3.4 Water Supply

3.4.1 Formulation of Rural Water Supply Plan

A rural water supply plan shall be formulated based on the results of the investigation. The following items shall be included in the plan.
(1) Determination of beneficiaries
(2) Estimation of future water demand
(3) Determination of proposed water supply system and volume
(4) Determination of water treatment plan
(5) Basic design of facilities
(6) Calculation of expected benefit

Explanation:

To develop a satisfactory rural water supply system, the following items shall be included in the formulation of the plan. In the SWIM projects, proposed water supply volume shall be from 120 liters/capita to 250 liters/capita (maybe corresponding to the water service level from II to III), depending on the socio-economic condition of the beneficial area.

(1) Determination of beneficiaries

Proposed beneficiaries shall be determined based on the results of the study on present water supply condition, and on the proposed storage capacity.

(2) Estimation of future water demand

Future water demand shall be estimated by population projection and per capita per day consumption according to the following procedure;
(a) Population projection in the project area,
(b) Future average water demand per capita per day,
(c) From (a) and (b), future water demand in the project area shall be estimated,
(c) Estimate the maximum day demand, and
(d) Estimate the maximum hour demand

250 liters/capita/day - NWRB standard of per capita consumption for water permit application.

(3) Determination of proposed water supply system and volume

The proposed water supply volume shall be determined according to the following procedure;
(a) Determination of target year
(b) Estimated future water demand at target year
(c) Determination of water supply system
(c) Present water supply volume
(d) Proposed water supply volume shall then be calculated from the balance between (b) and (c).

Distribution loss shall also be considered to the above estimation.

(4) Determination of water treatment plan

Based on the results of the water quality test, necessary treatment plan shall be formulated to assure the water quality for domestic uses. Water settling basin shall be planned to settle solids if necessary.

(5) Basic design of facilities

After determining the proposed water supply volume and water treatment plan, the basic design of the following facilities shall be made.

(a) Design of water intake and transmission supply line;
Design of water intake facilities and transmission supply line to the settling basin or to the storage tank, shall be made.

(b) Design of storage tank;
The storage tank capacity shall be at least equal to one-fourth of daily water demand of the community.
This storage tank shall be planned at elevated places and/or central to the distribution system. The design shall be made according to the standards set by the National Structural Code of the Philippines.

(c) Design of main pipes and laterals
Design of main pipe and lateral pipes shall be made according to the following procedure:

i) Layout of water distribution system shall be prepared.

ii) The flows in the main pipes and laterals shall be determined and designed based on the proposed maximum daily consumption.

iii) Pipe diameters corresponding to the pipe flows shall be determined.

iv) The type of pipe shall be determined (Plastic on G.I. pipe, PVC pipe, etc.)

v) Location of valves, fittings, etc. shall be determined.

Pipeline design shall be made according to the following criteria:

i) Minimum pressure at the remotest end of the system - 3 m (approx. 4.26 psi)

ii) Maximum velocity of flow in pipes:
- Main pipes : 3.0 meters/second
- Distribution pipes : 1.5 meters/second

The layout of the water supply system shall be presented. Besides, the schematic discharge diagram shall be presented.

(6) Calculation of Expected Benefit

(a) Economic Benefit

Since the value of water will hardly calculate properly, the economic benefit of water supply shall be calculated from alternative cost evaluation. The benefit shall be considered to be equal to the cost of most economically attractive project which will produce the same products or render the same service at the same place. The cost of the alternative shall be estimated in the same manner as the cost of the project.

(b) Financial benefit

Financial benefit shall be born from the water charge of users. The water charge per unit volume shall be determined so that the total revenue would be equivalent with the annual operation and maintenance cost of the water supply system as follows:

The unit water tariff (₱/liter) = (Annual O&M cost of water supply system, ₱)/(Annual water supply volume; liter)

Existing Studies:

(1) Determination of beneficiaries: Unknown.

(2) Estimation of future water demand

Population projection is done. Water demand per capita is estimated at 151 to 200 liters/day.

(3) Determination of proposed water supply volume

Future water demand is estimated to be equivalent to the proposed water supply volume.

(4) Formulation of water treatment plan

Chlorine application is planned.

(5) Basic design of facilities

Distribution system is not designed.

(6) Calculation of expected benefit

The construction cost of alternative deep wells is considered as economic benefit.

3.5 Inland Fishery

3.5.1 Formulation of Inland Fishery Development Plan

An inland fishery development plan shall be formulated based on the results of the investigation. The following items shall be included in the plan.

(1) Selection of fish species
(2) Determination of development scale
(3) Determination of stocking method
(4) Source of fingerlings
(5) Feed and feeding
(6) Care and maintenance
(7) Harvesting, processing and marketing
(8) Calculation of expected benefit
(9) Institution development

Explanation:

Although an inland fishery development is of secondary purpose in the SWIM projects, it should be an actual one. As mentioned in the guidelines for investigation, objective beneficiaries shall be set to those who live in the barangays near the reservoir. Following items should be mentioned in the feasibility study report.

(1) Selection of fish species

In selecting fish species to be cultured, familiarity of the people to the species should be considered. Popular species are tilapia, common carp, cat fish and mud fish.

(2) Determination of development scale

Target production of fish should be determined. Future demand of fish in the objective area shall be calculated according to population projection and the projection of per capita fish consumption rate.

(3) Determination of stocking method

In the determination of stocking method, relation between estimated fish demand and the scale of reservoir shall be considered.

(4) Source of fingerlings

Source of fingerlings should be mentioned after being

supplied for the first time by Bureau of Fisheries and Aquatic Resources (BFAR).

(5) Feed and feeding

The necessity of feeding depends on availability of natural feed in the reservoir such as plankton and aquatic plants. Feeding rate shall be determined.

(6) Care and maintenance

Fish stocking calendar shall be provided such as preparation of fingerlings, standard starting time of fish stocking, application time and amount of feed, harvesting time, etc.

(7) Harvesting, processing and marketing

Harvesting and marketing methods should be clarified. Processing shall be mentioned as may be necessary.

(8) Calculation of expected benefit

Expected benefit shall be calculated from the balance between gross benefit and total cost, as follows:

(a) Total Cost: (Material cost) + (Personnel cost)
where,
Material cost includes fingerlings, feed, fertilizer, catch net, fish cage, etc.
Personnel cost includes salary for care taker, labor wage, etc.

(b) Gross Benefit: (Culture area) x (fingerling density (1 - mortality rate)) x (average commercial fish size) x (number of culture per year) x (unit market price of fish)

(c) Net Benefit : (Gross Benefit) - (Total Cost)

(9) Institution development

In order to maintain inland fishery activity properly, institutional development plan shall be made. Organization, its function and fund source shall be planned.

Existing Studies:

STUDY ITEM	DPWH	NIA	BSWM
1. Selection of fish species	- Reason unknown. Tilapia is proposed.	- Reason unknown. Tilapia and carp is proposed.	- Reason unknown. Tilapia is proposed.
2. Determination of development scale	- Reservoir area and its depth.	- Unknown.	- Reservoir area at high water and low water levels.
3. Determination of culture method	- Theory unknown. Fish cage culture is proposed.	- Theory unknown. Free spawning is proposed.	- Theory unknown. Free spawning is proposed.
4. Care and maintenance	- Described.	- Unknown.	- Unknown.
5. Production	- Proposed annual production between 10 and 1,471 tons.	- Proposed annual production is 1.6 tons.	- Proposed annual production between 0.6 and 31.9 tons.
6. Marketing	- Surrounding municipalities.	- Unknown.	- Unknown but basically planned to be consumed within a beneficial area.
7. Institution	- Unknown.	- Unknown.	- Unknown but an institutional officer from BSWM will be assigned after completion of dam.

3.6 Flood Control

Flood control is regarded as incidental purpose in the SWIM Projects.

Explanation:

The SWIM Projects are conceived as a first line of defense against floods. However, since the water impounding dams are located in the small rivers/tributaries and remote areas, effect to mitigation of flood by those dams is considered to be nominal. In formulation of the SWIM Projects, flood control is regarded as incidental purpose and direct benefit of flood control is not estimated.

As explained in Section 3.11.3, effect to mitigation of flood damage shall be discussed showing a peak-cut volume of the design flood discharge from viewpoint of socio-economic impacts of the project.

Existing Studies:

In all the previous studies, flood control is regarded as incidental purpose and direct benefit of flood control is not estimated.

3.7 Environmental Conservation

3.7.1 Environmental Assessment

The assessment of the potential environmental impacts shall be made on the basis of information collected from the existing sources and investigation.

Explanation:

(1) Environmental impacts

The impacts of dam and reservoir projects on selected environmental parameters are illustrated in Table E.3.1, which includes irrigation component as well as the main dam and reservoir itself. This tabulation is intended only to indicate the main environmental impacts, which may vary widely from project to project. Impacts shall be considered at all stages of the project; construction and operation phases.

Table E.3.1 ENVIRONMENTAL IMPACTS OF DAM & RESERVOIR PROJECT INCLUDING IRRIGATION

ENVIRONMENTAL PARAMETER	DAM AND RESERVOIR	IRRIGATION
1. Physical Effects		
- Surface Water	2	2
- Ground Water	1	1
- Sedimentation/Erosion	2	-
2. Ecological Effects		
- Vegetation	1	-
- Fish and Wildlife	2	1
3. Socio-Economic Effects		
- Land Use	2	1
- Public Health	2	1
- Lifestyles	2	2
4. Compensation		
- Resettlement	3	1

NOTES: Numerical Values: 3 = probable major impact;
2 = intermediate;
1 = significant but relatively minor

Some of the major impacts are described below.

(a) Dam and Reservoir

(i) Surface water
- Increase of water level in watershed area
- Decrease of water level and quantity downstream of the dam

- Eutrophication of the reservoir

(ii) Groundwater
- Alterations in groundwater table
- Changes in groundwater sources

(iii) Sedimentation
- Sedimentation in reservoir
- Alteration of river beds downstream of the dam

(iv) Public health
- Altering hazards of water-oriented diseases and insect-post

(v) Resettlement
- Displacement of communities to be resettled.

(b) Irrigation

(i) Effects of return flows on river water salinity

(ii) Effects of run-off from farming areas containing residues of fertilizer and toxic chemicals on stream ecology and terrestrial wildlife.

(2) Environmental assessment

Proper assessment of the environmental impacts of the proposed project basically consists of following two steps:

(a) predicting the future state under the without-project condition, and
(b) predicting the environmental state under the with-project condition.

An important objective of the assessment is the identification of the adverse impacts of the project, and the most difficult task in the assessment is the determination of the magnitude of the impacts.

Table E.3.2 has been used as the sheet of checklist for the identification of the type of impacts and for the determination of the magnitude of impacts.

Table E.3.2 IMPACT IDENTIFICATION AND EVALUATION CHECKLIST FOR RECOMMENDED SCHEME

ENVIRONMENTAL PARAMETERS	IMPACT		MAGNITUDE OF IMPACT					
	+	-	O	L	M	H	U	N
A. EXISTING PHYSICAL AND CHEMICAL CHARACTERISTICS								
1. Earth								
a. Mineral Resources								
b. Soils								
c. Land Forms								
d. Unique Physical Features								
2. Water								
a. Stream, Drainage, Effluent								
b. Groundwater								
c. Quality, Temperature								
d. Recharge								
3. Processes								
a. Floods								
b. Erosion								
c. Stress-Strain (Earthquake)								
d. Downstream Sedimentation								
B. EXISTING CULTURAL FACTORS								
1. Land Use								
a. Agricultural								
b. Residential								
c. Industrial								
d. Commercial								
e. Forestry								
f. Grazing								
g. Wetlands								
2. Infrastructures								
a. Major Structures								
b. Utility Networks								
c. Transportation Networks								
3. Aesthetics and Human Interests								
a. Scenic Views and Vistas								
b. Parks and Reserves								
c. Rare and Unique Species								
d. Historical and Archeological Sites and Objects								
4. Cultural Status								
a. Employment								
b. Life Styles								
c. Health and Safety								
d. Population Density								
e. Food Production								
5. Recreation								
a. Resorts								
b. Swimming, Fishing								
C. ECOLOGICAL RELATIONSHIP								
1. Food Chain								
2. Water-Related Disease Vectors								
3. Insect Vectors								
D. OTHERS								

LEGEND:

+	Positive Environmental Impact	M	Moderate Environmental Impact
-	Negative Environmental Impact	H	High Environmental Impact
O	No Environmental Impact	U	Unknown Environmental Impact
L	Minor Environmental Impact	N	No Applicable

3.7.2 Formulation of Environmental Conservation Plan

Environmental conservation plan shall be formulated in order to eliminate or reduce the severity of adverse impacts.

Explanation:

Mitigation measures shall be instituted, or reasonable alternatives shall be considered prior to project implementation so that significant adverse impacts can be eliminated or reduced.

(1) Mitigation measures

Typical mitigation measures which could be instituted in water resources development projects are listed below.

(a) Reforestation, replanting
(b) Fish hatchery, fish ladders, relocation of animals
(c) Treatment of waste disposal and/or spoil bank
(d) Treatment of muddy water
(e) Safety measure for people (net, fence, etc.)
(f) Maintenance or augmentation of minimum flows
(g) Periodic release of sediment for downstream replenishment
(h) Restriction of development and population pressures around reservoir
(i) Development of new settlements
(j) Adequate compensation of displaced residents

(2) Alternative plan

In cases where no satisfactory mitigation is practicable and the environmental damage is quite significant, alternative plan must be considered which would avoid the environmental effect.

As a guide, a list of possible alternative to water resources development projects is presented below.

(a) Reducing the size of project and project facilities
(b) Importation of water from other basins or from the existing projects
(c) Improved utilization of available water
(d) Development of other reservoir projects
(e) Enlargement of existing projects
(f) Control or restriction of development around and in the vicinity of reservoir

Existing Studies:

The study on physical, ecological and cultural impacts to surrounding environment are reported in some projects of NIA and DPWH. The assessment is mainly conducted in line with the Guideline of NEPC (National Environmental Protection Council).

Positive and negative environmental impacts are mentioned as follows.

(1) Positive environmental impacts

(a) Physical characteristics

- stability of stream condition
- retention of groundwater
- decrease of sediment volume to down stream

(b) Culture factor

- agriculture security
- transportation networks
- scenic views and vistas
- creation of job opportunity
- enhancement of living standards including recreation opportunity

(2) Negative environmental impacts

(a) Physical characteristics

- earth and soil outflow during construction
- coldlization of irrigation water
- decrease of dissolved oxygen
- erosion of land surrounding reservoir
- stability decrease of the ground for earthquake
- devastation of forest and nature area

(b) Ecological relationship

- water-related disease vectors

The study on the environmental impacts is not particularly described in the BSWM projects.

3.8 Watershed Management Plan

3.8.1 Formulation of Watershed Management Plan

In order to support future development in the watershed area, an integrated watershed management plan shall be formulated according to the following procedure:

(1) Determination of the proposed land use
(2) Determination of the forest areas for water resources conservation and for soil erosion control
(3) Prioritization of the areas where measures are to be taken

Explanation:

A watershed management plan shall be formulated based on the present natural and socio-economic conditions and on the existing development plan in the area. The plan shall be formulated according to the following procedure.

(1) Determination of the proposed land use

Taking into consideration the present natural condition such as geographic condition, geology, vegetation, and also the socio-economic aspects like the present land use and future development plans, future land use in the watershed area shall be proposed. Following classification shall be made and presented on a future land use map:

(a) Forest area
  - for production purposes
  - for protection purposes
(b) Agriculture area
(c) Grassland area for grazing
(d) Residential area
(e) Industrial area including mines

Watershed management plan, therefore, shall be formulated to conserve or protect the above area as well as the downstream area.

(2) Determination of the forest areas for water resources conservation and for soil erosion control

As for the critical forest areas in terms of geography and geology, zoning of water resources conservation and soil erosion control shall be made. A proper management plan for the zoned areas shall be planned.

(3) Prioritization of the areas where measures are to be taken

In the objective watershed area, priority ranking of the areas on which measures are to be taken shall be made according to urgency and importance. The measures to be taken shall also be specified. Followings are principal measures widely taken in the Philippines:

(a) soil erosion control
- hillside works(both engineering and vegetative works)
- construction of check dams
- revetment work

(b) afforestation
- planting
- forest management

Existing Studies:

Unknown.

