3.7 Environment

The Environmental Impact Assessment procedure includes the following assessments :

- Preliminary Environmental Assessment
- Detailed Environmental Assessment

Environmental impacts of the project shall be studied during these two stages of environmental assessment.

(1) Preliminary Environmental Assessment

The objective of the preliminary environmental assessment is to identify the major environmental problems and to incorporate appropriate abatement and mitigating measures into the project plan. Besides, the significant residual environmental impacts shall be identified. The steps to be followed in the preliminary environmental assessment during the survey and investigation stage are as follows :

- Screening of the Major Environmental Components
- Preliminary Assessment Matrix and Significance of the Environmental Impacts
- Water Quality Survey
- Reporting of the Preliminary Environmental Assessment

(a) Screening of the major environmental components

Screening is necessary to identify the major environmental components which will have a significant impact from the project development. The major environmental components related to small reservoir development are as follows :

- Physicochemical
  Land, Surface Water, Ground water, Atmosphere, and Noise
- Biological
  Species and Populations, Habitats and Communities
- Human
  Health and Safety, Social and Economic Factors and, Aesthetic and Cultural Factors

(b) Preliminary assessment matrix & significance of the environmental impacts

The impact of the project activities on the various environmental components shall be analysed using a Preliminary Assessment Matrix as shown in Table 3.6. This matrix shall be modified to suit the requirement of a particular project. The significance of the environmental impact shall be noted as follows :

0 - No impact
1 - Potentially significant adverse environmental impact for which a design solution has been identified
2 - Adverse environmental impact that is potentially significant but insufficient information has been obtained to make a reliable prediction (Significant Unknown Impact)
3 - Residual and significant adverse environmental impact (Significant Known but Unsolvable Impact)
4 - Significant environmental enhancement (Useful for environmental development)

The impacts of the project shall be found out at various stages of the project as follows :

- Site investigation
- Site preparation and project construction
- Operation and maintenance
- Abandonment and
- Consequent activities

Public participation in terms of public opinion sampling, public meetings or workshops is necessary in the environmental data collection.

Table 3.6 PRELIMINARY ASSESSMENT MATRIX (1/2)

Name of the State : _____
Name of the Project and Location : _____
Concerned Environmental Agency of the Area: _____
Name of the Person in charge : _____

PRELIMINARY ASSESSMENT MATRIX

Please make an "x" mark in the appropriate type of small reservoir (pond) and choose from the following :
0 - No Impact
1 - Potentially significant adverse environmental impact for which a design solution has been identified
2 - Adverse environmental impact that is potentially significant but insufficient information has been obtained to make a reliable prediction (Significant Unknown Impact)
3 - Residual and significant adverse environmental impact (Significant Known but Unsolvable Impact)
4 - Significant environmental enhancement (Useful for environmental development)

ENVIRONMENTAL COMPONENTS	TYPE OF SMALL RESERVOIR (POND)					
	TYPE A	TYPE B	TYPE C	TYPE D	TYPE E	Others
I. PHYSICOCHEMICAL						
1. LAND						
(i) Change of Land use (Devastation or desertification)						
(ii) Soil Erosion						
(iii) Soil Salinization						
(iv) Deterioration of soil fertility						
(v) Others						
2. SURFACE WATER						
(i) Water Balance						
(ii) Flooding						
(iii) Soil sedimentation						
(iv) Water Quality						
(v) Drainage Pattern						
(vi) Change in Existing Use						
(vii) Others						
3. GROUNDWATER						
(i) Change in groundwater hydrology						
(ii) Water Quality						
(iii) Change in Existing Use						
(iv) Others						
4. ATMOSPHERE						
(i) Atmospheric pollution						
(ii) Others						
5. NOISE						
(i) Noise Pollution						
(ii) Others						

Type A - Dam on small reservoir, Type B - Pond in lowland, swamp and idle land
Type C - Abolished river, Type D - Upstream of present intake, Type E - Tin mine pond or lake
Others - Any other type of small reservoir or other water resource development

Pl. Note : For the particular type of small reservoir in the area, the various project activities like land reclamation, canalisation etc. need to be considered for all stages of project development which include Site investigation, Site preparation and Project construction, Operation & Maintenance, Abandonment and Consequent activities

Table 3.6 PRELIMINARY ASSESSMENT MATRIX (2/2)

Please make an "x" mark in the appropriate type of small reservoir (pond) and choose from the following :
0 - No Impact
1 - Potentially significant adverse environmental impact for which a design solution has been identified
2 - Adverse environmental impact that is potentially significant but insufficient information has been obtained to make a reliable prediction (Significant Unknown Impact)
3 - Residual and significant adverse environmental impact (Significant Known but Unsolvable Impact)
4 - Significant environmental enhancement (Useful for environmental development)

ENVIRONMENTAL COMPONENTS	TYPE OF SMALL RESERVOIR (POND)					
	TYPE A	TYPE B	TYPE C	TYPE D	TYPE E	Others
II. BIOLOGICAL						
6. SPECIES AND POPULATIONS						
(i) Terrestrial Vegetation						
(ii) Terrestrial Wildlife						
(iii) Other Terrestrial Fauna						
(iv) Aquatic/Marine Flora						
(v) Fish						
(vi) Other Aquatic/Marine Fauna						
7. HABITATS AND COMMUNITIES						
(i) Terrestrial Habitats						
(ii) Terrestrial Communities						
(iii) Aquatic, Estuarine, Marine Habitats						
(iv) Aquatic, Estuarine, Marine Communities						
(v) Others						
III. HUMAN						
8. HEALTH AND SAFETY						
(i) Physical Safety						
(ii) Psychological Well-Being						
(iii) Outbreak of Diseases						
(iv) Others						
9. SOCIAL AND ECONOMIC						
(i) Employment						
(ii) Housing						
(iii) Change in Way of Life						
(iv) Involuntary Settlement						
(v) Population Increase						
(vi) Others						
10. AESTHETIC AND CULTURAL						
(i) Impacts on the Community						
(ii) Conflicts amoung communities						
(iii) Historic and Cultural Assets						
(iv) Others						

Type A - Dam on small reservoir, Type B - Pond in lowland, swamp and idle land
Type C - Abolished river, Type D - Upstream of present intake, Type E - Tin mine pond or lake
Others - Any other type of small reservoir or other water resource development

Pl. Note : For the particular type of small reservoir in the area, the various project activities like land reclamation, canalisation etc. need to be considered for all stages of project development which include Site investigation, Site preparation and Project construction, Operation & Maintenance, Abandonment and Consequent activities

(c) Water quality survey

Since water quality is one of the most important environmental components for the development of small reservoirs, a detailed water quality study shall be carried out at regular intervals. The field parameters including pH, temperature, EC, dissolved oxygen (DO), turbidity, and salinity shall be measured using a water quality checker. Water samples shall be collected at the water sources of the project sites and the following parameters shall be analysed. These are the parameters used by DID to interpret the quality of irrigation water.

Color, BOD, Ammoniacal Nitrogen, Nitrate Nitrogen, Total Solids, Dissolved Solids, Suspended Solids, Alkalinity, Hardness, Calcium, Magnesium, Potassium, Sodium, Iron, Silica, Chloride, Phosphate and Sulphate

Interim National Water Quality Standards (INWQS) for all these parameters is shown in Table 3.7. When the water is used for irrigation purpose, the water quality should be within the INWQS levels for class IV. If it will be used for other purposes like water supply, recreation etc., the water quality should meet the respective class standard.

Table 3.7 Interim National Water Quality Standards (INWQS) for Malaysia

No.	Parameters	Interim National Water Quality Standard				
		Class I	Class IIA	Class IIB	Class III	Class IV
1	pH	6.5-8.5	6.5-9.0	6.5-9.0	5-9	**5-9**
2	Temperature (° C)	-	-	-	-	-
3	EC (mS/cm)	1	1	-	-	**6**
4	Salinity (%)					
5	Turbidity (NTU)	5	50	50	-	-
6	Dissolved Oxygen (mg/l)	7	5-7	5-7	3-5	**3**
7	COD (mg/l)	10	25	25	50	**100**
8	Colour (TUC)	15	150	150	-	-
9	BOD (mg/l)	1	3	3	6	**12**
10	Ammoniacal Nitrogen (mg/l)	0.1	0.3	0.3	0.9	**2.7**
11	Nitrate Nitogen (mg/l)	-	7	-	0.028	**5**
12	Total Solids (mg/l)	525	1050	50	150	**4300**
13	Dissolved Solids (mg/l)	500	1000	-	-	**4000**
14	Suspended Solids (mg/l)	25	50	50	150	**300**
15	Alkalinity (mg/l)	-	-	-	-	-
16	Hardness	-	100	-	-	-
17	Calcium (mg/l)	-	-	-	-	-
18	Magnesium (mg/l)	-	-	-	-	-
19	Potassium (mg/l)	-	-	-	-	-
20	Sodium (mg/l)	-	-	-	-	-
21	Chloride (mg/l)	200	-	-	-	**79**
22	Fluoride (mg/l)	-	1	-	-	**1**
23	Phosphate (mg/l)	-	0.1	-	0.1	-
24	Sulphate (mg/l)	-	200	-	-	-
25	Iron (mg/l)	-	0.3	-	1	**1/5****
26	Silica (mg/l)	-	50	-	-	-

Class I : Conservation of natural environment water supply I - Practically no treatment necessary
Fishery I - Very sensitive species

Class IIA : Water supply II - conventional treatment required, Fishery II - Sensitive aquatic species

Class IIB : Recreational use with body contact

Class III : Water supply III - Extensive treatment required, Fishery III - Common and tolerant species

Class IV : Irrigation

** Iron : 1 - For leaves, and 5 - for others

(d) Reporting of the preliminary environmental assessment

Based on the results of the above survey, a preliminary assessment report shall be prepared as an integral part of the project planning report which shall include the project description, project options, description of the existing environment, potential significant impacts, mitigation and abatement measures, and residual impacts.

(2) Detailed Environmental Assessment

When significant environmental impacts are identified during the preliminary environmental assessment, a detailed environmental assessment will be necessary. It is also necessary when an EIA report needs to be submitted to DOE for approval. Objectives of the detailed environmental assessment are as follows :

- To describe the significant residual environmental impacts predicted from the final project plan,
- To specify mitigating and abatement measures in the final project plan and
- To identify the environmental costs and benefits of the community

The steps to be followed in the detailed environmental assessment are as follows :

- Additional Environmental Survey
- Environmental Impacts Survey
- Additional Water Quality Survey
- Mitigation and Abatement Measures
- Reporting of the Detailed Assessment

(a) Additional environmental survey

An additional environmental survey will be necessary to obtain detailed information on the environmental components discussed in the preliminary assessment. The existing environmental conditions should be clearly identified in qualitative and quantitative terms.

(b) Environmental impacts survey

Based on the results of the preliminary assessment, a level 2 matrix, which includes the impacts in quantitative terms, shall be prepared as shown in Table 3.8. This matrix shall be modified to suit the requirement, of a particular project. The environmental impacts of the project shall be examined in detail.

Table 3.8 LEVEL 2 MATRIX FOR ENVIRONMENTAL IMPACTS SURVEY (1/2)

Name of the Project and Location : _____
Concerned Environmental Agency of the Area: _____
Name of the Person in charge : _____

SUMMARY LIST OF ENVIRONMENTAL IMPACTS

ENVIRONMENTAL COMPONENTS	Present Amount	Impacts of the Project	Type of Impact	Impact Rating
I. PHYSICOCHEMICAL				
1. LAND				
(i) Land Use				
(ii) Soil Erosion				
(iii) Soil Fertility				
(iv) Soil Salinization				
(v) Others				
2. SURFACE WATER				
(i) Water Balance				
(ii) Flooding				
(iii) Soil Sedimentation				
(iv) Water Quality				
(v) Drainage Pattern				
(vi) Change in Existing Use				
(vii) Others				
3. GROUNDWATER				
(i) Groundwater Hydrology				
(ii) Water Quality				
(iii) Change in Existing Use				
(iv) Others				
4. ATMOSPHERE				
(i) Atmospheric Pollution				
(ii) Others				
5. NOISE				
(i) Noise Pollution				
(ii) Others				

Present Amount, and Impact of the Project shall be quantified for the environmental elements for which the data is available, and the quantity shall be noted with unit. e.g. Land Use : Present Amount = 300 ha ; Impact of the Project = + (or -) 50 ha. Where the environmental components shall not be quantified or data is not available, columns 3 and 4 alone shall be filled up.
Columns 3 and 4 : Type of Impact and Impact Rating (IR) : No Impact = NI ; IR = 0
Potentially significant adverse environmental impact for which a design solution has been identified = SAI ; IR = -1
2 - Adverse environmental impact that is potentially significant but insufficient information has been obtained to make a reliable prediction (Significant Unknown Impact) = SUI; IR = -2
3 - Residual and significant adverse environmental impact (Significant Known but Unsolvable Impact) = RSAI; IR = -3
4 - Significant environmental enhancement (Useful for environmental development)=SEE; IR = +1 to +3 based on importance.

