MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF
WATER RESOURCES DEVELOPMENT

COMPREHENSIVE STUDY ON THE UPPER KOMERING RIVER BASIN DEVELOPMENT

VOLUME II

ANNEXES

DECEMBER 1979

JAPAN INTERNATIONAL COOPERATION AGENCY
TOKYO, JAPAN

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ABBREVIATIONS AND LOCAL TERMS

Abbreviations and local terms used in this report are listed below:

A. ABBREVIATIONS

1. Length

mm	millimetre
cm	centimetre
m	metre
km	kilometer

2. Area

ha	hectare
km^2	square kilometer
m^2	square metre

3. Volume

lit	litre = 1,000 cm^3
m^3	cubic meter

4. Weight

mg	milligramme
g	gramme
kg	kilogramme
ton	1,000 kg

5. Time

sec	second
min	minute
hr	hour

6. Electrical measures

V	Volt
A	Ampere

KV	Kilovolt
W	Watt
KW	Kilowatt
MW	Megawatt
KWH	Kilowatt hour
MWH	Megawatt hour
KWH	Kilovolt ampere

7. Other measures

%	Percent
PS	Horse power
PH	Scale for acidity
°C	Centigrade
m^3/sec	Cubic meter per second
lit/sec/ha	Liter per second per hectare
T.S.P.	Triple Super Phosphate
t/ha	Ton per hectare
Nos	Numbers
m.e.	milligram equivalent
E.C.	electric conductivity
C.E.C.	cation exchange capacity

8. Technical terms

EL	Elevation above mean sea level
H	Height
H.W.L.	High water level
L.W.L.	Low water level
T.W.L.	Tail water level
F.W.L.	Flood water level
A.W.L.R.	Automatic water level recorder
S.G.	Staff gauge
G.H.	Gauge height
C.A.	Catchment area
Q	Discharge

9. Money

US$	Us Dollar
Rp.	Rupiah
US$	= Rp.625.-

10. Other Abbreviations

FAO	Food and Agriculture Organization of United Nations
UNDP	United Nations Development Program
DPU	Departemen Pekerjaan Umum (Department of Public Works)
PLN	Perusahaan Umum Listrik Negara (State Electricity Corporation)
IRRI	International Rice Research Institute
JICA	Japan International Cooperation Agency
G.R.P.	Gross Regional Products
G.D.P.	Gross Domestic Products
BRI	Bank Rakyat Indonesia (Indonesian People's Bank)

B. LOCAL TERMS

Kab.	Kabupaten
Prov.	Provinsi
OKU	Kabupaten Ogan Komering Ulu
OKI	Kabupaten Ogan Komering Ilir
BIMAS Baru	New Mass Guidance for Self-sufficiency in Food
BIMAS Biasa	Common Mass Guidance for Self-sufficiency in Food
CRIA	Central Research Institute for Agriculture, Bogor
PPS	Extension Specialist
PPM	Extension Supervisor
PPL	Field Extension Worker
BPP	Rural Extension Center

Wilud	Wilayah Unit Desa
Desa	Village
KUD	Fully developed farmer cooperative Desa
BUUD	Village farmer cooperative
Kontak-Tani	Key farmer or Leading farmer
DOLOG	Depot Logistic
Ani-Ani	Small Rice Harvesting Knife
Lebak	Back swamp behind river levee
Pelita	Five-Year Development Plan
Sawah	Wet-Rice Field
Kios	Small shop
BULOG	Board of Logistic
Dalam Angka	Statistical Data
Laporan Dinas Pertanian	Report of Agricultural Office
Palawijo (Polowijo)	Second Crop

ANNEX I CLIMATE, HYDROLOGY, AND WATER BALANCE

I.1 CLIMATE

The following data were mainly collected at Sub. P3.S.A. Sumatra Selatan, Sub. P3.S.A. Lampung, Pertanian Office in Baturaja, and Palembang. However, the observation was either completely stopped or conducted intermittently as follows:

1) Climatological Data

Observatory	Observation Period	Interrupted Period	Place of Data Provided
1. Belitang	1971~ 1979, June	Evaporation 1975 March, July 1978 March Rel.Humidity 1971 Jan, Feb, July, Nov. 1975 March 1976 May 1978 March Temperature 1971 Jan, Feb 1972 Jan, Feb 1974 June 1975 Jan, March 1976 May 1978 March Sunshine 1971 Jan, Feb, May-Dec 1972 Feb, July 1973 July 1975 March 1976 April 1978 Feb, March, Sept. Solar Radiation 1971 Feb-Dec 1972 Feb-May 1975 March 1978 March, Sept. Wind Velocity 1971 Feb-Dec 1975 March 1978 March, Sept.	Sub.P3SA Sum-Sel

Observatory	Observation Period	Interrupted Period	Place of Data Provided
2. Banding Agung	1973, May-1978	Evaporation 1973 Nov, Dec 1975 Oct, Nov 1976 Jan, July 1977 March, April June, Aug, Nov. 1978 March, April, June, Dec. Rel. Humidity 1973 Nov. 1977 May Temperature 1973 Nov. 1977 Jan, March-May July, Aug, Nov, Dec. Solar Radiation 1975 Feb, March, May, Aug-Dec 1976 Jan-Dec 1977 Jan-Dec 1978 Jan-Nov Wind Velocity 1975 Feb, Dec 1976 Feb-Dec 1977 Jan-Dec 1978 Jan-Dec	Sub.P3SA Sum-Sel
3. Raksajlwa	1978-1979, Sep.	Evaporation 1978 March, June, Sept Wind Velocity 1978 Jan	Sub.P3SA Sum-Sel
4. Kasul	1975-1977	Evaporation 1975, April, May, June, July Wind Direction 1975 Jan, June, July, Nov, Dec. 1976 Jan, March-Dec. 1977 Jan-Dec.	Sub.P3SA Lampung
5 Menggala	1975-1977	Evaporation 1975 Oct. 1976 Jan.	Sub.P3SA Lampung

