1960's, the general coverage of rainfall stations in Sarawak was very sparse. Within the Fourth Division there were only six stations. This situation of course reflected the small and scattered population of the area and the difficulties of communication.

1.7 The major concentration of field work will be on making current water discharge measurements. In addition to the four existing permanent discharge stations on the basin and its major tributaries, it is proposed to gauge at 8 other stations listed in Chapter 3, all accessible by road from either Miri or Hinnah. Regular samples will also be taken for analysis of chemical quality, and a limited number of samplings for suspended sediment will be made.

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The first visit to the mountainous region, SW of Miri, was a reconnaissance survey of the area. The second visit was made in 1953 when an attempt was made to establish a permanent station on the Miri river. The third visit was made in 1954 when the first permanent station was established on the Miri river. The fourth visit was made in 1955 when the second permanent station was established on the Miri river. The fifth visit was made in 1956 when the third permanent station was established on the Miri river.

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## 2. PRESENT AVAILABILITY OF HYDROLOGICAL DATA

### Climate

2.1 The Malaysian Meteorological Service operates two meteorological stations within the study region, at Miri and Bintulu. Both these stations are near the coast. Other stations in Sarawak are at Sibul and Kuching. The standard equipment and observing hours of these stations is shown in Appendix C. Annual summaries of observations have been published for the years up to and including 1968. Daily means of most elements are available for 1969-1971 in abstracts which are published monthly.

2.2 In addition to the Meteorological Service stations, the Agricultural Research Service operates a climate station at its Semangkok headquarters near Kuching. Records for this station are available from January 1968 and include temperature, relative humidity and rainfall. Since January 1970 sunshine data are also available for this station.

### Evaporation

2.3 At the Miri and Bintulu meteorological stations, USWB Class A evaporation pans and totalising anemometers were installed in 1963 under an agreement between the Meteorological Service and the Drainage and Irrigation Department. The evaporation and wind records are returned to the DID, who publish daily evaporation figures in the Hydrological Yearbooks. The wind records are not published, but have been abstracted from the original records for the purposes of this study.

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2.5 The data available for Miri and Bintulu are sufficient to enable monthly Penman type open water or potential evapotranspiration estimates to be made for a period of about 7 years.

### Rainfall

2.6 Until the founding of the Hydrological Branch in the early 1960's, the general coverage of rainfall stations in Sarawak was very sparse. Within the Fourth Division there were only six stations. This situation of course reflected the small and scattered population of the area and the difficulties of communications.

Climate

The Malaysian Meteorological Service operates two meteorological stations within the study region, at MITI and Banting. Both these stations are near the coast. Other stations in Sarawak are at Sibu and Kuching. The standard equipment and observing hours of these stations is shown in Appendix C. Annual summaries of observations have been published for the years 1950-59, and including 1960. Daily means of most elements are available for 1950-59 in statistics which are published monthly.

In addition to the Meteorological Service stations, the Agricultural Research Service operates a climate station at its Seremban headquarters near Kuching. Records for this station are available from January 1958 and include temperature, relative humidity and rainfall. Since January 1970 some other data are also available for this station.

Evaporation

At the MITI and Banting meteorological stations, USWB Class A evaporation pans and totalising anemometers were installed in 1953 under an agreement between the Meteorological Service and the Drainage and Irrigation Department. The evaporation and wind records are reported to the DIO, who publishes daily evaporation figures in the Hydrological Yearbooks. The wind records are not published, but have been abstracted from the original records for the purpose of this study.

The only inland evaporation station in the Fourth Division is at Long Akah on the Baling Barisan. The records from this station, which has a name distance outside the study area, is irregular.

The data available for MITI and Banting are sufficient to enable monthly Penman type open water or potential evaporation estimates to be made for a period of about 4 years, on a normal sea level basis on a daily basis. For stations 4-2, 4-14 and 4-15 a limited number of observations are available.

Rainfall

Until the founding of the Hydrological Branch in the early 1960s, the general coverage of rainfall stations in Sarawak was very sparse. Within the Fourth Division there were only six stations. This situation of course reflected the small and scattered population of the area and the difficulties of communication.

2.7 Within the last decade a determined effort to extend and improve the rainfall network has been made and within the study area of about 15,000 sq. Km there are now more than 20 rainfall stations. This density of 1.3 gauges per 1,000 sq. Km perhaps comes close to a reasonable minimum objective for a sparsely populated area and may be sufficient to define the distribution of mean annual rainfall. It is probably too sparse to define monthly rainfall, and certainly cannot define storm rainfall. With increasing development and improving communications, continued expansion of the network will be possible within the overall development plan for the region.