3.8.2 Formulation of Soil Erosion Control Plan

Soil erosion control is one of the urgent measures to be taken into account in the watershed management plan. Following works shall be considered as soil erosion control measures:
(1) Hillside engineering works
(2) Hillside vegetative works
(3) Construction of check dams
(4) Revetment works

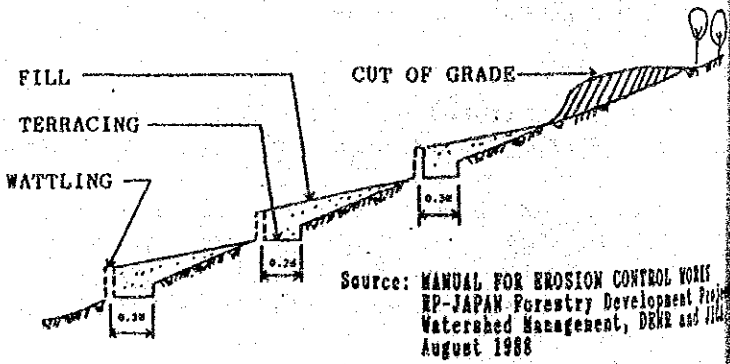
Explanation:

The most suitable soil erosion control measures shall be planned according to the present condition of the area to be protected.

(1) Hillside engineering works

Hillside engineering works are the supporting measure of the following vegetative works, and include the following main works:

(a) Grading works; steep hillside shall be graded to stabilize the move of earth. The slope to apply this works shall be more than 1:1.5.



Source: MANUAL FOR EROSION CONTROL WORKS
RP-JAPAN Forestry Development Pro
Watershed Management, DENR and JI
August 1988

Grading and Terracing

(b) Terracing; in order to stabilize earth on the hillside and to protect soil from further erosion hazard, terracing works shall also be applied. Standard size of a terrace shall be 2 to 3 meters in vertical height and 0.4 to 1 meter in width. Each

terrace shall be retained by riprap or dry stones.

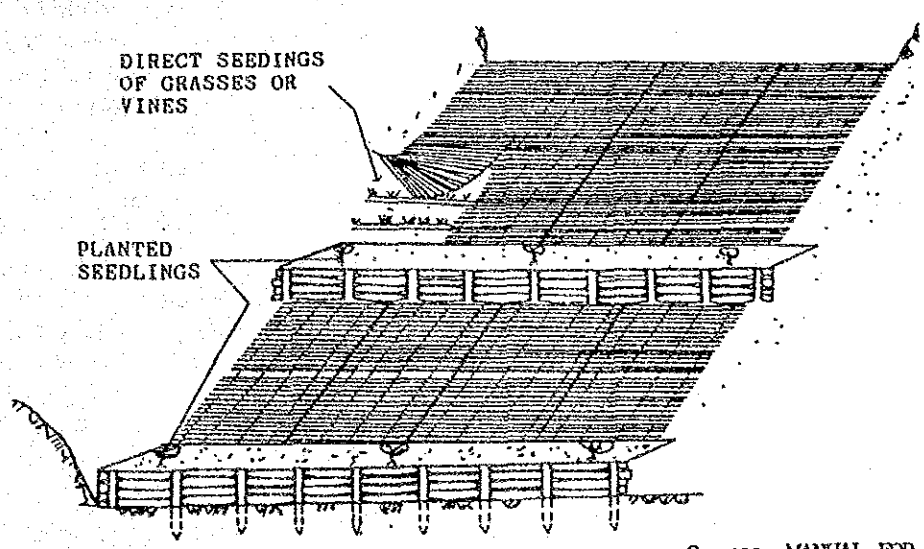
(c) Water channel works; for long hillside or a place where water comes from the eroded area, water channel works shall be applied to avoid further erosion which may be caused by the excess water flow. The materials used for water channel shall be concrete or grass and tree branches.

These works shall be applied according to the occasional demand. The location and scale on which the measures are to be taken shall be determined and presented by each works.

(2) Hillside vegetative works

Vegetative works shall be applied in general to the areas where engineering measures has been taken. Vegetative works include the following:

(a) Direct seeding works; to be applied to the area where both the soil and topographic conditions are favorable in terms of slope gradient, slope length and soil fertility. Matting treatment like cogon mat on the soil surface may be effective to enhance the germination of seeds and to prevent the move of earth.



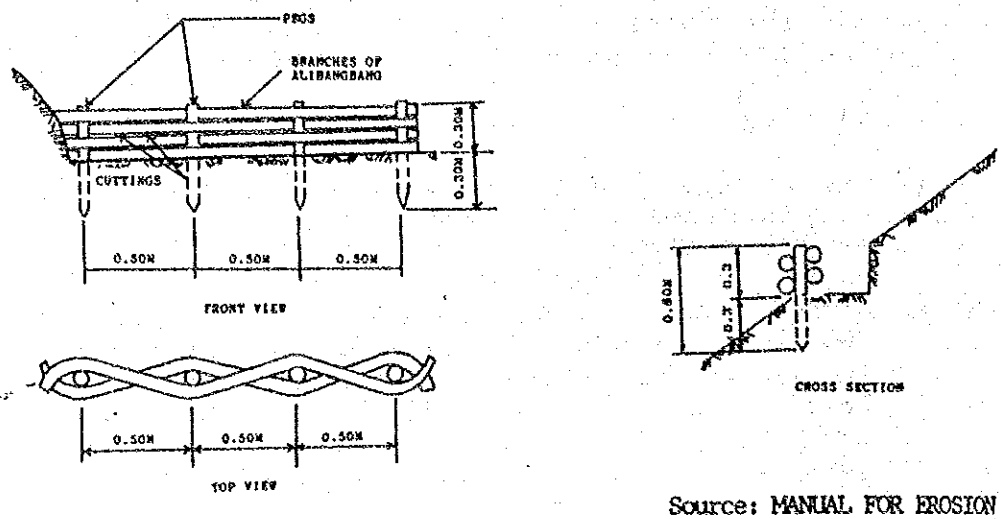
Source: MANUAL FOR EROSION CONTROL
RP-JAPAN Forestry Develop
Watershed Management, DE
August 1988

Direct Seeding with Cogon Mat

(b) Planting works; the nursery and/or branches of trees shall be planted to such sites as denuded and/or eroded areas, where re-greening is urgently required.
Planting species to be used shall be selected by adopting the principle of "right tree on right site". It is recommendable that species have the following characteristics:
- that are tolerable to drought and soil infertility,

- that root system develops quickly and fix soil,
- that has vigorous sprouting ability, and
- that has resistance to diseases and pest.

(c) Wattling; to be applied to stabilize the move of earth of terraces. It is an alternative measure to riprap works(engineering measure). Materials shall be selected from the available plants with sprouting ability such as kakawate, napier grass, ipil-ipil, etc.



Source: MANUAL FOR EROSION CONTROL RP-JAPAN Forestry Develop Watershed Management, E August, 1988.

Wattling

(3) Construction of check dams

Location, number and scale of proposed check dams shall firstly be determined and presented. Proper materials for the proposed dams shall be determined based on the easiness of procurement, cost, scale of proposed dam, etc. Dam types commonly used in the Philippines are of concrete, dry masonry and gabion.

(4) Revetment works

Revetment works shall be applied to the broken river banks in the watershed to prevent further amount of earth from flowing towards downstream. The location, scale and materials to be used shall be determined.

Existing Studies:

Described. Drawings are prepared for both check dams and vegetative control measures.

3.8.3 Formulation of Expansive Afforestation Plan

Apart from soil erosion control plan, expansive afforestation plan shall be formulated in order to enforce the function of soil and water conservation in the watershed area and the productivity of forest. The following measures shall be taken for this purpose:
(1) Afforestation
(2) Care and maintenance of the existing forest

Explanation:

Expansive afforestation plan shall be formulated for the forest area according to the proposed land use. In the plan formulation, measures to be taken shall be determined taking water conservation area and soil erosion control area into account. The following two measures shall principally be taken:

(1) Afforestation

Unutilized land and less utilized land shall be actively afforestated. Tree species shall be determined based on the natural condition such as climate and soil, and also on the purpose of use. Planting area and its density shall also be determined. Tree species recommended for planting in the Philippines are shown in the following table.

(a) For Vegetative Rehabilitation

Common Name	Scientific Name
1. Akleng parang	Albizzia procera
2. Cashew	Anacardium occidentale
3. Benguet pine	Pinus insularis
4. Yemane	Gmelina arborea
5. Bagras	Eucalyptus deglupta
6. Kaatoan bangkal	Anthocephalus chinensis
7. Kakawate	Gliricida sepium
8. Ipil-ipil	Leucaena glauca
9. Giant ipil-ipil	Leucaena leucocephala
10. Teak	Tectona grandis
11. Duhat	Syzygium cumi
12. Agoho	Casuarina spp.
13. Anabiong	Trema orientalis
14. Alibangbang	Pileostigma malabaricum
15. Narra	Pterocarpus indicus
16. Binayoyo	Antidesma frutescens
17. Katurai	Sesbania grandiflora
18. Datiles	Muntinga calabura
19. Alnus	Alnus spp.
20. Bagalunga	Melia dubia

(b) For Fuelwood

	Common Name	Scientific Name
1.	Ipil-ipil	Leucaena glauca
2.	Giant ipil-ipil	Leucaena leucocephala
3.	Agoho	Casuarina equisetifolia
4.	Kakawate	Gliricida sepium
5.	Bagalunga	Melia dubia
6.	Bakawan spp.	Rhizopora spp.
7.	Alibangbang	Pileostigma malabaricum
8.	Tamarind	Tamarindus indica
9.	Guava	Psidium guajava
10.	Camachile	Pithecellobium dulce
11.	Binayuyu	Antidesma ghaesembilla
12.	Akleng parang	Albizia procera
13.	Raintree	Samanea saman

(c) For Pulpwood

	Common Name	Scientific Name
1.	Pine spp.	Pinus spp.
2.	Kaatoan bangkal	Anthocephalus chinensis
3.	Bagras	Eucaliptus deglupta
4.	Balsa	Ochroma pyramidale
5.	Banlag	Xylopia ferryginea
6.	Giant ipil-ipil	Leucaena leucocephala
7.	Yemane	Gmelina arborea
8.	Alnus	Alnus spp.
9.	Auriculiformis	Acacia auriculiformis
10.	Falcataria	Albizzia falcataria

(d) For Timber

	Common Name	Scientific Name
1.	Pine spp.	Pinus spp.
2.	Mahogany	Swietenia macrophylla
3.	Molave	Vitex parviflora
4.	Narra	Pterocarpus indicus
5.	Teak	Tectona grandis
6.	Dipterocarp spp.	Dipterocarpus spp.
7.	Tindalo	Pahudia rhomboidea
8.	Kamagong	Diospyros philippenensis
9.	Kalantas	Toona calantas
10.	Danupra	Toona surine
11.	Dao	Dracontomelum spp.
12.	Akle	Serialbizia acle
13.	Raintree	Samanea saman

Source: The Philippine Recommends for Reforestation. PCARR, Technical Bulletin Series No.49, 1982, and FMB.

(2) Care and maintenance of the existing forest

Reforestation to the cut-over area, replanting for the open stand, thinning, salvage cutting of cull trees, etc. shall be planned in order to maintain the function of existing forest.

Existing Studies:

planned but tree species to be planted are unknown.

3.8.4 Formulation of Nursery Preparation Plan

In order to secure the number and amount of plants required for the project, a nursery shall be prepared in proper scale.

Explanation:

A nursery shall be prepared in order to produce plants to be planted and to store seeds. The location and area of the nursery shall be determined based mainly on the soil condition and accessibility to the site for the location and on the amount of seedlings for the area. Based on the climate condition, seedling production plan shall be formulated.

Existing Studies:

Unknown.

3.8.5 Integrated Social Forestry Program

As a countermeasure to kaingin activities, integrated social forestry program shall be applied.

Explanation:

Instead of removing the kaingineros from the watershed area, they shall be involved into the reforestation activity. In line with the integrated forestry program, they shall be taken part in the program.

Existing Studies:

Unknown.

3.8.6 Countermeasure to Forest Fire and Illegal Extraction of Forest Products

In order to maintain the function of forest as water resources conservation and soil erosion control, the protection plan against forest fire and illegat extraction of forest products shall be formulated. The following measure shall be taken into account:

(1) Selection of fire resistance tree species for afforestation
(2) Establishment of fire break and forest road
(3) Organizing patrol team and fire-fighters

Explanation:

(1) Fire resistance tree species shall be selected for afforestation in order to minimize the fire damage when it occurred.

(2) Forest road shall be proposed as a combined use with fire break along the catchment boundary and mountain ridges. The proposed forest road shall be 10 to 20 meters in width.

(3) In order to prevent fire occurrence and illegal cutting of forest trees, and to minimize the loss or damage, the organization of patrol team and fire-fighters shall be proposed.

Existing Studies:

Unknown.

3.9 Construction Plan and Implementation Schedule

3.9.1 Construction Plan and Construction Period

Considering scale of construction, meteo-hydrological condition and site conditions, the appropriate construction plan including monitoring system shall be formulated and the construction period be determined.

Explanation:

In the feasibility study report, the consideration and studies on construction plan and period for the dam and water utilization facilities shall be incorporated. The work procedure for formulation of construction plan and schedule is as follows:

(1) Determination of workable days based on the daily rainfall data

(2) Determination of construction system (by contractor or by force account)

(3) Estimation of required work volume categorizing into earth work, concrete work, and required man-power and construction material

(4) Determination of construction method (by machine or by man-power), considering construction scale and work volume

(5) Determination of type and number of construction machine based on ability of machine and work volume

(6) Determination of construction period, considering sequence of construction especially diversion works

Monitoring system during construction shall also be examined in order to inform the progress of construction and problems encountered to TWG-SWIM through the implementing agency.

According to the past study results and construction of the projects, the appropriate construction period for the project including dam and water utilization facilities, in terms of dam height, is as follows:

Dam Height	Construction Period
H < 15 m	6 months to 1 year
H ≥ 15 m	1 to 2 years

Existing Studies:

Item	DPWH	NIA	BSWM
Construction Period	2.5 - 3 years	3 years	4 - 6 months

3.9.2 Implementation Schedule

Considering pre-construction and main construction period, appropriate implementation schedule shall be formulated, including the fund requirement and the proposed organization for project implementation.

Explanation:

The implementation schedule shall be formulated including schedule for pre-construction work and main construction work, fund requirement and proposed organization for project implementation. The following studies shall be incorporated in the report:

(1) Implementation schedule shall be prepared considering the following periods and sequence:

- Period of fund arrangement for project implementation
- Period of detailed design work including its contract administration
- Period of preparatory work of construction such as land acquisition and construction of site office
- Period of main construction work including its contract administration

(2) Annual fund requirement for project implementation shall be shown based on the implementation schedule.

(3) Organization for project implementation shall be explained including the followings:

- Organization chart including required number of staff
- Responsibility of executing agency and other cooperating agencies

3.10 Cost Estimate

3.10.1 Construction Cost Estimate

Construction costs for dam and water utilization facilities shall be estimated including the following costs:

(1) Direct Cost
  (a) Cost for preparatory works
  (b) Construction cost of dam, water utilization facilities and watershed management
  (c) Contractor's tax

(2) Indirect Cost
  (d) Land acquisition and compensation cost
  (e) General administration cost
  (f) Cost for engineering services
  (g) Physical contingency
  (h) Price contingency

Explanation:

The cost estimates of the SWIM projects have been made in different way by each agency. The cost estimate shall be made, based on the local competitive bidding, in the following manner:

(1) Direct Cost

The direct cost shall be in principle estimated based on the bill of quantity and complex unit price including contractor's profit, overhead and tax.

(a) Cost for preparatory works

Preparatory works shall include:

- Mobilization and demobilization
- Construction of camp
- Construction of access road
- Temporary works
- Care of river and others

Cost for preparatory works shall be estimated at 10% of the construction cost of dam and other water utilization facilities.

(b) Construction cost of dam and water utilization facilities:

(i) Dam: construction cost shall be estimated based on the bill of quantity and complex unit price, categorizing into the following items:

- Dam body (excavation(m^3), embankment(m^3))
- Dam foundation (lump sum)
- Spillway (excavation(m^3), concrete(m^3))
- Outlet works (excavation(m^3), concrete(m^3))
- Mechanical work (gate(no.), valve(no.), pipe(ton))

(ii) Irrigation: construction cost shall be estimated based on the bill of quantity and complex unit price, categorizing into the following items:

- Civil work for canal (excavation(m^3), embankment(m^3))
- Civil work for structures (earth work(m^3), concrete(m^3))
- Mechanical work (gate(ton))

Unit construction cost per hectare (about ₱17,000 to 25,000/ha which is applied for communal irrigation project by NIA may be used for estimation.