Observatory	Observation Period	Interrupted Period	Place of Data Provided
		Rel. Humidity 1976 Jan, May-July Temperature 1976 Jan. Sunshine 1975 March, April, June-Sept. 1976 Jan-Dec. 1977 Sept, Oct. Wind Velocity 1976 Jan.	
ii) Daily Rainfall			
1. Batu Raja	1973-1978	1973 April, Dec 1976 March, April	Perfanian Office, Baturaja
2. Raksajiwa	1973-1978		- " -
3. Peninjawan	1973-1978	1973 Dec. 1976 May 1977 Feb.	- " -
4. Martapura	1973-1977	1973 Jan, Aug, Sep, Oct 1976 Feb.	- " -
5. Simpang	1973-1978	1973 Dec. 1975 April, Aug, Sep.	- " -
6. Buaymadang	1973-1978	1973 Dec. 1974 March, July, Aug. 1978 Feb, March, April, May, Aug, Nov, Dec.	- " -
7. Belitang BK O	1971-1974 1978-1979, Aug.		PU Belitang
BK IX	1971-1974 1978-1979, Aug.		- " -
BK X	1971-1979, Sep.		- " -
BK XVII	1977-1979, Aug.	1977 Dec. 1978 Jan	

Observatory	Observation Period	Interrupted Period	Place of Data Provided
8. Cempaka	1972-1978	1972 Dec 1973 Dec	Pertanian Office, Palembang and Baturaja
9. Muaradua	1972-1978	1973 Nov, Dec.	Pertanian Office, Baturaja
10. Md. Kisam	1974-1978	1974 April, May, July, Dec. 1976 July, Sept. 1977 March-Aug. Oct-Dec 1978 June, Aug-Dec.	- " -
11. Pl. Beringin	1973-1978	1973 Dec 1974 April, Sep-Dec 1975 Jan-Dec 1976 Jan-Dec 1977 Jan-Sep	- " -
12. Banding Agung	1973-1978	1973 April, Sep, Oct Dec 1974 May 1976 May, Sep 1977 March, April 1978 Aug, Sep	- " -
13. Gunung Raja	1975, March-1978	1978 Dec.	- " -
14. Pedamaran	1972-1978	1972 Nov, Dec. 1973 Oct.-Dec 1975 Sep 1976 Aug 1977 Dec	- " -
15. Tg. Lubuk	1972-1978	1973 Oct 1977 Dec	- " -
16. Kayu Agung	1972-1978	1978 May	- " -
17. Way Gham	1974, 1975, 1977	1974 Jan-July 1977 Dec	Sub.P3SA Lampung
18. Tahmi Lumut	1974-1976, 1978	1974 Jan-Aug 1975 March-Sep 1976 Jan, Aug, Oct, Dec 1978 Jan-April	- " -

Observatory	Observation Period	Interrupted Period	Place of Data
19. Bukit Kemuning	1974 July- 1978		Sub.P3SA Lampung
20. Sinar Ogan I	1973 June- 1979 July		- " -
21. Baradatu	1974 July- 1979 May	1978 March	- " -
22. Desa Purajaya	1973 June- 1979 May	1976 Nov, Dec 1978 Aug	- " -
23. Sumberjaya	1972 Feb- 1979 July		- " -
24. Kasui, FAO	1972- 1979 Aug	1979 March, June	- " -
25. Blambangan Umpu	1973-1977		- " -
26. Rantau Temiang	1973 June- 1979 July		- " -
27. Rantau Temiang (A-5)	1975 Dec- 1979 July		- " -
28. Tahmi Tg.Agung	1974 July- 1979 July		- " -
29. Mesir Hilir	1973 March- 1979 Aug.	1973 Dec 1974 Nov, Dec 1975 July	- " -
30. Kenten Palembang	1976- 1979 Oct.	1977 March, Dec	Pertanian Office, Palembang
31. Palembang Airport	1971- 1979 Oct.		

III) Monthly Rainfall

1. Pampangan	1963-1973	1963 Aug 1965 Nov, Dec 1979 Jan-April, June 1971 Sep-Dec 1973 Oct, Dec	- " -

Observatory	Observation Period	Interrupted Period	Place of Data Provided
2. Pedamaran	1963-1970	1963 June 1967 Aug, Sept 1970 March	Pertanian Office, Palembang
3. Belitang	1953-1957 1963-1970	1963 Feb, April 1966 Oct 1968 Oct 1969 Sep 1970 Nov, Dec	Sub.P3SA Sum-Sel Pertanian Office, Palembang
4. Muncakkabau	1963	1963 April, Oct, Nov.	Pertanian Office Palembang
5. Cempaka	1963-1973	1963 April, Oct 1964 Aug, Sept, Dec 1971 Jan, Feb 1973 Dec	
6. Prabumulih	1953-1957 1963-1976	1963 June, Nov. 1967 Aug, Sep 1970 Feb 1976 May	Sub.P3SA Sum-Sel Pertanian Office, Palembang
7. Muara Kuang	1955-1956 1964-1976	1956 March 1964 May 1975 Dec 1976 Nov	Sub.P3SA Sum-Sel Pertanian Office, Palembang
8. Batu Raja	1954-1957 1964-1969	1964 May-Aug, Dec 1965 July 1969 Aug-Oct	Sub.P3SA Sum-Sel Pertanian Office, Palembang
9. Gelumbang	1965-1970	1965 April, July 1968 July, Aug 1970 April, Sept.	Pertanian Office, Palembang
10. Tanjung Raja	1953-1957	1953 Feb, March, Dec. 1955 March 1956 Oct 1957 Nov, Dec 1966 Aug 1967 June	Sub.P3SA Sum-Sel Pertanian Office, Palembang
11. Sp. Padang	1966	1966 Aug, Dec	Pertanian Office, Palembang
12. Indralaya	1967-1968	1967 June 1968 Jan	- " -

