Conveyance Efficiency (C.E)

(unit: %)

Lateral/ Sub-Lateral	C.E.	Lateral/ Sub-Lateral	C.E.	Lateral/ Sub-Lateral	C.E.
Division-I				Division-II	
C	80	A-5	80	SIFFU-SMC	76
C-1	95	A-5 Extra	91	A	86
C-2	88	A-6	94	A-Extra	85
C-3	70	A-7	88	B	67
C-4	70	B	80	C	84
E	88	B-1	80	D	76
E-1	80	D	84	E	70
E-2	82	D-1	89	E-Extra	88
E-3	83	D-2	88	F	61
F	81	D-3	83	G	83
G	90	D-4	83	H	94
H	86	H-Extra	76	SIFFU-NMC	76
SLC	80	I	86	A	80
SHC	80	I-Extra	79	B	85
		J	79	NDC	76
		J-Extra	81		
Division-II		CEE	80		
A	74	RMC	80		
A-1	94	MAC-East	80		
A-2	76	MAC-West	80		
A-3	72				
A-4	92				

Unit weekly diversion water requirement for lateral canal basis exclusive effective rainfall is shown in Table 3-9.

3.4.2. Diversion Water Requirement

(1) Total Demand

The total diversion water requirement corresponding to a relative drought year for the projected Service Area of 97,400 ha was estimated on the daily basis in case of paddy cultivation for both dry and wet seasons, and estimated water requirement is summarized as shown below by each water resource such as Baligatan, Maris and Siffuris diversion dams.

Total Water Requirement by Water Resources

(unit: MCM)

Month	Baligatan Diversion Dam	Maris Diversion Dam	Siffuris Diversion Dam	Total
Jan.	37.6	287.2	35.5	360.3
Feb.	45.2	279.6	41.4	366.2
Mar.	52.0	164.6	43.3	259.9
Apr.	16.4	130.7	14.3	161.4
May	14.4	283.0	13.5	310.9
Jun.	48.6	221.1	38.6	308.3
Jul.	46.2	346.5	43.8	436.5
Aug.	23.6	182.7	21.3	227.6
Sep.	22.7	86.8	19.3	128.8
Oct.	11.5	66.4	12.5	90.4
Nov.	4.6	122.1	8.8	135.5
Dec.	34.2	216.2	30.5	280.9
Total	357.0	2,386.9	322.8	3,066.7

Diversion water requirements by lateral basis are compiled in Table 3-10 to Table 3-14.

(2) Water Duty in Irrigation System

(a) Water Duty at Main and Lateral Basis

Water duty at main and lateral basis was estimated from the results of estimation of diversion water requirements mentioned above. The estimated water duty at major main and lateral canals is shown in O/M Drawings No.14. The subsequent shows the maximum water duty during the cropping season at diversion dam sites:

Baligatan irrigation system: 1.71 lit/sec/ha
Maris irrigation system : 1.77 lit/sec/ha
Siffuris irrigation system : 1.51 lit/sec/ha

TABLE 3-9. PROPOSED DIVERSION WATER REQUIREMENT FOR MAJOR CANAL SYSTEM

Canal System	Area (ha)	Wet Season Demand (MCM)	Wet Season Demand/ha (mm/ha)	Dry Season Demand (MCM)	Dry Season Demand/ha (mm/ha)	Total Demand (MCM)	Total Demand/ha (mm/ha)
1. Baligatan Diversion Dam							
South High Canal	9,580	126.2	1,317	144.3	1,506	270.5	2,824
Oscariz Canal	3,100	40.8	1,316	45.7	1,474	86.5	2,790
Sub-total	12,680	167.0	1,317	190.0	1,498	357.0	2,815
2. Maris Diversion Dam							
Maris Main Canal	53,889	935.8	1,736	832.4	1,545	1,768.2	3,281
Macanao	6,040	99.0	1,639	110.5	1,829	209.5	3,469
Siffu East Extension	6,600	84.2	1,276	112.7	1,708	196.9	2,983
Sub-total	66,529	1,119.0	1,682	1,055.6	1,587	2,174.6	3,269
3. Siffuris Diversion Dam							
North Diversion Canal	7,074	91.0	1,286	121.4	1,716	212.4	3,002
Siffu North Canal	2,959	43.2	1,460	41.9	1,416	85.1	2,876
Siffu South Canal	8,160	105.7	1,295	132.0	1,618	237.7	2,913
Sub-total	18,193	239.9	1,319	295.3	1,623	535.2	2,942
T o t a l	97,402	1,525.9	1,567	1,540.9	1,582	3,066.8	3,149

Note: 1. Effective rainfall is counted in the above irrigation demand.
Water requirement covered by North Diversion cand is included in the group of Siffuris Diversion dam.

2. Above figures are obtained by dividing the estimated diversion water requirement at lateral base by system operation efficiency of 85 percent.

TABLE 3-10.

DIVERSION WATER REQUIREMENT BY LATERAL (WITH EFFECTIVE RAINFALL) (1)

(PAGE....1)
(UNIT = MCM)

PERIOD		BALIGATAN O.D.			LATERAL A (MARIS)										LAT.B	LAT.C
		S.M.C 9580HA	O.M.C 3100HA	TOTAL 12680HA	A-1 279HA	A-2 3993HA	A-3 673HA	A-4 84HA	A-5 579HA	A-5EX 92HA	A-6 202HA	A-7 87HA	LAT.A 1558HA	TOTAL 7547HA	1713HA	7920HA
JAN	*F	7.652	2.476	10.128	0.491	8.679	1.545	0.151	1.198	0.167	0.355	0.164	3.483	16.233	3.545	7.218
	*M	7.903	2.557	10.460	0.493	8.719	1.553	0.152	1.204	0.168	0.357	0.164	3.502	16.312	3.561	7.283
	*L	9.262	2.997	12.259	0.545	9.636	1.718	0.168	1.330	0.186	0.395	0.182	3.873	18.032	3.934	8.086
	*T	24.817*	8.030*	32.847*	1.529*	27.033*	4.816*	0.472*	3.732*	0.521*	1.107*	0.509*	10.857*	50.577*	11.041*	22.587*
FEB	*F	10.250	3.317	13.567	0.542	9.585	1.710	0.167	1.326	0.185	0.393	0.180	3.850	17.938	3.922	8.886
	*M	10.388	3.361	13.749	0.464	8.481	1.462	0.143	1.134	0.158	0.336	0.154	3.293	15.626	3.355	8.120
	*L	8.410	2.721	11.131	0.232	4.823	0.733	0.072	0.568	0.079	0.168	0.077	1.650	8.403	1.681	4.952
	*T	29.047*	9.399*	38.447*	1.239*	22.889*	3.904*	0.381*	3.028*	0.423*	0.897*	0.412*	8.793*	41.966*	8.958*	21.958*
MAR	*F	12.043	3.897	15.940	0.127	3.870	0.397	0.039	0.308	0.043	0.092	0.042	0.897	5.814	0.910	4.986
	*M	11.635	3.765	15.400	0.001	0.953	0.003	0.000	0.003	0.000	0.001	0.000	0.007	0.969	0.008	2.493
	*L	9.719	3.145	12.865	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.343
	*T	33.398*	10.807*	44.205*	0.128*	4.822*	0.401*	0.039*	0.310*	0.043*	0.092*	0.042*	0.905*	6.783*	0.918*	7.821*
APR	*F	6.740	2.181	8.921	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	*M	3.370	1.091	4.461	0.078	1.099	0.245	0.024	0.189	0.026	0.056	0.026	0.550	2.293	0.560	1.122
	*L	0.421	0.136	0.558	0.492	7.855	1.552	0.152	1.201	0.168	0.356	0.164	3.493	15.432	3.552	3.713
	*T	10.531*	3.408*	13.939*	0.570*	8.954*	1.796*	0.175*	1.390*	0.194*	0.413*	0.190*	4.043*	17.725*	4.112*	4.835*
MAY	*F	0.0	0.0	0.0	0.585	8.431	1.846	0.180	1.428	0.200	0.424	0.195	4.156	17.444	4.224	7.519
	*M	1.158	0.375	1.532	0.643	11.062	2.031	0.198	1.570	0.219	0.466	0.215	4.569	20.974	4.646	9.425
	*L	8.104	2.622	10.727	0.571	11.450	1.804	0.176	1.395	0.195	0.414	0.191	4.058	20.254	4.127	12.319
	*T	9.262*	2.997*	12.259*	1.800*	30.943*	5.681*	0.555*	4.393*	0.614*	1.303*	0.601*	12.783*	58.671*	12.997*	29.263*
JUN	*F	8.346	2.701	11.047	0.357	6.244	1.123	0.110	0.870	0.121	0.258	0.119	2.525	11.727	2.573	4.625
	*M	10.478	3.391	13.868	0.380	6.589	1.196	0.117	0.926	0.129	0.275	0.127	2.690	12.429	2.740	4.956
	*L	12.380	4.006	16.386	0.386	6.872	1.215	0.118	0.940	0.131	0.279	0.129	2.733	12.804	2.782	5.494
	*T	31.204*	10.097*	41.301*	1.122*	19.706*	3.535*	0.344*	2.736*	0.382*	0.813*	0.374*	7.948*	36.960*	8.095*	15.075*
JUL	*F	9.046	2.927	11.973	0.572	10.083	1.801	0.176	1.398	0.195	0.414	0.191	4.060	18.890	4.136	8.555
	*M	9.471	3.065	12.536	0.580	10.191	1.826	0.178	1.416	0.198	0.420	0.193	4.112	19.113	4.188	8.736
	*L	11.170	3.614	14.784	0.647	11.336	2.037	0.199	1.578	0.220	0.468	0.216	4.584	21.282	4.667	9.817
	*T	29.687*	9.607*	39.294*	1.798*	31.610*	5.664*	0.553*	4.391*	0.613*	1.302*	0.599*	12.756*	59.285*	12.992*	27.108*
AUG	*F	4.714	1.525	6.239	0.453	7.855	1.430	0.139	1.106	0.155	0.328	0.151	3.217	14.835	3.271	5.030
	*M	4.872	1.576	6.448	0.401	7.147	1.267	0.123	0.979	0.137	0.291	0.134	2.850	13.329	2.897	4.738
	*L	5.541	1.793	7.334	0.249	5.315	0.787	0.077	0.608	0.085	0.180	0.083	1.769	9.154	1.799	3.831
	*T	15.127*	4.895*	20.021*	1.104*	20.317*	3.484*	0.339*	2.693*	0.378*	0.799*	0.368*	7.836*	37.318*	7.967*	13.599*
SEP	*F	5.617	1.817	7.434	0.091	3.383	0.287	0.028	0.222	0.031	0.066	0.030	0.646	4.785	0.657	3.988
	*M	5.173	1.674	6.847	0.0	0.554	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.554	0.0	1.773
	*L	3.807	1.232	5.040	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.100
	*T	14.597*	4.724*	19.321*	0.091*	3.937*	0.287*	0.028*	0.222*	0.031*	0.066*	0.030*	0.646*	5.339*	0.657*	5.861*
OCT	*F	5.002	1.619	6.620	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	*M	2.223	0.719	2.942	0.037	0.524	0.116	0.011	0.090	0.013	0.027	0.012	0.261	1.089	0.266	0.556
	*L	0.137	0.044	0.182	0.290	4.132	0.912	0.089	0.707	0.099	0.210	0.097	2.056	8.592	2.092	4.035
	*T	7.362*	2.382*	9.745*	0.327*	4.656*	1.028*	0.100*	0.797*	0.111*	0.237*	0.109*	2.316*	9.681*	2.358*	4.591*
NOV	*F	0.0	0.0	0.0	0.260	3.954	0.817	0.080	0.632	0.088	0.188	0.086	1.841	7.945	1.869	3.821
	*M	0.640	0.207	0.848	0.277	5.241	0.871	0.085	0.673	0.094	0.201	0.092	1.966	9.501	1.990	4.735
	*L	2.284	0.739	3.023	0.242	5.022	0.762	0.075	0.588	0.082	0.175	0.080	1.720	8.747	1.740	5.609
	*T	2.924*	0.946*	3.870*	0.779*	14.216*	2.450*	0.240*	1.892*	0.265*	0.564*	0.259*	5.527*	26.193*	5.599*	14.165*
DEC	*F	5.457	1.766	7.223	0.416	7.294	1.313	0.128	1.016	0.142	0.301	0.139	2.952	13.701	3.007	5.101
	*M	7.034	2.276	9.310	0.432	7.541	1.365	0.133	1.055	0.147	0.313	0.144	3.067	14.197	3.123	5.354
	*L	9.455	3.059	12.514	0.480	8.519	1.516	0.148	1.172	0.164	0.347	0.160	3.406	15.912	3.468	6.322
	*T	21.945*	7.101*	29.047*	1.328*	23.354*	4.194*	0.409*	3.244*	0.453*	0.961*	0.444*	9.424*	43.809*	9.597*	16.776*
ANNUAL		229.901	74.394	304.294	11.815	212.437	37.240	3.635	28.828	4.028	8.554	3.937	83.834	394.307	85.290	183.638

TABLE 3-11.

DIVERSION WATER REQUIREMENT BY LATERAL (WITH EFFECTIVE RAINFALL) (2)

(UNIT = MCM)

PERIOD		LATERAL C (MARIS) C-1 427HA	C-2 958HA	C-3,4 4344HA	LAT.C 1420HA	TOTAL 7149HA	LATERAL D (MARIS) D-1 3089HA	D-2 8306HA	D-3,4 3517HA	LAT.D 2769HA	C.E.E 5473HA	TOTAL 23154HA	LATERAL E (MARIS) E-1 694HA	E-2,3 214HA	LAT.E 1754HA	TOTAL 2662HA
JAN	*F	0.327	0.792	4.525	1.297	6.941	2.524	6.852	3.086	2.403	4.372	19.236	0.629	0.188	1.437	2.254
	*M	0.331	0.804	4.568	1.315	7.017	2.555	6.920	3.121	2.423	4.515	19.534	0.630	0.189	1.441	2.261
	*L	0.368	0.897	5.075	1.465	7.805	2.845	7.691	3.473	2.689	5.291	21.990	0.702	0.210	1.606	2.518
	*T	1.025*	2.494*	14.168*	4.076*	21.763*	7.924*	21.463*	9.681*	7.515*	14.178*	60.760*	1.960*	0.587*	4.485*	7.032*
FEB	*F	0.406	0.985	5.585	1.607	8.583	3.119	8.468	3.824	2.963	5.856	24.230	0.768	0.231	1.773	2.772
	*M	0.347	0.843	4.945	1.375	7.510	2.761	7.736	3.386	2.623	5.934	22.441	0.779	0.235	1.802	2.815
	*L	0.174	0.422	2.812	0.689	4.097	1.570	4.717	1.925	1.492	4.804	14.509	0.622	0.187	1.439	2.249
	*T	0.927*	2.250*	13.343*	3.671*	20.190*	7.450*	20.922*	9.135*	7.078*	16.594*	61.180*	2.169*	0.653*	5.014*	7.836*
MAR	*F	0.102	0.248	2.440	0.402	3.192	1.368	4.750	1.670	1.297	6.880	15.966	0.716	0.215	1.643	2.574
	*M	0.001	0.002	0.601	0.003	0.607	0.337	2.375	0.411	0.319	6.647	10.089	0.391	0.117	0.896	1.404
	*L	0.0	0.0	0.0	0.0	0.0	0.0	0.327	0.0	0.0	5.553	5.879	0.080	0.024	0.183	0.287
	*T	0.103*	0.250*	3.040*	0.406*	3.799*	1.705*	7.452*	2.082*	1.617*	19.080*	31.935*	1.186*	0.356*	2.722*	4.265*
APR	*F	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.850	3.850	0.0	0.0	0.0	0.0
	*M	0.076	0.185	0.844	0.302	1.408	0.473	1.070	0.576	0.449	1.925	4.493	0.0	0.0	0.0	0.0
	*L	0.468	1.135	5.850	1.849	9.302	3.275	3.542	3.993	3.108	0.241	14.159	0.0	0.0	0.0	0.0
	*T	0.545*	1.320*	6.694*	2.151*	10.710*	3.747*	4.612*	4.569*	3.556*	6.016*	22.502*	0.0 *	0.0 *	0.0 *	0.0 *
MAY	*F	0.487	1.178	5.530	1.923	9.118	3.099	7.185	3.778	2.941	2.420	19.422	0.454	0.137	1.043	1.633
	*M	0.487	1.179	6.903	1.926	10.494	3.869	9.013	4.715	3.673	4.833	26.104	0.900	0.271	2.068	3.238
	*L	0.384	0.928	6.506	1.518	9.335	3.649	11.787	4.444	3.466	7.072	30.418	1.265	0.381	2.905	4.552
	*T	1.358*	3.284*	18.939*	5.366*	28.947*	10.617*	27.985*	12.937*	10.080*	14.325*	75.944*	2.619*	0.788*	6.016*	9.424*
JUN	*F	0.170	0.415	2.529	0.673	3.786	1.421	4.461	1.737	1.355	5.565	14.539	0.481	0.144	1.110	1.734
	*M	0.205	0.500	2.936	0.811	4.452	1.643	4.777	2.006	1.574	5.231	15.231	0.497	0.150	1.148	1.796
	*L	0.214	0.521	3.270	0.847	4.852	1.824	5.290	2.227	1.753	4.610	15.704	0.568	0.171	1.311	2.050
	*T	0.589*	1.436*	8.735*	2.331*	13.090*	4.888*	14.528*	5.971*	4.681*	15.406*	45.474*	1.546*	0.465*	3.569*	5.580*
JUL	*F	0.395	0.954	5.415	1.553	8.318	3.017	8.169	3.682	2.875	5.502	23.244	0.742	0.223	1.709	2.675
	*M	0.406	0.981	5.532	1.601	8.520	3.085	8.325	3.768	2.943	5.853	23.973	0.745	0.224	1.716	2.686
	*L	0.458	1.109	6.222	1.816	9.605	3.473	9.335	4.245	3.316	6.620	26.988	0.840	0.253	1.935	3.028
	*T	1.260*	3.044*	17.169*	4.970*	26.443*	9.575*	25.828*	11.695*	9.133*	17.975*	74.206*	2.328*	0.701*	5.360*	8.388*
AUG	*F	0.251	0.613	3.289	0.994	5.147	1.835	4.784	2.240	1.740	2.828	13.427	0.358	0.109	0.829	1.296
	*M	0.222	0.543	3.001	0.880	4.646	1.673	4.505	2.043	1.587	2.918	12.727	0.371	0.113	0.862	1.345
	*L	0.138	0.337	2.232	0.547	3.253	1.244	3.643	1.519	1.180	3.249	10.836	0.397	0.121	0.923	1.441
	*T	0.611*	1.492*	8.522*	2.421*	13.046*	4.752*	12.932*	5.802*	4.507*	8.996*	36.989*	1.126*	0.342*	2.614*	4.082*
SEP	*F	0.070	0.170	1.982	0.277	2.498	1.107	3.783	1.356	1.053	3.753	11.052	0.492	0.148	1.131	1.772
	*M	0.0	0.0	0.324	0.0	0.324	0.181	1.681	0.222	0.172	2.615	4.872	0.233	0.070	0.536	0.839
	*L	0.0	0.0	0.0	0.0	0.0	0.0	0.095	0.0	0.0	1.478	1.573	0.021	0.006	0.048	0.075
	*T	0.070*	0.170*	2.306*	0.277*	2.823*	1.288*	5.559*	1.578*	1.225*	7.846*	17.496*	0.746*	0.224*	1.715*	2.685*
OCT	*F	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.591	0.591	0.0	0.0	0.0	0.0
	*M	0.038	0.091	0.417	0.148	0.694	0.234	0.530	0.284	0.221	0.0	1.269	0.0	0.0	0.0	0.0
	*L	0.272	0.659	3.027	1.075	5.033	1.695	3.849	2.065	1.607	0.0	9.216	0.0	0.0	0.0	0.0
	*T	0.310*	0.750*	3.444*	1.224*	5.727*	1.928*	4.379*	2.349*	1.829*	0.591*	11.076*	0.0 *	0.0 *	0.0 *	0.0 *
NOV	*F	0.240	0.579	2.785	0.945	4.549	1.564	3.648	1.902	1.479	0.0	8.593	0.236	0.071	0.540	0.846
	*M	0.218	0.526	3.416	0.855	5.014	1.923	4.521	2.337	1.814	0.366	10.961	0.469	0.141	1.075	1.685
	*L	0.164	0.397	2.807	0.642	4.010	1.586	5.349	1.925	1.490	1.305	11.655	0.604	0.182	1.388	2.175
	*T	0.622*	1.502*	9.008*	2.442*	13.574*	5.074*	13.519*	6.164*	4.783*	1.671*	31.209*	1.309*	0.395*	3.003*	4.706*
DEC	*F	0.234	0.563	3.166	0.922	4.884	1.777	4.852	2.159	1.676	3.118	13.583	0.465	0.141	1.070	1.676
	*M	0.259	0.622	3.455	1.018	5.355	1.938	5.095	2.350	1.826	4.018	15.228	0.459	0.139	1.053	1.651
	*L	0.292	0.701	4.064	1.147	6.204	2.277	6.019	2.759	2.146	5.401	18.603	0.564	0.171	1.290	2.025
	*T	0.785*	1.886*	10.685*	3.087*	16.443*	5.992*	15.967*	7.268*	5.648*	12.537*	47.413*	1.489*	0.451*	3.413*	5.352*
ANNUAL		8.204	19.878	116.052	32.421	176.554	64.941	175.146	79.231	61.652	135.215	516.183	16.478	4.962	37.911	59.352

TABLE 3-12.

DIVERSION WATER REQUIREMENT BY LATERAL (WITH EFFECTIVE RAINFALL) (3)

(UNIT = MCM)

PERIOD		LAT.F 555HA	LAT.G 137HA	LAT.H 182HA	L.HEX 801HA	LAT.I 1084HA	LAT.J 714HA	L.IEX 75HA	L.JEX 196HA	<--MACANAO-EAST M.C--> R.M.C 1776HA	MEMC 3126HA	TOTAL 4902HA	<--MACANAO-WEST M.C--> LADECO 967HA	MWMC 171HA	TOTAL 1138HA	<--NORTH--> S.F.E 6600HA
JAN	*F	0.498	0.110	0.154	0.760	0.916	0.653	0.069	0.176	1.372	3.215	4.587	1.877	0.332	2.209	6.870
	*M	0.499	0.110	0.154	0.762	0.919	0.655	0.069	0.176	1.378	2.356	3.735	1.870	0.331	2.201	6.415
	*L	0.554	0.122	0.171	0.848	1.020	0.729	0.077	0.196	1.674	2.803	4.478	2.143	0.379	2.522	6.136
	*T	1.551*	0.342*	0.479*	2.370*	2.855*	2.036*	0.214*	0.548*	4.425*	8.375*	12.799*	5.890*	1.042*	6.932*	19.421*
FEB	*F	0.609	0.135	0.188	0.934	1.117	0.802	0.084	0.215	1.887	3.260	5.147	2.147	0.380	2.526	7.047
	*M	0.618	0.137	0.190	0.947	1.132	0.814	0.085	0.218	1.892	3.330	5.222	2.150	0.380	2.530	7.381
	*L	0.494	0.110	0.152	0.757	0.905	0.650	0.068	0.174	1.538	2.702	4.240	1.733	0.306	2.039	6.009
	*T	1.721*	0.382*	0.530*	2.638*	3.154*	2.266*	0.238*	0.608*	5.316*	9.292*	14.609*	6.029*	1.066*	7.096*	20.436*
MAR	*F	0.565	0.126	0.174	0.870	1.038	0.746	0.078	0.200	2.185	3.824	6.009	2.309	0.408	2.717	8.464
	*M	0.308	0.068	0.095	0.475	0.566	0.407	0.043	0.109	2.220	3.878	6.099	2.328	0.412	2.740	8.573
	*L	0.063	0.014	0.019	0.097	0.116	0.083	0.009	0.022	2.432	4.284	6.716	2.547	0.450	2.998	9.512
	*T	0.936*	0.208*	0.289*	1.441*	1.719*	1.237*	0.130*	0.331*	6.836*	11.987*	18.824*	7.185*	1.271*	8.456*	26.548*
APR	*F	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.968	3.652	5.620	1.911	0.338	2.249	8.411
	*M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.031	2.347	3.378	1.001	0.177	1.178	6.008
	*L	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.169	1.043	1.212	0.164	0.029	0.193	3.605
	*T	0.0 *	0.0 *	0.0 *	0.0 *	0.0 *	0.0 *	0.0 *	0.0 *	3.167*	7.042*	10.210*	3.076*	0.544*	3.620*	18.024*
MAY	*F	0.359	0.080	0.111	0.552	0.660	0.473	0.050	0.127	0.0	0.066	0.066	0.0	0.0	0.0	1.188
	*M	0.711	0.158	0.220	1.094	1.309	0.939	0.099	0.251	0.321	0.452	0.774	0.273	0.048	0.321	0.0
	*L	0.999	0.222	0.309	1.539	1.840	1.321	0.139	0.353	2.247	3.168	5.415	1.992	0.352	2.345	0.0
	*T	2.069*	0.460*	0.640*	3.185*	3.810*	2.732*	0.287*	0.731*	2.569*	3.686*	6.254*	2.265*	0.401*	2.666*	1.188*
JUN	*F	0.379	0.084	0.117	0.586	0.698	0.502	0.053	0.134	2.194	3.171	5.365	2.041	0.361	2.402	2.738
	*M	0.393	0.087	0.121	0.607	0.723	0.520	0.055	0.139	2.072	3.944	6.016	2.054	0.363	2.417	5.542
	*L	0.450	0.100	0.139	0.694	0.827	0.595	0.063	0.159	1.597	3.298	4.895	1.663	0.294	1.957	7.362
	*T	1.222*	0.271*	0.377*	1.887*	2.247*	1.617*	0.170*	0.431*	5.863*	10.413*	16.276*	5.758*	1.018*	6.776*	15.642*
JUL	*F	0.584	0.130	0.180	0.905	1.075	0.776	0.081	0.206	1.686	2.892	4.578	2.163	0.382	2.545	7.919
	*M	0.587	0.131	0.181	0.909	1.080	0.779	0.082	0.207	1.858	3.147	5.005	2.257	0.399	2.656	8.227
	*L	0.663	0.147	0.205	1.023	1.220	0.878	0.092	0.234	2.093	3.693	5.786	2.509	0.444	2.953	8.097
	*T	1.834*	0.408*	0.567*	2.837*	3.375*	2.433*	0.256*	0.648*	5.637*	9.732*	15.370*	6.928*	1.225*	8.154*	24.243*
AUG	*F	0.285	0.063	0.088	0.439	0.522	0.375	0.039	0.101	0.881	1.543	2.425	1.608	0.284	1.892	3.127
	*M	0.297	0.065	0.091	0.456	0.542	0.388	0.041	0.105	0.925	1.605	2.530	1.632	0.289	1.920	3.573
	*L	0.318	0.070	0.097	0.488	0.580	0.415	0.044	0.112	1.066	1.837	2.903	1.821	0.322	2.143	4.128
	*T	0.899*	0.197*	0.276*	1.383*	1.644*	1.178*	0.124*	0.318*	2.873*	4.985*	7.858*	5.061*	0.895*	5.955*	10.828*
SEP	*F	0.390	0.087	0.121	0.596	0.718	0.515	0.054	0.138	1.120	1.886	3.006	1.771	0.313	2.084	3.495
	*M	0.185	0.041	0.057	0.283	0.340	0.244	0.026	0.065	0.958	1.672	2.630	1.515	0.268	1.783	3.617
	*L	0.016	0.004	0.005	0.025	0.030	0.022	0.002	0.006	0.560	1.134	1.694	0.886	0.157	1.042	3.693
	*T	0.592*	0.131*	0.183*	0.904*	1.089*	0.780*	0.082*	0.209*	2.638*	4.692*	7.330*	4.172*	0.738*	4.910*	10.805*
OCT	*F	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.360	1.299	1.658	0.381	0.067	0.448	4.662
	*M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.213	0.213	0.0	0.0	0.0	3.291
	*L	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.036
	*T	0.0 *	0.0 *	0.0 *	0.0 *	0.0 *	0.0 *	0.0 *	0.0 *	0.360*	1.511*	1.871*	0.381*	0.067*	0.448*	9.990*
NOV	*F	0.186	0.041	0.057	0.286	0.341	0.245	0.026	0.066	0.0	0.0	0.0	0.0	0.0	0.0	0.673
	*M	0.371	0.082	0.114	0.570	0.682	0.489	0.051	0.131	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	*L	0.480	0.106	0.148	0.735	0.881	0.630	0.066	0.169	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	*T	1.037*	0.230*	0.320*	1.591*	1.904*	1.364*	0.143*	0.366*	0.0 *	0.0 *	0.0 *	0.0 *	0.0 *	0.0 *	0.673*
DEC	*F	0.367	0.082	0.113	0.567	0.673	0.485	0.051	0.129	0.650	0.919	1.568	0.565	0.098	0.653	1.712
	*M	0.362	0.081	0.111	0.560	0.664	0.479	0.050	0.128	1.344	1.904	3.247	1.331	0.235	1.566	3.557
	*L	0.446	0.099	0.137	0.687	0.815	0.587	0.062	0.158	1.960	2.870	4.830	2.167	0.383	2.550	5.371
	*T	1.175*	0.263*	0.361*	1.815*	2.152*	1.551*	0.163*	0.415*	3.954*	5.692*	9.645*	4.053*	0.717*	4.770*	10.641*
ANNUAL		13.035	2.894	4.021	20.051	23.948	17.195	1.806	4.604	43.637	77.408	121.046	50.798	8.983	59.780	168.439

TABLE 3-13.

