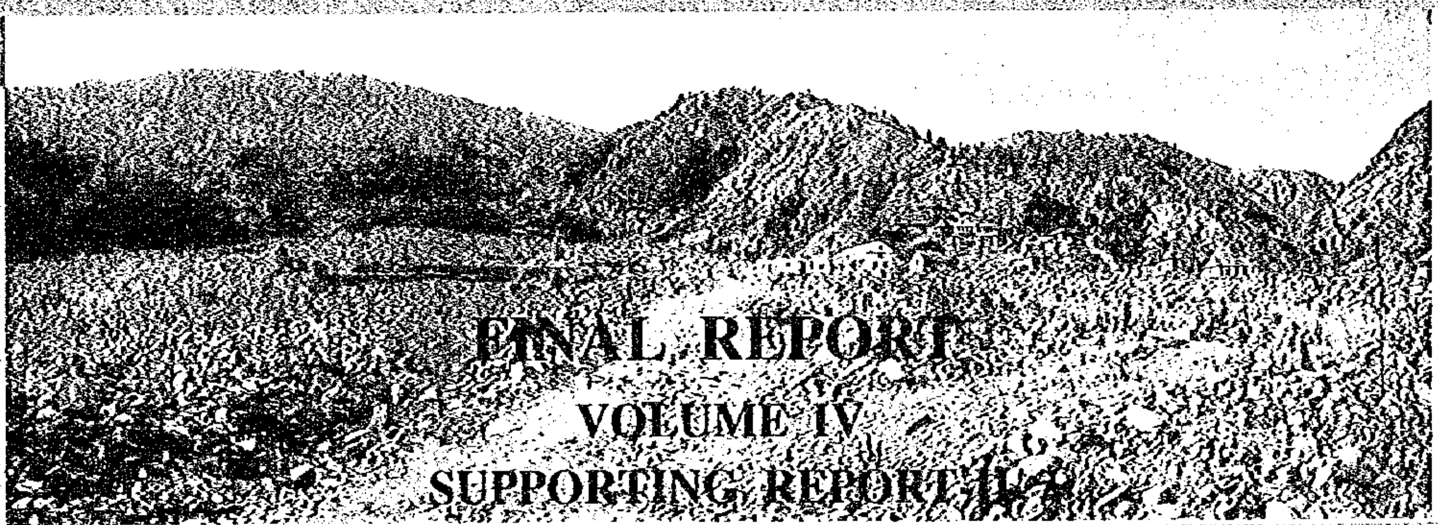
社会開発調査部報告書

No. 52

JAPAN INTERNATIONAL COOPERATION AGENCY

DEPARTMENT OF SOIL CONSERVATION
MINISTRY OF FOREST AND SOIL CONSERVATION
HIS MAJESTY'S GOVERNMENT OF NEPAL

THE STUDY ON THE DISASTER PREVENTION PLAN FOR SEVERELY AFFECTED AREAS BY 1993 DISASTER IN THE CENTRAL DEVELOPMENT REGION OF NEPAL



FINAL REPORT
VOLUME IV
SUPPORTING REPORT II-[illegible]

ANNEX-4 : PRELIMINARY DESIGN FOR DISASTER PREVENTION MEASURES
ANNEX-5 : COMMUNITY DISASTER EVACUATION SYSTEM

MARCH 1997

NIPPON KOEI CO., LTD., TOKYO, JAPAN
INA CORPORATION, TOKYO, JAPAN

S S S
J R
97-035

THE STUDY ON THE DISASTER PREVENTION PLAN FOR SEVERELY AFFECTED AREAS FINAL REPORT MARCH 1997 NIPPON KOEI CO., LTD.

JAPAN INTERNATIONAL COOPERATION AGENCY

DEPARTMENT OF SOIL CONSERVATION
MINISTRY OF FOREST AND SOIL CONSERVATION
HIS MAJESTY'S GOVERNMENT OF NEPAL

THE STUDY ON THE DISASTER PREVENTION PLAN FOR SEVERELY AFFECTED AREAS BY 1993 DISASTER IN THE CENTRAL DEVELOPMENT REGION OF NEPAL

FINAL REPORT

VOLUME IV

SUPPORTING REPORT-II

ANNEX-4 : PRELIMINARY DESIGN FOR DISASTER PREVENTION MEASURES

ANNEX-5 : COMMUNITY DISASTER EVACUATION SYSTEM

MARCH 1997

NIPPON KOEI CO., LTD., TOKYO, JAPAN
INA CORPORATION, TOKYO, JAPAN

The Study on The Disaster Prevention Plan for Severely Affected Areas by 1993 Disaster in The Central Development Region of Nepal

Composition of Reports

Volume I :	Executive Summary	
Volume II :	Main Report	
Volume III :	Supporting Report - I	
	Annex-1 :	Disaster Analysis
	Annex-2 :	Disaster Prevention Plan
	Annex-3 :	Hydrology
Volume IV :	Supporting Report - II	
	Annex-4 :	Preliminary Design for Disaster Prevention Measures
	Annex-5 :	Community Disaster Evacuation System
Volume V :	Supporting Report - III	
	Annex-6 :	Participatory Community Development Plan
	Annex-7 :	Agriculture
Volume VI :	Supporting Report - IV	
	Annex-8 :	Community Forestry
	Annex-9 :	Preliminary Design for Community Infrastructures
	Annex-10 :	Environmental Studies
Volume VII :	Data Book - I	
	1.	Questionnaires and answers for Households Sampling
	2.	Minutes for Discussion with People
	3.	Report on Geological Investigation of Kulekhani Reservoir
	4.	Collected Meteo-hydrological Data
	5.	Material for Seminar
	6.	Manual for Mulberry Tree Plantation (Nepalese Version)
Volume VIII :	Data Book-II	
	1.	Topographic Maps Produced by the Study

Exchange Rate

The exchange rates used in this Study are:

NRs.55.75 = US$1.00 = ¥109.1
as of June, 1996

ANNEX - 4

PRELIMINARY DESIGN FOR DISASTER PREVENTION MEASURES

The Study
on
The Disaster Prevention Plan
for
Severely Affected Areas by the1993 Disaster
in
The Central Development Region of Nepal

FINAL REPORT

Supporting Report

**Annex-4 : Preliminary Design for
Disaster Prevention Measures**

TABLE OF CONTENTS

2. CONSTRUCTION PLAN AND SCHEDULE

3. COST ESTIMATE

Page

LIST OF TABLES

LIST OF FIGURES

Page

The Study
on
The Disaster Prevention Plan
for
Severely Affected Areas by the 1993 Disaster
in
The Central Development Region of Nepal

FINAL REPORT

Supporting Report

Annex - 4 : Preliminary Design for Disaster Prevention Measures

1. PRELIMINARY DESIGN FOR PRIORITY DISASTER PREVENTION AND PROTECTION MEASURES

1.1 Phedigaon / Phatbazar CDPP

Figure 1.1.1 shows the priority plan for Disaster prevention for Phedigaon/Phatbazar. The outlines of preliminary designs for priority schemes are described as follows:

1.1.1 Gully Erosion Control Works

Gully erosion control works that consist mainly of gabion-made checkdams are to be arranged in devastated torrents developing in the upper reaches of Dhungakate Khola and Ghatte Khola. Both of the torrents are situated on the alluvial fan of Phedigaon where the most disastrous event happened to occur in July, 1993. A few series of checkdams should be disposed to control prevailing gully erosion on condition that their foundation is longitudinally propped by other stronger individual check-dams in the downstream, because gabion-made check-dams are less stronger against a fierce energy of debris/sediment flows along the torrent. As for the design of individual check-dams, it will be indicated in the next section.

The gabion checkdam is to be combined with masonry (wet masonry) works, in case of need, especially against the attaining portion to the original ground, the wing portion of the dam body to be inserted into the torrent bank, the apron portion subject to scouring and other forces. The gabion structures are to be strengthened by way of bio-engineering from the long-term point of view. The use of Vitex negundo (simali), Alnus nepalensis (utis) and other available grass species will be effective not only for the gabion checkdams but also for the gabion revetment which connects the checkdams to each other and props the toe of hillslopes.

A longitudinal planning is of significance to bring about equilibrated profiles of the torrent. Design gradients of the torrent are taken as about 1/2 to 2/3 of the existing gradient so that new gradients may form equilibrated profiles along the stream on the whole. The height of every gabion checkdam will be less than several metres because of structural bounds and actually it is not always needed to build up a higher one. This is because the role of those checkdams is not to detain the sediment but to check the undercutting of torrential flows and hereby to prop the foot of hillslopes. The plan and structural components can been seen in Figure 1.1.2. Vegetative measures on gabions are hoped to be brought into effect by the local people since seasonal implementation is absolutely needed.