(iii) Mini-hydropower: construction cost shall be estimated based on the bill of quantity and complex unit price, categorizing into the following items:

- Civil works (excavation(m^3), concrete(m^3))
- Generating and electrical equipment (lump sum)
- Transmission line (km)

(iv) Water supply: construction cost shall be estimated based on the bill of quantity and complex unit price, categorizing into the following items:

- Civil works (excavation(m^3), concrete(m^3))
- Water conveyance pipe (ton)
- Purification plant (lump sum)

(v) Watershed management: construction cost shall be estimated showing breakdown costs of labors, materials transportation, etc., categorizing into the following items:

- Construction of check dam
- Hillside works including engineering and vegetative works
- Afforestation works
- Preparation of nursery

(c) Contractor's tax

The contractor's tax shall be estimated based on the direct cost. The tax shall be tentatively estimated at the rate of 5 % of the direct cost.

(2) Indirect Cost

(d) Land acquisition and compensation cost shall be estimated based on the prevailing actual land costs and compensation costs to be investigated.

(e) General administration cost to be spent by the Government during construction shall be estimated at 3% of the total direct cost.

(f) Cost for engineering services shall be estimated at the filowing rate of the total direct construction cost:

For feasibility study	:	3 %
For detailed design	:	6 %
For construction supervision	:	10 %

(g) Physical contingency shall be estimated at the following rate of the total cost of items (a) to (f):

At pre-feasibility stage	:	20 %
At feasibility stage	:	15 %
At detailed design stage	:	10 %

(h) Price contingency shall be estimated at the rate of 7%/year for local currency portion and 3%/year for foreign currency portion of items (a) to (g), based on the construction schedule.

3.10.2 Estimation of Operation and Maintenance, and Replacement Cost

---

The following costs relating to operation and maintenance of the project shall be estimated:

(1) Annual operation and maintenance costs of dam and water utilization facilities

(2) Replacement costs for mechanical and electrical equipment such as gates, generating power plant, etc.

Explanation:

For properly evaluating the project, operation and maintenance, and replacement costs shall be estimated in the following manner:

(1) Annual operation and maintenance costs of dam and water utilization facilities shall be estimated as follows:

(a) Dam: 0.5% of total construction cost of dam
(b) Water utilization facilities: 2.5% of total construction cost of facilities

(2) Replacement costs for mechanical and electrical equipment shall be same as the estimated costs for initial installation. Useful life is as follows:

(a) Mechanical equipment: 25 years
(b) Electrical equipment: 25 years

Existing Studies:

ITEM	DPWH	NIA	BSWM
I. Construction Cost Estimates			
1. Condition of Cost Estimates	Costs are divided into two parts; (i) contract costs and (ii) government works	All works are done by contract base.	All works are done by contract base.
2. Direct Cost			
(1) Preparatory Works	Mobilization and demobilization, clear and grub, temporary works, access road, care of river, right of way	Right of way, damages, access road, clearing reservoir, service facilities, and mobilization.	Camp, access road, mobilization and demobilization, clear and grub.
(2) Civil Works			
- Dam and appurtenant	Dam embankment, dam foundation, outlet works, spillway and bridges.	Dam Embankment, Dam Foundation, Spillway, Outlet Works	Dam embankment, excavation spillway and outlet works.
- Irrigation	Considered in two projects only.	Considered at evaluation by NIA evaluation division	Considered and broken down
- Power	Power house, tailrace and bypass structure, excavation		Not planned.
- Watershed	Not Planned	Not Planned.	Considered but not broken down.
- Water Supply	Main line and ditribution line.	Not Planned.	Not planned.
(3) Mechanical Works			
- Power Plant	Mini-hydro plant, substation, battery charger, switchboards, electrical systems.	Turbine-generator, Auxillary Switchyard equipment, etc.	Not planned.
- Gate, pipe, etc.	Penstock, valves, pipes	Penstock, tailrace, valve, etc.	Not planned.
3. Indirect Cost			
(1) Land Acquisition	Not mentioned.	Not mentioned.	Not mentioned.
(2) Engineering Service (E/S)	(Total cost + contingencies) * 10%	(Total Cost) * (10% - 20%)	((Direct cost - cost for watershed development) + contingencies) * 10%
(3) Governmental Admi.	Considered in several projects	Not mentioned.	Not mentioned.
(4) Contingencies			
- Physical	(Total cost) * 10%	(Total Cost) * (10% - 15%)	(Direct cost - cost for watershed development) *
- Price	Not mentioned	Not mentioned.	Not mentioned.
(5) Others	Tax, overhead and profit.		
II. O&M Cost and Replacement Cost	O&M cost only.	Considered at evaluation by NIA	Not mentioned.
Dam cost/Embankment volume(US$/m3)	ave: 15.9 (range: 2.3 - 33.5)	ave: 15.4 (range: 4.0 - 37.1)	ave: 9.2 (range: 0.8 - 1
Dam cost/Irrigation area (US$/ha)	ave:9,654(range:1,204-42,752)	ave:18,451(range:5,071-47,075)	ave: 3,397(range: 395-1

3.11 Project Evaluation

3.11.1 Economic Evaluation

Using economic costs and benefits, economic evaluation shall be made by calculating the following economic indices:
(1) Economic Internal Rate of Return; EIRR
(2) Benefit-Cost Ratio; B/C
(3) Net Present Value; NPV

Explanation:

The economic evaluation shall be made in terms of the following economic indices:

(1) Economic Internal Rate of Return; EIRR

EIRR shall be calculated by the following procedure:

(a) Calculation of economic costs including construction cost and O&M and replacement costs shall be made as;
- Reducing transfer payment such as land acquisition cost, tax and price contingency
- Multiplying conversion factor (estimated by World Bank or NEDA) by the financial costs of direct construction costs as follows:
  for foreign cost : 1.2
  for common labor cost : 0.6
  for other local costs : 1.0

(b) Calculation of economic benefits derived from each development sector explained in Sections 3.2.3, 3.3.4, 3.4.1 and 3.5.1 shall be made.

(c) Preparation of cost-benefit flow for 25 years from the commencement of the construction, considering the construction schedule and build-up period for full development of the project.

(d) Discount rate for equaling the present values of cost and benefit is EIRR.

(2) Benefit-Cost Ratio; B/C

The same procedure shall be taken in the items (a) to (c) for calculation of EIRR. Then;

(a) The present values of cost and benefit shall be calculated at the discount rate of 15%.

(b) Ratio of the present value of benefit to the present value of benefit is B/C.

(3) Net Present Value; NPV

NPV is the surplus of reducing the present value of cost from the present value of benefit discounted at rate of 15%.

Existing Studies:

ITEMS	UNIT	DPWH	NIA	BSWM
1. Irrigation Benefit				
- Estimate Method		Incremental benefit between with and without project conditions	Incremental benefit between with and without project conditions	Incremental benefit between with and without project conditions
(1) Unit benefit (service area basis)	US$/ha	ave: 1,497 (434 - 6,402)	ave: 1,108 (480 - 1,911)	ave: 1,405 (78 - 4,940)
(2) Unit benefit (storage water volume basis)	US$/m3	ave: 0.35 (0.04 - 1.62)	ave: 0.28 (0.10 - 0.73)	ave: 1.07 (0.04 - 13.58)
(3) Unit benefit (embankment volume basis)	US$/m3	ave: 2.93 (0.49 - 9.06)	ave: 3.7 (1.1 - 10.9)	ave: 4.98 (0.11 - 18.6)
2. Mini-hydropower Benefit				
- Estimate Method		alternative diesel plant cost.	alternative diesel plant cost.	-
(1) Investment Cost (power plant)	US$/kW	ave: 972 (427 - 1,723)	ave: 488 (431 - 530)	-
(2) Annual Cost				
(i) Fuel Consumption Rate	lit/kWh	ave: 0.34 (0.26 - 0.44)	not presented	-
(ii) Fuel Cost	US$/lit	ave: 0.41 (0.24 - 0.53)	ave: 0.35 (0.31 - 0.37)	-
3. Watershed Development/Management Benefit				
- Source of Benefit		-	-	fruits and/or animal production
(1) Unit benefit (service area basis)	US$/ha	-	-	ave: 1,123 (43 - 6,810)
4. Water Supply				
- Estimate Method		an alternative deep well	-	-
(1) Unit Benefit (water demand volume basis)	US$/m3	ave: 2.7 (0.2 - 5.2)	-	-
(2) Unit Benefit (embankment volume basis)	US$/m3	ave: 3.4 (0.5 - 6.3)	-	-
5. Inland Fishery Benefit				
(1) Unit Benefit (reservoir area basis)	US$/ha	ave: 17,880 (883 - 50,587)	321	ave: 3,373 (130 - 24,011)
(2) Unit Benefit (embankment volume basis)	US$/m3	ave: 2.29 (0.36 - 6.17)	0.01	ave: 0.62 (0.03 - 3.96)

Remarks: All values shown are adjusted based on the exchange rate between Philippine pesos and US dollars.

3.11.2 Financial Analysis

Financial analysis shall be made through the studies on the following items:
(1) Farm budget analysis of beneficiaries
(2) Capacity to pay for investment cost and operation and maintenance costs

Explanation:

The financial evaluation shall be made as follows:

(1) Farm budget analysis of beneficiaries

Farm budget analysis shall be made to examine net increase of earnings of beneficiary by the project on financial basis. The analysis for beneficiary by irrigation development shall be done based on the following procedure:

(a) Determination of typical farm holding size and family size

(b) Estimation of net revenue of typical farm family on without-project condition by reducing production cost and living cost from gross benefit

(c) Estimation of net revenue of typical farm family on with-project condition

(d) Estimation of net increase of earnings

(2) Capacity to pay for investment cost and operation and maintenance costs

Capacity to pay shall be examined whether beneficiary has enough capacity to repayment of investment cost or payment of O&M cost, or not. The analysis shall be made based on the following conditions:

(a) Investment cost for dam and appurtenant structures will not be returned by beneficiaries.

(b) Investment cost for water utilization facilities other than mini-hydropower development will be amortized by beneficiaries.

(c) O&M cost for dam and water utilization facilities other than mini-hydropower development will be paid by beneficiaries.

(d) As for mini-hydropower development, the facility will be turned-over to local electrical cooperative. The cooperative will repay all investment cost for mini-hydropower facilities.

Based on the above conditions, in case of irrigation beneficiaries, the capacity to pay for investment cost and O&M cost shall be examined considering amortization schedule, O&M cost and net increase of earnings.

In case of mini-hydropower development, the repayment schedule shall be prepared.

Existing Studies:

Unknown

3.11.3 Socio-economic Impacts

The socio-economic impacts of the project shall be examined.

Explanation:

The socio-economic impacts of the project shall be examined on the following items:

(1) Effect to mitigation of flood damage

Since it is difficult to quantify direct benefit for flood control, effect to mitigation of flood damage shall be discussed showing a peak cut of the design flood discharge through flood routing analysis.

(2) Number of beneficiaries

Number of beneficiaries by the project shall be estimated by development sector such as irrigation, mini-hydropower and inland fishery.

(3) Increase of employment opportunities

Employment opportunities shall be estimated as number of labors to be employed during construction and O&M stage.

(4) Peace and order

Contribution of the project to peace and order shall be discussed.

(5) Others

In addition to the above socio-economic impacts, the following indirect benefits will be conceived from watershed management development:
(a) Protection of soil erosion
(b) Water-resource conservation

(c) Production of timber
(d) Increase of employment opportunities

Existing Studies:

Unknown

4 GUIDELINE FOR DESIGN OF MAJOR STRUCTURES (Dam and Its Appurtenant Structures)

4.1 Basic Consideration in Design

Dam shall be designed so as to fulfill necessary dam functions and safety, being equipped with economically acceptable facilities in harmony with its environment.

Explanation:

The basic 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 safe and efficient dam operation and management.

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

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 economized as much as possible.

4.2 Main Features of Dam and Reservoir

4.2.1 Feature of Reservoir

Feature of reservoir which is main factor for determining dam height shall be in principle composed of the following capacities:
(1) Inactive or dead storage capacity
(2) Active storage capacity
(3) Surcharge volume
(4) Total storage capacity

Explanation:

(1) Inactive or dead storage capacity

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

(2) Active storage capacity

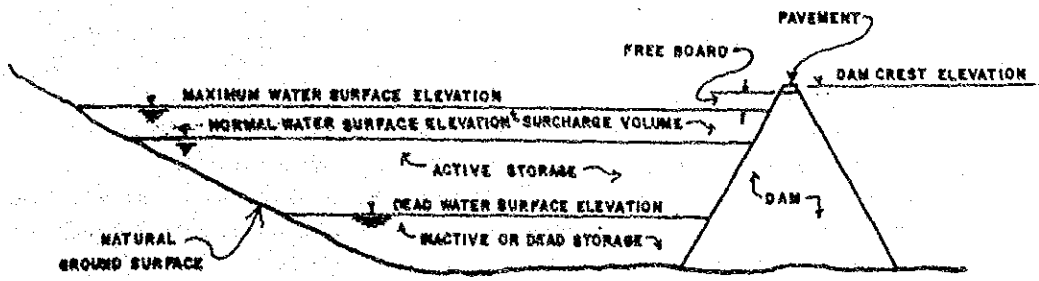
Active storage capacity means the required storage volume determined by water balance study.

(3) Surcharge volume

Surcharge volume is calculated through flood routing analysis against inflow design flood and shall be kept above full water level.

(4) Total storage capacity

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



Existing Studies:

Agency	Inactive or Dead Storage Capacity (MCM)						Total
	0.1-0.5	0.5-1	1-5	5-10	>10	Unknown	
DPWH	16	6	2	2	0	1	27
NIA	27	44	9	5	0	0	85
BSWM	144	0	0	0	0	1	145
Total	187	50	11	7	0	2	257

Agency	Active Storage Capacity (MCM)						Total
	0-1	1-5	5-10	10-50	>50	Unknown	
DPWH	15	9	1	1	0	1	27
NIA	28	43	9	5	0	0	85
BSWM	143	1	0	0	0	1	145
Total	186	53	10	6	0	2	257

Agency	Total Storage Capacity (MCM)						Total
	0-1	1-5	5-10	10-50	>50	Unknown	
DPWH	15	9	1	1	0	1	27
NIA	27	42	10	6	0	0	85
BSWM	143	1	0	0	0	1	145
Total	185	52	11	7	0	2	257

4.2.2 Feature of dam

Feature of dam shall be formed with the followings:
(1) Design flood discharge and maximum water surface elevation
(2) Normal water surface elevation or high water level
(3) Dead water surface elevation or low water level
(4) Freeboard
(5) Dam crest elevation
(6) Dam height
(7) Extra banking
(8) Width of dam crest

Explanation:

(1) Design flood discharge and maximum water surface elevation (MWSE)

The design flood discharge should be determined on the basis of meteo-hydrological investigations and analysis. The maximum water surface elevation is defined as the maximum reservoir water level when the design flood discharge occurs at the normal water surface elevation in the reservoir.
The magnitude of design flood discharge is as follows (refer to Item 3.1.2 of Guideline for Project Planning):

In case of dam height, $H<15m$; at least 25-year flood
In case of dam height, $H\geq15m$; at least 100-year flood

(2) Normal surface water elevation (NSWE) or high water level (HWL)

The normal surface water elevation or high water level shall be maximum level of water stored by the dam for the purpose of the project.