Observatory	Observation Period	Interrupted Period	Place of Data Provided
13. Kurungannyawa	1955, 1957 1966	1957 May, Oct-Dec 1966 Aug	Sub.P3SA Sum-Sel Pertanian Office, Palembang
14. Muara Dua	1952-1956 1967-1973	1952 May, Oct 1967 Aug, Sept 1973 Nov, Dec	Sub.P3SA Sum-Sel Pertanian Office, Palembang
15. Sukaraja	1969	1969 March	Pertanian Office, Palembang
16. Tanjung Lubuk	1969-1970	1969 March, May, June 1970 June	- " -
17. Kamboja	1970	1979 Jan-March	- " -
18. TJ. Batu	1970	1970 Aug	- " -
19. Raksajiwa	1970	1970 June-Aug	- " -
20. Pengandonan	1970-1971	1970 Jan, April-June Aug-Dec 1971 Jan-July, Nov, Dec.	- " -
21. Peninjauan	1970	1970 Jan, Feb, July	- " -
22. Semendo	1970	1970 Jan, Feb, July Aug, Nov	- " -
23. Martapura	1951-1956 1974-1976	1974 July-Dec 1976 Feb	Sub.P3SA Sum-Sel Pertanian Office, Palembang
24. Sukamaju	1975	1975 July, Oct-Dec	Pertanian Office, Palembang
25. Kayu Agung	1951-1954, 1956	1953 June 1956 Jan, Feb, Oct, Dec	Sub.P3SA Sum-Sel
26. Muara Enim	1951-1957	1951 May 1952 July 1954 Aug 1957 March	- " -
27. Talang Betutu	1952-1955, 1957	1953 Jan, Aug, Dec 1955 April	- " -

Observatory	Observation Period	Interrupted Period	Place of Data Provided
28. Pengadonang	1952-1957	1953 Jan-May	Sub.P3SA Sum-Sel
29. TJ. Raja	1953-1957	1953 Feb, March, Dec 1955 March 1956 Oct 1957 Nov, Dec	- " -
30. Simpang Sendar	1955, 1957	1955 Jan, Feb, July Aug,	- " -

1.2 HYDROLOGY

1.2.1 Data Collection

The following data were mainly provided by Sub P3.S.A. Sumatra Selatan, Sub P3.S.A. Lampung, P.U. Belitang, D.P.M.A., P3.S.A. Jakarta, and Department of Agriculture.

1) Mean Daily Discharge

Station	Observation Period	Interrupted Period	Place of Data Provided
1. Banding Agung	1972-1978	1974 June, July, Aug, Nov, Dec. 1975 Jan, Feb, March, May, July 1976 Jan, July, Aug, 1977 Jan, Feb. Nov, Dec. 1978 March, June, July, Aug, Nov, Dec.	Sub.P3SA, Sum-Sel
2. Martapura	1972-1978	1974 Feb, May, June, Aug, Sept, Oct, Nov. 1975 April, May, July, Oct. 1976 Jan, March, May, June, Sept, Nov. 1977 Jan, Feb, April, June, July, Aug, Oct. 1978 Feb, March, May, June, July, Aug, Sept, Oct, Nov, Dec.	Sub.P3SA, Sum-Sel
3. Batu Raja	1971-1978		Sub.P3SA, Sum-Sel
4. Batuputih	1972, June-1974, Dec.		Sub.P3SA, Sum-Sel
5. Tanjung Rambang	1972, May-1978	1972 May 1974 March, April, May June, July, Aug, Nov, Dec.	Sub.P3SA, Sum-Sel

Station	Observation Period	Interrupted Period	Place of Data Provided
		1976 April, Aug.	
		1977 Feb, March, July, Aug.	
		1978 March, Nov.	
6. Tanjung Raja	1972-1978	1972 Sept, Oct, Nov.	Sub.P3SA, Sum-Sel
		1974 April, May, Aug, Sept, Oct, Nov.	
		1975 Jan, Feb, April, May, June, July Sept, Oct, Nov, Dec.	
		1976 Jan, Feb, March, April, May, July, Sept, Oct, Nov, Dec.	
		1977 Jan, Feb, June, July, Sept, Oct.	
		1978 Dec.	
7. Pakuan Ratu	1972, July-1977	1975 Jan, Feb, March, April, May.	Sub.P3SA, Lampung
8. Rantau Jangkung	1972, July-1978		Sub.P3SA, Lampung
9. Tanjung Agung	1972, July-1978	1978 Oct, Nov.	- " -
10. Negri Batin	1972, July-1978	1977 Dec. 1978 Jan.	- " -
11. Rantau Temiang	1972, Nov.-1978		- " -
12. Besay	1974, Oct.-1977		- " -
13. Banjar Masin	1972-1978	1974 Jan	- " -

ii) Water Level

1. Kurungan Nyawa	1974-1978	1974 Jan, Feb, March, April, May, June, July, Sept.	P.U. Belitang
2. Kayu Agung	1978, Oct.-1979, Sept.		Sub.P3SA, Sum-Sel

iii) Hydrograph

Station	Observation Period	Interrupted Period	Place of Data Provided
1. Banding Agung	1973-1978		Sub.P3SA, Sum-Sel
2. Martapura	1971-1978		- " -
3. Menanga	1971-1978		- " -
4. Kayu Agung	1978, Oct.-1979, Aug.		- " -
5. Batu Raja	1971-1978		- " -
6. Batuputih	1973-1974		- " -
7. Tanjung Rambang	1973-1978		- " -
8. Tanjung Raja	1971-1978		- " -

iv) Rating Curve

1. Banding Agung	Sub.P3SA, Sum-Sel
2. Martapura	- " -
3. Batu Raja	- " -
4. Batuputih	- " -
5. Tanjung Rambang	- " -
6. Tanjung Raja	- " -

v) Conversion Table

1. Banding Agung	Sub.P3SA, Sum-Sel
2. Martapura	- " -
3. Batu Raja	- " -
4. Batuputih	- " -
5. Tanjung Rambang	- " -
6. Tanjung Raja	- " -

vi) Others

		Place of Data Provided
1.	Hydrological Network Lampung Province Sumatra Final Report Part 2 Volume I	P3SA, Jakarta
2.	A Provisional Note on the Water Resources Availability in the River Basin of Tulangbawang	Sub.P3SA, Lampung
3.	Feasibility Study on the Way Seputih and Way Sekampung Basins Volume 4 Water Resources	- " -
4.	Chemical Studies on the Water In South East Asia Water Quality in Indonesia	D.P.M.A.
5.	Laboratorium Sedimen, Air Musi, Air Enim	D.P.M.A.
6.	Analisa Lumpur Particle Size Analysis of Suspend Sediment Unsur2 Kesuburan Dalam Air Sungai	D.P.M.A.
7.	Hasil Analisa Water Quality Standard Air Bersih & Analisa Air Ogan dan Komering	D.P.M.A.
8.	Water Quality untuk Steam Generator dan Power Plant	D.P.M.A.
9.	Land and Water Resources Development in South East Sumatra	Department of Agriculture
10.	Peta Staslun Hidrologi Propinsi Lampung Skala 1 : 250,000	Sub.P3SA, Lampung
11.	Peta Staslun Hidrologi and Meteorologi Propinsi Sumatra Selatan	Sub.P3SA, Sum-Sel
12.	Tidal Data at Palembang in 1979	- " -

1.2.2 Stream Flow Measurement

Stream flow measurement was made at Banding Agung, Martapura, Lempuing and Baturaja out of the following gauging stations to check the existing rating curves.

