CHAPTER 6

CHAPTER 6 FORMULATION OF IRRIGATION DEVELOPMENT PLAN

6.1 Plan Formulation Strategy

The basic plan formulation strategy for the Project is in line with objectives and management policy as set out in the formulated and enforced Irrigation Policy promulgated by the government in 1992. Particular attention is given to the following items stipulated in the objectives of the said Policy, and these have been specifically included in the various sector plans.

- To optimally develop irrigation services through cost effective investment in the irrigation development and extension programs.

- To ensure greater returns in the short run by meeting the water requirements of farmers' fields with an objective of increasing agriculture production.

- To decrease the government's involvement in the construction, maintenance and operation of irrigation schemes by gradually increasing the participation of organized users.

6.2 Social Preparation Plan

Before the implementation of the irrigation system in TIP, it is necessary to establish social awareness among the beneficiary groups of the Project area about the benefit of the system and role to be played by the farmers.

6.2.1 Role of the farmers as defined by the Irrigation Policy of Nepal

The Irrigation Policy of Nepal 1992 clearly emphasizes increased participation by organized farmers groups in all stages of project implementation and O&M. It is expected the policy will provide improved agriculture support services to farmers in irrigated areas. DOI is to introduce decentralized management practices and transparency in budget planning and expenditures, and increased role and responsibilities to WUAs are to be realized. Importance is given for local resource mobilization by progressively decreasing the government contribution to O&M of irrigation systems.

The participatory approach adopted in the Irrigation Policy aims at increasing the effectiveness of irrigation systems by involving water users in making and implementing decisions that will lead to an equitable, productive and sustainable system. The Irrigation Policy in Nepal provides for an important role by the organized farmer groups in all aspects of irrigation system management.

6.2.2 Raising Awareness (Receptivity) of Beneficiaries regarding TIP Implementation

It is necessary to make the farmers capable of taking responsibility in the management of the irrigation systems and derive benefits from the system. It is necessary to create awareness among the farmers on different aspects of TIP. The campaign for awareness generation would be done by holding meetings between the project staff and farmers at the irrigation block level. The awareness generation would be undertaken by mobilizing local agency staff at VDC of Khadgabhanjyang village, at Bidur Municipality area by the ward committee chairmen and campaigning about the role of the farmers in the O&M of TIP by the members of the District Development Committee. Where the literacy rate is high, pamphlets would be distributed to make the beneficiary understand his or her role in O&M of the system and benefits to be received from the Project.

Video films on irrigation water management and agriculture development would be exhibited to the farmers of the irrigation blocks.

1) Campaign for the formation of WUAs.

Organized groups of farmers through water users' associations would be the vehicle for the promotion of participatory irrigation management. The campaign for the formation of water users' associations requires sufficient lead time before the physical implementation of the irrigation system. Two months will be required to create awareness among the farmers on the need of the formation of WUAs under TIP.

2) Orientation of TIP and Need to Organize WUAs

The farmers in the TIP command area are to be oriented about the features of TIP.

They are:

- TIP will be for 9 month irrigation
- Crops are to be planned on the basis of 9 month water availability
- The main canals and some of the main branch canals will be of pipe system
- Some part of command area is to be served by pumps.
- The TIP is divided into 12 independent units called irrigation blocks (A-L)
- WUAs must take the responsibility of O&M of each block including the operation and maintenance cost of these lift pumps.
- The farmers have to share a certain percentage of construction cost as the part of their participation in physical infrastructure development
- Farmers are to be informed about the alternative cropping patterns which will bring them more income.

In order to carry out this orientation program regarding TIP, it would be necessary to form WUAs at each irrigation block before the physical implementation of the Project. Each WUA should be a self -governing, self regulating and self-supporting unit. WUA should not be an appendage of an other agency. The self-governing feature of the WUA indicates that it elects or selects the members of the executive committee by the general body of the farming community. It executes the decisions of the committee without the need of the input or approval from any agency. In the same way, the self -regulating characteristics of the WUA indicates that it formulates its own rules and regulations that reflect local needs and local characteristics of the farming community. The self-supporting feature of WUA enables it to generate sufficient income internally to finance its own operation and maintenance responsibilities. Effort to establish WUA with these features will help to develop a functioning WUA at different levels.

6.2.3 Training Programs

(1) Training Programs to Prepare for WUA Organization

(a) Orientation program directed at district level government officials

The district level officials orientation program shall be organized in order to brief these personnel on the TIP objectives and role to be played by related district level offices.

The objective shall be:

- to establish coordination among district officials on TIP activities

The content of the orientation program shall be to provide briefing on proposed activities of TIP and discuss ways and means of effecting district level inputs in the fulfillment of TIP objectives. This will be a one day program. It is expected to have 30 participants.

(b) Training Program to the Catalyst

The catalysts are to help form the WUAs at different levels of the TIP. The objectives of training program shall be

- to imbue catalysts with development skills in group formation
- to learn better communication skills
- to learn training methodology

The content of the program shall be:

- process of WUA formation
- group dynamics
- social psychology
- training techniques/methods

The program will include exercises which are to be done in real life situations. The program shall be of 5 days. It should be organized as soon as the catalysts are identified.

(2) Training Program for WUA Capacity Development

After organizing WUAs, human resource development in respect to WUA shall be an important component of TIP. In order to strengthen the WUA institutional capacity, the following training program is proposed:

(a) Orientation program to 1000 beneficiary farmers including female farmers

This orientation program aims at providing orientation on the Trishuli Irrigation Project, its features, matters relating to water management, cropping pattern, role and responsibility of the farmers. The main objective of the orientation program shall be to make the farmers aware of new opportunities to result from the irrigation system.

The orientation shall take place in each block. The orientation program will be conducted by organizing seminar, meetings and workshops. This program starts before and/or after the construction activities. It is proposed to hold about 20 activities. Each orientation program will consist of about 50 farmer participants.

(b) Training to farmers representatives at sub-block level WUAs

This program shall take place after the formation of sub-block level WUAs. The objectives of this program shall be:

- to develop the understanding about WUA membership
- overall role of the WUA in agriculture development

The content of the training program shall be:

- functioning of WUA
- office management
- financial management
- O&M activities
- agriculture activities

The training program shall be held in three locations; head, middle and tail.

The duration of the workshop shall be for 3 days. Number of participants shall be 100. The project staff in charge of the WUA takes the responsibility for organizing the training program. Resource persons from other district level departments will be mobilized.

(c) Training program to WUA representatives at the block level

This training program is for the WUA representatives at the WUA block level. The representatives consist of (a) chairman, (b) vice chairman, (c) secretary and (d) treasurer.

The objectives of this training program are:

- to make the officials develop skill on management
- to develop capacity to institutionalize WUA
- to make them aware of new opportunities in the TIP

The content of the program shall be:

- office management
- financial management
- O&M
- record maintenance
- water management
- agriculture development

The program shall be for 5 days. 3 workshops will be organized. The total participants shall be about 60.

(d) Farmer to farmer training program

This program will be organized for the mixed group of beneficiary including WUA members.

Objectives:

- peer group learning
- farmers can learn quickly from other farmer's experience
- to build confidence in the farmers, "if others can do it, why not we"
- to expose to the farmers to improved management of irrigation systems and agriculture practices in other locations places.

Observation tour groups will be organized to take the farmers of TIP to:

- Pittuwa Irrigation System, Chitawan
- Khageri Irrigation System, Chitawan
- Chhatis Mauja, Butawal
- Argeli and Chherlung system, Palpa
- Agriculture and horticulture farms in Chitawan Palpa and Pokhara.

About 200 farmers will be exposed to new locations through the F-F training program. Duration of the program shall be for 10 days.

8 groups consisting of 20 farmers will be taken on the observation tours. After their return, they will have to organize farmer meetings in their respective irrigation sub-blocks to discuss what they have observed and what can be beneficial for TIP, what can be adopted, what can not be adopted, etc. It is expected that such discussion at the sub-block level after the observation tours will serve to arouse interest on the part of many farmers.

(e) Training Program to Pump Operators

A training program shall be organized directed at pump operators of the irrigation system. The UWAs at block level will designate the operators.

Objective: The objective shall be:

- to make the operators of WUA proficient in pump operation at the block level.

A 2 days training program in the Project site area will be organized.

Cost Estimate of Training Program in Social Preparation

	Unit cost	Total cost (N.Rs)
a. Orientation program to 1000 farmers	100/person	100,000
b. Training to farmer representatives at the sub-block level : 100 farmers	200/person	20,000
c. WUA officials at the block level : 60 officials	300/person	18,000
d. F-F training to 200 farmers	500/person	100,000
e. Govt. officials at the district level : 30 officials	200/person	6,000
f. Training program to catalysts : 10 persons	2000/person	20,000
g. District irrigation staff : 10 persons	200/person	2,000
h. Pump Operators : 30	150/person	4,500
i. WUA repesentatives : 50 persons	1,000/person	50,000
j. WUA representatives at the sub-block level : 140 persons	1,000/person	140,000
k. District irrigation staff : 10 persons	3,000/person	30,000
l. Others		9,500
Total		500,000

Training Equipments/Requirement

TV	1 set	750,000 N.Rs
VCR		
Overhead projector		
Slide projector		
Video camera		
Screen		
White boards		

6.3 Agricultural Development Plan

6.3.1 Agricultural Development Plan Formulation

It is self evident in the Project area that agriculture is the main engine to accelerate economic growth under participation of the Project area general population. Almost all of the farm households in the Project area are to be benefited by the agricultural development.

The agricultural development plan should be fully confirm the following:

(1) Government policy background
(2) Poverty alleviation
(3) Food security
(4) Crop diversification
(5) Access to markets

(1) Government Policy Background

The government policy plan in Nepal is to accelerate the agricultural growth rate from 3 percent per annum to 5 percent per annum. The strategy for agricultural growth as stated in "Nepal Agriculture Perspective Plan" June 1995 has seven components : (1) accelerating agricultural growth, (2) focus on a reasonable limitation of inputs, (3) prioritization of appropriate inputs, i.e. irrigation, fertilizers, technologies, and agricultural roads, (4) priority on high value crops, (5) promotion of vegetables, vegetable seeds, fruits, potatoes, etc. under the foregoing priorities; (6) increased farm income and employment; and (7) improvement of the implementation mechanism. The agricultural development plan under the Project should therefore be in line with accelerating agricultural growth rate, crop diversification and selection of high value crops, and inputs use with improved irrigation system.

(2) Poverty Alleviation

A large number of marginal and small farm households having less than 0.5 ha farm-plots are generally observed to belong to the abject poverty class in the Hill. The proposed agricultural development plan is to be in line with the concept of poverty alleviation of small farm households via an improved irrigation system. Thus, the agricultural plan is specifically directed towards the needs of these small farm households.

The increase in crop diversification and intensification with the envisioned irrigation system is planned to increase cropping intensity, increase yield per hectare, increase productivity and production of both foodgrains and vegetables. Many small and medium farm households have potential to rise out of poverty on the basis of increase in agricultural productivity. The plan is as follows to increase cropping intensity, yield, productivity and crop diversification.

(i) Increased cropping intensity

- by 50 % (from 138% to 217% CI) in the case of 9 months irrigation scheme, and
- by 100% (from 138% to 300% CI) in the case of 12 months irrigation scheme

(ii) Increased Unit Yield

- by 50% (from 2.3mt/ha to 3.5mt/ha) with irrigation, new improved seeds, varieties and fertilizer use.
- by 100% (from 2.3mt/ha to 4.6mt/ha) with new varieties, new inputs, technologies and trained farmers under an improved irrigation system.

(iii) Diversification of crops to more productive and profitable high value crops such as vegetables and potato suitable for the project sites. The 9 month irrigation plan is to increase the cropped area for vegetables by 444% to reach to 48 % of the total cropped area.

(iv) Introduction of high value crops with high bio-mass production both for animal feed and maintaining soil fertility.

(v) Alley cropping, inter-cropping, mixed-cropping and relay cropping with leguminous crops.

The large and medium farm households with more than 0.5 ha of farm would enjoy benefits from new high yielding varieties, new technologies, and increase in total production with crop diversification.

(3) Food Security

The slow growth in the production of foodgrains in the past has gradually eroded food security. The government of Nepal has prioritized policy to increase food availability to the population. The agricultural development plan is in line with the government policy to make foodgrains adequately available in the Project area, which will extend to the small farmers with their increasing purchasing power for family food consumption. The supply of foodgrains (cereal crops production) is planned to be available through improved technology adoption by the farmers together with new high yielding varieties.

Thus, the agricultural development plan has adopted two lines of defense for providing food security to small farmers:

(i) The first is to ensure adequate physical quantities of foodgrains available in the Project area;

(ii) The other is to ensure that the poor have adequate purchasing power to obtain that food.

The plan has also considered households level food security by:

(i) Access to productive resources
- Income opportunities and
- Employment opportunities

(ii) Reduction in shortfall of foodgrains
- Small farm households are in shortfall of foodgrains and this is one indicator of food insecurity (44% small farms with less than 0.5 ha of land).
- Medium farm households to be lifted above the poverty line (reduced the food insecurity) from the present food shortfall situations.

(4) Crop Diversification

High value crops (vegetables etc.) account for 8 percent of the total cropped area of Nepal and contribute 14% of total agricultural GDP.

Crops	Mountain	Hill	Terai	Nepal	(%)
Vegetables	7	50	82	139	45%
Potato	17	49	19	85	28%
Fruits	11	37	20	68	22%
Others	0	13	4	17	5%
Total	35	149	125	309	100%
Rate of HVC to total crops	10%	10%	6%	8%	

High value crops are particularly critical for higher income to the small farmers. They offer an opportunity for high income per hectare for small farm households with favourable income generations for increasing their capability to purchase foodgrains required to meet their family consumption. The successful cultivation of high value crops is also planned to reduce poverty of these small farm households.

(5) Access to Markets

Farmers are responsive to market demands and technological innovation if they are given access to markets as demonstrated in the case of VFC project by the farmers of Rapti zone and also in the case of PAC by the farmers of PAC/Sindhuwa. Traditionally, Nepal's hill farmers have had limited access to the market network for the commercialization of their production. But the TIP area has an advantage due its linkage with Kathmandu market.

There are also examples of effective private-public interaction in Nepal. The VFC project of Rapti zone has demonstrated the potential for improving small farm incomes by providing access to markets for high value crops produced by those small farmers households.

- Strengthening market information system,
- Strengthening to establish link with major markets, and
- Facilitating market linkages

6.3.2 Plan Formulation Strategy

The Study Team also drew on the valuable body of experience and lessons learned from other hill irrigation projects as well as from the previous Battar Irrigation Project and Dhikure-Chaugadha Irrigation Project carried out in Nepal under similar conditions and applied this to formulation of the project plan. These experiences and lessons can be summarized as follows:

(1) Adoption of a participatory approach with active participation of the beneficiaries (the users) from the incipient planning stage,

(2) Very cost effective, efficient and pragmatic design of the agricultural support services;

(3) Formulation of a project which can readily obtain the coordinated and integrated support, cooperation and collaboration of the concerned government line agencies in achieving design targets;

(4) Formulation of the agricultural development plan under the Project is to be based on the following factors;

- The experiences of farmers from the Battar Lift Irrigation Project in cereals as well as in vegetable cropping pattern are effectively applied to the formulation of the project plan.

- The present experiences and performance of the farmers in adopting both the cereal crops and vegetable crops in Dhikure-Changadha Irrigation Development Area close to TIP have helped us in formulation of the agricultural development plan.

- The comparative advantage of the location and profitability of crops especially vegetables crops and fine quality rice (Pokhareli Masino Variety) are effectively applied to the formulation of the project plan.

- The preferences and the priorities of crops based on previous experiences and the present observations have also been effectively applied in planning; and

- The knowledge and knowhow (skills) of the user farmers have also been applied in formulating the agricultural development plan.

6.3.3 Basic Plan Strategy

In approaching the basic strategy for the plan, the types of irrigation schemes (gravity flow and lift irrigation), farm size and tenancy situation with Kumal groups of the Study area have been applied. The basic criteria included selection of : (1) foodgrain crops to meet the food requirement of the Study site and surrounding areas; (2) selection of other crops which comprise primarily the most profitable and potential vegetable crops; and (3) anticipated yield based on the performance of some of the farmers in the Dhikure Irrigation Project Area. In addition to irrigation and fertilizer application and adoption of superior seed varieties, access to new technologies and access to markets with effective agricultural support services are keys to achieve the design yields.

(1) Meeting Foodgrain Requirement

The national agricultural development policy has focused on increased cereals production to meet the food grain requirement of the hill districts. Most of the hill districts including Nuwakot are food deficit. The Study area is also a food deficit area (see Table 5.3.2-4).

Farmers experience and preferences for maize, paddy and wheat (cereal crops) were indicated in field survey to meet their food requirements. Therefore an overall cropping of 46% of cereals crops is planned under the Project, ranging 25% to 70% in the 12 irrigation blocks.

A 20% increase in cropped area is planned in the Study area as shown in Table 6.3.4-1. And as a result, a 255% increase in food grain production is anticipated to meet the local food requirement.

(2) Focus on Vegetable Cultivation for Higher Income and Employment

Growing only cereal foodgrain on less than 0.50 ha of farm land a family of 6 members neither met the foodgrain requirement nor rise above the poverty line. The long term Agricultural Perspective Plan (APP) has also prioritized the introduction of high value crops including vegetables. The farmers of the Study area have also indicated during the field survey their experience, preference and desire for potential introduction of vegetable and potato. The farmers of the Project area are also aware of the profitability and comparative advantage that they have in the cultivation of vegetables. The plan is to involve small and marginal farmers in vegetable cultivation to increase their income and employment and make them capable to purchase foodgrains for family consumption.

Although extension of vegetable cropping has not been pursued in the Study area due to lack of irrigation water, the farmers indicated their previous experiences in vegetable cultivation as well as the performance of farmers in the Dhikure-Chaugadhi and Jiling areas with irrigation facilities. Therefore, an overall cropping of 54% of vegetable crops and potato is planned under the Project, ranging 30% to 75% in the specific irrigation blocks.

(3) Anticipated Yield

Although, the average yields national wide (including rain-fed fields) have been stagnant for cereal crops except wheat, an anticipated yield target of 4.5 mt/ha has been set. Similarly anticipated yield targets of 15.0 mt/ha have been set for vegetable crops.

Table 6.3.3-1 Anticipated Crop-wise Unit Yield with the Project

(Unit: mt/ha)

Crops	At present in the Project area 1) (mt/ha)	At present in the Project area 2) (trainer's manual) (mt/ha)	Farm survey results 3) (mt/ha)	Anticipated yield with Project (mt/ha)
Paddy	2.40	4.3 to 7.3 Trishuli Masino Pokhreli Masino Khumal 2.44	5.00	5.00
Upland Paddy	2.06	3.0 to 7.0 Chino Ball Bindheswors	-	4.00
Maize	2.08	3.0 to 6.0 Khumal Yellow Rampur Composite Arun-3	4.00	4.00
Wheat	1.36	3.0 to 5.0 Khumal Yellow Rampur Composite Arun-3	4.00	4.00
Potato	10.00	30.0 to 32.0 Kupir Jyoh Cardinal.	18.00	18.00
Cabbage	15.00	16.0 to 30.0	40.00	25.00

Source: 1) Field Survey, JICA Study Team, Jan. 1997
2) Trainers Manual, 1988
3) Field Survey of Dhikure Irrigation Area

In field survey of selected farmers with limited irrigation facilities, it was found that the average yield for high yielding rice varieties with recommended fertilizer applications was on an average 5.0 mt/ha. Therefore, an anticipated yield under the Project is set at 4.5 mt/ha. for cereal crops, to be achieved by the 3rd year from the first year that cultivation is possible. In order to achieve this, adoption of high yielding varieties with improved seeds, improved fertilizing methods and application amounts are necessary, and improved cultural practices; planting, weeding, and cultivation.

6.3.4 Agricultural Development Plan

(1) Land Use

The land use plan is to be in line with the proposed cropping pattern with a total land use rate of 217% (under 9 months irrigation condition) or 300% (under 12 months irrigation condition). The cropped area under the plan is upgraded to 1,643.90 ha (217%) or 2,273.10 ha (300% cropping rate) per 9 months or 12 months irrigation, respectively.

Table 6.3.4-1 Present and Proposed Cropped Area

Irrigation Block		At present		Design (9 months)		Design (12 months)	
		Cropped Area (ha)	CI (%)	Cropped Area (ha)	CI (%)	Cropped Area (ha)	CI (%)
A	Cereals	25.63	110	32.62	140	41.94	180
	Vegetables	0.0	0	13.98	60	27.96	120
	Total	25.63	110	46.60	200	69.90	300
B	Cereals	65.28	136	67.20	140	86.40	180
	Vegetables	2.40	5	28.80	60	57.60	120
	Total	67.68	141	96.00	200	144.00	300
C	Cereals	87.67	118	104.02	140	133.74	180
	Vegetables	11.89	16	44.58	60	89.16	120
	Total	99.56	134	148.60	200	222.90	300
D	Cereals	106.63	131	81.40	100	113.96	180
	Vegetables	8.14	10	81.40	100	130.24	120
	Total	114.77	141	162.80	200	244.20	300
E	Cereals	133.38	128	104.20	100	145.88	140
	Vegetables	18.75	18	104.20	100	166.72	160
	Total	152.13	146	208.40	200	312.60	300
F	Cereals	25.80	86	29.90	100	411.86	140
	Vegetables	13.20	44	29.90	100	47.84	160
	Total	39.00	130	56.81	200	89.70	300
G	Cereals	51.60	100	51.50	165	72.10	140
	Vegetables	19.09	37	51.50	25	82.40	160
	Total	70.69	137	103.00	190	154.50	300
H	Cereals	41.52	120	48.44	175	62.28	180
	Vegetables	4.84	14	20.76	25	41.52	120
	Total	46.36	134	69.20	200	103.80	300
I	Cereals	41.35	96	34.65	100	34.65	75
	Vegetables	15.25	33	57.75	90	103.95	225
	Total	59.60	129	92.40	190	138.60	300
J	Cereals	48.85	86	42.60	100	42.60	75
	Vegetables	24.99	44	71.00	90	127.80	225
	Total	73.84	130	113.60	190	170.40	300
K	Cereals	67.94	86	59.25	100	59.25	75
	Vegetables	34.76	44	98.75	90	177.75	225
	Total	102.70	130	158.00	190	237.00	300
L	Cereals	170.91	133	205.60	200	205.60	140
	Vegetables	23.13	18	179.90	70	179.90	160
	Total	194.04	151	385.50	270	385.50	300
Total	Cereals	869.56	115	861.38	156	1,040.26	137
	Vegetables	176.44	23	782.52	51	1,232.84	163
	Total	1,046.00	138	1,643.9	217	2,273.10	300

Under the 9 months irrigation plan, the cropped area of vegetable crops is to be upgraded to 48% (782.52ha) whereas under the 12 months irrigation plan, it could be upgraded to 54% (1232.84ha). Thus, the cropped area for vegetables and potato has increased to 444% under the 9 months irrigation plan and to 700% under the 12 months irrigation plan.

Present and proposed cropping areas for various field crops are as follows:

Crops	Cropped Areas			
	At present	(9 months)	(12 months)	% Increase
Paddy	212.22	472.18	472.18	223
Upland Paddy	33.36	45.50	45.50	136
Maize	432.27	279.45	279.45	65
Millet	153.19	0	0	0
Wheat	38.52	64.25	243.13	631
Sub-total (cereals)	869.56 (83%)	861.38 (52%)	1,040.26 (46%)	120
Vegetables	176.44 (17%)	782.52 (48%)	1,232.84 (54%)	699
Total	1,046.00 (100%)	1,643.90 (100%)	2,273.10 (100%)	217

(2) Cropping Plan

The cropping plan is to be in line with the cropping patterns indicated in Figure 6.3.4-1 and 6.3.4-2. The water demand for vegetable crops is planned at half that for paddy.

In order to achieve both the food requirement as well as lifting of small and marginal farm households above the poverty, the focus of the cropping plan is vegetable crops based on their marketability and profitability. Given the natural conditions, farmer experiences in the area, factors of profitability, comparative advantages, marketability, focus on marginal farmers, proximity to farm land, farmers organization and farm labour availability as shown in Table 6.3.4-2, the introduction of vegetables is very much emphasized and optimized.

The major factors considered for the cropping plan are:

(1) Soil and topographic conditions;
(2) Farmers experiences and preference;
(3) Proximity to farm;
(4) Access to market and economic status; and
(5) Farmers organization and labour availability

The design cropping plan are presented below in Figure 6.3.4-1 and 6.3.4-2.