(3) Dead water surface elevation (DWSE) or low water level (LWL)

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

(4) Freeboard

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

In case of dam height, H < 15 m;

$$H_f \geq h_w + 0.5$$

In case of dam height, H $\geq$ 15 m;

$$H_f \geq h_w + 1.0$$

where,

H_f : Height of freeboard (m)
h_w : Wind wave height on reservoir surface (m)
(example: $hw = 0.032 \times F \times V + 0.763 - 0.271 \times F^{1/4}$)
F : Fetch of reservoir (km)
V : Maximum observed wind velocity (km/hr)

In addition, it shall be confirmed that the inflow peak discharges of 50-year flood in case of H < 15 m and 200 year-flood in case of H $\geq$ 15 m shall be released safely within the freeboard. If the height of freeboard is not enough to fulfill these requirement, the following two alternatives shall be examined as countermeasure:

(a) Increasing height of freeboard
(b) Widening crest of spillway

(5) Dam crest elevation

Dam crest elevation shall be decided by the following equation:

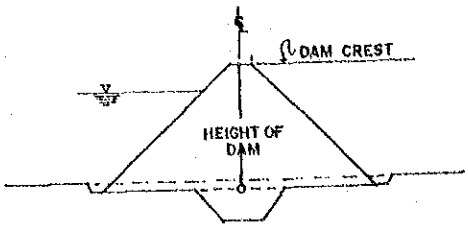
Dam crest elevation (DEL) = MWSE + H_f + (pavement thickness)

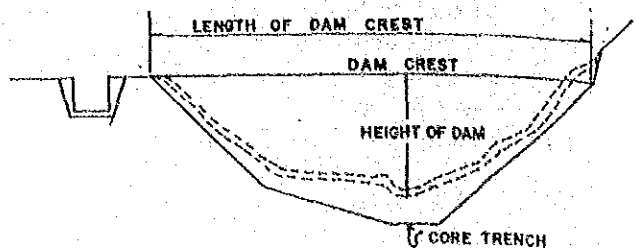
Dam crest should be protected against damages caused by drying, shrinkage, fissuring and other erosion. The minimum thickness of protection pavement is recommended at 20 cm.

(6) Dam height

Dam height is regarded as the maximum difference height between the dam crest elevation and the top of the dam foundation after stripping, not considering the excavation depth of core trench.

Thickness of stripping varies with subsurface condition of the proposed dam site. Generally the thickness to be stripped is 20 cm to 50 cm.





(7) Extra banking

Extra banking shall be considered against settlement of dam embankment. Thickness of extra banking shall be estimated at 1 to 2 % of dam height (except for weak foundation). In case of weak foundation, extra banking shall be decided through the settlement study.

(8) Width of dam crest

The width of dam crest shall be determined considering the minimum required width for construction and utilization as 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)

Existing Studies:

Freeboard is calculated by the following formula in the existing designs:

$$F_b = H_r + H_s$$

$$H_r = 1.5 \times H_w$$
$$H_w = 0.032 \times \sqrt{F \times V} + 0.763 - 0.271 \times F^{1/4}$$
$$H_s = (2 \text{ to } 5\%) \text{ of } H_d$$

where,

F_b : freeboard (m)
H_w : design wave height (m)
V : wind velocity (km/hr)
H_d : dam height (m)
H_r : wave run-up (m)
F : reservoir fetch (km)
H_s : embankment settlement (m)

The relation between dam height and freeboard in the existing designs is shown in Fig.E.4.1.

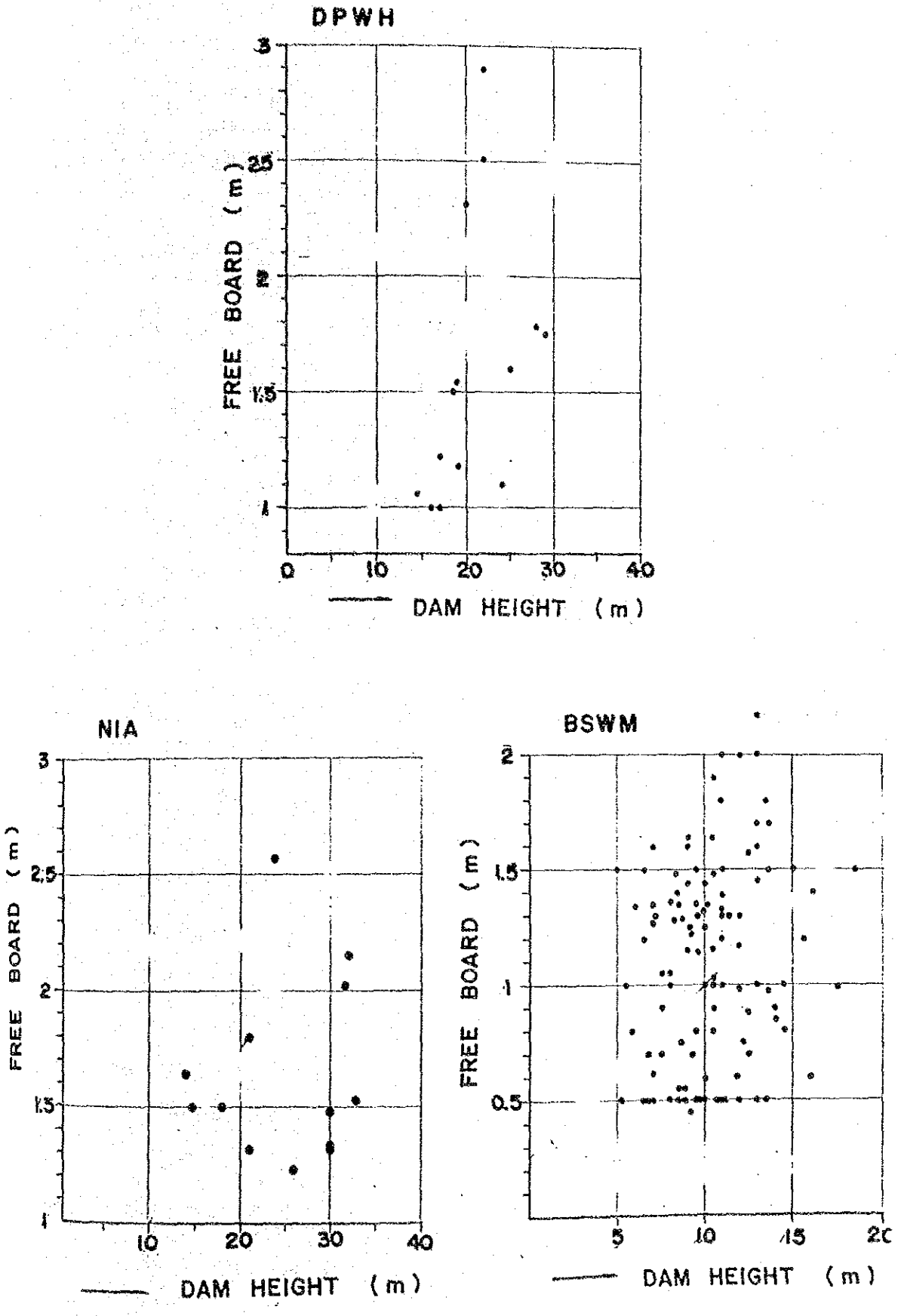


Fig.E.4.1 RELATION BETWEEN DAM HEIGHT AND FREEBOARD

The embankment settlement is determined as follows:

Item	DPWH	NIA	BSWM
Embankment settlement	$H_s=0.02H_d$	$H_s=0.01H_d$ ($H_d<30m$) $H_s=0.02H_d$ ($Hd\geq 30m$)	$H_s=(2$ to $5\%)H_d$

Note; H_s: embankment settlement, H_d: dam height

The width of dam crest is determined in the existing designs as follows:

DPWH : $W = 0.5x(5/3x\sqrt{H}+3.6H^{1/3}-3)$
NIA : $W = (H/5+10)+0.33$
BSWM : $W = 5/3x\sqrt{H}$

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

The relation between width of dam crest and dam height in the existing designs is shown in Fig.E.4.2. The widths of dam crest in the existing designs are compared with the recommended width as follows:

Dam Height	Recommended	DPWH	NIA	BSWM
10	5.0	5.01	4.0	5.3
20	7.0	7.11	4.7	7.5
30	9.0	8.65	5.3	9.1

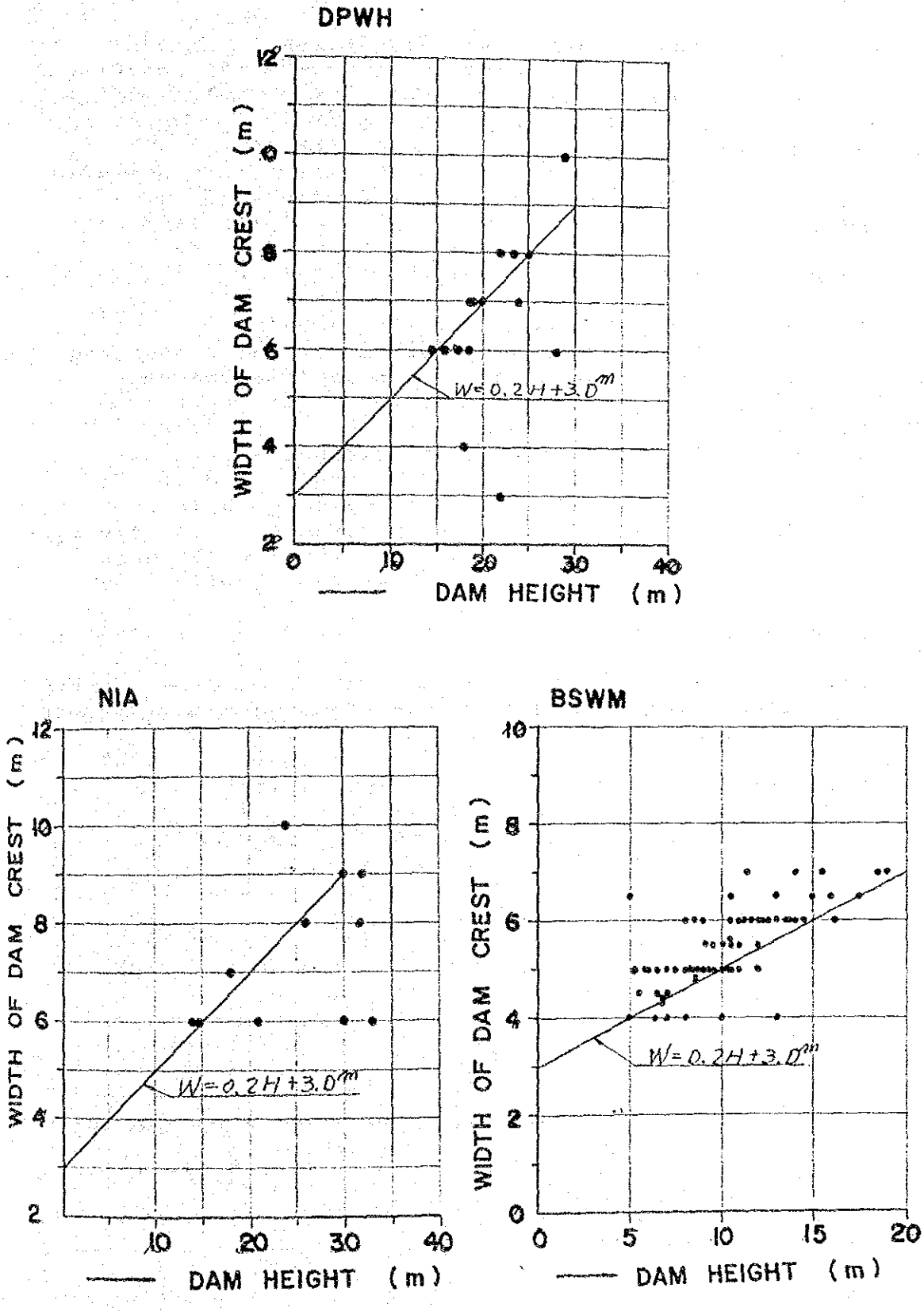


Fig.E.4.2 RELATION BETWEEN DAM HEIGHT AND WIDTH OF DAM CREST

4.3 Dam Foundation

4.3.1 Required Conditions of Dam Foundation

Dam foundation shall possess necessary water tightness and strength, and be sufficiently safe against sliding failure or seepage failure.

Explanation:

(1) Weak foundation

(a) A sufficient safety factor should be considered in design against sliding failure of the foundation when a dam is constructed on weak foundation such as saturated clay, silt and loose sand.

(b) Classification of weak foundation

- Dam height, H $\geq$ 15 m: N-value $\leq$ 20
- Dam height, H < 15 m: N-value $\leq$ 4 ;very weak
  N-value = 4-10 ;weak
  N-Value =10-20 ;medium

(2) Pervious foundation

(a) Reduction of seepage within tolerable limits and countermeasures for pore water pressure induced by seepage are necessary.

(b) Classification of pervious foundation

Coefficient of permeability is in the order of 10^{-4} cm/sec as following foundation:
- Porous rock foundation
- Cracky rock foundation
- Sand and gravel foundation

4.3.2 Foundation Treatment

Foundation treatment measure shall be studied on the following items:
(1) Reduction of seepage
(2) Bearing on dam stability
(3) Reduction of piping

Explanation:

(1) Foundation treatment measure is an important factor relating to dam construction cost of SWIM projects. Foundation treatment measure shall be studied in the feasibility study.

(2) Standard on design for tolerable limit seepage

Allowable daily seepage is commonly limited to about less than 0.05% of total reservoir capacity from the viewpoint of storage efficiency of the reservoir.

(3) Stability analysis against piping is done using the following equations:
- Critical hydraulic gradient equation
- Justin's equation

(4) Method of reduction of seepage

(a) For soil foundation;

Measures for reduction of seepage within tolerable limits mainly depend on the geological structure of the foundation. Conventional methods adopted for the various types of permeable foundation are as follows:
- cut-off trench works
- impervious blanket
- wide core, etc.

(b) For rock foundation;

Grouting method for joints, cracks and faults is useful generally.

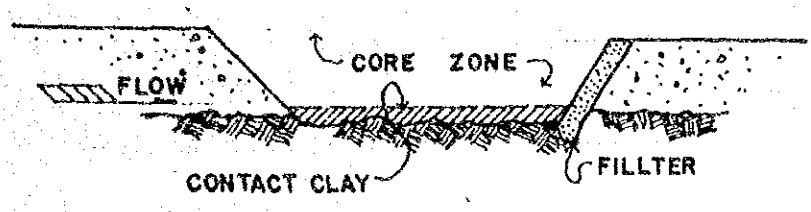
(5) Measures for reduction of piping

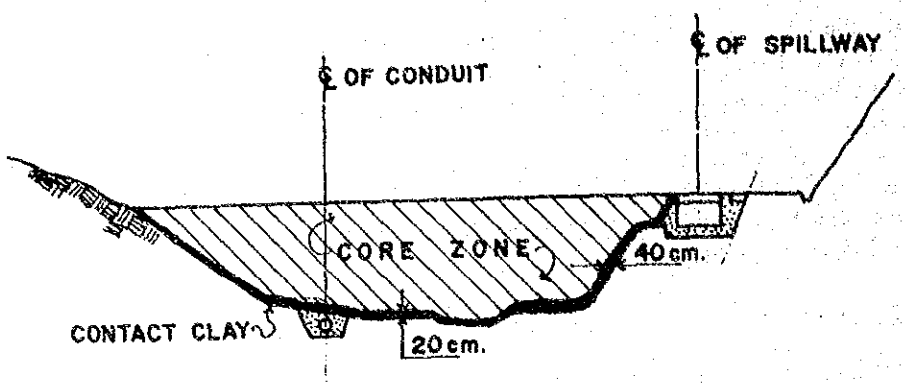
(a) Filter and drains

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

(b) Contact clay works

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





4.4 Design of Dam Embankment

4.4.1 General

Fill dam shall possess necessary water tightness and strength, and be sufficiently safe against sliding failure or seepage failure.

Explanation:

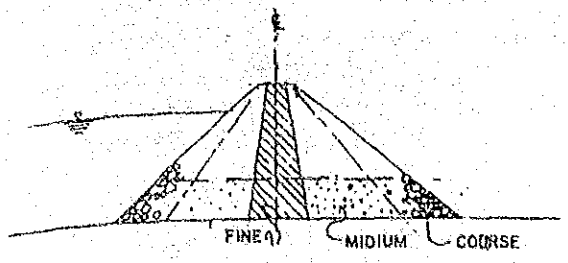
Fill dam has the advantage in utilization of almost all kinds of materials in the vicinity of the dam site. It shall be planned to use excavated materials from spillway, dam foundation, outlet works and borrow materials in the reservoir area, in order to minimize construction cost and increase reservoir capacity.

4.4.2 Zoning of Embankment

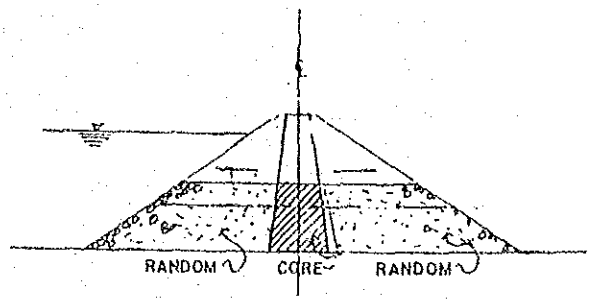
Zoning for fill dam shall be determined considering characteristics of embankment materials available at the site.