2.8 At present, autographic rain-gauges are operated at the meteorological stations at Miri and Bintulu, and also at Marudi since March 1970.

Hourly rainfall totals have been abstracted and are summarised in the annual Meteorological Summaries for Miri and Bintulu. Monthly maximum 3-hour and 1-hour rainfall are published in the DID Hydrological Yearbooks. Storm analyses and depth-duration studies have not so far been undertaken.

#### River records

2.9 The bar chart, Appendix D, shows the river data available in the Fourth Division. There are at present four stations, Nos. 4 - 8 to 4 - 11, classed as permanent discharge stations. However, the rating of 4-8 is at present incomplete and at 4-9 a relationship remains to be developed between water level at the daily gauge and water level at the discharge section some distance upstream before daily discharges can be derived. Thus there are at present published daily discharge figures for stations 4-10 and 4-11 only. Of these only the former, on the Btg Tinjar, lies within the study area and even its catchment is mostly outside.

2.10 Most of the stations listed in Appendix D are tidal, or are temporary water level stations operated in connection with either bridge design or drainage schemes. Where available, daily mean gauge heights based on twice daily staff gauge readings have been published. For stations 4-12, 4-14 and 4-15 a limited amount of unpublished rating information, in the form of discharge measurements and cross-sections, exists. The possibility of deriving daily flows for these rivers is being investigated.

#### Chemical quality

2.11 In connection with planned or existing public or institutional water

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supply, the following information is provided:

Chemical quality

2.12 The following information is provided for the rivers being investigated:

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2.14 The following information is provided for the rivers being investigated:

2.15 The following information is provided for the rivers being investigated:

2.16 Most of the stations listed in Appendix B are tidal, or are temporary

outside the river, or are based on Appendix B of the FWD Annual Report

on the Big River. The only river gauge and gage for which a reading is available

daily discharge figures for stations 4-10 and 4-11 only. Of these only the former

before daily discharges can be derived. Thus there are at present published

the daily gauge and water level at the discharge section some distance upstream

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permanent discharge stations. However, the rating of 4-8 is at present inoperative

Division. There are at present four stations, Nos. 4-8 to 4-11, classified as

2.17 The bar chart, Appendix D, shows the river data available in the Fourth

River records

analyses and depth-duration studies have not so far been undertaken.

and 1-hour rainfall are published in the DID Hydrological Yearbook. Storm

Meteorological Summaries for Mill and Binton. Monthly maximum 3-hour

Hourly rainfall totals have been ascertained and are summarized in the annual

stations at Mill and Binton, and also at several other gauges since 1970.

2.18 At present, autographic rain-gauges are operated at the meteorological

overall development plan for the region.

communications, continued expansion of the network will be possible within the

cannot define storm rainfall. With increasing development and improving com-

annual rainfall. It is probably too apt to define monthly rainfall, and certainly

sparsely populated area and may be sufficient to define the distribution of mean

1,000 sq km perhaps comes close to a reasonable minimum objective for a

there are now more than 20 rainfall stations. The density of WFD stations is

rainfall network has been made and it is not clear whether additional facilities

Within the last decade a substantial effort to extend and improve WFD facilities

supplies, the Public Works Department has accumulated a considerable volume of raw water quality data. All samples are analysed at the Government Analytical Laboratory in Kuching. A copy of the standard form for reporting analytical results is shown in Appendix F. All results are readily available at PWD Headquarters in Kuching.

2.12 Sites in the Fourth Division for which raw water quality data are available are: -

- (a) S. Liku new waterworks intake
- (b) Batang Baram at Marudi
- (c) Batang Baram at Long Lama
- (d) Bario (mountain stream)
- (e) S. Sibiu, planned Bintulu waterworks intake
- (f) Nyabau Dam, old Bintulu supply
- (g) S. Luak at Kabuloh
- (h) S. Kejapil

2.13 Collection of water samples for analysis does not at present form part of the programme of the Hydrological Branch of the DID.

#### Sediment

2.14 The Hydrological Branch of the DID has suitable equipment for sampling suspended sediment, and total suspended solids are readily analysed at the Government Analytical Laboratory. However, it has not thus far been possible to start sediment sampling within the programme of the Hydrological Branch.

#### Water supplies

2.15 Within the study area, three towns have public water supplies as shown in the table below. The table is based on Appendix 27 of the PWD Annual Report for 1970.