Fig. 6.3.4-1 Proposed Cropping Pattern for 9 months Irrigation (1/2)

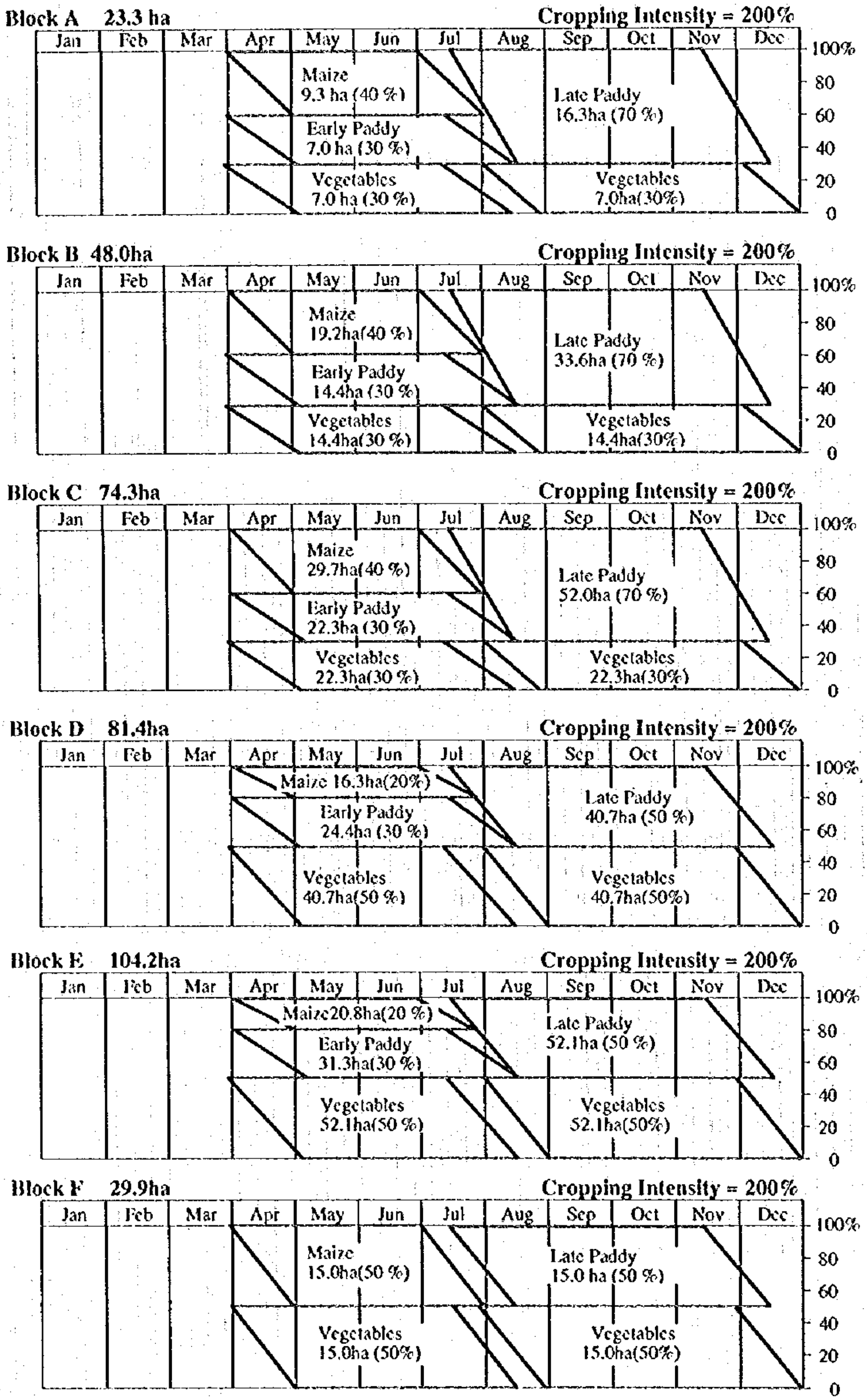


Fig. 6.3.4-1 Proposed Cropping Pattern for 9 Months Irrigation (2/2)

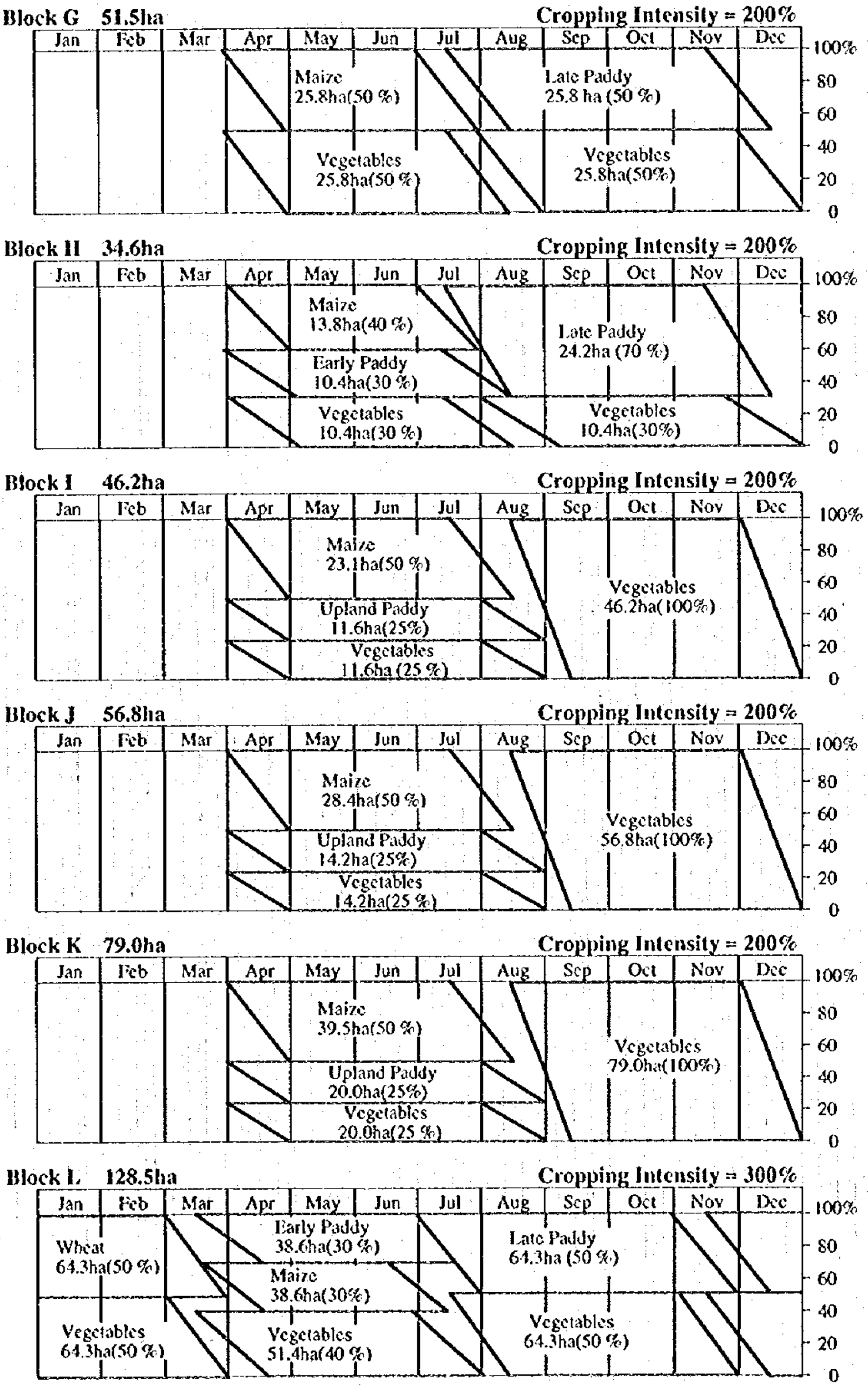


Fig. 6.3.4-2 Proposed Cropping Pattern for 12 Months Irrigation (1/2)

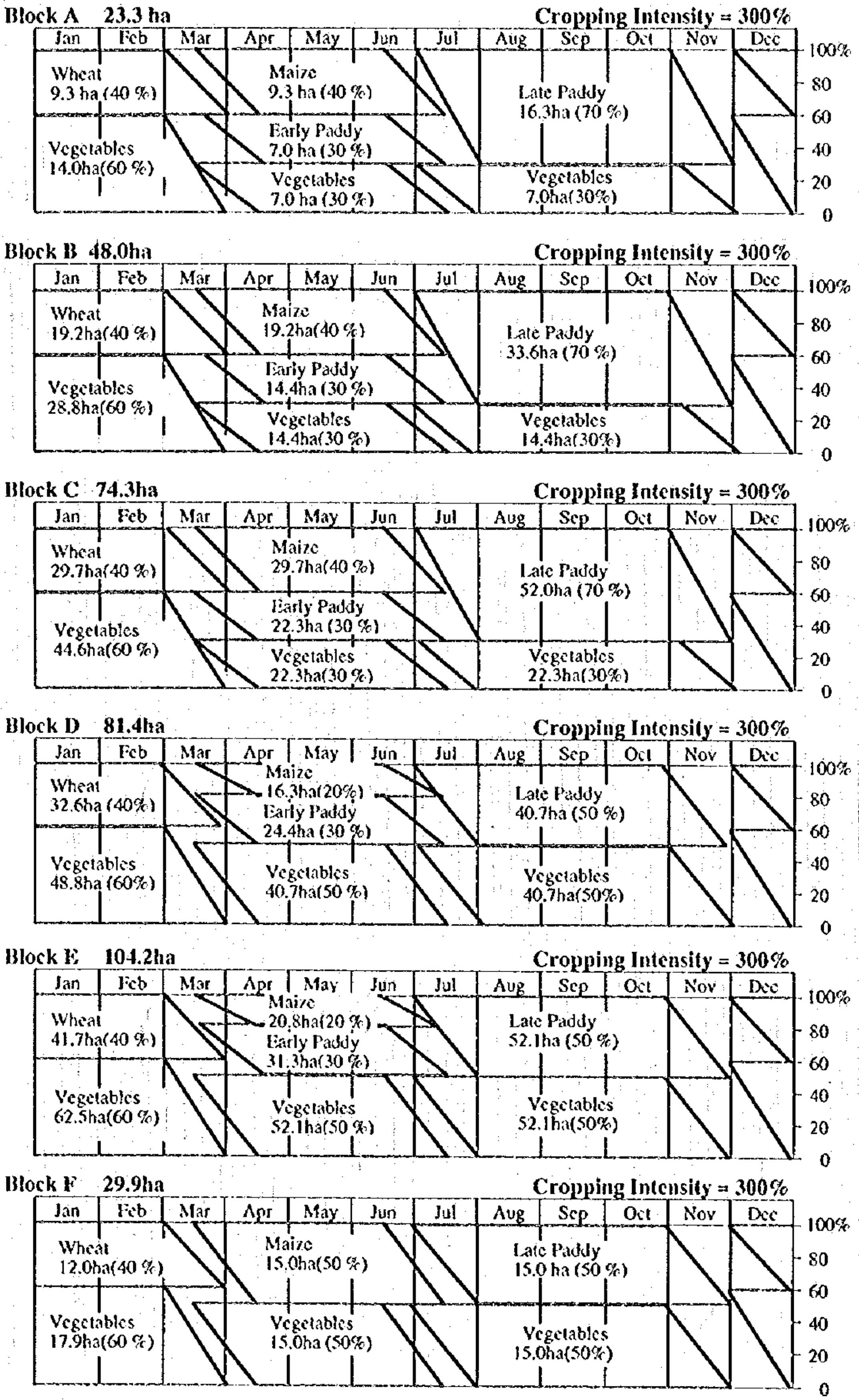


Fig. 6.3.4-2 Proposed Cropping Pattern for 12 Months Irrigation (2/2)

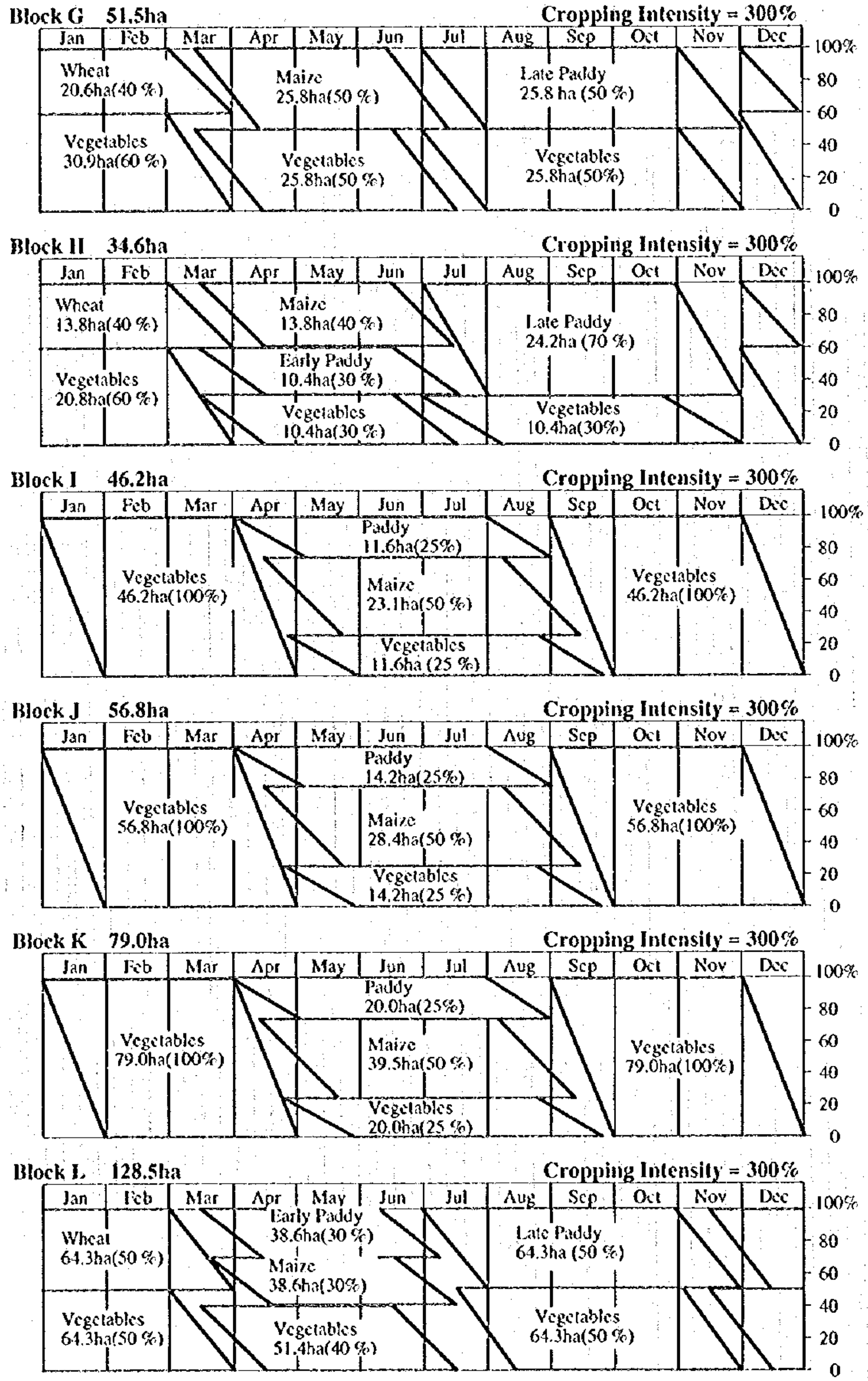


Table 6.3.4-2 Factors Referred to in Designing the Cropping Pattern (1/3)

Irrigation Block	Natural Conditions			Focus on Marginal & Small Farm Households			
	Soil condition moisture regime	Topo-graphy	Land use	Landless HH (no.)	Small farm (<0.5ha)	Focus on Vegetables	
						Cropped area (%)	Priority
A	wet	slope terrace	paddy	2	14	40	med.
B	dry-wet	middle + lower terrace	upland paddy	13	39	40	-do-
C	dry-wet	-do-	-do-	78	164	40	-do-
D	dry-wet	-do-	-do-	2	73	53	high
E	dry-wet	-do-	-do-	3	77	53	-do-
F	dry-wet	-do-	-do-	-	-	53	-do-
G	dry-wet	-do-	-do-	9	88	53	-do-
H	dry-wet	-do-	-do-	42	65	40	med.
I	dry	upper terrace	-do-	1	62	75	v.high
J	dry	-do-	-do-	3	28	75	-do-
K	dry	-do-	-do-	3	34	75	-do-
L	wet	terrace pan	paddy	3	86	46	med.
Total				159	730		

Source: Soil survey and DDC farm household survey.

Table 6.3.4-2 Factors Referred to in Designing the Cropping Pattern (2/3)

Irrigation Block	Proximity to farm land (%)	Farmer Experience and Preference				Access to markets	Linkages developed	Economic status
		Farmer experience	Farmer skills & knowhow	Farmer training	Farmers preferences			
A	10	low	med.	low	low	local traders	yes	higher
B	30	med.	-do-	med.	med.	local market	-do-	-do-
C	20	-do-	-do-	-do-	-do-	-do-	-do-	lower
D	100	-do-	-do-	-do-	-do-	local traders	-do-	higher
E	100	-do-	-do-	-do-	-do-	-do-	no	-do-
F	-	-	-	-	-	-	-	-
G	100	low	low	low	low	local traders	no	lower
H	30	med.	med.	med.	med.	-do-	yes	-do-
I	100	low	low	low	low	-do-	no	-do-
J	100	-do-	-do-	-do-	-do-	-do-	-do-	higher
K	100	-do-	-do-	-do-	-do-	-do-	-do-	-do-
L	30	med.	med.	med.	med.	-do-	yes	lower

Source : Based on the field observation and farmers interviews.

Table 6.3.4-2 Factors Referred to in Designing the Cropping Pattern (3/3)

Irrigation Block	Farmers Organization & Networks			Farm Labour Availability			Off-farm employment
	FOs	Savings & credit	HRD local capacity	Family labour	Large HH (%)	Small HH (%)	
A	yes	yes	no	low	21	45	low
B	no	no	yes	-do-	4	83	high
C	-do-	-do-	-do-	-do-	7	82	-do-
D	yes	yes	-do-	high	6	70	low
E	-do-	-do-	-do-	-do-	5	64	-do-
F	-	-	-	-	-	-	-
G	yes	yes	yes	high	17	54	low
H	-do-	-do-	-do-	low	9	69	high
I	no	no	no	high	11	48	low
J	-do-	-do-	-do-	-do-	10	61	-do-
K	-do-	-do-	-do-	-do-	8	52	-do-
L	yes	yes	yes	low	19	39	-do-
Total					11	62	

Source: Field survey.

(3) Improvement of Agricultural Practices, Anticipated Yield and Design Production

In order to improve agricultural practices of field crops, (i) improvement in planting good quality seeds, (ii) fertilizer application amount, time and methods, and (iii) improvement on production technologies are necessary

Timely and proper ploughing and land preparation for planting good quality seeds of new high yielding crop varieties was limited by the soil moisture (delay rains or bad monsoon). With irrigation, timely planting of high quality seed is planned. Under the plan, the demand for quality seed will increase to 822 metric tons.

Table 6.3.4-3 Estimated Seed Requirement for Field Crops in the Project Area

(Unit: kg)

Irrigation Block	Crops					
	Paddy	Upland Paddy	Maize	Wheat	Potato	Vegetables
A	1,666	0	186	932	14,000	7
B	3,432	0	384	1,920	28,000	15
C	4,904	0	446	2,229	60,000	37
D	5,820	0	488	2,442	60,000	35
E	8,597	0	521	2,605	50,000	28
F	1,973	0	299	1,495	15,000	8
G	3,257	0	515	2,575	30,000	16
H	2,379	0	346	1,730	16,000	10
I	0	635	693	0	88,000	50
J	0	781	852	0	108,000	60
K	0	1,086	1,185	0	150,000	80
L	8,835	0	642	3,212	128,000	70
Total	40,863	2,502	6,557	19,140	747,000	416

It is also planned to introduce new varieties for local seed multiplication in the Project area. To accomplish this plan, it will be essential to avail of multiplication technology support from the District Agricultural Development Office (DADO) and the horticulture farm in Trishuli, and obtain foundation seeds from the agricultural farms and stations under the Nepal Agricultural Research Council (NARC). As seed multiplication for paddy, wheat, maize, potato, french beans, etc. is at present undertaken by some farmers at Chandipokhari in irrigation blocks E an L, it is planned to introduce such multiplication technology through its external expansion in close relationship with DADO and the horticulture farm. The Project area has potential not only to meet the local demand of the Project area but also to meet the demand of the neighbouring villages outside the Project area.

Table 6.3.4-4 Seed Multiplication Area and Production in the Project Area

Crops	Seed Requirement (mt)	Area for Seed Multiplication (ha)	Seed Production (mt)	Surplus Seed Production for Sale (mt)
Paddy	41	15	60	19
Upland Paddy	3	5	15	12
Maize	7	10	20	13
Wheat	20	20	60	40
Potato	750	75	750	0
Vegetables	1	2	2	1
Total	822	127	907	85

Note: (1) Local seed multiplication to be initiated in a few selected irrigation blocks.
(2) Surplus seed production is planned in order to supply seeds in the neighbouring villages without project.
(3) Locally available seeds are expected to be cheap and of good quality.

With regard to improvement of fertilizer application amounts and methods, it is anticipated that the marginal and small farm households may suffer shortage of fertilizer amount for vegetable cultivation and therefore need both the technical assistance and production loans (rural credit system) with special support of the Project in the initial phase.

Table 6.3.4-5 Estimated Urea, DAP and Organic Manure Required for Field Crops Production in the Project Area

Irrigation Blocks	Fertilizers required			
	Urea (mt)	DAP (mt)	MOP (mt)	Organic Manure (1000 Duko)
A	14	7	6	16
B	29	14	10	32
C	47	23	16	54
D	51	26	17	56
E	58	26	21	63
F	18	9	6	19
G	31	16	12	34
H	21	11	7	23
I	35	17	9	42
J	43	20	11	53
K	61	29	15	74
L	84	42	28	96
Total	492	240	158	562,000

Sustainable agriculture with high value crops in small and marginal farm households is a big challenge in the Project area.

Table 6.3.4-6 **Potential Monthly per Capita Income from Field Crops and Percentage of Poverty Line**

Monthly per Capita Income	Types of Farm Households				
	Marginal	Small	Medium	Large	Average
At Present	23	61	180	374	155
(without project)					
Ratio for PL					
Poverty Line (%)					
at Rs. 3,945	7%	18%	55%	114%	47%
at US$ 150	3%	9%	25%	53%	22%
With Project	147	398	826	2,062	893
(9 months Irrigation)					
Poverty Line (%)					
at Rs. 3,945	45%	121%	251%	627%	272%
at US$ 150	21%	56%	117%	291%	126%
With Project	215	584	1,209	3,024	1,309
(12 months Irrigation)					
Poverty Line (%)					
at Rs. 3,945	65%	177%	370%	920%	398%
at US$ 150	30%	82%	171%	427%	185%

Source: Farmer interviews and design calculations.

Note: Marginal types of farm households need specialized activities in the Project area to rise above the poverty line, whereas small and medium types of farm households can be lifted above the poverty line with the design agricultural development plan.

The demand for soil fertility maintenance and humus content of the soil is very high. Therefore, it is planned to include leguminous vegetable crops as well as pulses in the cropping pattern of small and marginal farm households.

Anticipated yields under the Project are 4.5 tons per hectare for cereals and 15 tons per hectare for vegetables. Although a target yield of 25 tons per hectare of vegetables would be possible depending on the types of vegetable crops, the design yield has been planned at 15 tons per hectare to be in the safe side.

(4) Target Yield and Production

On the assumption of target yields for cereal crops of 4.5 mt/ha and 15.0 mt/ha for vegetables, irrigation block-wise crop production is shown in the table below.

Irrigation Block	At present		With Project (9 months)		With Project (12 months)	
	Cropped area (ha)	Production (mt)	Cropped area (ha)	Production (mt)	Cropped area (ha)	Production (mt)
A	25.63	76.89	46.60	368.48	69.90	610.46
B	67.68	158.91	96.00	748.80	144.00	1,257.60
C	99.56	142.44	148.60	1,159.08	222.90	1,946.66
D	114.77	224.54	162.80	1,611.72	244.20	2,474.56
E	152.13	332.81	208.40	2,063.16	312.60	3,167.68
F	39.00	61.06	59.80	583.05	89.70	899.99
G	70.69	119.50	103.00	1,004.25	154.50	1,550.15
H	46.36	88.74	69.20	539.76	103.80	906.52
I	59.60	76.32	92.40	1,004.85	138.60	1,697.85
J	73.84	115.53	113.60	1,235.40	170.40	2,087.40
K	102.70	160.68	158.00	1,718.25	237.00	2,903.25
L	199.04	362.83	385.50	3,623.70	385.50	3,623.70
	1,051.00	1,920.25	1,643.90	15,660.50	2,273.10	23,125.82

Design production for 9 months irrigation is computed at 3,917.70 tons of cereals production and 11,737.80 tons of vegetable production totaling to 15,655.50 tons. This represents a possible two fold increase over the present 1,819.69 tons of cereals production, whereas the vegetable production is a many fold increase over the present production.

The design production for perennial irrigation is anticipated to be 4,633.22 tons of cereals and 18,492.60 tons of vegetable production, totaling 23,125.82 tons.

Present and design field crop production are as follows:

Crops	Crop Production					
	At present	%	9 months	%	12 months	%
Paddy	508.94	100	2,360.90	464	2,360.90	464
Upland Paddy	68.59	100	182.00	265	182.00	265
Maize	897.74	100	1,117.80	125	1,117.80	125
Millet	291.88	100	0.0	-	0.0	-
Wheat	52.54	100	257.00	489	972.52	1,851
Sub total (Cereals)	1819.69 (95%)	100	3,917.70 (25%)	215	4,633.22 (20%)	255
Vegetables	150.56 (5%)	100	11,737.80 (75%)	7,796	18,492.60 (80%)	12,282
Total	1,920.25	100	15,655.50	815	23,125.82	1,204

Table 6.3.4-7 Estimated Field Crop Production (9 month irrigation)

(Unit: mt)

Irrigation Block	Field Crops						
	Paddy	Upland Paddy	Maize	Wheat	Cereals total	Vegetables	Total
A	116.50	0	37.28	0	153.78	209.70	363.48
B	240.00	0	76.80	0	316.8	432.00	748.80
C	371.50	0	118.88	0	490.38	668.70	1,159.08
D	325.60	0	65.12	0	390.72	1,221.00	1,611.72
E	416.80	0	83.36	0	500.16	1,563.00	2,063.16
F	74.75	0	59.80	0	134.55	448.50	583.05
G	128.75	0	103.00	0	231.75	772.50	1,004.25
H	173.00	0	55.36	0	228.36	311.40	539.76
I	0	46.20	92.40	0	138.60	866.25	1,004.85
J	0	56.80	113.60	0	170.40	1,065.00	1,235.40
K	0	79.00	158.00	0	237.00	1,481.25	1,718.25
L	514.00	0	154.20	257.00	925.20	2,698.50	3,623.70
Total	2,360.90	182.00	1,117.80	257.00	3,917.70	11,737.80	19,573.20

Table 6.3.4-8 Estimated Field Crops Production (12 month irrigation)

(Unit: mt)

Irrigation Block	Field Crops						
	Paddy	Upland Paddy	Maize	Wheat	Cereals total	Vegetables	Total
A	116.50	-	37.28	37.28	191.06	419.40	610.46
B	240.00	-	76.80	76.80	393.6	864.00	1,257.60
C	371.50	-	118.88	118.88	609.26	1,337.40	1,946.66
D	325.60	0	65.12	130.24	520.96	1,953.60	2,474.56
E	416.80	0	83.36	166.72	666.88	2,500.80	3,167.68
F	74.75	0	59.80	47.84	182.39	717.60	899.99
G	128.75	0	103.00	82.40	314.15	1,236.00	1,550.15
H	173.00	0	55.36	55.36	283.72	622.80	906.52
I	0	46.20	92.40	0	138.60	1,559.25	1,697.85
J	0	56.80	113.60	0	170.40	1,917.00	2,087.40
K	0	79.00	158.00	0	237.00	2,666.25	2,903.25
L	514.00	0	154.20	257.00	925.20	2,698.50	3,623.70
Total	2,360.90 (10%)	182.00 (1%)	1,117.80 (5%)	972.52 (4%)	4,633.22 (20%)	18,492.60 (80%)	23,125.82 (100%)

(5) Anticipated Crop Production Cost and Farmer Income

Present and design crop production costs are indicated below.