Explanation:

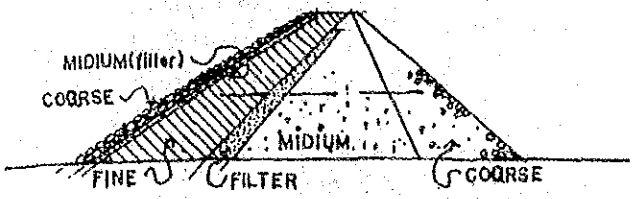
In order to determine zoning plan, characteristics of embankment materials available at the site shall be grasped. The zoning shall be done so as to avoid sudden change of characteristics of materials. In case of sudden change, transition zone such as filter shall be placed between of both zones.



Case I : Central Core (Rockfill) Type



Case II : Central Core (Earthfill) Type



Case III : Inclined Core Type

ZONING PATTERN

4.4.3 Design of Core Zone

Core zone shall possess necessary water tightness and necessary width.

Explanation:

(1) Width and permeability of core zone

Factors in determining the width of the core zone are as follows:

(a) Permeability coefficient of the core zone
(b) Physical and soil mechanical interrelationships with the adjacent zones
(c) Presence of filter
(d) Minimum width for compaction

Generally, permeability coefficient of the core materials shall be less than the order of 10^{-5} cm/sec. In order to ensure the stability of dam, it is recommended that the core width is at 30 to 50% of the water depth.

(2) Contact portion of core zone and bed rock

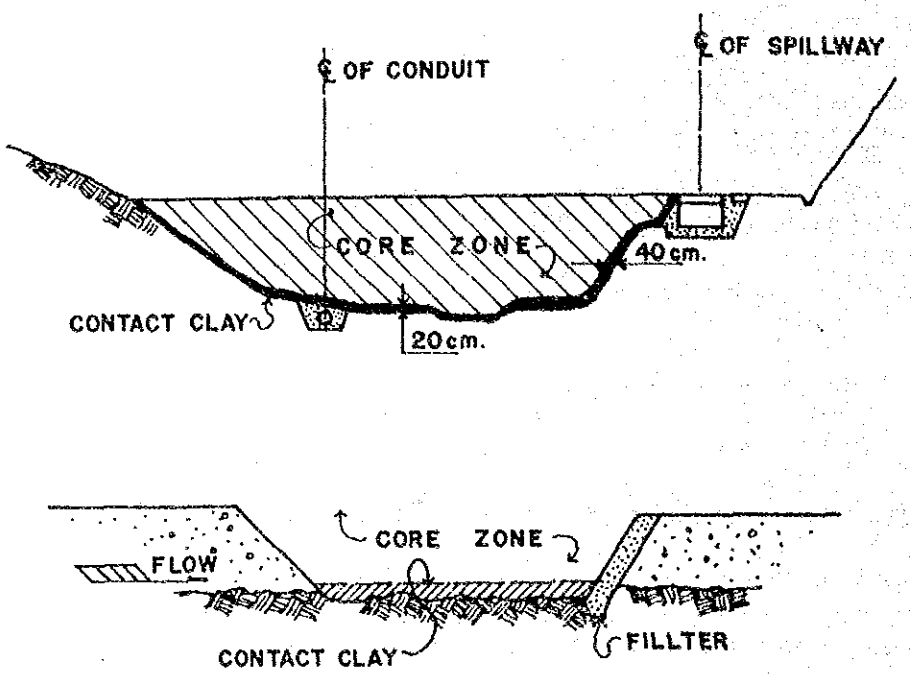
Contact clay shall be placed at the contact portion of core zone and bed rock or concrete face considering the following function:

(a) Adherence of the core zone to bed rock or concrete face
(b) Countermeasure for piping

(c) Absorption of shearing and deformation caused by settlement at both abutments

The materials of contact clay shall be wet-side CH soil. The contact clay shall be placed with the thickness of 20 cm on the base of cut-off and the width of 40 cm on both abutment sides.

The filter shall be provided at the downstream side of cut-off as shown below.



4.4.4 Design of Random Zone

Random zone shall possess necessary shearing strength and density in order to support core zone and to ensure the stability of embankment.

Explanation:

Soft rock, weathered rock and gravelly soils, etc. are preferable for random zone. Soft rocks such as mudstone, sand stone and shale are easily slaked. In case of use of such soft rocks, they shall be crashed or well weathered.

If the same machinery as that used for core zone can be adopted, it is recommendable even for a low dam to be of zoned type with random zone.

4.4.5 Design of Rock Zone

Rock zone shall be placed outside of transition or random zone.

Explanation:

Rock zone can be adopted only under the following condition:

(a) Excavated material is available from dam foundation and appurtenant structures

(b) Quarry is available at low cost from the reservoir area or nearby quarry site.

4.4.6 Filter and Drain

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

Explanation:

(1) Homogeneous type dam

Drains are installed to prevent the downstream slope of dam from spring water. In case that dam height is around 15 m, a toe drain or horizontal drain is installed. In case of dam height of around 25 m, horizontal drains covering the entire downstream base of dam are placed and vertical drains are provided near the center of the dam body. In the case that dam height is over 25 m, they serve for rapidly lowering the seepage line and dissipating the pore pressure during the construction.

(2) Zone type dam

Vertical drains or filter shall be provided outside of core zone or at zone boundaries where characteristics of materials in adjoining both zones are largely different.

Existing Studies:

DPWH/NIA : Filter materials are planned through gradation control of materials, considering the results of grain size analysis for impervious and pervious zones.

BSWM : There is no filter zone, because BSWM plans only homogeneous earthfill type dam. Toe drain is adopted after gradation control of materials.

4.4.7 Embankment Slopes and Berms

Embankment slopes and location of berms shall be determined to maximize the stability of dam and minimize the dam section.

Explanation:

(1) Embankment slope

(a) In case of dam height, H < 15 m;

In the feasibility stage, in case of stable foundation, embankment slopes can be determined from the following reference without conducting stability analysis:

Material Core Zone	Homogeneous US	Homogeneous DS	Zone Type-1 US	Zone Type-1 DS	Zone Type-2 US	Zone Type-2 DS
GC, GM	1:3.0	1:2.0	1:2.5	1:2.0	1:2.0	1:2.0
SC, SM	1:3.0	1:2.0	1:2.5	1:2.0	1:2.0	1:2.0
CL, ML	1:3.5	1:2.5	1:3.0	1:2.5	1:2.0	1:2.0
CH, MH	1:4.0	1:2.5	1:3.5	1:2.5	1:2.0	1:2.0

Note; US : upstream slope
DS : downstream slope
Zone Type-1 : wide core type
Zone Type-2 : narrow core type
Material of random zone and other zone: GW, GP, SW, SP
Reference : "Design of Small Dam", USBR

(b) In case of dam height, H $\geq$ 15 m

Embankment slopes shall be determined from the results of the stability analysis for dam embankment and foundation.

(2) Berm

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

4.4.8 Protection Works for Embankment

Embankment shall be protected against the erosion by waves and rainfall, etc.

Explanation:

(1) Upstream slope protection

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

(2) Downstream slope protection

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

4.5 Stability Analysis

4.5.1 Study Case of Sliding Failure

Dam body and foundation including contact plane between embankment and foundation shall have enough resistance against sliding.

Explanation:

(1) Study case and condition

Case	Water level in reservoir	Design seismic factor (%)	Safety factor
1	Empty (after construction)	0	Fs > 1.5
		50	Fs > 1.2
2	Normal full water level	0	Fs > 1.5
		100	Fs > 1.2
3	Rapid drawdown; lowest water level	0	Fs > 1.5
		50	Fs > 1.2

(a) Case 1: Pore pressure during the construction remains. Stress indication is total stress.

(b) Case 2: Seepage flows in steady condition at normal full water level. Stress indication is effective stress.

(c) Case 3: Water level suddenly drops from normal full water level to lowest water level, and pore pressure remains. Stress indications is effective stress.

(2) Stability analysis

The "Slip Circle Method" is one of the stability analysis to determine the safety factor represented by the ratio of the sum of sliding moment to the sum of resistance moment. The calculation is executed in relation to the center of slip circle for each slice.

(a) For total stress analysis; using parameters (c,ϕ) for case 1:

$$Fs = \frac{\Sigma\{cxl + (N-Ne)\tan\phi\}}{\Sigma(T+Te)}$$

(b) For effective stress analysis; using parameters (c',ϕ') for case 1, 2 and 3:

$$Fs = \frac{\Sigma\{c'xl + (N-U-Ne)\tan\phi'\}}{\Sigma(T+Te)}$$

where,

Fs	:	Safety factor
c,c'	:	Cohesion of material on sliding surface of each slice c : for total stress analysis c' : for effective stress analysis
ϕ,ϕ'	:	Angle of shear resistance of material on a sliding surface of each slice ϕ : for total stress analysis ϕ' : for effective stress analysis
l	:	Length of a sliding surface of each slide
N	:	Normal load acting on sliding surface of each slice
T	:	Tangential load acting on sliding surface of each slice
Te	:	Tangential seismic load acting on sliding surface of each slice
Ne	:	Normal seismic load acting on sliding surface of each slice
U	:	Pore pressure acting on sliding surface of each slice (Resultant of the pore water pressure due to seepage)

With regard to the dam to be constructed on soft foundation and slakable surface foundation, study on a safety factor is necessary for sliding moment acting through the foundation and along the contact plane respectively.

(3) Seismic coefficient

Design seismic coefficient shall be determined in accordance with the location and foundation of dam. Data of earthquake for the dam site can be collected from PAGASA.

Seismic zone in the Philippines is shown on Fig.E.4.3. Seismic coefficient varies depending on the geological structures of the site, for instance, seismic force in soil ground is expected to be intensified compared with the rock ground.

The following seismic coefficient is recommended for the SWIM projects.

Zone	for SWIM projects	in Japan*
Strong seismic zone :	Kh $\geq$ 0.15	Kh = 0.15
Medium seismic zone :	Kh $\geq$ 0.12	Kh = 0.12 - 0.15
Weak seismic zone :	Kh $\geq$ 0.05	Kh = 0.10 - 0.12

Note; *: referred to the "Design Criteria for Dam of Planning and Design Criteria for Land Improvement Projects", 1981, the Ministry of Agriculture, Forestry and Fisheries, Japan.

Existing Studies:

Stability analysis of dam body by means of sliding surface method is made only in the NIA projects. DPWH makes stability analysis in the detailed design stage and BSWM conducts that just before construction. The safety factors applied by each agency are summarized below.

Item	DPWH	NIA	BSWM
Safety factor	1.1 - 1.5	1.2 - 1.5	12% of dam height

The seismic coefficients recommended in the previous feasibility reports are shown in Fig.E.4.4.

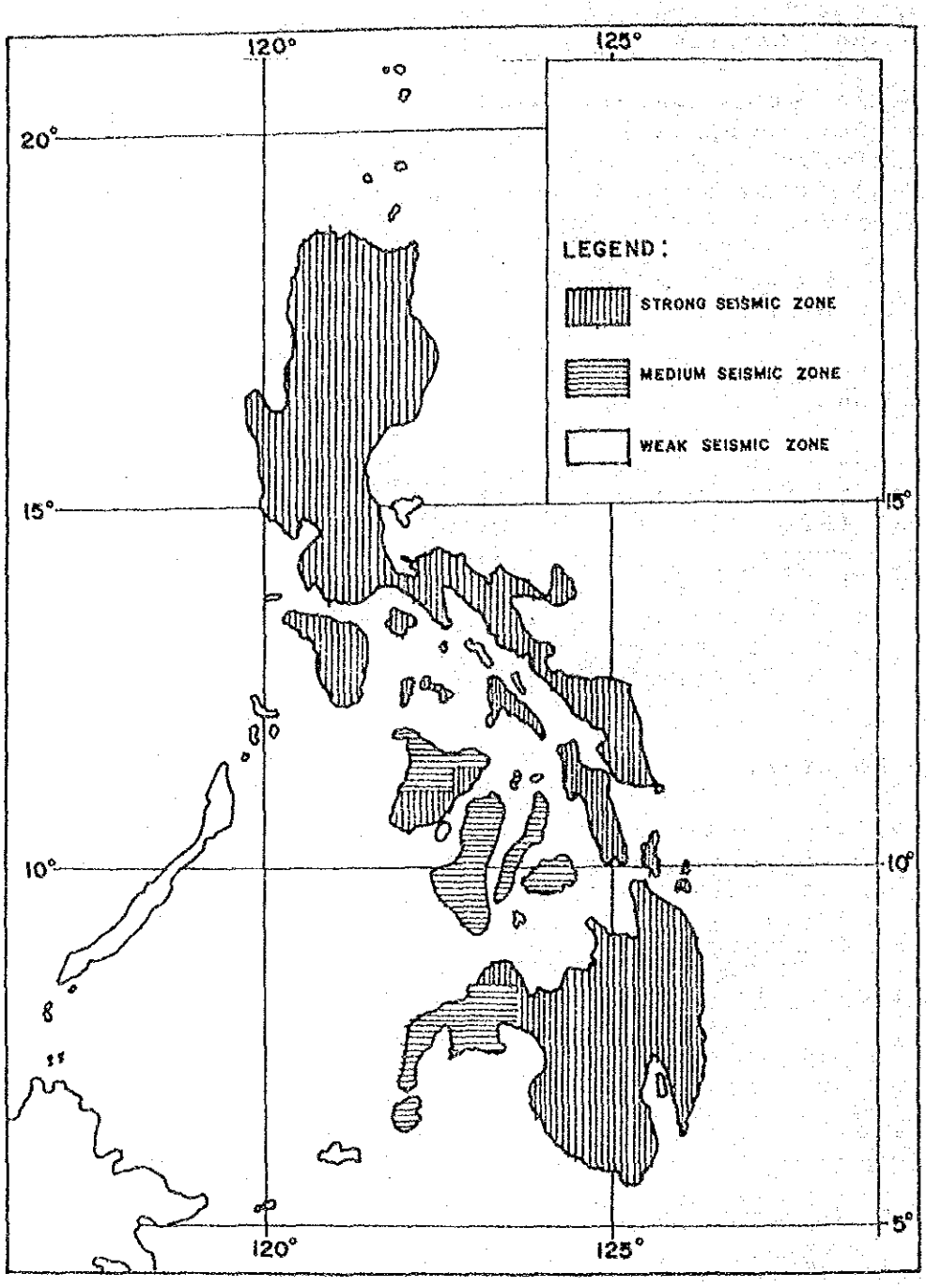


Fig.E.4.3 Seismic Zone of the Philippines by DPWH & ASEP (1968)

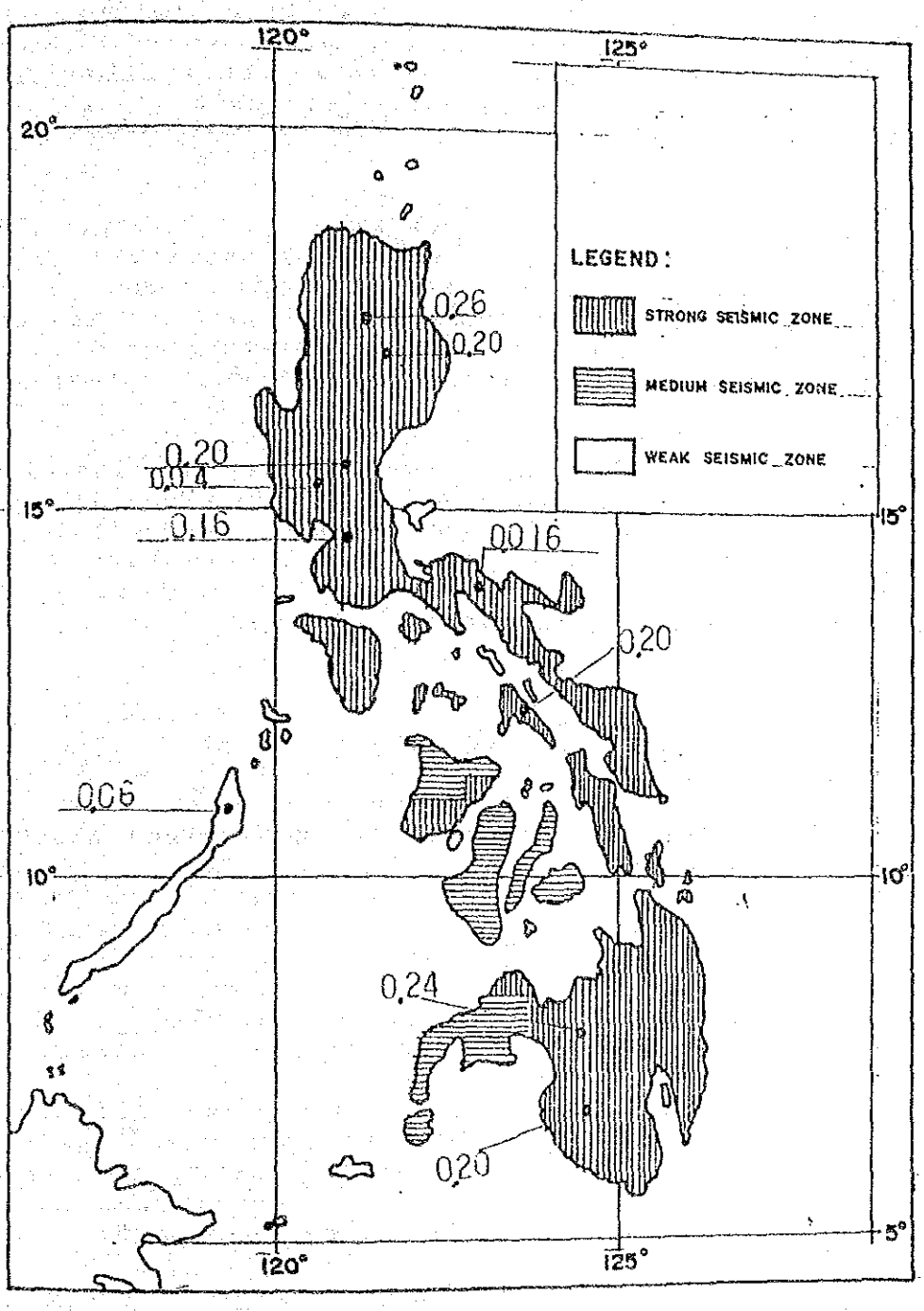


Fig.E.4.4 Seismic Coefficients of SWIM Existing Studies

4.6 Spillway

4.6.1 General

Spillway shall be designed so as to release surplus water or design flood discharge without giving any damage to reservoir, dam and its appurtenant structures including spillway itself. Spillway shall be of ungated type.