DIVERSION WATER REQUIREMENT BY LATERAL (WITH EFFECTIVE RAINFALL) (4)

(PAGE....4)
(UNIT = MCM)

PERIOD		DIVERSION C. N.D.C 7074HA	TOTAL 13674HA	SIFFU SOUTH MAIN CANAL LAT.A 2987HA	LAT.B 1723HA	LAT.C 480HA	LAT.D 1071HA	LAT.E 333HA	LAT.F 640HA	LAT.G 693HA	LAT.H 233HA	TOTAL 8160HA	SIFFU NORTH MAIN CANAL LAT.A 880HA	LAT.B 226HA	N.M.C 1853HA	TOTAL 2959HA
JAN	*F	7.364	14.234	2.193	1.582	0.352	0.869	0.293	0.649	0.515	0.153	6.606	0.797	0.193	1.758	2.748
	*M	6.876	13.291	2.370	1.590	0.354	0.875	0.295	0.652	0.517	0.154	6.807	0.799	0.193	1.763	2.756
	*L	6.577	12.713	2.768	1.933	0.431	1.066	0.358	0.793	0.629	0.186	8.164	0.890	0.215	1.961	3.065
	*T	20.816*	40.237*	7.331*	5.104*	1.137*	2.811*	0.946*	2.094*	1.661*	0.493*	21.577*	2.486*	0.601*	5.482*	8.569*
FEB	*F	7.553	14.599	2.990	2.188	0.485	1.202	0.406	0.895	0.712	0.211	9.090	0.973	0.236	2.161	3.371
	*M	7.911	15.292	3.034	2.194	0.487	1.206	0.407	0.898	0.714	0.212	9.152	0.988	0.240	2.192	3.419
	*L	6.440	12.449	2.459	1.785	0.396	0.979	0.330	0.729	0.581	0.172	7.432	0.789	0.192	1.751	2.732
	*T	21.904*	42.340*	8.483*	6.167*	1.367*	3.387*	1.143*	2.523*	2.007*	0.595*	25.673*	2.750*	0.668*	6.104*	9.521*
MAR	*F	9.072	17.536	3.523	2.540	0.563	1.388	0.469	1.035	0.823	0.245	10.586	0.908	0.219	2.013	3.140
	*M	9.188	17.761	3.354	2.584	0.571	1.412	0.477	1.054	0.836	0.249	10.538	0.495	0.120	1.098	1.713
	*L	10.195	19.706	2.611	2.831	0.625	1.547	0.522	1.154	0.916	0.273	10.480	0.101	0.024	0.224	0.350
	*T	28.455*	55.003*	9.488*	7.955*	1.760*	4.348*	1.467*	3.243*	2.575*	0.767*	31.604*	1.504*	0.363*	3.335*	5.203*
APR	*F	9.015	17.426	1.534	2.278	0.507	1.249	0.421	0.929	0.741	0.219	7.877	0.0	0.0	0.0	0.0
	*M	6.439	12.447	0.378	1.193	0.266	0.654	0.220	0.487	0.388	0.115	3.700	0.0	0.0	0.0	0.0
	*L	3.864	7.468	0.0	0.195	0.043	0.107	0.036	0.080	0.064	0.019	0.544	0.0	0.0	0.0	0.0
	*T	19.318*	37.342*	1.911*	3.666*	0.816*	2.011*	0.677*	1.495*	1.193*	0.352*	12.121*	0.0 *	0.0 *	0.0 *	0.0 *
MAY	*F	1.273	2.461	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.575	0.139	1.276	1.991
	*M	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.141	0.276	2.531	3.949
	*L	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.605	0.388	3.560	5.552
	*T	1.273*	2.461*	0.0 *	0.0 *	0.0 *	0.0 *	0.0 *	0.0 *	0.0 *	0.0 *	0.0 *	3.321*	0.803*	7.367*	11.491*
JUN	*F	2.935	5.673	1.303	1.193	0.265	0.653	0.220	0.487	0.387	0.115	4.623	0.609	0.148	1.356	2.113
	*M	5.940	11.483	2.630	2.391	0.531	1.309	0.442	0.975	0.775	0.230	9.284	0.631	0.153	1.405	2.188
	*L	7.890	15.252	3.486	3.100	0.689	1.698	0.573	1.264	1.004	0.299	12.113	0.720	0.174	1.605	2.500
	*T	16.765*	32.407*	7.419*	6.684*	1.485*	3.661*	1.236*	2.726*	2.165*	0.644*	26.020*	1.961*	0.474*	4.366*	6.801*
JUL	*F	8.488	16.407	3.393	1.998	0.446	1.093	0.370	0.817	0.652	0.194	8.963	0.941	0.228	2.093	3.262
	*M	8.818	17.045	2.715	1.954	0.436	1.069	0.361	0.798	0.637	0.189	8.160	0.945	0.229	2.102	3.276
	*L	8.678	16.775	3.212	2.395	0.532	1.309	0.443	0.976	0.780	0.231	9.879	1.065	0.258	2.367	3.690
	*T	25.985*	50.228*	9.321*	6.348*	1.415*	3.471*	1.173*	2.592*	2.069*	0.614*	27.003*	2.951*	0.715*	6.562*	10.228*
AUG	*F	3.351	6.478	1.301	1.008	0.223	0.553	0.186	0.407	0.322	0.096	4.097	0.454	0.111	1.015	1.580
	*M	3.829	7.402	1.398	1.016	0.225	0.557	0.188	0.411	0.325	0.097	4.216	0.470	0.115	1.054	1.640
	*L	4.424	8.552	1.587	1.164	0.259	0.638	0.215	0.473	0.374	0.112	4.821	0.504	0.123	1.129	1.756
	*T	11.605*	22.433*	4.286*	3.188*	0.707*	1.749*	0.589*	1.291*	1.020*	0.305*	13.134*	1.428*	0.349*	3.199*	4.976*
SEP	*F	3.746	7.240	1.394	1.029	0.231	0.568	0.191	0.419	0.334	0.099	4.265	0.624	0.151	1.380	2.155
	*M	3.877	7.494	1.445	1.069	0.240	0.591	0.198	0.436	0.347	0.102	4.428	0.296	0.072	0.654	1.021
	*L	3.959	7.652	1.452	1.055	0.237	0.583	0.195	0.430	0.342	0.101	4.394	0.026	0.006	0.058	0.091
	*T	11.581*	22.386*	4.291*	3.153*	0.708*	1.742*	0.585*	1.285*	1.022*	0.302*	13.088*	0.946*	0.229*	2.091*	3.267*
OCT	*F	4.997	9.660	2.011	1.542	0.344	0.846	0.286	0.632	0.500	0.150	6.310	0.0	0.0	0.0	0.0
	*M	3.527	6.819	1.266	0.771	0.172	0.423	0.143	0.316	0.250	0.075	3.416	0.0	0.0	0.0	0.0
	*L	2.183	4.219	0.532	0.106	0.024	0.058	0.020	0.043	0.034	0.010	0.828	0.0	0.0	0.0	0.0
	*T	10.707*	20.697*	3.809*	2.419*	0.539*	1.327*	0.448*	0.991*	0.785*	0.235*	10.553*	0.0 *	0.0 *	0.0 *	0.0 *
NOV	*F	0.722	1.395	0.004	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.004	0.299	0.072	0.661	1.032
	*M	0.0	0.0	0.222	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.222	0.594	0.144	1.318	2.056
	*L	0.0	0.0	1.589	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.589	0.766	0.185	1.701	2.653
	*T	0.722*	1.395*	1.815*	0.0 *	0.0 *	0.0 *	0.0 *	0.0 *	0.0 *	0.0 *	1.815*	1.659*	0.401*	3.680*	5.741*
DEC	*F	1.835	3.548	1.862	0.753	0.187	0.413	0.139	0.307	0.244	0.073	3.959	0.590	0.142	1.313	2.045
	*M	3.813	7.370	2.393	1.558	0.346	0.853	0.288	0.636	0.506	0.150	6.730	0.582	0.140	1.296	2.018
	*L	5.757	11.129	2.422	2.275	0.505	1.243	0.419	0.928	0.738	0.219	8.749	0.716	0.172	1.590	2.478
	*T	11.405*	22.046*	6.677*	4.586*	1.018*	2.509*	0.846*	1.872*	1.488*	0.442*	19.438*	1.887*	0.455*	4.199*	6.541*
ANNUAL		180.536	348.975	44.331	49.270	10.951	27.015	9.111	20.113	15.985	4.749	202.026	20.895	5.058	46.385	72.338

TABLE 3-14.

DIVERSION WATER REQUIREMENT BY LATERAL (WITH EFFECTIVE RAINFALL) (5)

(UNIT = MCM)

PERIOD	MARIS DIVERSION DAM: MARIS MAIN CANAL (53889HA)	MACANAO EAST+WEST (6040HA)	MARIS DIVERSION DAM: RETURN FL LAT.A-2,4,8 (5790HA)	MARIS DIVERSION DAM: NORTH DIVERSION (7074HA)	SIFFU EAST EXTENSION (6600HA)	BALIGATAN DIVERSION: SOUTH HIGH CANAL (9580HA)	BALIGATAN DIVERSION: OSCARIZ MAIN CANAL (3100HA)	SIFFU DIVERSION: NORTH MAIN CANAL (2959HA)	SIFFU DIVERSION: SOUTH MAIN CANAL (8160HA)
JAN *F	58.762	6.796	< 12.376>	7.364	6.870	7.652	2.476	2.748	6.606
*M	59.311	5.935	< 12.432>	6.876	6.415	7.903	2.557	2.756	6.807
*L	66.081	7.000	< 13.738>	6.577	6.136	9.262	2.997	3.065	8.164
*T	184.155*	19.731*	< 38.546>*	20.816*	19.421*	24.817*	8.030*	8.569*	21.577*
FEB *F	70.415	7.673	< 13.674>	7.553	7.047	10.250	3.317	3.371	9.090
*M	64.009	7.752	< 11.979>	7.911	7.381	10.388	3.361	3.419	9.152
*L	39.199	6.279	< 6.575>	6.440	6.009	8.410	2.721	2.731	7.432
*T	173.623*	21.704*	< 32.228>*	21.904*	20.436*	29.047*	9.399*	9.521*	25.673*
MAR *F	37.239	8.727	< 4.819>	9.072	8.464	12.043	3.897	3.140	10.586
*M	17.641	8.839	< 0.961>	9.188	8.573	11.635	3.765	1.713	10.538
*L	6.931	9.714	< 0.0 >	10.195	9.512	9.719	3.145	0.350	10.480
*T	61.811*	27.279*	< 5.780>*	28.455*	26.548*	33.398*	10.807*	5.203*	31.604*
APR *F	3.850	7.869	< 0.0 >	9.015	8.411	6.740	2.181	0.0	7.877
*M	9.875	4.556	< 1.682>	6.439	6.008	3.370	1.091	0.0	3.700
*L	46.157	1.405	< 11.558>	3.864	3.605	0.421	0.136	0.0	0.544
*T	59.883*	13.830*	< 13.241>*	19.318*	18.024*	10.531*	3.408*	0.0 *	12.121*
MAY *F	61.772	0.066	< 12.835>	1.273	1.188	0.0	0.0	1.991	0.0
*M	79.662	1.094	< 15.906>	0.0	0.0	1.158	0.375	3.949	0.0
*L	87.725	7.760	< 15.753>	0.0	0.0	8.104	2.622	5.552	0.0
*T	229.159*	8.920*	< 44.494>*	1.273*	1.188*	9.262*	2.997*	11.491*	0.0 *
JUN *F	41.537	7.767	< 8.927>	2.935	2.738	8.346	2.701	2.113	4.623
*M	44.249	8.433	< 9.446>	5.940	5.542	10.478	3.391	2.188	9.284
*L	46.712	6.852	< 9.773>	7.890	7.362	12.380	4.006	2.500	12.113
*T	132.498*	23.052*	< 28.146>*	16.765*	15.642*	31.204*	10.097*	6.801*	26.020*
JUL *F	69.755	7.123	< 14.395>	8.488	7.919	9.046	2.927	3.262	8.963
*M	71.172	7.661	< 14.558>	8.818	8.227	9.471	3.065	3.276	8.160
*L	79.850	8.739	< 16.201>	8.678	8.097	11.170	3.614	3.690	9.879
*T	220.776*	23.523*	< 45.154>*	25.985*	24.243*	29.687*	9.607*	10.228*	27.003*
AUG *F	44.915	4.317	< 11.265>	3.351	3.127	4.714	1.525	1.580	4.097
*M	41.665	4.450	< 10.167>	3.829	3.573	4.872	1.576	1.640	4.216
*L	32.438	5.046	< 7.191>	4.424	4.128	5.541	1.793	1.756	4.821
*T	119.018*	13.813*	< 28.623>*	11.605*	10.828*	15.127*	4.895*	4.976*	13.134*
SEP *F	27.371	5.090	< 4.068>	3.746	3.495	5.617	1.817	2.155	4.265
*M	9.603	4.413	< 0.554>	3.877	3.617	5.173	1.674	1.021	4.428
*L	1.857	2.737	< 0.0 >	3.959	3.693	3.807	1.232	0.091	4.394
*T	38.831*	12.240*	< 4.622>*	11.581*	10.805*	14.597*	4.724*	3.267*	13.088*
OCT *F	0.591	2.106	< 0.0 >	4.997	4.662	5.002	1.619	0.0	6.310
*M	3.873	0.213	< 0.800>	3.527	3.291	2.223	0.719	0.0	3.416
*L	28.969	0.0	< 6.314>	2.183	2.036	0.137	0.044	0.0	0.828
*T	33.433*	2.319*	< 7.114>*	10.707*	9.990*	7.362*	2.382*	0.0 *	10.553*
NOV *F	28.871	0.0	< 5.902>	0.722	0.673	0.0	0.0	1.032	0.004
*M	36.378	0.0	< 7.316>	0.0	0.0	0.640	0.207	2.056	0.222
*L	37.153	0.0	< 6.836>	0.0	0.0	2.284	0.739	2.653	1.589
*T	102.402*	0.0 *	< 20.055>*	0.722*	0.673*	2.924*	0.946*	5.741*	1.815*
DEC *F	44.419	2.221	< 10.429>	1.835	1.712	5.457	1.766	2.045	3.959
*M	47.343	4.814	< 10.796>	3.813	3.557	7.034	2.276	2.018	6.730
*L	55.524	7.380	< 12.134>	5.757	5.371	9.455	3.059	2.478	8.749
*T	147.286*	14.415*	< 33.359>*	11.405*	10.641*	21.945*	7.101*	6.541*	19.438*
ANNUAL	1502.873	180.626	<301.362>	180.536	168.439	229.901	74.394	72.338	202.026

END OF GO.SEVERITY CODE=10

(b) Water Duty at On-farm Basis

Unit area of irrigation at on-farm level so called rotational area is 20 - 30 ha on an average. Distribution of irrigation water at on-farm level will be discussed in two stages of paddy cultivation as mentioned below;

Land Soaking and Preparation Stages

According to the proposed cropping pattern, land soaking and preparation periods extend from the middle of October to the middle of February for dry season paddy and from the middle of April to the end of July for wet season paddy. Water supply during these periods is planned with rotation irrigation of seven days by rotation unit having an average area of four to six hectares. According to NIA O/M Manual, the maximum unit water duty during these periods is 3.2 lit/sec/ha to 4.0 lit/sec/ha for rice class land and 6.4 lit/sec/ha to 8.0 lit/sec/ha for dual class land.

Normal Crop Growth Stage

The crop growth stage of a paddy extends from the end of November to the beginning of May for dry season paddy and from the end of May to the beginning of November for wet season paddy respectively. Irrigation water supply during these periods is planned to be simultaneous irrigation. The maximum unit water duty during these periods is 0.8 lit/sec/ha to 1.8 lit/sec/ha for rice class land and 1.6 lit/sec/ha to 4.0 lit/sec/ha for dual class land based on the above mentioned O/M Manual.

MEASUREMENT OF FIELD WATER REQUIREMENT

1. Selection of Measuring Sites

Percolation rates vary according to soil and groundwater conditions. Grouping of land and measuring points are, therefore, determined based upon soil and groundwater investigation, and in most cases, the rates are given as follows:

Number of Measuring Points

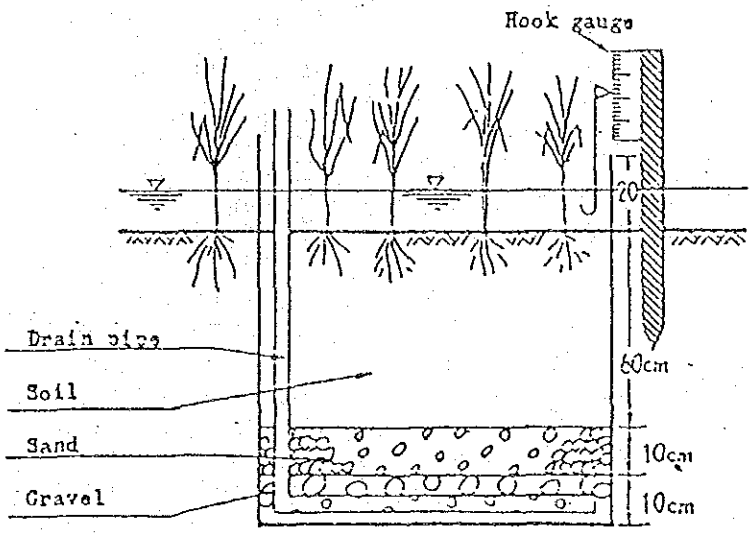
Irrigation Block (ha)	Number of Measuring Points
0 - 60	3
60 - 150	4
150 - 300	5
300 - 500	7

2. Measurement of Evapotranspiration

A water-tight tank so illustrated below will be used with the case being given to the following points;

- The size of the tank should not be smaller than 0.5 m in diameter.
- In order to provide the soil in the tank with the same rate of percolation as the actual field, water should occasionally be sucked up from the lower part and measured.
- The tank should be set more than one meter away from the border ridges.

Evapotranspiration Measuring Tank-Lysimeter

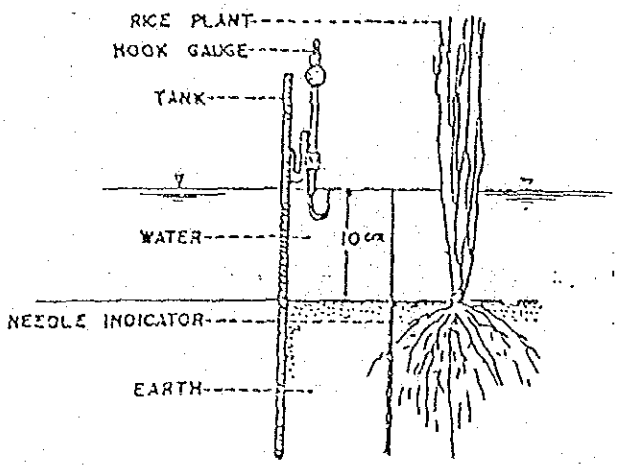


3. Measurement of Percolation Rate

Percolation is divided into two types, namely horizontal and vertical. Their percolation rates are affected by many factors, such as texture of soil, depth of top soil, groundwater level, etc.

Horizontal or levee percolation usually predominate in terraced paddy fields where the elevation of each field differs considerably. Some studies on horizontal percolation with special emphasis on potential flow lines show that horizontal percolation is 3 to 10 times greater than vertical one. However, much of the water "lost" in horizontal percolation is available for reuse because it is either collected in the drainage ditches or flows into an adjacent field. In principle, percolation should be determined by actual measurement.

Direct field measurement of field water requirements, that is, daily decrease in water depth, will be measured in principle throughout the entire irrigation period. The water level is measured with a hook gauge or scale (see the following figure) once a day, usually at 9 A.M.



This measurement indicates the total field water requirement, i.e. the sum of evapotranspiration and percolation (both horizontal and vertical). As the former is considered constant to some extent and can be determined by various methods, the percolation rate can be obtained easily. This method is widely practised to determine the field water requirement.

4. Measuring Records

Daily observations of evapotranspiration and percolation rates would be tabulated in Form 3-13.

FORM 5-13. MEASUREMENT OF PERCOLATION RATE

Location:

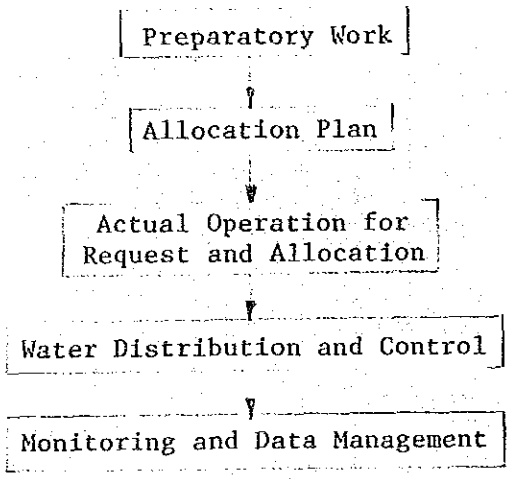
(unit: mm/day)

Month Day	Rainfall (A)	Evapotranspiration				Field Water Requirement				Percolation Rate
		Read (1)	Read (2)	Difference (B)	(C)=(B)-(A)	Read (1)	Read (2)	Difference (B)	(E)=(D)-(A)	(F)=(E)-(C)
1/1										
2										
3										
4										
5										
6										
7										
8										
24										
25										
26										
27										
28										
29										
30										
31										
				Ave.=				Ave.=		Ave.=

3.4.3. Irrigation Water Allocation Plan

(1) Procedure of Irrigation Water Allocation

General procedure of irrigation water allocation, as compiled in Figure 3-7, will be summarized as follows:



(2) Preparatory Work

Main purpose of the preparatory work is the decision of Irrigation Diagram. The activities of the work is as follows and the flow chart for water allocation procedure is illustrated in Figure 3-8.

a. Water Master (WM) estimates, on turnout basis, service area to be irrigated accurately by use of cadastral maps.

b. WM summarizes Definitive Service Area (DSA) on irrigation block basis, formulated on the basis of canal flow diagram in consideration of area commanded by major check & head gates and division boundary.

c. Area Engineer (AE) summarizes and corrects DSA on division basis.