Public Water Supplies in the Fourth Division

<u>Place</u>	<u>Type of supply</u>	<u>Average quantity</u>		<u>Est. av. per capi</u>	
		<u>mld</u>	<u>gpd</u>	<u>ld</u>	<u>gd</u>
Miri	RTPF	2.32	510,000	118	26
Bintulu	IGPC	0.69	152,000	95	21
Marudi	RTPF	0.41	91,000	100	22

Notes: R = river, T = fully treated, P = pumped, F = fluorinated,  
I = impounded, G = gravity, C = chlorinated.

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- (b) Batang Batan at Marudi
- (c) Batang Batan at Long Lams
- (d) Barlo (mountain stream)
- (e) S. Sibin, planned Bintulu waterworks intake
- (f) Nyabas Dam, old Bintulu waterworks intake
- (g) S. Lusak at Kuching
- (h) S. Ketaqui

Place	Average quantity of supply (mld)	Est. av. per capt. (gd)
(f) Nyabas Dam, old Bintulu waterworks intake	27.0	60
(h) S. Ketaqui	18.0	40

13. Collection of water samples for analysis does not at present form part of the programme of the Hydrological Branch of the DID.

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14. The Hydrological Branch of the DID has suitable equipment for sampling suspended sediment, and total suspended solids are readily analyzed at the Government Analytical Laboratory. However, it has not thus far been possible to start sediment sampling within the programme of the Hydrological Branch.

Water supplies

15. Within the study area, three towns have public water supplies as shown in the table below. The table is based on Appendix 27 of the PWD Annual Report for 1970.

Place	Type of supply	Average quantity		Est. av. per capt. (gd)
		mld	gd	
Marudi	RTPE	0.41	81,000	22
Bintulu	IGPC	0.68	122,000	21
Miri	RTPE	2.32	210,000	26

Notes: R = river, T = fully treated, P = pumped, I = unimproved, G = gravelly, C = chlorinated.

2.16 Work on a new 9 mld (2 mgd) supply for Miri, abstracting water from the S. Liku, is well advanced. Plans for a new 3.4 mld (0.75 mgd) supply for Bintulu, to replace the existing inadequate supply from the Nyabau Dam, are also complete, and the scheme is expected to go to tender shortly. A small 0.9 mld (0.02 mgd) supply for the Kabuloh Farm Institute is also nearly complete. Plans are in hand for a 1.3 mld (0.29 mgd) supply for Bekenu, Openg Bazaar and Bukit Peninjan, based on abstraction from the S. Kejapil. The latter two places are new settlements within the Lambir-Subis land development scheme.

2.17 Per capita consumption in a developing area is highly variable, depending upon availability and also whether the supply is metered. Figures used for estimating requirements in the Johor Tenggara study were: -

<u>Type of population</u>	<u>Average consumption per head</u>	
	<u>l/d</u>	<u>g/d</u>
urban	270	60
rural	180	40
scattered	90	20

2.18 The Lambir-Subis development plan quotes a demand in Sarawak rising from 54 lph/day (12 gph/day) on introduction of piped supply, to 113 lph/day (25 gph/day). However, where supplies are unmetered and unrestricted, consumption even in rural settlements may rise above 300 lph/day (65 gph/day).

- maximum and minimum thermometers )
- wet and dry bulb hygrometer ) in Stephenson screen
- thermohygrograph (weekly chart) )
- Campbell-Stokes sunshine recorder
- RIMCO radiometer
- USWB Class A evaporation pan
- Totalling anemometer
- Tilting Siphon recording raingauge (daily chart)

in addition to the standard daily raingauge at present in use. This expansion has been agreed to verbally by Mr. Sim Eng Sook of the Agricultural Research Division.

2.16 Work on a new 8 mhd (3 mhd) supply for the S. 11th Well advanced. Plans for a new 3.4 mhd (0.75 mhd) supply for the S. 11th Well advanced. Plans for a new 3.4 mhd (0.75 mhd) supply for the S. 11th Well advanced. Plans for a new 3.4 mhd (0.75 mhd) supply for the S. 11th Well advanced.

2.17 Per capita consumption in a developing area is highly variable, dependent on many factors. The figures used for estimating requirements in the Jabor Tenggar study were -

Average consumption per head	
Type of population	lit/d
urban	210
total	180
scattered	90

2.18 The Lambir-Sabia development plan shows a demand in Sarawak rising from 54 lph/day (12 gph/day) on introduction of piped supply, to 113 lph/day (25 gph/day). However, water supplies are available in Sarawak even in rural settlements, and it is proposed to supply this water with

following:

- 1) existing and additional waterworks
- 2) in Sarawak
- 3) ...
- 4) ...
- 5) ...
- 6) ...
- 7) ...
- 8) ...
- 9) ...
- 10) ...

In addition to the standard daily drainage at present in use, this expansion has been agreed to be undertaken by Mr. Jim Day, Chief of the Agricultural Research Division.