Explanation:

Earthfill or rockfill dams are easily destroyed by topping of water over the dam crest, which causes flood damages to downstream area. Therefore, spillway must have enough capacity to release the design flood discharge and its function shall be simplified by adopting an ungated type to avoid disaster caused by mis-operation of gate.

In addition, an emergency spillway may be installed for securing the safety of dam against unforeseen flood if it can be constructed considering the topographic condition. Since definite criteria for emergency spillway have not been established, installation of emergency spillway is determined based on the particular conditions of each dam.

4.6.2 Design Discharge

Design discharge for spillway shall be determined through the flood routing analysis.

Explanation:

Design discharge shall be determined through the flood routing analysis by applying different inflow according to the dam scale as follows:

In case of dam height, $H < 15$ m;

Peak out-flow estimated through flood routing analysis at the design flood magnitude of at least 25-year.

In case of dam height, $H \geq 15$ m;

Peak out-flow estimated through flood routing analysis at the design flood scale of 100-year.

After determination of the design discharge, it shall be confirmed that the following discharge can be released from spillway within the freeboard, considering the function of emergency spillway if installed:

In case of dam height, H < 15 m;

Peak in-flow at the design flood magnitude of at least 50-year flood.

In case of dam height, H ≧ 15 m;

Peak in-flow at the design flood magnitude of at least 200-year flood.

Existing Studies:

In general, adopted return periods on design flood discharge are 100 years for DPWH and NIA, 25 years for BSWM. There are some exceptions as shown below.

Return Period(years)	DPWH	NIA	BSWM
50	-	-	1
300	-	1	-
500	1	1	-
1,000	-	1	-

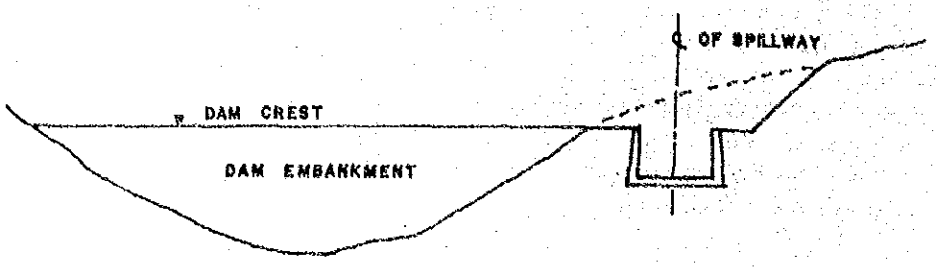
4.6.3 Alignment of Spillway

Alignment and location of spillway shall be determined considering the following points:
(1) To be short length and straight centerline.
(2) To be located apart from dam embankment.
(3) To be located on sound foundation.

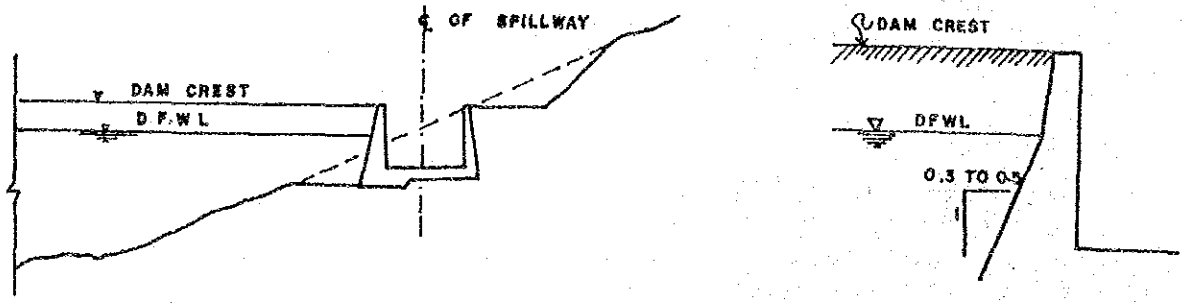
Explanation:

(1) Centerline of spillway is recommended to be short and straight from the viewpoint of hydraulic condition. In case that some curve settings are required to avoid a great deal of excavation volume, such curve settings shall be limited in subcritical flow portion.

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



In case that the wall of spillway directly contact 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 as illustrated below.



(3) Spillway shall be constructed on the sound foundation against settlement, seepage and vibration. Especially, inlet portion and energy dissipator portion shall be located on the hard foundation. Required bearing capacity of foundation is as follows:

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

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

4.6.4 Selection of Spillway Type

Spillway is generally composed of inlet portion, guide portion and energy dissipator portion. The types for each portion shall be selected considering the scale of spillway, topographic and geological conditions, easiness of construction and operation and maintenance.

Explanation:

(1) Selection of type

The following types are recommended for each portion:

(a)	Inlet portion	: straight crest type, curved crest type, side spillway type
(b)	Guide portion	: chute type
(c)	Energy dissipator portion	: hydraulic jump type (type II or type III), ski-jump type

(2) Inlet portion

Inlet portion consisting of approach channel and non-gated weir shall be designed considering the followings:

(a) Height of weir

Appropriate height of weir is necessary from the sill of approach channel and crest elevation of weir shall correspond to the normal full water level.

(b) Length of weir

Length of weir shall be determined through the alternative study between increasing the dam height and widening the weir length, considering the topographic condition.

(3) Guide portion

Guide portion is composed of subcritical and supercritical flow section. The following shapes are recommended for each section:
- Subcritical flow section : rectangular or trapezoidal
- Supercritical flow section: rectangular

(4) Energy dissipator portion including link canal to existing downstream river.

The followings shall be considered in design of energy dissipator.

(a) Energy dissipator shall be straight and have uniform rectangular section.

(b) Inflow velocity shall be uniform.

(c) Water surface after energy dissipator and/or link canal should be lower than that of downstream river.

Existing Studies:

Each portion of spillway is designed as follows:

Item	DPWH	NIA	BSWM
Type	-Chute	-Chute -Side channel	-Chute
Inlet portion	-Trapezoidal section with masonry	-Trapezoidal section with masonry	-Trapezoidal section with masonry
Overflow weir	-Ogee section	-Ogee section	-Without weir
Supercritical flow portion	-Rectangular section with concrete	-Rectangular section with concrete	-Rectangular section with concrete
Energy dissipator	-Hydraulic jump type -Ski-jump type	-Hydraulic jump type -Ski-jump type	-Hydraulic jump type -Ski-jump type

4.6.5 Hydraulics

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

Inlet portion:	Straight/curved crest type	-Overflow discharge formula
	Side spillway type	-Overflow discharge formula and equation of motion
Guide portion:	Chute type	-Bernoulli's formula
Energy dissipator portion	: Hydraulic jump type	-Hydraulic jump formula

Explanation:

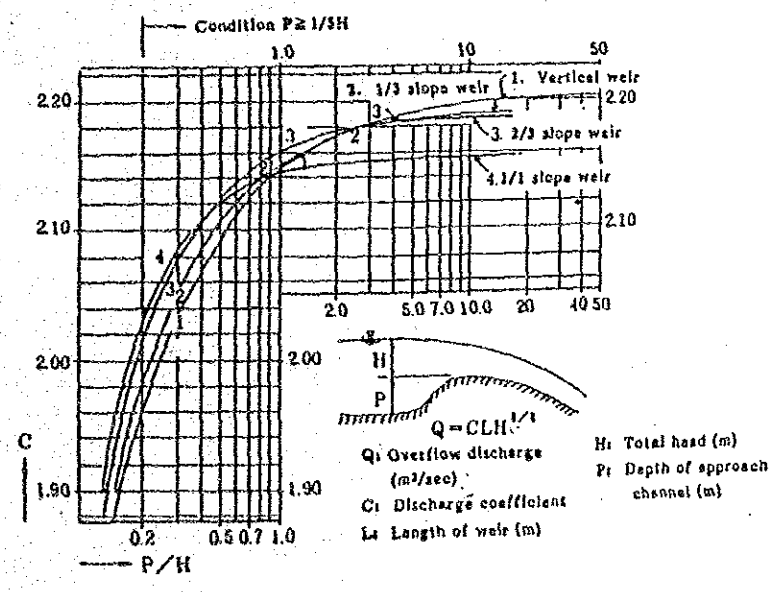
(1) Overflow discharge formula

Complete overflow shall be realized at the weir of the inlet portion. The following discharge formula shall be adopted:

$$Q = CxLxH^{3/2}$$

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

The example of coefficient is as follows:



(2) Freeboard

Freeboard to be add on water surface of each portion is recommended as follows:

(a) Subcritical flow section

- more than velocity head

(b) Supercritical flow section

$$Fb = 0.6 + 0.037 \times V \times d^{1/3}$$

where, Fb : freeboard (m)
V : flow velocity (m/sec)
d : water depth (m)

(c) Energy dissipator portion

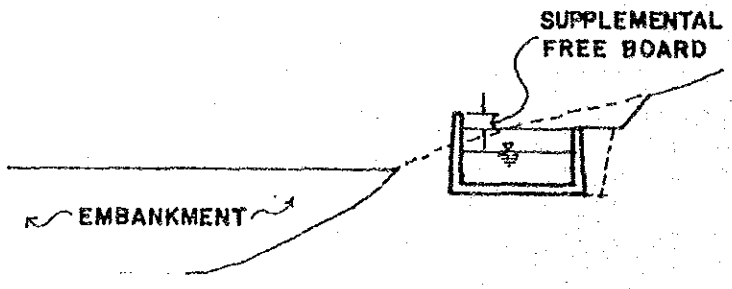
$$Fb = 0.1 \times (V + d)$$

where, Fb : freeboard (m)
V : flow velocity of entrance (m/sec)
d : water depth in basin (m)

(d) Clearance to bridge

In case of design overflow depth, H $\geq$ 2.5 m; Hf $\geq$ 1.5 m
In case of design overflow depth, H $<$ 2.5 m; Hf $\geq$ 1.0 m

Note: If water surface is higher than the surface of the downstream slope of dam embankment, supplemental freeboard shall be considered as illustrated below.



Existing Studies:

The following discharge formula is generally adopted:

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

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

Discharge coefficient adopted by each agency is as follows:

DPWH : 1.7 - 2.2
NIA : 1.7 - 2.1
BSWM : 1.7

4.6.6 Structure

Structure shall have enough stability against buoyancy overturning, sliding and bearing capacity. Furthermore, for the safety of structure, lining of channel and necessary drains shall be considered.

Explanation:

(1) Stability

In case of concrete channel, a flume type is generally recommended, but if channel width is too wide compared with channel height, a retaining wall type is recommended.

When a side wall of channel is designed as a retaining wall type, the following conditions shall be satisfied:

- Stability against overturning;

Normal load ; $e \leq B/6$
Seismic load ; $e \leq B/3$
where, e : eccentrical distance
B : foundation width of retaining wall

- Stability against sliding;

Safety factor in normal condition : $F \geq 1.5$
Safety factor in earthquake : $F \geq 1.2$

(2) Lining

Each portion of spillway shall be lined with the following materials:

(a) Inlet portion
- Approach channel : concrete or wet masonry
- weir section : concrete

(b) Guide portion
- subcritical section : concrete or wet masonry
- supercritical section: concrete

(c) Energy dissipator : concrete

(d) Link canal : concrete or wet/dry masonry

(3) Drains

In the downstream portion of the center of dam, underdrains shall be provided as required behind of the side wall and under the base. Drained water shall be conveyed and discharged safely.

Furthermore, it is recommended to provide the drainage ditch along the spillway to prevent infiltration of rain water behind of the side wall.

4.7 Outlet Works

4.7.1 General

Outlet works shall have necessary function to intake/release any discharge ranging from the maximum design discharge and the minimum design discharge without giving structural damages to the dam and reservoir.

Explanation:

Design discharge of outlet works shall be determined based on the design discharge required for the following purposes:

(a) Irrigation
(b) Mini-hydropower
(c) Water supply
(d) Service discharge; for existing water rights or maintenance flow
(e) Diversion of flood during construction
(f) Emergency release

4.7.2 Layout of Outlet Works

Outlet works shall be composed of the following portions:
(1) Intake portion
(2) Conduit portion
(3) Control portion

Explanation:

(1) 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.

Intake tower or inclined intake structure is favorably adopted to dams of which the available water depth is high or the control of discharge is necessary.

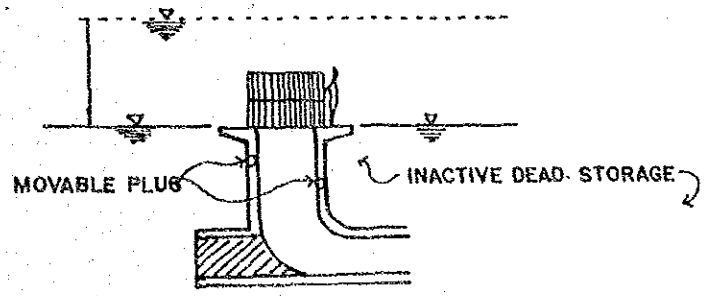
Intake portion shall be designed taking into consideration the following items:

(a) Intake portion shall be located outside of the toe of dam embankment.

(b) The sill of intake portion shall be located at equal or lower than the minimum water elevation (MWE).

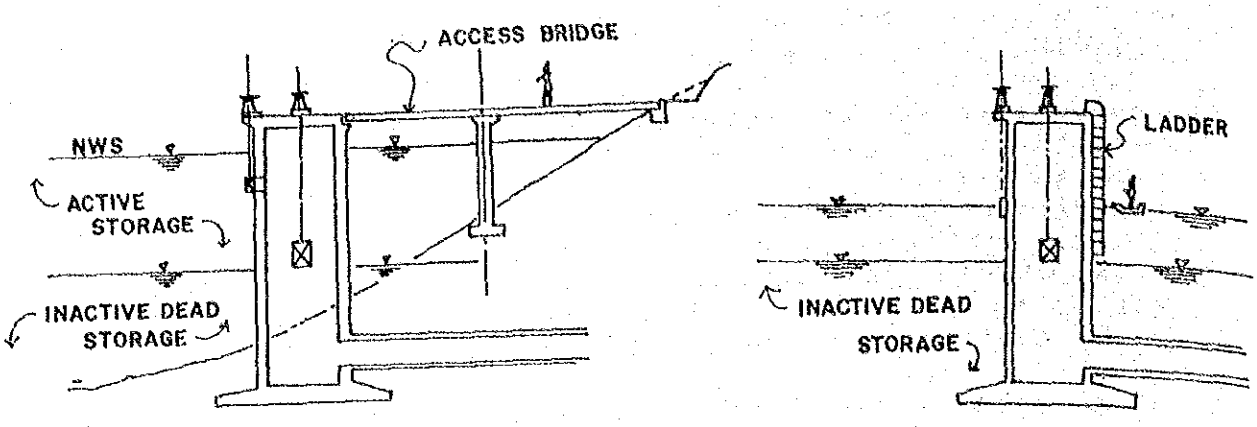
(c) Trashrack shall be installed.