1.1.2 Main Checkdams

Checkdam Dh-1 is planned to put at the outfall of Dhungakate Khola onto the Phedigaon alluvial fan with a view to controlling the outflow of debris-flows and Checkdam Dh-2 will be situated about 200 m upstream from Dh-1 for the purpose of checking steep gradient of the torrent as well as giving a support to the collapsed hillslopes and a series of gabion checkdams upstream. Checkdams of Gh-6, Gh-7 and Gh-8 in Ghatte Khola are planned to locate at the downstream end of a series of gabion checkdams. The roll of these dams are the same as that of Checkdam Dh-2. Figure 1.1.3 (1/2) shows plan, profile and typical cross section of Checkdam Dh-1. The basic dimensions of Checkdams Dh-2, Gh-6, Gh-7 and Gh-8 are shown in Figure 1.1.3 (2/2).

Taking the case of Dh-1 as an example, the design procedure can be accounted for. Different from the procedure taken for general dams, special points must be kept in mind as shown in the following:

a) The dimensions of spillway, i.e., the width and the depth of overflow section, should be determined at first, because the spillway is merely a channel itself through which debris/sediment flows pass down. Insufficient dimensions are most hazardous, leading to utter breakdown of the structure.

b) In case of checkdam design, the step of dam body on the downstream side should be confined to 1: 0.2 to 0.3 because of free fall of flood water with boulders and stones. Otherwise the dam body will seriously be damaged by falling stones.

c) The crown thickness of overflow section should be given much thicker than usually imagined. In other words, a greatly broad crest should be appreciated. The crown of checkdam is subject to striking and abrasion of boulders and stones in flood water.

d) It is hardly possible to find a good foundation of bedrock at a site where a checkdam is to be built up, and hence the protection of checkdam foundation becomes the key issue in designing. The apron to protect the foundation and the water-cushion with a sub-dam to mitigate the energy of falling water are usually designed based upon experienced facts.

e) The wing segment of the dam body will be exposed to fierce flows of debris/sediment on its face. External forces acting on the wings of the checkdam are not definitely determined. It is required to design the cross-section with a higher safety factor so that it may resist some dynamic forces like impact forces due to the striking of boulders. Incised insertion of the dam wings into the natural ground of both banks is also needed in order to ensure the safety of dam-body abutments.

Thus, the design procedure in which the above-mentioned points of attention peculiar to the design of checkdam are included can simply be written as follows:

Design of Spillway Dimensions

↓

Design of Dam Body (Overflow-Section)

↓

Design of Foundation such as Apron, Sub-dam, Water-Cushion

↓

Design of Dam Wing Section (Non-overflow Section)

↓

Design of Appurtenant Structures

(1) Spillway dimensions

As seen in Annex-3, the peak flood discharge at the dam-site is assumed to be 28 m^3/sec. However, considering the flow situations mingled with debris and mud and the decrease of velocity, the objective discharge to determine the dimensions of the spillway has been taken as 15 m^3/sec around. By way of applying the commonly used formula of weir as well as open channel formula, the dimensions of Dh-1 spillway have been determined in a form of trapezoid with bottom width: 5.0 m, upper width: 7.0 m, and height: 2.0 m. Dh-2 spillway requires bottom width: 3.0 m, upper width: 5.0 m, and height: 1.5 m.

The dimension of the spillway may have a safety factor enough for the passage of debris/mud flows.

(2) Design of dam body (overflow section)

The major external force is, needless to say, static water pressure. In this case it may be practically assumable that static earth pressure of sediment accumulation is included in the water pressure since the dam is low in height (less than 10 m). Also, the effect of earthquake can be assumed negligibly small.

In accordance with the above mentioned points of attention in items (c) and (b), the crown thickness of the spillway section is given 3.0 m and the downstream slope of the dam body is taken as 1: 0.2. From the stability conditions of the dam body, the upstream slope of the body can be worked out at ease. Thus it has a trapezoidal section with crown thickness: 3.0 m, height : 8.0 m, downstream slope: 0.20, upstream slope: 0.31.

As for the foundation, it may not be needed to design the apron and the sub-dam because there is found rather solid bed-rock at the proposed sites. However, depending upon the consequences of further examination about bedrock, it might be necessary to take supplementary measures to strengthen the foundation which includes the apron portion.

As for the design of the wings of the dam body, it is essential to build it up much stronger, as being mentioned in item (e) by way of giving thick body with resistible materials against threatening forces and the impact due to debris/sediment flows. Designed sections of wings can be seen in Figure 1.1.3. In the same figure there are found peculiar types of wings which have ascending slopes to the bank. The slope should be a little steeper than the existing gradient of torrent-bed, lest the wings should be overtopped by debris/mud flows.

The structure is designed to be composed of wet masonry, rubble concrete and plain concrete. Plain concrete with 1.0 m thick placed on the upstream side of the dam body may be placed against the strike of debris/sediment flows. The crown of the spillway is also to be covered with plain concrete in order to protect the abrasion due to debris/sediment flows.

Meanwhile, the design of Checkdams Dh-2, Gh-6, Gh-7 and Gh-8 shall be done in a similar way to that of Dh-1 as the structure is almost the same and the description of them are omitted.

1.1.3 Channel Works

(1) Dhungakate Khola

General plan and profile of channel works for Dhungakate Khola is shown in Figure 1.1.4, and the preliminary design of the related structures are shown in Figure 1.1.5.

The main objective of the channel work is to restore the damaged farm land on the alluvium fan area. According to the theory of Sabo engineering there will be alternative measures that the alluvium fan area is left as it is and utilised as debris retarding basin. However, the idea is strongly opposed by the villager's so that the fertile cultivation area is quite limited in the community, and the land reclamation at alluvium fan area is particularly beneficial for landless people who has lost their farm land by the disaster.

Considering the above situations in village, the Study Team has judged that the channel work with adequate capacity and land reclamation at the alluvium fan area would be the only solution for encouraging the poorest people in the community.

The design calculation of channel works are as below:

i) <u>Design Condition</u>
Peak flood discharge(Q_o) : 18.4 m^3/s (Outlet to Alluvial Fan)
Peak flood discharge(Q_o) : 27.2 m^3/ s (Downstream End of Alluvial Fan)
Rate of debris mixture (R): 10%
Maximum flood flow :

$Q_{max} = Q_o \times (1+0.1)=20.2$ m^3/s (Outlet to Alluvial Fan)
$Q_{max} = Q_o \times (1+0.1)=29.9$ m^3/s (Downstream End of Alluvial Fan)

ii) Drop Check Chute
In order to decrease the steep gradient of the riverbed, three drop check chutes are planned as shown in Figure 1.1.4. The chute structure is mainly composed of wet masonry.

iii) Channel
The channel is designed as trapezoidal with its bottom width of 3.5 m. Side slopes are 1:1 and stone pitching is to be made in order to protect the channel and the embankment. On the right bank of upstream section between Ch.0+800 to 1+024, toe of the hill is liable to be slided, therefore, the protection composed of gabion revetment and vegetation is applied.

iv) Consolidation Dam
The consolidation dam is planned at Ch.0+700 in order to keep up the planned channel gradient and its course and to prevent relocation of debris in the river bed and erosion on the channel bank. The structure is shown in Figure 1.1.5.

(2) Ghatte Khola

For the same reason as the channel works for Dhungakate Khola, channel work at Ghatte Khola is planned.

General plan and profile of channel works for Ghatte Khola is shown in Figure 1.1.6, and the preliminary design of the related structures are shown in Figure 1.1.7. The design condition of the channel is shown below:

i) Design Condition
Peak flood discharge(Q_o) :22.5 m^3/s (Outlet to Alluvial Fan)
Peak flood discharge(Q_o) :24.6 m^3/s (Downstream End of Alluvial Fan)
Rate of debris mixture (R): 10%
Maximum flood flow :
$Q_{max} = Q_o \times (1+0.1)= 24.8$ m^3/s (Outlet to Alluvial Fan)
$Q_{max} = Q_o \times (1+0.1)= 27.0$ m^3/s (Downstream End of Alluvial Fan)

ii) Drop Check Chute
In order to decrease the steep gradient of the riverbed, two drop check chutes are planned as shown in Figure 1.1.6. The chute structure is mainly composed of wet masonry.

iii) Channel
The channel is designed as trapezoidal with its bottom width of 3.5 m in the whole section (Ch.0+100 to 0+700). Side slopes are 1:1 and stone pitching is to be made in order to protect the channel and the embankment.

iv) Consolidation Dam
The consolidation dam is planned at Ch.0+700 in order to keep up the planned channel gradient and its course and to prevent relocation of debris in the river bed and erosion on the channel bank. The structure is shown in Figure 1.1.7.