## THE HYDROLOGICAL NETWORK IN RELATION TO REGIONAL PLANNING

### General

3.1 The initial aims of the hydrological survey in Sarawak are set out in Chapter 1 of the first Hydrological Yearbook (1962-63), and clearly aim at the accumulation of data required for most aspects of water resources development. It is appropriate therefore to consider the hydrological network of the DID in the Fourth Division as the basic source of data for the water resources planning and development which will form part of the overall regional planning study.

3.2 It can be seen from chapter 2 above that the overall availability of hydrological data in the study area is low and that it will therefore be necessary to make provision for increased data collection within the development period. Some general steps to expand the present network will be taken during the present studies, and more detailed plans, related to the various stages of overall development planning, will also be prepared during the study. The remainder of this chapter outlines proposed additions to the hydrological network which will be carried out under the special studies allocation.

### Climate

3.3 The Agricultural Research Station at Kabuloh offers a suitable situation for establishment of a climate station away from the coast and in an area reasonably representative of developed land. It is proposed to equip this station with the following instruments: -

- maximum and minimum thermometers )
- wet and dry bulb hygrometer ) in Stephenson screen
- thermohygrograph (weekly chart) )
- Campbell-Stokes sunshine recorder
- RIMCO radiometer
- USWB Class A evaporation pan
- Totalising anemometer
- Tilting Siphon recording raingauge (daily chart)

in addition to the standard daily raingauge at present in use. This expansion has been agreed to verbally by Mr. Sim Eng Siok of the Agricultural Research Division.



## Rainfall

3.4 The newly completed sections of the Miri-Bintulu road, and some of the spur roads off this, provide access to some areas which could previously only be reached by boat or on foot. However, the road and subsequent developments are too recent to have substantially altered the pattern of permanent settlements upon which the rainguage network depends for its observers. The number of new rainfall stations which can readily be established is therefore limited. Allowance is being made for 12.

3.5 In addition to the autographic rainguage which will be installed at Kabuloh, an additional recording rainguage will be established at one other station. Selection will depend upon suitability of site and observer.

## River records

3.6 The rivers whose yields are most likely to be critical elements of any development plans in their areas are the smaller rivers with catchments up to a few hundred square miles which drain directly into the South China Sea. Such rivers are the S. Sibuti, S. Niah and S. Suai. The new Miri-Bintulu road traverses the catchments of these rivers, vastly improving access. It is proposed to establish discharge stations on the main stem of a number of these rivers, as well as at the intake sites already being developed or planned for development as water supply intakes. The rivers on which discharge stations will be established, subject to detailed survey and location of suitable sites, are: -

- S. Liku at new intake
- S. Kejapil at proposed intake site
- S. Sibuti near road bridge
- S. Niah near road bridge
- S. Suai near road bridge
- S. Sibiu near proposed intake site.

3.7 The S. Liku will be equipped with a float-operated water level recorder as has already been arranged between PWD and DID. The others will be equipped temporarily with pressure-bulb water level recorders being purchased from study funds. Plans can be elaborated with DID for eventual conversion of the most suitable sites to permanent discharge stations.

The newly completed sections of the drainage network and sub-  
the spot roads of this, provide access to some of the drainage  
only be reached by boat or on foot. However, this water is being  
ments are too recent to have substantially altered the pattern of permanent  
statements upon which the drainage network depends for its operation. The

number of new rainfall stations which can readily be established is therefore  
limited. Allowance is being made for 12 new stations which are being  
in addition to the automatic rain gauge which will be installed at Kambon.  
Additional recording rain gauges will be established at one other station. Selec-  
tion will depend upon suitability of site and observer.

River records  
The river water is being collected from a point where it is being  
The river water is being collected from a point where it is being  
development plans in their areas are the smaller rivers with catchments up to  
a few hundred square miles which drain directly into the South China Sea. Such  
rivers are the S. Sibut, S. Nish and S. Sual. The new Miri-Bintulu road tra-  
verses the catchments of these rivers, thereby providing access. It is proposed  
to establish discharge stations on the main stems of these rivers, as  
well as at the intake sites already being developed or planned for development as  
water supply intakes. The rivers on which discharge stations will be established

subject to detailed survey and location of suitable sites, are:-

- 5. Liku at new intake
- 5. Kējū at proposed intake site
- 5. Sibut near road bridge
- 5. Nish near road bridge
- 5. Sual near road bridge
- 5. Sibin near proposed intake site

5.7 The S. Liku will be equipped with a float-operated water level recorder  
has already been arranged between PWD and DID. The others will be equipped  
temporarily with pressure-bubb water level recorders being purchased from study  
funds. Plans can be elaborated with DID for eventual conversion of the most  
suitable sites to permanent discharge stations.