Table 3.8 LEVEL 2 MATRIX FOR ENVIRONMENTAL IMPACTS SURVEY (2/2)

ENVIRONMENTAL COMPONENTS	Present Amount	Impacts of the Project	Type of Impact	Impact Rating
II. BIOLOGICAL				
6. SPECIES AND POPULATIONS				
(i) Terrestrial Flora				
(ii) Terrestrial Fauna				
(iii) Aquatic/Marine Flora				
(iv) Aquatic/Marine Fauna				
(vi) Others				
7. HABITATS AND COMMUNITIES				
(i) Terrestrial Habitats				
(ii) Terrestrial Communities				
(iii) Aquatic, Estuarine, Marine Habitats				
(iv) Aquatic, Estuarine, Marine Communities				
(v) Others				
III. HUMAN				
8. HEALTH AND SAFETY				
(i) Physical Safety				
(ii) Psychological Well-Being				
(iii) Outbreak of Diseases				
(iv) Others				
9. SOCIAL AND ECONOMIC				
(i) Women Development				
(ii) Employment				
(iii) Housing				
(iv) Change in Way of Life				
(v) Involuntary Settlement				
(vi) Population Increase				
(vii) Others				
10. AESTHETIC AND CULTURAL				
(i) Impacts on the Community				
(ii) Conflicts amoung Communities				
(iii) Historic and Cultural Assets				
(iv) Others				

(c) Additional water quality survey

An additional water quality survey shall be carried out based on the results of the water quality analysis during the preliminary survey. If the water from small reservoir development will be used for drinking or other purposes, heavy metals and other relevant parameters shall also be analysed.

(d) Mitigation and abatement measures

Based on the results of the detailed environmental survey, the assessor should design suitable mitigation and abatement measures and should be incorporated into the project plan. The environment conservation plan is discussed in section 4.5.

(e) Reporting of the detailed assessment

A detailed assessment report shall be prepared, which shall include project description, project options, description of the existing environment, potential significant impacts, mitigation and abatement measures, residual impacts and project evaluation.

3.8 Agro-tourism Survey

Agro-tourism is an essential component of the Government's products diversification strategy to promote Malaysia as a leading tourist destination in the world. The small reservoirs apart from serving as the water source for agriculture, can also be used for tourism purposes such as fishing and other recreational activities. Besides tourists can also participate in agriculture activities like fruit picking. These project areas can be developed into unique destinations for the enjoyment, relaxation and education of tourists.

An agro-tourism survey shall be carried out in the project areas which have a good potential for agro-tourism development. Relevant data and information shall be collected in the project areas on the following aspects:

1) Number of tourists visiting or passing through the project area or the nearby areas before implementing the agro-tourism project
2) Present agricultural conditions and the possibility of introducing fruits, orchid gardens, and potted flowers
3) Possibility of involving tourists in agriculture related activities like fruit picking, etc.
4) Possibility of using small reservoirs for fishing and other recreational activities
5) The accessibility and cost of transportation to the area
6) Present infrastructure facilities such as electricity, water, roads, etc. and,
7) Present tourist areas and recreational facilities such as parks, children's park, etc. in the project area or nearby areas.
8) Project owners' intention for the agro-tourism development

The data and information shall be used to analyse the tourism potential of the area and to decide the type of the tourism facilities.

3.9 Examples of Field Surveys and Investigations

Figure.3.8 shows the examples of field survey and investigations for the small reservoir development for the Feasibility Study made by the JICA Study Team. The examples show the survey methods and operation, main items of surveys and investigations in case of the Kedawang Project (KH4 & 5). The detailed outputs of surveys and investigations are shown in the Annexes of each study fields, Volume II of F/S report.

Check lists for the surveys and investigations are attached below.

Fig.3.8 Examples of Field Surveys and Investigations(KH 4 & 5)

Fields of Surveys	Operation/Methods of Surveys	Survey Items	Examples of Outputs(KH4&5)
Meteorology & Hydrology	Collecting data & Information	Topo-maps	Topo-maps(1/50,000)
		Hydrological data	Daily rainfall data(Table3.2 of Guidelines)
		Meteorological data	Monthly meteorological data(Table3.1 of Guidelines)
	Field survey (1)Interview survey	Vegetation Water use	
	(2)Hydrological observation	River discharge	Installation of hydrological station in Katapang dam site
	Compiling hydrological & meteorological records	Rainfall	Monthly rain fall(Table3.2 of Guidelines)
		Meteorological data	Annex-II of Volume II,F/S report
	Hydrological Analysis	Runoff	Table II.12.C,Annex-II of Volume II F/S report
		Flood	Table II.16,Annex-II of Volume II F/S report
		Sediment load	Fig.3.4 of Guidelines
		Probable rainfall	Table II.5,Annex-II of volume II F/S report
Water resources and Irrigation & Drainage	Collection data & Information	Topo-maps	Topo-maps(1/50,000),Cad astral maps
		Reference documents on irrigation & drainage	Design manual for water conveyance system 1980,etc. Drawings of irrigation & drainage development plan in the Lembu area
	Topographic survey	Dram & reservoir sites	Topo-maps(1/1,000)for dam and reservoir sites of Ketapang and Lembu pond areas
	Field investigation (1)Inventory survey on existing facilities	Existing irrigation & drainage facilities	Drawings of irrigation and drainage development plan in the Lembu area
		Land acquisition	Information of current conditions for land acquisition
		Land leveling	Local requirements of land leveling
	(2)Survey on construction materials, equipments and labour	Material costs	Market price in Langkawi
		Reference data of construction cost	4 cases of construction costs in Langkawi Technical specifications of the similar projects

Examples of Field Surveys and Investigations

Fields of Surveys	Operation/Methods of Surveys	Survey Items	Examples of Outputs(KH4&5)
Geology & Geotechnics	Collecting data & Information	Topo-maps Aerial photographs	Topo-maps(1/50,000)
		Geological maps	Geological maps (1/500,000 and 1/63,360) Geological data published by Government
	Field Investigation (1)Drilling and in-situ geotechnical tests at dam sites	Subsurface geological conditions	Drilling log(Fig.IV.3,Annex IV of Volume II , F/S report) Geological profile(Fig.IV,5 & IV.6,Annex IV of Volume II,F/S report) Permeability of the foundation layer of dams
	(2)Survey in the surrounding area of the reservoir	Land form of the reservoir	
	(3)Material Investigation	Location and quantity of the materials	Location of the borrow areas(Fig.IV,4,Annex IV of Volume II,F/S report)
	(4)Laboratory tests	Mechanical properties of soils	Test results(Table IV.3,Annex IV of Volume II,F/S report)
Agriculture	Collecting data & information	Regional policy of agriculture development Present conditions of agriculture, land use,soils statistic data of agriculture	Present conditions of agriculture, land use, soils,agriculture production, population and agricultural employment,farm size,land tenure,(Section 5.4.4 A of main report,F/S report)
	Farmers Interview Survey	Local conditions of agriculture,agro society land use	Summary of farmers interview survey(Annex V.2 of Volume II,F/S report) Summary of farm budget(Annex V.3 of Volume II,F/S report)
	Soil survey	Soil profile, Soil properties, Crop suitability	Summary of soil survey(Annex V.1 of Volume II,F/S report)
Agro economy	Collecting data & information	Statistic data of agro economy and agriculture	Present conditions (Section 7.3.1 of Annex VII)
	Field Investigation & Farm Budget Analysis	Local conditions of agro economy, agriculture,land use,agro society,farm gate prices and off-farm income	Summary of household survey (Section 7.3.2 of Annex VII)

Examples of Field Survey and Investigations

Fields of Surveys	Operation/Methods of Surveys	Survey Items	Examples of Outputs(KH4&5)
Environment	Field Surveys (1)Preliminary Assessment ↓ (2)Detailed Assessment	Major environmental components	→ Major Environmental Problems (Table A.6.3.1,Annex VI of Volume II,F/S report) Water quality(Table 5.4.3 of Main report)
		Significant environmental impacts	
Agro tourism	Collecting data & information	Data & information of local tourists activities Conditions of transportation	→ Table 5.4.4 of Main report ,F/S report Section 5.4.8 of Main report
	↓ Field survey	Conditions of agriculture,infrastructure facilities Accessibility to the project area Present tourist areas	

CHECK LIST FOR SURVEY AND INVESTIGATION

1 Meteorological & Hydrological Survey
- Topographical maps (1/25.000 or 1/50,000)
- Locations of Meteorological & Hydrological Stations
- Meteorological & Hydrological records
- Catchment area (acreage, land use/vegetation, soils)
- Floods (water level of the maximum floods, inundated areas cross sections of rivers)
- Low flow (annual low water level)
- Sedimentation rate
- Water use
- Conditions of water resources (rivers originate from springs or swampy areas?)

2 Analysis of Hydrological Data
- Suitable selection of meteorological & hydrological stations for the project areas
- Long-term records of more than 10 years
- Identification of the catchment area for the project (acreage of catchment area)
- Check the analysis method (Refer to "the Hydrological Procedures" published by DID)
- Analysis items
  Runoff, Provable flood, Sedimentation

3 Topographic Survey
- Topographic maps of reservoir sites and irrigation areas
  (dam & reservoir site scale of 1/1,000 with a contour interval of 0.5m or 1.0m
  irrigation areas scale of 1/5,000 with a contour interval of 0.5m to 1.0m)
- Longitudinal & cross section of the dam axis

4 Survey on Irrigation and Drainage Areas
- Location of existing water resources development facilities and irrigation & drainage facilities
- Capacity and dimension of the facilities
- Maintenance conditions of the facilities
- Water management conditions of the facilities
- Water right and water use including ground water use
- Land use and the possibility of land acquisition
- Present farming conditions and irrigation method
- Topographic maps (1/25,000 or 1/50,000) and cad astral maps
- Hazard potential in downstream from dam site (Human habitation, permanent structures, land use etc.)