Table I-1 Hydrometric Stations

No.	River	Place	Rating Curve	Gauge
1.	Selabung	Banding Agung	Yes	A.W.L.R.
2.	Komering	Martapura	Yes	"
3.	Pisang	Sri Numpi I	None	"
4.	Komering	Kurungan Nyawa	None	S.G.
5.	Belitang	Raman Condong	None	"
6.	Belitang	Cahaya Bumi	None	A.W.L.R.
7.	Lempuing	Cahaya Bumi	Yes	"
8.	Komering	Menanga	None	"
9.	Komering	Compaka	None	"
10.	Randu	Suka Bumi	None	S.G.
11.	Arisan	Gunung Batu	None	"
12.	Jambu	Tg. Lubuk	None	"
13.	Sigonan	Suka Raja	None	"
14.	Anyar	Anyar	None	"
15.	Komering	Kayu Agung	None	A.W.L.R.
16.	Komering	Kayu Agung	None	S.G.
17.	Ogan	Baturaja Kota	Yes	"
18.	Ogan	Baturaja Terusan	None	A.W.L.R.

A.W.L.R. : Automatic Water Level Recorder
S.G. : Staff Gauge

Table I-2 shown the results of measurement.

Table I-2 Results of Streamflow Measurement

Gauging Station	Observed Date	Stream Flow	Gauge Reading
Banding Agung	Oct. 23, 1979	15.99 m3/sec.	0.81 m
Martapura	Oct. 27, 1979	128.62	1.94
Baturaja Kota	Oct. 28, 1979	129.14	1.38
Cahaya Bumi	Oct. 29, 1979	73.77	3.17

The discharges measured were plotted in their rating curves. As they were relatively well fitted to the curves, they are usable for the estimation of the discharge.

1.2.3 Checking the Existing Hydrological and Metero Stations

The following hydrological and climatological stations were checked during the survey.

Table I-3 Existing Hydrological and Climatological Stations

A. Gauging Station

Name of Station	Place	Checked Date	Gauge	Maintenance
Ogan	Baturaja Kota	Oct. 22, 1979	S.G.	
Ogan	Baturaja Terusan	Oct. 22, 1979	A.W.L.R.	
Selabung	Banding Agung	Oct. 24, 1979	A.W.L.R.	
Komering	Martapura	Oct. 27, 1979	A.W.L.R.	
Komering	Kurungan Nyawa	Oct. 27, 1979	S.G.	
Pisang	Sri Numpi I	Oct. 29, 1979	A.W.L.R.	
Lemputing	Cahya Bumi	Oct. 2, 1979	A.W.L.R.	
Belitang	Raman Condong	Oct. 2, 1979	S.G.	
Belitang	Cahya Bumi	Oct. 2, 1979	A.W.L.R.	
Komering	Menanga	Nov. 2, 1979	A.W.L.R.	
Komering	Cempaka	Nov. 2, 1979	A.W.L.R.	
Randu	Suka Bumi	Nov. 11, 1979	S.G.	
Arisan	Gunung Batu	Nov. 11, 1979	S.G.	
Jambu	Tg. Lubuk	Nov. 5, 1979	S.G.	
Sigonan	Suka Raja	Nov. 12, 1979	S.G.	
Anyar	Lubuk Rukam	Nov. 12, 1979	S.G.	
Komering	Kayu Agung	Nov. 8, 1979	A.W.L.R.	
Komering	Kayu Agung	Nov. 8, 1979	S.G.	

B. Climatological Station

Place	Checked Date	Remarks
Raksajwa	Oct. 22, 1979	
Baturaja (Pertanian Office)	Oct. 22, 1979	Standard rainfall gauge only

Place	Checked Date	Remarks
Banding Agung	Oct. 24, 1979	
Banding Agung (Mess PEMDA)	Oct. 24, 1979	
Belitang	Oct. 29, 1979	
Martapura	Oct. 29, 1979	Standard rainfall gauge only
Kurungan Nyawa	Oct. 29, 1979	

According to the survey, the following problems are pointed out:

1. In Baturaja Terusan gauging station, recording papers had not been supplied for two weeks, and the staff gauge was missing.
2. In Lemputing (Cahya Bumi) gauging station, the automatic recorder did not work often because the diameter of the floater well was small for moving the float and the weight.
3. In the Randu River, the downstream staff gauge was missing.
4. In Banding Agung, a standard rainfall gauge was installed at about three meters from the gauge reader house. Then climatological station was removed at Mess PEMDA in 1972 but its automatic rainfall gauge is out of order.

1.2.4 Proposed Meteoro & Hydro Stations to be Established

To consolidate data available, two meteorological stations and two automatic water level gauging stations will be installed in the area. These station sites were decided in the following places in considering future maintenance.

a. Meteorological station

1. Agriculture office in Tulangbawang Transmigration Project I
2. P.U. Office in Kayu Agung

b. Automatic water level gauge station

1. Komering river P.U. office in Muaradua
2. Matja river Cahya Bumi (A floater well and recorded house only has laready been installed by P.U.)

1.2.5 River Flow of the Komering

The Komering river (named as the Selabung river in the uppermost stream) having a water surface area of about 127 km^2 at water surface elevation of 542 m above mean sea level, and flows to northwest direction up to the confluence of the Baru river, and turn to northeast direction at a right angle. At Muaradua, it joins with the Saka river, one of its large tributaries and flows through hilly area to Martapura.

The Komering river runs meandering in flat plain to the north. Near Cempaka, most of the streamflow flows into the Ogan river through the Randu, the Arisan, the Jambu, the Sigonang, and the Anyar river.

The catchment area of the Komering river upstream from Kurungan Nyawa is about 4,474 km^2 including the Lake Ranau's catchment area of about 508 km^2.