### Chemical quality

APPENDIX A

3.8 Regular raw water samples will be taken at discharge stations and submitted to the Government Analytical Laboratory through the DID. Particular attention will be paid to the organic quality of the water, in view of possible future pollution.

### Sediment

3.9 As indicated in Chapter 2 above, regular sediment sampling has not so far been undertaken in Sarawak. A small amount of suspended sediment sampling will be undertaken, to familiarise DID staff with methods and equipment.

### Instruments and equipment

3.10 Of the instruments and equipment needed during the study period, only those which cannot be provided locally from Government stores are being ordered. In particular, note has been taken of equipment available in DID stores in Kuching and Miri. This has avoided the need for purchase of some costly items such as sinker weights for current meters, sounding reels and sediment samplers. Appendix E lists the major items which will be required, together with their sources. No unused equipment left over from the Johor Tenggara Study is available. Transport, including land rover and boats, is provided for under the general project requirements.

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Date	Place	Dept./Office/Officer
1.8.72	Kuala Lumpur	Economic Planning Unit Mr. Selvarathan
1.6.72	"	Drainage and Irrigation Dept. Hydrology Branch Mr. Tan Ho-Tin
2.6.72	"	Binnie & Partners (Malaysia)
3.6.72	Miri	Project Office
4.6.72	Miri	Miri-Bintulu road
7.6.72	Sibu	Meteorological Station Mr. Peter Heng
8.6.72	Kuching	Drainage and Irrigation Department. Mr. Alfred Teo Chin Muat (Director)

Itinerary

30.5.72 left London  
 31.5.72 to 3.6.72 Kuala Lumpur  
 4.6.72 Kuching  
 5.6.72 to 7.6.72 Miri  
 8.6.72 to 11.6.72 Kuching  
 11.6.72 to 12.6.72 Kota Kinabalu  
 13.6.72 to 14.6.72 Brunei  
 15.6.72 to 19.6.72 Miri  
 20.6.72 to 22.6.72 Kuching  
 22.6.72 to 24.6.72 Kuala Lumpur  
 25.6.72 arrived back in London.



APPENDIX B MEETINGS AND VISITS

Date	Place	Dept./Office/Officer	Purpose
1. 6. 72	Kuala Lumpur	Economic Planning Unit Mr. Selvanathan	Liaison Discussion of present state of hydrological data collection in West Malaysia. DID's plans for data publication (river flows 1961-65 gone to printer, 1966-70 hoped for 1973, thereafter annually: rain-fall 1959-65 published, 1966-70 in preparation).
1. 6. 72	" "	Drainage and Irrigation Dept. Hydrology Branch Mr. Tan Ho Tin	Examination of hydrological data available for Brunei and Sabah and arranging for copies of potentially useful data.
2. 6. 72	Kuching "	Binnie & Partners (Malaysia)	Liaison with Project staff. Preliminary discussion of hydrological requirements. Outlining programme for remainder of visit. Review of available reports and maps.
5. 6. 72	Miri	Project Office	Reconnaissance trip 78 miles to bridge construction site on S. Suai. Inspection of S. Sibuti, S. BaKas, S. Niah and S. Suai at bridge sites. Spur road to Batu Niah and Niah.
6. 6. 72	Miri	Miri-Bintulu road	Inspection of station equipment and layout while en route from Miri to Kuching.
7. 6. 72	Sibu	Meteorological Station Mr. Peter Heng	Discussion of current work of Hydrology Branch Arrangement for examination of available hydrological data. Discussion of work proposed under Special Studies and arrangement for later fieldwork.
8. 6. 72	Kuching	Drainage and Irrigation Department. Mr. Alfred Teo Chin Huat (Director)	



APPENDIX B

(2)