5 Survey on Existing Social Infrastructures
- Locations of existing social infrastructures
- Dimensions of the infrastructures
- Maintenance conditions of the infrastructures

6 Survey on Construction Materials & Costs
- Current contract methods of other projects in the vicinity areas
- Market prices of construction materials, equipment and labour
- Transportation cots of materials and equipment

7 Geological Investigation

- Topographic maps (1/25,000 or 1/50,000)
- Aerial photographs
- Geological maps
- Land form classification in dam and reservoir areas
- Geological, physical, mechanical and hydraulic properties at the dam foundation and spillway
  crest by drilling and geotechnical tests

(i) Geological properties (Geological profile, soil types, bearing capacity)
(ii) Physical properties (Specific gravity, natural water content, organic matter content etc.)
(iii) Mechanical and hydraulic properties (Compaction, permeability, consolidation triaxial compression)

- The possibility of landslide and landslip after ponding
- Leakage conditions through the surrounding natural ground
- Borrow materials (Location and quantity)

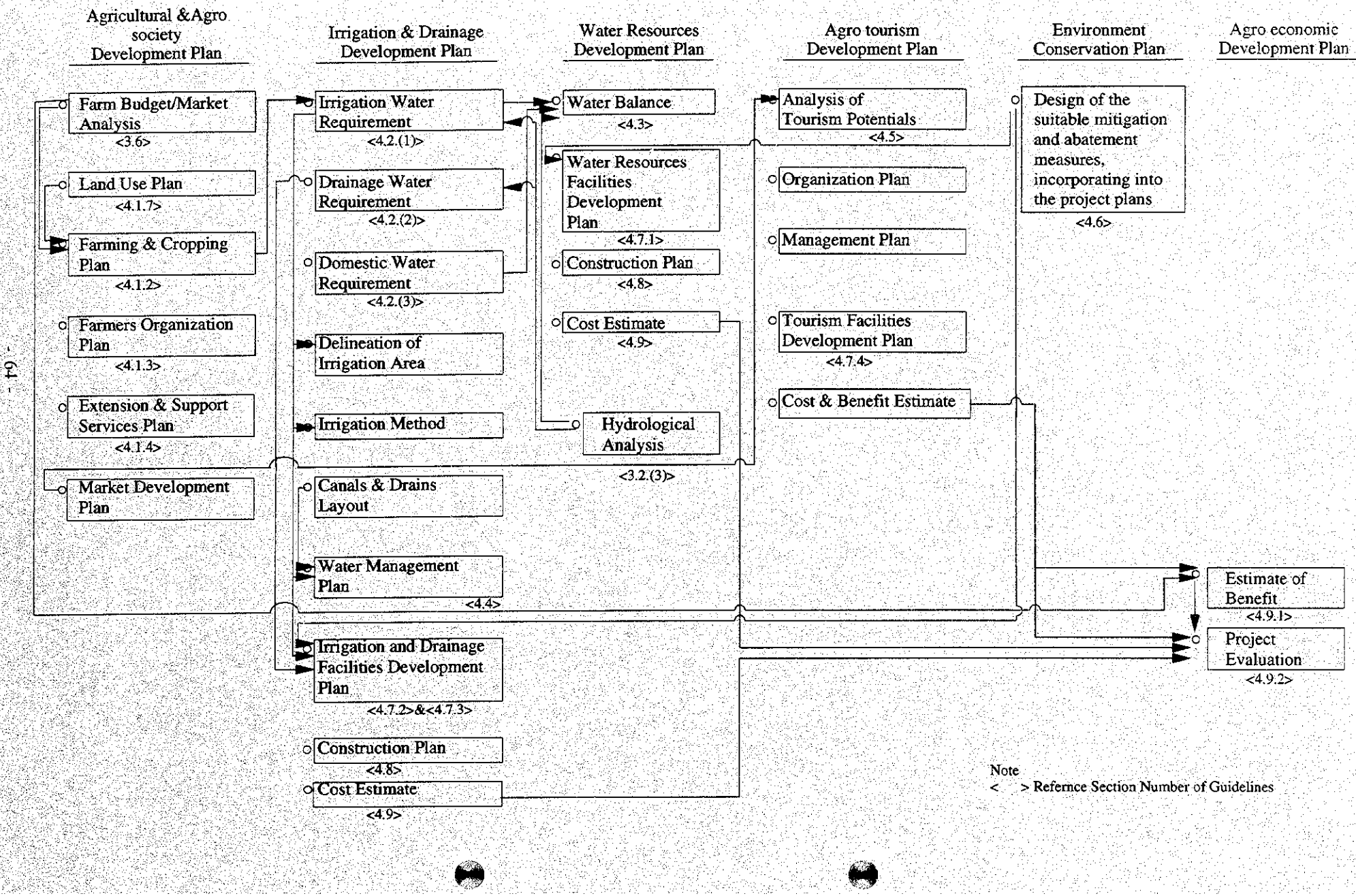
8 Agriculture
- Land use
- Soils
- Agriculture conditions (farming, cropping pattern, crop intensity, unit yield, production lives
  livestock)
- Agro society (household, family characteristics land ownership)
- Farm economy (farming costs)
- Marketing
- Farmers' organisation
- Agricultural supporting system
- Farmers' intention for the development plan

9 Agro Economy
- Agricultural investment
- Labour requirement for farming
- Land use
- Transportation and market
- Farm gate prices
- Off-arm income

10 Environment
- Physicochemical components (land, surface water, ground water atmosphere and noise)
- Biological components (species and populations, habitants and communities)
- Human components (health and safety, social and economic factors aesthetic and cultural factors)
  (Refer to Tables 3.6 to 3.8 of Guidelines)

11 Agrotourism
- Potentials of tourists
- Present agriculture conditions
- Transportation
- Present tourist areas and recreational facilities in the project area or nearby areas
- Beneficiary's intention for the agrotourism development

Fig.4.1 Flow of the Development Plans



IV PLAN AND STUDY

Figure 4.1 shows the flows of the development plans and studies of each field. The numbers which are inserted under the items are the reference section of these guidelines.

4.1 Agriculture Development Plan

4.1.1 Land Use Plan

The land use plan shall be discussed with the agency of project owner and DID, based on the farmers' request. Land use will be planned to be extended as large as possible within the availability of water, labor and cost of production. In some cases the labor shortage can be covered with hired laborers. The production cost including hired labor wages, will be arranged by a bank cultivation loan with a guarantee by the project owner (Government agencies).

4.1.2 Farming and Cropping Plan

The major factors of farming operations are land preparation, seeding, fertiliser, compost and chemical application. The cropping plan is mainly defined by the cropping pattern, crop intensity, and crop spacing. The unit yield of crops will be effected by conditions of farming and the cropping plan.

(1) Farming operation

Some of the farm operations are very important for achieving the target yield, and some of the improvements in farming methods are recommended to increase the yield.

Planning should be considered for achieving the target yield easily and economically. The improvement of the actual farming standard is also a project target. In order to make use of the irrigation facilities as well as possible, the following operations should be improved.

- Land preparation methods: use of ridgers in upland crop cultivation.
- Seeding or Nursery: varies case by case for each crop.
- Compost application: most soils have a low content of organic carbon, and are acidic with low pH (less than 5.0).
- Fertiliser and chemical application: as recommended by MARDI, DOA & FOA

(2) Cropping plan

The labor requirement should be taken into consideration for planning the crop pattern and crop intensity, and in some cases, a shortage of labor has to be solved by hiringn outside laborers.

A labor shortage is evident in most area, including the villages of the projects. However, the development plan for farming with new irrigation facilities can be proposed so farmers can earn a better income than working outside the farm. Besides, working opportunities for women will be proposed. With enough irrigation facilities, commercial farming by hired labours will be possible in the future.

In the SRD projects, the main crops to be irrigated will be substantial vegetables and fruits. Drip and/or micro jet sprinkler irrigation facilities shall be considered as on-farm irrigation facilities, and for vegetables cultivation, new technical farm facilities such as rain shelters shall be considered to improve the quality of crops for market.

4.1.3 Farmers Organisation Plan

Two kinds of farmers organisation will be needed for the project implementation.

One is a production group, and the other is a water users group. For the small projects, these can be organised into one unit.

The farmers organisations or farmers groups are also related to the governmental agencies such as FOA and DOA.

The activities of the farmers organisation should include on-farm water management of the irrigation facilities as well as farming and marketing co-operation. On-farm water management is very important for crop cultivation in the off- season. DID will help the farmers organisations or farmers groups through FOA or DOA.

In addition, it will be recommended for farm management to cope with labor shortages for crop cultivation by group farming, or mini estate farming.

4.1.4 Extension and Support Services Plan

FOA supports paddy cultivation by providing machinery services for land preparation and harvesting, and subsidised fertilisers. DOA provides technical services for the extension of vegetable and fruit trees, in particular. DID manages irrigation facilities and operation and maintenance for the farmers. In this SRD project, the co-operation between DID and the project owner agency (DOA or FOA) will be necessary for its successful implementation.

The irrigation facility support services for farmers will be carried out by DID through the project owner agencies such as DOA or FOA. Therefore, detailed instructions on the irrigation facilities have to be planned by DID.

4.2 Irrigation and Drainage Plan

(1) Irrigation Water Requirement

Irrigation water requirement for paddy, orchard and other specified crops, such as commercial crops undertaken by the Government program will be calculated based on the cropping pattern of the agriculture development plan. However, if the proposed crops are vegetable, the irrigation water requirement shall be calculated based on the typical kind and type of vegetable and/or the largest planted vegetable in the project area.

The irrigation water requirement for the project shall be planned to supply irrigation water sufficiently during a drought year with a return period of 5 years.

The calculation factors of the irrigation water requirement such as potential evapo transpiration (ETo) crop coefficient (Kc), pre saturation, land soaking requirement and percolation for paddy, effective rainfall, and irrigation efficiency are determined as follows.

(i) Potential Evapo Transpiration (ETo)

- Modified Penman method (FAO paper NO.24) and/or
- HP.17 "Estimating Potential Evapo Transpiration Using the Penman Produce" 1991 could be adopted.
- ETo for horticulture under rain shelter is estimated at 90% of normal ETo.(Suggestion by MARDI)

(ii) Crop Coefficient(Kc)

- refer to FAO paper NO.24

(iii) Pre saturation, land soaking requirement and percolation for Paddy Field(direct seeding method)

Due to changing cultural practices of paddy planting, pre saturation and land soaking requirements have to be determined on a project by project basis. However, the pre

saturation and land soaking water requirements under the MUDA conditions could be used as useful guidelines.

(iv) Probable rainfall

Probable rainfall for the estimation of irrigation water requirements which are adopted for design discharge of irrigation facilities, is the with a return period of 5 years.

(v) Effective rainfall

Effective rainfall for orchard cultivation is based on USDA SCS method (refer to FAO paper NO.25).

Effective rainfall for horticulture cultivation under rain shelter is nil. Effective rainfall for paddy shall be obtained by consultation with DID staff on project by project basis.

(vi) Irrigation Method & Efficiency

According to the MARDI information, the overall irrigation efficiency of the respective methods are as shown below.

Irrigation System	Topographic condition	Efficiency
Drip Irrigation System	General	90%
	Hilly area	85-90%
Sprinkler	General	75-80%

The following overall irrigation efficiency of horticulture and orchard are adopted for the pilot projects as shown below.

Drip irrigation system for orchard 85%
Sprinkler irrigation system for horticulture 75%

On the other hand, Overall irrigation efficiency of paddy shall be obtained by consultation with DID staff on a project by project basis.

(2) Drainage Water Requirement

The drainage water requirement in the project areas will be estimated using " the Hydrological Procedures " published by DID.

(3) Domestic Water Requirement

The domestic water requirement is estimated to project the future population of towns and villages, and is assumed at a range between 150 lit/person to 250 lit/person depending on the living standard of the inhabitants.

However, the domestic water requirement for the Project shall be discussed with the regional domestic water supply company.