(Unit: Rs/ha)

Crops	Types of Farm Households	Crop Production Costs		
		At Present	With Project	% Increase
Paddy	Small	8,745	20,370	233
	Medium	13,227	20,370	154
	Large	15,950	20,370	128
Upland paddy	Small	5,295	17,515	330
	Medium	8,515	17,515	205
	Large	11,115	17,515	157
Maize	Small	4,551	17,867	393
	Medium	9,356	17,867	190
	Large	11,356	17,867	157
Millet	Small	1,055	-	-
	Medium	3,802	-	-
	Large	6,550	-	-
Wheat	Small	5,805	14,545	250
	Medium	7,800	14,545	186
	Large	9,800	14,545	148
Other crops	Small	600	-	-
	Medium	1,40	-	-
	Large	4,600	-	-
Potato	Small	-	45,700	-
	Medium	-	45,700	-
	Large	-	45,700	-
Cabbage	Small	-	64,200	-
	Medium	-	64,200	-
	Large	-	64,200	-
Radish	Small	-	19,025	-
	Medium	-	19,025	-
	Large	-	19,025	-
Beans	Small	-	18,565	-
	Medium	-	18,565	-
	Large	-	18,565	-

Note: The average land sizes of small, medium and large farmers are 0.12 ha, 0.37 ha, 0.78 ha and 1.60 ha, respectively.

Anticipated farmer incomes are indicated below.

Crops	Gross Income (Rs/ha)	Production Cost (Rs/ha)	Net Income (Rs/ha)	With Deign	
				% Increase of Net Income	Comparative Advantage (%)
Paddy	50,075	15,110	34,965	321	148
Upland paddy	35,060	11,885	23,175	238	98
Maize	34,000	13,867	20,133	239	84
Wheat	28,000	11,345	16,655	915	69
Potato	90,000	35,300	54,700	v. high	228
Cabbage	125,000	52,200	72,800	v. high	303
Radish	60,000	11,025	48,975	v. high	204
Beans	80,000	10,565	69,435	v. high	289

As indicated above the income increase with the irrigation project is very high and the comparative advantage of vegetables for farmer income is high.

(6) Improvement of Support Services Systems Focusing on Marginal and Small Farmers

As the focus of the Project is to alleviate poverty of the targeted marginal and small farmers, the DOA and ASCs are expected to formulate agriculture extension strategy for supporting these marginal farmers to lift them above the poverty line.

The proposed support services are:

(i) Cultivation credits are necessary in the case of the introduction of vegetables. The DOA is to take steps to facilitate cultivation loans by banks or through rural saving and credit systems of small farmers to ensure new improved seeds, chemical fertilizers, agro-chemicals and adoption of new technologies at recommended levels.

(ii) Under the plan due consideration is to be given to the introduction of vegetables based on their marketability and profitability.

(iii) A good technical support systems is anticipated under the plan preferably an expatriate be arranged for 3 to 5 years to the Project for the successful introduction and adoption of cultivation by small and marginal farmers for profitable marketing.

(iv) A massive training program both of field staff and farmers is planned. A series of trainings and on-the-spot guidance is required at various stages of vegetable cultivation for successful introduction and adoption. However, the detail planning of such training is to meet the immediate needs of the small and marginal farmers.

(v) The introduction of vegetables in the rainy season is planned with the provision of plastic houses and product handling and storage sheds for the vegetable products.

(vi) A good collaboration with the area agricultural research centers and horticultural farms is essential. It is necessary to strengthen the crop verification systems for newly introduced vegetable crops.

(vii) A good water management support system is also necessary to meet the critical stages when crop plants need irrigation and the amount required.

The following special support services systems are necessary for the small and marginal farmers to participate actively in the introduction of vegetable.

(i) Introduction of local seed multiplication programs through small farmers.

(ii) Initial support system for the large number of marginal farmers (around 990 HH) for the introduction of vegetables in their fields.

(iii) A massive training program on leadership development among the small and marginal farmers.

(iv) Identification, recognition and utilization of small and marginal farmers as trainer farmers to other small and marginal farmers (farmer-to-farmer concept).

(v) Initial support services on the provision of technology and inputs for lifting them above the poverty line.

(vi) Arrangement of soft loans or cultivation credits is also necessary in the case of small and marginal farmers.

(vii) The small and marginal farmers lack space for handling their products. It is therefore planned to establish handling and storage facilities for the groups of farmers.

Overall, about 41% of the total farm households with less than 0.5 ha of land is to be involved in introduction and adoption of vegetable cultivation, their seed multiplications, handling, processing and marketing functions. The Project needs to arrange the required breeder / foundation seeds for seed multiplication, inputs for increasing productivity, handling and storage facilities to reduce losses of poor farmers; processing facilities to add value to the small farmers products and marketing support to find linkage development and actual marketing of the products.

6.3.5 Agricultural Marketing Plan

The agricultural marketing plan under the Project is to be formulated according to the strategy below. This is based on an examination of the demand relationship for the increment in food production, including the production, collection · shipment and distribution stages, which will result from the shift from subsistence to commercial agriculture which will result from the introduction of food production technology and high value crops into the Project area. Promotion of food production technology and high value crops is a key component of government agricultural policy.

(a) An appropriate marketing plan is to be formulated with consideration to the marketability (in regional markets as well as Kathmandu and other large urban centers) of surplus agricultural products.

(b) In order to facilitate smooth collection and shipment of surplus agricultural products, necessary appurtenant market and distribution facilities are to be established, as well as a stable supply network for essential agricultural production inputs.

(1) Production Stage

1) Selection of Crops to be Introduced

High yield vegetable crops including cabbage, potato, radish, french beans, etc. are targeted for introduction to the area as well as market oriented crops, based on criteria of farmer desire, topographical conditions, soil conditions, levels of existing farm management technology, and crop marketability.

2) Estimation of Self-sufficiency Rate in Food Production

Estimation of self-sufficiency rate in food production takes into account the factors described below of population, per capita nutrition, and crop loss.

(a) Estimated Population

The estimated population in the year 2000/01 when target yields under the Project are to be achieved was calculated on the basis of data available at the Nuwakot District Statistics Office. Area-wise estimated population is as indicated in Appendix 6.3.5-1.

(b) Per Capita Nutrition

Minimum daily nutrition per capita as set by the National Planning Commission is 2,250 calories. If this amount is computed in terms of annual per capita caloric requirement from cereal and vegetable intake, this comes to 191 kg of cereals and 102 kg of vegetables (including potato).

(c) Crop Loss

Based on the crop loss criterion determined by the Marketing Development Division of DOA (see Appendix 6.3.5-2), harvested agricultural products have been computed in terms of edible form.

As indicated in Appendix 6.3.5-3, results of calculation based on the above assumptions show a present self sufficiency rate in food production of 81.7% in the Project area. In other words, there is an insufficiency of food production in the area. The rate is particularly low in Irrigation Block C at 39%, reflecting the fact that average farmer landholdings in the block of 0.25 ha are minimal compared to the overall average for the area of 0.52 ha. With implementation of the Project, average self-sufficiency rate for the area of 81.7% would rise to 140.9% in the case of 9 month irrigation, making possible the out-shipment of surplus agricultural products. Nevertheless, it is estimated that the specific self sufficiency rates for irrigation blocks C, H and I would still remain below 100%. In the case of perennial irrigation, the average self-sufficiency rate in food production for the Project area would reach 173.5%

3) Calculation of Agricultural Product Surplus

The quantities of surplus agricultural products which could be shipped by irrigation block, as determined from calculations based on the increment in agricultural production under the Project (see Appendix 6.3.5-4), are as shown in Appendix 6.3.5-5. These are summarized in Table 6.3.5-1 below.

Table 6.3.5-1 Shippable Quantities of Surplus Agricultural Products

Crop	9 month irrigation (mt)	Perennial irrigation (mt)
Paddy	925	984
Maize	285	422
Wheat	183	568
Cereals (subtotal)	1,393	1,974
Vegetables	11,442	19,150
Total	12,835	21,124

In the case of irrigation blocks which do not achieve self-sufficiency in food production under the Project (i.e. Irrigation Blocks C, H, and I in the case of 9 month irrigation and Irrigation Block I in the case of perennial irrigation), it is assumed that these households would be able to market surplus vegetables at an average farmgate price of Rs 5.25/kg and use the proceeds from such sales to purchase coarse rice (Mota variety) at a market price of Rs 13.5/kg to offset insufficiency in cereal production. On this basis, it is assumed that all irrigation blocks will be able to self sufficiently achieve the minimal nutritional requirement per capita. The shippable amounts of surplus agricultural products indicated in the table above are those quantities after achievement of self-sufficiency in the Project area.

4) Estimation of Agricultural Input Requirements

In order to achieve the yield targets for crops to be introduced under the Project, it is essential that agricultural inputs such as improved seeds, chemical fertilizer, agro-chemicals, etc. be supplied to the farmer in a timely manner and in appropriate volume. Such a supply system would make effective use of existing AIC and private retailer marketing routes. Require amounts of agricultural inputs in the case of 9 month irrigation and perennial irrigation are estimated below.

(a) Improved Seed

Diffusion of improved seed in the Project area is 40.2% of all farmers. Some 85% of farmers use home grown seeds, which is a factor in the deterioration of seed quality. Necessary quantities of improved seed for each irrigation block are indicated in Appendix 6.3.5-6. A summary is given in Table 6.3.5-2 below.

Table 6.3.5-2 Estimated Improved Seed Requirements

(unit: mt)

Crop:	9 month irrigation		Perennial irrigation	
	Requirement	Increment	Requirement	Increment
Paddy	26.0	12.2	26.0	12.2
Upland rice	2.5	1.0	2.5	1.0
Maize	5.6	-5.7	5.6	-5.7
Wheat	6.4	1.8	24.3	19.7
Cereals (subtotal)	40.5	9.3	58.4	27.2
Vegetables	978.9	978.9	1,542.0	1,542.3
Total	1,019.4	988.2	1,600.7	1,569.5

Accordingly, seed supply in the cases of 9 month irrigation and perennial irrigation are 1,019.4 mt and 1,600.7 mt, respectively.

(b) Chemical Fertilizer

Distribution of chemical fertilizer to farmers is via 11 AIC licensed retail outlets scattered in the Project area. Estimated fertilizer consumption by irrigation block is shown in Appendix 6.3.5-7. A summary is given in Table 6.3.5-3 below.

Table 6.3.5-3 Estimated Chemical Fertilizer Consumption

(unit: mt)

Crop:	9 month irrigation						Perennial irrigation					
	Urea		DAP		Total		Urea		DAP		Total	
	Consumption	Increment	Consumption	Increment	Consumption	Increment	Consum-ption	Increment	Consumption	Increment	Consumption	Increment
Paddy	94.4	56.2	47.2	13.3	141.6	69.5	94.4	56.2	47.2	13.3	141.6	69.5
Upland rice	9.1	2.4	4.6	4.6	13.7	7.0	9.1	2.4	4.6	4.6	13.7	7.0
Maize	55.9	'-30.6	27.9	-15.3	83.8	-45.9	55.9	-30.6	27.9	-15.3	83.8	-45.9
Wheat	12.9	5.1	6.4	2.6	19.3	7.7	48.6	40.9	24.3	20.4	72.9	61.3
Cereals (subtotal)	172.3	33.1	86.1	5.2	261.4	38.3	208.0	68.9	104.0	23.0	312.1	91.9
Vegetables	156.5	156.5	97.8	97.8	254.3	254.3	246.6	246.6	154.1	154.1	400.7	400.7
Total	328.8	189.6	183.9	103.0	512.7	292.6	454.6	315.5	258.1	177.1	712.7	492.6

Accordingly, chemical fertilizer amounts required in the case of 9 month irrigation are 328.8 mt of urea and 183.9 mt of DAP, or a total of 512.7 mt. In the case of perennial irrigation, required amounts are 454.6 mt of urea and 258.1 mt of DAP, or a total of 712.7 mt.

(c) Agro-chemicals

Distribution of agro-chemicals to farmers is via 9 retail outlets scattered in the Project area. Estimated agro-chemical consumption by irrigation block is shown in Appendix 6.3.5-8. A summary is given in Table 6.3.5-4 below.

Table 6.3.5-4 Estimated of Agro-chemical Consumption

(unit: lit.)

Crop:	9 month irrigation		Perennial irrigation	
	Consumption	Increment	Consumption	Increment
Paddy	165.3	91.0	165.3	91.0
Upland rice	15.9	4.2	15.9	4.2
Maize	97.8	97.8	97.8	97.8
Wheat	22.5	22.5	85.1	85.1
Cereals (subtotal)	301.5	215.5	364.1	278.1
Vegetables	1,226.2	1,226.2	1,931.9	1,931.9
Total	1,527.7	1,441.7	2,296.0	2,210.0

Accordingly, required amounts of agro-chemicals are 1,527.7 lit. in the case of 9 month irrigation and 2,296.0 lit. in the case of perennial irrigation.

(2) Shipping and Distribution Stage

1) Shipping Structure

Under the present shipping-to-market pattern, farmers mainly move their products on an independent basis. Group shipment is performed only by the Phirkep Devighat community development group. Under the Project, farmer groups will be organized under each irrigation block WUA by specialty crop. In order that surplus agricultural products may be efficiently collected and shipped, particularly in the case of vegetables which must be moved while still fresh, it is recommended that group shipping be instigated.

Formulation of the collection, shipping and marketing plan for surplus agricultural products and collection of marketing data will be the responsibility of the Agricultural Marketing Sub-committee described later. It will be essential that this be done in collaboration with the relevant line agencies, and with the support and self-initiative of the field level farmer groups under the WUA.

2) Demand Projection and Shipping Quotas for Surplus Agricultural Products

The objective under the Project is to market surplus agricultural products in local markets (Bidur) and the major urban market of Kathmandu, making full use of existing urban-rural agricultural marketing linkage and Project area's comparative advantage (geographical location, and function of the area as a vegetable supply base for Kathmandu).

(a) Cereals

Estimated demand for cereals at each market is set out in Table 6.3.5-5. In calculating demand, the same methodology as applied to the previously discussed self-sufficiency rate in food production was used. Priority of supply will be given to local markets, with the remainder of surplus products to be shipped to markets in Kathmandu.

Table 6.3.5-5 Estimated Demand and Shipping Quotas for Surplus Cereals (2000/01)

(unit mt)

Crops:	Estimated Marketed Volume		Demand Projection		Allocation of Marketable Volume			
					Local markets		Kathmandu markets	
	9 month irrigation	Perennial irrigation	Local markets	Kathmandu markets	9 month irrigation	Perennial irrigation	9 month irrigation	Perennial irrigation
Paddy	925	984	497	170,024	497	497	428	487
Maize	285	422	191	65,598	191	191	94	231
Wheat	183	568	129	44,187	129	129	54	439
Total	1,393	1,974	817	279,809	817	817	576	1,157

Assumptions adopted in the above calculations are given below.

a) In calculating the cereal demand for local markets (Bidur), food insufficiency quantity was computed based on estimated population and self-sufficiency in food production (applying the same rate of 81.7% use for the Project area) of Bidur city in 2000/01. Target population for Bidur was estimated excluding the Project area.

b) Estimated demand for Kathmandu markets was computed based on estimated population of Kathmandu district (2000/01) and self-sufficiency rate in food production (self-sufficiency rate in 1994/95 of 18.3% was adopted).

As a result of the above calculations, in order for Bidur city and Kathmandu district to meet food demand, 817 mt and 279,809 mt of cereals, respectively, are required. If the surplus cereal production under the Project is directed at these markets in the case of 9 month irrigation, demand at Bidur can be completely met, with the remaining 576 mt able to offset 0.21% of the demand in Kathmandu district. Under the perennial irrigation scenario, shipment of cereals to Kathmandu would rise to 1,157 mt, or 0.41% of the district's demand.

(b) Vegetables

Surplus vegetables produced under the Project would be shipped, as in the case with cereals, to local and Kathmandu markets. Estimated demand in each market is indicated in Table 6.3.5-6.

Table 6.3.5-6 Estimated Demand and Shipping Quotas for Surplus Vegetables (2000/01)

(unit: mt)

Crops:	Estimated Marketed Volume		Demand Projection		Allocation of Marketable Volume			
					Local markets		Kathmandu markets	
	9 month irrigation	Perennial irrigation	Local markets	Kathmandu markets	9 month irrigation	Perennial irrigation	9 month irrigation	Perennial irrigation
Vegetables	11,442	19,150	1,609	123,482	1,609	9,833	1,609	17,541

In calculating demand for vegetables, criteria of (i) per capita consumption of 102 kg per year (to meet the caloric intake requirement from vegetables), and (ii) estimated population (2000/01) were applied.

As a result of the above calculations, in order for Bidur city and Kathmandu district to meet food demand, 1,609 mt and 123,482 mt of vegetables, respectively, are required. If the surplus vegetable production under the Project is directed at these markets in the case of 9 month irrigation, demand at Bidur can be completely met, with the remaining 9,833 mt able to offset 8.0% of the demand in Kathmandu district. Under the perennial irrigation scenario, shipment of vegetables to Kathmandu would rise to 17,541 mt, or 14.2% of the district's demand. The foregoing do not take into account, however, factors of increased consumer income or changes in dietary preferences.

3) Agricultural Product Prices, and Marketing Routes

(a) Cereals

Paddy from the Study area (Pokhareli variety) is famous in Kathmandu as "Trishuli rice". The variety has an excellent taste and solid demand for it exists in Kathmandu. Retail price of Pokhareli in Kathmandu markets is shown in Table 6.3.5-7 (see Appendix 6.3.5-9 for details).

Table 6.3.5-7 Harvesting Periods and Retail Prices of Cereal Crops in Kathmandu (1995/96)

Case	Crops	Harvesting Period	Monthly Average Retail Price in Kathmandu (Rs/kg)					
			Corresponding Period	Highest	(Month)	Lowest	(Month)	Annual Average
9 months Irrigation	Rice (Pokhareli)	Mid Jul - Mid Aug	23.75	24.63	Aug/Sep	23.00	Jan/Feb, Apr-Jul	23.64
		Mid Nov - Mid Dec	24	24.63	Aug/Sep	23.00	Jan/Feb, Apr-Jul	23.64
	Rice (Mota)	Early Aug - Late Aug	13.17	19.00	Apr-Jul	12.38	Feb/Mar	14.59
	Maize	Early Jul - Late Jul	9.69	12.50	Feb/Mar	9.69	Jul-Sep	10.42
	Wheat	Early Mar - Late Mar	10.94	11.00	Mar/Apr	9.88	Jul-Sep, Dec/Jan	10.18
Perennial Irrigation	Rice (Pekhareli)	Mid Jun - Mid Jul	23.00	24.63	Aug/Sep	23.00	Apr-Jul, Jan/Feb	23.64
		Early Nov - Late Nov	24.13	24.63	Aug/Sep	23.00	Apr-Jul, Jan/Feb	23.64
	Rice (Mota)	Early Aug - Late Aug	13.17	19.00	Apr-Jul	12.38	Feb/Mar	14.59
	Maize	Mid Jun - Mid Jul	n.a.	12.50	Feb/Mar	9.69	Jul-Sep	10.42
	Wheat	Early Mar - Late Mar	10.94	11.00	Mar/Apr	9.88	Jul-Sep, Dec/Jan	10.18

Monthly average retail price of rice in Kathmandu at the design shipping period from the Project area is Rs 23.75/kg, which is slightly higher than the annual average of 23.64/kg, indicating that at least the annual average price level is virtually assured for shipped rice. Marketing route for paddy is planned via 6 existing collection and shipment centers (Gerkhu, Battar, Gangate, Inarpati, Devighat, Phirkep Devighat) to rice milling facilities in Kathmandu).

The 94 mt of maize and 54 mt of wheat (231 mt and 439 mt, respectively, in the case of perennial irrigation) destined for Kathmandu would be shipped via the existing route (as with rice) to poultry feed plants (Quality Feed Industry, Star Feed Industry). These plants mainly purchase maize and wheat from the Trishuli and Nepalganj areas for conversion to poultry and livestock feed (broilers, egg layers, livestock), which is then sold to wholesalers. Although the retail price in Kathmandu for maize at the design time of shipping is lower than the annual average, that for wheat corresponds to the peak price enabling an overall advantageous price level.

(b) Vegetables

Nuwakot district functions at present as a vegetable supply base for the major consumption center of Kathmandu. Percentage of total supply to the Kalimati Wholesale Market in Kathmandu accounted for by products from Nuwakot district are 10.8% for cabbage, 18.9% for red potato, 15.8% for white potato, 46.5% for red radish, 53.6% for white radish, and 14.5% for french beans reflecting the comparative advantage which Nuwakot has over other producing areas with regards to produce destined for Kathmandu.

Vegetable prices undergo significant change at each stage from the farm-gate to the retail outlet due to lack of storage facilities including cold storage. Wholesale prices in Kathmandu for the vegetable crops to be introduced under the Project (cabbage, potato, radish, french beans) are indicated in Table 6.3.5-8 (see Appendix 6.3.5-10 for details)

Table 6.3.5-8 Harvesting Periods and Wholesale Prices of Vegetables in Kalimati Wholesale Market (1995/96)

Crops	Harvesting Period	Monthly Average Wholesale Prices (Rs/kg)					
		Corresponding Period	Highest	(Month)	Lowest	(Month)	Annual Average
Cabbage	Early Mar - Late Apr	5.45	15.60	Apr/May	3.73	Mar/Apr	7.18
	Early Dec - Late Dec	6.85	8.98	Nov/Dec	5.50	Dec/Jan	7.18
Red Potato	Early Mar - Late Apr	6.40	6.99	Mar/Apr	4.50	Feb/Mar	9.41
	Early Nov - Late Dec	11.13	13.80	Oct/Nov	4.50	Dec/Jan	9.44
White Potato	Early Mar - Late Apr	5.84	6.78	Mar/Apr	5.35	Apr/May	8.10
	Early Nov - Late Dec	9.00	11.96	Oct/Nov	6.90	Oct/Nov	8.10
Red Radish	Mid Jun - Mid Aug	9.00	10.15	Jun/Jul	6.83	Jul/Aug	6.33
	Early Nov - Late Nov	4.71	5.90	Oct/Nov	3.17	Oct/Nov	6.33
White Radish	Mid Jun - Mid Aug	4.77	4.92	Jun/Jul	4.61	Jun/Jul	4.46
	Early Nov - Late Nov	5.20	12.90	Oct/Nov	3.06	Nov/Dec	4.46
French Beans	Early Jul - Mid Aug	18.87	23.24	Aug/Sep	15.50	Jun/Jul	16.40

Although the wholesale price in Kathmandu for cabbage at the design time of shipping is lower than the annual average of Rs 7.18/kg, that for potato, radish and french beans is higher than the annual average. The shipping period is accordingly concluded to be optimum. This is reflected in the fact that french beans in particular would be at a higher price (18.87/kg in contrast to the annual average of Rs 16.4/kg) indicating that a high profitability can be expected.

Marketing route for vegetables would be via the vegetable collection and shipment center to be described later, to local markets and the Kalimati Wholesale Market in Kathmandu. The Kalimati market receives vegetables and fruits shipped from the central hill districts and central Terai districts near Kathmandu, and in light of increased handling of products foreseen for the future the wholesale capabilities of the market are being expanded by the ongoing Kalimati Fruits and Vegetables Wholesale Market Project financed by HMG, UNCDF (United Nations Capital Development Fund) and UNDP. Upon completion of the said project, the new market will feature 8,800 m² of selling space, multi-purpose sheds, a fish market, a farmer's market, cold storage facilities, etc. The project will promote expanded market activities and contribute to improved nutrition for Kathmandu consumers.

4) Agricultural Inputs

(a) Improved Seed

Improved seed for cereals and vegetables are mainly distributed to the farmers of the area via 9 retail outlets which purchase their supplies from AIC and seed and agro-chemical wholesalers in Kathmandu. In light of the fact that farmer groups will be organized under the Project for each irrigation block, it is recommended that a seed production structure be established whereby marginal and small farmers who are particularly in a socio-economically disadvantaged position specialize in seed cultivation. This will enhance and stabilize their income, and at the same time guarantee timely and stable seed supply to the farmer groups. To accomplish this, it will be necessary to avail of agricultural technology support from DADO and obtain foundation seeds from NARC.

(b) Chemical Fertilizer

Chemical fertilizers are distributed to the farmers solely via 11 AIC licensed private traders in the area. Nevertheless, it is reported that supply of fertilizers in a timely fashion and in appropriate quantities is not being carried out. The reason for this is that AIC determines import quantities from abroad according to fixed demand criteria which do not allow for unexpected fluctuations in quota requirements. In order to rectify this, the government is encouraging the participation of the private sector in the fertilizer market; however, since private traders are not eligible for the type of government subsidy for transport costs which enables AIC to maintain a uniform price throughout the country, there is concern that retail prices by private sector entities would show regional variations.

Accordingly, in order to ensure timely and adequate supply of chemical fertilizers, it is essential that the Agricultural Marketing Sub-committee to be discussed later act in concert with AIC to formulate a fertilizer demand plan based on each year's cropping plan. Required supplies would be planned to reach the farmer via the existing distribution network (513 mt in the case of 9 month irrigation, and 659 mt in the case of perennial irrigation). Also, it is necessary to examine in collaboration with ADB/N personnel the possibility of either establishing savings and credit societies to extend credit, or issuing of ADB/N coupons for fertilizer credit to marginal and small farmers in order to assist them in achieving the economic independence to purchase fertilizers.

AIC's current storage facilities are indicated in Table 6.3.5-9. Total storage capacity of these is 1,800 mt, of which 1,550 mt of capacity is located in Trishuli.

Table 6.3.5-9 Current AIC Storage Facilities

Location	Nos.	Storage Capacity	Use
Ranipauwa	1	50	fertilizer
Barahi	1	50	fertilizer
Tupche	1	50	fertilizer
Chhahre	1	50	fertilizer
Chaughara	1	50	fertilizer
Trishuli	3	500	fertilizer
	1	50	seed
Total	9	1,800	

As amounts of fertilizer input under the Project are estimated at 513 mt in the case of 9 month irrigation and 713 mt in the case of perennial irrigation, the above existing facilities are concluded to be ample.

(c) Agro-chemicals

It is planned under the Project to effectively utilize the existing marketing network for distribution of agro-chemicals through 9 sales outlets. Input amounts under the Project would be 1,528 liters in the case of 9 month irrigation and 2,296 liters in the case of perennial irrigation.