Date	Place	Dept/Office/Officer	Purpose
8.6.72	Kuching	Drainage and Irrigation Dept. Hydrology Branch	Examination of available published and unpublished hydrological records. Discussion of field and office methods. Arrangements for abstraction of unpublished data. Review of available hydrological equipment.
9.6.72	Kuching	Public Works Department Hydraulics Branch Mr. Hendry, Mr. Maguire	Information on existing and planned public water water supplies in the 4th Division.
9.6.72	Kuching	Sarawak Electricity Supply Co. Mr. W. Lai (Chief Engineer)	Discussion of preliminary hydro-electric survey of Sarawak carried out by Snowy Mountain Hydro-Electric Authority in 1963. Copy of report.
9.6.72	Kuching	Geological Survey Department Mr. Kho Chin Heng (Chief Geologist)	Discussion of available geological information for the Project area. Copies of relevant Memoirs and Reports.
10.6.72	Kuching	Drainage and Irrigation Department Hydrology Branch	Continued review and abstraction of hydrological data.
11.6.72	Kuching	Meteorological Station, Airport	Inspection of equipment and layout.
11.6.72	Bintulu	Meteorological Station, Airport	Inspection of equipment and layout.
12.6.72	Kota Kinabalu	Drainage and Irrigation Department, Hydrology Section, Kapayan. Mr. G. Sham	Discussion of available data, current methods and equipment. Copies of published data to 1968.
12.6.72	Kota Kinabalu	Meteorological Station, Airport Mr. Dominic	Inspection of equipment and layout.



## APPENDIX B

(3)

Date	Place	Dept/Office/Officer	Purpose
13.6.72	Brunei	Department of Agriculture Mr. Allan	Discussion of collected rainfall and climatic data. Arrangement for copies of data to be forwarded.
13.6.72	Brunei	Meteorological Station, Airport Mr. Ho	Inspection of equipment and layout. Note of records on file. Abstraction of temperature and sunshine records.
14.6.72	Seria	Brunei Shell Petroleum Co. Exploration Department Mr. van Veen (Chief Geologist)	Description of Project area and request for any information on thickness and water-bearing characteristics of main geological formations.
		Topographic Department Mr. Riemersma.	Discussion of meteorological data collected by BSP.
16.6.72	Miri	Kabuloh Agricultural Experimental Station	Inspection of site for climatological station. Arrangement for copies of daily rainfall data to be forwarded. Discussion of roof catchments for domestic supply and for watering cattle.
16.6.72	Miri	Bekenu and Beluru	Reconnaissance of two spur roads. Inspection of S. Kejapil. Assessment of possibility for climate station at Beluru.
17.6.72	Miri	Sarawak Land Development Corp. Mr. Schwartz.	Discussion of planting programme, water supplies for settlements and palm oil processing.
19.6.72	Miri	New Lambir Waterworks Mr. A. Lee (Waterworks Supt)	Inspection of intake and plant. Assessment of gauging problems.
19.6.72	Miri	Meteorological Station, Airport	Inspection of equipment and layout.



APPENDIX B

(4)

Date	Place	Dept/Office/Officer	Purpose
20.6.72	Kuching	Department of Agriculture Agricultural Research Division Mr. Sim Eng Siok	Discussion of climate observations at Research Stations. Verbal arrangement for initiation of climate observations and rearrangement of climate station at Kabuloh.
21.6.72	Kuching	Government Analytical Lab. Mr. Chin (Chief Chemist)	Discussion of routine arrangements for analysis of water samples and elements normally analysed. Possibility of sediment analyses.
21.6.72	Kuching	Drainage and Irrigation Department Hydrology Branch	Finish collection of existing data.
22.6.72	Kuala Lumpur	Malaysian Meteorological Service Headquarters Mr. A. David	Discussion of meteorological data available for East Malaysia. Arrangement for copies of monthly abstracts to be forwarded.
22.6.72	Kuala Lumpur	Messrs. George Kent (Malaysia)	Inquiry into availability and cost of various types of hydrological instruments.
23.6.72	Kuala Lumpur	Binnie & Partners (Malaysia)	Collection of copies of relevant hydrological data for Brunei and Sabah.
23.6.72	Kuala Lumpur	Economic Planning Unit Mr. Selvanathan	Pre-departure liaison. Outline results of preliminary visit. Arrange for request for E. Malaysia climate data to be formally submitted to the Meteorological Service.

Date	Place
28.8.13	Киев
29.8.13	Киев
30.8.13	Киев
31.8.13	Киев
32.8.13	Киев

1. Описание метеорологических условий в Киеве.  
 2. Описание метеорологических условий в Киеве.  
 3. Описание метеорологических условий в Киеве.  
 4. Описание метеорологических условий в Киеве.  
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11. Описание метеорологических условий в Киеве.  
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 15. Описание метеорологических условий в Киеве.  
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 19. Описание метеорологических условий в Киеве.  
 20. Описание метеорологических условий в Киеве.

Malaysian Meteorological Service

Standard equipment and observing hours at first order stations

The main stations are equipped with self-recording instruments, records from which are tabulated hourly. These hourly values are corrected before publication by comparison with all available eye readings of standard non-autographic instruments. The hourly values published for Kuala Lumpur, Penang, Kota Bharu and Kuantan are computed from actual eye readings made every hour.