FIGURE 3-7. FLOW CHART OF IRRIGATION WATER SUPPLY FOR THE MARIIS

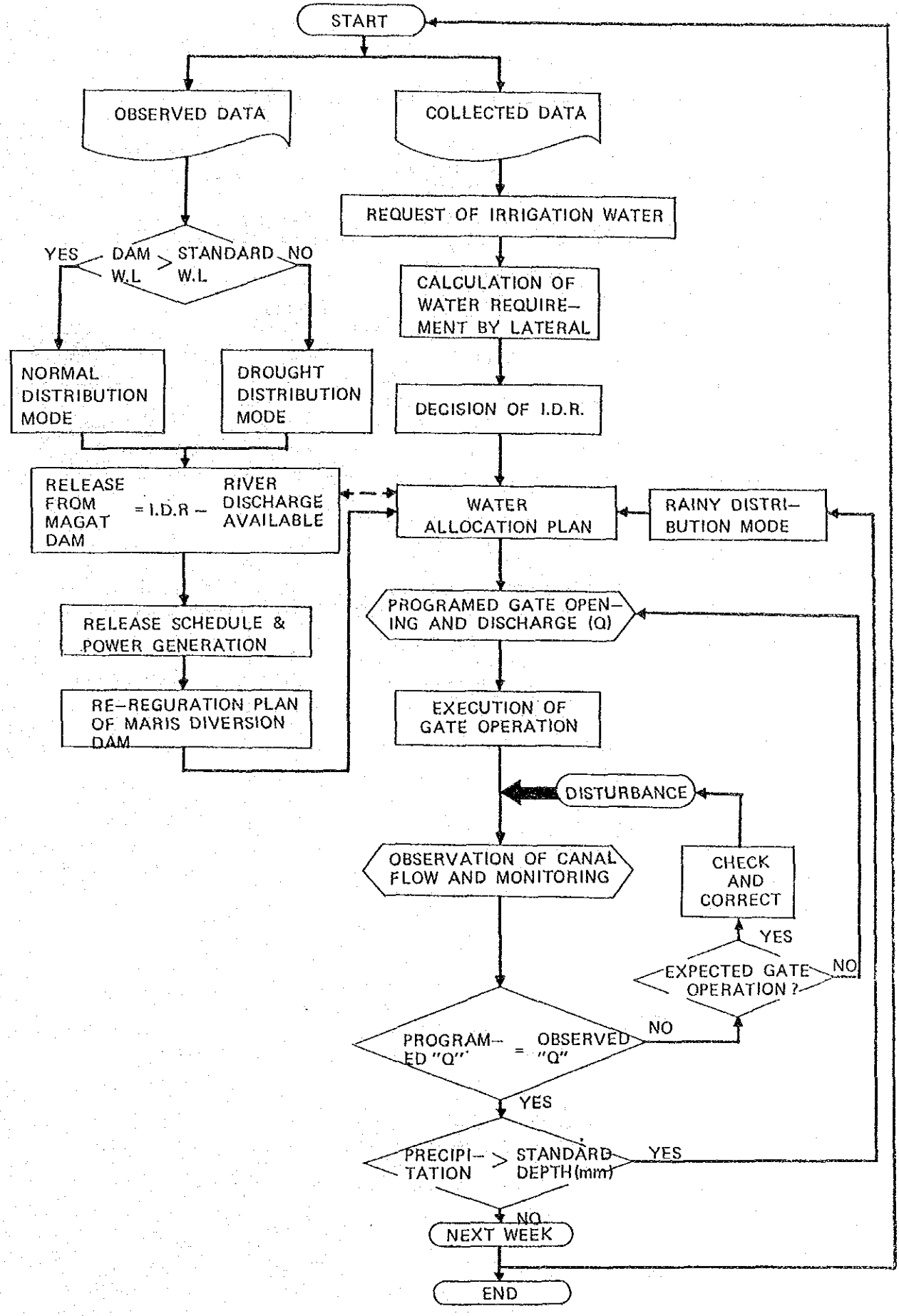
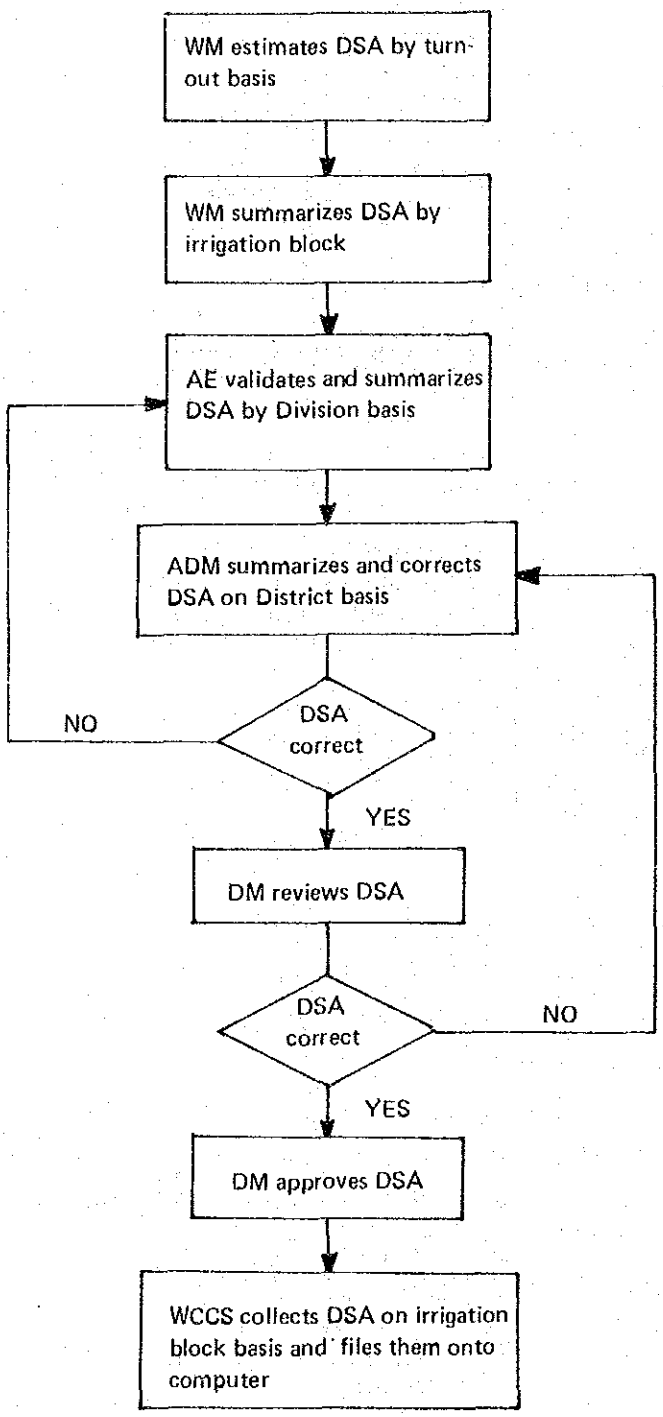


FIGURE 3–8. FLOW CHART FOR PREPARATORY WORK



d. Assistant District Manager (ADM) summarizes and corrects DSA on district basis.

e. District Manager (DM) reviews and approves and submits them to WCCS, Head Office.

f. WCCS collects DSA on irrigation block basis, arranges and files them onto computer disk memory.

(3) Allocation Plan

The allocation plan shall be made according to the request from FIG or farmers. The procedure of the work is shown in Figure 3-9 according to the following activities;

a. Request and allocation plan of irrigation water shall be prepared at least one month before coming cropping season for each major canal systems. IA prepares irrigation area and schedule to be requested (IAR) by FIG and/or farmers.

b. WM reviews and adjusts area and schedule requested by IA, and summarizes them on irrigation block basis.

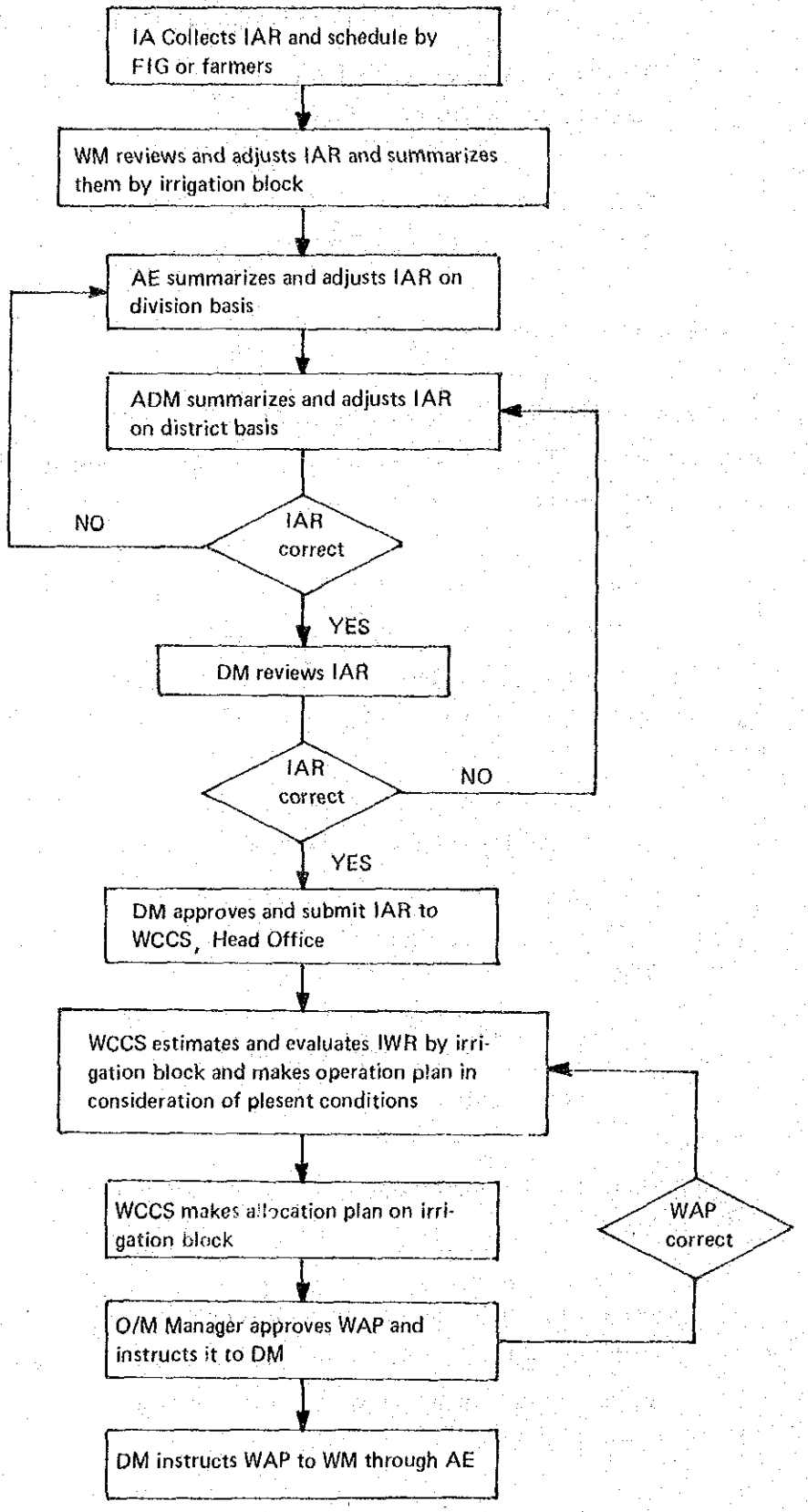
c. Area Engineer summarizes and adjusts them on division basis.

d. Assistant District Manager summarizes and adjusts them on district basis.

e. District Manager reviews and approves and submits them to WCCS.

f. WCCS estimates promptly and accurately irrigation requirement on irrigation block basis at major check/head gates by means of computer processings.

FIGURE 3-9. FLOW CHART FOR ESTIMATION OF ALLOCATION PLAN



g. WCCS adjusts irrigation water requirement estimated in consideration of effective rainfall available, existing storage in the Magat reservoir and runoff expected from rivers and creeks.

h. Based on above adjustment Operation Manager decides the allocation plan of irrigation water on irrigation block basis as well of outflow at reservoir and diversion dams on weekly basis, and instructs it to each district manager.

i. District Manager instructs WM and IA to keep programmed allocation of irrigation water as scheduled in coming cropping season.

(4) Actual Operation for Request and Allocation

The prepared irrigation plans in operation levels may or may not be followed depending on actual field conditions. The target area to be under irrigation for any period may be under estimated or over estimated as there are several variables that directly or indirectly influence the rate of farming activities.

The process therefore will be one where irrigation water will be requested by each District to the Operation and Engineering Division on a weekly basis and the available supply allocated and distributed to the different laterals. Because of the short turn-around period, the WM must religiously monitor the weekly progress of farming activities in their area coverage to the Area Engineers every Thursday. The Area Engineers will review, correct and summarize the request for the evaluation of the Operation Engineer and District Manager. The District's water request will be forwarded to the Engineering and Operation Division for evaluation the following day, Friday, after which the water request will be forwarded to the Dam Division and each District.

The release and control of water will be based on the computed water duty by the WCCS. The flow chart of complete process is shown in Figure 3-10 and each activity is explained item by item as follows:

a. WM monitors progress of farming activities under irrigation every week and reports stage-wise area to be irrigated in coming week to AE by Thursday morning.

b. AE adjusts and summarizes the area on Division basis, and submits them to ADM by Thursday evening.

c. ADM validates and summarizes the area on District basis, and submits them to DM by Friday morning.

d. DM reviews and submits the District's water request to WCCS, OED for estimation of the water allocation by Friday morning.

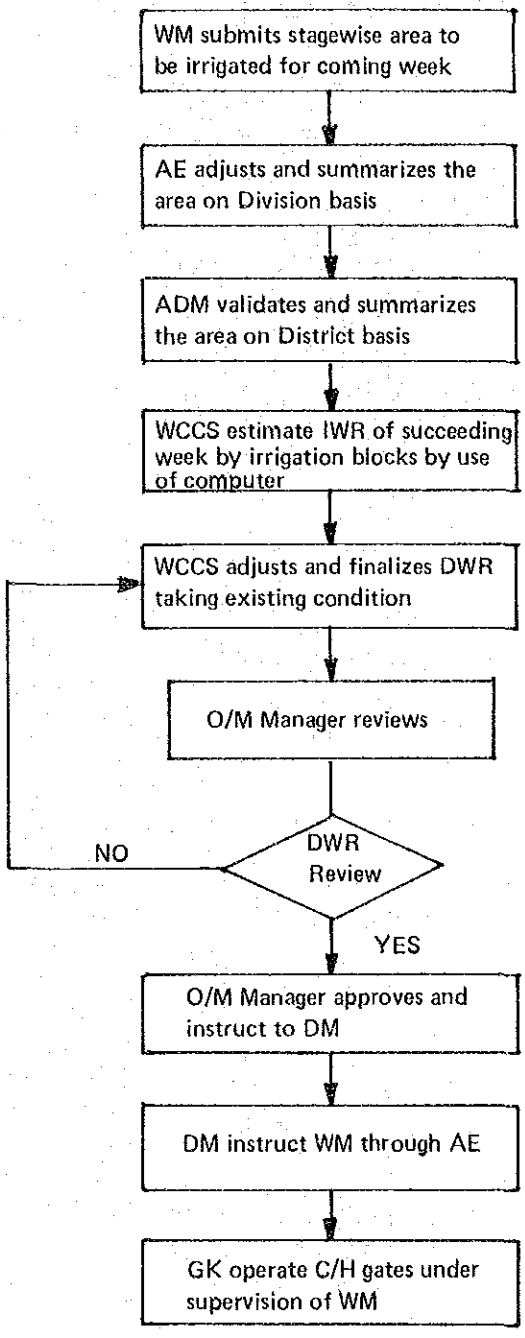
e. WCCS estimates irrigation water requirement of succeeding week on irrigation block basis by use of computer.

f. WCCS then adjusts computed results and finalizes diversion water requirement on irrigation block basis taking the existing status of water balance such as storage in the dam, available flow in rivers and effective rainfall on the field into consideration based on revised computation. Diversion water requirement is accumulated at major check/head gates and also at important point of discharge control by Friday evening, and submits them to O/M Manager for approval.

g. O/M Manager reviews and approves the operation plan of Diversion Requirement (DR), and instruct it to DM in Monday morning.

h. DM instruct the operation plan to WM through AE.

FIGURE 3–10. FLOW CHART FOR ACTUAL REQUEST AND ALLOCATION



FORM 3-14. DEFINITIVE SERVICE AREA ON TURN-OUT (FIG) BASIS FOR ____ CROP, 19___

District:
Division:

Irrigation Block No. (1)	Name of Main Lateral Canal (2)	Turnout No. (3)	Projected Area (Ha) (4)	Irrigated in last year(ha)		Programed Area (ha)		Programed Irrigation Schedule	
				Wet Crop (5)	Dry Crop (6)	Wet Crop (7)	Dry Crop (8)	Starting Date(9)	Working Period(Week)(10)
Sub-Total									
Sub-Total									

Notes: 1. Items (1) to (6)/(7) are to be filled in previously by WCCS, and then this form is to be distributed to Water Master earlier than 70 days before irrigation practice.
2. Water Master estimates the definitive service areas to be irrigated on turnout basis, summarizes them on irrigation block basis, and submits the form to Area Engineer a latest 60 days before irrigation practice.
3. Anticipated starting date of irrigation(Land Soaking) is to be assigned on Monday.

FORM 3-15. DEFINITIVE SERVICE AREA ON IRRIGATION BLOCK BASIS FOR ___ CROP, 19___

District:
Division:

Irrigation Block		Projected Area(ha) (3)	Irrigated in Last Year(ha)		Programed Area(ha)	
No(1)	Name(2)		Wet Crop(4)	Dry Crop(5)	Wet Crop(6)	Dry Crop(7)
Division Total						

Notes: 1. Items (1) to (5)/(6) are filled in previously by WCCS, and then this form is distributed to Area Engineer earlier than 70 days before irrigation practice.
2. Area Engineer completes the form summarizing definitive service area on Division basis, and submits it to District Manager through Assistant District Manager.
3. District Manager submits the form to WCCS at latest 55 days before irrigation practice.

FORM 3-16. IRRIGATION BLOCK BASIS PROGRAMMED FARMING SCHEDULE FOR ___ CROP, 19____

District:

Division No. (1)	Irrigation Block No. (2)	Projected Irrigation Area (3)	Programed Irrigation Area (4)	Land Soaking		Land Preparation		Crop Maintenance Stage		Terminal Drainage	
				From (5)	TO (6)	From (7)	To (8)	From (9)	To (10)	From (11)	To(12)

Notes: 1. Programed farming schedule is to be prepared by WCCS on the basis of the anticipated starting date of irrigation and working period reported on irrigation block basis by District Office.
2. WCCS prepares the form and distributes it to Area Engineer at latest 45 days before programed irrigation practice.
3. Items (5) to (12) give specified dates of farming practice as shown below;

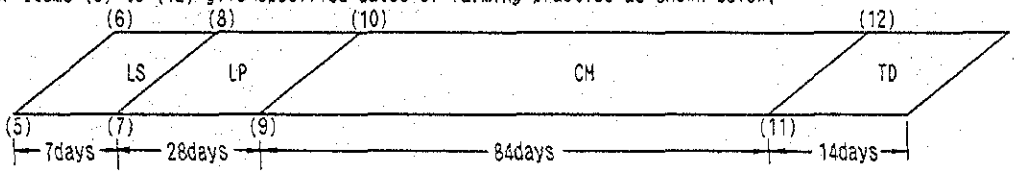


TABLE 3–17. WEEKLY IRRIGATION WATER REQUEST

Chief of FIG: _____ FIG or Turn–out No.: _____

Irrigation Block: _____

Lateral _____

Date:	Name of Turn–out	Service Area (ha)	Lot Parcel No.	Farming Activities (ha)						Irrigation Water Requirement lit/sec	Remarks
				L.S.	L.P	V.S	R.S	T.D	F.L		
FIG or Turn–out Total											

Note: To be submitted regularly every Friday morning to the Area Engineer In-charge.

Submitted by:

_____

Chief of FIG or Turnout

TABLE 3–18. WEEKLY IRRIGATION WATER REQUEST

W. M Name: _____ IRRI. BLOCK NO.: _____

Division No.: _____

Lateral _____

Date:	Name of FIG or Turn–out	Service Area (ha)	Farming Activities (ha)						Irrigation Water Requirement	Remarks
			L.S	L.P	V.S	R.S	T.D	F.L	lit/sec	
Irrigation BlocksTotal										

Note: To be submitted regularly every Friday morning to the Area Engineer In–charge.

Submitted by:

_____ Water Master (W.M)

_____ District Manager

3.4.4. Water Distribution and Application

(1) Water Distribution

The requested irrigation demand will be simultaneously released every Monday. Measures will be taken by the District's field personnel to ensure that all headgates of laterals and sub-laterals are properly operated to prevent any maldistribution in and within the different laterals as a result of either a decrease or increase in the previous week's discharge. By the time deliveries normalized in all laterals, the Hydrologists of each Districts will patrol all lateral headgates of their supply canals to counter-check discharge delivered and give feedback to the Area Engineers/WMs. The time duration for each activity is presented as follows;

a. Districts continue water distribution of IDRs for the week. (Saturday and Sunday)

b. WCCS relays requested IDRs to the Dam which release requested IDRs for the Districts. (Monday)

   WCCS allocates released IDRs, monitors Districts releases and receives feedback.

c. District distributes released IDRs in their area coverage; gives feedback to WCCS. (Monday to Wednesday)

d. WCCS informs the Districts of their actual irrigation efficiencies for the previous week for their information prior to the start of the next requesting cycle. (Wednesday)

(2) Water Control

In case of heavy rain, reduction in supply will be effected. Controls may be done at the turnout, sub-laterals, laterals, main canal or at any combination of two or more flow points depending on the actual flow and maximum operating capacity of the canal. The ideal order of flow reduction starts from the turnout going upstream up to the diversion dam. This, however, is next to automation of irrigation operation which for the moment is complex for our operations man. The reduction process will therefore be done at selective levels preferably starting at the sub-laterals until such time that field personnel acquire the necessary expertise to implement the process methodically.

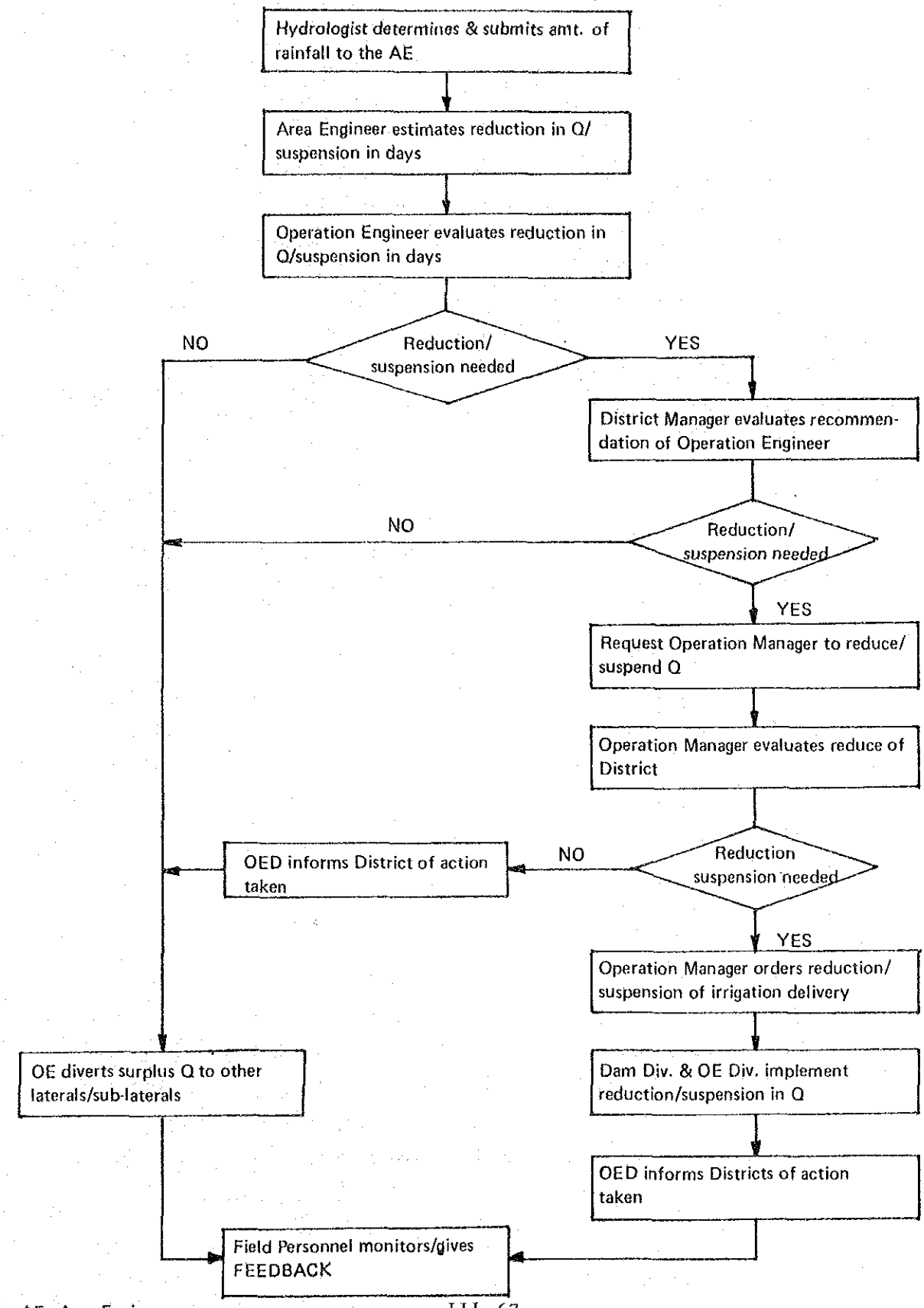
The Area Engineers must have complete knowledge where to divert surplus discharge to another sub-lateral if the amount of surplus can be safely accommodated, otherwise, it will request for the reduction or total suspension, as the case may be, of the discharge in the lateral. Any request for reduction of discharge in the lateral must be forwarded immediately to the Operation and Engineering Division for action the following day. This necessarily will trigger a chain reaction where the discharge in the Main Canal will be correspondingly reduced since water conservation is of primary importance. The conserved water will be temporarily stored in the mini-reservoirs between the main reservoir and the MRIS Dam.

The flow chart of the process is shown in Figure 3-11.

The adoption of irrigation suspension in the MRIIS service area will be based on the following criteria:

Range of previous day rainfall, mm	Rice lands (CWR=7-11 mm/day)	Range of previous day rainfall, mm	Dual class lands (CWR=15-18 mm/day)
8 - 15	1	18 - 29	1
16 - 30	2	above-30	2
Above-31	3		

FIGURE 3–11. FLOW CHART OF REQUEST FOR REDUCTION/ SUSPENSION DUE TO RAINFALL



AE–Area Engineer
OE–Operation Engineer
OED–Operation and Engineering Division

(3) Distribution Method

There are two general methods of water distribution namely, simultaneous and rotational methods. In the first method, water is continuously supplied to the different laterals while in the latter, the delivery of water is rotated either by sections of main canal or by laterals.

In most irrigation projects, MRMP included all farm level facilities and structures were designed based on the rotational method of irrigation by farm ditches. While this method allows for maximum water utilization in the farm, it is patterned after foreign models which the Filipino farmer find hard to jibe with his farm operations.

In the gravity areas, simultaneous water distribution will be implemented except in critical periods where the level or water in the reservoir demands the implementation of the rotational scheme.

In the pump areas where the cost of delivering irrigation water to the farm is much higher compared to the gravity areas, maximum water utilization must be done. The rotational method of water distribution by sections of main canal will therefore be implemented since this method favors a more intensive utilization of both rainfall and irrigation.