5) Road Network

With completion of an all-weather road network extended to Kathmandu, transport of agricultural products and inputs can be accomplished smoothly in the rainy season as well. Accordingly, shipment of surplus agricultural products to Kathmandu is concluded to pose no problem. Specifically, given successful completion of the Kathmandu-Ranipauwa road segment currently under construction and the proposed Ranipauwa-Trishuli segment, transport time and cost will be reduced. In addition, widening of the Trishuli-Galchi road is planned (1997~99) which will reduce the distance to Kathmandu by about 20 km and result in savings on transportation costs of around 29%. This will enable reduced product shipping cost and more advantageous price structure for goods.

6) Marketing Information

At present, market conditions at the Kalimati Wholesale Market are broadcast by radio. However, farmer's have extreme difficulty obtaining information on conditions at other markets, as well as the cereals market in Kathmandu. Since market conditions and the status of supply from competing production areas has a major influence on shipping prices, it is necessary that the Agricultural Marketing Sub-committee collect and analyze relevant market data during the product shipping season.

7) Standardization and Grading

Low farmer awareness about quality control and consumer emphasis on cheap price rather than quality are principal factors in the lagging introduction of a standardization and grading system for agricultural products. Accordingly, it is necessary to cultivate such an awareness about the importance of quality control at the producer, or farmer end. As appropriate quality control will ensure an advantageous farm-gate price for farmers, as well as a more attractive margin for collection and shipping agents and millers, it is planned to provide farmer training to instill in the area farmers an awareness of the high importance of quality control.

8) Post-harvest Facilities

(a) Food Storage

Farmers use traditional storage methods for basic food for self-consumption such as storage in bamboo / earthen containers, jute sacks, etc. However, according to the Department of Agriculture, storage losses from such methods reach around 10%. Since 1990/91, a post harvest loss reduction programme under the Rural Save Grain Project has been in progress with the aim of modernizing food storage at the farm level. This program to transfer appropriate food storage technology to the farmer is an important step in improving the self-sufficiency rate of food production.

(b) Agricultural Product Processing

There are 26 rice mills in the Project area which engage in rice milling, flour production and oil extraction. Processing capacity at each facility is 150~200 kg/hr, which is ample for the cereal quantity to be produced under the Project for self consumption.

(c) Establishment of Vegetable Collection and Shipping Center

Under the Project, it is expected that surplus vegetable products totaling 11,442 mt in the case of 9 month irrigation and 19,150 mt in the case of perennial irrigation will be collected and shipped. In order to facilitate the smooth collection of vegetables from each farmer group, and ship the same to local and Kathmandu markets in fresh condition, it is planned to establish vegetable collection and shipping centers at Bidur, Battar, Pipaltar and Devighat. These centers are to be well equipped with water supply. Scale of each such center, the area they will service are indicated in Table 6.3.5-10.

Table 6.3.5-10 Vegetable Collection and Shipping Centers

Location	No.	Storage Capacity (mt/no.)	Service Area
Bidur	1	50	Irrigation Blocks A,B
Battar	1	150	Irrigation Blocks C,D,E
Pipaltar	1	150	Irrigation Blocks I,J,K
Devighat	1	150	Irrigation Blocks F,G,H,L
Total	4	500	

With regard to cold storage facilities, these are not considered necessary in light of the fact that potato and vegetable crops targeted for introduction to the area do not readily spoil, and that the harvested produce will be moved out of the shipping center the day after arrival.

(3) Establishment of Agricultural Marketing Sub-committee

An Agricultural Marketing Sub-committee will be established under the Project Management Committee to be set up in the course of the Project. The sub-committee will comprehensively manage the inflow of agricultural inputs and the outflow of surplus agricultural products. Sub-committee members will comprise the Nuwakot DADO Agricultural Development Officer, the AIC Trishuli Branch Manager, and WUA members from each irrigation block.

Under the systematic management by the sub-committee of agricultural shipping and marketing, it will be possible to raise the income of Project area farmers, provide production incentive to farmers and create an environment conducive to investment in agriculture.

(4) Farmer Training in Agricultural Marketing

Due to low awareness about marketing of agricultural products and lack of technical know-how, farmers have been pushed into the weak position of price-takers rather than price-setters. Accordingly, in order to nurture a higher self awareness as producers and realize an advantageous position in terms of shipping of surplus agricultural products, it will be essential that training of sub-committee members be carried out by agricultural marketing specialist from the DOA Marketing Information Division and the Kalimati Fruits and Vegetables Wholesale Market Board. Planned subjects of training would be proper cleaning of produce, grading, packaging and transporting, quality control, storage methods, techniques in collecting supply-demand and price information, and development of marketing networks.

6.4 Irrigation and Drainage Plan

6.4.1 Basic Plan

(1) Basic Strategy of the Irrigation Plan

1) Water source under the Project is to be the main Trishuli river

2) Intake location is to be modified from the originally planned site (at the intake immediately upstream of aqueduct no. 2) to downstream of the NEA balancing reservoir.

3) The Project will adopt in principal 9 month irrigation.

4) However, Zone B (Pokharephant, A = 129 ha) is planned as a separate irrigation system from Zone A, which includes the former Battar irrigation area, and will adopt perennial irrigation with discharge diverted from the main Trishuli river.

5) On the basis of natural and environmental conditions existing in the Project area, the main induction canal is to be pipeline.

6) Irrigation method will be a combination of gravity and pumped irrigation. In the design pumped irrigation area, irrigation by block will be independent via small scale pumps to be established at scattered locations in the area.

(2) Basic Strategy for the Drainage Plan

1) In the design gravity irrigation area, there are existing small natural drainage channels with ample function. These will be incorporated under the Project, and consequently no new drainage canal construction is planned.

2) Supply of irrigation discharge to blocks I (Majhitar), J (Majhajdon/Pipaltar) and K (Pipaltar) in the pumped irrigation design area, and the farmland along Tadi river in Block G (Tollo Pipaltar) of the gravity irrigation design area is envisioned to pose the threat of landslide. Accordingly, a terminal drainage facilities plan for these areas will be formulated in coordination with the on-going Soil Conservation and Watershed Management Project by the government.

6.4.2 Irrigation Plan

(1) Benefit Area

The Project benefit area is 749.18 ha as indicated below.

Zone A		Command area (ha)
<Gravity area>		
A	Gerkhutar*	14.75
B	Bidur	47.99
C	Battar	74.30
D	Inarpati/Ghadigaon	81.36
E	Maharamidihi	104.21
F	Chwadilchandipokhari	29.90
G	Tallo Pipaltar	51.54
H	Devighat	34.59
	Subtotal	438.64
<Lift area>		
I	Majhitar	46.20
J	Majhagaon/Pipaltar	56.80
K	Pipaltar	79.02
	Subtotal	182.02
	Zone A total	620.66
	Zone B	
L	Pokharephant	128.52
	Grand total	749.18

* Regarding the exclusion of Gerkhutar from the general benefit area:

Gerkhutar (A = 8.56 ha) comprises one part of Block A as originally designated during the field study period. It is to be excluded from the general irrigation area due to the availability of drainage from the adjoining hill area, which precludes the need for additional irrigation discharge.

(2) Irrigation Area

Design irrigated area is 749 ha for this scheme. Under the scheme, double cropping of paddy would be continued in the low land of the command area. The present cropping intensity of 138 would be improved to 217%.

Irrigation block	Benefit area (ha)	Present		With Project	
		Cropped area (ha)	CI (%)	Cropped area (ha)	CI (%)
Zone A:					
A	14.75	25.63	110	46.60	200
B	47.99	67.68	141	96.00	200
C	74.30	99.56	134	148.60	200
D	81.36	114.77	141	162.80	200
E	104.21	152.13	146	208.40	200
F	29.90	39.00	130	56.81	200
G	51.54	70.69	137	103.00	190
H	34.59	46.36	134	69.20	200
I	46.20	59.60	129	92.40	190
J	56.80	73.84	130	113.60	190
K	79.02	102.70	130	158.60	190
		194.04	151	385.50	270
Zone B:					
L	128.52	194.04	151	385.50	270
Total	749.18	1,046.00	138	1,643.90	217

(3) Schematic Proposed Irrigation Distribution System

A schematic layout of the proposed irrigation distribution system under the Project is shown in Figure 6.4.3-1.

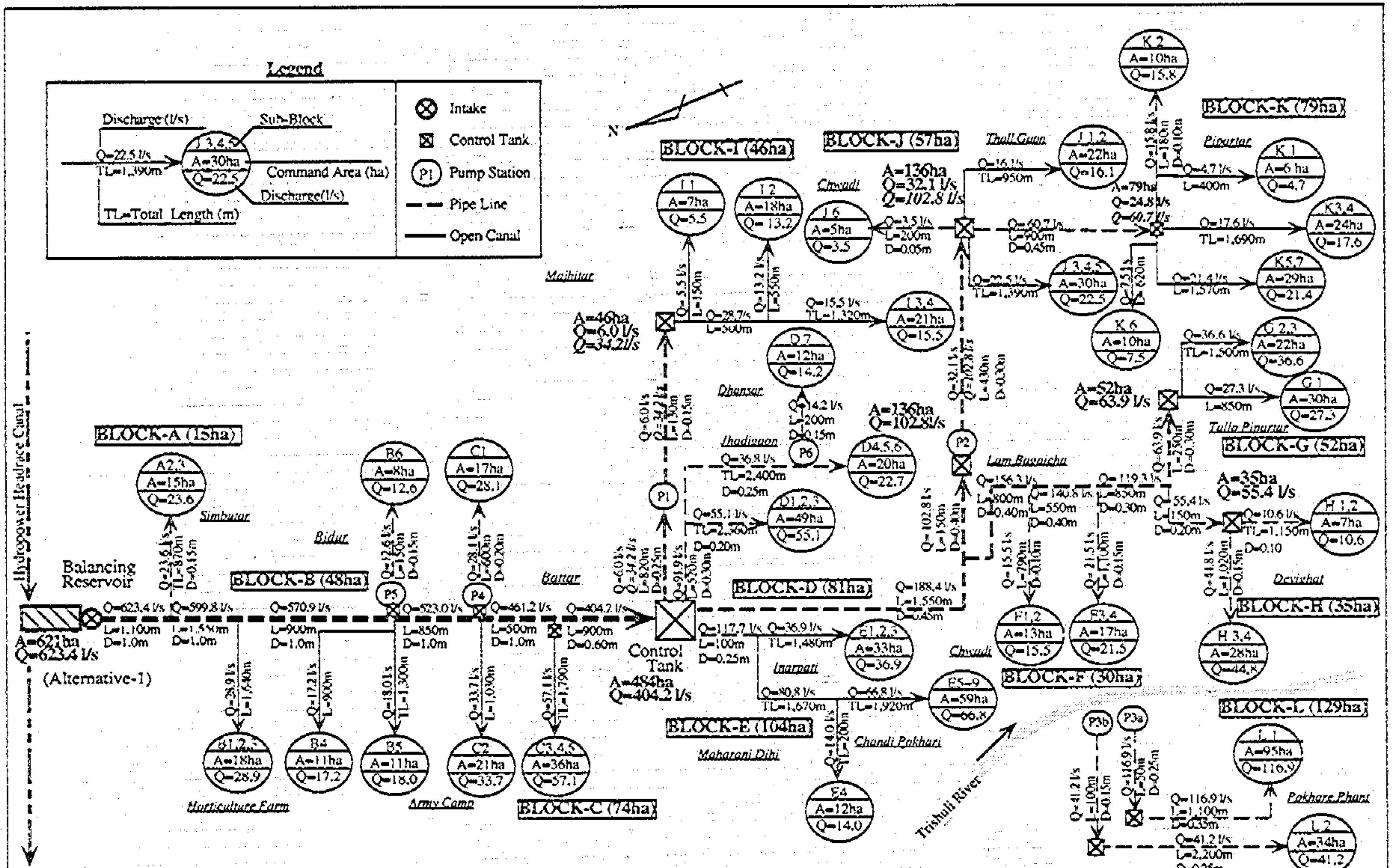


Fig. 6.4.3-1 Proposed Irrigation Distribution System

6.4.3 Water Requirement

(1) Adoption of Proposed Copping Calendar

The following 5 types of proposed cropping calendar, which is recommended by the Study Team, were adopted to calculate the maximum water requirement in the Zone A Command Area.

Design Cropping Pattern

(% : cropping intensity)

<Zone A>	Apr~May		Jul~Dec		
Irrigation block:	Maize	Paddy	Vegetables	Paddy	Vegetables
A,B,C,H	40	30	30	70	30
D,E	20	30	50	50	50
F,G	50	--	50	50	50
I,J,K	50	25	25	--	100

(% : cropping intensity)

<Zone B>	Nov~Mar		Mar~Jul			July~Nov	
Irrigation block:	Wheat	Veg.	Paddy	Maize	Veg.	Paddy	Veg.
L	50	50	30	30	40	50	50

(2) Source of Calculation Criteria

For calculation, methodology made reference to the publication in Nepal, "Hill Irrigation Engineering, Institute of Engineering, Tribhuvan University, Jan. 1995", with consideration of the result of field surveys.

(3) Effective Rainfall

Monthly rainfall data during 1971~ 1990 at station nos. 1003 (Trishuli) and 1004 (Nuwakot), and their analyses are shown in Table 6.4.3-1. Effective rainfall is calculated with the value of the following factor 'f' from 80% probable rainfall (P80%).

For paddy crops	f=0		P(80%) < 5 mm
	f=0.85	5mm	< P(80%) < 100mm
	f=0.70	100mm	< P(80%) <
For upland crops	f=0.70		for any amount of P(80%)

The result of monthly analysis is summarized below:

Unit:(mm)

Season	Dry Season				Wet Season					Dry Season			
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Mean rainfall (1971~90)	11	17	29	55	100	313	510	504	256	96	8	16	1,915
80% Probable rainfall ($P_{80\%}$)	0	13	14	39	103	276	431	489	221	80	4	10	1,679
Effective rainfall(P-eff)													
1) For paddy crops	0	11	12	33	72	302	302	342	155	68	0	8	1,196
2) For upland crops	0	9	10	28	72	193	302	342	155	56	3	7	1,175

(4) Evapotranspiration (ETo)

The following value was adopted for Penman Reference Crop Evapotranspiration for the Study area, where the subject observation station is located at 500 m elevation, which is geographically similar to Trishuli.

Station: Khairitar (815), Western Development Region — Unit: (mm/day)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean	Total/year
1.9	2.8	3.9	5.1	5.3	5.1	4.5	4.6	4.0	3.3	2.4	1.8	3.7	1,361

(5) Crop Coefficient (Kc)

Crop coefficients in each stage related to the water requirement calculation, for the wet and dry seasons, respectively, are shown below:

Crop Stage	Initial		Development		Mid Season		Late Season		Harvest	
Season	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry
Rice	1.10	1.15	1.10	1.50	1.10	1.30	0.95	1.05	0.95	1.05
Wheat	0.30	0.40	0.70	0.80	1.05	1.20	0.65	0.75	0.20	0.25
Maize	0.30	0.50	0.70	0.90	1.05	1.20	1.00	1.15	0.95	1.10
Vegetable (cabbage)	0.40	0.50	0.70	0.80	0.95	1.10	0.90	1.10	0.80	0.95

(7) Operational Water Requirement

For paddy cultivation, the following amount of water loss for operational water requirement has been factored in:

	Land Preparation	Initial Flooding (after land preparation)	Percolation (during ponding)
Early Paddy	150mm/1.0month	100mm/1.0month	10mm/day
Late Paddy	55mm/0.5month	100mm/1.0month	10mm/day (Silty-loams)

(8) Irrigation Efficiency

For determining gross irrigation requirement, the following irrigation efficiencies are adopted according to "Hill Irrigation Engineering, Institute of Engineering". Reflecting this, main canal efficiency for the pipeline system is to be assumed at 90 %.

Type of Crop	Field Application Efficiency	On-farm Distribution Canal Efficiency	Main Canal Efficiency
Paddy Crops	90 %	75 %	90 %
Upland Crops	70 % (silty-loams)	75 %	90 % (pipeline system)

(9) Estimation of Tentative Gross Irrigation Requirement

Water requirement for gross irrigation is accordingly estimated in Table 6.4.3-2~6 for gravity irrigation area and lift irrigation area. As a result of this calculation, peak water requirement occurs during the first period of October. In this instance at Zone A (blocks A~K), water requirement at the diversion intake point would be estimated as per below:

Gravity area			
Block A,B,C,H	1.60 lit/s/ha	171.6 ha	274.6 lit/s
Block D,E	1.13 lit/s/ha	185.6 ha	209.7 lit/s
Block F,G	1.24 lit/s/ha	81.4 ha	100.9 lit/s
Lift area			
Block I,J,K	0.13 lit/s/ha	182.0 ha	38.2 lit/s
Total		620.6 ha	623.4 lit/s

Table 6.4.3-1 Analysis on Rainfall Data

Station 1003 : Trishuli
1004 : Nuwakot (Unit:mm)

1. Rainfall Data (1971 ~ 1990 : 20 Years)

Year	3 months			9 month										Station
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly	No.
1971	2	5	16	76	163	561	321	358	93	147	2	0	1,744	1003
1972	7	25	62	16	70	283	379	422	204	82	15	0	1,565	1003
1973	40	30	34	39	128	348	280	425	359	110	21	0	1,814	1003
1974	19	4	14	20	141	121	374	485	392	76	0	7	1,653	1003
1975	26	4	0	24	110	294	407	93	394	338	10	6	1,706	1003
1976	8	0	12	6	98	283	336	489	211	20	0	0	1,463	1003
1977	4	0	18	142	159	305	480	574	198	69	24	54	2,027	1004
1978	0	29	91	8	104	448	674	782	269	132	3	2	2,542	1004
1979	2	32	0	20	11	221	744	399	47	100	10	51	1,637	1003
1980	0	39	40	15	56	671	780	743	158	41	0	3	2,546	1003
1981	44	6	54	161	110	287	463	600	235	2	24	0	1,986	1004
1982	14	20	52	92	23	259	512	695	172	22	16	2	1,879	1004
1983	34	31	58	99	74	249	469	663	290	156	0	43	2,166	1004
1984	12	4	9	70	89	214	482	349	526	16	0	6	1,777	1004
1985	10	4	0	85	81	175	691	381	248	167	0	55	1,897	1004
1986	0	19	22	71	113	546	763	468	364	121	5	56	2,548	1004
1987	2	29	11	78	30	337	692	484	276	142	17	17	2,115	1004
1988	0	11	27	26	97	322	551	401	227	0	0	0	1,662	1004
1989	0	0	0	0	209	167	394	708	317	46	0	11	1,852	1004
1990	0	47	65	59	140	173	404	553	130	131	13	6	1,721	1004
Mean	11	17	29	55	100	313	510	504	256	96	8	16	1,915	

2. Analysis on Monthly Data

(Unit:mm)

Year	1	1~2	12~2	12~3	11~3	11~4	10~4	10~5	9~5	9~6	8~6	8~7
1971/ 72	7	32	32	94	96	112	259	329	422	705	1,063	1,442
1972/ 73	40	70	70	104	119	158	240	368	572	920	1,342	1,622
1973/ 74	19	23	23	37	58	78	188	329	688	809	1,234	1,608
1974/ 75	26	30	37	37	37	61	137	247	639	933	1,418	1,825
1975/ 76	8	8	14	26	36	42	380	478	872	1,155	1,248	1,584
1976/ 77	4	4	4	22	22	164	184	343	554	859	1,348	1,828
1977/ 78	0	29	83	174	198	206	275	379	577	1,025	1,599	2,273
1978/ 79	2	34	36	36	39	59	191	202	471	692	1,474	2,218
1979/ 80	0	39	90	130	140	155	255	311	358	1,029	1,428	2,208
1980/ 81	44	50	53	107	107	268	309	419	577	864	1,607	2,070
1981/ 82	14	34	34	86	110	202	204	227	462	721	1,321	1,833
1982/ 83	34	65	67	125	141	240	262	336	508	757	1,452	1,921
1983/ 84	12	16	59	68	68	138	294	383	673	887	1,550	2,032
1984/ 85	10	14	20	20	20	105	121	202	728	903	1,252	1,943
1985/ 86	0	19	74	96	96	167	334	447	695	1,241	1,622	2,385
1986/ 87	2	31	87	98	103	181	302	332	696	1,033	1,501	2,193
1987/ 88	0	11	28	55	72	98	240	337	613	935	1,419	1,970
1988/ 89	0	0	0	0	0	0	0	209	436	603	1,004	1,398
1989/ 90	0	47	58	123	123	182	228	368	685	858	1,566	1,970
Maxmum	44	70	90	174	198	268	380	478	872	1,241	1,622	2,385
Minimum	0	0	0	0	0	0	0	202	358	603	1,004	1,398
Mean	12	29	46	76	83	138	232	329	591	891	1,392	1,912
Std.Dev.	14	19	27	46	51	69	86	79	128	157	171	276
P-80%	0	13	23	37	41	80	159	263	483	759	1,248	1,679

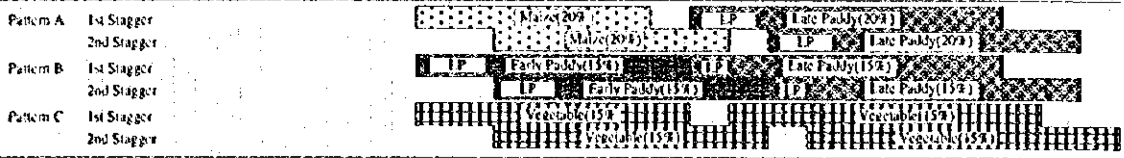
3. Monthly Result

(Unit:mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly
1)P-80%	0.0	13.1	14.2	39.3	103.1	275.7	431.1	489.1	220.7	79.5	3.7	9.7	1,679
1st Half	1.2	4.9	6.9	16.5	43.6	116.3	196.1	237.3	143.9	57.4	11.3	4.1	840
2nd Half	1.6	6.7	10.2	27.6	73.1	157.3	222.8	211.0	92.7	30.3	2.6	3.6	840
2)Effective Rainfall													
<Paddy>	0.0	11.1	12.0	33.4	72.2	193.0	301.7	342.4	154.5	67.5	0.0	8.3	1,196
1st Half	1.0	4.2	5.9	14.0	31.2	81.4	137.3	166.1	100.7	44.6	8.4	3.1	598
2nd Half	1.4	5.7	8.7	21.5	51.2	110.1	155.9	147.7	66.4	25.3	1.0	3.1	598
<Upland Crops>													
	0.0	9.2	9.9	27.5	72.2	193.0	301.7	342.4	154.5	55.6	2.6	6.8	1,175
1st Half	0.8	3.4	4.9	11.5	30.5	81.4	137.3	166.1	100.7	40.2	7.9	2.9	588
2nd Half	1.1	4.7	7.2	19.3	51.2	110.1	155.9	147.7	64.9	21.2	1.8	2.5	588

Table 6.4.3-2 Calculation for Water Requirement for Block A, B, C, H under 9 Months Irrigation

Item	Unit	Jan 1st	Jan 2nd	Feb 1st	Feb 2nd	Mar 1st	Mar 2nd	Apr 1st	Apr 2nd	May 1st	May 2nd	Jun 1st	Jun 2nd	Jul 1st	Jul 2nd	Aug 1st	Aug 2nd	Sep 1st	Sep 2nd	Oct 1st	Oct 2nd	Nov 1st	Nov 2nd	Dec 1st	Dec 2nd
Season						Dry Season								Wet Season								Dry Season			
Days		15.5	15.5	14.0	14.0	15.5	15.5	15.0	15.0	15.5	15.5	15.0	15.0	15.5	15.5	15.5	15.5	15.0	15.0	15.5	15.5	15.0	15.0	15.5	15.5
ET_o	(mm/day)	1.9	1.9	2.8	2.8	3.9	3.9	5.1	5.1	5.3	5.3	5.1	5.1	4.5	4.5	4.6	4.6	4.0	4.0	3.3	3.3	2.4	2.4	1.8	1.8
	(mm)	29.5	29.5	39.2	39.2	60.5	60.5	76.5	76.5	82.2	82.2	76.5	76.5	69.8	69.8	71.3	71.3	60.0	60.0	51.2	51.2	36.0	36.0	27.9	27.9
Rain P(80%)	(mm)	1.2	1.6	4.9	6.7	6.9	10.2	16.5	27.6	43.6	73.1	116.3	157.3	196.1	222.8	237.3	211.0	143.9	92.7	57.4	30.3	11.3	2.6	4.1	3.6
Effective Rain (mm)	Paddy	1.0	1.4	4.2	5.7	5.9	8.7	14.0	21.5	31.2	51.2	81.4	110.1	137.3	155.9	166.1	147.7	100.7	66.4	44.6	25.3	8.4	1.0	3.1	3.1
	Upland	0.8	1.1	3.4	4.7	4.9	7.2	11.5	19.3	30.5	51.2	81.4	110.1	137.3	155.9	166.1	147.7	100.7	64.9	40.2	21.2	7.9	1.8	2.9	2.5