1.1.4 Coffering Dike in Ghatte Khola (Ph-2)

A coffering dike is planned to put at the outfall of Ghatte Khola onto Phedigaon alluvial fan with a view to coffering an irregularly deviated course of debris flows in the 1993 disaster. This coffering dike (debris-flow training groyne) is expected to protect the cultivated land and the existing facilities of the Phedigaon alluvial fan, instead of a checkdam at the outfall of Ghatte Khola where the geological and geomorphologic situations are not fitted for construction of checkdam. (For the purpose of erosion control it is scheduled to set up masonry and gabion-made checkdams along the tributary of Ghatte Khola upstream near the source of sediment yield.)

The dimensions of the coffering dike are shown in Figure 1.1.7. The structure is composed of stone masonry (wet), boulder riprap, and concrete (rubble concrete). It is necessary for this dike to resist a fierce force of debris-flows until the erosion control works in the upstream will become successful. The tip end of the structure should be secured from localised scouring with big boulder riprap, and the portion attaining to the bank should be strengthened by way of applying bio-engineering in particular.

1.1.5 Training Dike in Dhungakate Khola (Ph-3)

The existing torrent-bed of Dhungakate Khola is higher than that of Ghatte Khola, and the flows of Dhungakate Khola accordingly tend to overflow toward Ghatte Khola through narrow channels on the alluvial fan where cultivated land exists, particularly on the upper portion of the alluvial fan. In order to protect the cultivated field from trespassing by debris/sediment flows, it is substantially necessary to provide some training dikes along the left bank of Dhungakate Khola. Five training dikes are to be set out in accordance with the topography there. The one located at the most upstream may perform like a coffering dike that was described in Section 1.1.4. The original view of the training dike is shown in Figure 1.1.4.

On the right bank of Dhungakate Khola, there is a small tributary merging with Dhungakate Khola. It is required to put a few training dikes to realise a smooth merging of the flow as well as consolidating the toe of hillslopes. Two dikes are located as shown in Figure 1.1.4.

1.1.6 Revetment Works along Dhungakate Khola (Ph-7)

The hillslopes located in the right bank of Dhungakate Khola, in the elevation of 1,900 m or so, have a trend to generate a landslide in a mass. It is needed to provide some revetment works so as to prevent the outbreak of disastrous landslide.

The simple gabion revetment is envisaged to set up for the segment of Dhungakate Khola where landslides tend to occur. Those gabions are recommended to be strengthened by a bio-engineering method. The ground beneath and on the gabions can be covered with vegetation such as Salix spp. and Vitex negundo. Also the vegetated riprap channel with stone-pitching and appropriate grass spp. is recommendable to set up in front of the gabion revetment. Figure 1.1.8 suggests a practical way of executing.

1.1.7 Hillside Works

(1) Hillside Works in Phedigaon Area

Hillside works in the Phedigaon area are designed to carry out on some limited hillslopes along Dhungakate Khola and Ghatte Khola. Implementation will amount to 2.68 ha. The sites can be found in Figure 1.1.1. The objective sites are devastated to a great extent. Rocky surfaces of the slopes are utterly unstable, subject to erosion and weathering. Simple terracing works with stones will be applied to mitigate erosion as well as to create the space of soil for tree-planting. This method is useful to use stones available in/around the objective sites, but has a disadvantage that the sites tend to become dry. Seasonal execution is required to keep the moisture of soil in planting space.

Upon executing the method of simple terracing with stones, the following deserve attention.

a) Terraces shall be set out along the contour line.
b) The top of cliff shall be trimmed in a manner of edge rounding.
c) Some grass roots shall be put between stones and on terraces.
d) Soil shall be enough for roots developing and desirably fertilised.

Figure 1.1.9 shows an example of dimensions.

Wattling/wicker work is also applicable for the same purpose so long as the piles can be driven into the earth and flexible twig fascines or bamboo materials are available nearby. In case that the piles cannot be driven, it may be fine to use the steel bars, instead.

Execution remarks can be briefly given as follows:

a) The works shall be set out along the contour line.
b) Sharp edges, particularly to cliff edges, shall be rounded.
c) Sprout-capable slip of fascines shall be put into the earth through the gaps of wattlings.
d) Pile-driving shall reach to the hard/compact layer of the ground.
e) Shallow drilling and simple cementation shall be done so as to fix the piles firmly in the earth.
f) Execution shall be done immediately before the rainy season.
g) Soil volume of the terrace space shall be good enough for tree-planting and desirably manured before planting.

As for the species of trees to be introduced to the hillside works, it is necessary to select such species as being bearable under strict conditions of sterile and dry land. And it is common that such species have been chosen among locally dominant species of trees. In the case of the Phedigaon area, it is actually practical to introduce Nepali alder (Alnus nepalensis) and Blue pine (Pines wallichiana). Meanwhile, as for the species of grasses, it is also practical to use Napir grass (Pennisetium purpureum), Amliso (Thysanolaena maxima), etc.

The intervals of tree-planting will be about 40 cm, that is: at the rate of five seedlings per 2m length of the terrace. Three seedlings out of five will be Alnus nepalensis and the rest of two will be Pinus wallichiana, in general.

After planting the trees in such a manner, it is essentially needed to pay careful attention to the growth of planted trees.

The following are of significance for the purpose.

- The growth of Alnus nepalensis is feared to overwhelm that of Pinus spp. within several years. It is necessary to check a rapid growth in its height and stretching by means of proper cutting, particularly cutting of its stem. Cut-materials should be used for the mulching and manuring on the site.

- It should be strictly prohibited to conduct pasturing in an established extent of hillside works.

- The use of jute-net for covering naked hillslopes is recommendable for the purpose of introducing grasses to mitigate the sheet erosion.

In sense of expecting natural regeneration of forests in reliable process of so-called plant succession, the introduction of grass species to the devastated hillslopes is most desirable on condition that the surface soil scarcely moves down to be settled to a certain degree. The significance of foundation works in the hillside works will, thus, become clear. Foundation works such as terracing with stones or wattling/wickering will sometimes lead to the natural invasion of grass species and tree species like Alnus nepalensis. If the growth of grasses exceed that of trees, grasses or bushes should be cut properly from time to time.

1.2 Namtar / Tilar CDPP

Figure 1.2.1 shows the priority plan for disaster prevention for Namtar/Tilar. The outline of preliminary schemes are described as follows:

1.2.1 Checkdam Na-1

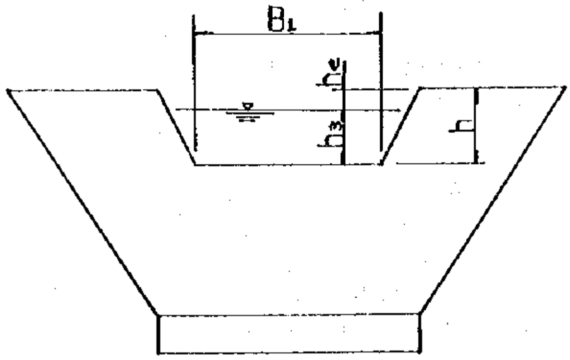
Checkdam Na-1 is planned to mitigate sediment transportation to the downstream stretch and to support the toe portion of the upstream large scale landslides on the right bank. Figure 1.2.2 shows the plan, profile and typical section of the checkdam. The design concept is basically the same as that of Checkdams Dh-1 and Dh-2 mentioned in Sub-section 1.1.2. The preliminary design calculation is shown below:

(1) Design Condition

Dam height (H): 12.5 m
Peak flood discharge(Q_o) : 346.5 m^3/s
Rate of debris mixture (R): 15%
Maximum flood flow : $Q_{max} = Q_o \times (1+0.15) = 398.5\ m^3/s$

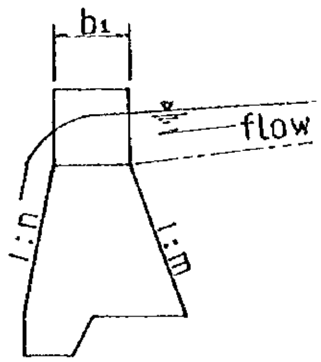
(2) Overflow Section

The dimensions of overflow section are worked out as follows:



$B_1 = 40$ m
$h_3 = 3.3$ m
$h_c = 0.7$ m
$h = 4.0$ m

(3) Dam Body



The dimensions of dam body are worked out as follows:

Crest width (b_1) : 3 m
Downstream slope (n) : 0.3
Upstream slope (m) : 0.35

Wet masonry and rubble concrete are used for upstream / downstream slopes and inner dam body respectively.