(4) Water Application

Water application can be either continuous submergence or intermittent. In the former, a certain level of water is maintained in the paddies 2-3 days after transplanting and drained only 10-14 days before the expected harvest. This method however, inhibit proper aeration of the root zone of crops and will result to a water logged soil which is not the ideal environment for the growth and development of crops. In the latter, water is alternately

introduced to and drained from the farm. The only major objection to this method is that growth of weeds will be encouraged, however, with the present technology in weed control this will not pose a real problem.

The intermitted method of irrigation application will be encouraged among farmers in the service area during the normal irrigation period to prevent the degradation of the soil and maintain its productive capacity.

Partial drainage will likewise be encouraged after the maximum tillering stage to inhibit the grouwth of non-productive tillers.

3.4.5. Procedure of Estimation by Computer

(1) Irrigation Requirement Based on Irrigation Schedule

A computerized sub-system for estimation of irrigation water requirement on the basis of requested schedule of irrigation will be developed in near future, and will be progressed at least one month before the coming cropping season.

(2) Weekly Basis Computerized Sub-system of Irrigation Diversion Water Requirement

The sub-system is developed in order to obtain rapidly and accurately the irrigation diversion at each small unit, on the basis of planted areas of various cropping stages at present under irrigation. In general this kind of computation is simple, but it is no exaggeration to say that manual computation is of time consuming and of no practical use for a large scale irrigation project such as the MRIIS, since an enormous volume of data are to be handled. In estimating the required irrigation diversion of the successive week based on the data reported from each WM. Much time has been consumed to process these data consequently resulting in serious problems that they are not used timely and effectively to manage available water resources in the area. In order to solve the above problem, a series of computer sub-systems by use of a micro computer was developed aiming at smooth and efficient execution of routine procedures needed for water management works.

This sub-system is to support the effective operation of the MRIIS water management system, by means of computing irrigation water requirements at about 650 check-points in the service area. The systems will produce the followings;

1) Weekly irrigation requirement on the basis of planting area by farming stage for about 650 terminal irrigation blocks as given on the Irrigation Diagram.

2) Required canal discharges mainly at the check points on the boundary between WMs.

The system comprises the following three functions;

1) Data entry and master file maintenance
2) Computation of irrigation requirement
3) Output printing

In addition, program size and language used are as below;

Language used : BASIC
Program steps : about 1,500

This system is developed within the limits of the available memory and/or peripheral equipments of the micro computer in the computer section, MRIIS. It is so recommendable to improve the system as a whole inclusive of language used, when a large scale computer will be introduced in future.

a. System Configulation

In order to operate the system, it is required to prepare "MASTER FILE" for registration of information regarding service area. "UNIT WATER REQUIREMENT FILE" and "IRRIGATION DIAGRAM FILE", in addition to the "BASIC PROGRAM".

a-1. Entire service area is divided into about 650 irrigation blocks and informations concerning areal condition on each irrigation block are registered as the MASTER FILE on the hard disk memory. The MASTER FILE is defined as direct access file, having the following structure.

Structure of Master File

Rec Key	Area Name	Acss Poit	Area	Req. Type	Elmt No.	Successive Week Plat'g Area (ha)						Irrigation Requirement			
						LS	LP	VS	RS	TD	FL	LS	LP	VS	RS
4co	12ch	3col		2col	3col										

Where;

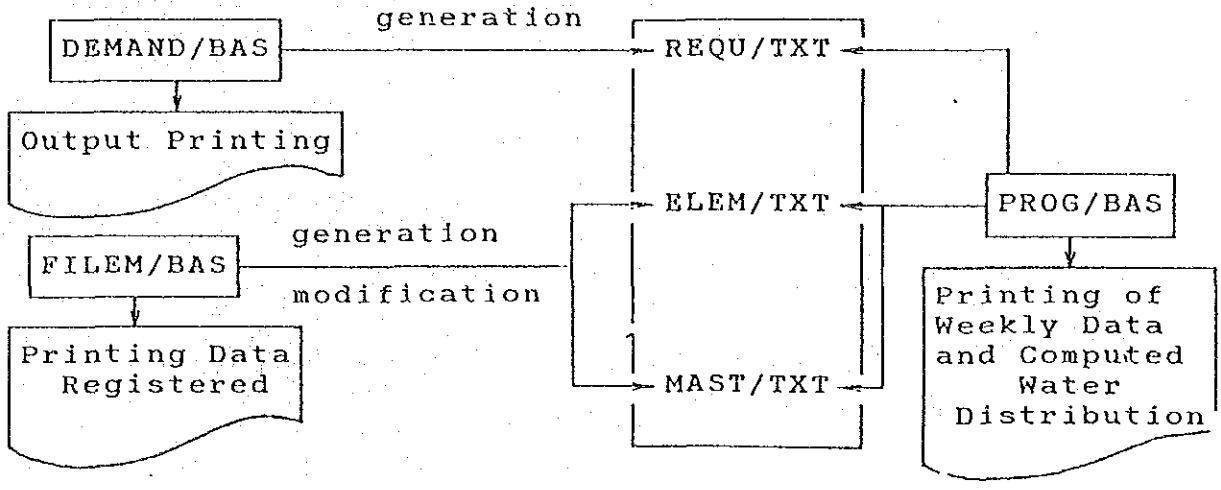
Record Key : Key number appended to each irrigation block
Area Name : Name appended to each irrigation block on the irrigation diagram
Access Point : Pointer to show how each record is connected, indicating the following access record
Area : Acreage (ha) of irrigation block
Unit Requirement Type : 50 types of unit irrigation requirement prepared in O/M Manual
Element Number: Element number to which irrigation area belongs, where an element is defined as a canal system lying between check points on the WM boundary

a-2. 50 types of unit irrigation requirement are being prepared for main and lateral canal depending on canal and soil type, and are registered on the hard disk memory as the direct access file in terms of liter/sec/ha by farming stage. This means that the program "DEMAND/BAS" for computation of unit irrigation requirement must be re-processed any time on the occasion of modification of cropping schedule.

a-3. Irrigation Diagram File

From the viewpoint of water management, it is needed to inspect the flowing discharge in canals at the important check points. Check points are mainly selected on the WM boundary. In this system, canals lying between check points are defined as an element and the area commanded by this element is considered as the irrigation block. Names are attached to each element comprising IRRIGATION DIAGRAM FILE.

Program and file relationships are visualized as follows;



b-2. Operation Procedure

1) The following 6 files are already generated and stored on a floppy disk;

"DEMAND/BAS": Program for computation of unit irrigation water requirement

"FILEM/BAS" : Program for file maintenance

"PROG/BAS" : Program for weekly data entry and computation of required water distribution

"REQU/TXT" : Data file for unit irrigation requirement of 50 types

"ELEM/TXT" : Data file for element name

"MAST/TXT? : Master file for various data and information peculiar to each irrigation block

Programs are executable on floppy disk base, however it is recommendable first to copy all files on the hard disk memory.

ii) To copy files from floppy to hard disk

- After power on, use the following system command;
  COPY DEMAND/BAS TO DEMAND/BAS: 4

- The above command finds the file "DEMAND/BAS" on floppy disk and duplicates it to the hard disk, to which reference No. "4" is assigned, with the same file name

- Repeat the same procedure for all files.

iii) To execute the programs

- Input the following command to get BASIC MODE.
  BASIC -F:n
  Where, -F:n designates the maximum number of file to be opened during program execution. The value "n" is taken for each program as;
  For "DEMAND/BAS" ... n = 1
  For "FILEM/BAS" .... n = 1
  For "PROG/BAS" ..... n = 3

- Load program as under;
  LOAD " PROG/BAS:4"
  Where "4" indicates to load the program from the device assigned as "4".

b. Operation Manual

b-1. Programs are divided into 3 parts;

i) Demand/Bas : Computes unit irrigation requirement and generates data file "REQU/TET". Program is processed on the occasion either tile destroyed or cropping schedule modified.

ii) Filem/Bas : Modifies and/or prints the records wrote on the master file "MAST/TXT" in which Area Name, Acreage, Unit Irrigation Requirement Type and Element No. are registered, and the record stored on the "ELEM/TXT" in which element name is wrote.

iii) Prog/Bas : Computes irrigation water requirement based on the condition given on the above files; REQU/TXT, ELEM/TXT and MAST/TXT. After initializing, following functions are select.

- Data Entry ... To input weekly planting area for each irrigation block and at the same time computes irrigation water requirement and stores it on the file "MAST/TXT"

- Editing of Entered Data ... To edit and modify inputted data

- Printing of Entered Data ... To print inputted data

- Execution of Water Distribution Program ... To summarize computed results and to print them

- End of Work ... Exit of system

- Execute program as;

  RUN

  The program provides a menu to edit data inputted, and will not proceed to the next step if logical errors are included in the inputted data. In this connection, use keys to move cursor.

  When printing function is selected, message will be displayed asking whether the printer is ready or not. To start printing, enter a character "Y", any key on the keyboard such as " ", as "Q" in order, with the printer head adjusted at the top end of printing sheet.

  As shown in the flow chart, program will process the data immediately and the processed data will update the file after once the areal data under consideration were inputted and "ENTER/RETURN" key was pressed. Accordingly in case of the interruption of either intensional or accidental such as power stoppage, the processings can be continued consecutively after initialization of the system.

  In this connection press "BREAK" for intentional interruption.

c. File Structure

c-1. "REQU/TXT"

Data for a type of unit water requirement comprise twelve months' requirements for four farming stages. 12 months' requirements for one farming stage forms one record. Consequently record length is 12 x 4bytes = 48 bytes. Records registered in the file are as under;

1st record	type-1	LS-stage	12 months unit requirement
2nd record	-1	LP-stage	-do-
3rd record	-1	VS-stage	-do-
4th record	-1	RS-stage	-do-
5th record	-2	LS-stage	-do-
6th record	-2	LP-stage	-do-
7th record	-2	VS-stage	-do-
8th record	-2	RS-stage	-do-
.	.	.	
.	.	.	
.	.	.	
197th record	-50	LS-stage	-do-
198th record	-50	LP-stage	-do-
199th record	-50	VS-stage	-do-
200th record	-50	RS-stage	-do-

c-2. "ELEM/TXT"

Name of each element is record in the file, a record comprising 15 bytes. Record No. corresponds to element No.

c-3. "MAST/TXT"

Record format is as below;

RECORD KEY	2 bytes
AREA NAME	15
ACCESS POINT	2
AREA (ha)	4
UNIT REQUIREMENT TYPE	2
NO. OF ELEMENT	2
LAND SOAKING AREA	4
LAND PREPARATION AREA	4
VEGETATIVE STAGE AREA	4
REPRODUCTIVE STAGE AREA	4
TERMINAL DRAINAGE AREA	4
FALLOW LAND AREA	4
DEMAND FOR LAND SOAKING	4
DEMAND FOR LAND PREPARATION	4
DEMAND FOR VEGETATIVE STAGE	4
DEMAND FOR REPRODUCTIVE SDTAGE.....	4
TOTAL	67 bytes

FIGURE 3-12. GENERAL FLOW OF PROG/BAS

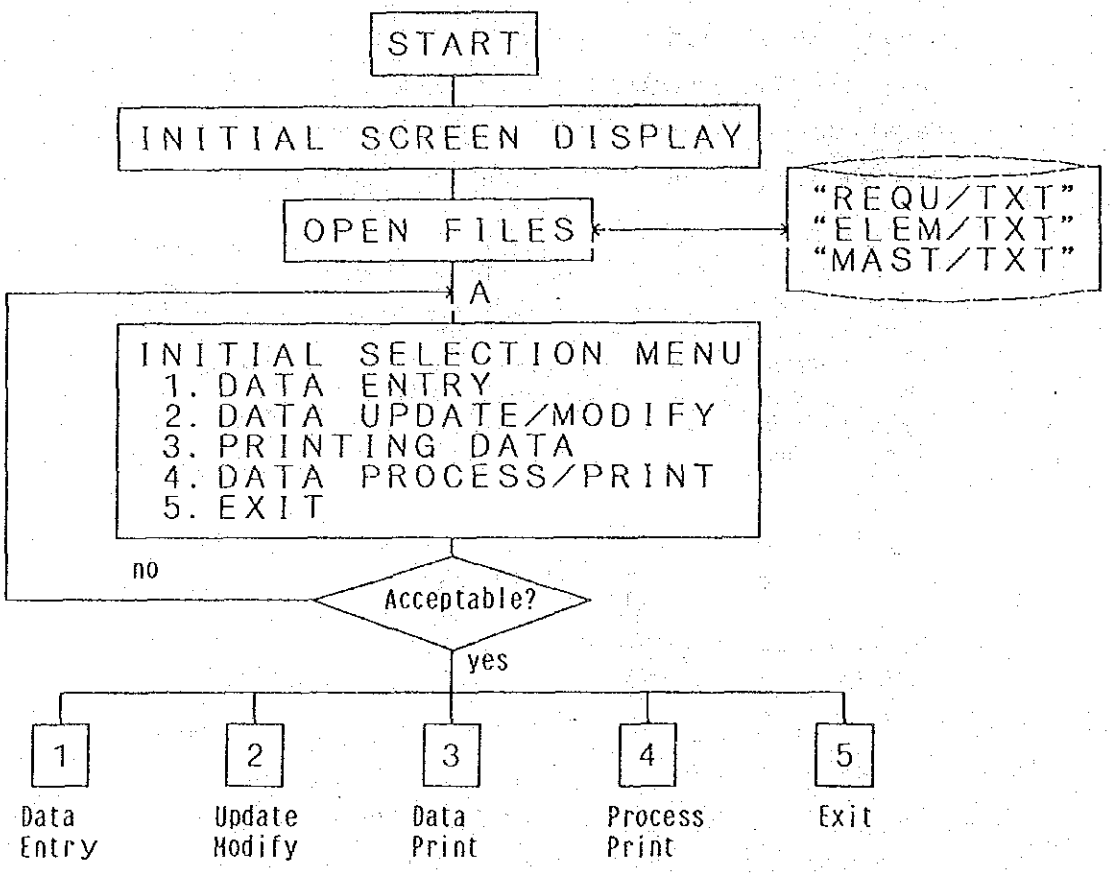


FIGURE 3-13. DATA ENTRY SUB-FLOW

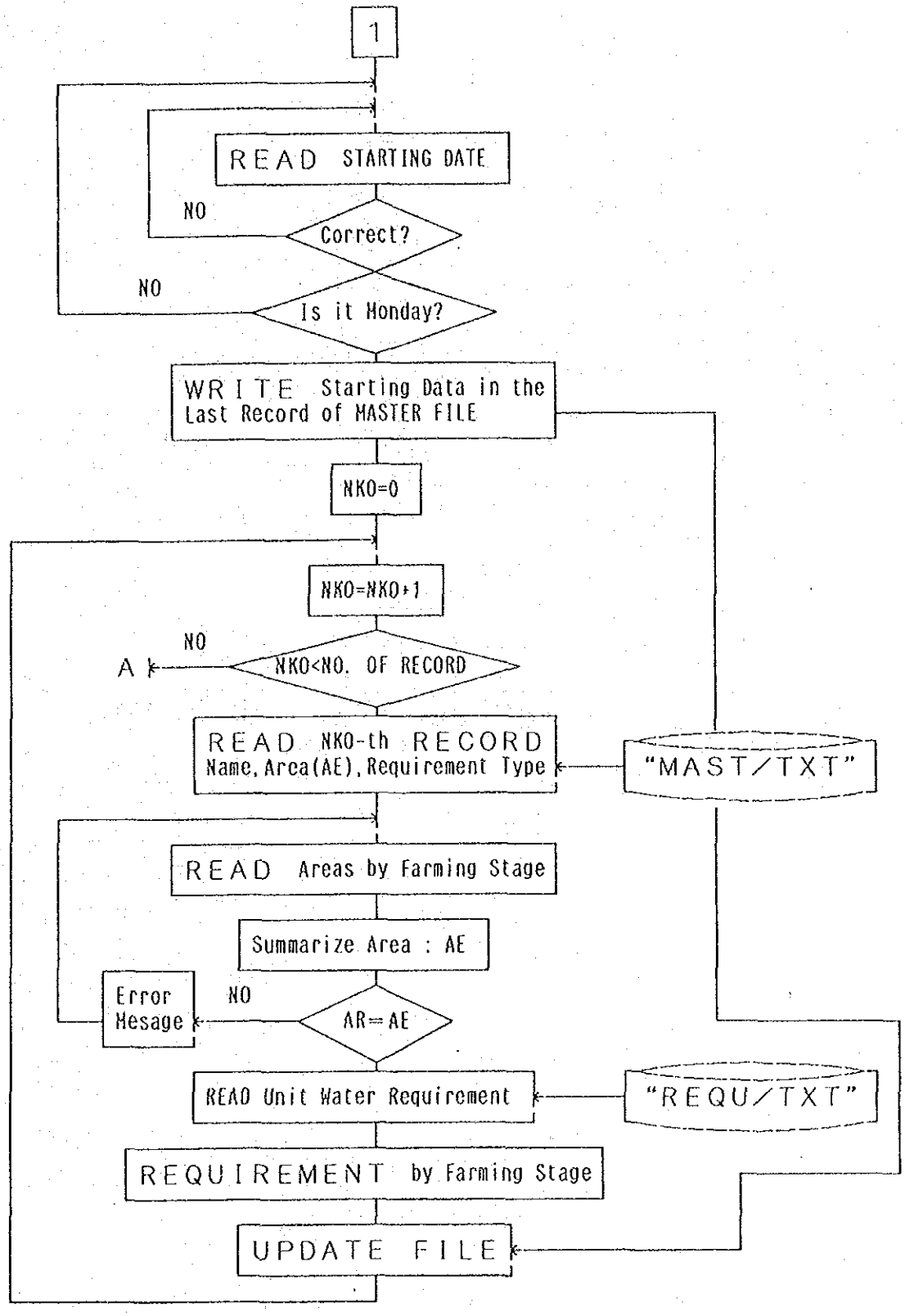


FIGURE 3-14. DATA EDIT SUB-FLOW

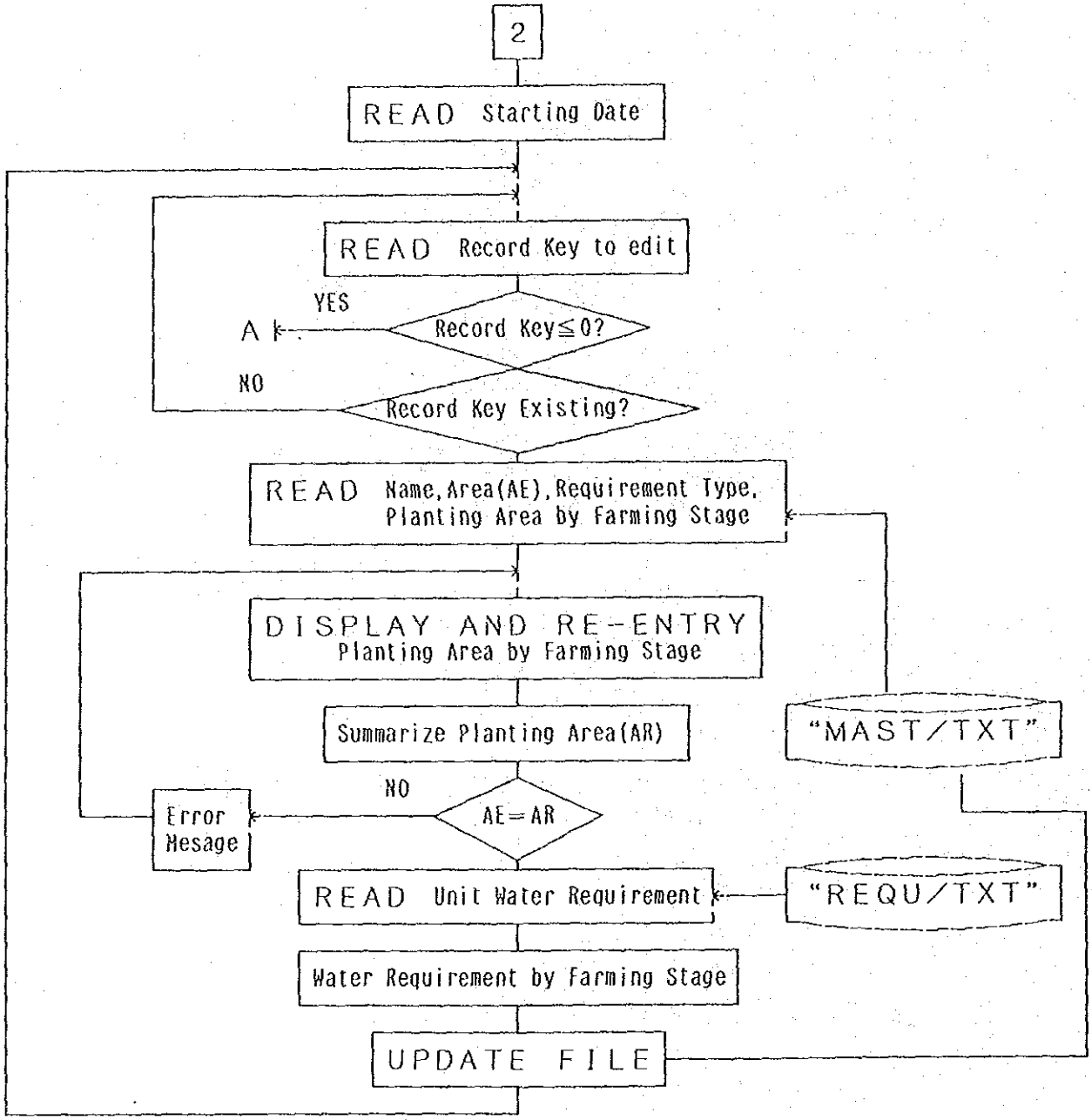
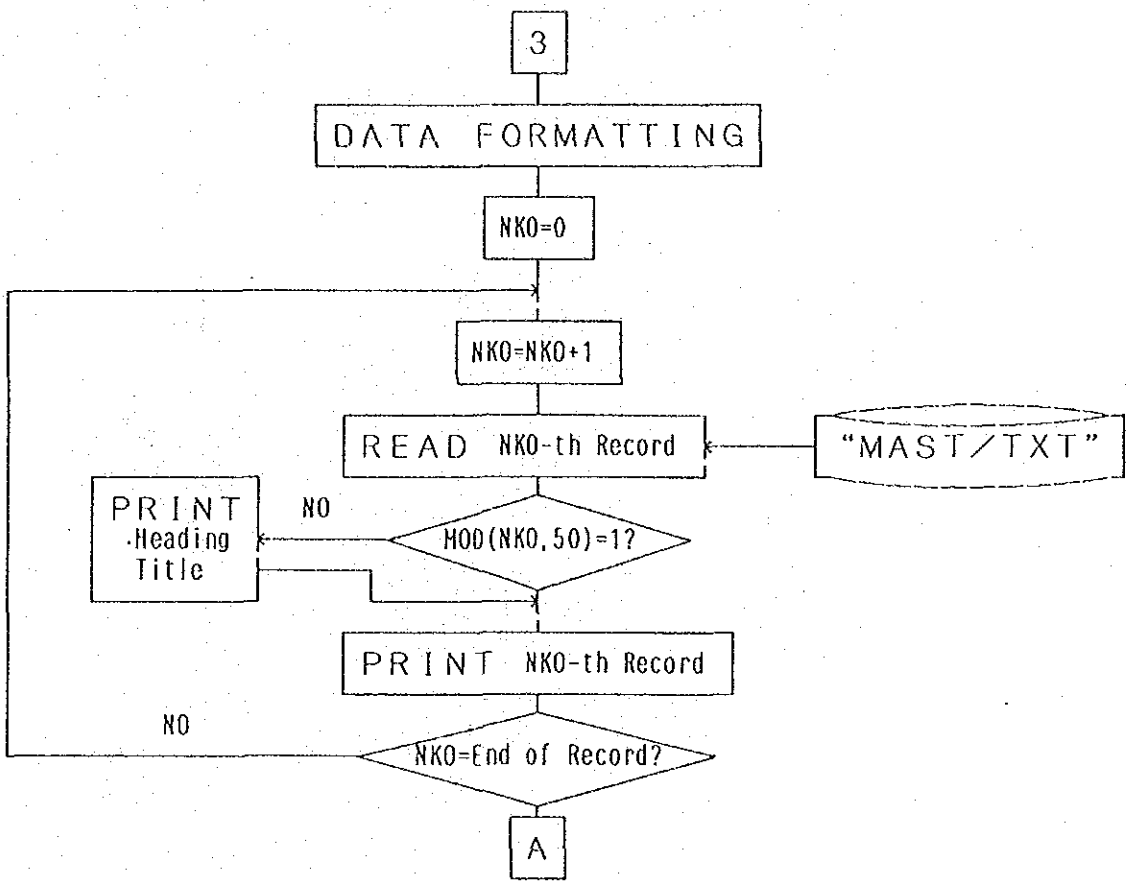


FIGURE 3-15. DATA PRINTING SUB-FLOW



EXIT SUB-FLOW

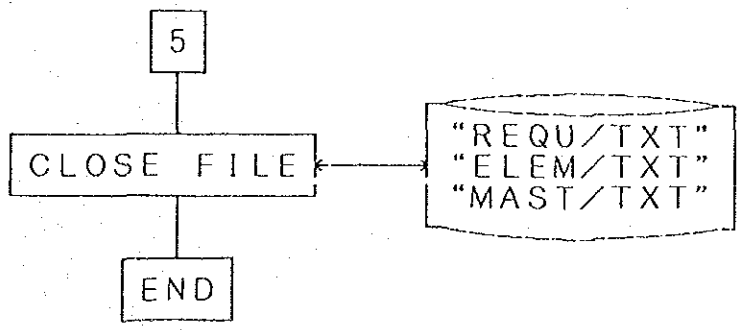
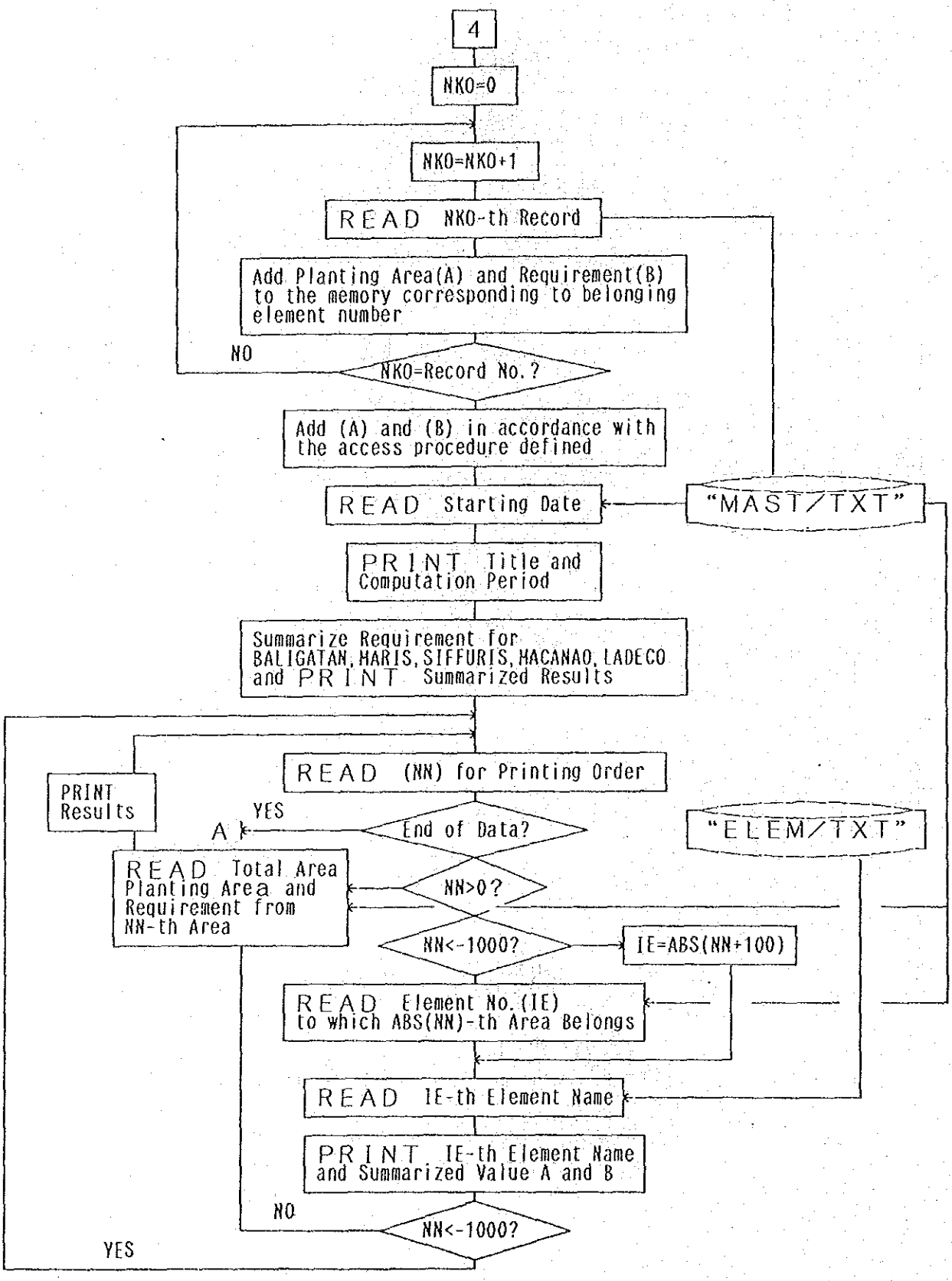


FIGURE 3-16. WATER DISTRIBUTION COMPUTATION & PRINT SUB-FLOW



3.5. Operation Rule of Magat Reservoir

3.5.1. Magat Reservoir Operation Rule Curve

To optimize the utilization of water stored in the Magat Reservoir, a system of withdrawal and filling-up has been established. This will not only greatly entrance the opportunity for staring enough watch to supply annual irrigation requirement in the service area but also minimize waste of water as well as incidental damage to crops and properties in the area during typhoon occurrence.