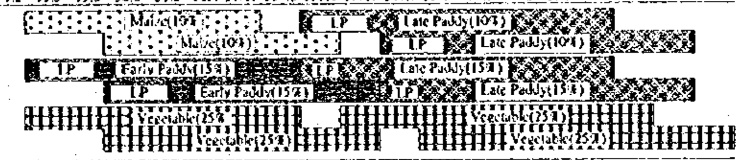


Item	Unit	Jan 1st	Jan 2nd	Feb 1st	Feb 2nd	Mar 1st	Mar 2nd	Apr 1st	Apr 2nd	May 1st	May 2nd	Jun 1st	Jun 2nd	Jul 1st	Jul 2nd	Aug 1st	Aug 2nd	Sep 1st	Sep 2nd	Oct 1st	Oct 2nd	Nov 1st	Nov 2nd	Dec 1st	Dec 2nd
<Pattern A> 1st Stagger																									
1. Crop Coefficient	kc							0.50	0.90	1.05	1.05	1.00	0.95		1.10	1.10	1.10	1.10	1.10	1.30	1.05	1.05			
2. ET Crop	(mm)							38.3	68.9	86.3	86.3	76.5	72.7		76.7	78.4	78.4	66.0	66.0	66.5	53.7	37.8			
3. Land Preparation	(mm)														75.0	75.0	50.0	50.0							
4. Percolation	(mm)																155.0	150.0	150.0	155.0					
5. Field Requirement	(mm)							38.3	68.9	86.3	86.3	76.5	72.7		151.7	153.4	283.4	266.0	216.0	221.5	53.7	37.8			
6. Irrigation Require	(mm)							26.7	49.5	55.8	35.1	0.0	0.0		0.0	0.0	135.7	165.3	149.6	176.9	28.4	29.4			
Crop Intencity	(%)							20%	20%	20%	20%	20%	20%		20%	20%	20%	20%	20%	20%	20%	20%			
7. Irrigation Net								5.3	9.9	11.2	7.0	0.0	0.0		0.0	0.0	27.1	33.1	29.9	35.4	5.7	5.9			
Field Effiency	(%)							70%	70%	70%	70%	70%	70%		90%	90%	90%	90%	90%	90%	70%	70%			
Farm Effiency	(%)							75%	75%	75%	75%	75%	75%		75%	75%	75%	75%	75%	75%	75%	75%			
Main Effiency	(%)							95%	95%	95%	95%	95%	95%		95%	95%	95%	95%	95%	95%	95%	95%			
8. Irrigation Gross	(mm)							10.7	19.9	22.4	14.1	0.0	0.0		0.0	0.0	42.3	51.5	46.7	55.2	11.4	11.8			
<Pattern A> 2nd Stagger																									
1. Crop Coefficient	kc									0.30	0.70	1.05	1.05	1.00	0.95		1.10	1.10	1.10	1.30	1.30	1.30	1.05	1.05	
2. ET Crop	(mm)									24.6	57.5	80.3	80.3	69.8	66.3		78.4	66.0	66.0	66.5	66.5	46.8	37.8	29.3	
3. Land Preparation	(mm)																75.0	75.0	50.0	50.0					
4. Percolation	(mm)																		150.0	155.0	155.0	150.0			
5. Field Requirement	(mm)									24.6	57.5	80.3	80.3	69.8	66.3		153.4	141.0	266.0	271.5	221.5	196.8	37.8	29.3	
6. Irrigation Require	(mm)									0.0	6.3	0.0	0.0	0.0	0.0		5.7	40.3	199.6	226.9	196.2	188.4	36.8	26.2	
Crop Intencity	(%)									20%	20%	20%	20%	20%	20%		20%	20%	20%	20%	20%	20%	20%	20%	
7. Irrigation Net										0.0	1.3	0.0	0.0	0.0	0.0		1.1	8.1	39.9	45.4	39.2	37.7	7.4	5.2	
Field Effiency	(%)									70%	70%	70%	70%	70%	70%		90%	90%	90%	90%	90%	90%	70%	70%	
Farm Effiency	(%)									75%	75%	75%	75%	75%	75%		75%	75%	75%	75%	75%	75%	75%	75%	
Main Effiency	(%)									95%	95%	95%	95%	95%	95%		95%	95%	95%	95%	95%	95%	95%	95%	
8. Irrigation Gross	(mm)									0.0	2.5	0.0	0.0	0.0	0.0		1.8	12.6	62.3	70.8	61.2	58.7	14.7	10.5	
<Pattern B> 1st Stagger																									
1. Crop Coefficient	kc							1.15	1.50	1.10	1.10	1.10	0.95	0.95	1.10	1.10	1.10	1.10	1.10	1.30	1.05	1.05			
2. ET Crop	(mm)							88.0	114.8	90.4	90.4	84.2	72.7	66.3	76.7	78.4	78.4	66.0	66.0	66.5	53.7	37.8			
3. Land Preparation	(mm)							75.0	75.0	50.0	50.0				55.0	50.0	50.0								
4. Percolation	(mm)									155.0	155.0	150.0				155.0	155.0	150.0	150.0	155.0					
5. Field Requirement	(mm)							163.0	189.8	295.4	295.4	234.2	72.7	66.3	131.7	283.4	283.4	216.0	216.0	221.5	53.7	37.8			
6. Irrigation Require	(mm)							149.0	168.2	264.1	244.2	152.8	0.0	0.0	0.0	117.3	135.7	115.3	149.6	176.9	28.4	29.4			
Crop Intencity	(%)							15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%			
7. Irrigation Net								22.3	25.2	39.6	36.6	22.9	0.0	0.0	0.0	17.6	20.4	17.3	22.4	26.5	4.3	4.4			
Field Effiency	(%)							90%	90%	90%	90%	90%	70%	70%	90%	90%	90%	90%	90%	90%	70%	70%			
Farm Effiency	(%)							75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%			
Main Effiency	(%)							95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%			
8. Irrigation Gross	(mm)							34.8	39.3	61.8	57.1	35.7	0.0	0.0	0.0	27.4	31.7	27.0	35.0	41.4	8.5	8.8			
<Pattern B> 2nd Stagger																									
1. Crop Coefficient	kc									1.10	1.10	1.10	1.10	1.10	0.95	0.95	1.10	1.10	1.10	1.30	1.30	1.30	1.05	1.05	
2. ET Crop	(mm)									90.4	90.4	84.2	84.2	76.7	66.3	67.7	78.4	66.0	66.0	66.5	66.5	46.8	37.8	29.3	
3. Land Preparation	(mm)									75.0	75.0	50.0	50.0				55.0	50.0	50.0						
4. Percolation	(mm)											150.0	150.0	155.0				150.0	150.0	155.0	155.0	150.0			
5. Field Requirement	(mm)									165.4	165.4	284.2	284.2	231.7	66.3	67.7	133.4	266.0	266.0	221.5	221.5	196.8	37.8	29.3	
6. Irrigation Require	(mm)									134.1	114.2	202.8	174.1	94.5	0.0	0.0	0.0	165.3	199.6	176.9	196.2	188.4	36.8	26.2	
Crop Intencity	(%)									15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	
7. Irrigation Net										20.1	17.1	30.4	26.1	14.2	0.0	0.0	0.0	24.8	29.9	26.5	29.4	28.3	5.5	3.9	
Field Effiency	(%)									90%	90%	90%	90%	90%	70%	70%	90%	90%	90%	90%	90%	90%	70%	70%	
Farm Effiency	(%)									75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	
Main Effiency	(%)									95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	
8. Irrigation Gross	(mm)									31.4	26.7	47.4	40.7	22.1	0.0	0.0	0.0	38.7	46.7	41.4	45.9	44.1	11.1	7.9	
<Pattern C> 1st Stagger																									
1. Crop Coefficient	kc							0.50	0.80	0.95	0.95	0.95	0.90	0.80		0.40	0.70	0.95	0.95	1.10	1.10	1.10	0.95		
2. ET Crop	(mm)							38.3	61.2	78.0	78.0	72.7	68.9	55.8		28.5	49.9	57.0	57.0	56.3	56.3	39.6	34.2		
3. Land Preparation	(mm)																								
4. Percolation	(mm)																								
5. Field Requirement	(mm)							38.3	61.2	78.0	78.9	72.7	68.9	55.8		28.5	49.9	57.0	57.0	56.3	56.3	39.6	34.2		
6. Irrigation Require	(mm)							26.7	41.9	47.5	26.9	0.0	0.0	0.0		0.0	0.0	0.0	0.0	16.1	35.1	31.7	32.4		
Crop Intencity	(%)							15%	15%	15%	15%	15%	15%	15%		15%	15%	15%	15%	15%	15%	15%	15%		
7. Irrigation Net								4.0	6.3	7.1	4.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	2.4	5.3	4.8	4.9		
Field Effiency	(%)							70%	70%	70%	70%	70%	70%	70%		70%	70%	70%	70%	70%	70%	70%	70%		
Farm Effiency	(%)							75%	75%	75%	75%	75%	75%	75%		75%	75%	75%	75%	75%	75%	75%	75%		
Main Effiency	(%)							95%	95%	95%	95%	95%	95%	95%		95%	95%	95%	95%	95%	95%	95%	95%		
8. Irrigation Gross	(mm)							8.0	12.6	14.3	8.1	0.0	0.0	0.0		0.0	0.0	0.0	0.0	4.8	10.6	9.5	9.7		
<Pattern C> 2nd Stagger																									
1. Crop Coefficient	kc									0.40	0.70	0.95	0.95	0.95	0.90	0.80		0.40	0.70	0.80	1.10	1.10	1.10	1.10	0.95
2. ET Crop	(mm)									32.9	57.5	72.7	72.7	66.3	62.8	57.0		24.0	42.0	40.9	56.3	39.6	39.6	30.7	26.5
3. Land Preparation	(mm)																								
4. Percolation	(mm)																								
5. Field Requirement	(mm)									32.9	57.5	72.7	72.7	66.3	62.8	57.0		24.0	42.0	40.9	56.3	39.6	39.6	30.7	26.5
6. Irrigation Require	(mm)									2.4	6.3	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.7	35.1	31.7	37.8	27.8	24.0
Crop Intencity	(%)									15%	15%	15%	15%	15%	15%	15%		15%	15%	15%	15%	15%	15%	15%	15%
7. Irrigation Net										0.4	0.9	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.1	5.3	4.8	5.7	4.2	3.6
Field Effiency	(%)									70%	70%	70%	70%	70%	70%	70%		70%	70%	70%	70%	70%	70%	70%	70%
Farm Effiency	(%)									75%	75%	75%	75%	75%	75%	75%		75%	75%	75%	75%	75%	75%	75%	75%
Main Effiency	(%)									95%	95%	95%	95%	95%	95%	95%		95%	95%	95%	95%	95%	95%	95%	95%
8. Irrigation Gross	(mm)									0.7	1.9	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.2	10.6	9.5	11.4	8.4	7.2
Irrigation Gross Total (Pattern A+B+C)	(mm)							53.6	71.8	130.5	110.4	83.2	40.7	22.1	0.0	27.4	75.9	129.7	190.6	213.7	148.1	142.5	46.9	26.8	7.2
	(l/s/ha)							0.41	0.55	0.97	0.82	0.64	0.31	0.16	0.00	0.20	0.57	1.00	1.47	1.60	1.11	1.10	0.36	0.20	0.05

Table 6.4.3-3 Calculation for Water Requirement for Block D, E under 9 Months Irrigation

Season		Dry Season								Wet Season												Dry Season			
Month		Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
Period		1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Days		15.5	15.5	14.0	14.0	15.5	15.5	15.0	15.0	15.5	15.5	15.0	15.0	15.5	15.5	15.5	15.5	15.0	15.0	15.5	15.5	15.0	15.0	15.5	15.5
ET_o	(mm/day)	1.9	1.9	2.8	2.8	3.9	3.9	5.1	5.1	5.3	5.3	5.1	5.1	4.5	4.5	4.6	4.6	4.0	4.0	3.3	3.3	2.4	2.4	1.8	1.8
	(mm)	29.5	29.5	39.2	39.2	60.5	60.5	76.5	76.5	82.2	82.2	76.5	76.5	69.8	69.8	71.3	71.3	60.0	60.0	51.2	51.2	36.0	36.0	27.9	27.9
Rain F(80%)	(mm)	1.2	1.6	4.9	6.7	6.9	10.2	16.5	27.6	43.6	73.1	116.3	157.3	196.1	222.8	237.3	211.0	143.9	92.7	57.4	30.3	11.3	2.6	4.1	3.6
Effective Rain	Paddy	1.0	1.4	4.2	5.7	5.9	8.7	14.0	21.5	31.2	51.2	81.4	110.1	137.3	155.9	166.1	147.7	100.7	66.4	44.6	25.3	8.4	1.0	3.1	3.1
(mm)	Upland	0.8	1.1	3.4	4.7	4.9	7.2	11.5	19.3	30.5	51.2	81.4	110.1	137.3	155.9	166.1	147.7	100.7	64.9	40.2	21.2	7.9	1.8	2.9	2.5

Pattern A 1st Stagger
2nd Stagger
Pattern B 1st Stagger
2nd Stagger
Pattern C 1st Stagger
2nd Stagger



<Pattern A> 1st Stagger																									
1. Crop Coefficient	kc							0.50	0.90	1.05	1.05	1.00	0.95		1.10	1.10	1.10	1.10	1.10	1.30	1.05	1.05			
2. ET Crop	(mm)							38.3	68.9	86.3	86.3	76.5	72.7		76.7	78.4	78.4	66.0	66.0	66.5	53.7	37.8			
3. Land Preparation	(mm)														75.0	75.0	50.0	50.0							
4. Percolation	(mm)																155.0	150.0	150.0	155.0					
5. Field Requirement	(mm)							38.3	68.9	86.3	86.3	76.5	72.7		151.7	153.4	283.4	266.0	216.0	221.5	53.7	37.8			
6. Irrigation Require	(mm)							26.7	49.5	55.8	35.1	0.0	0.0		0.0	0.0	135.7	165.3	149.6	176.9	28.4	29.4			
Crop Intencity	(%)							10%	10%	10%	10%	10%	10%		10%	10%	10%	10%	10%	10%	10%	10%			
7. Irrigation Net								2.7	5.0	5.6	3.5	0.0	0.0		0.0	0.0	13.6	16.5	15.0	17.7	2.8	2.9			
Field Efficency	(%)							70%	70%	70%	70%	70%	70%		90%	90%	90%	90%	90%	90%	70%	70%			
Farm Efficency	(%)							75%	75%	75%	75%	75%	75%		75%	75%	75%	75%	75%	75%	75%	75%			
Main Efficency	(%)							95%	95%	95%	95%	95%	95%		95%	95%	95%	95%	95%	95%	95%	95%			
8. Irrigation Gross	(mm)							5.4	9.9	11.2	7.0	0.0	0.0		0.0	0.0	21.2	25.8	23.3	27.6	5.7	5.9			
<Pattern A> 2nd Stagger																									
1. Crop Coefficient	kc									0.30	0.70	1.05	1.05	1.00	0.95		1.10	1.10	1.10	1.30	1.30	1.30	1.05	1.05	
2. ET Crop	(mm)									24.6	57.5	80.3	80.3	69.8	66.3		78.4	66.0	66.0	66.5	66.5	46.8	37.8	29.3	
3. Land Preparation	(mm)																75.0	75.0	50.0	50.0					
4. Percolation	(mm)																		150.0	155.0	155.0	150.0			
5. Field Requirement	(mm)									24.6	57.5	80.3	80.3	69.8	66.3		153.4	141.0	266.0	271.5	221.5	196.8	37.8	29.3	
6. Irrigation Require	(mm)									0.0	6.3	0.0	0.0	0.0	0.0		5.7	40.3	199.6	226.9	196.2	188.4	36.8	26.2	
Crop Intencity	(%)									10%	10%	10%	10%	10%	10%		10%	10%	10%	10%	10%	10%	10%	10%	
7. Irrigation Net										0.0	0.6	0.0	0.0	0.0	0.0		0.6	4.0	20.0	22.7	19.6	18.8	3.7	2.6	
Field Efficency	(%)									70%	70%	70%	70%	70%	70%		90%	90%	90%	90%	90%	90%	70%	70%	
Farm Efficency	(%)									75%	75%	75%	75%	75%	75%		75%	75%	75%	75%	75%	75%	75%	75%	
Main Efficency	(%)									95%	95%	95%	95%	95%	95%		95%	95%	95%	95%	95%	95%	95%	95%	
8. Irrigation Gross	(mm)									0.0	1.3	0.0	0.0	0.0	0.0		0.9	6.3	31.1	35.4	30.6	29.4	7.4	5.3	
<Pattern B> 1st Stagger																									
1. Crop Coefficient	kc							1.15	1.50	1.10	1.10	1.10	0.95	0.95	1.10	1.10	1.10	1.10	1.10	1.30	1.05	1.05			
2. ET Crop	(mm)							88.0	114.8	90.4	90.4	84.2	72.7	66.3	76.7	78.4	78.4	66.0	66.0	66.5	53.7	37.8			
3. Land Preparation	(mm)							75.0	75.0	50.0	50.0				55.0	50.0	50.0								
4. Percolation	(mm)									155.0	155.0	150.0				155.0	155.0	150.0	150.0	155.0					
5. Field Requirement	(mm)							163.0	189.8	295.4	295.4	234.2	72.7	66.3	131.7	283.4	283.4	216.0	216.0	221.5	53.7	37.8			
6. Irrigation Require	(mm)							149.0	168.2	264.1	244.2	152.8	0.0	0.0	0.0	117.3	135.7	115.3	149.6	176.9	28.4	29.4			
Crop Intencity	(%)							15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%			
7. Irrigation Net								22.3	25.2	39.6	36.6	22.9	0.0	0.0	0.0	17.6	20.4	17.3	22.4	26.5	4.3	4.4			
Field Efficency	(%)							90%	90%	90%	90%	90%	70%	70%	90%	90%	90%	90%	90%	90%	70%	70%			
Farm Efficency	(%)							75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%			
Main Efficency	(%)							95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%			
8. Irrigation Gross	(mm)							34.8	39.3	61.8	57.1	35.7	0.0	0.0	0.0	27.4	31.7	27.0	35.0	41.4	8.5	8.8			
<Pattern B> 2nd Stagger																									
1. Crop Coefficient	kc									1.10	1.10	1.10	1.10	1.10	0.95	0.95	1.10	1.10	1.10	1.30	1.30	1.30	1.05	1.05	
2. ET Crop	(mm)									90.4	90.4	84.2	84.2	76.7	66.3	67.7	78.4	66.0	66.0	66.5	66.5	46.8	37.8	29.3	
3. Land Preparation	(mm)									75.0	75.0	50.0	50.0				55.0	50.0	50.0						
4. Percolation	(mm)											150.0	150.0	155.0				150.0	150.0	155.0	155.0	150.0			
5. Field Requirement	(mm)									165.4	165.4	284.2	284.2	231.7	66.3	67.7	133.4	266.0	266.0	221.5	221.5	196.8	37.8	29.3	
6. Irrigation Require	(mm)									134.1	114.2	202.8	174.1	94.5	0.0	0.0	0.0	165.3	199.6	176.9	196.2	188.4	36.8	26.2	
Crop Intencity	(%)									15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	
7. Irrigation Net										20.1	17.1	30.4	26.1	14.2	0.0	0.0	0.0	24.8	29.9	26.5	29.4	28.3	5.5	3.9	
Field Efficency	(%)									90%	90%	90%	90%	90%	70%	70%	90%	90%	90%	90%	90%	90%	70%	70%	
Farm Efficency	(%)									75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	
Main Efficency	(%)									95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	
8. Irrigation Gross	(mm)									31.4	26.7	47.4	40.7	22.1	0.0	0.0	0.0	38.7	46.7	41.4	45.9	44.1	11.1	7.9	
<Pattern C> 1st Stagger																									
1. Crop Coefficient	kc							0.50	0.80	0.95	0.95	0.95	0.90	0.80		0.40	0.70	0.95	0.95	1.10	1.10	1.10	0.95		
2. ET Crop	(mm)							38.3	61.2	78.0	78.0	72.7	68.9	55.8		28.5	49.9	57.0	57.0	56.3	56.3	39.6	34.2		
3. Land Preparation	(mm)																								
4. Percolation	(mm)																								
5. Field Requirement	(mm)							38.3	61.2	78.0	78.0	72.7	68.9	55.8		28.5	49.9	57.0	57.0	56.3	56.3	39.6	34.2		
6. Irrigation Require	(mm)							26.7	41.9	47.5	26.9	0.0	0.0	0.0		0.0	0.0	0.0	0.0	16.1	35.1	31.7	32.4		
Crop Intencity	(%)							15%	15%	15%	15%	15%	15%	15%		15%	15%	15%	15%	15%	15%	15%	15%		
7. Irrigation Net								4.0	6.3	7.1	4.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	2.4	5.3	4.8	4.9		
Field Efficency	(%)							70%	70%	70%	70%	70%	70%	70%		70%	70%	70%	70%	70%	70%	70%	70%		
Farm Efficency	(%)							75%	75%	75%	75%	75%	75%	75%		75%	75%	75%	75%	75%	75%	75%	75%		
Main Efficency	(%)							95%	95%	95%	95%	95%	95%	95%		95%	95%	95%	95%	95%	95%	95%	95%		
8. Irrigation Gross	(mm)							8.0	12.6	14.3	8.1	0.0	0.0	0.0		0.0	0.0	0.0	0.0	4.8	10.6	9.5	9.7		
<Pattern C> 2nd Stagger																									
1. Crop Coefficient	kc									0.40	0.70	0.95	0.95	0.95	0.90	0.80		0.40	0.70	0.80	1.10	1.10	1.10	1.10	0.95
2. ET Crop	(mm)									32.9	57.5	72.7	72.7	66.3	62.8	57.0		24.0	42.0	40.9	56.3	39.6	39.6	30.7	26.5
3. Land Preparation	(mm)																								
4. Percolation	(mm)																								
5. Field Requirement	(mm)									32.9	57.5	72.7	72.7	66.3	62.8	57.0		24.0	42.0	40.9	56.3	39.6	39.6	30.7	26.5
6. Irrigation Require	(mm)									2.4	6.3	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.7	35.1	31.7	37.8	27.8	24.0
Crop Intencity	(%)									15%	15%	15%	15%	15%	15%	15%		15%	15%	15%	15%	15%	15%	15%	15%
7. Irrigation Net										0.4	0.9	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.1	5.3	4.8	5.7	4.2	3.6
Field Efficency	(%)									70%	70%	70%	70%	70%	70%	70%		70%	70%	70%	70%	70%	70%	70%	70%
Farm Efficency	(%)									75%	75%	75%	75%	75%	75%	75%		75%	75%	75%	75%	75%	75%	75%	75%
Main Efficency	(%)									95%	95%	95%	95%	95%	95%	95%		95%	95%	95%	95%	95%	95%	95%	95%
8. Irrigation Gross	(mm)									0.7	1.9	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.2	10.6	9.5	11.4	8.4	7.2
Irrigation Gross Total (Pattern A+B+C)	(mm)							48.2	61.9	119.3	102.1	83.2	40.7	22.1	0.0	27.4	53.8	97.7	136.1	150.8	111.8	107.2	39.5	21.5	7.2
	(l/s/ha)							0.37	0.45	0.89	0.76	0.64	0.31	0.16	0.00	0.20	0.40	0.75	1.05	1.13	0.83	0.83	0.31	0.16	0.05

Table 6.4.3-4 Calculation for Water Requirement for Block F, G under 9 Months Irrigation

Season		Dry Season										Wet Season										Dry Season			
Month		Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
Period		1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Days		15.5	15.5	14.0	14.0	15.5	15.5	15.0	15.0	15.5	15.5	15.0	15.0	15.5	15.5	15.5	15.5	15.0	15.0	15.5	15.5	15.0	15.0	15.5	15.5
ET_o	(mm/day)	1.9	1.9	2.8	2.8	3.9	3.9	5.1	5.1	5.3	5.3	5.1	5.1	4.5	4.5	4.6	4.6	4.0	4.0	3.3	3.3	2.4	2.4	1.8	1.8
	(mm)	29.5	29.5	39.2	39.2	60.5	60.5	76.5	76.5	82.2	82.2	76.5	76.5	69.8	69.8	71.3	71.3	60.0	60.0	51.2	51.2	36.0	36.0	27.9	27.9
Rain P(80%)	(mm)	1.2	1.6	4.9	6.7	6.9	10.2	16.5	27.6	43.6	73.1	116.3	157.3	196.1	222.8	237.3	211.0	143.9	92.7	57.4	30.3	11.3	2.6	4.1	3.6
Effective Rain	Paddy	1.0	1.4	4.2	5.7	5.9	8.7	14.0	21.5	31.2	51.2	81.4	110.1	137.3	155.9	166.1	147.7	100.7	66.4	44.6	25.3	8.4	1.0	3.1	3.1
(mm)	Upland	0.9	1.1	3.4	4.7	4.9	7.2	11.5	19.3	30.5	51.2	81.4	110.1	137.3	155.9	166.1	147.7	100.7	64.9	40.2	21.2	7.9	1.8	2.9	2.5