Average run-off of the Komering river at Martapura is about 223 m^3/sec. or 7,033 x $10^6 m^3$ in annual runoff. The monthly average discharge of the Komering river reaches its maximum in April, and is approximately 330 m^3/sec. The minimum occurs in September, and is approximately 127 m^3/sec. The river discharge varies from year to year dominated by the amount of rainfall. Therefore, the steamflow pattern is dominated by the seasonal distribution of rainfall. Maximum flood dischange recorded at Martapura in 1977 was 1,079 m^3/sec. and minimum discharge 26.4 m^3/sec in October 1972.

1) Monthly discharge

Daily discharge of interrupted period at Martapura is estimated by converting the water level available at Kurungan Nyawa gauge station into those at Martapura gauge station.

To find the relationship between the water level of the two gauge stations, correlation analysis is made. In the calculation, 1053 of input data (from 1974 to 1978) are used to find correlation.

The following regression line is obtained.

$$y = 0.814x + 0.043$$

where x : Water level at Kurungan Nyawa
y : Water level at Martapura

Obtained correlation coefficient = 0.85

With the correlation equation, water level at Martapura was obtained, and then converted into the discharge.

ii) Rainfall-Runoff correlation

In case of no water level data available at Kurungan Nyawa, the discharge at Martapura is estimated by using rainfall of Muaradua.

The calculation procedure is shown below.

1. Accumulated monthly rainfall at Muaradua is obtained at first.
2. By using correlation equation shown in Fig. I-9, accumulated monthly rainfalls at Muaradua is converted into those at residual basin in between the Banding Agung gauge station and the Martapura gauge station.
3. From accumulated monthly rainfall at residual basin, accumulated loss rainfall is obtained by Fig. I-20.
4. After getting accumulated loss rainfall at residual basin, effective rainfall is changed into runoff, and it is converted into discharge at Martapura by using Fig. I-11.

These considerations are based on the fact that the streamflow originally recorded at the Martapura gauge station do not reflect the immediate rainfall, especially during low flow period, since it includes the streamflow from Lake Ranau, which is naturally regulated by the lake.

These figures were derived from the report (Land and Water Resources Development in South Eastern Sumatra Indonesia, Belitang Extension Area Agricultural Development Project prepared by FAO).

I.2.6 Drought Runoff Analysis

The river discharge of the Komering river varies from year to year dominated by the amount of rainfall. Due to the change in the amount of rainfall, drought year occurs in a cycle of about five years, and it causes wide variation in annual discharge.

The maximum and minimum annual streamflows were recorded at 379.9 m^3/sec. in 1978, and 148.5 m^3/sec in 1963.

Non-excess probable monthly discharges of 1/5 year (20%) at Martapura are estimated by Hazen method from the discharge data for 27 years, (1952-1978) as shown in the following Table 1-4 and Fig. 18.

Table 1-4 Drought Runoff (m^3/sec)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Discharge	225	190	250	275	210	123	92	82	65	70	110	210

1.2.7 Flood Runoff Analysis

The flood of the Komering reaches its maximum usually between February and May. The flood discharge at Martapura is estimated by applying Hazen method to the maximum mean daily discharge there.

The probabilities of the flood discharge are taken as 1/5, 1/10, 1/20, 1/50, 1/100, 1/200 and 1/1000 year, and are presented in the following Table 1-5.

Table 1-5 Calculated Flood Run-off at Martapura

Return Period	W (x) %	Flood Run-off	Remarks
5 year	20	860	
10	10	900	
20	5	960	
50	2	1030	
100	1	1100	
200	0.5	1180	
1000	0.1	1330	

1.2.8 Runoff of the Ogan, Pisang and Tulangbawang Rivers

i) Stream flow of the Ogan at Seri Kumbang

Discharge at Seri Kumbang is roughly estimated by weighted mean of

specific discharge at Batu Raja and at Tanjung Rambang as shown in the following Table I-6.

Table I-6 Discharge of Ogan River At Seri Kumbang

CA = 2,802 km^2

	Specific discharge in Batu Raja	Specific discharge at Tg. Rambang	Weighted mean specific discharge	Q m^3/sec	Remarks
Jan	0.064	0.040	0.055	154	Baturaja CA
Feb	0.067	0.043	0.058	163	= 2096 km^2
Mar	0.063	0.042	0.055	154	Tg. Rambang
Apr	0.111	0.041	0.084	235	CA = 1318 km^2
May	0.068	0.017	0.048	134	
Jun	0.035	0.009	0.025	70	
Jul	0.027	0.004	0.018	50	
Aug	0.025	0.003	0.016	45	
Sep	0.043	0.011	0.031	87	
Oct	0.042	0.009	0.029	81	
Nov	0.055	0.025	0.043	120	
Dec	0.068	0.037	0.056	157	

ii) Stream flow of the Pisang at Palasjaya

Discharge at Palasjaya has been estimated in the report, Hydrological Network Lampung Province Sumatra, Final Report Part 2 Volume I Hydrology and Water Resources. Therefore, the discharge was derived from the report (Table 7.4 Estimated Long-term Monthly and Annual Mean Runoff) as shown in the following table

Table I-7 Discharge at Palasjaya m^3/sec

CA= 157 km^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Discharge	6.5	6.7	5.1	4.5	3.7	2.8	2.1	1.8	1.9	2.4	3.7	5.3	3.9

iii) Streamflow of the Tulangbawang at Pakuanratu

Discharge at Pakuanratu also has been estimated in the abovementioned report.

Table I-8 Discharge at Pakuanratu m^3/sec

C.A. = 3,427 m^3/sec

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Discharge	210	260	240	240	190	140	91	81	100	130	180	200	170

1.2.9 Flow Conditions of the Komering River in the Lower Reach

There are five rivers connecting from the Komering to the Ogan between Cempaka and Kayu Agung, that is the Randu, the Arisan, the Jambu, the Sigonang and the Anyar from upstream to downstrea. On the other hand, the Lempuing river flows into the Komering river between the entrances of the Sigonang river and the Anyar river, and large Lebak area is located along the right bank of the Komering river. Because of such conditions, flow conditions in this area are very complicated.

In these five rivers, the Randu, and the Jambu river have a lot of discharge. Therefore, these two river are used for navigation, but in the case of the Randu river, fast flow and a lot of driftwood make it difficult for ships to pass through the river.