The Magat reservoir will be operated under the optimum operation rule, which was proposed through simulation of the reservoir operation in consideration of the combined effect of dimension of the existing dam facilities, available inflow into the reservoir, losses and demand for dual purposes of irrigation and power generation. Major conditions given are as under:

Dam Facility

-	Full Supply Level (FSL)	EL.193.0 m
-	Full Supply Capacity	1,090 MCM
-	Lowest Supply Level (LSL)	EL.160.0 m
-	Minimum Storage	270 MCM
-	Effective Storage	820 MCM

Inflow (30 years: 1953 - 1985)

-	Maximum Annual Inflow	12,530 MCM/yr
-	Minimum Annual Inflow	3,280 "
-	Average	7,430 "

Irrigation Demand

(Projected Area = 97,402 ha: Cropping Intensity 200%)

		Area (ha)	Demand (MCM/yr)
-	Direct Service Area	80,243	2,537
-	Supply to Macanao Area	6,040	90
-	Supply to SSMC Area	8,160	62
-	SNMC Area	2,959	-Siffu Runoff-
	Total	97,402	2,689

(1) Operation Rule

Since the reservoir capacity is not sufficiently large enough to meet water demand in the critical dry period, operation of the reservoir should be undertaken in such a way that two purposes confronting each other, namely; 1) promotion of effective water release and ii) restriction of release in preparation for unforeseen drought, can be adjusted. To cope with this, it is useful to zone the storage area into two areas corresponding to the respective purpose. Under the normal condition, the reservoir will be operated so as to keep the Basic Storage Line (BSL). In the event when the actual storage volume sinks below the BSL, the Restrictive Release Line (RRL) may be applied. The BSL and RRL are planned by calculating the required storage-levels for the projected drought which indicate certain safely probability of the reservoir operation. The BSL and RRL finally compose the Storage Operation Rule.

During wet season when inflow into the reservoir largely exceeds irrigation demand under the normal condition, the reservoir should be so operated that i) as much water release as possible be allotted for power generation, ii) as small amount of water as possible be wasted through spillage and iii) reservoir level be finally recovered to the full water level as frequent as possible at the end of December. The combination of the above two aspects in dry and wet seasons will define the conception of the operation rule curve.

(2) Reservoir Operation

The optimum rule curve of the Magat Reservoir was determined based on the simulated results of reservoir operation and is given in Figure 3-13. The proposed operation rule curve is briefly explained as follows:

- The reservoir shall be operated so as to restore its water level, as much as possible, to the full water level of 193 m at the end of December.

- Under the normal condition when the reservoir maintains storage within a normal range, the reservoir during the period from the end of December to the end of June shall be operated with the "Standard Mode Basic Storage Line (BSL)" as the target. When the reservoir stage exceeds the line, 100 percent of irrigation requirement will be released from the reservoir and the minimum power requirement will be satisfied with this water.

- In case when the reservoir stage exceeds even the "High Mode BSL", available storage above this line will be allotted to power generation.

- In case that the reservoir stage lowered the "Standard Mode BSL", one of the "Restrictive Release Line (RRL) shall be applied in accordance with the magnitude of storage deficit envisaging rapid restoration of reservoir storage.

- During the wet months from July to December where power generation takes the initiative in operating the reservoir, the reservoir shall be operated according to the existing available storage and the rate of allowable water release as defined in the proposed operation rule.

(3) Storage Deficit and Irrigation Area Control

The Magat runoff largely depends on typhoons visiting the drainage basin and irregularity is remarkable. In addition the effective storage of 820 MCM is considered too small as compared with the Magat runoff, about 7,400 MCM/year on average. Judging

from the historical runoff record collected at the damsite, there will be many occasions where the storage is rapidly restored with one typhoon, and also frequent cases where disappointing small inflow comes into the reservoir in wet season. Therefore, it is unavoidable to waste almost 880 MCM/year of water through spillways, and at the same time it involves much risk for the agriculture side that water supply from the reservoir is interrupted. At the establishment of the operation rule, careful attention was paid so that water supply from the reservoir was not interrupted at the important and serious period of irrigation, but still more due to the fact that the power generation is given much weight in controlling water release in wet season, the simulated result shows frequent occasions where the reservoir will not restore its storage at the end of wet season carrying over such effects in the succeeding cropping season, in the case when the inflow is much less than expected.

Therefore, if the storage deficit as simulated is not acceptable from the agronomic point of view, necessary countermeasure, such as reduction of planting area in the succeeding cropping period on the basis of the available reservoir storage at the critical point of time, will be required in the actual practice or reservoir operation. Although it is desirable to estimate potentiality of irrigation as well as the area to be planted by a reasonable prediction of reservoir inflow combined with the presently available storage, it seems almost impossible to predict the inflow. Accordingly the study was made on the rate of irrigation area reduction based on simple correlation between storage deficit simulated and available storage at the end of March and September, respectively for wet season rice and dry season rice.

Figure 3-14 presents such a correlation. Since the irrigation project generally allows crop damages of once in ten years, three exclusive points (i.e. 3/30 years = 1/10) are eliminated from the study. The remainders produce an envelope curve, which is defined

as the "Area Reduction Curve". However in general, reduction of planting area promotes increase of reservoir stage which in turn promotes release of water for power generation, shortage of water for irrigation supply also increases and the correlation is modified. In the study three steps of modification were progressed.

(4) Optimum Reservoir Operation

The optimum reservoir operation among several alternatives was studied taking into account the frequency and amount of water shortage for irrigation as well as hydro-electric power generated. In consequence the "Reduction Curve (2)' for irrigation area control is recommendable as the provisional rule for the Magat reservoir operation. As the result of simulation, the cropping intensities for wet and dry season paddy at about 90 percent and 85 percent respectively would be expected in terms of averages in the entire period of simulation of 30 years.

(5) Power Energy to be Generated

The power energy at the Magat power plant to be produced in the optimum reservoir operation was estimated as in the following table.

Comparison of Magat Power Output

Month	Projected by NPC in 1985	Actual Achievement Aug.193 - Oct.1986	Estimated by Calculation
Jan.	75.4	71.7	78.3
Feb.	80.8	73.1	101.5
Mar.	40.8	53.2	60.8
Apr.	31.3	33.2	61.2
May	51.3	95.0	93.9
Jun.	70.0	121.5	111.5
Jul.	170.0	128.1	161.3
Aug.	255.0	137.6	117.1
Sep.	340.0	167.4	203.7
Oct.	225.0	152.1	204.2
Nov.	170.0	163.0	133.4
Dec.	108.3	91.4	84.4
Annual	135.1	107.4	122.7

Although it seems that NPC's projection of power generation especially during wet months is to some extent over-estimated when the available Magat run-off and reservoir capacity are taken into consideration, the reservoir would produce power well-distributed throughout a year, as compared with the actual achievement, if the proposed rule of reservoir operation is adopted together with the irrigation area reduction curve (2). In this connection, the spillage would be minimized also to about 880 MCM/year.

On the other hand, the Baligatan Power Plant newly constructed by NIA produces the following power output, which is expected to be used for the energy of Pumping Plant No.1 to No.3 in the service area.

(unit: MW)

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Mean Annual
3.6	4.1	3.7	0.8	0.8	3.2	2.3	1.3	1.3	0.5	-	2.3	2.0

In this connection, characteristic curves of the both power plants are presented in Figures 3-15 and 3-16.

3.5.2. Periodic Updating of Operation Rule

The operation rule of the Magat Reservoir is to be updated periodically on the basis of experiences and achievement of actual reservoir operation and on the basis of available and updated record of stream flow and other hydrological data, for the purpose of finding the final target for controlling the limited water resources.

A series of computer program systems developed for data processings required for the simulation of the Magat reservoir operation include the following programs.

Computer Programs Developed

Program	Data Processing and Analysis
PDISMA	Generation of Daily Inflow into Magat Reservoir
PDISSF	Generation of Daily Runoff from Siffu River
MAGEFEC	Computation of Effective Rainfall
DIVWREQ	Computation of Irrigation Water Requirement in consideration of Effective Rainfall
PDWRQN	Computation of Diversion Water Requirement by Lateral
DEMAND	Computation of Irrigation Demand Dependant upon Magat Reservoir
PRSD	Computation of Required Storage for Drought
STORAGEH	Computation of Required Storage for Drought, in consideration of required Minimum Release for Power Generation
STRGSORT	Statistical Evaluation of Required Storage
MAGATD	Magat Reservoir Operation (Daily Computation)

All programs were developed by and have been provided for the VAX11/750 Computer Systems installed in ICE Building, NIA Control Office in Manila. Source program lists and sample outputs as well are also available in the Hydrology Section, Project Development Department.

In order to progress updating study of the Magat Reservoir operation, all of data files used are also to be updated.

Date File	Contents
MGTTQ	Ten-daily inflow into Magat Reservoir
MGTDQ	Daily inflow into Magat Reservoir
SIFTQ	Ten-daily runoff of Siffu river
SIFDQ	Daily runoff of Siffu river
EFE3YAVE	Effective rainfall expected in 3-year reoccurrence drought
DWR3YAVE	Irrigation diversion requirement by lateral, with consideration of effective rainfall
WREQ01	Irrigation diversion requirement at major control points of MRIIS irrigation system
WDEM01	Irrigation requirement dependant upon the Magat Reservoir (to be released from Magat reservoir)
STRG01	Time-series of required storage for drought, for establishment of operation rule curves

3.6. Operation Rule of Diversion Dams

3.6.1. Maris Diversion Dam

The water management at the Maris diversion dam is carried out under the supervision of the Dam District Office, including reservoir control for the daily maximum discharge from the Magat Hydroelectric Power Plant and water distribution to the main canals at Maris. The operation rule of the Maris diversion dam is described as bellows.

(1) Operation of Re-regulating Reservoir

The Maris diversion dam plays a role as a re-regulation dam of the water released from the Magat Hydroelectric Power Plant, during the dry season when power output varies from the maximum available to zero. (See FIGURE 3-17, 3-18, 3-19, 3-20)

As the daily total volume of water released from the power plant throughout the year is normally limited to daily irrigation demand, it is necessary to store the water at Maris Diversion Dam so that it can be released uniformly through 24 hours to suit irrigation need.

The storage capacity of the Maris reservoir for regulating water is about 8 MCM with the stop log units put on, and when stop logs are placed, the reservoir water level rises to EL.105.10 m.

The stop logs must be taken away before there is any danger with logs in overtopping by excess river water. They should be withdrawn without any delay when the Magat reservoir is in its refilling cycle and reaches EL.175 m.

The water released from the Magat dam includes the water to meet the irrigation demand and some excess water to be spilled, and

such surplus water to be discharged from the Magat dam can be considered as the surplus water to be spilled from the Maris diversion dam. The said surplus water has brought about in a period of July through December according to the records in 1985.

The water level at the Maris diversion dam is fluctuated by released water from the Magat dam, intake discharge of the main canals and spilled water from the spillway of Maris diversion dam controlled by stop logs.

Naturally, the operation of the above three discharges will be executed in the manner as shown in the table below.

Re-regulation of Water and Stop Log

Re-regulation	Water Level of Magat Dam	Release from Magat Dam		Required Intake Discharge of Main Canal	Stop Log Mode
I. No Re-regulation	above upper standard W.L near to 193 m	V_M Q_M	>= >=	V_m Q_m	not used
II. Partial Re-regulation	above the Standard W.L 175 m - 190 m	V_M Q_M	> <	V_m Q_m (Sometimes)	partially used
III. Full Re-regulation	Below 175 m	V_M Q_M	= <	V_m Q_m (Sometimes)	totally used

where,

Q_M = Unit discharge at Magat dam (cu.m/sec)

Q_m = Unit intake amount of main canals at Maris dam (cu.m/sec)

T_M = Duration for discharge to meet Q_M (hr)

T_m = Duration for discharge to meet Q_m (hr)

V_M = Daily total release from Magat Dam

= $\Sigma(Q_M \times T_M)$ ... Cu.m

V_m = Daily total intake water into main canals at Maris diversion dam

= $\Sigma(Q_m \times T_m)$ .... Cu.m

The stop logs shall be operated based on the above regulation table, however, the stop log opening and operation rule according to the relation between Q_M and Q_m, shall be decided by the detailed manuals prepared by O/M Staff.

(2) Operation of Intake Facilities

The programmed intake water amount will be instructed from WCCS of Head Office.

The water intake of main canals at the Maris diversion dam has been made by steady discharge control with gates installed at the heads of main canals, which are operated appropriately according to fluctuation of water level at the diversion dam.

The gates operation has been conducted empirically according to fluctuation of water level at the starting point of the main canal and such empirical works have resulted in difficulty in grasping the accurate intake amount.

The water intake facilities shall function to permit the water to be correctly taken at the design discharge into both the main canals at the Maris diversion dam. It cannot be said from the survey that the intake gate operation has been practiced appropriately, and the reasons are considered as follows.

- Control Office at the Maris diversion dam cannot catch the time-serial fluctuation of discharge caused by power generation.

- There is a poor gate operation systems provided without any operation rule firmly established.

- The intake water has been measured improperly. This might be because the conversion table between water level and discharge has been prepared inadequately.

- The gate operation mechanism is hackneyed.

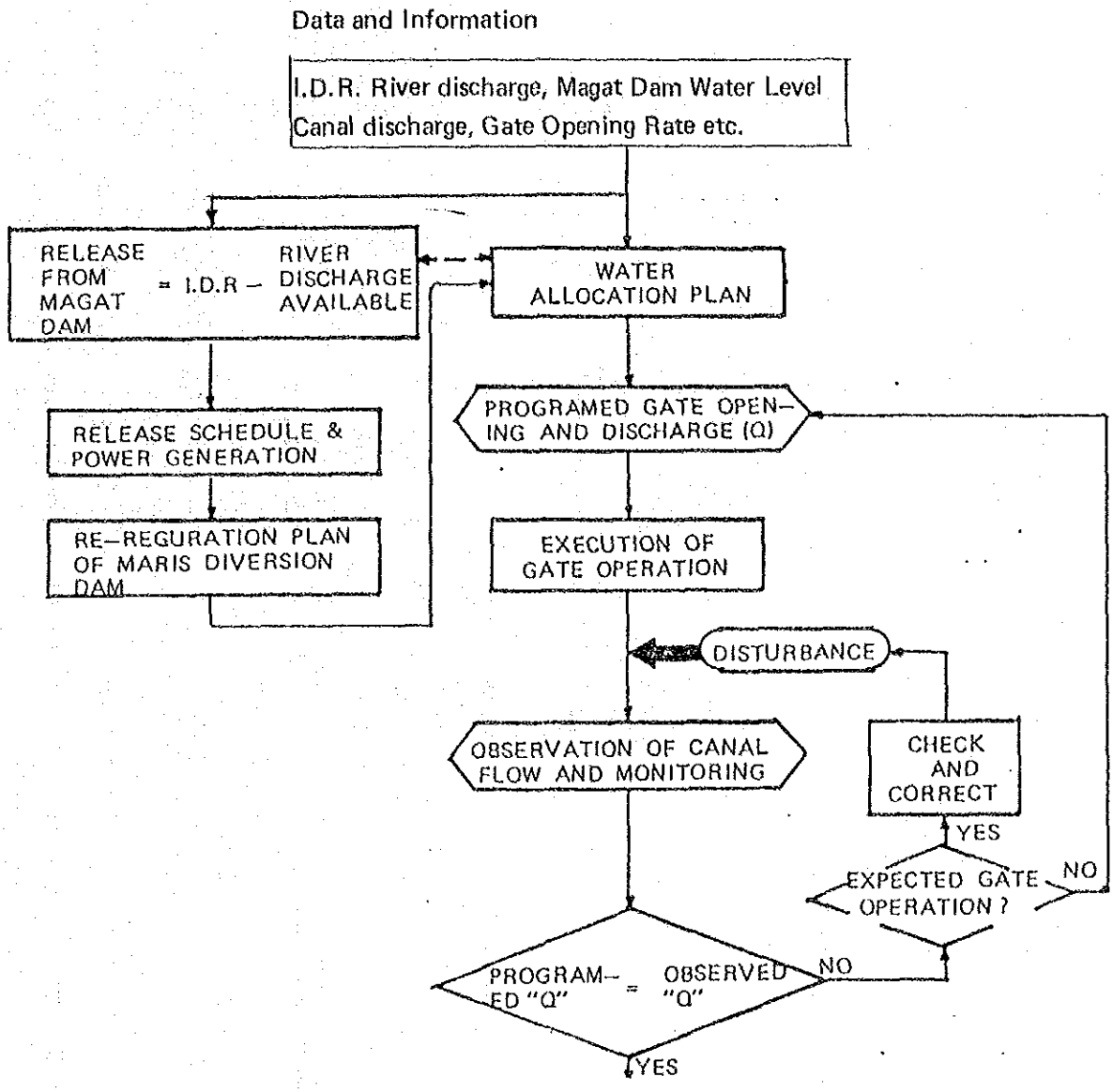
The existing operation system mentioned above shall be improved mechanically and technically, and the water intake at the Maris diversion dam shall be controlled properly and automatically. For this purpose, the operation working sheets for Maris diversion dam are proposed as shown in Form 3-14 and 3-15.

The routine works for gate operation will be practiced by using the new monitoring system and data processing system with micro computer in cooperation with NPC.

Form 3-14 and 3-15 "Gate Operation Schedule and Record for Maris Diversion Dam" shall be filled up with present and future figures.

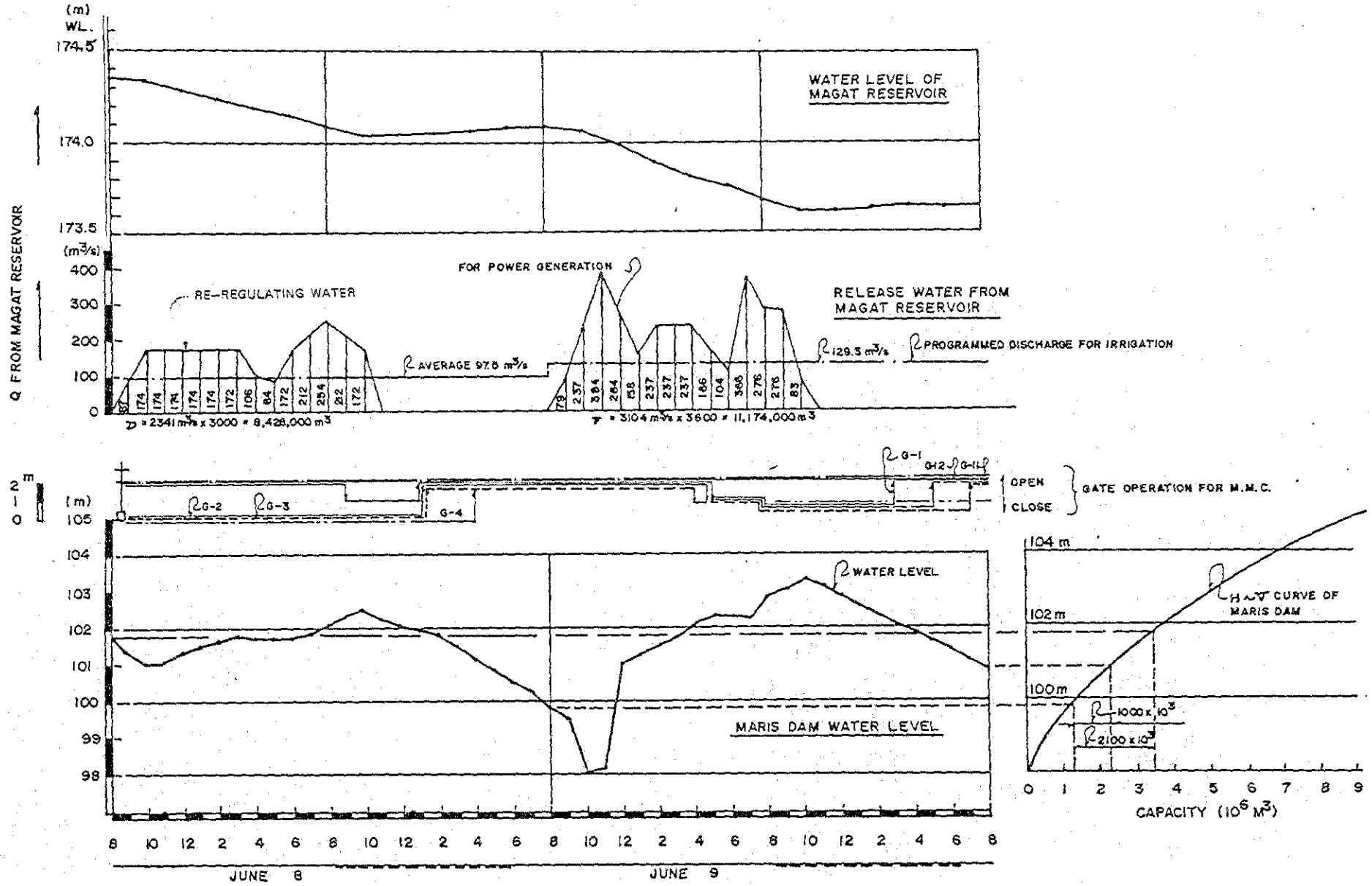
Present figure is actual (observed) values and future figure means forecasted (programmed) ones.

The operation routine for Maris diversion dam will be carried out with closed loop procedure mentioned below.



The weekly and daily working sheets for upstream section of the Maris main canal are shown in Table 3-16, 3-17, and 3-18, respectively.