**EQUIPMENT**

The equipment of the main stations are uniform and include the following instruments :-

- Mercury barometer.
- Stevenson Screen with dry and wet bulb psychrometer and maximum and minimum thermometers.
- Five-inch raingauge of British Meteorological Office standard pattern.
- Dines pressure tube anemometer recording direction and speed.
- Thermograph, bi-metallic spiral spring type.
- Hair Hygograph.
- Recording raingauge, tilting siphon pattern.
- Campbell-Stokes sunshine recorder.

The following additional instruments are in use but their records are not included in the summaries:-

- Barograph.
- Besson Nephoscope.
- Maximum and Minimum wet bulb thermometers.
- Grass Minimum thermometers.
- Earth thermometers at depths of one foot and four feet.
- Evaporation Tank.

The exposure of instruments of all stations is conventional.

HOURS OF OBSERVATIONS (station time)

	0200	0500	0800	1100	1400	1700	2000	2300
Kuching	x	x	x	x	x	x	x	x
Sibu		x	x	x	x	x	x	
Bintulu	x	x	x	x	x	x	x	x
Miri	x		x	x	x	x	x	
K. Kinabalu	x	x	x	x	x	x	x	x
Sandakan		x	x	x	x	x	x	

In E. Malaysia station time is 8 hrs. in advance of G. M. T.

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**HOURS OF OBSERVATIONS (station time)**

	0200	0500	0800	1100	1400	1700	2000	2300
Kuching	x	x	x	x	x	x	x	x
Sibu		x	x	x	x	x	x	
Bitulu	x	x	x	x	x	x	x	x
Miri	x		x	x	x	x		
K. Kintabau	x	x	x	x	x	x	x	x
Sandakan		x	x	x	x	x	x	

In F. Malaysia station time is 8 hrs. in advance of G.M.T.

Note: Daily radiosonde ascents started at Kota Kinabalu in August 1967.  
 Thrice daily observations of wind drift using balloons are made at Kota Kinabalu,  
 Bintulu and Kuching.

Dist. 45/12/1967

Compend 7/4/68

VIETMINHSTA  
 (Central S.W.)

Time	Temp	Humidity	Wind	Wind Drift	Pressure	Clouds	Remarks
0000	24.0	85	1000	1000	1000		
0300	23.0	85	1000	1000	1000		
0600	22.0	85	1000	1000	1000		
0900	21.0	85	1000	1000	1000		
1200	20.0	85	1000	1000	1000		
1500	19.0	85	1000	1000	1000		
1800	18.0	85	1000	1000	1000		
2100	17.0	85	1000	1000	1000		
2400	16.0	85	1000	1000	1000		

1. All data should be checked and corrected before use.  
 2. All data should be checked and corrected before use.  
 3. All data should be checked and corrected before use.



Job No. 10.88  
Date Jul. 72 Page 1 of 1 pages

4th DIVISION  
Computed 73 Chkd.

& PARTNERS  
WESTMINSTER  
LONDON, S.W.1

sg. (wavy)  
sg. (unwavy)

re-egared.  
R(N) Weekly recorder  
S staff gauge

River and Station	No.	Spring rate (sq. mi.)	Gauge type	1962	1963	1964	1965	1966	1967	1969	1970	1971	Remarks
Big. Ennam at Kuala Ennam	4-1	8073	R(W)										
S. Nyaban at Nyaban Dam	4-2	0.17	R(W)										
S. Sibuti at Kelutit	4-3	—	R(W)										
S. Sibuti at Ranika Ranema	4-4	—	R(W)										
S. Sibuti at Sump	4-5	—	R(W)										
Big. Ennam at Nalundi	4-6	—	R(W)										
S. Liku	4-7	26*	R(W)										
Big. Barram at Liu Nalua	4-8	1015	S										
Big. Barram at long Pina	4-9	3732	S										
Big. Tujar at long Jegan	4-10	923	S										
S. Titch at long Ternisa	4-11	1248	S										
S. Sebin	4-12	60	S										
S. Opak	4-13	—	S										
S. Sibuti	4-14	67.5	S										
S. Niah	4-15	310	S										
S. Suan	4-16	219	S										
S. Sook Meuk	4-17	—	S										
S. Sook Padi	4-18	—	S										
S. Nussa at Kuala Nussa	4-19	—	S										

small dam for Birtulu NAGC  
Supply. Dam m'ntd in 1968.