4.3 Water Resources Development Plan

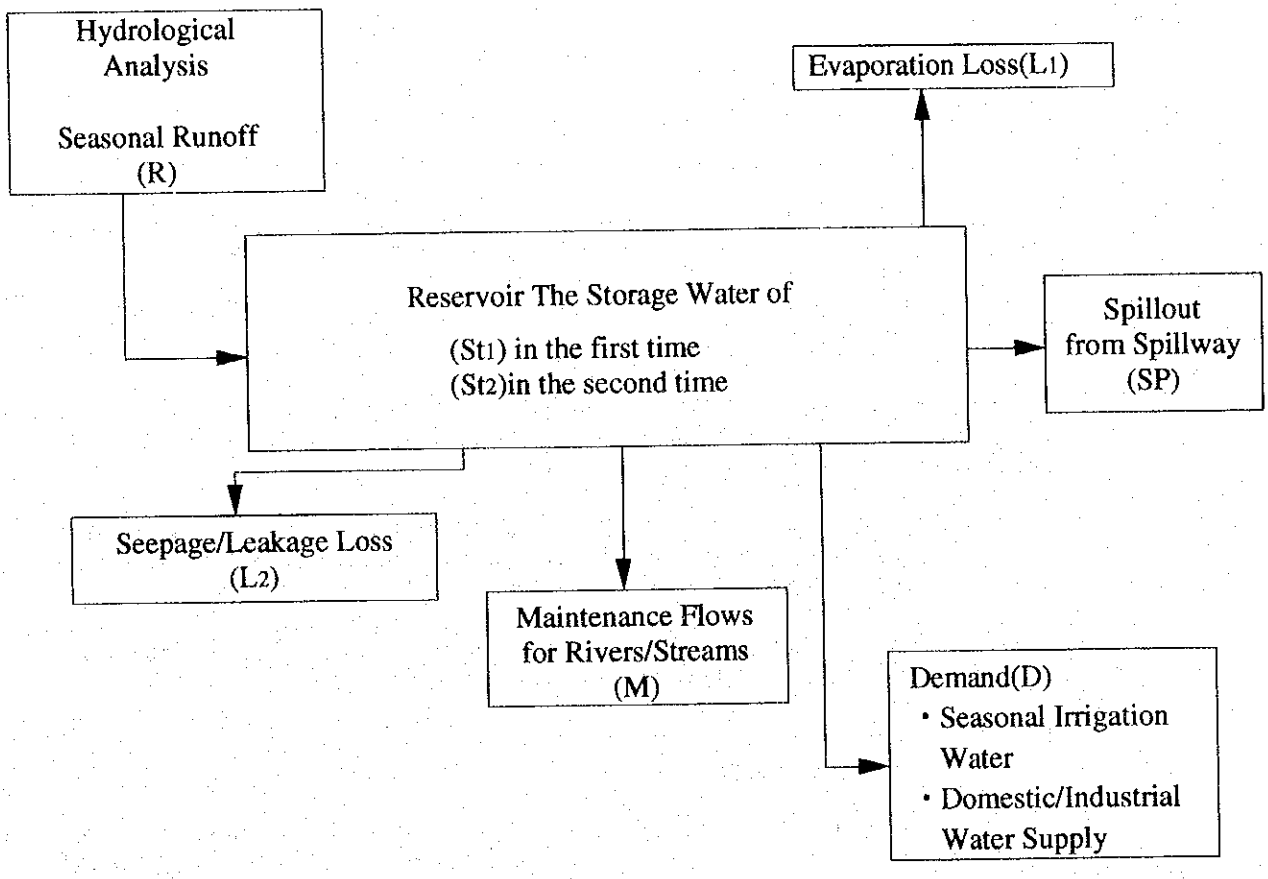
To determine the storage capacity of a reservoir, water balance of a reservoir will be made using the seasonal irrigation water requirement, long term runoff of more than 20 years which are estimated by the hydrological analysis, maintenance flow and reservoir loss of evaporation & seepage.

Figure 4.2 shows the concept of water balance of a reservoir. The storage capacity of reservoir, which will empty once in 5 years, will be found out. The calculation period of the reservoir operation will be basically half-month. However, a monthly calculation period could

be allowed, if data for irrigation water requirements with half-month calculation period are not sufficient or available.

The maintenance flow shall be estimated, taking into consideration the current water use in downstream areas from the dam. Evaporation loss from reservoir and seepage loss of the dam and foundation could be tentatively assumed at 5 mm/day in total.

Fig.4.2 Concept of Water Balance



Water Balance

$$St_2 = St_1 + R - (D + L_1 + L_2 + M) - SP$$

4.4 Water Management Plan

(1) Rotation of Irrigation Water Supply

For the design of the pipeline system, rotation of the irrigation water supply shall be scheduled to use a similar diameter of pipes and pump capacity in order to save construction cost, and to facilitate maintenance work.

(2) Regional Water Management

If existing reservoirs and/or ponds are located within and around the project areas, special facilities for the conveyance of water from and to the different water resources, such as link canals and related structures, shall be laid out to develop methods for regional water management.

4.5 Agro-tourism Development Plan

The following factors should be carefully considered in agro-tourism development:

1) The preservation and protection of the environment against over-exploitation of natural resources and pollution of the environment.

2) A balanced emphasis should be given to the development of tourism in the international / domestic markets.

3) Tourism programmes and projects should be selective and should include the control of pollution, water quality, sewerage discharge, and soil erosion as well as the preservation of forests and other ecosystems.

4) Since fruits development and other activities take years after planting, agro-tourism is a time consuming activity as well as land consuming. Therefore long-term planning is necessary for agro-tourism development

5) The quality of basic facilities like accommodation, rest rooms, communication, water and electricity supplies should be considered to sustain its competitive edge.

6) Safety of visitors, adequacy of emergency facilities and accident prevention measures should also be considered.

7) The basic policy of small reservoir development is 'in-situ development' combined with low initial investment cost, quick yielding benefits, and cheap & easy O/M. Therefore for small reservoir development projects, 'agro-tourism' shall be planned only as a part of the agricultural development which will increase the income of the farmers.

4.6 Environment Conservation Plan

The environment conservation plan should be moulded around the normal project planning process and should be carried out as a part of the environmental impact assessment. The environment conservation plan shall be carried out after the environmental survey, discussed in section 3.7.

Based on the results of the surveys, major environmental problems and environmental impacts shall be identified. The assessor should design suitable mitigation and abatement measures, which should be incorporated into the project plan.

Some of the major environmental impacts related to small reservoir development and the environment conservation plan are discussed below :

4.6.1 Physio-chemical Issues

(1) Soil Erosion

Soil erosion occurs because of the loosening of soil due to land preparation activities, removal of vegetation cover etc., and the potential adverse impacts are as follows :

- Degradation of land productivity,
- Land deterioration and desertification and
- Sedimentation in the reservoirs and lower basins

The mitigation measures which shall be incorporated into the project plan are as follows :

- Physical soil conservation measures such as contour bench terraces in sloppy area, etc.
- Agronomic soil conservation measures such as proper land use planning with suitable vegetation cover, and grassed waterways.

(2) Soil Salinization

Soil salinization is the accumulation of soluble salts due to poor irrigation water quality, inadequate water management, rise of ground water level etc. Major potential adverse impacts are as follows :

- Degradation of land productivity,
- Land deterioration and desertification and
- Reduction in crop yield

The mitigation measures which shall be incorporated into the project plan are as follows :

- Proper drainage and leaching out of soluble salts with irrigation water of low salt content.
- Gypsum treatment
- Proper cropping pattern, and introduction of salt tolerant crops

(3) Soil Sedimentation

Soil sedimentation is the settlement of transported sediments by rivers, estuaries, and reservoirs caused by soil erosion due to land development and construction works.

The following mitigation measures shall be followed :

- Watershed management planning
- Proper land use planning with suitable vegetation and earth cover

(4) Changes in Surface Water Hydrology

Changes in surface water hydrology are caused by changes in the river discharge, water use, or water level of the river by the construction of small reservoirs, or related facilities. The potential adverse impacts are as follows :

- Water shortage or flooding problems in low-lying areas,
- Violation of the existing water rights.
- Adverse effects on fishery and other ecological systems

To avoid adverse impacts, careful planning is necessary on the physical, biological and social environment of the project area.

(5) Changes in Ground Water Hydrology

Changes in ground water hydrology are caused by the changes in the ground water table or ground water recharge by the infiltration of irrigation water or the exploitation of ground water. The adverse impacts include soil salinization, and deterioration of the drainability of the land. Therefore, a careful planning and study is necessary on the ground water source of the project area.

(6) Inundation or Flooding

Inundation or flooding occurs due to overflowing of the river onto the surrounding land caused by increased runoff from the river or poor water management. Potential adverse impacts include harmful effects to humans and livestock, outbreak of diseases, and degradation of ecosystem.

The mitigation measures which shall be incorporated into the project plan are as follows :

- Adequate drainage facilities to drain excessive water
- A flood control reservoir
- Proper operation of the reservoir and drainage canals

(7) Water Contamination and Deterioration of Water Quality

Water contamination and deterioration of water quality is caused by the discharge of domestic, livestock and agro-processing wastes into the waterways, and due to soil erosion, and agrochemical and fertiliser runoff into the river system.

The pollution source should be identified, and the water quality at this location should be verified. If the water quality exceeds the Interim National Water Quality Standard, suitable water quality control and regulating measures such as a retention pond and erosion control measures should be followed.

4.6.2 Biological and Ecological Issues

(1) Deterioration or Degradation of Vegetation

Deterioration or degradation of vegetation is caused due to development activities including the removal of vegetation cover, alteration of land use, alteration of the environmental conditions, etc. The potential adverse impacts include soil erosion, reduction of valuable fauna and flora, reduction of biological diversity, and reduction of green tracts. Appropriate land use planning, and the establishment of preserved areas or buffer zones, are necessary to prevent deterioration or degradation of the vegetation.

(2) Adverse Impacts on the Indigenous Fauna or Flora

Adverse impacts on the indigenous fauna or flora are caused by the destruction or deterioration of habitats due to the development activities such as land reclamation, land clearing, construction of roads, and irrigation and drainage canals.

The distribution of important fauna and flora should be identified and a suitable management strategy and appropriate land use planning are necessary to conserve them.

(3) Degradation of the Ecosystem with Biological Diversity

Biological diversity is a characteristics of wild species and natural ecosystems that allows them to withstand external stress. Conservation of the ecosystem with biological diversity is therefore a form of natural resource management with the primary aim of maintaining long term biological resources. The negative impacts are caused by development activities such as land reclamation, land clearing, construction of roads, and irrigation and drainage canals. The distribution of biological diversity, and important fauna and flora should be identified, and a suitable management strategy is necessary to conserve the ecosystem.

(4) Extinction of Wetlands and Swampy Areas

Wetlands can contribute to local rainfall, serve as a low cost water purification system, act as a buffer against floods, and help the preservation of biological diversity.

Extinction of wetlands and swampy areas will be caused by reservoir development activities such as disturbance of earth surfaces or construction of small dams, road construction, field burning and extinction due to indirect effects such as drying. Mitigation measures include an appropriate land use and drainage plan, establishment or strengthening of conservation areas, and buffer zones.

(5) Destruction or Degradation of Forests

The destruction or degradation of forests is caused due to direct destruction or deterioration of supporting environmental conditions by the reservoir development activities such as land clearing, road construction, irrigation and drainage canal development.

The adverse environmental impacts include reduction of biological diversity, development of soil erosion, and extinction of useful, valuable or indigenous fauna and flora.

A baseline survey should be carried out on the distribution of important fauna and flora, and the establishment or strengthening of conservation areas and buffer zones is necessary.

4.6.3 Socio-economic Issues

(1) Involuntary Settlement

Involuntary settlement is the forced settlement of the inhabitants away from their dwelling places in the areas to be inundated by the development projects.

Major potential adverse impacts are as follows :

- Significant negative socio-economic impact to both new settlers and the host people
- Outbreak of conflict between the new settlers and the host people
- Negative impacts to the natural environment in and around the settlement areas

To avoid these adverse impacts, the following mitigating measures should be implemented :

- Selection of a settlement area should be based on the desires of the affected people
- Adequate provisions should be made for housing and social infrastructures
- Compensation should be made in terms of economic means and infrastructures

(2) Substantial Changes in the Way of Life

Substantial changes in the way of life are the alteration and disruption on the community, especially the role of women in the family and the society, caused by development activities.

Special considerations should be given to socially weak people such as ethnic minorities. Evaluation should be made on the traditional system which has evolved within the natural and socio-economic environment of the project area. Women's role and the impacts of a project should be assessed aiming at women's role in development, the impacts on women's welfare, and social or custom related practices regarding women's role. Project formulation shall be made considering the way of life of affected people in order to avoid rapid changes in traditional way of life.

(3) Conflicts Among Communities and People

Conflicts among communities and people are caused due to conflicting interests between beneficiaries and non-beneficiaries, new settlers and host people, people in the project area and those affected in the surrounding area.

Special consideration should be given to those who may be victimised by the development. Project formulation should be based on the concerns of these people and the related organisation.

(4) Occupational Change, and Loss of Labour Opportunity

Involuntary occupational change shall be caused due to land acquisition and loss or deterioration of the means of economic activities. It shall have potential adverse impacts on the disappearance of the traditional production system, and shall decrease labor opportunities in rural areas and drift populations to the urban area. A development plan shall be formulated based on the present economic environment of the affected areas. Sufficient compensation and support measures shall be provided for the affected population.

(5) Outbreak of Diseases

The spreading of diseases is caused by development activities such as the creation of a conducive environment which propagates pathogenic agents.

Special consideration is required regarding the inadvertent creation of habitats of pathogenic insects due to small reservoir development.