Pattern A 1st Stagger
2nd Stagger
Pattern B 1st Stagger
2nd Stagger

		Jan 1st	Jan 2nd	Feb 1st	Feb 2nd	Mar 1st	Mar 2nd	Apr 1st	Apr 2nd	May 1st	May 2nd	Jun 1st	Jun 2nd	Jul 1st	Jul 2nd	Aug 1st	Aug 2nd	Sep 1st	Sep 2nd	Oct 1st	Oct 2nd	Nov 1st	Nov 2nd	Dec 1st	Dec 2nd
<Pattern A> 1st Stagger																									
1. Crop Coefficient	kc							0.50	0.90	1.05	1.05	1.00	0.95		1.10	1.10	1.10	1.10	1.10	1.30	1.05	1.05			
2. ET Crop	(mm)							38.3	68.9	86.3	86.3	76.5	72.7		76.7	78.4	78.4	66.0	66.0	66.5	53.7	37.8			
3. Land Preparation	(mm)														75.0	75.0	50.0	50.0							
4. Percolation	(mm)																155.0	150.0	150.0	155.0					
5. Field Requirement	(mm)							38.3	68.9	86.3	86.3	76.5	72.7		151.7	153.4	283.4	266.0	216.0	221.5	53.7	37.8			
6. Irrigation Require	(mm)							26.7	49.5	55.8	35.1	0.0	0.0		0.0	0.0	135.7	165.3	149.6	176.9	28.4	29.4			
Crop Intencity	(%)							25%	25%	25%	25%	25%	25%		25%	25%	25%	25%	25%	25%	25%	25%			
7. Irrigation Net								6.7	12.4	13.9	8.8	0.0	0.0		0.0	0.0	33.9	41.3	37.4	44.2	7.1	7.3			
Field Efficency	(%)							70%	70%	70%	70%	70%	70%		90%	90%	90%	90%	90%	90%	70%	70%			
Farm Efficency	(%)							75%	75%	75%	75%	75%	75%		75%	75%	75%	75%	75%	75%	75%	75%			
Main Efficency	(%)							95%	95%	95%	95%	95%	95%		95%	95%	95%	95%	95%	95%	95%	95%			
8. Irrigation Gross	(mm)							13.4	24.8	27.9	17.6	0.0	0.0		0.0	0.0	52.9	64.4	58.3	68.9	14.2	14.7			
<Pattern A> 2nd Stagger																									
1. Crop Coefficient	kc									0.30	0.70	1.05	1.05	1.00	0.95		1.10	1.10	1.10	1.30	1.30	1.30	1.05	1.05	
2. ET Crop	(mm)									24.6	57.5	80.3	80.3	69.8	66.3		78.4	66.0	66.0	66.5	66.5	46.8	37.8	29.3	
3. Land Preparation	(mm)																75.0	75.0	50.0	50.0					
4. Percolation	(mm)																		150.0	155.0	155.0	150.0			
5. Field Requirement	(mm)									24.6	57.5	80.3	80.3	69.8	66.3		153.4	141.0	266.0	271.5	221.5	196.8	37.8	29.3	
6. Irrigation Require	(mm)									0.0	6.3	0.0	0.0	0.0	0.0		5.7	40.3	199.6	226.9	196.2	188.4	35.8	26.2	
Crop Intencity	(%)									25%	25%	25%	25%	25%	25%		25%	25%	25%	25%	25%	25%	25%	25%	
7. Irrigation Net										0.0	1.6	0.0	0.0	0.0	0.0		1.4	10.1	49.9	56.7	49.0	47.1	9.2	6.5	
Field Efficency	(%)									70%	70%	70%	70%	70%	70%		90%	90%	90%	90%	90%	90%	70%	70%	
Farm Efficency	(%)									75%	75%	75%	75%	75%	75%		75%	75%	75%	75%	75%	75%	75%	75%	
Main Efficency	(%)									95%	95%	95%	95%	95%	95%		95%	95%	95%	95%	95%	95%	95%	95%	
8. Irrigation Gross	(mm)									0.0	3.2	0.0	0.0	0.0	0.0		2.2	15.7	77.8	88.4	76.5	73.4	18.4	13.1	
<Pattern B> 1st Stagger																									
1. Crop Coefficient	kc							0.50	0.80	0.95	0.95	0.95	0.90	0.80		0.40	0.70	0.95	0.95	1.10	1.10	1.10	0.95		
2. ET Crop	(mm)							38.3	61.2	78.0	78.0	72.7	68.9	55.8		28.5	49.9	57.0	57.0	56.3	56.3	39.6	34.2		
3. Land Preparation	(mm)																								
4. Percolation	(mm)																								
5. Field Requirement	(mm)							38.3	61.2	78.0	78.0	72.7	68.9	55.8		28.5	49.9	57.0	57.0	56.3	56.3	39.6	34.2		
6. Irrigation Require	(mm)							26.7	41.9	47.5	26.9	0.0	0.0	0.0		0.0	0.0	0.0	0.0	16.1	35.1	31.7	32.4		
Crop Intencity	(%)							25%	25%	25%	25%	25%	25%	25%		25%	25%	25%	25%	25%	25%	25%	25%		
7. Irrigation Net								6.7	10.5	11.9	6.7	0.0	0.0	0.0		0.0	0.0	0.0	0.0	4.0	8.8	7.9	8.1		
Field Efficency	(%)							70%	70%	70%	70%	70%	70%	70%		70%	70%	70%	70%	70%	70%	70%	70%		
Farm Efficency	(%)							75%	75%	75%	75%	75%	75%	75%		75%	75%	75%	75%	75%	75%	75%	75%		
Main Efficency	(%)							95%	95%	95%	95%	95%	95%	95%		95%	95%	95%	95%	95%	95%	95%	95%		
8. Irrigation Gross	(mm)							13.4	21.0	23.8	13.5	0.0	0.0	0.0		0.0	0.0	0.0	0.0	8.1	17.6	15.9	16.2		
<Pattern B> 2nd Stagger																									
1. Crop Coefficient	kc									0.40	0.70	0.95	0.95	0.95	0.90	0.80		0.40	0.70	0.80	1.10	1.10	1.10	1.10	0.95
2. ET Crop	(mm)									32.9	57.5	72.7	72.7	66.3	62.8	57.0		24.0	42.0	40.9	56.3	39.6	39.6	30.7	26.5
3. Land Preparation	(mm)																								
4. Percolation	(mm)																								
5. Field Requirement	(mm)									32.9	57.5	72.7	72.7	66.3	62.8	57.0		24.0	42.0	40.9	56.3	39.6	39.6	30.7	26.5
6. Irrigation Require	(mm)									2.4	6.3	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.7	35.1	31.7	37.8	27.8	24.0
Crop Intencity	(%)									25%	25%	25%	25%	25%	25%	25%		25%	25%	25%	25%	25%	25%	25%	25%
7. Irrigation Net										0.6	1.6	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.2	8.8	7.9	9.4	7.0	6.0
Field Efficency	(%)									70%	70%	70%	70%	70%	70%	70%		70%	70%	70%	70%	70%	70%	70%	70%
Farm Efficency	(%)									75%	75%	75%	75%	75%	75%	75%		75%	75%	75%	75%	75%	75%	75%	75%
Main Efficency	(%)									95%	95%	95%	95%	95%	95%	95%		95%	95%	95%	95%	95%	95%	95%	95%
8. Irrigation Gross	(mm)									1.2	3.2	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.4	17.6	15.9	18.9	13.9	12.0
Irrigation Gross Total (Pattern A+B)																									
	(mm)							26.8	45.8	53.0	37.4	0.0	0.0	0.0	0.0	0.0	55.4	80.1	136.1	165.8	125.9	119.9	53.6	27.1	12.0
	(l/s/ha)							0.21	0.35	0.40	0.28	0.00	0.00	0.00	0.00	0.00	0.41	0.62	1.05	1.24	0.94	0.93	0.41	0.20	0.09

Table 6.4.3-5 Calculation for Water Requirement for Block I, J, K under 9 Months Irrigation

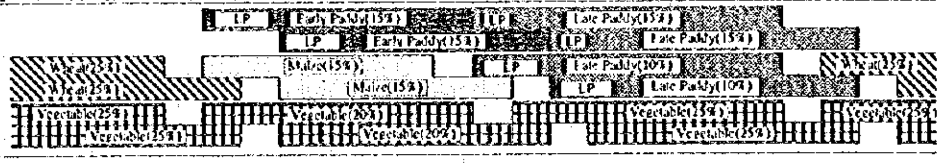
Season		Dry Season												Wet Season								Dry Season			
Month		Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
Period		1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Days		15.5	15.5	14.0	14.0	15.5	15.5	15.0	15.0	15.5	15.5	15.0	15.0	15.5	15.5	15.5	15.5	15.0	15.0	15.5	15.5	15.0	15.0	15.5	15.5
ET_o	(mm/day)	1.9	1.9	2.8	2.8	3.9	3.9	5.1	5.1	5.3	5.3	5.1	5.1	4.5	4.5	4.6	4.6	4.0	4.0	3.3	3.3	2.4	2.4	1.8	1.8
	(mm)	29.5	29.5	39.2	39.2	60.5	60.5	76.5	76.5	82.2	82.2	76.5	76.5	69.8	69.8	71.3	71.3	60.0	60.0	51.2	51.2	36.0	36.0	27.9	27.9
Rain R(80%)	(mm)	1.2	1.6	4.9	6.7	6.9	10.2	16.5	27.6	43.6	73.1	116.3	157.3	196.1	222.8	217.3	211.0	143.9	92.7	57.4	30.3	11.3	2.6	4.1	3.6
Effective Rain	Paddy	1.0	1.4	4.2	5.7	5.9	8.7	14.0	21.5	31.2	51.2	81.4	110.1	137.3	155.9	166.1	147.7	100.7	66.4	44.6	25.3	8.4	1.0	3.1	3.1
(mm)	Upland	0.8	1.1	3.4	4.7	4.9	7.2	11.5	19.3	30.5	51.2	81.4	110.1	137.3	155.9	166.1	147.7	100.7	64.9	40.2	21.2	7.9	1.8	2.9	2.5

Item	Unit	Jan 1st	Jan 2nd	Feb 1st	Feb 2nd	Mar 1st	Mar 2nd	Apr 1st	Apr 2nd	May 1st	May 2nd	Jun 1st	Jun 2nd	Jul 1st	Jul 2nd	Aug 1st	Aug 2nd	Sep 1st	Sep 2nd	Oct 1st	Oct 2nd	Nov 1st	Nov 2nd	Dec 1st	Dec 2nd
<Pattern A> 1st Stagger																									
1. Crop Coefficient	kc							0.50	0.90	1.05	1.05	1.05	1.00	0.95			0.40	0.70	0.95	1.10	1.10	1.10	0.95		
2. ET Crop	(mm)							38.3	68.9	86.3	86.3	80.3	76.5	66.3			28.5	42.0	57.0	56.3	56.3	39.6	34.2		
3. Land Preparation	(mm)																								
4. Percolation	(mm)																								
5. Field Requirement	(mm)							38.3	68.9	86.3	86.3	80.3	76.5	66.3			28.5	42.0	57.0	56.3	56.3	39.6	34.2		
6. Irrigation Require	(mm)							26.7	49.5	55.8	35.1	0.0	0.0	0.0			0.0	0.0	0.0	16.1	35.1	31.7	32.4		
Crop Intencity	(%)							25%	25%	25%	25%	25%	25%	25%			25%	25%	25%	25%	25%	25%	25%		
7. Irrigation Net								6.7	12.4	13.9	8.8	0.0	0.0	0.0			0.0	0.0	0.0	4.0	8.8	7.9	8.1		
Field Efficency	(%)							70%	70%	70%	70%	70%	70%	70%			70%	70%	70%	70%	70%	70%	70%		
Farm Efficency	(%)							75%	75%	75%	75%	75%	75%	75%			75%	75%	75%	75%	75%	75%	75%		
Main Efficency	(%)							95%	95%	95%	95%	95%	95%	95%			95%	95%	95%	95%	95%	95%	95%		
8. Irrigation Gross	(mm)							13.4	24.8	27.9	17.6	0.0	0.0	0.0			0.0	0.0	0.0	8.1	17.6	15.9	16.2		
<Pattern A> 2nd Stagger																									
1. Crop Coefficient	kc									0.50	0.90	1.20	1.20	1.20	1.15	1.10			0.40	0.80	1.10	1.10	1.10	1.10	0.95
2. ET Crop	(mm)									41.1	73.9	91.8	91.8	83.7	80.2	78.4			24.0	40.9	56.3	39.6	39.6	30.7	26.5
3. Land Preparation	(mm)																								
4. Percolation	(mm)																								
5. Field Requirement	(mm)									41.1	73.9	91.8	91.8	83.7	80.2	78.4			24.0	40.9	56.3	39.6	39.6	30.7	26.5
6. Irrigation Require	(mm)									10.6	22.7	10.4	0.0	0.0	0.0	0.0			0.0	0.7	35.1	31.7	37.8	27.8	24.0
Crop Intencity	(%)									25%	25%	25%	25%	25%	25%	25%			25%	25%	25%	25%	25%	25%	25%
7. Irrigation Net										2.6	5.7	2.6	0.0	0.0	0.0	0.0			0.0	0.2	8.8	7.9	9.4	7.0	6.0
Field Efficency	(%)									70%	70%	70%	70%	70%	70%	70%			70%	70%	70%	70%	70%	70%	70%
Farm Efficency	(%)									75%	75%	75%	75%	75%	75%	75%			75%	75%	75%	75%	75%	75%	75%
Main Efficency	(%)									95%	95%	95%	95%	95%	95%	95%			95%	95%	95%	95%	95%	95%	95%
8. Irrigation Gross	(mm)									5.3	11.4	5.2	0.0	0.0	0.0	0.0			0.0	0.4	17.6	15.9	18.9	13.9	12.0
<Pattern B> 1st Stagger																									
1. Crop Coefficient	kc							1.15	1.50	1.10	1.10	1.10	1.10	0.95	1.95		0.40	0.70	0.95	1.10	1.10	1.10	0.95		
2. ET Crop	(mm)							88.0	114.8	90.4	90.4	84.2	84.2	66.3	136.0		28.5	42.0	57.0	56.3	56.3	39.6	34.2		
3. Land Preparation	(mm)							75.0	75.0	50.0	50.0														
4. Percolation	(mm)																								
5. Field Requirement	(mm)							163.0	189.8	140.4	140.4	84.2	84.2	66.3	136.0		28.5	42.0	57.0	56.3	56.3	39.6	34.2		
6. Irrigation Require	(mm)							149.0	168.2	109.1	89.2	2.8	0.0	0.0	0.0		0.0	0.0	0.0	16.1	35.1	31.7	32.4		
Crop Intencity	(%)							12.5%	12.5%	12.5%	12.5%	12.5%	12.5%	12.5%	12.5%		12.5%	12.5%	12.5%	12.5%	12.5%	12.5%	12.5%		
7. Irrigation Net								18.6	21.0	13.6	11.1	0.3	0.0	0.0	0.0		0.0	0.0	0.0	2.0	4.4	4.0	4.0		
Field Efficency	(%)							90%	90%	70%	70%	70%	70%	70%	70%		70%	70%	70%	70%	70%	70%	70%		
Farm Efficency	(%)							75%	75%	75%	75%	75%	75%	75%	75%		75%	75%	75%	75%	75%	75%	75%		
Main Efficency	(%)							95%	95%	95%	95%	95%	95%	95%	95%		95%	95%	95%	95%	95%	95%	95%		
8. Irrigation Gross	(mm)							29.0	32.8	27.3	22.3	0.7	0.0	0.0	0.0		0.0	0.0	0.0	4.0	8.8	7.9	8.1		
<Pattern B> 2nd Stagger																									
1. Crop Coefficient	kc									1.10	1.10	1.10	1.10	1.10	1.10	0.95	1.95		0.40	0.80	1.10	1.10	1.10	1.10	0.95
2. ET Crop	(mm)									90.4	90.4	84.2	84.2	76.7	76.7	67.7	139.0		24.0	40.9	56.3	39.6	39.6	30.7	26.5
3. Land Preparation	(mm)									75.0	75.0	50.0	50.0												
4. Percolation	(mm)																								
5. Field Requirement	(mm)									165.4	165.4	134.2	134.2	76.7	76.7	67.7	139.0		24.0	40.9	56.3	39.6	39.6	30.7	26.5
6. Irrigation Require	(mm)									134.1	114.2	52.8	24.1	0.0	0.0	0.0	0.0		0.0	0.7	35.1	31.7	37.8	27.8	24.0
Crop Intencity	(%)									12.5%	12.5%	12.5%	12.5%	12.5%	12.5%	12.5%	12.5%		12.5%	12.5%	12.5%	12.5%	12.5%	12.5%	12.5%
7. Irrigation Net										16.8	14.3	6.6	3.0	0.0	0.0	0.0	0.0		0.0	0.1	4.4	4.0	4.7	3.5	3.0
Field Efficency	(%)									90%	90%	70%	70%	70%	70%	70%	70%		70%	70%	70%	70%	70%	70%	70%
Farm Efficency	(%)									75%	75%	75%	75%	75%	75%	75%	75%		75%	75%	75%	75%	75%	75%	75%
Main Efficency	(%)									95%	95%	95%	95%	95%	95%	95%	95%		95%	95%	95%	95%	95%	95%	95%
8. Irrigation Gross	(mm)									26.1	22.3	13.2	6.0	0.0	0.0	0.0	0.0		0.0	0.2	8.8	7.9	9.5	7.0	6.0
<Pattern C> 1st Stagger																									
1. Crop Coefficient	kc							0.50	0.80	0.95	0.95	0.95	0.95	0.90	0.80		0.40	0.70	0.95	1.10	1.10	1.10	0.95		
2. ET Crop	(mm)							38.3	61.2	78.0	78.0	72.7	72.7	62.8	55.8		28.5	42.0	57.0	56.3	56.3	39.6	34.2		
3. Land Preparation	(mm)																								
4. Percolation	(mm)																								
5. Field Requirement	(mm)							38.3	61.2	78.0	78.0	72.7	72.7	62.8	55.8		28.5	42.0	57.0	56.3	56.3	39.6	34.2		
6. Irrigation Require	(mm)							26.7	41.9	47.5	26.9	0.0	0.0	0.0	0.0		0.0	0.0	0.0	16.1	35.1	31.7	32.4		
Crop Intencity	(%)							12.5%	12.5%	12.5%	12.5%	12.5%	12.5%	12.5%	12.5%		12.5%	12.5%	12.5%	12.5%	12.5%	12.5%	12.5%		
7. Irrigation Net								3.3	5.2	5.9	3.4	0.0	0.0	0.0	0.0		0.0	0.0	0.0	2.0	4.4	4.0	4.0		
Field Efficency	(%)							70%	70%	70%	70%	70%	70%	70%	70%		70%	70%	70%	70%	70%	70%	70%		
Farm Efficency	(%)							75%	75%	75%	75%	75%	75%	75%	75%		75%	75%	75%	75%	75%	75%	75%		
Main Efficency	(%)							95%	95%	95%	95%	95%	95%	95%	95%		95%	95%	95%	95%	95%	95%	95%		
8. Irrigation Gross	(mm)							6.7	10.5	11.9	6.7	0.0	0.0	0.0	0.0		0.0	0.0	0.0	4.0	8.8	7.9	8.1		
<Pattern C> 2nd Stagger																									
1. Crop Coefficient	kc									0.40	0.70	0.95	0.95	0.95	0.95	0.90	0.80		0.40	0.80	1.10	1.10	1.10	1.10	0.95
2. ET Crop	(mm)									32.9	57.5	72.7	72.7	66.3	66.3	64.2	57.0		24.0	40.9	56.3	39.6	39.6	30.7	26.5
3. Land Preparation	(mm)																								
4. Percolation	(mm)																								
5. Field Requirement	(mm)									32.9	57.5	72.7	72.7	66.3	66.3	64.2	57.0		24.0	40.9	56.3	39.6	39.6	30.7	26.5
6. Irrigation Require	(mm)									2.4	6.3	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.7	35.1	31.7	37.8	27.8	24.0
Crop Intencity	(%)									12.5%	12.5%	12.5%	12.5%	12.5%	12.5%	12.5%	12.5%		12.5%	12.5%	12.5%	12.5%	12.5%	12.5%	12.5%
7. Irrigation Net										0.3	0.8	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.1	4.4	4.0	4.7	3.5	3.0
Field Efficency	(%)									70%	70%	70%	70%	70%	70%	70%	70%		70%	70%	70%	70%	70%	70%	70%
Farm Efficency	(%)									75%	75%	75%	75%	75%	75%	75%	75%		75%	75%	75%	75%	75%	75%	75%
Main Efficency	(%)									95%	95%	95%	95%	95%	95%	95%	95%		95%	95%	95%	95%	95%	95%	95%
8. Irrigation Gross	(mm)									0.6	1.6	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.2	8.8	7.9	9.5	7.0	6.0
Irrigation Gross Total (Pattern A+B+C)																									
	(mm)							49.1	68.1	99.2	81.9	19.1	6.0	0.0	0.0	0.0	0.0	0.0	0.0	16.9	70.3	63.5	70.3	27.9	24.0
	(l/s/ha)							0.38	0.53	0.74	0.61	0.15	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.53	0.49	0.54	0.21	0.18

Table 6.4.3-6 Calculation for Water Requirement for Block L

Season						Dry Season										Wet Season								Dry Season	
Month		Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
Period		1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Days		15.5	15.5	14.0	14.0	15.5	15.5	15.0	15.0	15.5	15.5	15.0	15.0	15.5	15.5	15.5	15.5	15.0	15.0	15.5	15.5	15.0	15.0	15.5	15.5
ET_o	(mm/day)	1.9	1.9	2.8	2.8	3.9	3.9	5.1	5.1	5.3	5.3	5.1	5.1	4.5	4.5	4.6	4.6	4.0	4.0	3.3	3.3	2.4	2.4	1.8	1.8
	(mm)	29.5	29.5	39.2	39.2	60.5	60.5	76.5	76.5	82.2	82.2	76.5	76.5	69.8	69.8	71.3	71.3	60.0	60.0	51.2	51.2	36.0	36.0	27.9	27.9
Rain P(80%)	(mm)	1.2	1.6	4.9	6.7	6.9	10.2	16.5	27.6	43.6	73.1	116.3	157.3	196.1	222.8	237.3	213.0	143.9	92.7	57.4	30.3	11.3	2.6	4.1	3.6
Effective Rain	for Paddy	1.0	1.4	4.2	5.7	5.9	8.7	14.0	21.5	31.2	51.2	81.4	110.1	137.3	155.9	166.1	147.7	100.7	66.4	44.6	25.3	8.4	1.6	3.1	3.1
(mm)	for Upland	0.8	1.1	3.4	4.7	4.9	7.2	11.5	19.3	30.5	51.2	81.4	110.1	137.3	155.9	166.1	147.7	100.7	64.9	40.2	21.2	7.9	1.8	2.9	2.5

Pattern A 1st Stagger
2nd Stagger
Pattern B 1st Stagger
2nd Stagger
Pattern C 1st Stagger
2nd Stagger



Item	Unit	Jan 1st	Jan 2nd	Feb 1st	Feb 2nd	Mar 1st	Mar 2nd	Apr 1st	Apr 2nd	May 1st	May 2nd	Jun 1st	Jun 2nd	Jul 1st	Jul 2nd	Aug 1st	Aug 2nd	Sep 1st	Sep 2nd	Oct 1st	Oct 2nd	Nov 1st	Nov 2nd	Dec 1st	Dec 2nd
<Pattern A> 1st Stagger																									
1. Crop Coefficient	kc						1.15	1.50	1.30	1.10	1.10	0.95	0.95	1.10	1.10	1.10	1.10	1.10	1.10	1.05	1.05				
2. ET Crop	(mm)						69.5	114.8	99.5	90.4	90.4	72.7	72.7	76.7	76.7	78.4	78.4	66.0	66.0	53.7	53.7				
3. Land Preparation	(mm)						75.0	75.0	50.0	50.0				55.0	50.0	50.0									
4. Percolation	(mm)								150.0	155.0	155.0				155.0	155.0	155.0	150.0	150.0						
5. Field Requirement	(mm)						144.5	189.8	299.5	295.4	245.4	72.7	72.7	131.7	281.7	283.4	233.4	216.0	216.0	53.7	53.7				
6. Irrigation Require	(mm)						135.8	175.7	277.9	264.1	194.2	0.0	0.0	0.0	125.8	117.3	85.7	115.3	149.6	9.1	28.4				
Crop Intencity	(%)						15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%				
7. Irrigation Net							20.4	26.4	41.7	39.6	29.1	0.0	0.0	0.0	18.9	17.6	12.9	17.3	22.4	1.4	4.3				
Field Efficency	(%)						90%	90%	90%	90%	90%	70%	70%	90%	90%	90%	90%	90%	90%	70%	70%				
Farm Efficency	(%)						75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%				
Main Efficency	(%)						95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%				
8. Irrigation Gross	(mm)						31.8	41.1	65.0	61.8	45.4	0.0	0.0	0.0	29.4	27.4	20.1	27.0	35.0	2.7	8.5				
<Pattern A> 2nd Stagger																									
1. Crop Coefficient	kc								1.15	1.10	1.10	1.10	1.10	0.95	0.95	1.10	1.10	1.10	1.10	1.30	1.30	1.05	1.05		
2. ET Crop	(mm)								88.0	90.4	90.4	84.2	84.2	66.3	66.3	78.4	78.4	66.0	66.0	66.5	66.5	37.8	37.8		
3. Land Preparation	(mm)								75.0	75.0	50.0	50.0				55.0	50.0	50.0							
4. Percolation	(mm)										150.0	155.0	155.0				155.0	150.0	150.0	155.0	155.0				
5. Field Requirement	(mm)								163.0	165.4	290.4	289.2	239.2	66.3	66.3	133.4	283.4	266.0	216.0	221.5	221.5	37.8	37.8		
6. Irrigation Require	(mm)								141.4	134.1	239.2	207.8	129.1	0.0	0.0	0.0	135.7	165.3	149.6	176.9	196.2	29.4	36.8		
Crop Intencity	(%)								15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%		
7. Irrigation Net									21.2	20.1	35.9	31.2	19.4	0.0	0.0	0.0	20.4	24.8	22.4	26.5	29.4	4.4	5.5		
Field Efficency	(%)								90%	90%	90%	90%	90%	70%	70%	90%	90%	90%	90%	90%	90%	70%	70%		
Farm Efficency	(%)								75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%		
Main Efficency	(%)								95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%		
8. Irrigation Gross	(mm)								33.1	31.4	55.9	48.6	30.2	0.0	0.0	0.0	31.7	38.7	35.0	41.4	45.9	6.8	11.1		
<Pattern B> 1st Stagger																									
1. Crop Coefficient	kc	1.20	1.20	0.75	0.25		0.50	0.90	1.20	1.05	1.00	0.95		1.10	1.10	1.10	1.10	1.10	1.10	1.05	1.05		0.40	0.80	1.20
2. ET Crop	(mm)	35.3	35.3	29.4	9.8		30.2	68.9	91.8	86.3	82.2	72.7		76.7	76.7	78.4	78.4	66.0	66.0	53.7	53.7		14.4	22.3	33.5
3. Land Preparation	(mm)													75.0	75.0	50.0	50.0								
4. Percolation	(mm)															155.0	155.0	150.0	150.0						
5. Field Requirement	(mm)	35.3	35.3	29.4	9.8		30.2	68.9	91.8	86.3	82.2	72.7		151.7	151.7	283.4	283.4	216.0	216.0	53.7	53.7		14.4	22.3	33.5
6. Irrigation Require	(mm)	34.5	34.2	26.0	5.1		23.1	57.3	72.5	55.8	31.0	0.0		14.5	0.0	117.3	135.7	115.3	149.6	9.1	28.4		12.6	19.4	30.9
Crop Intencity	(%)	25%	25%	25%	25%		15%	15%	15%	15%	15%	15%		10%	10%	10%	10%	10%	10%	10%	10%		25%	25%	25%
7. Irrigation Net		8.6	8.5	6.5	1.3		3.5	8.6	10.9	8.4	4.6	0.0		1.4	0.0	11.7	13.6	11.5	15.0	0.9	2.8		3.1	4.9	7.7
Field Efficency	(%)	70%	70%	70%	70%		70%	70%	70%	70%	70%	70%		90%	90%	90%	90%	90%	90%	70%	70%		70%	70%	70%
Farm Efficency	(%)	75%	75%	75%	75%		75%	75%	75%	75%	75%	75%		75%	75%	75%	75%	75%	75%	75%	75%		75%	75%	75%
Main Efficency	(%)	95%	95%	95%	95%		95%	95%	95%	95%	95%	95%		95%	95%	95%	95%	95%	95%	95%	95%		95%	95%	95%
8. Irrigation Gross	(mm)	17.3	17.1	13.0	2.6		6.9	17.2	21.8	16.8	9.3	0.0		2.3	0.0	18.3	21.2	18.0	23.3	1.8	5.7		6.3	9.7	15.5
<Pattern B> 2nd Stagger																									
1. Crop Coefficient	kc	0.80	1.20	1.20	1.20	0.75	0.25		0.50	0.70	1.05	1.05	1.00	0.95		1.10	1.10	1.10	1.10	1.30	1.30	1.05	1.05		0.40
2. ET Crop	(mm)	23.6	35.3	47.0	47.0	45.3	15.1		38.3	57.5	86.3	80.3	76.5	66.3		78.4	78.4	66.0	66.0	66.5	66.5	37.8	37.8		11.2
3. Land Preparation	(mm)															75.0	75.0	50.0	50.0						
4. Percolation	(mm)																	155.0	155.0	150.0	150.0				
5. Field Requirement	(mm)	23.6	35.3	47.0	47.0	45.3	15.1		38.3	57.5	86.3	80.3	76.5	66.3		153.4	153.4	271.0	271.0	216.5	216.5	37.8	37.8		11.2
6. Irrigation Require	(mm)	22.7	34.2	43.6	42.4	40.5	8.0		18.9	27.0	35.1	0.0	0.0	0.0		0.0	5.7	170.3	204.6	171.9	191.2	29.4	36.8		8.6
Crop Intencity	(%)	15%	15%	15%	15%	15%	15%		15%	15%	15%	15%	15%	15%		10%	10%	10%	10%	10%	10%	10%	10%		25%
7. Irrigation Net		3.4	5.1	6.5	6.4	6.1	1.2		2.8	4.1	5.3	0.0	0.0	0.0		0.0	0.6	17.0	20.5	17.2	19.1	2.9	3.7		2.2
Field Efficency	(%)	70%	70%	70%	70%	70%	70%		70%	70%	70%	70%	70%	70%		90%	90%	90%	90%	90%	90%	70%	70%		70%
Farm Efficency	(%)	75%	75%	75%	75%	75%	75%		75%	75%	75%	75%	75%	75%		75%	75%	75%	75%	75%	75%	75%	75%		75%
Main Efficency	(%)	95%	95%	95%	95%	95%	95%		95%	95%	95%	95%	95%	95%		95%	95%	95%	95%	95%	95%	95%	95%		95%
8. Irrigation Gross	(mm)	6.8	10.3	13.1	12.7	12.2	2.4		5.7	8.1	10.5	0.0	0.0	0.0		0.0	0.9	26.6	31.9	26.8	29.8	5.9	7.4		4.3
<Pattern C> 1st Stagger																									
1. Crop Coefficient	kc	1.10	1.10	1.10	0.95		0.50	0.80	1.10	0.95	0.90	0.80			0.40	0.70	0.95	0.95	0.95	1.10	0.95		0.50	0.80	1.10
2. ET Crop	(mm)	32.4	32.4	43.1	37.2		30.2	61.2	84.2	78.0	73.9	61.2			27.9	49.9	67.7	57.0	57.0	56.3	48.6		18.0	22.3	30.7
3. Land Preparation	(mm)																								
4. Percolation	(mm)																								
5. Field Requirement	(mm)	32.4	32.4	43.1	37.2		30.2	61.2	84.2	78.0	73.9	61.2			27.9	49.9	67.7	57.0	57.0	56.3	48.6		18.0	22.3	30.7
6. Irrigation Require	(mm)	31.5	31.2	39.7	32.6		23.1	49.7	64.8	47.5	22.7	0.0			0.0	0.0	0.0	0.0	0.0	15.1	27.4		16.2	19.4	28.1
Crop Intencity	(%)	25%	25%	25%	25%		20%	20%	20%	20%	20%	20%			25%	25%	25%	25%	25%	25%	25%		25%	25%	25%
7. Irrigation Net		7.9	7.8	9.9	8.1		4.6	9.9	13.0	9.5	4.5	0.0			0.0	0.0	0.0	0.0	0.0	4.0	6.9		4.0	4.9	7.0
Field Efficency	(%)	70%	70%	70%	70%		70%	70%	70%	70%	70%	70%			70%	70%	70%	70%	70%	70%	70%		70%	70%	70%
Farm Efficency	(%)	75%	75%	75%	75%		75%	75%	75%	75%	75%	75%			75%	75%	75%	75%	75%	75%	75%		75%	75%	75%
Main Efficency	(%)	95%	95%	95%	95%		95%	95%	95%	95%	95%	95%			95%	95%	95%	95%	95%	95%	95%		95%	95%	95%
8. Irrigation Gross	(mm)	15.8	15.7	19.9	15.5		9.3	19.9	26.0	19.1	9.1	0.0			0.0	0.0	0.0	0.0	0.0	8.1	13.7		8.1	9.7	14.1
<Pattern C> 2nd Stagger																									
1. Crop Coefficient	kc	0.80	1.10	1.10	1.10	1.10	0.95		0.50	0.70	0.95	0.95	0.90	0.80			0.40	0.70	0.95	1.10	1.10	1.10	0.95		0.50
2. ET Crop	(mm)	23.6	32.4	43.1	43.1	66.5	57.4		38.3	57.5	78.0	72.7	68.9	55.8			28.5	42.0	57.0	56.3	56.3	39.6	34.2		14.0
3. Land Preparation	(mm)																								
4. Percolation	(mm)																								
5. Field Requirement	(mm)	23.6	32.4	43.1	43.1	66.5	57.4		38.3	57.5	78.0	72.7	68.9	55.8			28.5	42.0	57.0	56.3	56.3	39.6	34.2		14.0
6. Irrigation Require	(mm)	22.7	31.2	39.7	38.4	61.6	50.3		18.9	27.0	26.9	0.0	0.0	0.0			0.0	0.0	0.0	16.1	35.1	31.7	32.4		11.4
Crop Intencity	(%)	25%	25%	25%	25%	25%	25%		20%	20%	20%	20%	20%	20%			25%	25%	25%	25%	25%	25%	25%		25%
7. Irrigation Net		5.7	7.8	9.9	9.6	15.4	12.6		3.8	5.4	5.4	0.0	0.0	0.0			0.0	0.0	0.0	4.0	8.8	7.9	8.1		2.9
Field Efficency	(%)	70%	70%	70%	70%	70%	70%		70%	70%	70%	70%	70%	70%			70%	70%	70%	70%	70%	70%	70%		70%
Farm Efficency	(%)	75%	75%	75%	75%	75%	75%		75%	75%	75%	75%	75%	75%			75%	75%	75%	75%	75%	75%	75%		75%
Main Efficency	(%)	95%	95%	95%	95%	95%	95%		95%	95%	95%	95%	95%	95%			95%	95%	95%	95%	95%	95%	95%		95%
8. Irrigation Gross	(mm)	11.4	15.7	19.9	19.3	30.9	25.2		7.6	10.8	10.8	0.0	0.0	0.0			0.0	0.0	0.0	8.1	17.6	15.9	16.2		5.7
Irrigation Gross Total (Pattern A+B+C)	(mm)	51.3	58.8	65.9	50.9	43.1	75.6	78.3	159.2	147.9	141.1	48.6	30.2	2.3	29.4	45.7	73.9	110.1	125.2	88.8	121.2	30.6	49.1	19.5	39.6
	(l/s/ha)	0.38	0.44	0.54	0.42	0.32	0.56	0.60	1.23	1.10	1.05	0.37	0.23	0.02	0.22	0.34	0.55	0.85	0.97	0.66	0.91	0.24	0.38	0.15	0.30