(d) It is recommended that simple facilities for getting water from the inactive or dead storage zone be installed in case of an emergency like extraordinary drought.



(e) Inclined intake structure shall be located on stable foundation.

(f) Intake tower shall have the facility to go to tower deck such as access bridge or ladder as illustrated below.



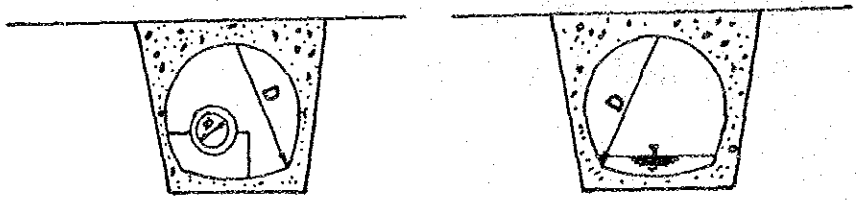
Note: Pier for access bridge is recommended to be installed on stable natural ground foundation.

(2) Conduit portion

(a) The conduit of diversion works shall be used as that of outlet works after construction.
The use of conduit varies according to the conduit size (D) for diversion and the calculated conduit size (ϕ) for outlet works as illustrated below.

in case of $D \geq \phi$

(TYPE A)



PRESSURE FLOW FREE FLOW

in case of $D \leq \phi$

(TYPE B)

PRESSURE FLOW

Type A is recommendable in case of high water pressure.

(b) The conduit shall be constructed on stable foundation.

(c) The shape of conduit is recommended to be circular since circular section is structurally stable against high inner/outer pressure.

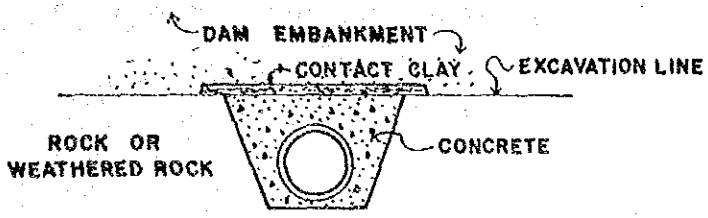
(d) The conduit shall be lined with the following materials especially in case of Type B.

- For zoned earthfill type dam;
  Portion before core zone; concrete
  Portion from core zone; steel

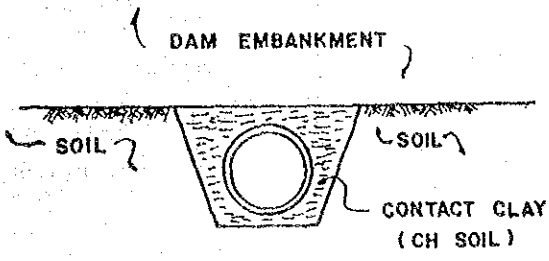
- For homogeneous earthfill type dam; steel

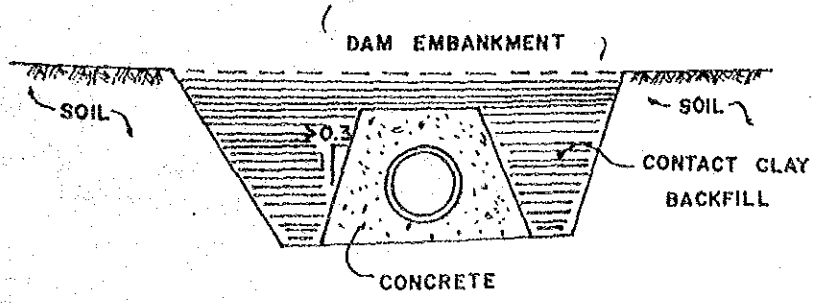
(e) The backfill materials of the conduit shall be concrete or contact clay (CH soil) as follows:

- In case of rock or weathered rock foundation:



- In case of soil foundation:





(3) Control portion

(a) Control portion shall be located outside of toe of the dam embankment.

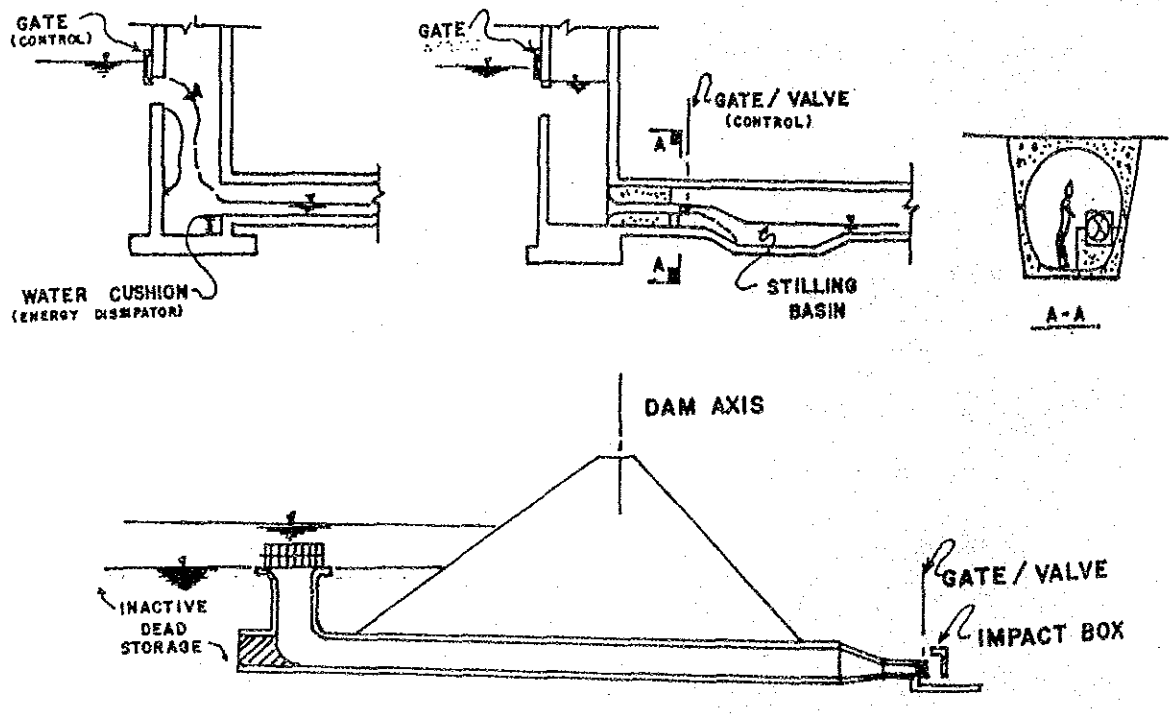
(b) Some sets of control gate/valve shall be installed in order to allow releasing the wide range of discharge. Each set must have main and sub-gate/valve for its maintenance or replacement.

(c) Location of gate/valve at the control portion shall be determined taking the following into consideration;
- Accessibility to gate/valve
- Sufficient space for constructing energy dissipator against jet flow just after gate/valve
- Utilization of water, etc.

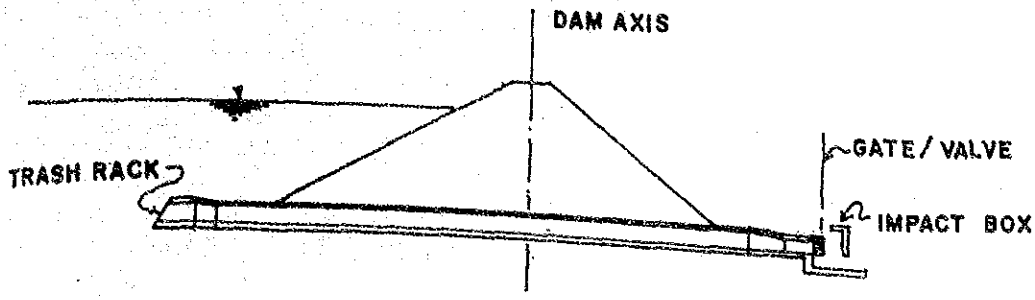
(c) Energy dissipator shall be designed just after the gate/valve to convey water smoothly into main canal.

(d) Water measurement facility shall be installed after the controlling portion to measure the released discharge.

For reference, some illustrations for recommendable control section are presented.



OPERATION IN UPSTREAM SIDE



OPERATION IN DOWNSTREAM SIDE

Control section may be installed on the conduit way if no adverse effect to the dam body is expected.

Existing Studies:

Items	DPWH	NIA	BSWM
Type of Intake	-Drop inlet	-Drop inlet	-Drop inlet
Screen	-Equipped	-Equipped	-Equipped
Conduit pipe	-Concrete	-Concrete	-Steel
Control site	-At outlet	-At outlet	-At outlet
Control mechanism	Operation of gate/valve by manual		
Energy dissipator	-Impact box	-Impact box	-Impact box

4.7.3 Hydraulics

Scales of intake, conduit and control portions shall be properly determined by hydraulic calculation using the authorized method like Bernoulli's formula.

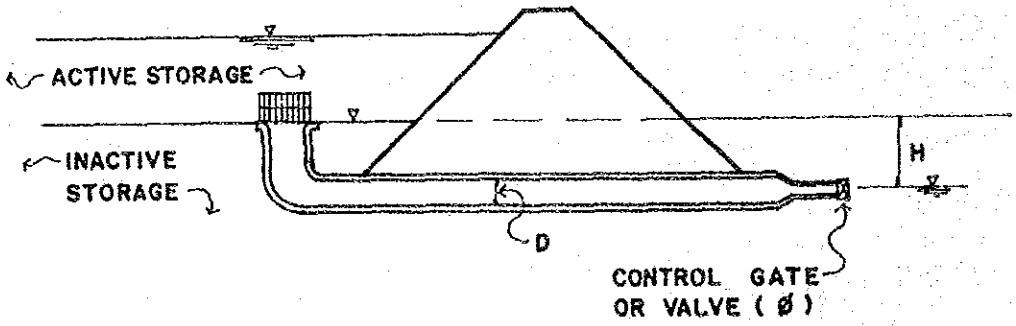
Explanation:

(1) Equation (sample)

$$H = h_t + h_e + h_b + h_f + h_e + h_g + h_v$$

where,

H : total head between the low water level and center of control gate/valve
h_t : screen loss
h_e : entrance loss
h_b : bend loss
h_f : friction loss
h_e : contraction loss
h_g : gate or valve loss
h_v : velocity head (exit loss) at the outlet



(2) Procedures for decision of facility scale

(a) Firstly, by assuming the diameter (D) of conduit, necessary diameter (ϕ) of control gate or value is calculated.

(b) Facility costs of some alternative combinations are estimated.

(c) Finally, the most economical combination is selected.

4.7.4 Structure

Each portion of outlet works shall have enough stability against any expected load condition.

Explanation:

(1) Intake portion

(a) Intake structure must have sufficient dead weight against buoyancy.

(b) Intake structure must be stable against overturning and sliding.

(c) Foundation of intake structure shall have enough bearing capacity against load of structure.

(2) Conduit portion

(a) Conduit pipe installed in dam foundation shall have enough strength against load due to dam embankment and internal water pressure. The structural analysis shall be made at cross section and longitudinal section to the axis of conduit.

(b) Leakage and piping along the conduit shall be avoided.

(3) Control portion

(a) The same consideration as intake portion shall be made.

4.8 Diversion Works during Construction

4.8.1 Design Diversion Flood

Design diversion flood shall be determined based on the characteristics of streamflow; discharge and frequency of flood, and construction period.

Explanation:

Magnitude of design diversion flood shall be determined on the basis of construction period as follows:

Construction period*	Design diversion flood**
one dry season or one relative dry season	- 5 to 10-year flood during construction period
1 year - 2 year	- 5 to 10-year flood

Note; *: Construction period for river portion of dam embankment

**: Magnitude of design diversion flood shall be determined taking into account the extent of damages to the downstream area, damages to embankment and delay of construction.

4.8.2 Diversion methods

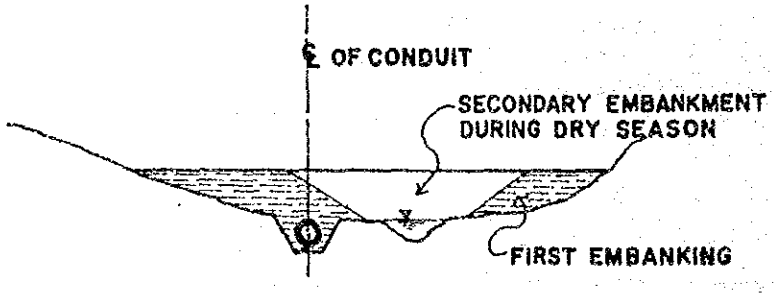
Diversion during dam construction shall be made by economical methods considering the embankment procedure.

Explanation:

Typical diversion methods are classified as follows:

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

Tunnel type shall be avoided from viewpoint of construction cost in the SWIM projects. The conduit installed for the outlet works shall be mainly used in parallel with the natural open channel as illustrated below.



4.8.3 Size of Conduit

Size of conduit shall be determined based on the design diversion flood and required design discharge for the purpose of the project, such as irrigation, mini-hydropower and water supply.

Explanation:

(1) Hydraulic conditions and determination of conduit size

The required size of conduit shall be calculated under the free-flow condition based on the design diversion flood. The calculated size may be larger than the required size for releasing the design discharge for irrigation, mini-hydropower and water supply.

(2) Sill of conduit

Sill elevation of conduit shall be determined based on the design hydraulic gradient, low water level and various conditions during construction.

(3) Cofferdam

Crest elevation of cofferdam shall be determined based on the design water level for diversion works and appropriate height of freeboard.

4.9 O&M Facilities

Dam and its appurtenant structure shall be equipped with necessary facilities for operation and maintenance to efficiently use storage water for long term.

Explanation:

The following facilities shall be provided:

Object	Facility	Location (quantity)	Remarks
Dam safety	bench mark	near the dam (2 pieces)	at undisturbed place
	concrete pegs	dam crest (install with 20 meters interval)	to find settlement of dam embankment

	measuring device for leakage	just after drain zone in embank-ment (one set)	to measure leakage through dam
Effective use of water	gauging staff	in the reser-voir near dam (one set)	to knoe water level
	discharge measuring device	just after control portion of outlet works	to release water efficie-ntly

Note: Bench marks are used not only for levelling the dam crest but also for levelling the sills of every appurtenant structures.

4.10 Preparation of Drawings

Necessary drawings shall be prepared and incorporated in the feasibility report.

Explanation :

The following drawings shall be prepared:

Items	Drawings	Remarks
General	general plan	with dimension of every facilities including reservoir
Dam	typical section and profile	showing geology, foundation treatment
Spillway	plan and profile	with structural section
Outlet	plan and profile	with structural section

5 GUIDELINE FOR OPERATION AND MAINTENANCE (O&M) OF MAJOR STRUCTURES (Dam and Its Appurtenant Structures)

5.1 Purpose and Application of the Guideline

This guideline deals with O&M work for only earthfill type dam and its appurtenant structures of SWIM projects, and shall be used for preparing general concept of O&M works for the dam in the feasibility stage.

Explanation:

This guideline presents a basic concept of O&M works for only earthfill type dam body, outlet works, spillway and reservoir of the SWIM projects. In the feasibility stage, general concept of O&M for the project shall be examined with emphasis on organizational set-up and responsibilities on O&M works.

For preparation of O&M manual of the individual SWIM projects, this guideline shall be further developed incorporating the O&M procedure of the other water utilization facilities and specific conditions of each SWIM project.

5.2 Organization for O&M

Organization for O&M shall consist of implementing agency, regional office (or provincial office, district office, etc.) of implementing agency, and farmers' association.