(6) Damage to Historic, Religious and Cultural Assets

Direct or indirect damage to historic, religious, or cultural sites due to development activities shall have an adverse impact on tourism and the living conditions of the local people.

Comprehensive countermeasures are essential based on the identification of distribution, value, preservation policies, and existing conservation measures for historic remains and cultural assets.

4.7 Outline Design of the Main Facilities

4.7.1 Water Resources Development Facilities

Salient features of the dams and excavated ponds shall be decided by studying the following technical points.

The reservoir storage volume curves (H-Q curves) are prepared using topographical maps on a scale of 1 : 1,000.

The dead storage capacity of reservoirs and ponds shall be determined based on the estimation of the sedimentation volume for the project life period. After fixing a normal high water level (N.H.W.L) of reservoirs and ponds, the flood water level of the service spillway, the design flood water level (D.F.W.L) of the emergency spillway, and the crest elevation of the dam, including the freeboard of dams, shall be fixed.

For the determination of the embankment slopes of dams, it is recommendable to make a stability analysis of the dams in case the dam height is greater than 5m. If a stability analysis of dams could not be made due to a lack of geological and soil mechanical data, the embankment slope with a dam height of less than 15 m, could be basically determined by referring to Chapter 5 of these guidelines.

Seepage loss from the dam body and foundation shall be calculated based on the geological data of the foundation, and if the seepage water amount is estimated to be over the allowable range, prompt treatment for seepage loss such as blankets, centre core blankets, etc. shall be designed.

The location of the service spillway and emergency spillway shall be separated from the dam body and the spillways shall be fixed original hills and/or cliffs in referring to the topographical detailed maps on a scale of 1 : 1,000. The intake system for irrigation water shall be combined with the service spillway.

4.7.2 Irrigation and Drainage Development Facilities

(i) Design Discharge

The design discharge for the irrigation facilities shall adopt a peak irrigation water requirement with a probability of 80% based on the proposed cropping pattern.

(ii) Irrigation & Drainage flow chart

The irrigation water flow chart shall be prepared using the design discharge for irrigation, the lay out of canal system, and the rotation system of water supply.

In line with the preparation of irrigation flow charts, the drainage flow chart shall also be prepared in the similar procedure.

(iii) Pumps

In cases the pumps have to design for irrigation water supply, the suction head of the pump shall be studied to select the type of pumps, based on the fluctuation range of the water level of the reservoirs, ponds, and rivers, between the normal water level, the design flood water level and the low water level. If the fluctuation range of water is wider than 6 m, a submersible pump can be recommended, subject to the design discharge and water head of the pumps. In case of a low suction head of less than 4m, a volute pump can be recommended.

To decide the pump discharge, pump operation shall be designed for 24-hours operation during the period of peak irrigation water requirement. Rotation of the irrigation water supply shall be studied to provide the most convenient combination and number of pumps, including one (1) stand by pump, and the pipeline shall be selected with a similar diameter.

(iv) Pipe lines

In case the water head of the pipeline is less than 70m, PVC pipe is recommended, however if the required water head is over 70 m , alternative plans such as booster pump system, up-grading of the pipe quality and pump type shall be studied from technical and financial viewpoints.

The energy line of the water head in the pipeline after a sudden closure of the water supply shall be checked to deal with any occurrence of water hammer.

4.7.3 Social Infrastructures

The flood discharge of rivers flowing in and around the Project area shall be examined whether the floods give the severe damage to the project areas or not.. In case of small streams and/or rivers in and around the Project area, the design flood discharge for the social infrastructures for to the project such as culverts, bridges, and cross drains are recommended to adopt 10 year-flood.

4.7.4 Agro-tourism Facilities

Based on the data and information obtained through the agro-tourism survey, the agro-tourism facilities shall be planned considering the following factors:

1) Tourism potential of the project area and the nearby areas

2) Possibility of management of the tourism facilities by individual farmers, farming groups or related organisations

3) Availability of funds for agro-tourism facilities. The size of these facilities shall be designed based on the factors mentioned above:

i)	Fishing facilities	
ii)	Wooden bridges over small reservoirs	
iii)	Wooden pathways inside the paddy fields	
iv)	Modern technological vegetable farming using sunshine shelters	
v)	Orchid gardens using sunshine shelters	
vi)	Jogging and walking courses	
vii)	Children's parks with facilities like swings, and slides	
viii)	Accommodation facilities and temporary rest houses	
ix)	Refreshment shops	
x)	Parking areas	
xi)	Souvenir and agricultural products stall :	Some of the products from the farms can also be sold in these shops.
xii)	Trees and flowers along the roads :	These will improve the landscape and attract more tourists.

The agro-tourism facilities selected for a particular project area should have a certain uniqueness with attractions to stimulate the tourists to visit the place again and again. It should emphasise the educational, ecological, and scientific significance of the rich flora, and fauna of the area.

New strategies should also be developed to attract more tourists. This will include measures such as the upgrading and diversification of tourist facilities as well as the provision of supporting services such as access roads, communication facilities etc. Family day packages shall be introduced to enhance the team spirit through various farm activities such as fishing, fruit harvesting, fruit tasting etc. These measures should be capable of meeting the demands and requirement of the tourists. Besides sufficient opportunities should be given to the local population to participate in the growth of agro-tourism.

4.8 Construction Plan

Taking into consideration the aims of small reservoir development, mechanical construction methods are recommendable. The construction plan and implementation schedule of the projects shall be prepared to adopt mechanical construction methods based on the work quantity of major construction items such as earthworks, concrete works, and piling works, etc..

As for diversion work for embankment of dam body, diversion work for the flood shall be given to the barrel portion of culvert spillway during construction period Therefor, construction of a culvert spillway shall be given a priority in the schedule prior to the commencement of the embankment work of the dam body.

4.9 Cost & Benefit Estimation and Project Evaluation

4.9.1 Estimate of Costs and Benefits

The aim of the overall estimate of costs and benefits is to determine the incremental net benefit (gross benefit minus cost) over the project life between the situations with the proposed project and without the project.

The following explanations (including Section 4.9.2) are based on the textbook, Gittinger, J.P.IBRD, World Bank 1982: "Economic Analysis of Agricultural Projects." Baltimore: JH University Press.

Two types of costs and benefits are identified; tangible and intangible. Tangible costs and benefits are possible to be quantified, and intangible are not. The major tangible benefits of an agricultural project is an increase in farm production. Some of the other major benefits include,

- quality improvement,
- change in time of sale,
- change in location,
- change in product form,
- cost reduction through mechanisation,
- reduced transport costs,
- losses avoided.

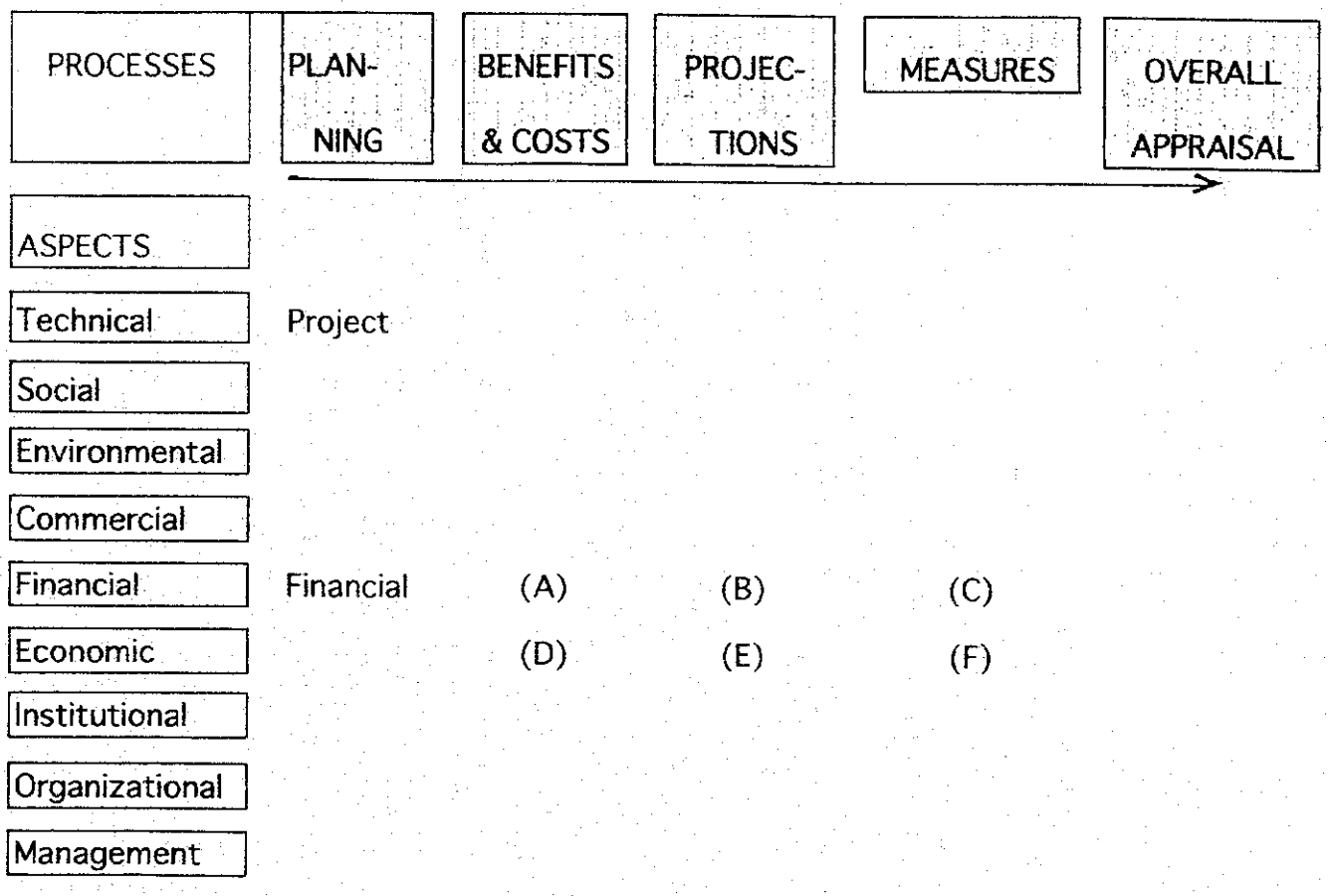
In some cases external benefits may be taken into account. Then the intangible benefits must be enumerated and explained.

- Costs
  Major items of cost consist of materials, equipment, labor, land, contingency, taxes, debt service, and sunk costs (if any). In practice, costs of the project investment are presumed to be estimated by a quantity surveyor at the (A) stage in Figure 4.3. Its method is explained in section 4.9.2.

- Benefits
  Financially, benefit is farm net income. The method we use in our F/S is a standard farm investment analysis. In terms of time span, the analysis consists of two parts. The first part is an estimate of a farm economy. It is carried out within the context of calculating financial benefits (gross income) and costs in the present situation, which is the base of the "without" situation. Its source is the farm plan prepared in the previous adage of project formulation. A simplified flow chart for farm investment analysis is given in Figure.3.7.

The corollary of it is a step of financial projections, which constitute another part of the estimates. It corresponds to the cell (A) and (B) in Figure 4.3. This is the base of "with" situation in the project formulation. The flow explained here could be easily traced in our feasibility study.

Fig. 4.3 **Project Economic & Financial Analysis**



(2) Unit Price Analysis and Cost Estimate

For unit price analysis for the construction cost, two methods, (i) an individual unit price analysis for the project using the cost of basic construction materials, labor, and equipment and (ii) a convenient analysis using the bidding prices of other projects, are considered.

Taking into account the current tender and contract conditions of civil works in Malaysia, the recommendable unit price analysis method is the convenient analysis. However, if a convenient analysis is made, much attention should be paid to the field conditions, quantity of works, and price schedule recently issued by Quantity Survey Section of DID and/or Ministry of Public Works.

The cost estimates of the Project shall be composed of the following 5 items.

- Direct construction cost,
- Physical contingency,
- Land acquisition cost,
- Engineering services cost and
- Administration cost

Physical contingency may be estimated at about 15% of the direct construction cost, and engineering service cost and administration cost will be estimated at about 10% and 5% of direct construction cost respectively.