6.4.4 Intake Plan

(1) Option 3 (downstream of the balancing reservoir) out of the options below was selected as the intake location as a result of close discussions with NEA. Reasons for selection are as follows.

<Candidate sites and required measures>

Candidate site	Location	Measures required
Option 1	Upstream of existing desilting basin	New construction of desilting basin
Option 2	Between existing desilting basin and balancing reservoir	Rehabilitation of existing desilting basin
Option 3	Downstream of balancing reservoir	Measures to eliminate sediment flow into reservoir.

<Selection criteria>

Option 1:

1) Induction pipeline route is the longest (approx. 2 km longer than option 3), and construction cost the highest due to need to construct new desilting basin and crossing structure for existing NEA desilting basin outlet
2) Intake facility must be located at great distance, making O&M difficult
3) Intake location is roughly 0.3 m higher than option 3; however, this does not result in any significant increase in the area that can be gravity irrigated

Option 2:

Appropriate space is not available, and facility construction would be difficult

Option 3:

1) Induction canal route is the shortest, and construction cost the cheapest.
2) Examination must be made of measures to deal with excess discharge over the design discharge for the desilting basin (desilting basin design discharge: Q = 45.60 m^3/s; excess discharge: Q = 0.63 m^3/s

(2) Discharge Capacity of Hydropower Station Canal

Under the intake method in option 3, the discharge in excess of the design discharge for the hydropower station canal ($Q = 0.63\ m^3/s$) would be diverted. In this regard, study is necessary on the discharge carrying capacity of the hydro station canal (rehabilitation completed in 1995), and the capacities of the desilting basin and balancing reservoir. The said canal was rehabilitated as of December 1995 to have a design discharge below aqueduct no. 2 of $Q = 45.6\ m^3/s$. The Study Team examined the canal discharge carrying capacity based on canal free board and power station discharge records, and confirmed as a result that the canal has the capacity to carry discharge in excess of $Q = 50\ m^3/s$. Accordingly, it is possible to divert irrigation discharge downstream of aqueduct no. 2 without necessitating any further rehabilitation works.

(3) Design Intake Discharge

Annual intake from the balancing reservoir (April~December) is shown below. According to the table, peak intake of $Q = 624\ \ell/s$ occurs in early October.

(unit: l/s)

Block:	Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
	ear.	lat.	ear.	lat.	ear.	lat.	ear.	lat.	ear.	lat.	ear.	lat.	ear.	lat.	ear.	lat.	ear.	lat.
A,B,C,H (171.6 ha)	74	99	175	148	115	56	29	0	36	103	180	265	275	200	198	65	36	9
D,E (185.57 ha)	69	89	165	141	119	58	30	0	37	74	139	195	210	154	154	58	30	9
F,G (81.44 ha)	17	29	33	23	0	0	0	0	0	33	50	86	101	77	76	33	16	7
K,J,K (182.02 ha)	69	96	135	111	27	9	0	0	0	0	0	0	38	96	89	98	38	33
Total	229	313	508	423	261	123	59	0	73	210	369	546	624	527	517	254	120	50

6.4.5 Desilting Plan for Balancing Reservoir

(1) Past Estimated Sediment

Based on data collected by the Study Team, amount of sediment inflow into the balancing reservoir is estimated as follows (May~September):

Year	Q (m^3/s)	Reservoir sedimentation (m^3)			Remarks
		Total	C+M	F	
1977~79	31.15	115,300	20,000 (17%)	95,300 (83%)	DHM data
-do-	41.06	229,800	46,100 (20%)	183,700 (80%)	NEA data
Post December 1995	45.31	262,000	52,400 (assumed)	209,000 (assumed)	-do-

C = coarse sediment (d > 0.2 mm)
M = medium sediment (0.075 mm < d < 0.2 mm)
F = fine sediment (d < 0.075)

(2) Future Estimated Sediment

1) Reservoir Inflow Discharge

Inflow discharge records for the balancing reservoir subsequent to December 1995 are as follows. From the table, average inflow discharge to the balancing reservoir is estimated at approximately Q = 45.31 m^3/s (average for May~September).

1996:	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Min.	39.1	34.0	28.3	34.0	39.6	39.6	42.5	28.3	36.8	28.3	42.5	34.0
Max.	53.7	39.6	48.1	50.9	50.9	50.9	48.1	48.1	48.1	48.1	49.5	50.9
Ave.	44.6	36.1	38.2	43.5	45.1	46.5	45.1	44.1	43.0	45.2	44.1	40.3

The above average discharge of Q = approx. 45 m^3/s is approximately the same as that estimated in the Indian Engineering Report obtained from NEA (Q = 45 m^3/s). Accordingly, the sediment inflow volume of V = 262,000 m^3 indicated in the same report has been adopted as the future sediment inflow volume.

2) Annual Sediment Volume

On the basis of past sedimentation records, the following table has been prepared which assumes that 20% (C + M = coarse sediment + medium sediment) of sediment accumulates in the reservoir, with the remaining fine sediment (F) being carried downstream in the direction of the power station as suspended load.

Period	No. of years	① Ave. annual sediment (m^3)	② Existing sediment	③ Generated sediment (m^3)	④ Dredged volume	②+③-④ Net sediment	Remarks
1970~86	15	33,000 (20,000~46,000)	0	495,000 (33,000 × 15 yrs)	65,000 (495,000-430,000)	430,000	· Arrival of dredger in 1976 · Sediment volume of V = 430,000 m^3 confirmed by NEA
1986~95	9	33,000	430,000	297,800 (33,000 × 9 years)	146,000	581,000	Sediment volume of V = 146,000 m^3 confirmed by NEA
1995~96	1	52,000	581,000	52,000	0	633,000 (estimated total sediment volume as of Dec. 96)	

On the basis of the above:

- Total sediment volume as of December 1996 is estimated at V_1 = 633,000 m^3. Since the design sediment volume is V_2 = 510,000 m^3, the remaining V = 123,000 m^3 (V_1 - V_2) represents the estimated buildup in the reservoir effective volume (V = 250,000).

- The estimated volume by the Study Team as a result of field survey was an estimated V = 110,000 m^3 which approximates the above V = 123,000 m^3 figure (see Figure 6.4.5-1).

- Accordingly, on the basis of the above sediment records, V = 52,000 m^3/year (corresponding to 20% of sediment inflow into the reservoir; i.e. C + M = coarse + medium sediment) of sediment is estimated to accumulate.

(3) Basic Strategy for Sediment Removal

On the basis of the above study:

1) Present sediment volume totals approximately 633,000 m^3, which exceeds the reservoir design sediment volume of 510,000 m^3.

2) The excess sediment volume of 123,000 m^3 corresponds to 50% of the effective capacity of the reservoir (V = 250,000).

3) The following dredging works are envisioned:

① The sediment volume of V = 123,000 m³ which has reduced the effective volume of the reservoir is to be removed as soon as possible, and the design reservoir function restored and maintained.

② Next, maintenance dredging is to be performed at a rate of 62,400 m³/year (52,000 × 1.20).

③ The dredging in ② above is to be repeated each year.

(4) Dredging Plan

Dredging equipment will include dredger, backhoe, bulldozer and dump truck, to perform the following works:

	New dredger	Machinery
Dredged volume:	V = 62,400 m³	V = 123,000 m³
Period:	3 months (October~December)	6 months (November~April)
Dredging scale:	(dredger)	(mechanical equipment)
	Dredged volume: $\frac{62,400}{20 days \times 3 mos. \times 6 hrs/day} = 180 m^3/hr \approx 3 m^3/s$	1 backhoe, 7 dump trucks, 2 bull dozers, pump + generator
	Pumped volume: 3 m³/min × 1/0.2 = 15 m³/min	Backhoe capacity Q = 593 m³/s
Dredging method:	Use of 2 dredgers (existing + new)	Coffer dam method
Total dredging cost:	Rs 150 million	Rs 85 million

note: Dredging cost takes into account procurement cost for new dredger and equipment, operator and labor costs, local transport cost, etc.

- According to the above study, the optimum approach is to utilize sediment for coffer dam construction, backhoe and bulldozer dredging, and transport of removed sediment by dump truck (see Figure 6.4.5-2)

- The above dredging cost was calculated assuming purchase of new equipment; however, local leasing of equipment available in-country would result in a cheaper dredging cost.

(5) Conclusion

- Power station side design discharge conveys a sediment load into the balancing reservoir estimated at 52,000 m³. The design irrigation discharge is Q = 0.70 m³/s, and the additional sediment to conveyed by this is considered within the ± tolerance range for sediment load in power station discharge.

- However, sediment in the balancing reservoir has progressed to the point where the design effective storage capacity of the reservoir has been reduced. This has begun to have a negative impact on power station function, and it is desirable that sediment removal be done as soon as possible by the NEA side.

- Accordingly, the following approach to sediment removal from the balancing reservoir is adopted under this Project.

1) Sediment dredging would be performed in the future by NEA.

2) Under the Project, leakage prevention works would be carried out at the existing ejector tank downstream of the balancing reservoir, as a measure to maintain reservoir capacity.

3) Along with these leakage prevention works, diversion of discharge from the main canal pipeline will be done to the existing fish culture farm which enjoys water rights.

Calculation for Sediment Volume

Block	Area(m²)	Volume(m³) t = 1.5m (Assumed)
A-①	1/2×250×140=17,500	
A-②	1/2×150×40= 3,000	
Sub-Total	20,500	20,500×1.5= 30,750
B-①	1/2×60×60= 1,800	
B-②	1/2×370×60= 11,100	
B-③	1/2×370×50= 9,250	
B-④	1/2×280×50= 7,000	
Sub-Total	29,150	29,150×1.5= 43,725
C-①	1/2×190×90= 8,550	
C-②	1/2×130×40= 2,600	
C-③	1/2×100×40= 2,000	
C-④	1/2×110×30= 1,650	
C-⑤	1/2×110×50= 2,750	
C-⑥	1/2×170×50= 4,250	
C-⑦	1/2×170×10= 850	
Sub-Total	22,650	22,650×1.5= 33,975
Total	72,300	108,450

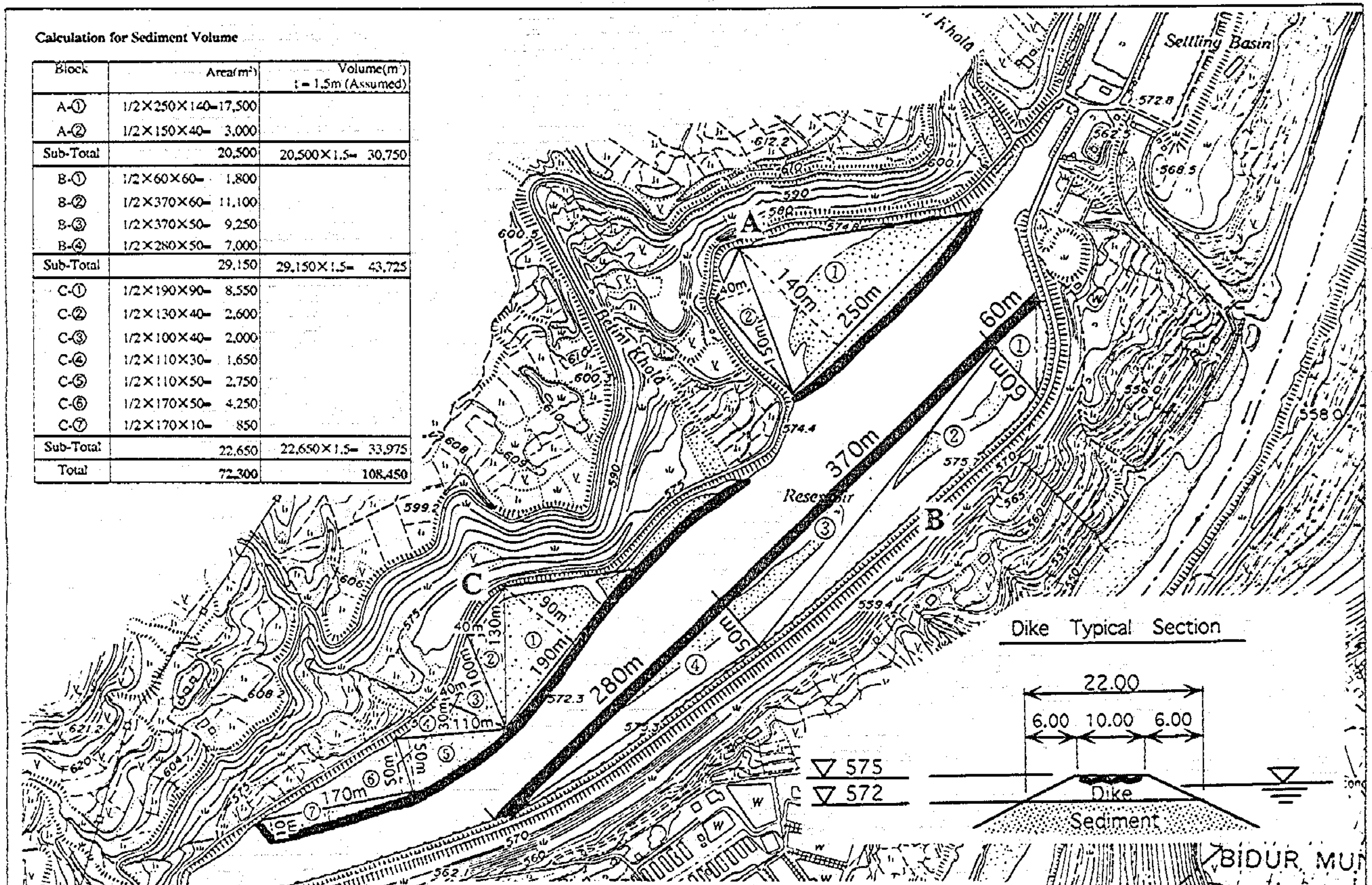


Fig. 6.4.5-1 Present Sediment Condition

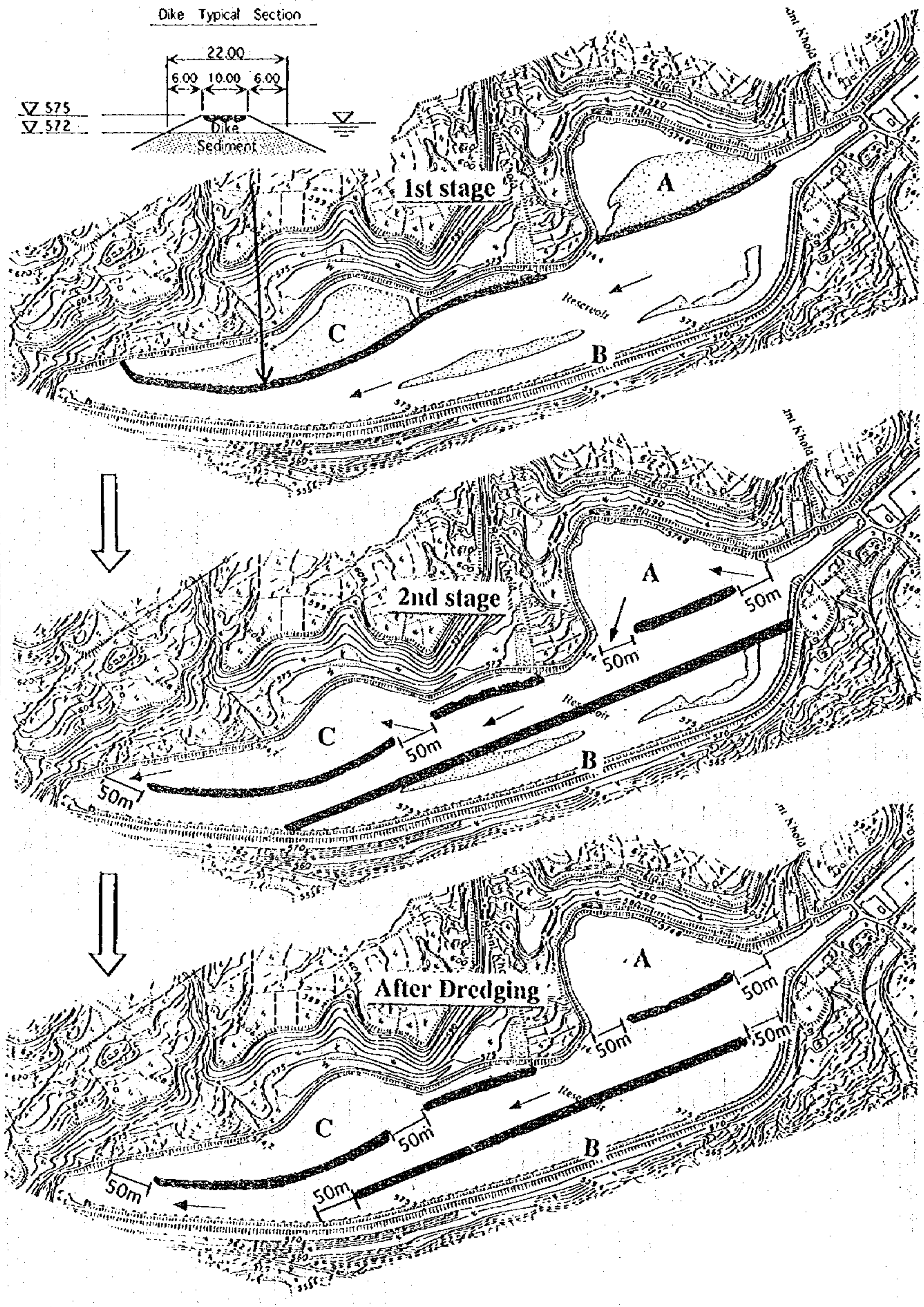


Fig 6.4.5-2 Process of Dredging

6.4.6 Facility Plan

(1) General

A general description of the facility plan under the Project is given below.

Major facility	Construction works	Features
<Zone A>		
a. Intake	Intake tank	B = 4.0 × H = 5.0 m, RC structure
	Discharge pipe	ο 1000 mm (SP) × 50 m, concrete foundation
	Turnout pipe	ο 500 × 25 m, turnout tank (1 no.)
b. Main canal	Pipe laying works	Total length L = 5,800 m (ο 1000 mm: L = 4900 m; ο 900 m: L = 900 m (including aqueduct below balancing reservoir: L = 200 m; Trishuli crossing aqueduct: 450 m; and army camp crossing aqueduct: L = 20 m
c. Balancing reservoir	Discharge regulating works	Reverse "T" reinforcement wall works (H = 4.50 m × B = 4.0 m) × L = 100 m; valve; bypass pipe: one set
d. Branch canal	Branch canal works	Total length: L = 6.4 km (ο 200~430)
	Conveyance pipe works	Total length: L = 560 m (ο 150 × 130 m + ο 300 × 430 m)
	Pump station works	5 locations
	Receiving tank	10 locations
e. Terminal facilities	Canal works	One set
<Zone B>		
a. Intake	Pump station works	1 location
b. Induction canal	Induction canal works	ο 240 × L = 50 m and ο 150 × 100 m
c. Distribution canal	Pipe laying works	Total length 3.3 km (ο 240 × L = 50 m and ο 250 × 2200 m)
d. Terminal facilities	Receiving tank and field canal works	One set

(2) Plan Description

<Zone A: 620 ha>

a. Intake Facility

- The facility is an intake tank to be constructed at the extreme downstream of the power station balancing reservoir.

- Foundation of the intake tank is to be supported by ø 400 steel pegs.

- Design intake water level is planned at HWL equivalent to the reservoir FSL of EL 573.45.

- Reinforcing works (rip-rap) are to be constructed upstream of the intake tank to prevent eroded sediment inflow.

- A water level regulating gate will be installed in the tank in order to regulate discharge in conjunction with the discharge gauging meter to be set up at the downstream of the discharge pipe.

- The discharge pipe (main canal) is planned as ø 1000 steel pipe taking into consideration elevation differential of foundation existing in the downstream area. Foundation support is to be concrete, with 360 ° wrapped concrete straps. A concrete cut-off is to be constructed at the embankment center to prevent seepage.

- A diversion facility for discharge to the fish cultivation farm is planned at the downstream portion of the main canal pipeline. A discharge gauging meter will be installed at the said diversion point for control aperture of the diversion gate.

- In installing the main canal pipeline, it is planned to perform excavation and backfilling at the existing reservoir embankment (excavation height: 5~7 meters; excavation length: 40 m).

b. Main Canal Works

- This is planned as a 5.8 km, ø 1000 (L = 4.9 km) and ø 600 (L = 0.9 km) steel pipeline from the intake site to the irrigation area.