During dry season, river flow is stagnant in the Sigonang, and the Anyar river. People living along these river dig wells in the riverbed.

In the past, Sub.P3SA Sumatra Selatan measured discharge at the following places several times.

River	
1. Komering	Cempaka
2. Randu	Sukabumi
3. Arisan	Gunung Batu
4. Jambu	Tg. Lubuk
5. Sigonang	Sukaraja
6. Lempuing	Sri Nanti

The results of discharge measurement are shown in the table.

	Cempaka Q1	Randu Q2	Arisan Q3	Jambu Q4	Komering QR=Q1-Q2-Q3-Q4	QR/Q1
Nov. 1976	597.7	222.7	16.4	187.7	171.5	0.29
Feb. 1977	326.6	116.5	7.8	116.4	85.9	0.26
Mar. 1977	272.2	104.5	7.3	117.9	42.5	0.16
Jul. 1978	172.9	86.2	2.3	49.9	34.5	0.20
Aug. 1978	225.6	80.3	4.1	76.3	64.9	0.29
					Average	0.24

About 45% of the discharge flows into the Randu from the Komering, and about 25% of the discharge of the Komering is remaining at downstream from the entrance of the Jambu river. Namely, 75% of the discharge flows into the Randu, the Arisa, and the Jambu from the Komering.

	Cempaka Q1	Sri Nanti Q2	Q Q1+Q2	Kayu Agung Q3	Q3/Q	Q3/Q1
Nov. 1977	45.0	10.8	55.0	9.2	0.16	0.20
Aug. 1978	225.6	73.0	298.6	78.4	0.26	0.35
Sep. 1978	111.6	35.3	146.9	39.0	0.27	0.35
Oct. 2978	159.0	28.4	187.4	34.3	0.18	0.22
				Average	0.22	0.28

As shown in the above table, about 78% of the discharge from the Komering and the Lempuing into the Ogan, and about 22% of the above two rivers flows down to Kayu Agung.

Table I - 9 DISCHARGE AT CEMPAKA, SUKABUMI, GUNUNG BATU, TG. LUBUK SUKARAJA, SRI NANTI, ANYAR AND KAYU AGUNG.

RIVER	LOCATION	D A T E	DISCHARGE	MAX.VELOC	MEAN.VELOC	MAX.DEPTH	MEAN.DEPTH	A R E A	WIDTH	REMARKS
Komering	Cempaka	Nov. 21. 1976	597.7	1.65	1.37	5.52	3.61	436.31	110.20	
		Feb. 1. 1977	326.6	1.34	1.14	3.93	2.73	287.86	105.50	
		Mar. 23. 1977	272.1	1.21	1.10	3.78	2.58	269.79	104.50	
		Nov. 18. 1977	45.0	0.72	0.48	1.25	0.82	93.06	113.00	
		Jul. 19. 1978	172.9	1.31	0.95	3.48	1.82	182.69	100.50	
		Aug. 15. 1978	225.6	1.08	0.91	3.38	2.37	247.23	104.50	
		Sep. 1. 1978	111.6	0.92	0.71	2.15	1.38	157.80	114.00	
		Oct. 25. 1978	159.0	1.14	0.81	2.64	1.48	196.15	133.00	
Kandu	Sukabumi	Nov. 21. 1976	222.7	1.89	1.36	4.98	3.92	162.8	41.50	
		Feb. 2. 1977	116.5	1.39	1.05	5.78	2.84	110.65	39.00	
		Mar. 23. 1977	104.5	1.37	1.06	5.11	2.60	98.63	38.00	
		Nov. 18. 1977	23.3	1.02	0.48	2.60	1.20	48.83	35.00	
		Jul. 20. 1978	86.2	1.49	0.86	3.45	2.61	100.65	38.50	
		Aug. 15. 1978	80.2	1.21	0.89	4.70	2.39	90.27	38.00	
		Oct. 25. 1978	87.6	1.34	0.96	3.10	2.12	90.98	43.00	
		Sep. 1. 1978	54.4	1.13	0.75	2.48	1.69	72.60	43.00	
		Nov. 7. 1979	122.5	1.72	0.88	4.11	2.78	139.12	50.00	
Harisan	Gunung Batu	Nov. 23. 1976	16.4	0.76	0.53	2.25	1.52	31.16	20.50	
		Feb. 2. 1977	7.8	0.61	0.50	1.27	0.89	15.75	17.75	
		Mar. 24. 1977	7.3	0.60	0.46	1.25	0.93	15.84	17.00	
		Jul. 20. 1978	2.3	0.52	0.33	0.65	0.51	6.88	13.50	
		Aug. 14. 1978	4.1	0.52	0.38	1.12	0.73	10.94	15.00	
		Aug. 31. 1978	0.5	0.24	0.18	0.38	0.27	2.58	9.50	
		Oct. 25. 1978	1.4	0.38	0.27	0.68	0.42	5.07	12.00	

RIVER	LOCATION	D A T E	DISCHARGE	MAX.VELOC	MEAN.VELOC	MAX.DEPTH	MEAN.DEPTH	A R E A	WIDTH	REMARKS
Jambu	Tj.Lubuk	Nov. 22. 1976	187.1	1.33	1.03	3.73	2.39	181.69	76.00	
		Feb. 3. 1977	116.2	1.07	0.90	2.33	1.77	129.13	73.00	
		Mar. 24. 1977	117.8	1.34	0.84	2.32	1.92	139.94	73.00	
		Nov. 18. 1977	6.4	0.44	0.28	0.84	0.34	23.23	68.50	
		Jul. 18. 1978	49.9	1.20	0.85	2.68	1.10	58.47	53.00	
		Aug. 14. 1978	76.3	1.07	0.79	2.22	1.49	96.16	64.50	
		Aug. 31. 1978	24.9	0.73	0.51	1.25	0.65	48.70	74.50	
		Oct. 24. 1978	44.8	0.81	0.59	1.20	0.90	76.60	84.50	
		Nov. 3. 1979	93.7	1.21	0.78	2.00	1.60	119.83	75.00	
Sigonang	Sukaraja	Nov. 23. 1976	90.7	1.39	1.04	3.18	2.42	87.11	36.00	
		Feb. 14. 1977	69.6	1.20	0.93	2.62	1.95	75.26	38.50	
		Mar. 25. 1977	68.4	1.17	0.94	2.57	1.91	72.91	38.00	
		Jul. 18. 1978	32.5	1.17	0.83	1.91	1.23	39.14	31.75	
		Aug. 14. 1978	49.1	1.17	0.90	2.26	1.61	54.61	34.00	
		Aug. 31. 1978	15.5	0.94	0.61	1.28	0.73	25.55	35.00	
		Oct. 24. 1978	25.1	0.88	0.60	2.22	1.16	41.59	36.00	
		Nov. 7. 1979	55.9	0.68	0.55	4.34	3.20	102.23	32.00	
Lemputing	Srinanti	Jul. 19. 1978	65.9	0.49	0.37	4.56	3.44	180.67	52.50	
		Nov. 17. 1977	10.8	0.36	0.25	2.20	1.10	42.79	39.00	
		Aug. 13. 1978	73.0	0.51	0.39	4.54	3.44	185.58	54.00	
		Aug. 31. 1978	35.3	0.33	0.21	4.21	3.05	170.67	56.00	
		Oct. 24. 1978	28.4	0.26	0.17	4.15	2.98	165.51	55.50	