Explanation:

(1) If the dam and its appurtenant structures are turned over to farmers' association after initial ponding, the farmers' association shall take responsibilities on O&M work of the dam and appurtenant structures after turn-over. If the dam and its appurtenant structures are not turned over to any association, the implementing agency or its regional office (or provincial office, district office, etc.) shall take all responsibilities on O&M work of the dam and its appurtenant structures.

(2) Even if the dam and its appurtenant structures are turned over to farmers' association, the O&M work on items 5.3.3, 5.3.5 and 5.3.6 shall be done by the implementing agency or regional office (or provincial office, district office, etc.) of the implementing agency.

5.3 Operation and Maintenance

5.3.1 Documents and Data to be Filed

O&M body responsible for operation and maintenance of dam and its appurtenant structures shall keep the documents relevant to properties and water rights and other agreements on O&M, and other O&M data.

Explanation:

The following data relating to O&M work shall be prepared and/or filed:

(1) Reports and drawings prepared in planning, detailed design and construction stages

(2) Records of regular inspection and measurement

(3) Records of significant repair and rehabilitation works

(4) Ledger of O&M organization

5.3.2 Division of O&M Period

O&M period shall be divided into three stages considering the characteristics of dam behavior, and the measurement and periodical inspection shall be scheduled for each period as mentioned below.

Explanation:

(1) First Stage : from the beginning of the initial ponding to the initial full storage

(2) Second Stage: from the end of initial full storage to the steady condition of dam behavior

(3) Third Stage : afterwards the second stage

5.3.3 Initial Ponding

Initial ponding shall be done by the full responsibility of the implementing agency. The initial ponding of the reservoir shall be commenced based on the adequate ponding plan after confirming that all necessary construction works are completed prior to the actual ponding.

Explanation:

A ponding plan shall be set up considering dam safety, countermeasures for spillwater during flood, treatment for submersible objects, river condition, etc.

Prior to initial ponding, it is essential to confirm the safety of ponding. Especially, it must be confirmed that the following facilities or work are completed and/or sufficiently functioned:

(1) Dam body
(2) Maintenance facilities
(3) Relocation roads
(4) Land compensation in the reservoir area
(5) Safety measures against for land slide around the reservoir
(6) Safety measures against for back water to the upstream area

5.3.4 Measurement

Necessary measurement shall be made by the O&M body in order to confirm the stability of dam behaviors and conditions.

Explanation:

The measurement on leakage, deformation and seepage line shall be made as follows:

Monitoring	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

Note : The measurement on seepage line shall be made only for homogeneous type dam.

5.3.5 Inspection

Regular and temporary inspection shall be done by the implementing agency even after turn-over of the project to farmers' association, in order to observe the conditions of the dam and its appurtenant structures.

Explanation:

The regular inspection on dam body, its appurtenant structures and ground surface around abutments shall be done as follows:

Items to be Inspected		1st Stage	2nd Stage	3rd Stage
Dam body	- leakage - slope	once/week	once/2 months	3 times/year
Outlet Works & Spillway	- leakage - scouring - deformation - damage - obstructions - others	once/week	once/2 months	3 times/year
Ground Surface Around Abutments	- leakage - crack - land slide	once/week	once/2 months	3 times/year

5.3.6 Detailed Investigation

If significant problems are found through measurement and inspection on the dam and its appurtenant structures, detailed investigation shall be conducted to clarify its cause by the implementing agency.

Explanation:

(1) Leakage : In case that continuous increase of leakage through dam body is observed even after 2nd stage or leakage is found around the outlet work, urgent countermeasures to prevent it shall be required.

(2) Seepage Line: In case that spring water is observed on the downstream slope, it shall be required to research its cause and to take a necessary action to ensure dam safety.

(3) Settlement : The graph showing annual settlement of dam body shall be prepared. Based on the record, it shall be examined whether its settlement is caused by creep or sliding of dam foundation. If required, counterweghting or extra embanking for dam body shall be made.

5.3.7 Maintenance

Maintenance work shall include minor repairing works clarified by the detailed investigation and other necessary regular maintenance works. Major repair and rehabilitation works shall be executed through discussion between the O&M body and the implementing agency.

Explanation:

The check items during maintenance work are categorized as follows:

(1) Daily Patrol : - removal of floating obstacles around the gates
- pollution of water
- function of discharging irrigation water, etc.

(2) Emergency Patrol: - removal of floating logs around the spillway
- rise of water level
- confirmation of function of gates

(3) Maintenance : - mowing of dam slope and its surroundings; 3 times/year
- painting of mechanical equipment; 1 time/year
- dredging of settling basin; 3 times/year
- repair of gully and undulation of crest of dam; 3 times/year

5.3.8 Operation

Appropriate and safe operation shall be made for intake of water and discharge of flood based on operation manual to be prepared.

Explanation:

For the appropriate and safe operation for intake of water

and discharge of flood, preparation of operation plan is indispensable. The operation plan shall be prepared annually based on the actual water demand and expected water resource which be analyzed based on the past hydrological data. The operation plan shall include the followings:

(1) Organization and responsibilities on operation of gate

(2) Water demand; irrigation, mini-hydropower, etc.

(3) Available water resources

(4) Operation schedule for discharging required water

(5) Operation rule for emergency case

5.4 The Articles of Farmers' Association

The beneficiaries shall organize the farmers' association, and the association shall prepare the articles of the association under the guidance of the implementing agency.

Explanation:

The articles of the association shall include the following items (Form of the articles is shown in REFERENCE 1.):

(1) Name, address and purpose of the association

(2) Membership

(3) Rights and duties of members

(4) Termination and suspension of membership

(5) Membership fees and dues

(6) Membership meeting

(7) Board of director and committee

(8) Officers of the association

(9) Education and training committee

(10) Finance and development committee

(11) Operation and maintenance committee

(12) Dissolution and liquidation

(13) Other rules and regulations

(14) Use and disposition of association funds

(15) Miscellaneous provisions

(16) Amendments

5.5 Share of O&M Cost

The implementing agency and farmers' association shall discuss and settle the share of O&M cost before official turn-over of the project.

Explanation:

All the O&M cost of dam and its appurtenant structures shall be shouldered by the implementing agency and farmers' association. The annual O&M cost shall be estimated based on the responsible works by the implementing agency and farmers' association, categorizing as follows:

(1) Cost spent by the implementing agency
(2) Cost spent by farmers' association
(3) Total cost

Share of total O&M cost to association shall be examined and determined considering capacity to pay of the beneficiaries.

5.6 Collection of O&M Cost

The implementing agency and farmers' association shall discuss and settle the collection method of O&M cost before official turn-over of the project.

Explanation:

Upon determining the share of O&M cost between the implementing agency and farmers' association, the collection method for O&M cost chargeable to farmers-beneficiaries shall be formulated. The O&M cost may be collected in the form of "O&M bill" and be collected through farmers' association every after harvest season. Such arrangement should be specified in the written agreement to be prepared as a part of the documents needed for the official turn-over of the project from the implementing agency to farmers' association.

ANNEX F

INSTITUTIONAL DEVELOPMENT

ANNEX F INSTITUTIONAL DEVELOPMENT

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ANNEX F INSTITUTIONAL DEVELOPMENT

1. INTRODUCTION

According to the 1980-1985 Development Plan of SWIM evolved in 1980, 426 projects were scheduled for implementation. Of this number, only 49 projects were constructed(this includes projects whose construction is on-going as of the preparation of this report). Although many constraints to such limited progress of implementation were identified, the key factors are; (1) insufficient studies and investigations on projects proposed for implementation, (2) lack of guidelines for the prioritization of these candidate projects, and (3) ineffective implementing procedures with unclear and ambiguous responsibility area of each participating organization.

A considerable number of potential SWIM projects all over the country still remain un-implemented. Therefore, appropriate countermeasures to solve present constraints are deemed compelling necessity. The master plan study will largely contribute to the improvement of implementation of the present and future SWIM projects through (1) preparation of an inventory of SWIM projects, (2) review of the existing plans and designs, (3) establishment of the guidelines for implementation and management, and (4) preparation of action program for orderly implementation.

This Annex, "Institutional Development", gives a full account of (1) the present institutional procedures and its current problems, (2) institutional development plan of the SWIM projects and (3) the 10-years action program related to the institutional development plan.

Data and information used in this study were provided by the following government offices:

- Department of Public Works and Highways (DPWH)
- National Irrigation Administration (NIA)
- National Water Resources Board (NWRB)
- National Electrification Administration (NEA)

- Bureau of Soils and Water Management (BSWM)
- Forest Management Bureau (FMB)
- National Economic and Development Authority (NEDA)

The stated functions and responsibilities of the agencies in the implementation of SWIM Program were taken from interviews with the PMO-MFC/SWIM management and implementing/cooperating agencies' coordinators due to the absence of documents defining functions and responsibility areas of each category in the implementation of SWIM projects. Only one document was found available pertaining to this. It is an issuance from the Office of the Secretary, DPWH (see Reference-1).

While impediments to project implementation are numerous, the study is confined to its own constraints and limitations. The institutional development plan evolved in this study is not panacea to the present situation, however, it is hoped that it will ameliorate the present circumstances abounding the implementation of SWIM Program. The study encompassed, among others, procedures of implementation from project identification to the operation and maintenance of the projects, organizational features of the program, and financial aspects.

2. PRESENT INSTITUTIONAL AND FINANCIAL SITUATIONS

2.1 Organizations and Agencies Related to the SWIM Projects

2.1.1 SWIM Committee

In order to ensure the effective and coordinated implementation of the SWIM projects, an inter-agency Small Water Impounding Management (SWIM) Committee was established by the Presidential Letter of Instruction No.898 dated 25 July, 1979.

On July 1987, the SWIM Committee was re-organized in line with the new policy for re-structuring of government offices and is presently constituted by the top-echelon officials each from:

- Department of Public Works and Highways : Chairman
- Department of Environment and Natural Resources : Member
- Department of Agriculture : Member
- Department of Budget and Management : Member

The SWIM Committee is an autonomous body. The organizational structure of the Committee is shown in Fig.F.2.1. The Committee is responsible for the following major functions:

1) formulation and coordination of operational policies and targets for the development of SWIM projects,

2) interfacing activities with the programs for Bagong Lipunan Sites and Services (BLISS), livelihood, energy development, food production, water supply, flood control, erosion control, and watershed management,

3) determination of priority areas for SWIM development,

4) adoption of infrastructure programs of SWIM,

5) selection of the lead implementing agency and cooperating agencies for each SWIM project,

6) overall coordination and supervision of SWIM programs implementation, and

7) regular reporting to the President on the performance and progress of the SWIM projects.

2.1.2 Technical Working Group and Project Management Office

(1) Technical Working Group

The Technical Working Group (TWG) for implementation of the SWIM programs was also established under the Ministry of Public Works by the Presidential Letter of Instruction No.898 dated 25 July, 1979 to serve as the technical and executive arm of the SWIM Committee.

After the creation of the Project Management Office for the SWIM Projects (PMO-SWIM) in DPWH, the SWIM-TWG was re-organized (see Fig.F.2.1) and is presently constituted by the representatives each from:

- PMO-SWIM : Chairman
- National Water Resources Board (NWRB) : Co-chairman
- Department of Public Works and Highways (DPWH) : Member
- National Irrigation Administration (NIA) : Member
- Farm Systems Development Cooperation (FSDC) : Member
- National Electrification Administration (NEA) : Member
- Bureau of Soils and Water Management (BSWM) : Member
- Forest Management Bureau (FMB) : Member
- Bureau of Fisheries and Aquatic Resources (BFAR): Member
- Department of Budget and Management (DBM) : Member

The present activities of TWG are rather limited mainly due to

financial constraints; however, the TWG is expected to be responsible for the following:

1) identification, selection and approval of the projects submitted by the agencies for inclusion in the SWIM program,

2) review and preparation of approval and/or recommendation for the project studies, surveys and designs undertaken or to be undertaken by the agencies,

3) preparation of infrastructure program of SWIM, and

4) monitoring and coordination of project construction in accordance with the policies, guidelines and programs adopted by the SWIM Committee.

(2) Project Management Office (PMO-MFC/SWIM)

The PMO-SWIM was established on July 1982. It is headed by a Project Manager, who is concurrently the chairman of the Technical Working Group (TWG).

Because of relatedness in functions, the PMO-SWIM was merged with PMO-MFC on June 1, 1989, hence the new combination, PMO-MFC/SWIM. The organizational structure is presented in Fig.F.2.2. Major functions of this office on the implementation of the SWIM Program are:

1) to supervise, monitor and coordinate the implementation of SWIM projects,

2) to develop standards and guidelines for planning, programming and prioritizing of the SWIM projects, and

3) to develop standards, criteria and guidelines for all technical activities involved in planning, design, construction, utilization and operation and maintenance of the facilities under the SWIM projects.

Since its inception, PMO-MFC/SWIM has been responsible for the use of the SWIM project fund which is being financed from the regular annual budgetary allocation of DPWH.

2.1.3 Implementing Agencies

The following are the present functions and responsibilities of the implementing agencies:

1) To conduct reconnaissance survey and identify projects,

2) To submit project proposals to TWG for possible funding under the SWIM program

3) To take the consent of beneficiaries to implement a project

4) To guarantee acquisition of land required for the construction of facilities

5) To prepare feasibility studies and detailed designs

6) To enter into contract for the implementation of projects

7) To submit to DPWH the required financial and physical progress accomplishment reports for monitoring and evaluation purposes

8) To submit necessary documents for the liquidation of funds in the implementation of projects

Six (6) implementing agencies that are involved in the implementation of the SWIM projects are; DPWH, NIA, BSWM, NEA, FMB and FSDC (FSDC was abolished in January 1988 leaving the number of implementing agencies to five (5)). These implementing agencies are outlined hereinafter. Their organizational structures are presented in Figs.F.2.3 to F.2.7.

(1) Department of Public Works and Highways (DPWH)

The DPWH is tasked to be the lead agency in the implementation of the SWIM Program as provided in LOI 898. The funding for SWIM program is taken from the yearly allocation of DPWH Infrastructure Program. Responsibilities of DPWH in the implementation of the SWIM Program:

- To conduct the required engineering studies for proposed SWIM projects, particularly for flood control.

- To implement the SWIM projects particularly but not limited to flood control.

The DPWH is the coordinating agency of all SWIM projects through the PMO-MFC/SWIM. It is, at the same time, one of the implementing agencies. The SWIM projects said to be implemented by DPWH is carried out by the PMO-MFC/SWIM. It has implemented twelve (12) projects. Of the twelve (12) projects, ten (10) were completed and two (2) are still on-going.

(2) National Irrigation Administration (NIA)

NIA was created out of the Irrigation Division of the Bureau of Public Works by way of Republic Act No.3601 (NIA Charter) on June 17, 1963. The NIA Charter was amended by Presidential Decree No.552 on September 11, 1974 where NIA was granted broader power and authority to undertake more comprehensive water resources development projects for irrigation purposes as well as concomitant activities such as flood control, drainage, land reclamation, mini-hydropower development, etc. Presidential Decree No.552 was further amended by Presidential Decree No.1702 on July 18, 1980 which increased the capitalization of NIA 10 billion pesos. Responsibilities of NIA in the implementation of the SWIM Program:

- to conduct the required engineering studies for proposed SWIM projects, particularly irrigation,

- to implement its submitted and duly approved SWIM scale projects with irrigation as the main features,

- to coordinate, assist and participate with other cooperating agencies in the implementation of the SWIM projects particularly those with irrigation component,

- to construct and fund the necessary irrigation distribution facilities of all SWIM projects with irrigation components,

- to assist the establishment of beneficiaries' associations,

- to assist the operation and management of beneficiaries' associations, and

- to collect amortization fee for irrigation facilities from beneficiaries' associations.

NIA has implemented three (3) SWIM projects so far; one is completed and other two projects are still under construction.

(3) Bureau of Soils and Water Management (BSWM)

BSWM was created from the former Bureau of Soils by virtue of the Executive Order No.116 dated January 30, 1987 as a staff bureau under the Department of Agriculture. The former Bureau of Soils was established by the Executive Order No.216 on January 1957. The BSWM is tasked to construct structures for the protection of soil erosion and other land related problems and construction of small irrigation systems under its water management program (The construction of small irrigation systems was formerly the function of the defunct Farm Systems Development Corporation.). Responsibilities of BSWM in the implementation of SWIM Program:

- to conduct the required engineering studies for proposed SWIM projects, particularly soil erosion and small scale irrigation,