FIGURE 3–17. MARIS DIVERSION DAM OPERATION (8, 9TH JUNE, 1986)



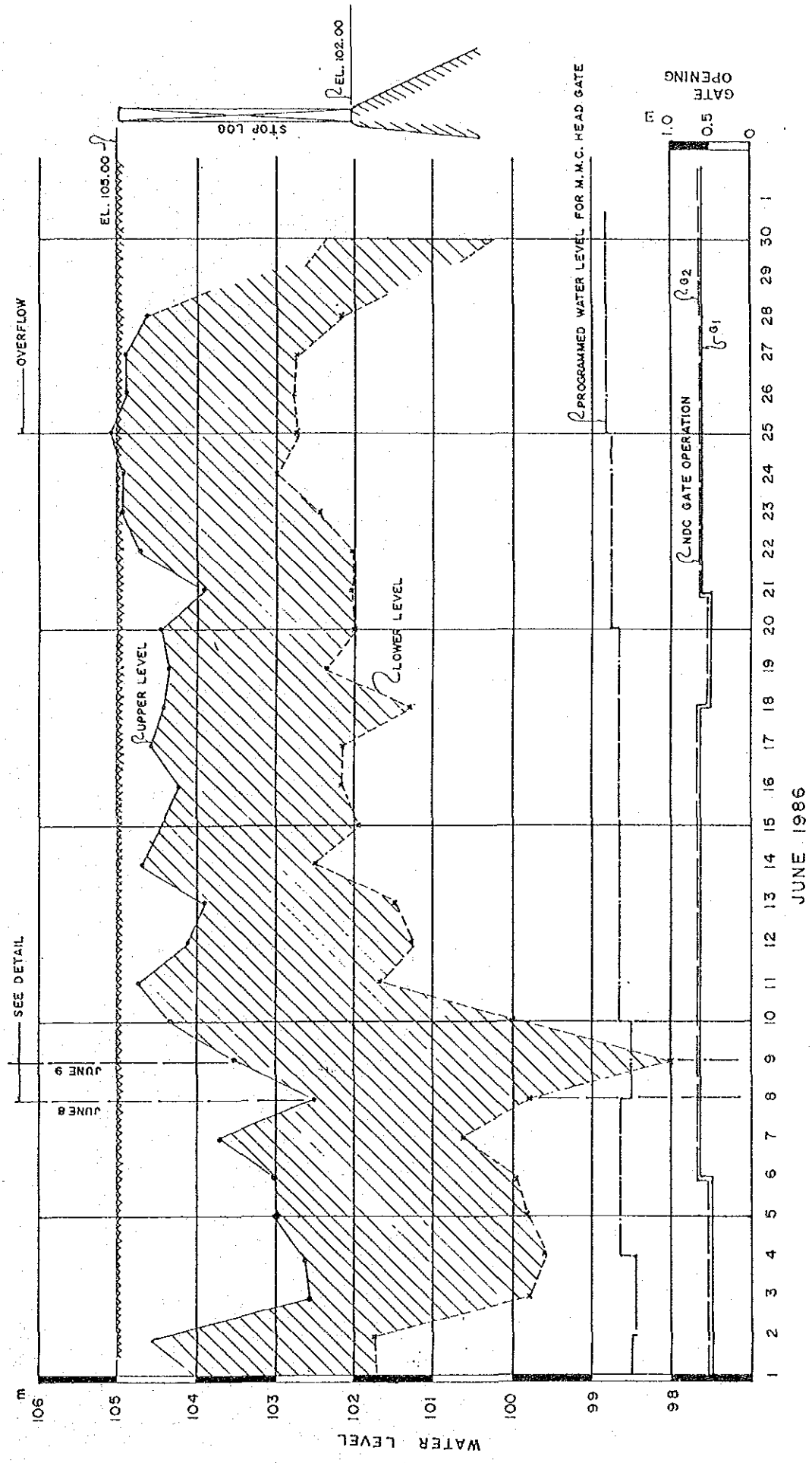


FIGURE 3–18. VARIATION OF MARIS MAIN CANAL INTAKE WATER

FIGURE 3-19. YEARLY FLUCTUATION OF WATER LEVEL OF MARIS DIVERSION DAM

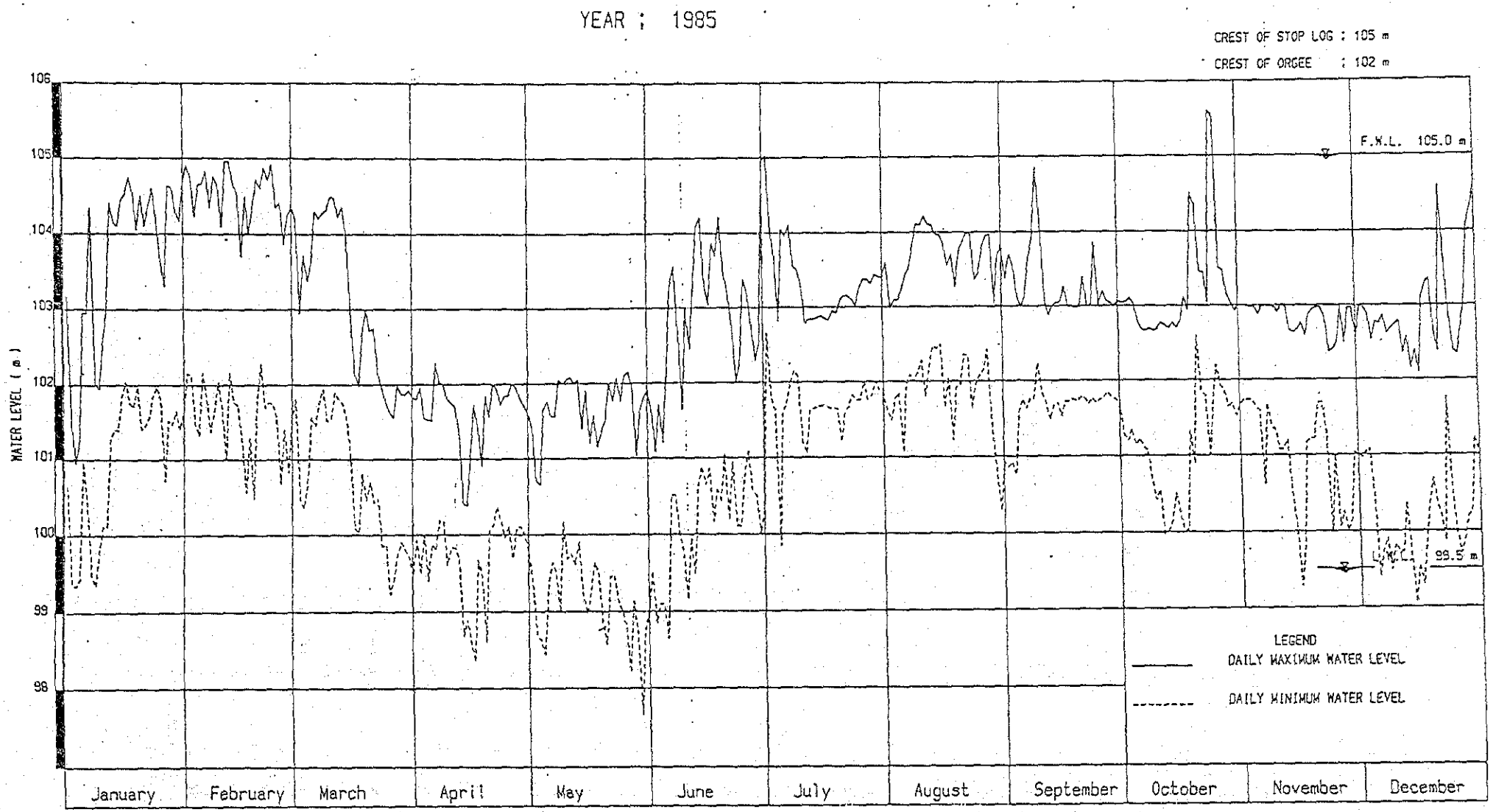
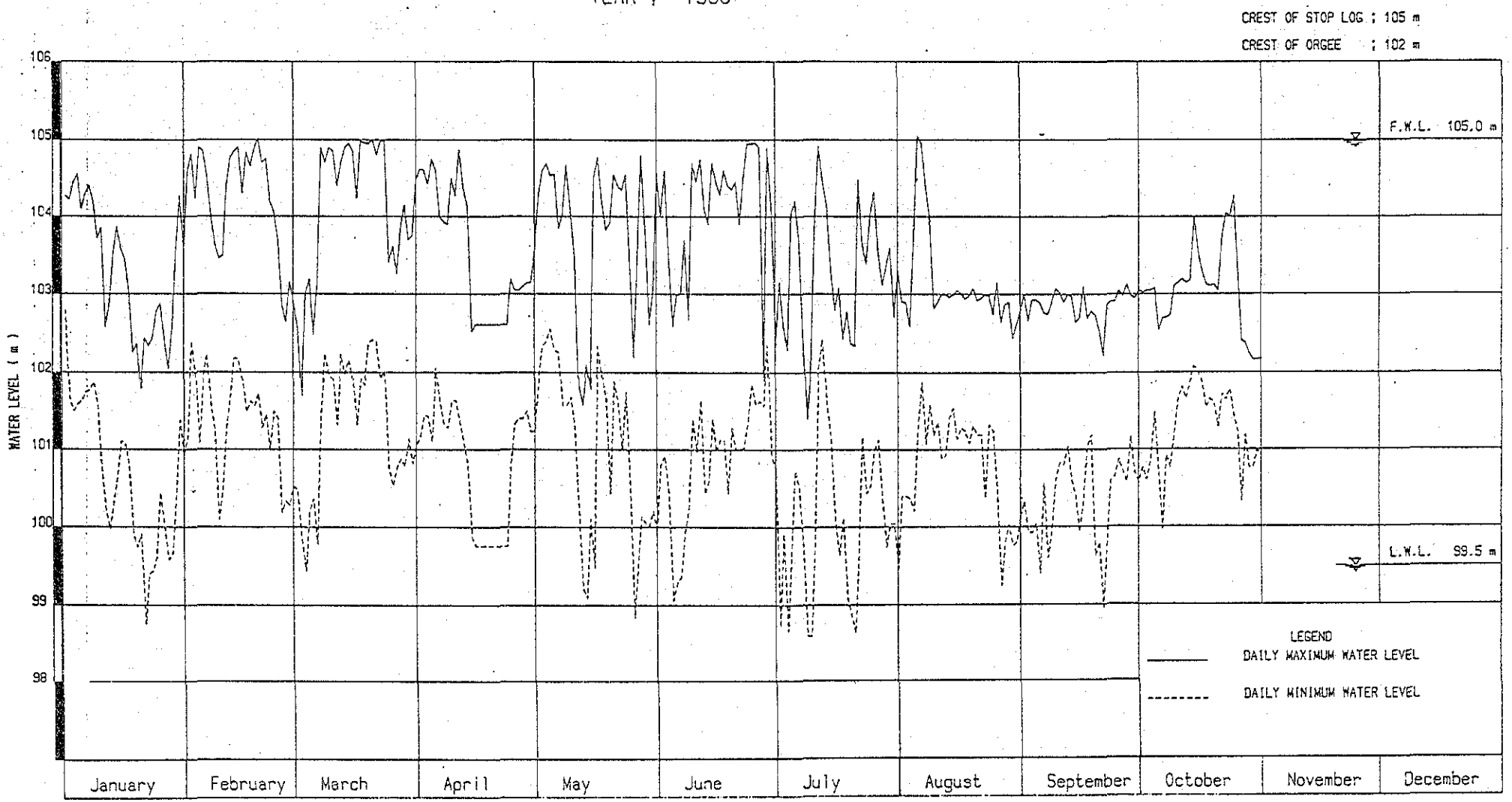


FIGURE 3–20. YEARLY FLUCTUATION OF WATER LEVEL OF MARIS DIVERSION DAM



FORM 3–19. OPERATION SCHEDULE AND RECORD FOR MARIS DIVERSION DAM

Date: _____

FORM M–1

Time		Magat Dam Elev. (m) *	Out Flow Schedule From Magat Dam *			Intake Schedule of Maris Dam *			Net Inflow to Maris Dam	Forecasted Maris Dam Elevation	Gate Opening (M)						Remarks
											Spillway			Stoplog Mode	Intake Gate Mode		
			Power Plant	Spillway	Total ①	MMC	NDC	Total ②	③ = ①–②		GR–1	GR–2	GL–1		MMC	NDC	
AM 8:00	P																
	A																
9:00	P																
	A																
10:00	P																
	A																
11:00	P																
	A																
N 12:00	P																
	A																
PM 1:00	P																
	A																
2:00	P																
	A																
3:00	P																
	A																
4:00	P																
	A																
5:00	P																
	A																
6:00	P																
	A																
7:00	P																
	A																
8:00	P																
	A																
9:00	P																
	A																
10:00	P																
	A																
11:00	P																
	A																
MN 12:00	P																
	A																
AM 1:00	P																
	A																
2:00	P																
	A																
3:00	P																
	A																
4:00	P																
	A																
5:00	P																
	A																
6:00	P																
	A																
7:00	P																
	A																
8:00	P																
	A																
Daily Total	P																
	A		ΣQ_p					ΣQ_i									

Note:

1. Data and Information marked * should be collected to MARIS Control Office before 24 hours to operate the Maris Intake and Spillway Gate.
2. MARIS Reservoir Elevation for the following day is forecasted using by net inflow and Stage–Volume Curve of Maris reservoir.
3. Daily total of released water (ΣQ_p) from Magat Dam to Maris Diversion Dam through power plant should be decided base on reservoir water level (Rule Curve) and daily intake schedule of irrigation water (ΣQ_i), by Dam Operation Manager in cooperate with NPC, so, "$\Sigma Q_p \cong \Sigma Q_i$" is prerequisite for power generation plan.
4. Programed gate opening is discribed in Form M–2.
5. P: Programed figure (Upper Line)
   A: Actual figure observed (Bottom Line)

Prepared by: _____ Submitted by: _____

FORM 3-20. GATE OPERATION SCHEDULE AND RECORD FOR MARIS DIVERSION DAM

Date: _____

FORM M-2

Time	Items	Reservoir Elevation (m)	Maris Main Canal												NDC			Stop-log Mode
			Discharge (m^3/s)	Gate Opening Rate (m)											Discharge (m^3/s)	Gate Opening		
				G-1	G-2	G-3	G-4	G-5	G-6	G-7	G-8	G-9	G-10	G-11	G-12		G-1	G-2	
8:00	Programed / Actual																		
9:00	P / A																		
10:00	P / A																		
11:00	P / A																		
12:00	P / A																		
13:00	P / A																		
14:00	P / A																		
15:00	P / A																		
16:00	P / A																		
17:00	P / A																		
18:00	P / A																		
19:00	P / A																		
20:00	P / A																		
21:00	P / A																		
22:00	P / A																		
23:00	P / A																		
24:00	P / A																		
1:00	P / A																		
2:00	P / A																		
3:00	P / A																		
4:00	P / A																		
5:00	P / A																		
6:00	P / A																		
7:00	P / A																		
Daily Total	Programed / Actual																		

FORM 3-21. WEEKLY DAM AND DIVERSION DAM OPERATION RECORD (For ____ to ____, Month ____, Year ____)

Date: unit: Elevation (m), Outflow (m^3/s)

Items \ Day	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.	Sun.	Weekly Total
Magat Reservoir								
Elevation								
Outflow: Power Plant								
Outflow: Spillway								
Outflow: B.O.W 1/								
Outflow: Total								
Maris Diversion Dam								
Water Level (Max.)								
Water Level (Min.)								
Outflow: M.M.C								
Outflow: N.D.C								
Outflow: Spillway								
Outflow: Total								
Baligatan Diversion Dam								
Water Level (Max.)								
Water Level (Min.)								
Outflow: S.H.C								
Outflow: Oscariz M.C								
Outflow: Spillway								
Outflow: Total								
Siffuris Diversion Dam								
Water Level (Max.)								
Water Level (Min.)								
Outflow: S.S.M.C								
Outflow: S.N.M.C								
Outflow: Spillway								
Outflow: Total								

Prepared by Maris Head Office

1/ B. O. W: Baligatan Outlet Works

FORM 3–22. WEEKLY IRRIGATION WATER DISTRIBUTION RECORD FOR UPSTREAM OF MARIS MAIN CANAL

Date: (unit: m^3/s)

Items \ Day	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.	Sun.	Weekly Total
LAT – A								
A – 1								
A – 2								
A. Bel. Lat A–2								
Sub–Total								
LAT – A Extra								
S. L. C								
LAT – B								
LAT – C Extra								
LAT – C								
Gadanan Supply								
LAT – D								
LAT – E								
MMC. Bel. Lat – D								
M.C.T.O								
M.M.C Total								

Prepared by Maris Head Office

Note: Distribution water "Q" is estimated by equation mentioned below;

$$Q = \frac{q \times t \times n}{24}$$

where; Q : Daily average discharge (m^3/s)

q : Observed discharge (Monitored)

t : Monitoring interval (1 hour)

n : Monitoring times per day (24)

FORM 3-23. IRRIGATION WATER DISTRIBUTION AND GATES OPERATION RECORD FOR UPSTREAM OF MARIS MAIN CANAL

Date:

Mon. Day	Hour	Site	Water Level (m)			Flow (m^3/s)		Gate Opening Rate (m)									
								Check Gate						Head Gate			
			Upstream	Downstream	Lateral	Main	Lateral	G-1	G-2	G-3	G-4	G-5	G-6	G-1	G-2	G-3	G-4
	12:00	LAT-A															
		S. L. C.	"										–			–	–
		LAT-B										–	–		–	–	–
		MINI-A			–	–	–						–				
		LAT-C															–
		GADANAN		–		–		–	–	–	–	–	–			–	–
		LAT-D							–	–	–	–	–				–
		LAT-E		–		–		–	–	–	–	–	–		–	–	–
		LATA-1	–					–	–	–	–	–	–	–	–	–	–
		LAT-2	–					–	–	–	–	–	–	–	–	–	–
	18:00	LAT-A															
Daily Total/Average																	

OPERATION NOTE						
oo / xx 18:30	LAT-B	oo.oo	△△.△△	☆.☆☆	- - . - -	xx.xx

G-2.
Gate opening change 0.5 m to 1.0 m

Note: Monitoring of water delivery in the Maris Main Canal is practiced every six hours and printed automatically.

3.6.2. Baligatan Diversion Dam

(1) Operation Rule

The water management at the Baligatan diversion dam is carried out by the Dam District Office. It is water release control to the South high and Oscariz main canals. The operation of the diversion dam shall be made in accordance with the following rules.

i. The inflow into the diversion dam is almost equivalent to the water released from the Magat dam. The catchment area of diversion dam is so small in its acreage that the runoff discharge decreases rapidly when rainfall was over.

ii. The water level shall be controlled in principle at EL.128.30 m by steady flow regulation. The normal water level at the diversion dam is maintained by elevation on crest of the ogee plus overflow depth (EL.128.40 m +) at maximum.

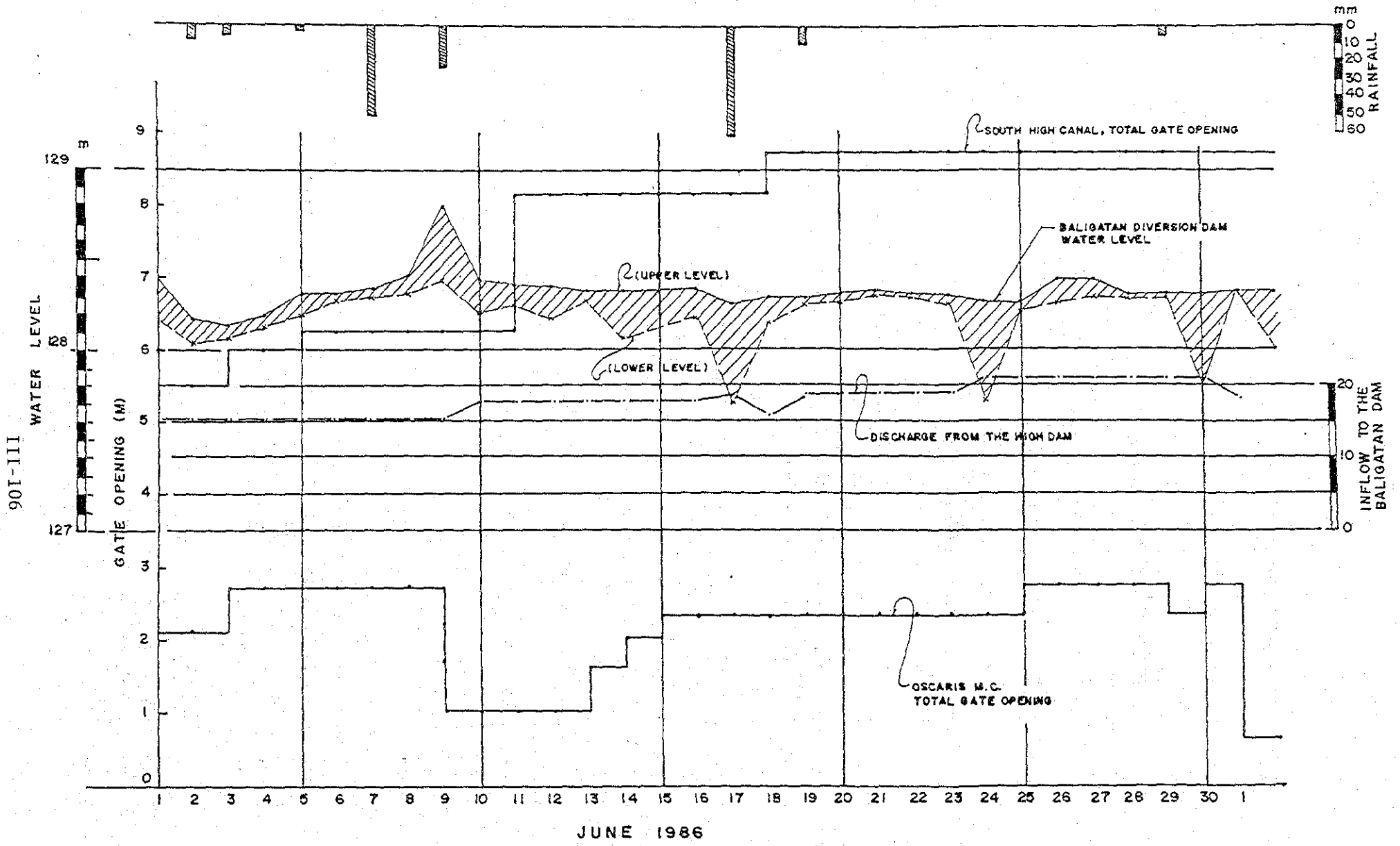
iii. The diversion dam actually provides no capacity of water storage and all of the discharge water from the Magat dam is diverted to the both main canals.

(2) Water Intake Control

The diversion works are provided so as to divert the water into two main canals of the South High and the Oscariz. The water intake control is carried out by appropriate gate operation in corresponding to the water level at the diversion dam. In the both main canals, however, the gate operation should be carefully practiced to meet the water level in the canals where there will be back water caused by daming up with check gates operation.

The O/M routine sheets for Baligatan diversion dam are shown in Form 3-19.

FIGURE 3–21. OPERATION OF BALIGATAN DIVERSION DAM



FORM 3–24. OPERATION SCHEDULE AND RECORD FOR BALIGATAN DIVERSION DAM

Date: _____

Time		Reservoir Water Level	Discharge of B.O.W.	Outflow					Gate Opening								Remarks
									S. H. C.						OSCARIZ		
				S.H.C.	O.M.C.	Spillway	Ogee	Total	G_1	G_2	G_3	G_4	G_5	G_6	G_1	G_2	
8:00	P																
	A																
12:00	P																
	A																
16:00	P																
	A																
20:00	P																
	A																
24:00	P																
	A																
4:00	P																
	A																
Daily Average	P																
	A																

Note: (units)
Outflow (m^3/s)
Gate Opening (m)
W.L (m)

3.6.3. Siffuris Diversion Dam

(1) Operation Rule

The water management at the Siffuris diversion dam has been executed by District III Office, including water release from the Siffu Diversion Dam and the water distribution to the main canals of the Siffu North and Siffu South areas. The operation rule of the diversion dam is as follows.

i. In principle, the water intake to the Siffu North main canal shall be practiced preferentially to the Siffu south main canal.

ii. When the Siffu river discharge is insufficient to the diversion requirements for both the main canals, such insufficiency in diversion water shall be supplemented in depending upon the Magat dam and supplemental water shall be diverted to the Siffu South main canal through the North diversion main canal.

(2) Water Intake Control

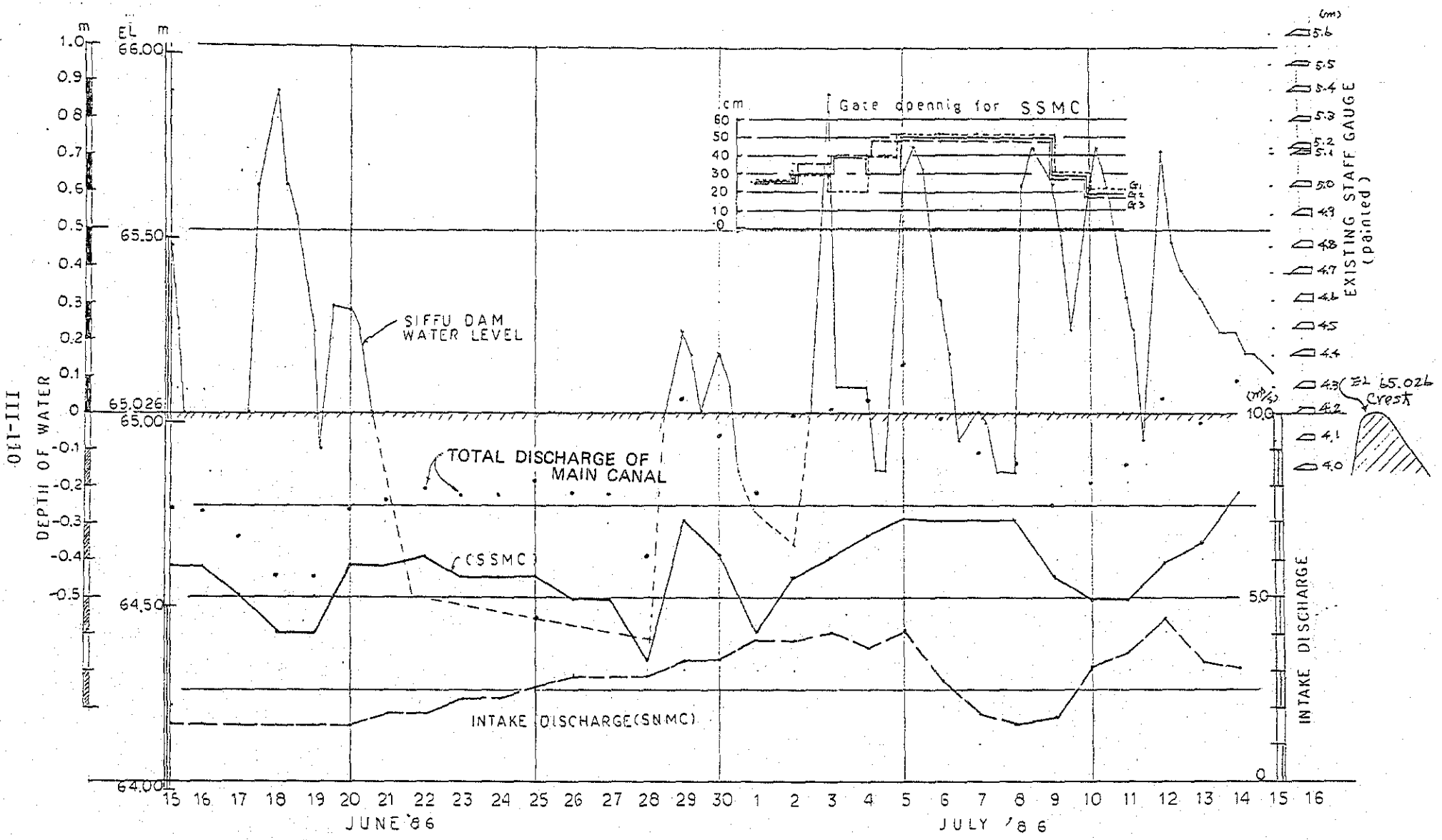
The water intake control will be comparatively easy for the river with abundant discharges in wet season. In case of dry season, however, when the river discharge can not meet the diversion requirements, the prudent gate operation will be essentially required for preferential diversion to the Siffu North main canal. After taken into the Siffu North main canal, the river water is diverted to the Siffu South main canal, although not accurately grasped in its amount. The Siffu South main canal is connected with the North diversion main canal which has been supplemented with water from the Magat dam. Ambiguity in the information has resulted from insufficiency in records and data on water intake at the Siffu diversion dam. In other respect, the flushing gates at the both

banks are so poorly maintained to be in operative with heavy piles of sand sediment around the immediate upstream of the gates. A series of these matters have caused hindrance of the gates from appropriate operation.