(4) Foundation

The foundation of the dam is assumed to be anchored to the solid rock.

(5) Dam Wing

The crest slope of dam wing is fixed in 1 : 10 as shown in Figure 1.2.2.

(6) Auxiliary Structure

The proposed damsite and its downstream are consisted of solid rock exposure and, therefore, the auxiliary structure (sub-dam) including the apron of the main dam are omitted.

1.2.2 Checkdam Na-2

Checkdam Na-2 is planed at about 500 m downstream from Checkdam Na-1 of which purposes are to detain the constable river material on the upstream. In addition Checkdam Na-2 is designed for multipurpose use for improve the transportation from Tribhuvan Highway to Namtar Community as river cross structure. Figure 1.2.3 shows the plan, profile and typical section of the Checkdam Na-2. The preliminary design calculation is shown as follows:

(1) Design Condition

Dam height (H): 5.5 m
Peak flood discharge(Q_o) : 340.7 m^3/s
Rate of debris mixture (R): 10%
Maximum flood flow : $Q_{max} = Q_o \times (1+0.1) = 374.7\ m^3/s$

(2) Overflow Section

The dimensions of overflow section are worked out as follows:

$B_1 = 50$ m
$h_3 = 2.6$ m
$h_e = 0.4$ m
$h = 3.0$ m

(3) Dam Body

The dimensions of dam body are worked out as follows:

Crest width (b_1) : 3.5 m (width is widened for vehicles passage)
Downstream slope (n) : 0.3
Upstream slope (m) : 0.2

Wet masonry and rubble concrete are used for upstream / downstream slopes and inner dam body respectively. Plain concrete is used for the crest. Drainage culverts are located in the dam body to let through the low water flow.

(4) Foundation

The depth of foundation is around 2.0-2.5 m in the riverbed and solid rock is not expected.

(5) Dam Wing

The crest slope of dam wing is fixed in 1 : 20 as shown in Figure 1.2.3.

(6) Auxiliary Structure

The auxiliary structure (sub-dam) including the apron of the main dam are omitted, however, three row of concrete blocks and two row of gabions are placed in order to protect the riverbed downstream.

1.2.3 Checkdam Na-3

Checkdam Na-3 is planned at outfall of Syarse Khola, to trap the debris flow occurring from Syarse Khola. Figure 1.2.4 shows the plan, profile and typical section of Checkdam Na-3. The preliminary design calculation is shown as follows:

(1) Design Condition

Dam height (H): 13.5 m
Peak flood discharge(Q_o) :80.1 m^3 / s
Rate of debris mixture (R): 50%
Maximum flood flow : $Q_{max} = Q_o \times (1+0.5) = 120.15\ m^3/s$

(2) Overflow Section

The dimensions of overflow section are worked out as follows:

$B_1 = 32$ m
$h_3 = 1.8$ m
$h_e = 0.6$ m
$h = 2.4$ m

(3) Dam Body

The dimensions of dam body are worked out as follows:

Crest width (b_1) : 3.0 m
Downstream slope (n) : 0.3
Upstream slope (m) : 0.52

On the crest and upstream slope of dam, plain concrete is applied. Wet masonry and rubble concrete are used for downstream slope and inner dam body respectively.

(4) Foundation

The proposed damsite has no solid rock exposure in the riverbed and the foundation is placed with the depth of around 2.0-2.5 m in the riverbed.

(5) Dam Wing

The slope of dam wing is fixed in 1 : 8 as shown in Figure 1.2.4.

(6) Apron

Three row of concrete blocks and boulder ripraps are placed in the apron. Wet masonry is used for the wing walls which connect main dam and sub dam.

(7) Auxiliary Structure

i) <u>Overflow Section</u>
The dimensions of overflow section of sub-dam are the same as that of the main dam.

ii) <u>Dam Body</u>
The dimensions of dam body are worked out as follows:
Crest width (b_1) : 2.5 m
Downstream slope (n) : 0.3
Upstream slope (m) : 0.1

On the crest, plain concrete is applied. Wet masonry is used for downstream slope and rubble concrete is used for the rest of the dam body.

1.2.4 Groundsill Na-4

Groundsill Na-4 is planned at just down stream of the confluence of Manhari Khola and Syarse Khola. There are two major objectives, one is to control the flood direction of the mainstream to the downstream channel, and another is to consolidate toe portion of Checkdam Na-3 at Syarse Khola. Figure 1.2.5 shows the plan, profile and typical section of Groundsill Na-4. The preliminary design calculation is shown below:

(1) Design Condition

Sill height (H): 4.0 m
Peak flood discharge(Q_o) :377.9 m^3/s
Rate of debris mixture (R): 10%
Maximum flood flow : $Q_{max} = Q_o \times (1+0.1) = 415.7 m^3/s$

(2) Overflow Section

The dimensions of overflow section are worked out as follows:

$B_1 = 50$ m
h = 3.0 m

(3) Main Sill

The dimensions of sill body of overflow section are worked out as follows:

Crest width (b_1) : 2.0 m
Height: 4.5 m
Downstream slope (n) : 0.2
Upstream slope (m) : 0.3

On the crest of sill, plain concrete is applied and wet masonry is used on the upstream slope. The rest of the sill body is formed with gabion structure.

(4) Apron

Apron is mainly composed of gabions. A concrete slab on the gabion is placed immediate downstream of main sill.

(5) Sub-sill

The dimensions of overflow section of sub-sill are the same as that of the main sill. The dimensions of sub-sill are worked out as follows:

Crest width (b_1) : 1.5 m
Height : 4.5 m

On the crest, plain concrete is applied. Wet masonry is used for the upstream slope and gabion is used for the rest of the sill body.

1.2.5 Channel and Bank Protection Works

Channel and bank protection works are designed so as to restore the land along the river as shown in Figure 1.2.6. The preliminary design calculation is as follows:

(1) Design Condition

Peak flood discharge(Qo) : 407.3 m3 / s
Channel width : 50 m

Riverbed gradient : 1 / 33.333 (Average)

(2) Channel

The channel is a trapezoid with 50 m of bottom width and 1:2 of its side slopes. The depth of the channel is 2 m including 0.5 m freeboard during the flood flow.

1.3 Chisapani CDPP

Figure 1.3.1 shows the priority plan for Disaster Prevention Plan for Chisapani. The outline of preliminary designs for priority schemes are described as follows:

1.3.1 Gully Control Works

There are three gullies selected as priority schemes, Dharapani Khola, and the two tributaries located on the east from the Dharapani Khola as shown in Figure 1.3.1.

At the mainstream 12 small checkdams are arranged with a height of 4.5 to 7.5 m. The two checkdams located on the down most part are designed as rubble concrete checkdams with the height of the 7.5 m to prop the series of gabion checkdams on the upstream. The two checkdams at the down most area should be strong enough to support the foundation of the upstream.

The upper 10 small checkdams as well as 17 small checkdams on the two tributaries are planned as gabion made with the height of 4.0 to 4.5 m, which are expected to construct as the people's participation project. It is noted that the gabion-made structures are not permanent structure, and it is necessary to maintain or restore as required. Vegetative support for sustaining the function of structures shall be applied as explained in sub-section 1.1.1.

1.3.2 Checkdam Ch-1

Checkdam Ch-1 is planned at the bottle neck of the upper reach on Chisapani Khola. The large scale failure which is quite unstable and threaten as the source of debris flow which would directory attack to the downstream residential area. The objectives of Checkdam Ch-1 are therefore to trap the debris flow for mitigating the damage potential to the downstream community, and to provide the foundation for proceeding the stabilisation works to the large scale failure. Although the designed sediment line on the upstream cannot be effective to support the toe portion of the failure, it would make possible to provide the foundation to the other countermeasures. Since the energy of debris flow is assumed quite big, the massive concrete structure as Checkdam Ch-1 is needed. The basic design concept of the Checkdam Ch-1, therefore, shall be same as Checkdam Dh-1 and Dh-2 at Phedigaon. Figure 1.3.2 shows the plan, profile and typical section of Checkdam Ch-1.