RIVER	LOCATION	D A T E	DISCHARGE	MAX.VELOC	MEAN.VELOC	MAX.DEPTH	MEAN.DEPTH	A R E A	WIDTH	REMARKS
Anyar	Anyar	Nov. 23. 1976	39.8	0.76	0.55	2.01	1.61	72.62	47.00	
		Feb. 4. 1977	31.9	0.80	0.63	1.31	1.07	50.39	47.00	
		Jul. 17. 1978	20.5	0.77	0.56	1.42	0.72	36.40	50.00	
		Aug. 13. 1978	17.8	0.75	0.58	0.89	0.65	30.48	47.00	
		Aug. 30. 1978	12.9	0.62	0.46	1.15	0.57	28.35	49.50	
		Sep. 20. 1978	29.0	1.18	0.59	1.43	0.89	49.30	55.00	
		Oct. 23. 1978	10.2	0.73	0.46	1.15	0.48	22.17	46.00	
		Nov. 7. 1979	34.8	1.10	0.90	1.49	0.90	50.11	55.50	
Komering	Kayu Agung	Nov. 24. 1976	259.3	1.19	0.76	3.48	2.83	339.60	120.00	
		Feb. 5. 1977	145.5	0.61	0.52	3.02	2.45	280.29	114.00	
		Mar. 22. 1977	125.9	0.58	0.48	2.97	2.32	263.68	113.60	
		Nov. 17. 1977	9.2	0.28	0.15	0.92	0.59	60.28	102.50	
		Jul. 17. 1978	77.2	0.55	0.38	2.61	1.88	204.99	109.00	
		Aug. 13. 1978	78.4	0.58	0.38	2.33	1.87	204.55	109.70	
		Aug. 30. 1978	39.0	0.41	0.31	1.57	1.13	126.37	112.00	
		Sep. 19. 1978	92.4	0.66	0.46	2.38	1.80	200.69	111.50	
		Oct. 23. 1978	34.3	0.37	0.28	1.59	1.10	123.95	112.50	
		Nov. 8. 1979	136.2	0.63	0.38	3.37	2.70	357.54	136.50	

1.3 WATER BALANCE

1.3.1 Assumption

i) Irrigation Area

The water balance is calculated based on the monthly streamflow of the Komering river at Martapura, incorporating the runoff from the drainage area, irrigation requirements, and return flow, and maintenance flow.

In calculation of the water balance, the following irrigation schemes are taken into consideration.

Scheme	Irrigable Area
Belitang proper	20,600 ha
Belitang extension	48,000
Tulangbawang	59,300
Lempuing	13,100
Lebak	76,000
Total	217,000 ha

ii) Division of basin

The downstream area from the Mucakkabau intake site to Sukabumi is tentatively assumed as a drainage area. The drainage area is about 1036 km^2, in which Lebak area is about 259 km^2.

iii) Runoff from the downstream area

Since there are no discharge data available from the area, the runoff is estimated by the following methods.

a) Rainfall in the area: Average monthly rainfall of Belitang and Cempaka are used for analysis.

b) Base flow: The discharge, 45.0 m^3/sec which was measured by Sub.P3SA at Cempaka in 1977 Nov. 18, is tentatively estimated as the minimum discharge, judging from the water level at

Menanga in 1977 Nov 18 was W.L. 31.80 m, and it is nearly the lowest water level according to the hydrograph of Menanga. Therefore, the base flow at Compaka is estimated to be 45 m^3/sec. Thus, the base flow of the drainage area is simply calculated at 20 m^3/sec deducting 25 m^3/sec at Martapura from the above discharge.

c) Potential evapotranspiration (ETo) from the field area: The values of potential evapotranspiration from the field area are derived from the values of irrigation requirements in Annex IV. Actual evapotranspiration is tentatively calculated multiplying 70% of plant coefficient by ETo from the view point of the present vegetation conditions in the area.

d) Evaporation from Lebak : The Lebak area is estimated at about 259 km^2 from the topographic map of 1/50,000 in scale. Evaporation from water surface is tentatively calculated multiplying 60% by potential evapotranspiration ETo.

Table I-10 Runoff from the Downstream Field Area

	R	ET	R-ET	Q1	Remarks
Jan.	363.0 mm	95.5 mm	267.5 mm	77.6 m^3/sec	A = 777 km^2
Feb.	267.4	86.2	181.2	58.2	
Mar.	348.7	97.7	251.0	72.8	
Apr.	304.0	94.5	209.5	62.8	
May	202.0	95.5	106.5	30.9	
Jun.	139.7	79.8	59.9	18.0	
Jul.	117.3	95.5	21.8	6.3	
Aug.	168.9	102.0	66.9	19.4	
Sep.	220,5	92.4	128.1	38.4	
Oct.	258.4	108.5	149.9	43.5	
Nov.	344.4	96.6	247.8	74.3	
Dec.	471.8	91.1	380,7	110.4	
	3,206.1 mm		2,070.8 mm	(65% of runoff coefficient)	