Major river at N. w.p. 34.12.71.  
NO cross-section data.  
Some rough estimates of minimum  
flows for new Min. supply works  
Rating not yet fully developed.  
10 m'ntd by 10.8.68

Rated section up of main gauge.  
Gauge correlation not yet developed.  
Rating based on 71 dist. marks

Rating based on 38 dist. marks.  
16 dist. marks, between 20.12.66  
and 18.1.68

No dist. marks

21 dist. marks, between 27.12.67  
and 17.1.68.

29 dist. marks, between 4.11.67  
and 5.6.70.

59-section 4.12.67 but no reading on  
fig. 8 dist. marks on 8.19.12.67.

\* at intake for new Min. water supply. Note: many records contain gaps which are not detailed here.



APPENDIX E HYDROLOGICAL EQUIPMENT ORDERED

Items	Numbers required	Available from D. I. D.	To be purchased	£ estimated c.i.f.	Remarks
<u>Water levels</u>					
1. Staff gauge plates, 1 m sections	60		X	215.00	
2. Water level recorder, float operated	1	X			for S. Lika intake
3. Water level recorder, pressure bulb	5		X	576.00	
<u>River flow</u>					
4. Current meter outfits, including wire suspension and wading equipment	2		X	490.00	two recently serviced meters not available from D. I. D.
5. Sounding reel	2	X			
6. Sinker weights 15 lb	1	X			
50 lb	1	X			
7. Echo sounder, inshore type	1	X			
8. Tagline	2		X	70.00	
9. Boat mooring line	1	X			
10. Boat boom outfit	1				to be made up locally
<u>Water quality</u>					
11. Depth-integrating suspended sediment samplers, suspended type	1	X			
12. Water sample bottles, 2½ litres	30		X	45.00	
13. Thermometers	3		X	6.00	
14. Portable conductivity meter	1	X			

APPENDIX E



APPENDIX E HYDROLOGICAL EQUIPMENT ORDERED

item	number required	available from DID	to be purchased	estimated c.i.f.	remarks
<u>Meteorological equipment</u>					
15. standard, 5" raingauge	12		x	150.00	
16. tilting syphon daily recording raingauge	2		x	280.00	to be manufactured locally
17. Class A evaporation pan	1		x	)	1 spare of each
18. hook gauge and stilling well for pan	1		x	)	
19. maximum and minimum thermometers	2		x	)	
20. thermohygraph	1		x	)	2 spare thermometers
21. wet and dry-bulb hygrometer	1		x	)	1 year's supply of cards
22. sunshine recorder	1		x	500.00	spare perspex dome
23. radiometer	1		x	)	to be manufactured locally
24. anemometer	1		x	)	
25. Stevenson screen	1		x	)	est. airfreight on met. instruments from UK.
26. humidity slide rule and tables	1		x	50.00	Total (all instruments) c. £2330 or M\$ 17,200.00

\* f.o.b. cost UK.

(a)

No.	Description	Quantity	Unit	Value	Remarks
38	Handwritten text				
32	Stencils	20	00		
34	Stencils				
33	Stencils				
35	Stencils				
31	Stencils	200	00		
30	Stencils				
18	Stencils				
18	Stencils				
11	Stencils				
10	Stencils	380	00		
12	Stencils	120	00		
	Meteorological equipment				

УБЕИДИХ Е НАВНОГОСИУГ ЕСЛИЬНЕАЛ ОУДЕБЕД

Tel. Kuching 24101

Government Analytical Laboratory,  
Sekama Road, Kuching, Sarawak.

Lab. No. ....

To: .....

Date: .....

Report on ..... water ..... samples from .....  
received on ....., labelled as follows:-

- (A) .....
- (B) .....

DESCRIPTIONS

- (A) .....
- (B) .....

RESULTS OF ANALYSIS IN PARTS PER MILLION

(A)                      (B)

- Ammoniacal Nitrogen (as N):-
- Albuminoid Nitrogen (as N):-
- Nitrate (as N):-
- Nitrite (as N):-
- Free Carbon Dioxide (CO<sub>2</sub>):-
- Total Alkalinity (as CaCO<sub>3</sub>):-
- Hardness: Total (as CaCO<sub>3</sub>):-
  - Calcium (as CaCO<sub>3</sub>):-
  - Magnesium (as CaCO<sub>3</sub>):-
- pH (Hydrogen-ion concentration):-
- Chloride (as Cl):-
- Residual Chlorine (Cl<sub>2</sub>):-
- Residual Alum (as Al):-
- Soluble Iron (as Fe):-
- Total Iron (as Fe):-
- Fluoride (as F):-
- Oxygen absorbed in 4 hours:-
- Biochemical Oxygen Demand (5 Days):-
- Solids: Total:-
  - Dissolved:-
  - Suspended:-
- Colour (Hazen Units):-
- Turbidity:-

REMARKS:-