The preliminary design calculation of Checkdam Ch-1 is shown below:

(1) Design Condition

Dam height (H): 7.5 m
Peak flood discharge(Q_o) :13.0 m^3 / s

Rate of debris mixture (R): 50%
Maximum flood flow : $Q_{max} = Q_0 \times (1+0.5) = 19.5\ m^3/s$

(2) Overflow Section

The dimensions of overflow section are worked out as follows:

$B_1 = 7.0$ m
$h_3 = 1.4$ m
$h_e = 0.6$ m
$h = 2.0$ m

(3) Dam Body

The dimensions of dam body are worked out as follows:

Crest width (b_1) : 2.5 m
Downstream slope (n) : 0.2
Upstream slope (m) : 0.28

On the crest and upstream slope of dam, plain concrete is applied. Wet masonry and rubble concrete are used for downstream slope and inner dam body respectively.

(4) Foundation

The proposed damsite has no solid rock exposure in the riverbed and the foundation is placed with the depth of around 2.0-2.5 m in the riverbed.

(5) Dam Wing

The width of the gully is rather narrow and the slope of dam wing is levelled.

(6) Apron

Gabions are used for the apron as shown in Figure 1.3.2.

(7) Auxiliary Structure

i) <u>Overflow Section</u>
The dimensions of overflow section of sub-dam are the same as that of the main dam.

ii) <u>Dam Body</u>
The dimensions of dam body are worked out as follows:
Crest width (b_1) : 2.5 m
Downstream slope (n) : 0.2
Upstream slope (m) : Vertical

On the crest, plain concrete is applied. Wet masonry is used for downstream slope and rubble concrete is used for the rest of the dam body.

1.3.3. Hillside Work

The objective site is shown in Figure 1.3.1. The area covers 2.75 ha of devastated hillslopes. The hillside works here require the installation of check-dams and some revetment works along the torrent located in a great landslide mass of the earth. The situations slightly differ from those in the Phedigaon area. Simple terracing with stones and some wattling/wickering works will also be applied. The manner of plant introduction will be almost the same as that in the Phedigaon area.

1.4 Mahadev Besi IDPP

Figure 1.4.1 shows general layout of priority schemes for Mahadev Besi IDPP.

The priority plan is consisted of two groundsills, spur dike and riverside park near the bridge site. The objectives for the priority are to stabilise the river channel nearby the bridge site such as to control the flood direction to minimise the affect to the bridge piers and abutments, to protect the river bank, and to design the river gradient at 1.3 % for smooth sediment transportation. The design calculation and the major aspects for designing for respective structure is show below:

1.4.1 Groundsill No.1 (Ref. to Figure 1.4.2)

(1) Design Condition

Sill height (H): 6.0 m
Peak flood discharge(Q_o) :529.2 m^3/s
Rate of debris mixture (R): 10%
Maximum flood flow : $Q_{max} = Q_o \times (1+0.1) = 582.12 m^3/s$

(2) Overflow Section

The dimensions of overflow section are worked out as follows:

$B_1 = 50$ m
$h = 4.0$ m

(3) Main Sill

The dimensions of sill body of overflow section are worked out as follows:

Crest width (b_1) : 2.5 m
Height: 6.0 m
Downstream slope (n) : 0.3
Upstream slope (m) : 0.2

On the crest of sill, plain concrete is applied and wet masonry is used both on the upstream and downstream slopes. The rest of the sill body is filled with rubble concrete.

(4) Apron

Apron is mainly composed of gabions and concrete slab. A concrete slab is placed immediate downstream of main sill. Wet masonry is used for the wing walls which connect main sill and sub structure.

(5) Sub-sill

The dimensions of overflow section of sub-sill are the same as that of the main sill. The dimensions of sub-sill are worked out as follows:

Crest width (b_1) : 2.0 m
Height : 3.0 m
Downstream slope (n) : 0.2
Upstream slope (m) :Vertical

On the crest, plain concrete is applied. Wet masonry is used for the downstream slope and rubble concrete is used for the rest of the sill body.

1.4.2 Groundsill No.2 (Ref. to Figure 1.4.3)

(1) Design Condition

Sill height (H): 4.0 m
Peak flood discharge(Q_o) :529.2 m^3/s
Rate of debris mixture (R): 10%
Maximum flood flow : $Q_{max} = Q_o \times (1+0.1) = 582.12 m^3/s$

(2) Overflow Section

The dimensions of overflow section are worked out as follows:

$B_1 = 55$ m
$h = 3.0$ m

(3) Main Sill

The dimensions of sill body of overflow section are worked out as follows:

Crest width (b_1) : 2.5 m
Height: 4.0 m
Downstream slope (n) : 0.3
Upstream slope (m) :Vertical

On the crest of sill, plain concrete is applied and wet masonry is used on the downstream slope. The rest of the sill body is filled with rubble concrete.

(4) Apron

Apron is mainly composed of gabions and concrete slab. A concrete slab is placed immediate downstream of main sill. Wet masonry is used for the wing walls which connect main sill and sub structure.

(5) Sub-sill

The dimensions of overflow section of sub-sill are the same as that of the main sill. The dimensions of sub-sill are worked out as follows:

Crest width (b_1) : 1.5 m
Height : 3.0 m
Downstream slope (n) : 0.2
Upstream slope (m) :Vertical

On the crest, plain concrete is applied. Wet masonry is used for the downstream slope and rubble concrete is used for the rest of the sill body.

1.4.3 Spur Dike with Bio-engineering

Five spur dikes are designed to be disposed at the immediate downstream of the groundsill No. 2 on its right bank side with a view to keeping the river course exactly toward the bridge site. The proposed location of the groundsill No. 2 is not enough for giving a proper direction of river flows toward the bridge site, because its location is a little far from the bridge site to be influential. In this sense, the proposed five spur dikes can be said to have the role to supplement the performance of groundsill No. 2, particularly in the aspect of lateral direction.

The tip end of every spur dike which has about 12 m in length shall coincide with the alignment of middle water-level channel on its right bank side. The interval of every spur dike will be 16 to 17 m and the flat space between every spur dike will become a high-water channel. The structure is, as seen in Figure 1.4.4, made of rubble masonry, dry masonry and boulder riprap which is placed on the foundation to protect it from localised scouring by floodwater.

The vegetative materials such as sprout-capable cuttings and fascine mattresses are placed between the dike and boulder riprap so as to grow up vegetation. The flat space between the spur dikes is also desirably covered with vegetation so that it forms a low bank shrub forest along the river.

For some proper materials for vegetation, it is suggested to introduce such species as Alhatoda vasica (Assuro), Sapix tetrosperma (Banish), Vitex negundo (Simali), Accasia pennata (Arei), and Dalbergia sisoo (Sisau). Tall tree spp. should be disposed near the original higher bank and shrub spp. near the watercourse. Definitely strict steps should be taken to ensure the vegetation growth. Otherwise all the efforts will be in vain.

1.4.4 Riverside Park at Mahadev Besi Bridge

At the confluence of Agra Khola with Mahesh Khola where the Mahadev Besi Bridge is situated, the riverbed has been awfully disturbed since the 1993 disaster, because accumulated boulders and stones around the bridge have become the best target for quarrying due to the shortage in construction materials around Kathmandu. In addition, the approach embankment of the bridge on the right bank of Agra Khola still remains even after the construction of the new bridge, hindering the river channel capacity to a great extent. This embankment should be dismantled as soon as possible and the remains of old piers should also be dismantled at the same time.

In terms of riverbed re-arrangement to give a safe capacity of the channel for flood discharge, it is recommended to set out a riverside park around the bridge, in a form commensurate to the planned channel works. Some of the spur dikes being designed on the right bank of Agra Khola immediate upstream of the Mahadev Besi Bridge are designed to be built up with vegetated gabions. They lend support to this park; that is, it is expectable that the vegetated channel would be materialised in harmony with the scenery of the rive side park.

The riverside park here envisaged will be able to improve riverside environment as well as the scenery around the bridge and hereby contribute to steady management and maintenance of the river. The layout of the riverside park is given in the Figure 1.4.4. For the choice of tree species, the table below will be useful.