Table I-11 Runoff from Lebak Area

	R	E	R-E	Q2	Remarks
Jan.	363.0 mm	81.8 mm	281.2 mm	27.2 m^3/sec	A = 259 km^2
Feb.	267.4	73.9	193.5	20.7	
Mar.	348.7	83.7	265.0	25.6	
Apr.	304.0	81.0	223.0	22.3	
May	202.0	81.8	120.2	11.6	
Jun.	139.7	68.4	71.3	7.1	
Jul.	117.3	81.8	35.5	3.4	
Aug.	168.9	87.4	81.5	7.9	
Sep.	220.5	79.2	141.3	14.1	
Oct.	258.4	93.0	165.4	16.0	
Nov.	344.4	82.8	261.6	26.1	
Dec.	471.8	78.1	393.7	38.1	
	3,206.1 mm		2,233.2 mm	(70% of runoff coefficient)	

Table I-12 Runoff from Dowstream Area

	Q1	Q2	Qb	Q1+Q2+Qb	Remarks
Jan.	77.6 m^3/sec	27.2 m^3/sec	20.0 m^3/sec	124.8 m^3/sec	
Feb.	58.2	20.7	"	98.9	
Mar.	72.8	25.6	"	118.4	
Apr.	62.8	22.3	"	105.1	
May	30.9	11.6	"	62.5	
Jun.	18.0	7.1	"	45.1	
Jul.	6.3	3.4	"	29.7	
Aug.	19.4	7.9	"	47.3	
Sep.	38.4	14.1	"	72.5	
Oct.	43.5	16.0	"	79.5	
Nov.	74.3	26.1	"	120.4	
Dec.	110.4	38.1	"	168.5	

As shown in Section I, 1.2.9 Flow Conditions of the Komering in the vicinity of Kayu Agung, the ratio of discharge to the Komering at Kayu Agung as against the discharge at Cempaka is about 28%. Therefore, 30% of monthly runoff from the downstream area is added to the monthly discharge at Martapura as shown below

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Q1+Q2+Q3	124.8	98.9	118.4	105.1	62.5	45.1	29.7	47.3	72.5	79.5	120.4	168.5
(Q1+Q2+Q3)x0.3	37.4	29.7	35.5	31.5	18.8	13.5	8.9	14.2	21.8	23.9	36.1	50.6

iv) Irrigation Requirements in the Basin

Irrigation requirements in the basin are derived from Table DIVERSION REQUIREMENTS OF EACH DEVELOPMENT AREA. In the following table, monthly irrigation requirements are for Belitang proper area, Belitang Extension area, Tulangbawang area, Lempuing area and Lebak area.

Table I-13 Monthly Irrigation Diversion Requirements (m^3/sec)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
19.34	12.66	39.67	46.55	66.75	90.99	96.55	90.50	51.34	50.25	58.67	48.59

v) Return flow

A large portion of irrigation water supplied is likely to return to the river system either as seepage (percolation losses) or as surface runoff due to inefficient water control. These return flows are of importance to the projects of which water resources are limited. The followings are preliminary quantifications of the return flows to the Komering at Sukabumi where the Randu Canal connecting the Komering to the Ogan starts. The irrigation areas involved in this study are the Muncakkabau area of 10,700 ha and the uppor Lebak area of 29,000 ha as shown in Fig. I-20.

For the approximation of the return flow, the following assumptions are established.

a) Around 50% of both the percolation losses in paddy fields and farm application loss in the upland crop fields flow into the Komering as the return flows.

CALCULATION OF RETURN FLOW

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1) Muncakkabau Area (10,700 ha)												
a. Percolation and farm application losses in mm					12.1	14.8	20.1	11.7	7.8	5.3		
b. Return flows (50 % of a) - in mm					6.1	7.4	10.1	5.9	3.9	2.7		
- in m3/sec					0.24	0.30	0.40	0.24	0.16	0.11		
c. Canal conveyance and operation losses in m3/sec	0.34	0.10	1.01	0.13	0.78	0.96	1.26	0.73	0.5[illegible]	1.26	1.08	0.41
d. Return flows in m3/sec (70 % of c)	0.24	0.07	0.71	0.09	0.55	0.67	0.88	0.51	0.[illegible]	0.88	0.76	0.29
e. Total return flows in m3/sec (b + d)	0.24	0.07	0.71	0.09	0.79	0.97	1.26	0.75	0.	0.99	0.76	0.29
2) Upper Lebak Area (29,000 ha)												
a) Percolation and farm application losses in mm					10.6	17.5	28.4	31.4	19.2	5.7		
b. Return flows (50 % of a) - in mm					5.3	8.8	14.2	17.2	9.6	2.9		
- in m3/sec					0.53	0.99	1.54	1.86	1.07	0.32		
c. Canal conveyance and operation losses in m3/sec	0.58	0.87	0.84	2.15	2.81	4.73	6.35	7.13	2.06	0.81	2.00	3.67
d. Return flows in m3/sec (70 % of c)	0.41	0.61	0.59	1.51	1.97	3.31	4.45	4.99	1.44	0.57	1.40	2.56
e. Total return flows in m3/sec (b+d)	0.41	0.61	0.59	1.51	2.55	4.30	5.99	6.85	2.51	0.87	1.40	2.56
3) T o t a l in m3/sec (1 + 2)	0.65	0.68	1.30	1.60	3.34	5.27	7.27	7.60	3.05	1.86	2.16	2.85

b) Around 70% of canal conveyance and operation losses also flow into the Komering as the return flows.

Based on the above assumptions, the following calculation is made (for the details of Irrigation losses vide Annex-IV).

vi) Maintenance flow

a) Navigation water

The minimum water depths for navigation are as follows.

Kind of boat	Tonnage	Minimum depth
Big boat	6 - 7 t	1.5 m
Medium boat	4	1 m
Small boat	1	0.75 m

The discharges required for each water depth at the following places are calculated.

1. Kurungan Nyawa
2. Menanga Tengah
3. Suka Bumi
4. Tanjung Lubuk

In the calculation, water slope is assumed to be 1/2,200, which is obtained from the water levels at Kurungan Nyawa and at Menanga Tengah, and for coefficient of roughness, 0.035 is adopted depending on riverbed materials. The water slope is tentatively applied for Suka Bumi and Tanjung Lubuk.
During dry season, it is said that only small boat can navigate in the Komering river. Therefore, 15 m^3 of the discharge should be released for navigation throughout the year.