The maintenance cost of the irrigation facilities could be estimated at about 1 to 2% of the direct cost. The replacement cost of some part of the facilities such as metal works of gates, trash screen, and pump shall be based on the durability period of these parts. Durability of the respective works could be estimated as follows:

Metal works	:	10~15 years
Pump	:	10~15 years

4.9.2 Project Evaluation

Figure 4.3 shows a simplified flow for the formulation and analysis of a project. This is a simplified reproduction of Figure 4.1 of Gittinger, J.P., IBRD, World Bank..

The major process of a projects' appraisal can be divided into three aspects, financial, economic, and social, and finally the overall appraisal.

(a) Financial Analysis

This analysis corresponds to the cell(C) in Figure 4.3. The following items are analysed.

- Cash-flow (break-even point, amortisation)
- Benefit-cost ratio, and/or net present value, and/or internal rate of return.
- Sensitivity analysis.

(b) Economic Analysis

The analysis corresponds to the cell (D), (E), and (F) in Figure 4.3. Firstly, the shadow exchange, opportunity costs of traded and non-traded items, and parity prices are calculated, and transfer items are identified.

Then, as a preliminary work to the analysis, benefits and costs, and projections which are calculated using financial values, is to be converted into the ones calculated by economic values.

The benefit-cost ratio, net present value, internal rate of return and sensitivity analysis shall be made by recalculating financially.

(c) Social Analysis

Income distribution, job creation, regional development in terms of improvement of rural living, social effects, and women's role are analysed.

(d) Overall Project Appraisal

All the nine aspects and all the planning of the project, and financial and economic costs-benefits measures are reviewed.

(e) Final Notes

So far, these discussions have been general, while dealing with the process of analysis. Now, they will become more specific.

Key words for the project are small, reservoir, development, and Peninsular Malaysia. As far as surveys and appraisals go, the specifics relate to a small community of small land holders who are water users of a reservoir in Peninsular Malaysia, in which a market economy prevails.

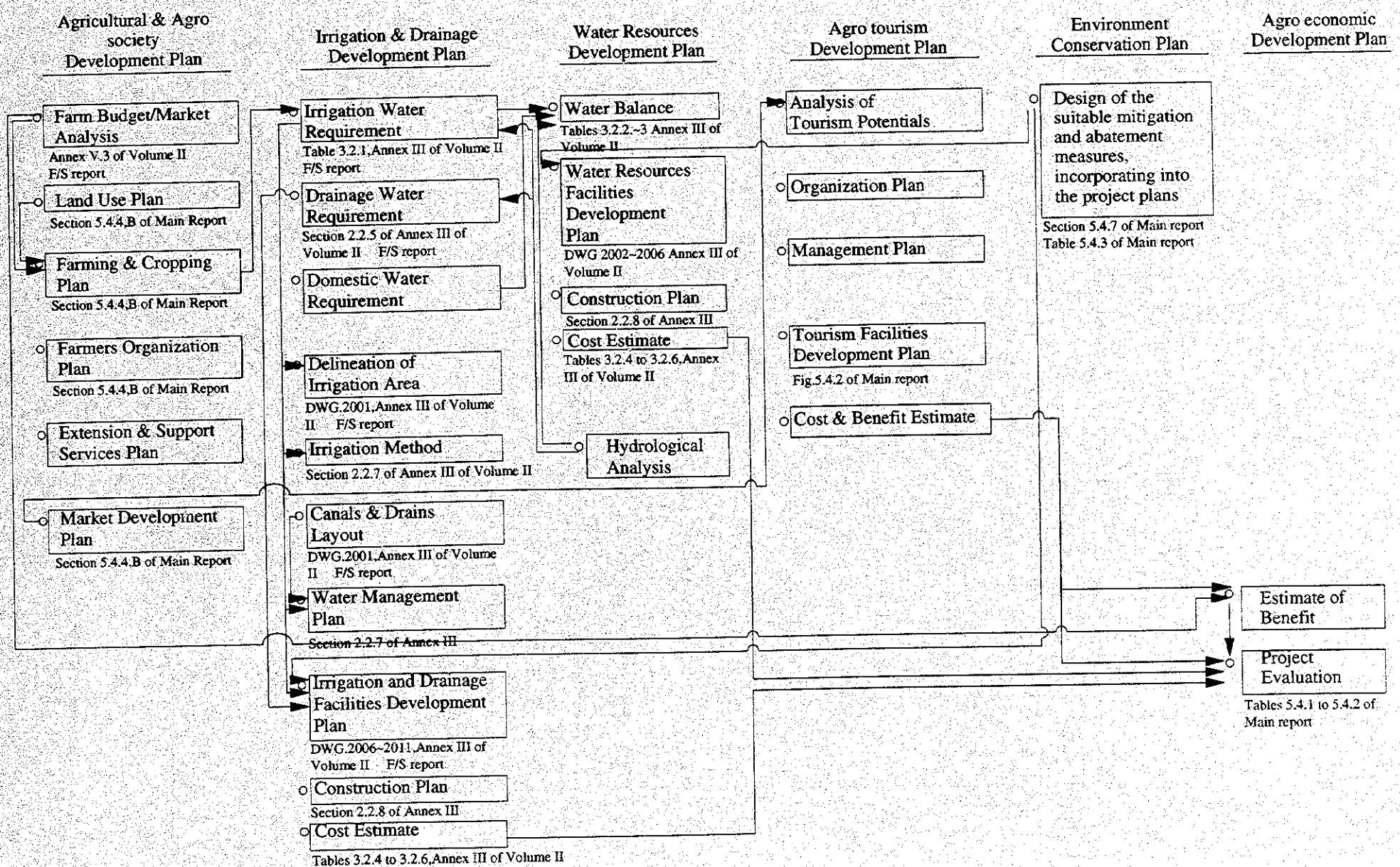
The small size of a target population may allow a researcher to conduct a total number survey instead of a sample survey. Either way, beyond the methods of the required interview and/or questionnaire, one's attitude of mind towards the members of the target community is most vital to the impartial understanding of the community, when he/she wants to conduct a social survey of the target beneficiaries of a project.

4.10 Examples of Flow of the Development Plans

Figure 4.4 shows the examples for the flow of the development plans in case of the Feasibility Study on the Kedawang Project which is made by the JICA Study Team.

The check lists for plan and study are attached below.

Fig.4.4 Examples of Flow of the Development Plans(KH4&5)



CHECK LIST FOR PLAN AND STUDY

1 Agriculture Development Plan
- Project life from viewpoint of cropping aspect
- The proposed corps based on the analysis of farm budget and market demand
- The proposed farming and cropping pattern
- Farmers' experiences for the proposed cropping and farming
- Land use
- Marketing and transportation
- Farmers' organisation and management
- Agriculture supporting system and extension services

2. Irrigation and Drainage Development Plan
- Project life from viewpoint of the durability of the facilities
- The proposed irrigation area
- Land use and land acquisition
- Hydrological year for the plan

For Irrigation Water Requirement
- Calculation period of irrigation water requirement
- Potential evapo transpiration
- Crop coefficient
- Pre saturation, land soaking requirement and percolation for paddy field
- Probable rainfall
- Effective rainfall
- Irrigation method and efficiency

For Layout of Canals, Drains and Farm Roads
- Design irrigation water requirement
- Flow chart of irrigation and drainage
- Water management/operation system
- Design discharge
- Suitable layout of farm roads
- Design standards of canals, drains and related structures
- Improvement and replacement of infrastructures

3. Water Resource Development Plan

For Water Balance in the Reservoir
- Catchment area at the proposed demand intake structure sites
- Runoff at the dam and intake structure sites
- Maintenance flow of river
- Evaporation loss and seepage loss
- Seasonal irrigation water requirement
- Domestic eater supply

For Layout of Facilities
- Land use and land acquisition
- Active storage capacity of dam
- Reservoir storage volume curves

- Estimation of accumulated sedimentation for the Project life and dead storage capacity
- Design flood discharge for the culvert spillway and emergency spillway and design water level
- Embankment slopes of dam
- Location of spillways
- Intake system
- Improvement and replacement of infrastructures

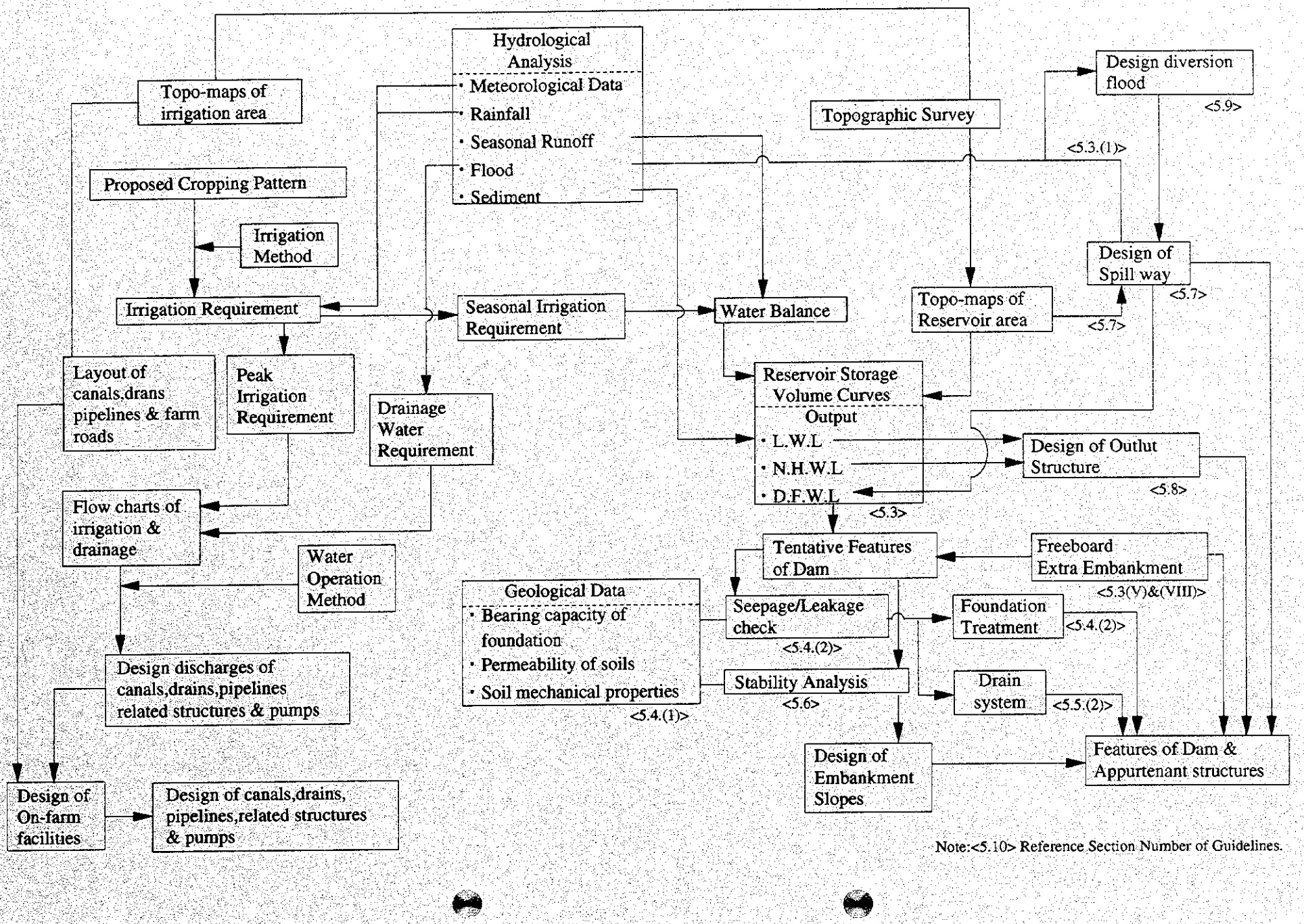
4. Agrotourism Development Plan
- Environmental impacts of physicochemical components
- Agriculture development plan

5. Environment Conservation Plan
- Mitigation measures of soil erosion, soil salinization, soil sedimentation
- Plans to avoid adverse impacts such as the water shortage or flooding problems in low-lying areas, the violation of the existing water rights, the adverse effects on fishery and other ecological systems
- Control and regulating measures of water quality
- Plans to prevent deterioration or degradation of the vegetation
- A suitable management to conserve the important fauna and flora
- Mitigation measures for the settlement
- Mitigation measures for the rapid changes in traditional way of life
- Sufficient compensation and support measures for the occupational change and loss of labour opportunity

6. Construction Plan
- Availability of construction equipment and access road plan
- Diversion work for embankment

7. Cost & Benefit Estimation
- Inflation rate for the up dating of previous cost

Fig.5.1 Work Flows of Design



Note:<5.10> Reference Section Number of Guidelines.