English/Local Name (Botanical name)	Remarks
Acacia/unknown (Acacia spp.)	leguminous tree (leguminosae), durable against dry/poor soil, easy germination of seeds, rapid growth expectable
Willd/Rato siris (Albizia julibrissin)	leguminous tree (leguminosae), tall tree with beautiful flower, durable against poor soil, strong against dryness, easy germination
Willow/unknown (Salix spp.)	preference to rather wet ground, easy propagation with twig slip, mostly middle tall tree, various species
Nepali alder/Utis (Alnus nepalensis)	soil-improvement tree with root nodule bacteria, having rather shallow root-system, showing very raid growth, fittable to planting on devastated ground / slopes
unknown/Simali (Vitex negundo)	strong, durable against dry/poor ground/slopes, even on rocky ground; easy propagation with small slips cut from twigs
Red sage/Kanda (Lantana camera)	bushy shrub, thorny stem, small flowers vary yellow, white, pink; easy propagation with stem cuttings; being used as ornamental hedge
Fire Thorn/unknown (Pyracantha spp.)	prefer sunny side to shadowy side; resistible against dry/poor ground; easy propagation with slips also with seeds
Wormwood/Titepati (Artemisia spp.)	grass species growing even on devastated ground, being used for medical purposes; propagation with cut slips of roots
Eupatoium/Banmara (Eupatorium spp.)	prefer sunshine and grow rapidly and vividly; easy propagation with slips of roots put in shallow ground (grass species)
Reed/unknown (Phragumites spp.)	prefer wet ground or humid soil; easy propagation with cut slips of roots put in shallow ground (grass species)

The riverside park mentioned above is also located beside the road approaching to the Mahadev Besi Bridge, hence the following should be taken into consideration for the implementation and even after the completion.

a) Shrub species should be arranged beside the road so that branches of tall trees would not be a hindrance to a safe sight distance of the traffic.

b) Tall tree species with seasonal blooms will be most desirable to be planted beside the road and inside the park properly in compliance with topography.

c) The seedlings of trees should duly be pruned so as to ensure the root-taking just before planting.

d) Invasion of cattle should strictly be prohibited. Installation of simple fences is indispensable for several years after planting.

e) Planting density of shrub species is to be one piece stand per 1 m^2 and that of tall tree species one piece stand per 5 m^2.

1.5 Kulekhani IDPP

1.5.1 Equipment for sand excavation and loading

At the beginning, it is planned to excavate 50,000 m^3 per year for dry season from December to May from the upper part of Kulekhani reservoir. The project is planned only to excavate and loading to the truck. The transportation of sand from Kulekhani to Kathmandu is expected by the private transportation companies under the order of sand suppliers. Accordingly, the transportation cost is not considered.

Based on the above assumptions, the required equipment are as follows:

- Bulldozer (26 ton) : 2 nos.
- Backhoe (1.2 m^3) : 2 nos.

1.5.2 Access Road to Kathmandu Valley

In the alternative study for sand transportation from Kulekhani reservoir to Kathmandu valley, it is concluded that utilising the Daksinkali route is required for Kulekhani sand being competitive in the market.

Daksinkali route, which is between Pharping - Humane Bhanjyang - Kulekhani is to connect Pharping Bazaar in Kathmandu district with Kulekhani village in Makwanpur district. Its total length is about 21 km. Out of this, about 10 km lie in Kathmandu district and rest in Makwanpur. The local people had started to work on some kilometres of the road on the Makwanpur side since last few years under food of work scheme and they are still working on it with the help from DDC and PLAN international.

The construction works of the remaining sections are still on going under the technical and financial support from PLAN international and the construction works is planned to complete in 2000. The road construction are carried out by PLAN international under the following concept:

(1) Strategy of Gradual Widening should be followed. recent conventional trend is to cut the full width of road in one time. It is natural law that any sudden big change can cause the big negative effect. Similarly in hill slope also when full width and height of road is obtained in one time, hill slope is destabilised by

reaching in meta-stable state (with reduced angle of stability) in shorter time. Therefore cutting is done phase wise. It takes three years to obtain full width and cut height. This provide time to help in adjusting hill slope with micro-biological properties of mountain i.e. small root of grass cover in slope.

(2) Mass Balancing technique is adopted. In conventional system of road building all the necessary width of road is obtained by cutting only and throwing down the earth below road. This practice of mass wasting has disastrous effect of mountain ecology. Therefore, road width is obtained by retaining cut earth by providing low-cost teraining structures. Road width is obtained in half cutting and half filling. This is called cut and fill method.

(3) Use of heavy Machinery should be avoided. Heavy machine like bull dozers cause more damage to the hill slope. This is used in conventional type of cut and throw method of road building. Principle of gradual widening also cannot be followed by using bulldozers. Instead of using heavy machinery, small types of tools should be used for careful handling of excavated material.

(4) No use of explosives. In the conventional method, use of blasting is practised carelessly, which has disastrous effect in mountain environment. The tremor of blasting rocks the hill slope badly and help to destabilise them. New micro-cracks are formed deep inside the earth surface. Seepage water deep inside the rock, further cause the destabilisation of slope. This may result in rock fall in future. This long term adverse effect on stability of slope does not cause in rock fall in future. This long term adverse effect on stability of slope does not cause in rock only, it can help to accelerate soil erosion also. Therefore, use of explosive have to be avoided. Simple had tools have to be used to excavate the rock. Rock types found in middle mountain of Nepal are quartzite, phyllite, limestone, schist, gneiss, sandstone, dolomites etc. majority of these rocks can be excavated manually.

(5) Natural Water Management System. In conventional system side drain is made all along the road in mountain side of road surface. This requires one meter wide additional surface width higher the cut area greater the possibility of potential landslide. Therefore following techniques are adapted.

a) As far as possible side drain in the road is not made in this approach. As an alternative of side drain, 5% outward slope in the road surface is provided in order to not to disturb the natural surface run off pattern.

b) But if the longitudinal gradient of road exceeds 7% then rain water accumulated has the tendency of flowing along the road surface. Then, small side drain is provided along with small diagonal drains at ten meters interval. This disperses the accumulated rain water in many smaller volume.

c) In wet land, water seeping area and in paddy field area proper side drains have to be provided.

(6) Maximum Use of Local Materials and Low-cost Engineering Structures. As far as possible locally available construction materials are to be used in this approach. Every materials obtained during road excavation is taken and used as valuable resource for road construction e.g. earth for embankment, stone for retaining structures, gravel for road surface, bushes and grasses for plantation

etc. Low-cost design is adopted for engineering structures. As far as possible, flexible structures made of locally available materials such as dry stone wall, gabion wall, jute bag wall, brush wood wall, dry-masonry causeway etc. are used. Those type of structures are compatible with the mountain eco-system.

(7) Emphasis on Bio-engineering and Road side Plantation Works. Vegetation is an essential part of every ecosystem. Bio-engineering is the most important guideline for this approach of road. Biological approach for slope protection and generation is most effective low-cost preventive measure and contributes to the long term sustainability. If bio-engineering measures are applied as curative stabilisation, they are mostly combined with sod engineering structures like dry stone wall and gabion crate wall. Vegetation measures are used for both preventive and curative purpose to stabilise hill slope and road. Bio-engineering measures have also been proved to be most effective for low cost and simpler maintenance of road.

Under the above concepts, the technical standard of designing the Daksinkali road are provided by PLAN international, and the construction works are on going under the following technical standard:

(A) Formation Width : Formation width of road including shoulder is 4.5 meter. This is enough for single lane in hill road. Wider and double lane road should be considered, only when there is serious need of it and when traffic volume exceeds 75 vehicles per day. Wider road demands for more volume of earth cut and higher cut height which create environmental hazard.

(B) By-pass : Sufficient by-pass have to be provided for the vehicles crossing from opposite direction. 7 meter wide and 25 meter long by-pass is required in average 200 meter of distance.

(C) Design Speed : For the road conceived of this type, it is necessary to reduce the construction cost reducing the earthwork substantially. Therefore, design speed should not be taken more than 30 km per hour.

(D) Gradient : Average gradient adopted is 7% not exceeding the maximum gradient of 12% . Gradient should be made as less as possible to minimise the complexity of water management mechanism.

(E) Horizontal Radius : Horizontal radius in hairpin bend should not be less than 9 meter. But it is preferable to make the radius more than 12 meter.

(G) Extra Widening : Extra widening is required to provide in curves where back wheel of vehicle does not follow the track of front wheel. Extra widening is 1.0 to 2.0 meter dependent on the radius to the possible extent of total 10 meter as arable lands are extremely limited in hills.

(H) Road Surface : Road surface is made outward slope of 5% to provide a natural drainage system.