- Principal canal structures include crossing structures over the Trishuli river and the small streams before and after the army camp.

- Earth works are to be performed mechanically.

c. Regulating Pond Works

- The facility will be located at the high elevation downstream of Irrigation Block C, and be an RC structure tank (30 m × 20 m × 2 m × V = 1200 m³).

- The regulating pond will store 1,200 m³ at all times, equivalent to 2 hours worth of the average annual irrigation discharge designed for the downstream area of 467 ha.

d. Branch Canal Works

- To convey water from the aforementioned regulating pond.

- Facility plan includes distribution canal works and receiving tanks for each irrigation block.

- Block receiving tanks will be of a structure to facilitate inflow discharge gauging.

e. Terminal Facilities

- This comprises canals to convey discharge from block receiving tanks to individual fields.

<Zone B >

a. Intake Facility

Pump station and house are planned (see related drawing)

b. Induction Canal

- This comprises main induction canal construction works from the pump station to the receiving tank.

- The receiving tank is to be of a construction which facilitates discharge gauging.

c. Distribution Canal

- To comprise canal works from the receiving tank to the principal terminal facility turn out points.

d. Terminal Facilities

- To comprise canal works to the field from the receiving tank facilities.

(3) Water Management Plan

a. Water Management Calculation Method

- Water management for the main canal and lift irrigation canals is according to the Hazen-Williams formula.

- Water management for terminal canals to farmer fields is by the Long formula.

b. Coefficients

- Hazen Williams: C = 130 (steel pipe); C = 150 (polyvinyl pipe)

- Manning: n = 0.020

c. Results of Water Management Calculation

Water management calculation results are indicated in Table 6.4.6-1 for main canal, branch canal and other conveyance canals.

d. Calculation for Pump Station Water Management

Table 6.4.6-2 indicates design pump lift, required electrical power, intake pipe diameter and outlet pipe diameter.

e. Terminal Canals

Table 6.4.6-4 indicates the cross-sectional features for the 4 types of terminal canals (A~D).

Table 6.4.6-1 Pipe Friction Loss and Dynamic Water Head (1/3)

(Proposed Intake ~ Proposed Control Tank)

Sta	Distance (m)	Ground Elevation GL(m)	Discharge Q $Q(m^3/s)$	Pype Type	C-value C	Pipe Length l(m)	Pipe Diameter D(m)	Area $\frac{3.14D^2}{4}$ $A(m^2)$	Velocity $\frac{Q}{A}$ v(m/s)	Cofficient of Friction Loss $\frac{133.65}{C^{1.85}D^{0.17}V^{0.15}}$ f	Friction Loss $\frac{f l v^2}{D 2g}$ h_f(m)	Dynamic Water Head HWL-573.6 H (m)	H-GL (m)	Remarks
0+000		573.89	1.23	SP								572.45	-1.44	Reservoir
0+050	50	566.73	1.23	SP	130	50	1.00	0.79	1.57	0.0153	0.0960	572.35	5.62	
0+100	50	566.52	0.63	SP	130	50	1.00	0.79	0.80	0.0170	0.0278	572.33	5.81	
0+200	100	553.90	0.63	SP	130	100	1.00	0.79	0.80	0.0170	0.0557	572.27	18.37	
0+300	100	551.81	0.63	SP	130	100	1.00	0.79	0.80	0.0170	0.0557	572.21	20.40	
0+400	100	550.40	0.63	SP	130	100	1.00	0.79	0.80	0.0170	0.0557	572.16	21.76	
0+500	100	550.68	0.63	SP	130	100	1.00	0.79	0.80	0.0170	0.0557	572.10	21.43	
0+600	100	551.05	0.63	SP	130	100	1.00	0.79	0.80	0.0170	0.0557	572.05	20.99	
0+700	100	551.72	0.63	SP	130	100	1.00	0.79	0.80	0.0170	0.0557	571.99	20.27	
0+800	100	549.73	0.63	SP	130	100	1.00	0.79	0.80	0.0170	0.0557	571.94	22.21	
0+900	100	533.42	0.63	SP	130	100	1.00	0.79	0.80	0.0170	0.0557	571.88	38.46	
1+000	100	549.32	0.63	SP	130	100	1.00	0.79	0.80	0.0170	0.0557	571.82	22.50	
1+100	100	531.08	0.63	SP	130	100	1.00	0.79	0.80	0.0170	0.0557	571.77	40.69	Suspension
1+200	100	531.11	0.60	SP	130	100	1.00	0.79	0.76	0.0171	0.0509	571.72	40.61	Bridge
1+300	100	530.87	0.60	SP	130	100	1.00	0.79	0.76	0.0171	0.0509	571.67	40.80	
1+400	100	532.14	0.60	SP	130	100	1.00	0.79	0.76	0.0171	0.0509	571.62	39.48	
1+500	100	524.10	0.60	SP	130	100	1.00	0.79	0.76	0.0171	0.0509	571.57	47.46	School
1+600	100	522.51	0.60	SP	130	100	1.00	0.79	0.76	0.0171	0.0509	571.51	49.01	
1+700	100	516.66	0.60	SP	130	100	1.00	0.79	0.76	0.0171	0.0509	571.46	54.80	Trishuli
1+800	100	515.48	0.60	SP	130	100	1.00	0.79	0.76	0.0171	0.0509	571.41	55.93	Bridge
1+900	100	514.22	0.60	SP	130	100	1.00	0.79	0.76	0.0171	0.0509	571.36	57.15	
2+000	100	514.45	0.60	SP	130	100	1.00	0.79	0.76	0.0171	0.0509	571.31	56.86	
2+100	100	513.05	0.60	SP	130	100	1.00	0.79	0.76	0.0171	0.0509	571.26	58.21	
2+200	100	524.66	0.60	SP	130	100	1.00	0.79	0.76	0.0171	0.0509	571.21	46.55	
2+300	100	523.24	0.60	SP	130	100	1.00	0.79	0.76	0.0171	0.0509	571.16	47.92	Horticulture
2+400	100	522.87	0.60	SP	130	100	1.00	0.79	0.76	0.0171	0.0509	571.11	48.24	
2+500	100	525.84	0.60	SP	130	100	1.00	0.79	0.76	0.0171	0.0509	571.06	45.22	
2+600	100	526.67	0.60	SP	130	100	1.00	0.79	0.76	0.0171	0.0509	571.01	44.34	
2+650	50	526.53	0.60	SP	130	50	1.00	0.79	0.76	0.0171	0.0254	570.98	44.45	
2+700	50	526.63	0.58	SP	130	50	1.00	0.79	0.74	0.0172	0.0239	570.96	44.32	
2+800	100	540.51	0.58	SP	130	100	1.00	0.79	0.74	0.0172	0.0478	570.91	30.40	Slop
2+900	100	562.01	0.58	SP	130	100	1.00	0.79	0.74	0.0172	0.0478	570.86	8.85	
3+000	100	561.54	0.58	SP	130	100	1.00	0.79	0.74	0.0172	0.0478	570.81	9.28	
3+100	100	560.89	0.58	SP	130	100	1.00	0.79	0.74	0.0172	0.0478	570.77	9.87	
3+200	100	560.02	0.58	SP	130	100	1.00	0.79	0.74	0.0172	0.0478	570.72	10.69	
3+300	100	559.51	0.58	SP	130	100	1.00	0.79	0.74	0.0172	0.0478	570.67	11.16	
3+400	100	563.07	0.58	SP	130	100	1.00	0.79	0.74	0.0172	0.0478	570.62	7.55	Slop
3+500	100	570.84	0.58	SP	130	100	1.00	0.79	0.74	0.0172	0.0478	570.57	-0.27	
3+550	50	570.65	0.58	SP	130	50	1.00	0.79	0.74	0.0172	0.0239	570.55	-0.10	
3+600	50	570.49	0.53	SP	130	50	1.00	0.79	0.67	0.0174	0.0202	570.53	0.04	
3+700	100	570.84	0.53	SP	130	100	1.00	0.79	0.67	0.0174	0.0404	570.49	-0.35	
3+800	100	571.19	0.53	SP	130	100	1.00	0.79	0.67	0.0174	0.0404	570.45	-0.74	
3+900	100	571.24	0.53	SP	130	100	1.00	0.79	0.67	0.0174	0.0404	570.41	-0.83	
4+000	100	547.74	0.53	SP	130	100	1.00	0.79	0.67	0.0174	0.0404	570.37	22.63	
4+100	100	570.99	0.53	SP	130	100	1.00	0.79	0.67	0.0174	0.0404	570.33	-0.66	Army Camp
4+200	100	570.38	0.53	SP	130	100	1.00	0.79	0.67	0.0174	0.0404	570.29	-0.09	
4+300	100	570.89	0.53	SP	130	100	1.00	0.79	0.67	0.0174	0.0404	570.25	-0.64	
4+400	100	570.58	0.53	SP	130	100	1.00	0.79	0.67	0.0174	0.0404	570.21	-0.38	
4+500	100	569.33	0.47	SP	130	100	1.00	0.79	0.60	0.0177	0.0324	570.17	0.85	
4+600	100	568.79	0.47	SP	130	100	1.00	0.79	0.60	0.0177	0.0324	570.14	1.35	
4+700	100	568.79	0.47	SP	130	100	1.00	0.79	0.60	0.0177	0.0324	570.11	1.32	
4+800	100	568.60	0.47	SP	130	100	1.00	0.79	0.60	0.0177	0.0324	570.08	1.48	
4+900	100	569.04	0.47	SP	130	100	1.00	0.79	0.60	0.0177	0.0324	570.04	1.01	
5+000	100	568.95	0.41	SP	130	100	0.60	0.28	1.45	0.0169	0.3027	569.74	0.79	
5+100	100	568.04	0.41	SP	130	100	0.60	0.28	1.45	0.0169	0.3027	569.44	1.40	Campus
5+200	100	566.16	0.41	SP	130	100	0.60	0.28	1.45	0.0169	0.3027	569.14	2.98	
5+300	100	565.35	0.41	SP	130	100	0.60	0.28	1.45	0.0169	0.3027	568.83	3.48	
5+400	100	565.15	0.41	SP	130	100	0.60	0.28	1.45	0.0169	0.3027	568.53	3.38	
5+500	100	564.77	0.41	SP	130	100	0.60	0.28	1.45	0.0169	0.3027	568.23	3.46	
5+600	100	564.27	0.41	SP	130	100	0.60	0.28	1.45	0.0169	0.3027	567.93	3.66	
5+700	100	562.94	0.41	SP	130	100	0.60	0.28	1.45	0.0169	0.3027	567.62	4.68	
5+800	100	562.44	0.41	SP	130	100	0.60	0.28	1.45	0.0169	0.3027	567.32	4.88	Prop.Tank

Note ; Volume of discharge, 0.600 m³/s is included at sta.0+000 ~ 0+050.

Table 6.4.6-1 Pipe Friction Loss and Dynamic Water Head (2/3)

P/H No.1

Station	Distance	Ground Elevation	Discharge Q	Type Type	C-value	Pipe Length	Pipe Diameter	Area	Velocity	Coefficient of Friction Loss	Friction Loss	Dynamic Water Head	H-GL	Hydrostatic Head	Remarks
								$\frac{3.14D^2}{4}$	$\frac{Q}{A}$	$\frac{133.65}{C^{1.85}D^{0.167}v^{0.15}}$	$f\frac{l v^2}{D 2g}$				
Sta	(m)	GL(m)	Q(m³/s)		C	l(m)	D(m)	A(m²)	v(m/s)	f	h_f(m)	H (m)	(m)	(m)	
<Proposed Control Tank ~ Proposed P/H No.1>															
0+000		562.28	0.0400	VU								563.00	0.72	563.00	Prop.Tank
0+100	100	547.91	0.0400	VU	150	100	0.25	0.05	0.81	0.0164	0.2228	562.78	14.87		
0+200	100	546.45	0.0400	VU	150	100	0.25	0.05	0.81	0.0164	0.2228	562.55	16.11		
0+300	100	546.50	0.0400	VU	150	100	0.25	0.05	0.81	0.0164	0.2228	562.33	15.83		
0+400	100	547.08	0.0400	VU	150	100	0.25	0.05	0.81	0.0164	0.2228	562.11	15.03		
0+500	100	546.39	0.0400	VU	150	100	0.25	0.05	0.81	0.0164	0.2228	561.89	15.50		
0+600	100	546.07	0.0400	VU	150	100	0.25	0.05	0.81	0.0164	0.2228	561.66	15.59		
0+700	100	546.40	0.0400	VU	150	100	0.25	0.05	0.81	0.0164	0.2228	561.44	15.04		
0+800	100	554.20	0.0400	VU	150	100	0.25	0.05	0.81	0.0164	0.2228	561.22	7.02		
0+830	30	561.00	0.0400	VU	150	30	0.25	0.05	0.81	0.0164	0.0668	561.15	0.15		P.H No.1

P/H No.2

Station	Distance	Ground Elevation	Discharge Q	Type Type	C-value	Pipe Length	Pipe Diameter	Area	Velocity	Coefficient of Friction Loss	Friction Loss	Dynamic Water Head	H-GL	Hydrostatic Head	Remarks
								$\frac{3.14D^2}{4}$	$\frac{Q}{A}$	$\frac{133.65}{C^{1.85}D^{0.167}v^{0.15}}$	$f\frac{l v^2}{D 2g}$				
Sta	(m)	GL(m)	Q(m³/s)		C	l(m)	D(m)	A(m²)	v(m/s)	f	h_f(m)	H (m)	(m)	(m)	
<Proposed Control Tank ~ Proposed P/H No.2>															
0+000		562.28	0.19	VU								563.00	0.72	563.00	Prop.Tank
0+100	100	547.91	0.19	VU	150	100	0.45	0.16	1.19	0.0140	0.2273	562.77	14.86		
0+200	100	544.76	0.19	VU	150	100	0.45	0.16	1.19	0.0140	0.2273	562.55	17.79		
0+300	100	544.18	0.19	VU	150	100	0.45	0.16	1.19	0.0140	0.2273	562.32	18.14		
0+400	100	543.07	0.19	VU	150	100	0.45	0.16	1.19	0.0140	0.2273	562.09	19.02		
0+500	100	541.13	0.19	VU	150	100	0.45	0.16	1.19	0.0140	0.2273	561.86	20.74		
0+600	100	540.63	0.19	VU	150	100	0.45	0.16	1.19	0.0140	0.2273	561.64	21.01		
0+700	100	539.32	0.19	VU	150	100	0.45	0.16	1.19	0.0140	0.2273	561.41	22.09		
0+800	100	538.51	0.19	VU	150	100	0.45	0.16	1.19	0.0140	0.2273	561.18	22.67		
0+900	100	537.78	0.19	VU	150	100	0.45	0.16	1.19	0.0140	0.2273	560.95	23.17		
1+000	100	537.45	0.19	VU	150	100	0.45	0.16	1.19	0.0140	0.2273	560.73	23.28		
1+100	100	536.52	0.19	VU	150	100	0.45	0.16	1.19	0.0140	0.2273	560.50	23.98		
1+200	100	539.46	0.19	VU	150	100	0.45	0.16	1.19	0.0140	0.2273	560.27	20.81		
1+300	100	539.41	0.19	VU	150	100	0.45	0.16	1.19	0.0140	0.2273	560.05	20.64		
1+400	100	540.04	0.19	VU	150	100	0.45	0.16	1.19	0.0140	0.2273	559.82	19.78		
1+500	100	539.15	0.19	VU	150	100	0.45	0.16	1.19	0.0140	0.2273	559.59	20.44		
1+600	100	551.35	0.19	VU	150	100	0.45	0.16	1.19	0.0140	0.2273	559.36	8.01		
1+750	150	558.22	0.11	VU	150	150	0.40	0.13	0.88	0.0150	0.2201	559.14	0.93	557.00	P.H No.2
<Proposed P/H No.2 ~ Tallo Pipaltar>															
0+000		558.48	0.16	VU								557.00	-1.48	557.00	P.H No.2
0+100	100	548.56	0.16	VU	150	100	0.40	0.13	1.27	0.0142	0.2935	556.71	8.15		
0+200	100	535.73	0.16	VU	150	100	0.40	0.13	1.27	0.0142	0.2935	556.41	20.68		
0+300	100	539.95	0.16	VU	150	100	0.40	0.13	1.27	0.0142	0.2935	556.12	16.17		
0+400	100	539.10	0.16	VU	150	100	0.40	0.13	1.27	0.0142	0.2935	555.83	16.72		
0+500	100	540.06	0.16	VU	150	100	0.40	0.13	1.27	0.0142	0.2935	555.53	15.47		
0+600	100	536.44	0.16	VU	150	100	0.40	0.13	1.27	0.0142	0.2935	555.24	18.80		
0+700	100	536.65	0.16	VU	150	100	0.40	0.13	1.27	0.0142	0.2935	554.95	18.30		
0+800	100	538.46	0.16	VU	150	100	0.40	0.13	1.27	0.0142	0.2935	554.65	16.20		
0+900	100	535.99	0.16	VU	150	100	0.40	0.13	1.27	0.0142	0.2935	554.36	18.37		
1+000	100	530.60	0.15	VU	150	100	0.40	0.13	1.19	0.0143	0.2605	554.10	23.50		
1+100	100	530.89	0.15	VU	150	100	0.40	0.13	1.19	0.0143	0.2605	553.84	22.94		
1+200	100	528.72	0.15	VU	150	100	0.40	0.13	1.19	0.0143	0.2605	553.58	24.86		
1+300	100	535.48	0.15	VU	150	100	0.40	0.13	1.19	0.0143	0.2605	553.32	17.84		
1+400	100	536.40	0.15	VU	150	100	0.40	0.13	1.19	0.0143	0.2605	553.06	16.66		
1+450	50	538.91	0.15	VU	150	50	0.40	0.13	1.19	0.0143	0.1302	552.93	14.01		
1+600	150	535.11	0.12	VU	150	150	0.35	0.10	1.25	0.0146	0.4954	552.43	17.32		
1+700	100	535.79	0.12	VU	150	100	0.35	0.10	1.25	0.0146	0.3303	552.10	16.31		
1+800	100	535.44	0.12	VU	150	100	0.35	0.10	1.25	0.0146	0.3303	551.77	16.33		
1+900	100	534.11	0.12	VU	150	100	0.35	0.10	1.25	0.0146	0.3303	551.44	17.33		
2+000	100	532.58	0.12	VU	150	100	0.35	0.10	1.25	0.0146	0.3303	551.11	18.53		
2+100	100	532.95	0.12	VU	150	100	0.35	0.10	1.25	0.0146	0.3303	550.78	17.83		
2+200	100	530.31	0.12	VU	150	100	0.35	0.10	1.25	0.0146	0.3303	550.45	20.14		
2+300	100	530.79	0.12	VU	150	100	0.35	0.10	1.25	0.0146	0.3303	550.12	19.33		
2+400	100	537.90	0.12	VU	150	100	0.35	0.10	1.25	0.0146	0.3303	549.79	11.89		
2+550	150	547.00	0.12	VU	150	150	0.35	0.10	1.25	0.0146	0.4954	549.29	2.29		Prop.Tank

Table 6.4.6-1 Pipe Friction Loss and Dynamic Water Head (3/3)

Station	Distance	Ground Elevation	Discharge Q	Pype Type	C-value	Pipe Length	Pipe Diameter	Area $\frac{3.14D^2}{4}$	Velocity $\frac{Q}{A}$	Cofficient of Friction Loss $\frac{133.65}{C^{1.85}D^{0.17}v^{0.15}}$	Friction Loss $\frac{f L v^2}{D 2g}$	Dynamic Water Head HWL=573.6	HGL	Hydrostatic Head
Sta	(m)	GL(m)	Q(m³/s)		C	l (m)	D (m)	A (m²)	v (m/s)	f	h_L (m)	H (m)	(m)	(m)
<A23>														
0+000		563.00	0.100	VU								563.00	0.00	563.00
0+520	520	548.00	0.100	VU	150	520	0.30	0.07	1.41	0.0147	2.5969	560.40	12.40	
1+570	1050	550.00	0.040	VU	150	1,050	0.25	0.05	0.81	0.0154	2.3392	558.06	8.06	
<D>														
0+000		563.00	0.100	VU								563.00	0.00	563.00
0+520	520	548.00	0.100	VU	150	520	0.30	0.07	1.41	0.0147	2.5969	560.40	12.40	
1+570	1050	550.00	0.040	VU	150	1,050	0.25	0.05	0.81	0.0164	2.3392	558.06	8.06	
2+420	850	540.00	0.010	VU	150	850	0.10	0.01	1.27	0.0180	12.6312	545.43	5.43	
<D123>														
0+000		563.00	0.030	VU								563.00	0.00	563.00
0+950	950	539.00	0.030	VU	150	950	0.20	0.03	0.95	0.0167	3.6847	559.32	20.32	
<F12>														
0+000		557.00	0.160	VU								557.00	0.00	557.00
0+900	900	535.99	0.160	VU	150	900	0.40	0.13	1.27	0.0142	2.6415	554.36	18.37	
1+690	790	505.00	0.020	VU	150	790	0.10	0.01	2.55	0.0162	42.3212	512.04	7.04	
<F34>														
0+000		557.00	0.160	VU								557.00	0.00	557.00
0+900	900	535.99	0.160	VU	150	900	0.40	0.13	1.27	0.0142	2.6415	554.36	18.37	
1+450	550	535.23	0.150	VU	150	550	0.40	0.13	1.19	0.0143	1.4326	552.93	17.69	
2+050	600	524.00	0.025	VU	150	600	0.15	0.02	1.41	0.0165	6.7422	546.18	22.18	
<F34>														
0+000		557.00	0.150	VU								557.00	0.00	557.00
0+900	900	535.99	0.160	VU	150	900	0.40	0.13	1.27	0.0142	2.6415	554.36	18.37	
1+450	550	535.23	0.150	VU	150	550	0.40	0.13	1.19	0.0143	1.4326	552.93	17.69	
2+050	600	524.00	0.025	VU	150	600	0.15	0.02	1.41	0.0165	6.7422	546.18	22.18	
<H12>														
0+000		547.00	0.060	VU								547.00	0.00	547.00
0+400	400	524.00	0.060	VU	150	400	0.20	0.03	1.91	0.0150	5.5931	541.41	17.41	
1+380	980	510.00	0.015	VU	150	980	0.10	0.01	1.91	0.0169	30.8334	510.57	0.57	
<H34>														
0+000		547.00	0.060	VU								547.00	0.00	547.00
0+400	400	524.00	0.060	VU	150	400	0.20	0.03	1.91	0.0150	5.5931	541.41	17.41	
0+550	150	491.00	0.050	VU	150	150	0.15	0.02	2.83	0.0149	6.0764	535.33	44.33	
1+030	480	490.00	0.025	VU	150	480	0.10	0.01	3.18	0.0157	38.8558	496.47	6.47	
<K>														
0+000		593.68	0.065	VU								595.00	1.32	593.00
0+900	900	593.63	0.065	VU	150	900	0.45	0.16	0.41	0.0165	0.2812	594.72	1.09	
<L1>														
0+000		490.00	0.120	VU								490.00	0.00	490.00
0+480	480	485.00	0.120	VU	150	480	0.35	0.10	1.25	0.0146	1.5854	488.41	3.41	
0+950	470	485.00	0.120	VU	150	470	0.35	0.10	1.25	0.0146	1.5524	486.86	1.86	
1+650	700	480.00	0.080	VU	150	700	0.30	0.07	1.13	0.0152	2.3134	484.55	4.55	
2+580	930	475.00	0.050	VU	150	930	0.20	0.03	1.59	0.0154	9.2808	475.27	0.27	
<L2>														
0+000		510.00	0.045	VU								510.00	0.00	490.00
0+750	750	500.00	0.045	VU	150	750	0.25	0.05	0.92	0.0162	2.0776	507.92	7.92	
2+550	1800	495.00	0.030	VU	150	1,800	0.20	0.03	0.95	0.0167	6.9816	500.94	5.94	
<No.1 Pump>														
0+000		558.22	0.040	SP										559.00
0+150	150	589.60	0.040	SP	130	150	0.15	0.02	2.26	0.0200	5.2401			591.00
<No.2 Pump>														
0+000		558.22	0.110	SP										
0+500	500	593.82	0.110	SP	130	500	0.30	0.07	1.56	0.0188	3.8812			557.00 596.00
<No.3a Pump>														
0+000		460.00	0.120	SP										
0+095	100	490.00	0.120	SP	130	100	0.25	0.05	2.44	0.0182	2.2157			460.00 490.00
<No.3b Pump>														
0+000		460.00	0.045	SP										460.00
0+095	100	510.00	0.045	SP	130	100	0.15	0.02	2.55	0.0197	4.3439			400.00
<No.4 Pump>														
0+000		570.00	0.030	SP										570.00
0+600	600	592.70	0.030	SP	130	600	0.20	0.03	0.95	0.0217	3.0326			594.00
<No.5 Pump>														
0+000		570.00	0.015	SP										570.00
0+150	150	575.00	0.015	SP	130	150	0.15	0.02	0.85	0.0232	0.8537			577.00
<No.6 Pump>														
0+000		546.40	0.015	SP										546.00
0+200	200	558.70	0.015	SP	130	200	0.15	0.02	0.85	0.0232	1.1382			570.00

Table 6.4.6-2 Design of Proposed Pump Station

Pump Sta.	Command area (ha)	Pump head		Design Discharge	Power (kV)	Dia (mm)	
		Actual	Total	(m^3/min)		Suction	Delivery
<Zone A>							
P_1 Jhadigaon	46	32	39	2.4	15 kW × 2 nos.	80	65
P_2 Chawadi	136	39	45	6.2	55 kW × 2 nos.	200	150
P_6 Dansar	12	24	27	1.0	5.5 kW × 2 nos.	65	50
P_4 Battar	17	24	30	1.8	7.5 kW × 2 nos.	80	65
P_5 Bidur	8	7	9	0.8	1.5 kW × 2 nos.	65	50
<Zone B>							
P3a Pokarephant	95	30	33	7.2	37.0 kW × 2 nos.	200	150
P3b Pokarephant	34	50	55	2.6	30.0 kW × 2 nos.	100	80

Design Sections of Wet Rubble Masonry Canal with Mortar Lining

20ℓ/s	Type D	B = 0.4	h = 0.25	H = 0.40
40ℓ/s	Type C	B = 0.5	h = 0.3	H = 0.45
60ℓ/s	Type B	B = 0.6	h = 0.35	H = 0.50
80ℓ/s	Type A	B = 0.7	h = 0.35	H = 0.55

I = 1/2000, Z = 0, n = 0.020