V DESIGN

5.1 General

In these guidelines, a basic design concept of the fill type dam and its appurtenant structures are presented for the feasibility study by referring to the design of small dam, issued by United States Bureau (USBR), the guidelines of the US Army Corps of Engineers, and the design standards of dam, issued by Ministry of Agriculture, Forestry & Fisheries, Japan.

It should be noted that this guidelines will be limited to only small dams which have the following conditions.

- Dam height : less than 15 m
- Storage capacity : less than 1.0 million m^3

If the proposed dams have conditions other than the described above, the design concept of dam shall be considered in regard to the safety, and other design standards of dams shall be used.

Design standards for irrigation & drainage canals and related structures could follow the DID's design standard such as " Design manual for water conveyance system 1980" and other standards authorised by the Government.

Figure. 5.1 shows general work flows of designs for dam & its appurtenant structures and irrigation & drainage facilities.

5.2 Basic Consideration in Design

The principles in dam design are to ensure envisaged dam functions including storage of water, control of river water, intake of water and other requirements for a safe and efficient dam operation and management.

In addition, safety of the dam body, appurtenant facilities of the reservoir, and natural ground around the reservoir should be ensured during and after completion of construction.

The dam shall be constructed in conformity with the natural and social environments in the surrounding area and the environmental impacts of dam construction shall carefully be studied to prevent adverse effects. Furthermore, both construction and O & M costs should be economised as much as possible.

5.3 Main Features of the Dam and Reservoir

(1) Features of the Reservoir

The features of the reservoir which are the main factors for determining the dam height shall be, in principle, composed of the following capacities:

- Dead storage capacity
- Active storage capacity
- Total storage capacity

(i) Dead storage capacity

Dead storage capacity is decided by adding the storage volume for inland fishery, etc., if required, to the estimated sediment volume.

(ii) Active storage capacity

Active storage capacity means the required storage volume determined by the water balance study.

(iii) Total storage capacity

Total storage capacity is the total storage volume of inactive or dead storage capacity and active storage capacity.

(2) Features of the Dam

(i) Design flood discharge

Design flood discharge should be determined on the basis of meteo-hydrological investigations and analysis. The following design flood discharges for spillways shall be adopted for design of spillway depending on the hazard potential in the down stream area from the proposed dam site.

Hazard Potential in downstream from dam site			Spillway Design Flood
Category	Loss of Life	Economic Loss	
Low	None Expected (No. permanent structures for human habitation)	Minimal (undeveloped to occasional structures or agriculture)	100-year flood
Significant	Few (No urban development and no more than a small numbers of inhabitable structures)	Appreciable (Notable agriculture, industry or structures)	100-year to 1/2 of PMF
High	More than a few	Excessive (Extensive community, industry or agriculture)	1/2 of PMF to PMF

Culvert spillway and emergency spillway shall share the design flood discharge mentioned above. The design flood discharge for a culvert spillway will be that of 30-year flood, and the remaining flood discharge shall be released by the emergency spillway.

(ii) Design Flood Water Level (D.F.W.L)

The design flood water level is defined as the maximum reservoir water level when the design flood occurs during full water storage with the normal water surface elevation in the reservoir.

(iii) Normal high water level (N.H.W.L.)

The normal high water level shall be the maximum level of water stored in the reservoir during the normal operation for the project.

(iv) Low water level (L.W.L.)

The low water level shall correspond to the water level for inactive or dead storage.

(v) Freeboard

Freeboard which is one of the elements for deciding the dam crest elevation shall be determined by the following equation:

In case of spillway without gates

$$Hf \geq hw + 1.0 \text{ m}$$

where,

Hd : Water depth of design discharge at spillway crest (m)
Hf : Height of freeboard (m)
hw : Wind wave height on the reservoir surface (m)
$hw = 0.00086 \times F^{0.45} \times V^{1.1}$
F : Fetch of reservoir (m)
V : Average wind speed for 10 minutes (m / sec)

(vi) Dam crest elevation

Dam crest elevation shall be decided by the following equation:

Dam crest elevation = D.F.W.L. + Hf + (pavement thickness)

The dam crest should be protected against damages caused by drying, shrinkage, fissuring and other erosion. The minimum thickness of the protection pavement is recommended at 20 cm.

(vii) Dam height

Dam height is regarded as the maximum different height between the elevation of the dam crest and the bottom of the dam foundation after stripping, not considering the excavation depth of the core trench. Thickness of stripping varies with the subsurface condition of the proposed dam site.

(viii) Extra banking

Extra banking shall be considered against the settlement of the dam embankment. Thickness of the extra banking shall be estimated at 10% of the dam height (except for a weak foundation). In the case of a weak foundation, extra banking shall be decided through the settlement study.

(ix) Width of the dam crest

The width of the dam crest shall be determined considering the minimum required width for construction and for utilisation as a road after construction, etc. The recommended width is as follows:

$$W \geq 0.2 \times H + 3.0$$

where,
W : width of dam crest (m)
H : dam height (m)

5.4 Dam Foundation

(1) Required Conditions of the Dam Foundation

The dam foundation shall possess necessary water tightness and strength, and be sufficiently secure against sliding failure or seepage failure.

(i) Weak foundation

- Safety should be considered in the design against sliding failure of the foundation when a dam is constructed on a weak foundation such as saturated clay, silt and loose sand.

- Classification of a weak foundation

Dam height, H < 15 m :	N - value < 4	;	very weak
	N - value = 4 - 10	;	weak
	N - value = 10 - 20	;	medium

(ii) Pervious foundation

- Reduction of seepage to tolerable limits and countermeasures for pore water pressure, induced by seepage, are necessary.

- Classification of a pervious foundation

Coefficient of permeability is in the order of 10^{-4} cm/sec for the following foundations:

Porous rock foundation
Cracky rock foundation
Sand and gravel foundation

(2) Foundation Treatment

Foundation treatment measures shall be studied based on the following items:

- Reduction of seepage
- Bearing on dam stability
- Reduction of piping

(i) The foundation treatment measure is an important factor related to the dam construction cost. Foundation treatment measures, shall be studied in the feasibility study.

(ii) Tolerable limit seepage

Allowable daily seepage is commonly limited to less than 0.05% of the total reservoir capacity in regard to the storage efficiency of the reservoir.

(iii) A stability analysis against piping is done using the following equations:

- Critical hydraulic gradient equation
- Justin's equation

(iv) Method of reducing of seepage

- For soil foundation;

Measures to reduce seepage to tolerable limits mainly depend on the geological structure of the foundation. Convenient methods adopted for the various types of permeable foundations are as follows:

cut-off trench works
impervious blankets
wide cores, etc.

- For rock foundations;

The grouting method for joints, cracks and faults is generally useful.

(v) Measures reducting piping

- Filter and drains

Protection works, such as filter and drains shall be provided for safety against piping.

- Contact clay works

Contact clay works using clay material grouped in CH shall be provided on the contact portion between the core trench and the rock base or concrete face for safety against piping.

5.5 Dam Embankment

(1) General

A fill dam has the advantage in utilizing of almost all kinds of materials in the vicinity of the dam site. It shall be planned to use excavated materials from the spillway, dam foundation outlet works and borrow materials in the reservoir area, in order to minimise construction costs and increase reservoir capacity.

(2) Filter and Drain

A filter and drain shall be provided to prevent piping or boiling and to safely drain seepage flow.

Homogeneous type dam

Drains are installed to prevent the downstream slope of the dam springing water. In case that the dam height is less than 15 m, a toe drain, horizontal drain, and/or chimny drain could be installed.

(3) Embankment Slopes and Berms

Embankment slopes and the location of berms shall be determined to maximise the stability of the dam and minimise the dam section.

Embankment slope

If the dam height is less than 15 m, stable foundation embankment slopes can be basically determined from the following reference without conducting a stability analysis in the feasibility study:

Materials	Slope	
	US	DS
GC to GM	1 : 3.0	1 : 2.0
SC to SM	1 : 3.0	1 : 2.0
CL to ML	1 : 3.5	1 : 2.5
CH to MH	1 : 4.0	1 : 2.5

Note ; US : upstream slope
DS : downstream slope
Material : SGW, GP, SW, SP
Reference : "Design of Small Dam", USBR

Berm

As for the downstream slope, berms of about 1.0 - 2.0 m wide shall be constructed usually at an interval of 7 to 10 m in height for collecting rain water and maintaining the dam.

(4) Protection Works for the Embankment

The embankment shall be protected against erosion by waves and rainfall etc.

Upstream slope protection

Protection works include dumped riprap, hand-placed riprap, concrete blocks. Riprap protection is recommended.

Downstream slope protection

Protection works include sodding, striped sodding, and natural grassing, and hand-placed riprap, etc.

5.6 Stability Analysis

The dam body and foundation, including the contact plane between the embankment and the foundation, shall have enough resistance against sliding under the following conditions of each case.

- Study case and condition

Case	Water level in reservoir	Design seismic factor (%)	Safety factor
1	Empty (after construction)	0	Fs > 1.4
2	Design flood water level	0	Fs > 1.5
3	Rapid draw down ; lowest water level	0	Fs > 1.3

Case 1: Pore pressure during the construction remains.
Stress indication is total stress.
Case 2 : Seepage flows in steady condition at the normal full water level.
Stress indication is effective stress.
Case 3 : Water level suddenly drops from normal full water level to lowest water level, and pore pressure remains.
Stress indications is effective stress.

- Stability analysis
  The "Slip Circle Method" is a stability analysis used to determine the safety factor represented by the ratio of the sum of the sliding moment to the sum of the resistance moment. The calculation is executed in relation to the centre of the slide circle for each slice.

5.7 Spillway

(1) Alignment of the Spillway

Dams are to be provided with a culvert spillway as the service spillway and a grass spillway as the emergency spillway. Alignment and location of the spillway shall be determined considering the following points:

- To be short and have a straight centreline.
- To be located apart from the dam embankment.
- To be located on a sound foundation.

(i) The centreline of the spillway is recommended to be short and straight in regard to its hydraulic condition. In case that some curve settings are required to avoid a great deal of excavation volume, they shall be limited to the sub critical flow portion.

(ii) In order to avoid piping at the contact portion of the core zone and concrete face of spillway, the spillway shall be located away from the dam embankment.

In case that the wall of the spillway directly contacts with the dam embankment, the concrete wall below the design flood water level shall be designed with slope of 1 : 0.3 to 0.5.

(iii) The spillway shall be constructed on sound foundations to avoid settlement, seepage and vibration. The inlet portion and the energy dissipater portion shall be especially located on hard foundations. The required bearing capacity of the foundation is as follows:

$$R = 3.0 \times H \ (ton/m^2)$$

where, R : bearing capacity (ton/m^2)
H : wall height of the spillway (m)

(2) Hydraulics

The size of the spillway shall be determined based on the following hydraulic calculation methods:

Overflow discharge formula

A complete overflow shall be realised at the weir of the inlet portion. The following discharge formula shall be adopted:

$$Q = C \times L \times H^{3/2}$$

where, Q : discharge (m^3 / sec)
C : discharge coefficient (less than 2.15)
L : length of weir (m)
H : total head (m)

5.8 Outlet Works

(1) General

Outlet works are necessary to intake/release any discharge ranging from the maximum design discharge and the minimum design discharge without causing structural damages to the dam and reservoir. Design discharge of outlet works shall be determined based on the design discharge required for the following purposes:

- Irrigation
- Water supply
- Service discharge ; for existing water rights or maintenance flow
- Diversion of floods during construction
- Emergency release

(2) Layout of Outlet Works

Outlet works shall be composed of the following portions:

- Intake portion
- Conduit portion
- Control portion

(i) Intake portion

There are, in general four types of intake portion; inclined intake structure, intake tower, drop inlet and bottom intake structure.
The type of intake portion shall be determined taking the following into consideration:

- purpose (control of discharge)
- available water depth
- design discharge
- condition to be handed over to project area.