(I) Retaining Structures : Drymasonry wall is provided upto 3.5 meter high and gabion crate wall is provided above 3.5 meter high wall. No cement wall is provided. Live brush wood wall or earth filled jute bag wall is also provided in the favourable sites.

Under the design concept and the technical standard of the Daksinkali road as above, it is worried that the transportation of Kulekhani sand by 10 ton trucks is doubtful in the following aspects:

- Width of 4.5 m is enough or not for smooth transportation of the sand,
- Gravel-fill road along steep valley such as Chakklel Khola is safety or not,
- Dry stone masonry and gabion masonry on the road edge along the steep valley is safety or not,
- Half cutting and half filling along the steep valley such as Chakkhel Khola is safety or not,
- Natural drainage system without drain ditch is sustainable or not.
- The bridge which would be provided across Chakkel Khola is enough to pass full load 10 ton truck or not.

There are some aspects above to be assessed prior to applying the route for sand transportation. The design and cost estimate shall be carried out after the completion of the route and the additional improvement works shall be planned if necessary.

2. CONSTRUCTION PLAN AND SCHEDULE

2.1 Basic Conditions

The construction plan has been worked out in due consideration of the climatological conditions prevailing over the construction sites, transportation of the construction materials, equipment, machinery and plants, availability of the dam materials, concrete aggregates and quantities of the works. The following basic conditions have been adopted for the construction planning.

(1) Workable period

Based on the monthly precipitation summary as shown in Table 2.1.1, suitable workable period is from October to April (6 months). It is assumed that most of the CDPP and IDPP works are executed within one year. Public holidays in Nepal, including the national holidays are listed in Table 2.1.2 as reference.

(2) Working hour

The gross working hours is assumed to be 10 hr / day, while the actual working hour of the constructional plants, equipment and machinery is set at 8 hours per day.

2.2 Phedigaon / Phatbazar CDPP

2.2.1 Accessibility

From Palung Bridge on Tribhuvan Highway, a dirt road is aligned on the right bank of Palung Khola up to the confluence of Gharti Khola, the distance of which is about 2 km. At the confluence, the riverbed is sometimes scoured after a heavy rain and vehicles cannot cross for a couple of days. The road distance between Kathmandu (Kalanki) and Palung Bridge is about 61 km.

The access to each proposed site is explained as follows:

Dhungakate Khola Site (Checkdam site)
After crossing the riverbed near the confluence, a temporary road is located in the river course of Palung Khola up to the confluence with Bhottekhoria Khola and then leads to the foot of the hill with the distance of about 2.8 km. A footpath through landslide slope is available on the left bank and it leads to the proposed site with the distance of about 0.5 km.

Ghatte Khola Site (Groyne site)
After crossing the riverbed near the confluence, a temporary road is located in the river course of Palung Khola up to the confluence with Bhottekhoria Khola and then leads to the foot of the hill with the distance of about 2.8 km. A footpath through the alluvial cone is available on the right bank and it leads to the proposed site with the distance of about 0.5 km.

2.2.2 Site Condition

Clear water flow was identified on the both proposed sites even at the end of the dry season. The following is the explanation on the Checkdam site:

> The proposed site is selected immediate upstream of the water fall of Dhungakate Khola, where the rock outcrop is prevailing especially on the right bank. Upstream of the proposed site, there is a small gully on the left bank and this is to be protected from further expansion. At higher portion of the left bank, the slope is utilised for cultivation, mainly for maize. Downstream of the water fall, three gabion structures were currently built, however, the lowest gabion is partially destroyed by the minor flood flows. These are utilised as groundsills for irrigation intake for Phatbazar .

2.2.3 Availability of Construction Materials

Gravel and sand are available at each proposed site, however, the amount is very limited. Aggregate for concrete is obtained from the riverbed of Palung Khola. There are abundant deposits at the confluence with Gharti Khola. Other major construction materials, such as cement, steel bars, timber, gabion wire, concrete pipes, fuel, and oil are to be transported from Hetauda.

2.2.4 Construction Plan

(1) Checkdam

i) Work volume
Major work items of Dh-1, Dh-2, Gh-6, Gh-7 and Gh-8 are as follows:

Dh-1
- Gravel, soil-excavation / 110 cu m
- Weathered Rock-excavation / 370 cu m
- Rock-excavation / 50 cu m
- Plain Concrete / 55 cu m
- Rubble Concrete / 395 cu m
- Wet Masonry / 120 cu m

Dh-2
- Gravel, soil-excavation / 95cu m
- Weathered Rock-excavation / 330cu m
- Rock-excavation / 50cu m
- Plain Concrete / 55cu m
- Rubble Concrete / 250cu m
- Wet Masonry / 100cu m

Gh-6
- Gravel, soil-excavation / 65cu m
- Weathered Rock-excavation / 225cu m
- Rock-excavation / 35cu m
- Plain Concrete / 35cu m
- Rubble Concrete / 125cu m
- Wet Masonry / 50cu m

Gh-7
- Gravel, soil-excavation / 60cu m
- Weathered Rock-excavation / 205cu m

- Rock-excavation / 30cu m
- Plain Concrete / 40cu m
- Rubble Concrete / 120cu m
- Wet Masonry / 60cu m

Gh-8
- Gravel, soil-excavation / 60cu m
- Weathered Rock-excavation / 220cu m
- Rock-excavation / 30cu m
- Plain Concrete / 40cu m
- Rubble Concrete / 135cu m
- Wet Masonry / 65cu m

ii) Construction plan

Because of the location of the site and the quantity of work, big construction machine is not expected. A temporary diversion channel is to be built prior to the foundation excavation. Excavation will be done by using manpower and pick hammers with an air compressor. Concrete work is to be done by using manpower and a concrete mixer. Aggregates are to be collected and transported from the confluence of Palung and Gharti Khola by a 11 ton dump truck after loading by a 0.6 cu.m backhoe, and will be unloaded at the foot of the hill. Then, they will be carried to the damsite where the concrete mixer is placed. Stone materials are to be collected from the riverbed near the site.

(2) Channel Work for Dhungakate Khola

i) Work volume

Channel work for LCB basis includes a 500m-long trapezoidal channel with three drop check chutes and one consolidation dam. Groyne and revetment are categorised as ICB basis. Major work items are as follows:

Channel work
- Gravel, soil-excavation / 4,100 cu m
- Weathered Rock-excavation / 490 cu m
- Wet Masonry / 180 cu m
- Free Draining Backfill / 40 cu m
- Embankment / 1,080 cu m
- Stone Pitching / 3,900 sq. m

Consolidation Dam
- Gravel, soil-excavation / 650 cu m
- Weathered Rock-excavation / 75 cu m
- Plain Concrete / 70 cu m
- Rubble Concrete / 130 cu m
- Wet Masonry / 155 cu m
- Boulder Riprap / 50 cu m
- Backfill / 145 cu m

Groyne
- Gravel, soil-excavation / 1,830 cu m
- Weathered Rock-excavation / 200 cu m
- Plain Concrete / 70 cu m
- Wet Masonry / 775 cu m
- Dry Masonry / 1,610 cu m
- Boulder Riprap / 300 cu m

Revetment - Gabion / 2,020 cu.m

ii) Construction plan

In due consideration of the location of the site and the quantity of work, big construction machine is required. River water generally underflows at the channel work section. Drop check chutes are to be built prior to the river channel excavation. Backhoes of 0.6 cu m and manpower are to be used for drop check chute excavation, whereas that of river channel are to done by two 15 ton bulldozers and two backhoes. Concrete work is to be done by using manpower and a concrete mixer. Aggregates are to be collected and transported from the confluence of Palung and Gharti Khola by a 11 ton dump truck after loading by a 0.6 cu.m backhoe, and will be unloaded near the sites of drop check chute, where the concrete mixer is placed.

(3) Channel Work for Ghatte Khola

i) Work Volume

Channel work for LCB basis includes one consolidation dam, two drop check chutes and a 600m-long trapezoidal channel. The coffering dike (Groyne) planned at the top of the alluvial fan is classified as ICB basis. Major work item is as follows:

Channel work
- Gravel, soil-excavation / 5,600 cu m
- Weathered Rock-excavation / 635 cu m
- Free Draining backfill / 70 cu m
- Embankment / 790 cu m
- Stone Pitching / 4,800 sq. m

Consolidation dam
- Gravel, soil-excavation / 900 cu m
- Weathered Rock-excavation / 220 cu m
- Plain Concrete / 100 cu m
- Rubble Concrete / 305 cu m
- Wet Masonry / 160 cu m
- Boulder Riprap / 55 cu m
- Backfill / 230 cu m

Coffering dike (Groyne)
- Gravel, soil-excavation / 520 cu m
- Weathered Rock-excavation / 130 cu m
- Rubble Concrete / 385 cu m
- Boulder Riprap / 325 cu m

ii) Construction plan

Similar construction plan of the channel work for Dhungakate Khola is to be applied.