In this connection, an improvement should be made on the intake gate control and operation system, so that the water intake can be practiced effectively to meet the water level fluctuation. The flushing gates on the both banks should be repaired for the purpose as well.

The operation routine sheets are shown in Form 3-20 and the operation records of Siffuris diversion dam during the Survey in 1986 are shown in the Figure 3-22.

FIGURE 3–22. OPERATION OF SIFFU DIVERSION DAM



FORM 3–25. OPERATION SCHEDULE AND RECORD FOR SIFFURIS DIVERSION DAM

Date: _____

Time	Items	River Water Level (m)	Outflow from Diversion Dam							Diversion Dam Operation									Request to Maris Dam (Q_M)		
			SSMC	SNMC	Ogee	Spillway		Total "Q_1" Inflow to the Dam		Programed "Q_P" Discharge		SNMC		Diversion Dam W.L	SSMC				for SSMC Q_1 **	for NDC Q_2 ***	NDC Intake $Q_M = Q_1+Q_2$
						Right	Left			SSMC O_{PS}	SNMC Q_{PN}	$Q_{PN}=Q_{PN}$	$G\cdot O_{pn}$		$Q_{AS}=$ * Q_1-Q_{PN}	Gate Opening G_1	G_2	G_3			
8:00	W.L								P												
	$G.O_{pn}$	–	–	–	–																
	Q								A												
12:00	W.L								P												
	$G.O_{pn}$	–	–	–	–																
	Q								A												
16:00	W.L								P												
	$G.O_{pn}$	–	–	–	–																
	Q								A												
20:00	W.L								P												
	$G.O_{pn}$	–	–	–	–																
	Q								A												
24:00	W.L								P												
	$G.O_{pn}$	–	–	–	–																
	Q								A												
4:00	W.L								P												
	$G.O_{pn}$	–	–	–	–																
	Q								A												
									P												
									A												
Daily Average	W.L								P												
	Q								A												

Note: W.L : Water Level (m)
$G.O_{pn}$: Gate Opening Rate (m)
Q : Discharge (m^3/s)
P : Programed Figure
A : Actual Figure (Observed)

* : Q_{AS}: Available supply water to the SSMC $Q_{AS} = Q_1 - Q_{PN} \leq Q_{PN}$
** : $Q_1 = Q_{PN} - Q_{AS}$
*** : Q_2 is I.D.R of NDC Service Area

3.7. Discharge Control in Canal System

3.7.1. Discharge Control Rule in Canal System

Canal discharge at the given point must principally be maintained the programed discharge which is required by it's service area. On the other hand, check gates shall be controlled it's opening to maintain the distribution water level (DWL) or the check water level (CWL) in the canal.

Practically, the discharge control in the canal shall be made by arranging the opening of the head gate for the appointed discharge to pass at the check point which is provided at the immediate downstream of the head gate. The check of the canal discharge at the check point may be done basing on the rating table prepared by the Hydrologist of Head Office in cooperation with them in each District Office.

3.7.2. Discharge Control in Canal System

Distributed discharge can be measured by a parshall flume provided at the immediate downstream of the head gate, on the other hand it is also obtained from the rating table, prepared previously at the appointed point in the canal. Accordingly, the rating table at the appointed point shall be made by discharge measurement.

The programed discharge is instructed from the Head Office to each District Office. The Water Master (WM) or Gate Keeper (GK) operate the head gates assigned them with a programed discharge. In case the canal discharge is short of the programed one, they must report the Area Engineer (AE) or District Manager (DM) about the situation.

The GK must take a daily record by Form 3-21 at each head gate point. The data must be submitted to WM by the end of week and he must file this data.

The WM must report the allocation result of irrigation water to AE by Form 3-22 and the AE or DM submit the result arranged the data by the Form 3-23 to the Head Office Engineer in charge as a reference.

3.7.3. Discharge Control of Turn-Out

Constant-head orifice structures have been used as turn-out in the irrigation system. Usually the two gates are applied for the structure. The first gate - the upstream gate - controls the size of the rectangular orifice. A second gate - the downstream gate - controls the water depth below the orifice and is operated to maintain the head across the orifice at a constant value.

The flow through the structure is varied by changing the area of the orifice. Actually, the gate is operated as following procedure:

i) Set the differential of water level (head) across the orifice.

ii) Decide the depth of opening of the orifice gate from Figure 3-23.

iii) Set the opening of orifice gate with the obtained (d)

iv) Arrange the control gate to keep the given head

The GK must take a daily record by Form 3-23 at all turn-out in charge him and he must submit those record to WM.

The WM must report the distribution result from each turn-out assigned him to AE, then the AE or DM submit the arranged data by Form 3-24 to WCCS in Head Office as a reference.

Form: 5-26.
From: (Name of GK)
To : (Name of WM)

Date: (Submitted Date)

Daily Record of Check & Head Gate Operation

Name of Canal: _____ Period: From _____ To _____

Name of Gate : _____, Size of Gate : (Width x Height) _____, Number of Gates: _____

Definite Water Level, Upstream: _____ m. Downstream: _____ m

Definite Differential Head : _____ cm

Code of Rating Table: _____

Operated[1]		(1) Programmed[2] Discharge (m^3/s)	(2) Delivered[3] Discharge (m^3/s)	(2) ÷ (1) x 100 Achievement of Delivery (%)	Water Level[4]		Difference of W.L. (3) − (4) (cm)	Gate Opening					
					Upstream (3) (m)	Downstream (4) (m)		G − 1		G − 2		G − 3	
Date	Hour							(m)	(%)	(m)	(%)	(m)	(%)

(Notes)

1/ Gate opening should be adjusted once or twice a day.

2/ Programmed discharge is instructed by the Water Master.

3/ Delivered Discharge is obtained by the rating table placed at immediate downstream of the head gate.

4/ Gate keeper must report the unusual condition of water level to Water Master in case the water level is in the excess of limitation allowed which should be determined in accordance with the value of hydraulic water depth to be maintained.

5/ This record should be submitted to the Water Master once a week.

From 3-27.
From: (Name of WM)
To : (Name of AE)

Date: (Submitted Date)

Weekly Record of Gate Operation in Division of WM

Period: From _____ To _____

Name of Canal	Name of Gate	(1) Programmed Discharge (m^3/s)	(2) Delivered Discharge (m^3/s)	(2)÷(1) x 100 Achievement of Delivery (%)	Water Level in Canal			
					Upstream		Downstream	
					Definite (m)	Actual (m)	Definite (m)	Actual (m)
			Max. Min. Ave.			Highest Lowest Ave.		Highest Lowest Ave.

(Note)

1/ The comment or the result of review on the achievement of water distribution should be attached to this record by assigned WM.

Weekly Record of Turn-out Operation in Division of WM

Period: From _____ To _____

Name of Canal	Name of Turn-out Gate	(1) Programmed Discharge (lit/s)	(2) Delivered Discharge (lit/s)	(2)÷(1) x 100 Achievement of Delivery (%)

(Note)

1/ The comment or the result of review on the achievement of water distribution should be attached to this record by assigned WM.

Form 3-28.
From: (Name of GK)
To : (Name of WM)

Date: (Submitted Date)

Daily Record of Turn-out Gate

Period: From _____ To _____

Name of Canal: _____

Name of Turn-out Gate: _____, Size of First Gate: (Width x Height)

Definite Differential Head: _____cm

Code of Rating Table: _____

Operated 1/		(1) Programmed 2/ Discharge (lit/s)	(2) Delivered 3/ Discharge (lit/s)	(2)÷(1) x 100 Achievement of Delivery (%)	Actual Differential Head (cm)	First Gate Opening (cm)	Reaction / Remarks 4/
Date	Hour						

(Note)

1/ Gate opening should be adjusted once or twice a day.

2/ Programmed discharge is instructed by Water Master.

3/ Delivered discharge is obtained by the rating cave of Figure-

4/ Gate keeper must inform the unusual condition of water level in canal in case the programmed discharge cannot be taken due to the low water level.

5/ This record should be submitted to the Water Master once a week.

Form 3-29.
From: (Name of District Manager)
To : (Name of Operation Manager)

Date: (Submitted Date)

Weekly Record of Water Distribution

Period: From _____ To _____

Name of Canal	Name of Critical / Ordinal Point	(1) Programmed Discharge (m^3/s)	(2) Delivered Discharge (m^3/s)	(2) ÷ (1) x 100 Achievement of Delivery (m^3/s)	Water Level in Canal			
					Upstream		Downstream	
					Definite (m)	Actual (m)	Definite (m)	Actual (m)
				Max. Min. Ave.			Highest Lowest Ave.	Highest Lowest Ave.

Weekly Record of Countermeasure Performed at Inadequate Points on Water Distribution

Period: From _____ To _____

Name of Canal	Name of Critical/ Ordinal Point	Performed Countermeasure

3.8. Discharge Measurement in Canal System

3.8.1. Importance of Discharge Measurement

The measurement of canal discharge and the preparation of rating tables are two of the most important activities in the operation of irrigation systems. There are about 380 discharge measuring devices in the system that require periodic discharge calibrations to maintain their accuracy. These discharge measuring devices are either Parshall Flume, calibrated staff gates or automatic water level recorders and are mostly installed in the conveyance canals. The entire operation activities actually depends on these devices. Throughout the irrigation period, the delivery of the periodic irrigation diversion requirements to all service canals are made possible by the presence of these devices in the headgates of these canals.

3.8.2. Method of Measurement

(1) Measuring Instrument

The current meter is the universally accepted instrument in measuring the velocity of flowing water. The instrument operates on the principle of proportionally between the velocity of the water and the angular velocity of the meter rotor. By placing a current meter at a point in a stream and counting the number of revolutions of the rotor during a measured interval of time, the velocity of water at that point is determined.

(2) Measurement by Current Meter

In measuring the flow rate, the width of the canal will be divided into several sections, a partial section having not more than ten (10) percent of the total canal discharge. The ideal measurement is one in which no partial section has more than five

(5) percent of the total discharge in it but this is very seldom accomplished. A properly marked tagline will be stretched across the canal to indicate the points of measurements. The depth in all marked points will be measured. The partial cross-sectional area is the product of the width extending laterally halfway from both sides of the point of measurement and the measured depth at the same point, and are defined by the depths of location 1,2,3, ... The velocity in every location will be taken. the partial discharge q_x is now computed for any partial cross section at location x as follows:

$$q_x = \frac{dxVx}{2} (b_{x+1} - b_{x-1})$$

where;

q_x = discharge through partial cross section x
d_x = depth of water at location x
b_{x+1} = distance from initial point to next location
b_{x-1} = distance from initial point to the preceding point of observation
V_x = mean velocity at location x

Thus, far example, the discharge through partial cross section is

$$q_4 = 1/2\ d_4\ V_4\ (b_5 - b_3)$$

It is usually necessary to estimate the velocity at the end sections as some percentage of the adjacent section because it is normally impossible to measure the velocity accurately with the current meter close to a boundary. There is also the possibility of damaging the equipment if the flow is turbulent. Again, with the end partial area known, the discharge q can be computed.

The summation of the discharge for all partial cross sections is the total point discharge of the canal.

(3) Method of Measurement

The current meter measures velocity at a point. The method of making discharge measurement at a cross section requires determination of the mean velocity in each of the selected verticals. The mean velocity in a vertical is obtained from velocity observations at several points in that verticals. The mean can be approximated by making a few velocity observations and using a known relation between these velocities and the mean in the vertical. The most commonly used methods of measuring velocity are:

(a) Six-tenth-method

An observation at 0.6 of the water depth in the vertical is used as the mean velocity. Actual measurement and mathematical theory has shown that the 0.6 depth methods gives reliable results whenever the depth is not more than 75 centimeters although other researchers like Linsley (1975) recommends the limit to be up to 100 cm. For practical purposes, this method will be used if canal depths do not exceed 100 cm.

(b) Two-point Method

In this method, observations are taken in all verticals at depths of 0.2 and 0.8 below the water surface. The average of these two observations is taken as the mean velocity in the vertical. Experience has shown that this method gives more consistent and accurate results than the six-tenth method. The two point method is not recommended to be used at depth less than 75 cm because the current meter would be too close to the water surface and to the stream bed to give dependable results.

Chew (1964) suggested that the method be utilized at depths greater than 1.5 ft: MWRC (1977) recommends depths greater than 0.5 meter and Linsley (1975) recommends the limit to be from 1 to 2 meters. Again, for practical purpose, the recommendation of Linsley will be followed in all calibration works in the system.

(c) Three-Point-Method

The three point method consists of observing the velocity at 0.2, 0.6 and 0.8 of the depth below the water surface, thereby combining the two-point and the six-tenth methods. The mean velocity is computed by averaging the results as follows:

$$V = \frac{V_{0.2} + V_{0.8} + 2V_{0.6}}{4}$$

where:

V = average section velocity

$V_{0.2}$, $V_{0.6}$ and $V_{0.8}$ = velocities at 0.2, 0.6 and 0.8 of the water depth, respectively

When more weights to the 0.2 and 0.8 depth observation is desired, the arithmetical mean of the three observations may be used. The first procedure is however more accurate and hence recommended for use in the system.

The three point method is used when the velocities in the vertical are normally distributed.

(4) Types of Measurement

The types of measurement usually employed in canal calibrations are the Wading and the Suspended Cable Methods.

(a) Measurement by Wading

This method is employed when the depth of the canal is shallow and under conditions of relatively slow currents. The limit of employing this method will be determined by the ability of the observers to cross safely and stand in positions while making an observations. The type of wading rod presently used in the system is the round rod which consists of a base plate, lower section, three intermediate sections, sliding support and a rod end. The current meter is mounted on the sliding support and is set at the desired position on the rod by sliding the support.

In making measurements, the observer will stand in position which will least affect the flow distribution passing the current meter. With the current meter along the tagline, he will face along the line toward the banks and will stand 1 to 3 inches downstream from the tagline and 18 inches or more from the meter rod supporting the rod with this upstream arm. The rods are kept in vertical position and the meter directly into the flow during every measurements.

(b) Measurement by Suspension

When a canal is too deep or the current is too swift where wading cannot be possible, the current meter is suspended by cables above the water surface. A sounding weight will be attached to the meter to keep it stationary in the water. Also, a sounding reel will be used which consists of a drum for winding the sounding cable, a crank and ratchet assembly for raising and lowering the weight and meter or holding them in any desired position and a depth indicator. In the system, the Stevens Sounding Reel is mostly used.

The detailed procedure of making actual measurement in the field is shown in the DISCHARGE MEASUREMENT MANUAL attached at the end of this section.

DISCHARGE MEASUREMENT MANUAL

1. Method of Discharge Measurement

To check the canal discharge at the critical point in the canal system is very important on the execution of water management. The canal discharge at the selected point is obtained from the rating table which is prepared previously by the discharge measurement.

The selected check points of canal discharge in the system are about 380 and those stations are shown in O/M drawing No.17. In order to make the canal discharge accurately, the rating table must be periodically reviewed.

The discharge measurement shall be made in accordance with the following manner;

i) Measuring Instrument

Current meter

ii) Measuring Interval

In measuring flow rate, the width of water surface of canal will be divided into several sections. The standard intervals of lines for the measurement of water depth and velocity are given in accordance with the size of canal as follows:

Width of Water Surface W (m)	Interval of Line for Measuring Water Depth M (m)	Interval of Line for Measuring Velocity N (m)
less tan 10	10 to 15% of W	N = 2 M
10 - 20	1.0	2.0
20 - 30	1.5	3.0
30 - 40	2.0	4.0
more than 40	3.0	6.0

iii) Measuring Method

Six-tenth method or two-point method is used for the actual measurement of velocity in the canal. Their details are shown in the O/M Manual, particle 3.9.2. Principally the six-tenth method is used whenever the depth is not more than 1.00 meters, while the two-point method is for the depth over 1.00 meters as shown below:

Water Depth D (m)	Location of Measuring Velocity	Name of Method
less than 1.0 m	0.6 of the Water Depth	Six-Tenth Method
more than 1.0 m	0.2 and 0.8 of the Water Depth	Two-Point Method

iv) Measuring Type

The wading and the Suspended Cable Methods are usually employed for the discharge measurement. When the depth of canal is shallow and under conditions of relatively slow current, the former is used while the latter is used in case where the canal is too deep or the current is too swift.

v) Discharge Estimation Method

The discharge estimation from the result of measurement is made by the following manner:

- The water depth is obtained from the average of two times measurement.

- The mean velocity is averaged the average of two times measurements at each point. In case when the Six-tenth Method is adopted, the value is used as the mean velocity.

- The scope of a partial cross section born by a lines is stretched to the middle between adjacent lines for measuring velocity, and the area surrounded by adjacent two lines for measuring water depth is calculated as a trapezoid.

- The amount of discharge is the summation of the products of the partial areas of the canal cross-section and their respective average velocities.

An example of the measurement note is shown in Form 3-25.

2. Preparation of Rating Table for Canal

Hydrologist must prepare the rating table/rating curve of the selected points of the canal system in his District. It is distributed to the Gate Keeper (GK) in charge, then they use the table/curve for the operation of head gates.

Actually the rating table can be made as the following manner:

- Measure the flow rate with various canal discharge as well as the gauge height at the selected point. Usually the change of flow rate is made by arranging the head gate located upstream of measuring point.

- Make the rating table which shows a relationship between the gauge height and discharge.

- Prepare the rating curve.

3. Preparation of Rating Table for Gate

The rating table/curve of head gates shall be made, so that the GK can control the distribution water by arranging the gate opening. The discharge volume released from gate is estimated by the following equation;

$$Q = CBd\sqrt{2g\,H}$$

where, Q: Discharge volume (cu.m/sec)
C: Discharge coefficient
B: Width of gate (m)
d: Opening height of gate (m)
g: Acceleration of gravity (9.8 m/sec/sec)
H: Energy head between upstream and downstream (m)

Accordingly gate opening height (d) is obtained as follows:

$$d = Q/\left(CB\sqrt{2g\,H}\right)$$

The gate opening height is obtained by assuming C value since others are known or observed values. However, C value must be decided based on the result of discharge measurement since it varies according to various factors such as gate size, type, head, etc.

When the C value is constant, the gate opening height (d) is expressed by a function of the energy head (H) as mentioned above formula. Accordingly, if the rating table between d and H is prepared, d can be obtained by measuring the energy head H.

For the preparation of a rating table C value must be decided. For this purpose, when the discharge measurement of canal is made, if the value of head and gate opening are recorded, the C value can be obtained. Form 3-6 is a recording of C value estimation by the field observation.

Moreover, the computed rating table should be illustrated neatly so that the Gate Keepers can be seen at a glance as shown in Figure 3-24.

Furthermore at the check and head gates in the upstream portion of MARIS main canal which will be operated automatically, the observation should carefully be made because the value will be the basic factor to decide the gate opening.

Form 3-30.

DISCHARGE MEASUREMENT NOTES

Date: _____ Time: From: _____ To: _____

Canal/Creek: _____ Station/Location: _____

Width: _____ Area: _____ Gage Height: _____

Method: _____ G.H. Change: _____ cm, in _____ hours

Observers: _____ Checked by: _____

Field Work												Desk Work				
		Water Depth (m)			Velocity					Velocity(m/s)		Area (s.m.)				
No. of Line	Discharge from Initial Point(m)	1st	2nd	Mean	Depth of Observation (m)	Revolution (round)	Time (sec) 1st	2nd	Mean	at Point	Mean	Mean Water Depth (m)	Width (m)	Partial Area (s.m.)	Total (s.m.)	Discharge (m^3/s)
1	0	0.70	0.70	0.70												
					0.20	20	40.0	42.0	41.0	0.38	0.33	0.85	1.00	0.85	1.97	0.65
2	1.0	1.01	0.99	1.00	0.80	20	60.0	58.2	59.1	0.28		1.12	1.00	1.12		
3	2.0	1.25	1.23	1.24												
					0.42	30	20.0	21.0	20.5	1.04	0.79	1.67	1.00	1.67	3.81	3.01
4	3.0	2.10	2.10	2.10	1.68	20	28.0	27.0	27.5	0.54		2.14	1.00	2.14		
5	4.0	2.20	2.15	2.18												
					0.45	45	30.0	29.0	29.5	1.09	0.84	2.21	1.00	2.21	4.23	3.55
6	5.0	2.25	2.23	2.24	1.79	20	25.5	24.5	25.0	0.59		2.02	1.00	2.02		
7	6.0	1.80	1.78	1.79												
					0.31	30	24.6	25.0	24.8	0.87	0.71	1.68	1.00	1.68	2.97	2.11
8	7.0	1.55	1.57	1.56	1.25	20	28.0	27.6	27.8	0.54		1.29	1.00	1.29		
9	8.0	1.00	1.02	1.01												
											0.64	0.83	1.00	0.83	1.36	0.87
10	9.0	0.65	0.63	0.64	0.38	30	35.2	34.2	0.64	0.64		0.53	1.00	0.53		
11	10.0	0.40	0.42	0.41												

Total Discharge (m^3/s)	10.19
Total Gross Section Area (m^2)	14.34
Mean Velocity (m/s)	0.71

Form 3-31. Record of Computed Discharge Coefficient

Name of Canal: _____ Name of Gate: _____

Elevation of Canal Bed: Gate Type : Slide Gate Lip Type of Leaf: _____

Upstream : _____ Gate Size : (Width x Height)

Downstream: _____ No. of Gate : _____

Date	Water Level (m)				Mean Differ-ential Head (m)	Gate Opening						Discharge (m^3/s)	Computed "C" Value	Observers' Remarks
	Upstream		Downstream			G – 1		G – 2		G – 3				
	Start	End	Start	End		m	%	m	%	m	%			

Name of Canal: _____ Name of Gate: _____

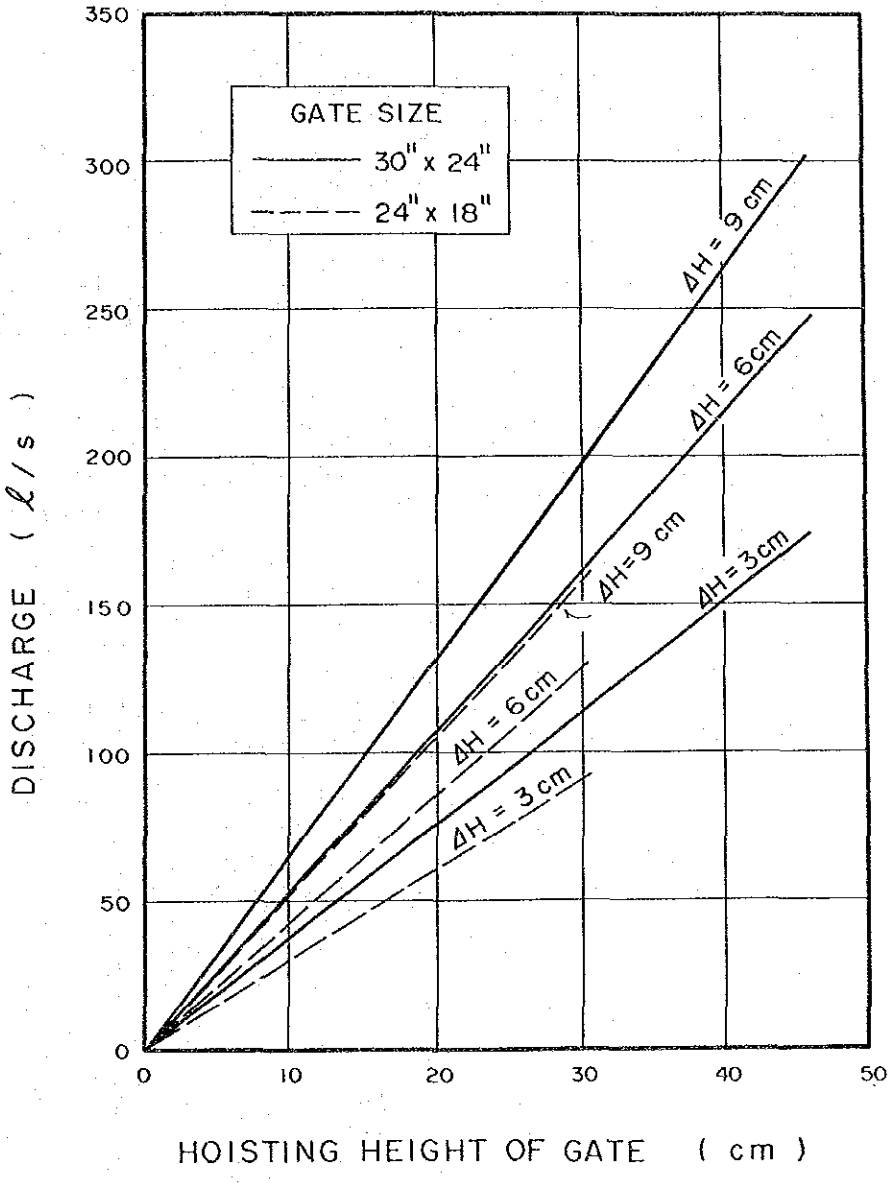
Elevation of Canal Bed: Gate Type : Radial Gate

Upstream : _____ Curvature Radius of Gate: _____ m

Downstream: _____ Height of Hinge: _____ m

Date	Water Level (m)				Mean Differ-ential Head (m)	Gate Opening						Discharge (m^3/s)	Computed "C" Value	Observers' Remarks
	Upstream		Downstream			G – 1		G – 2		G – 3				
	Start	End	Start	End		m	%	m	%	m	%			

FIGURE 3-23. OPERATION OF ORIFICE GATE



(Note)

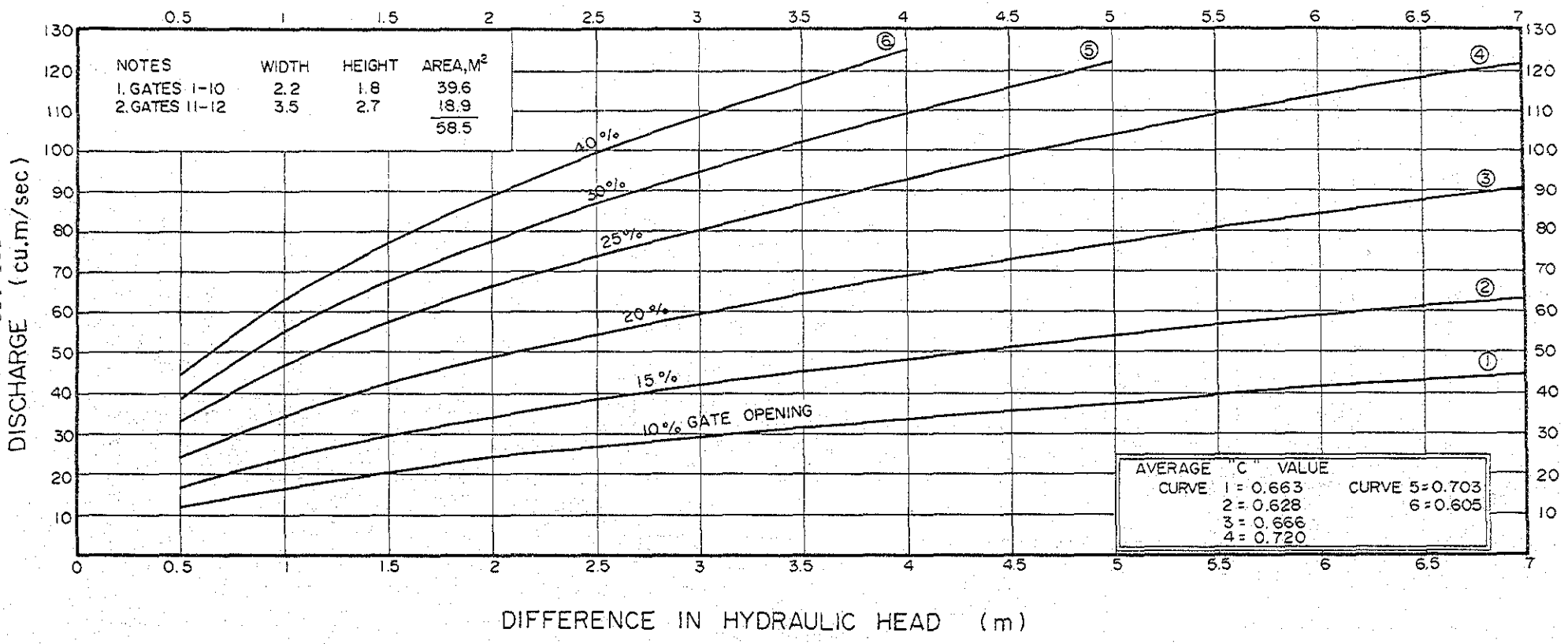
Computed equation of discharge

$$Q = C \cdot A \cdot \sqrt{2g \cdot \Delta H}$$

where,

- Q : Discharge
- C : Discharge coefficient (0.65)
- A : Area of Opening
- g : Acceration of Gravity
- Δ H : Loss of Orifice Gate

FIGURE 3–24. RATING CURVE OF MARIS MAIN CANAL AT THE INTAKE STRUCTURE



3.9. Monitoring and Evaluation

The monitoring and evaluation component completes the process of the operation cycle. During the delivery of water to all supply canals, there may occur a maldistribution within or among them as there are several factors that affect the distribution and application, like the estimate of area under irrigation, the accuracy of the water management parameters used, the unregulated utilization of checks/flashboards, in sensitive inflow points and the contribution of local inflows and rainfall.