The intake tower or inclined intake structure is favourably adopted to dams of which the available water depth is high or the control of discharge is necessary. The intake portion shall be designed taking into consideration the following items:

- The intake portion shall be located outside of the toe of dam embankment.
- The sill of the intake portion shall be located equal or lower than the low water level (L.W.L).
- A trashrack shall be installed.
- It is recommended that simple facilities for obtaining water from the dead storage zone be installed in case of an emergency, like extraordinary drought.
- The inclined intake structure shall be located on a stable foundation.
- The intake tower shall have the facility to go to the tower deck such as an access bridge or ladder.

(ii) Conduit portion

- The conduit of culvert spillway shall be used as the outlet works.
- The conduit shall be constructed on a stable foundation.
- The shape of conduit is recommended to be circular as a circular section is structurally stable against high inner/outer pressure.

(iii) Control portion

- The control portion shall be located outside the toe of the dam embankment.
- Sets of control gate/valve shall be installed in order to release a wide range of discharge. Each set must have main and sub-gate/valve for maintenance or replacement.
- The location of the gate/valve at the control portion shall be determined taking the following into consideration.

  Accessibility to gate/valve
  Sufficient space for constructing an energy dissipater against the jet flow behind the gate/valve
  Utilisation of water, etc.

- An energy dissipater shall be designed just behind the gate/valve to smoothly convey water into the main canal.
- A water measurement facility shall be installed behind the controlling portion to measure the released discharge.

5.9 Diversion Works during Construction

(1) Design Diversion Flood

The design diversion flood shall be determined based on the characteristics of the stream flow, the discharge and frequency of flood, and the construction period. The magnitude of the design diversion flood shall be determined on the basis of the construction period as follows:

Construction period*1	Design diversion flood*2
One off season or one relative off season	5 to 10-years flood during the construction period

1 year - 2 years	5 to 10-years flood

Note; *1 : Construction period for the river portion of the dam embankment
*2 : The magnitude of the design diversion flood shall be determined taking into account the extent of damages to the downstream area, damages to embankment, and delay of construction.

(2) Diversion Methods

Diversion during dam construction shall be made economically considering the embankment procedure.

Typical diversion methods are classified as follows:

- Conduit type
- Open channel type (using the natural river)

The conduit installed for the culvert spillway and/or outlet works shall be mainly used in parallel with the natural open channel.

5.10 O & M Facilities

The dam and its appurtenant structures shall be equipped with necessary facilities for operation and maintenance for long term use.

The following facilities shall be provided:

Object	Facility	Location (quantity)	Remarks
Dam safety	bench mark	near the dam (2 pieces)	at an undisturbed place
	concrete pegs	dam crest (install at 20 meters interval)	to secure settlement of dam embankment
	measuring device for leakage	just after drain zone in embankment (one set)	to measure leakage through the dam
Active use of water	gauging staff	in the reservoir near the dam (one set)	to measure the water level
	discharge measuring device	just after the control portion of the outlet works	to release water efficiently

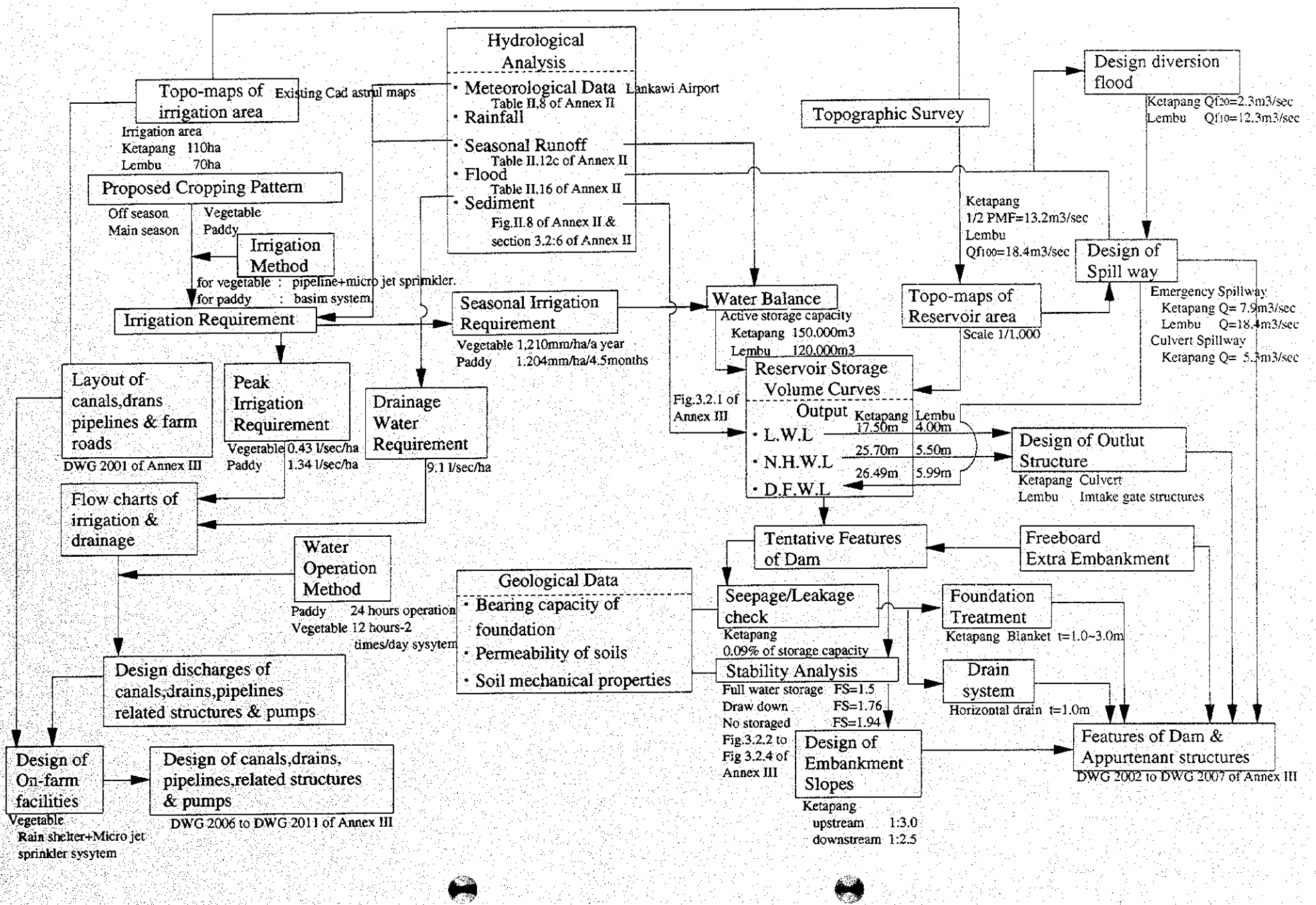
Note : Bench marks are used for levelling the dam crest and also for levelling the sills of all the appurtenant structures.

5.11 Examples of Work Flows of Design

Figure 5.2 shows the examples for work flows of design in case of the Feasibility Study of the Kedawang Project which is made by the JICA Study Team. The detailed design of structures are shown in Annex III of Volume II, the Study Report.

The check list of basic items for the design works are described in the attached papers.

Fig.5.2 Examples for Work Flows of Design(KH 4 & 5)



CHECK LIST OF DESIGN

1. Dam
   - Freeboard of dam
   - Seepage and leakage from dam and foundation
   - Foundation treatment
   - Drain system of dam body
   - Stability analysis (embankment slopes and berms)
   - Extra embankment
   - Dam crest
   - Width of the dam crest
   - Protection works of the embankment slopes

2. Spillway
   - Hazard potential in downstream from dam site
   - Alignment of the spillway
   - Foundation of the spillway (culvert spillway)
   - Protection work in downstream from spillway

3. Outlet Works
   - Alignment of the outlet works
   - Foundation of the outlet works

VI. OPERATION AND MAINTENANCE

6.1 General

These guidelines present a basic concept on the operation and maintenance work of the dam & its appurtenant structures and irrigation facilities.

Furthermore, " Guidelines for operation, maintenance and surveillance of dams 1989 " published by Malaysian Inter-Departental Committee shall be refered to preparation of the basic concept on operation and maintenance work of dam.

6.2 Organisation for O & M

Implementation models of the small reservoir developments are considered the following 3 cases.

(i) Government Construct-Government
(ii) Government Construct-User operate
(iii) User of Construct User Operate

Therefore, in cases of the implementation model (i) & (ii) organisation for O & M body shall consist of an implementing agency, DID, and a farmers' association or the other Government agencies. The implementing agency shall take all responsibilities of O & M work for the dam and its appurtenant structures, and ask the farmers' association or the other Government agencies to monitor the dam and its appurtenant structures in the initial stage of the O & M. In case of (iii), sigma organisation oh the body is only the project owner, all the O & M works shall be carried out by the project owners.

6.3 Reservoir Operation for Water Use

Appropriate and safe operation shall be made for the intake of water, and an operation manual shall be provided based on flood discharge.

For the appropriate and safe operation of the intake of water and the discharge of flood, preparation of an operation plan is indispensable. The operation plan shall be prepared annually based on the actual water demand and the expected water resource which shall be analysed based on the past hydrological data. The operation plan shall include the following :

- Organisation and responsibilities on operation of the gate
- Water demand; irrigation, etc.
- Available water resources
- Operation schedule for discharging required water
- Operation rules for emergencies

6.4 Operation against Flood

(1) Documents and Data to be Filed

The O & M body shall have full responsibility for the operation and maintenance of the dam and its appurtenant structures and shall keep the documents relevant to the properties, water rights, other agreements on O & M, and other O & M data. The following data relating to O & M work shall be prepared and/or filed:

- Reports and drawings prepared in planning, the detailed design and the construction stages
- Records of regular inspection and measurement
- Records of significant repair and rehabilitation works

- Ledger of the O & M organisation

(2) Division of O & M Period

O & M period shall be divided into three stages considering the characteristics of the dams behaviour and the measurement:

- First Stage : from the beginning of the initial ponding to the initial full storage
- Second Stage : from the end of initial full storage to the steady condition of dam behaviour
- Third Stage : after the second stage

(3) Initial Ponding

Initial ponding shall be done under full responsibility of the implementing agency. A ponding plan shall be set up considering dam safety, countermeasures for releasing water during flood, treatment for submersible objects, river condition, etc. Prior to the initial ponding, it is essential to confirm the safety of ponding. It must be specially confirmed that the following facilities and/or work are sufficiently completed:

- Dam body
- Maintenance facilities
- Relocation roads
- Land compensation in the reservoir area
- Safety measures against land slides around the reservoir
- Safety measures against back water in the upstream area

(4) Measurement

Necessary measurements shall be made by the implementing agency in order to confirm the stability of the dam behaviour and conditions. Measurement on leakage, deformation, and seepage line shall be made as follows:

Monitoring Items	1st Stage	2nd Stage	3rd Stage
Leakage	once/day	once/week	once/month
Deformation	once/week	once/month	once/6 months
Seepage Line	once/week	once/month	once/3 months

Measurement on the seepage line shall be made only for homogeneous type dams.

(5) Inspection

Regular and temporary inspections shall be carried out by the implementing agency in order to observe the conditions of the dam and its appurtenant structures. The regular inspection on the following items of dam body, its appurtenant structures and ground surface shall be carried out:

Dam body	- Leakage and dam slope
Outlet Works & Spillway	- leakage, scouring, deformation, damage, obstructions, etc.
Ground surface around abutment	- leakage, crack and land slide

6.5 Maintenance of the Dam, Reservoir and Other Related Facilities

Maintenance work are minor repair works, which are clarified by the detailed investigation and other necessary regular maintenance works. Major repair and rehabilitation works shall be executed through discussion between the farmers' association and the implementing agency, DID in case of the implementation mode (ii).