Overestimation of irrigation diversion will naturally result to a wasteful utilization of irrigation water and contributes to the drainage problems especially in the low-lying areas while underestimation of the irrigation requirement will subject the crops to unnecessary water stream which will decrease crop yield.

The gage of the irrigation performance is the extent at which the target discharges as reflected in the irrigation plan is approximated. The usual index used is the irrigation efficiency in the farm, laterals and main canals. The efficiency of water utilization in these three operation levels reflects the over-all performance of the system in terms of water management.

To be able to undertake a systematic monitoring and evaluation, the following activities will be undertaken:

a. Daily reading of gage heights at the critical points of the main canal, laterals, sub-laterals, turnouts and drainage re-use.

b. Weekly accounting of actual area under irrigation indicating therein the different stages of farming activity. This will be used in estimating the actual irrigation diversion requirement to be compared to the actual delivery for the period.

c. Daily reading of rainfall from which to base the amount of affective rainfall.

The report on the daily readings of gage heights and rainfall for the previous week will be submitted by the Gate Keeper/Ditchtender to the WM every Monday morning.

The WM will submit the summarized discharge in his area coverage together with the actual area under irrigation for the previous week to the Area Engineer every Monday.

The Area Engineer will summarize the report by laterals and submits the same to the Assistant District Manager (ADM). The Assistant District Manager will validate the report and then submits it to the District Manager (DM) for his review. The report will then be submitted to the Engineering and Operation Division (EOD) for evaluation every Friday. All evaluation reports will be furnished the four Districts every Wednesday to give time for the District personnel to know their previous weeks performance before sending their request for the next week. A seasonal water management evaluation report will be likewise prepared to determine the progress of water management implementation in the system.

Monthly operation report will be submitted to the Central Office strictly in accordance with the M Curve. Area Engineers will be required to prepare their own M Curve to be summarized by the Districts. The M Curve of the Districts will be reviewed by the EOD prior to its submission to the Central Office.

For purposes of gathering feedbacks, monthly Operation and Maintenance Meetings will be conducted to discuss matters pertaining to operation and maintenance activities.

3.10. Billing and Collection

The topic on Billing and Collection is not fully discussed in this manual because there is already an existing manual on Billing and Collection prepared by the Central Office presently used in all irrigation systems in the country. The reader is therefore advised to refer to said manual for information they may need. For MRIIS personnel, additional information on strategies in irrigation fee collection as well as the computerization of bills are included for their reference.

3.10.1. Computerization of Bills

MRMP acquired one set of microcomputer in 1982. It likewise trained personnel in computer programming in preparation for its system wide operation. The acquisition of the computer paved the way for more efficient and much faster preparation of irrigation fee bills.

MRMP's initial thrust on computerization covering 10,741 ha revealed interesting information as follows:

a. Estimated computer time spent in preparing a single bill is only one minute and four seconds compared to about 17 minutes when prepared manually or a time reduction of about 94 percent.

b. Personnel services is reduced by 85 percent.

c. Cost per bill is reduced from ₱3.47 when prepared manually to only ₱1.45 when computerized or a reduction of 58 percent. Savings of ₱2.02 for every bill prepared can therefore be realized.

With these encouraging results, the system will expand its computerization program to eventually cover the entire service area. All field personnel will then be obliged to submit their weekly LIPAs (List of Irrigated and Planted Area) to avoid delay in the processing of bills. The submission of LIPAs will be closely monitored by the EOD. Also, other aspects of Operation and Maintenance activities will be computerized to improve the system's over-all performance.

3.10.2. Strategies in Irrigation Fee Collection

The participation of strong, viable farmers organizations in the operation of an irrigation system is recognized as one approach in attaining financial viability of a system. Indirectly by adhering to irrigation schedules and cooperation in the proper maintenance of structures and facilities, delays are minimized thus reducing supervision and engineering cost. Numerous programs beneficial to O&M could be cited like the Lateral Turnover Contract Programs to IAs.

Gigantic efforts have already been exerted in improving the efficiency and effectiveness in irrigation fee collection through mass collection in the MRMP. However, management is still looking into other means of strengthening its schemes with farmers organization to increase irrigation fee collection. Hence this collection strategy is considered.

Three conditions can be cited to categorize the scheme wherein IAs/FIGs will fall under this strategy. These are:

a. Phase I - IA conducts collection campaign within its area coverage, serves bill and financial statement to its members, schedule date and place of assembly of collections (in cash or in kind). NIA O&M collects and issues receipts to individual IA members. An incentive of 3 percent of the total collection through this scheme is given to IA/FIG.

b. Phase II - IA do activities under Phase I and in addition, collect, issue receipt to members and remit the collection to the NIA district office. An incentive of 5 of the total IA collection/remittance will be given to IA. Policies of NIA in the collection and remittance will be applied.

c. Phase III - This is a one bill-one IA scheme
The NIA will issue a bill in the name of the IA indicating the total amount corresponding to the firmed-up area/planted area for a certain season. The IA collect irrigation fee from its members and is fully responsible to NIA in the payment of fees regardless of IA collection efficiency from its members.

Requirements and Procedures:

a. Selection Criteria - To be qualified, IAs must possess these qualifications:

- IA must have an existing lateral turnover contract with MRMP.
- IA must have a firmed-up area coverage duly certified by NIA wherein individual farm lots and individual tillers are indicated.
- IA must have at least cash fund amounting to ₱5,000.00.
- IA must be registered with the SEC.

b. Term of Contract - The contract shall be renewable every after two cropping seasons. However, NIA have the option to terminate the contract in accordance with NIA polices.

c. Commission Incentive - Aside from the 10% discount given to individual member through the IA when the irrigation fee payment is paid on or before the specific deadlines, commission incentive will be given in the name of the association.

- Computation of commission incentive

Incentive will be provided/awarded for collections on current accounts and back accounts.

i) Current Accounts

i.a. First Condition - For 100% collection efficiency based on the principal base (MC # 101s. 1980) 8% commission incentive based on the total discounted collection (10% awarded to individual member) will be given to IA.

Illustration:

Cropping Season	=	Wet Season
IA firmed up area	=	150 ha
Principal base	=	300 cavans
Total collection	=	300 cavans
Less : 10%	=	30 cavans
Commission Incentive	=	(300-30) (8%)

= 21 Cavans & 30 kg or ₱1.836.00

Note: If collection are made in kind and in cash or purely cash, compute equivalent values in cash in terms of NFA or approved NFA collection price.

i.b. Second Condition - For collection efficiency of 90-99.9 commission incentive of 5 percent will be given to IA.

Illustration:

Principal base	=	300 cavans
Total Collection	=	270 cavans
Less: 10%	=	27 cavans
Commissions Incentive	=	(270 - 27) (5%)

= 12 cavans & 7.5 kg or ₱1,032.75

i.c. Third Condition - For collection efficiency of 80 percent but less than 90 percent commission incentive of 3% will be given to IA.

Illustration:

Principal base	= 300 cavans
Total collection	= 240 cavans
Less: 10%	= 24 cavans
Commission Incentive	= (240-24) (3%)

= 6 cavans & 24 kg or ₱550.80

i.d. For collection lower than 80 percent of principal base 2% commission will be given.

ii) *Back Accounts*

For collection on back accounts, 5 percent commission incentive will be given on the total collections made for the January - June and July to December of current year.

d. Requirements in the Filling of Commission Incentive Claims

i) Claims for commission incentive shall be field by the IA through the Division/District Manager to the project/system committee for commission incentive to IA immediately after the close of the collection period supported by the following:

i.a. Computation of commission incentive earned in accordance with the above illustration.

i.b. Firmed-up area and list of members and their corresponding payments.

e. Approval of Commission Incentive Claim - The Project Manager/Operations Manager approves, disapproves or defers claims as recommended by the Commission on Incentive Committee within one (1) month from date of receipt.

f. Commission Incentive Committee - For the purpose of the preparation and evaluation of the commission incentive, there shall be created the following committees.

i) Division/District Committee - Division Manager, O & M Section Head, Head Billing Unit and Accounting Clerk.

ii) O/M System Committee - O/M Manager, Division Manager, Chief O & M and Accounting Clerk.

TABLE 3-32. PROPOSED IRRIGATION AREA AND FARMING SCHEDULE FOR _____ CROP, 19____

Turnout: (No.)	M.C/Lateral: (No.)	Irrigation Block No.	Division:	District:

Rotation Area No. (1)	Farm Lot No. (2)	Land Owner (3)	Cultivator (4)	Projected Area(ha) (5)	Area Irrigated(ha)		Requested Area (ha) (8)	Signiture Confirmation (9)	Remarks
					Wet Crop (6)	Dry Crop (7)			
Subtotal									
Subtotal									
Total on Turnout									

IA		WM		AE		DM		WCCS	
FIG		GK		ADM		DATE	19 / /	DATE OF REGISTERATION	
DATE	19 / /	DATE	19 / /	DATE	19 / /			19 / /	

Notes: 1. Items (1) to (7) are to be filled in previously by WCCS, and the form is distributed to WM at latest 70 days before irrigation practice.
2. Items (6) and (7) present the past record of area irrigated.
3. Irrigation areas requested by farmers are collected by IA/FIG and submitted to WM at latest xx days before irrigation practice.

FORM 3-33. MONITORING OF STATUS OF IRRIGATION FEE COLLECTION FOR 19__, _____ CROP AS OF _____

District Number:

Division No.	Planted Area (ha)	Collectible Area(ha)	Collectible Amount (pesos)	Collected Irrigation Fee on Weekly Basis (Pesos) month						Sub Total	Efficiency (%)
				1st week	2nd week	3rd week	4th week	5th week	6th week		
Total (Area I)											
Total (Area II)											
Total (District)											
Collection Efficiency, (%)											

Notes: 1. The table is prepared by Operation Section of Head Office, based on the weekly collection report from District Offices. Following three kinds of data are prepared in different sheet; the 1st is a Summary of Collection, the 2nd is Collection in cash and in kind, and the 3rd is collection by IAs and NIA,

2. The collection status on the turn-out basis is also prepared by the Operation Section for monitoring at each District Offices.

FORM 3-34. IRRIGATION FEE REGISTER

Name of Farmer _____
Land Owner _____
Area _____ ha

19 ____, _____ Crop
District _____

Year/ Season	Lot & Parcel No.	Planted Area (ha)	Rate	Current Account			Back Account			Exemption				Total Charge			Payments						
				Bill No.	Date Billed	Amount	Year	Amount	Others	Date	C.M. No.	Area (ha)	Amount	Total	Current	Penalty	O.R. No.	Date	Current Account	Back Account Yrar	Back Account Amount	Others	Total

CHAPTER IV. MAINTENANCE OF SYSTEM FACILITIES

CHAPTER IV. MAINTENANCE OF SYSTEM FACILITIES

4.1. Importance of Maintenance

Maintenance and repair works of irrigation system are inseparable from operations activities. It embrace basically, some major elements of irrigation system management. Without maintenance, operation cannot be efficiently implemented.

Most of failure in the irrigation system, especially in the implementation of water management can be attributed to poor maintenance of irrigation facilities. Eventually, these lead to low water utilization and to a loss of expected benefits from huge government investments.

As much as possible, the original design capacity of canals must be retained. To do this, plan for repairs, needed improvements and other related activities shall be undertaken properly. However, some activities like routine maintenance in nature may be done during irrigation season. Along this, the guideline or procedures for maintenance and repair works is necessary in bringing out better irrigation services to farmer clienteles. If the importance of maintenance and repair works is brought to the concern of the beneficiaries, the problem about preserving longer the useful life of the irrigation system's facilities could be minimized.

4.2. Inventories and Drawings for System Facilities

To prepare the inventories of system facilities is very important for the operation and maintenance in the irrigation system. At the same time, the lay out map of service area about 1/50,000 indicated stations, type and size of structures or gates are very useful on the execution of maintenance works.

4.2.1. Inventories of System Facilities

The inventories of system facilities shall be arranged by each kind of structure in every canal system. The form of inventory are shown in the Form 4-1 to 4-6 at the end of this Chapter.

4.2.2. Canal System Diagram

The basic canal system diagram shall be prepared for planning and designing of canal and related structures. The name of canal, service area, maximum discharge of canal is indicated in this diagram, as shown as O/M, DRW No.23, 24, 25 and 26.

4.2.3. Canal Layout Basic Map

The basic canal system map with a scale of 1/50,000 would be made to use for preparation of canal maintenance plan. The canal route shall be drawn in the plan as accurately as possible. The canal name is indicated in the map and the canal dimension is tabulated on the right side of the drawing. See O/M DRW No.29, 30, 31 and 32.

4.2.4. Road Layout Map

Road layout map with a scale of 1/50,000 may be prepared by using canal system map as O/M DRW No. 41, 42, 43 and 44. The road network, villages or towns are drawn on the map. This map is used for the basic map of road maintenance planning.

4.3. Routine Inspection of System Facilities

The system facilities shall be periodically inspected. The result of inspection is arranged and tabulated, then it will be used for basic data of maintenance plan.

4.3.1. Dam and Diversion Dams

The routine inspection of dam shall be carried out basing on the instructions mentioned in Operation and Maintenance Manual. Especially, the inspection of mechanical facilities shall be done basing on the recommended frequency as shown in Table 4-1.

The routine inspection of mechanical facilities shall be carried out basing on the recommended schedules as shown in Table 4-2, these data are used as the facilities' historical record. The visual inspection for concrete facilities are also carried out periodically when some damages are found on these facilities, they shall be investigated in detail and used for a maintenance data.

4.3.2. Canal System

All canals in the District service area shall be inspected every suspension period of irrigation, then the situation of scouring or siltation is recorded on the formulated table as shown in Form 4-4 and 4-5. At the same time, the damages of structures shall also be inspected and shall prepare the maintenance plan as O/M DRW No.33, 34, 35 and 36.

4.3.3. Pumping Station

The routine inspection of pump shall be made daily, monthly and in every six month according to the instruction of the Pump Inspection Manual attached in the end of this chapter.

The operation record shall be made by in accordance with Form 4-7.

4.3.4. Gate

Once every six months the visual inspection and trial operation shall be carried out in order to keep gates in a good condition.

TABLE 4-1. INSPECTION AND TRIAL OPERATION SCHEDULES FOR EQUIPMENT AT DAM

Item Number	Item	Recommended Frequency	Remarks
1.	Ogee Spillway gates	3 months	Trial operate
2.	Orifice Spillway gates	12 months when the reservoir is at low level.	Trial operate behind stop logs.
3.	Power intake trash racks	Annually when reservoir is at low level or excessive head loss is indicated.	Racks need to be withdrawn for cleaning. NPC to request for cleaning.
4.	Power intake closure gates	3 months	Trial operation by NPC
5.	Headworks metal work including gates	Annually when reservoir is at low level.	Install stop logs or bulkhead to inspect upstream faces Repaint as necessary.
6.	Baligatan Spherical valve and outlet gates	3 months	Trial operate
7.	Baligatan metal work including pipeline and gates	Annually	Repaint as necessary
8.	Emergency power generator at left interface	3 months	Trial operate

TABLE 4-2. INSPECTION AND TRIAL OPERATION SCHEDULES FOR GATES AT DIVERSION DAM

Item Number	Item	Recommended Frequency	Remarks
1.	Stop log gates and Gantly crane	6 months	Visual inspection and Trial operate
2.	Sand Sluice gates	3 months	- do -
3.	Intake gates	3 months	- do -

Especially the following points shall be inspected:

i) Are there no any defection on the parts of gate?
ii) Are spindles, hoists and gears greased up enoughly?
iii) Are there no any trash around gate?
iv) Is not wire ropes of radial gate cut or loosen?

4.4. Maintenance of System Facilities

System maintenance may be classified according to the nature of the work, namely:

a. Maintenance of dam and diversion dam
b. Maintenance of canal
c. Maintenance of structures and mechanical facilities
d. Maintenance of service/access road
e. Maintenance of system drain
f. Maintenance of pump
g. Maintenance of farm level facility

Personnel of the O & M, such as the Ditchtender, Gate Keeper, and WM are directly involved in these activities. It shall be their responsibility to see to it that irrigation facilities such as farmditches, irrigation canals, drainage ditches/canals, appurtenant structures, measuring devices, gates, access/service roads, etc., in their respective coverage are properly maintained. On the other hand, pump facilities and its appurtenances be in order for effective operation. Farm level facilities, as well, shall be maintained by farmer-users with the motivation of the WM concerned.

Prior to irrigation water releases, all these facilities much be in good shape. Once irrigation commences, farmer-users shall not be allowed to draw water from the canal unless farmditches are properly cleaned and ready to receive irrigation water. This procedure will oblige the end-users to do their part in the maintenance of the irrigation system.

4.4.1. Maintenance of Dam and Diversion Dam

Maintenance works of the Magat Dam and Diversion Dams shall be carried out according to the instruction given in the Operation and Maintenance Manual of the Magat River Multipurpose Project.

4.4.2. Maintenance of Canal

Embodied in MC# 70, series of 1972, are specific guidelines or procedures on the maintenance of irrigation canals.

a. Irrigation facilities operated by NIA, foremost among which are the irrigation canals, shall be maintained continuously and to qualify as satisfactorily maintained irrigation canal, it shall have;

i) No vegetation within normal water line

ii) No debris or unnecessary obstruction inside canal

iii) No open gap in canal embankment

iv) No vegetation on canal embankment more than six (6) inches tall except on one side slope (left or right as pre-determined) where vegetables or other cultivated crops may be grown if such will not interfere with proper operation and maintenance and with prior written permission from the superintendent or officer in-charge

b. Each Ditchtender or Gate Keeper without assigned quarter, shall be required to construct a resting hut very near his canal section. If no Right of Way adjacent to the canal can be acquired, this may be constructed on the canal embankment but shall not block the roadway on foot path. the hut shall be of light materials only and the Ditchtender may be provided with materials to be purchased at an amount not exceeding ₱50.00 per hut. This will be used by him for resting on "siestas" during off-hours and will be a good meeting place with farmers to develop intimacy with them.

c. Every Ditchtender and Gate Keeper shall carry a white flag 1' x 1.5' on a light pole at least 3 m high. He shall keep this erect within at least 50 m radius from where he is working. In addition, the white flag shall contain a NIA seal, name of irrigation system, and his name all properly printed with green paint, for purpose of identification. Corresponding demerits shall be imposed also to dirty flags.

d. Provisions of the Memorandum Circular on posting of time sheets by Ditchtenders, Gate Keepers and WM shall be strictly enforce towards accomplishment of this objective. Time sheets shall be posted together with the flagpole of the Ditchtenders/Gate Keepers while working in their

sections and strategically situated (at least within a 50 m radius) within job site. However, in case a Ditchtender is assigned by his immediate supervisor for group work like water monitoring activities outside his section, his time sheet, flagpole and flag shall be left in his rest hut together with leaflet note indicating therein his whereabouts. Inspecting supervisors shall make entries on posted time sheets after every inspection made. These time sheets shall be the basis of payment of salaries or wages.

The length of canal section that may be assigned to a Ditchtender or Gate Keeper varies with the criteria set forth on MC# 7, series of 1982, superseding portions of MC# 63, series, of 1970 and MC# 86, series of 1979. Generally, a ditchtender's section has an average length of 3.5 km while a Gate keeper's section may be 1.0 or 1.5 km depending on clearable area of canal section handling 3 major gates.

Desilting and backfilling of gaps along canal sections or embankments shall be accomplished depending on the following conditions:

i) If the volume of earthwork is more than 15 cu.m, the use of equipment is necessary.

ii) If the volume of earthwork is less than 15 cu.m but greater than 3 cu.m, group work is recommended.

iii) If the volume of earthwork is less than 3 cu.m, the ditchtender concerned shall undertake the needed work.

Aside from the above-mentioned maintenance procedures, operation and maintenance personnel shall be held responsible in safeguarding irrigation facilities from adverse practices of farmers such as dumping of garbage materials, wallowing of animals especially carabaos inside canals, improper checking of structures (like the use of bamboo branches, hay, talahib, etc.), demolition of farm ditches without proper approval, and others that may cause deterioration/destruction of canals and structures. All violations of this act shall be properly reported and endorsed to the Operations Manager/District Manager/Operation Engineer concerned.

4.4.3. Maintenance of Structures and Mechanical Facilities

Maintenance of structures may be carried out as required or may be undertaken once every cut-off/suspension of irrigation water. For structures on the major diversion points, maintenance activities may be done seasonally. However, immediately after water cut-off, inventory on this structures must be made so that the needed replacement materials will be purchased and the required repairs done.

Activities to be undertaken on the gates at major flow points shall be;

i) Oiling/greasing of lifting mechanism

ii) Replacement of minor worn-out (like bolts, nuts, cables, and rubber seals)

iii) Painting/repinting of slide gates or gate frames

iv) Removal of accumulated debris/stones inside barrel sections

v) Other dealing with electrical and mechanical works

For structures along laterals, routine maintenance works shall be done like removal of debris and oiling/greasing of lifting mechanism of turn-out gates and check gates.

Painting/repainting, calibration and other maintenance activities for discharge measuring devices shall be undertaken by the Hydrologist of each District. However, the DT/GK shall see to it that no debris will be accumulated on staff gages and other measuring devices for accuracy of reading.

4.4.4. Maintenance of Service/Access Road

Inventory report of existing roadways and canal embankment/protection dike needing surface, re-metalling and grading shall be prepared by the Area Engineers and submitted to the Operations Engineer two (2) months before the initial water delivery for the ensuing crop season.

Maintenance of existing service/access roads shall include activities such as hauling, placing, spreading, rolling and grading of surface materials. Road surfacing materials for roadways shall consist of pit-run gravel, talus rock, volcanic cinders, sand collars, or other similar granular materials.

Subgrade of existing roadways shall be prepared before placing surfacing materials in such existing roadways.

4.4.5. Maintenance of System Drain

All farm drains constructed by the NIA shall be maintained by farmer-beneficiaries/Irrigators Associations, however the maintenance of systems drains shall be the responsibility of the NIA following the guidelines or procedures provided for in MC# 70, series of 1978 in connection with clearing and removal of unnecessary obstructions in water flow.

The use of excavation equipments may be applied on system drain improvements and on new areas not provided with drainage facilities.

4.4.6. Maintenance of Pump

Regular maintenance of pump may be carried out as required during operation and routine inspection/maintenance shall be undertaken once every month at the following points;

- Cleaning inside the pumping station
- Working condition of meters such as pressure, water level, voltage, current, oil surface meter, etc.
- Working condition of electrical switches
- Working condition of accident indicator and emergency bell
- Vibration or abnormal sound of machines
- Oiling and greasing for necessary parts of machines
- Replacement of minor worn-out (like bolts, nuts, cables and rubber seals)
- Removal of accumulated debris at the intake screen
- Other dealing with electrical and mechanical works

4.5. Repair and Improvement Work

Repairs usually undertaken consists of earthworks, replacement of R.C Pipes, lubricating gate lifting devices, painting, rip-rapping, desilting and others.

4.5.1. Guidelines in Rehabilitation of System Facilities

Guidelines/pointers to be considered in repairing existing irrigation canals shall be as follows:

a. The capacity of existing canal section and structure shall be checked. If the capacity is greater than the required discharge, the canal section shall be maintained, however, if the canal section have lesser capacity than the required discharge it must be re-designed or enlarged.

b. For over-sized canals, backfiling of canal bottom and inside side slopes should not be repaired.