2.3 Namtar/Tilar CDPP

2.3.1 Accessibility

From Tribhuvan Highway near Chuniya, a road (classified as the district road by the DOR) is mainly aligned along the valley of Dhobi Khola (on the right bank), and it crosses the riverbed of Manhari Khola, about 1 km upstream of the confluence and follows the right bank of Manahari Khola down to the right abutment of the suspension bridge in Namtar. The district road is usually not motorable during the rainy season because it passes through three major landslide slopes along the right bank of Dhobi Khola and also goes across Manahari Khola without a bridge. There is no drainage system along the road, which also causes erosions on the road shoulders on the valley side. After big floods, Manahari Khola is not passable by cars. The road distance from Hetauda to Chuniya (the beginning point of district road) through Tribhuvan Highway is about 26 km, whereas that of the district road to Namtar is around 6 km. From Kathmandu (Kalanki) to Chuniya, it is around 104 km via Tribhuvan Highway. The access to each proposed site is as follows :

Manahari Khola (Checkdam Na-1 Site)
From the district road crossing point on Manahari Khola, a trail on the river bank leads to the proposed site with four hundred meters or so. An access road is to be aligned on the left bank.

Manhari Khola (Checkdam Na-2 Site)
The proposed site is located at about 50 m downstream of the crossing point of the district road.

Syarse Khola (Checkdam Na-3 Site)
Through the suspension bridge and/or the riverbed of Manhari Khola, the proposed site on Syarse Khola is accessible only on foot. A temporary access road crossing Manhari Khola is required.

Manhari Khola (Checkdam Na-4 Site)
The downstream site is accessible through the trail on the right river bank near the suspension bridge. The trail may be widened and improved to be an access road.

2.3.2 Site Conditions

In Manhari Khola and Gorduwa Khola, water is abundant throughout the year. Water flow, however, is not recognised at the proposed site of Syarse Khola, subsurface flow comes out just downstream of the site and utilised for water mills. The following is the description on each site:

Manhari Khola (Checkdam Na-1 Site)
The site is located at about 50 - 60 m downstream of sharp bend of Manhari Khola. Thick debris (about 2 - 2.5 m) is identified on the riverbed, especially on the left bank. Rocks are exposed on both river banks up to 20 - 30 m from the riverbed. Irrigation canals are also aligned on both banks, both of which are not

functioning well as some canal sections have been destroyed by rock failures. The heights from the riverbed to the canals are around 32 m on the right and 12 m on the left bank. Around 100 m downstream of the proposed site, the irrigation intake made of stones for Namtar is located on the right bank. The upper parts of both banks are covered with trees. A water pipe is crossing the valley upstream of the proposed site.

Manhari Khola (Checkdam Na-2 Site)
The site is located at about 100 m upstream of the confluence with Dhobi Khola. The right bank of the proposed site has a steep cliff, the lower part of which is composed of rock exposure and the upper is the talus deposit area. The irrigation canal is aligned through the rock exposure at around 8 m higher from the river bed. Terrace deposit is accumulated on the left side of the riverbed with the depth of 2 - 2.5 m and terraced fields form rather mild slopes on the right bank. Some big boulders are scattered in the riverbed, but there is no rock exposure in the riverbed and the left bank.

Syarse Khola (Checkdam Na-3 Site)
The proposed site is located about 100 m upstream of the confluence with Manhari Khola. Rocks are exposed on the lower part of both river banks, while on the river bed, debris is thickly deposited. Around 400 m upstream section, the left river bank had been scoured seriously. The water canal and the mill are located about 70 m downstream of the proposed site. Small scale cultivation (mainly maize) is identified on the left bank.

Manhari Khola (Groundsill Na-4 Site)
The site is located about 100 m downstream of the confluence of Syarse Khola and Manhari Khola. On the lower part of the right bank, solid rock is exposed, while on the left bank, the debris from Syarse Khola becomes lower and the debris with a thickness of 1 - 1.5 m from upstream of Manhari Khola is piled on the riverbed. On the upstream, the water canal is aligned on the right bank and the water mill is located 10 - 20 m away from the proposed site. Another temporary intake is also located about 50 m downstream.

2.3.3 Availability of Construction Materials

Boulders, grovel, and sand are available at each proposed site, and there are abundant deposits at the riverbed of Manhari Khola. Other major construction materials, such as cement, steel bars, timber, gabion wire, concrete pipes, fuel, and oil are to be transported from Hetauda.

2.3.4 Construction Plan

(1) Checkdam Na-1

i) Work Volume
Major work item is as follows:
-Gravel, soil-excavation / 3,200 cu m
-Weathered Rock-excavation / 2,100 cu m
-Rock-excavation / 100 cu m
-Plain Concrete / 70 cu m

-Rubble Concrete / 3,975 cu m
-Wet Masonry / 735 cu m

ii) Construction plan
An access road on the left could be built as a part of the preparatory work. Then, a temporary coffer bank is to be built on the one half of the river prior to the foundation excavation. Excavation will be done by using manpower, pick hammers with an air compressor and backhoes. Concrete work is to be done by using manpower, concrete mixers and a mobile crane. Aggregates and stone materials are to be collected from the riverbed close to the site. After the completion of the one half of the dam body with diversion channels, another temporary coffer is to be dumped to the opposite side in order to excavate the foundation of the rest of the dam body.

(2) Checkdam Na-2

i) Work Volume
Major work item is as follows:
-Gravel, soil-excavation / 8,100 cu m
-Weathered Rock-excavation / 2,000 cu m
-Rock-excavation / 100 cu m
-Plain Concrete / 870 cu m
-Rubble Concrete / 1,500 cu m
-Wet Masonry / 420 cu m
-Gabion / 220 cu m
-Concrete Block / 490 cu m

ii) Construction plan
The same procedure as that of Checkdam Na-1 may be taken.

(3) Checkdam Na-3

i) Work Volume
Major work item is as follows:
-Gravel, soil-excavation / 5,600 cu m
-Weathered Rock-excavation / 1,330 cu m
-Rock-excavation / 70 cu m
-Plain Concrete / 645 cu m
-Rubble Concrete / 5,055 cu m
-Wet Masonry / 750 cu m
-Boulder Riprap / 1,085 cu m
-Concrete Block / 385 cu m

ii) Construction plan
A temporary diversion channel is to be built prior to the foundation excavation. Excavation will be done by using manpower, pick hammers with an air compressor and backhoes. Concrete work is to be done by using manpower, concrete mixers and a mobile crane. Aggregates are to be collected from the confluence of Manhari and Syarse Khola. Stone materials are to be collected from the riverbed near the site.

(4) Groundsill Na-4

i) Work Volume

Major work item is as follows:
- -Gravel, soil-excavation / 6,170 cu m
- -Weathered Rock-excavation / 2,640 cu m
- -Plain Concrete / 180 cu m
- -Rubble Concrete / 630 cu m
- -Wet Masonry / 825 cu m
- -Boulder Riprap / 435 cu m
- -Gabion / 860 cu m

ii) Construction plan

The same procedure as that of Checkdam Na-1 may be taken.

(5) Channel Work for Manhari Khola

i) Work Volume

Major work item is as follows:
- -Gravel, soil-excavation / 78,400 cu m
- -Plain Concrete / 25 cu m
- -Boulder Riprap / 1,490 cu m
- -Gabion / 1,700 cu m
- -Embankment / 67,900 cu m
- -Backfill / 10,500 cu m

ii) Construction plan

A temporary coffer dike is to be applied in order to expedite the riverbed excavation.

2.4 Chisapani CDPP

2.4.1 Accessibility

From Phedigaon, a footpath on the ridge leads to the pass between Phedigaon and Chisapani through the village of Deurali. The distance is approximately 1.5 km and it takes about 45 minutes on foot. Almost horizontal footpath (at the elevation of about 2,100 m) is aligned on the northern slope of the Chisapani area from the pass to the centre of the Chisapani village. At present, there is no road available. A new road from the Bhottekhoria village to the Deurali village is now under construction, however, the time of completion is not yet clear. Therefore, the labour force is used for the transportation of construction materials from Phedigaon to Chisapani.

2.4.2 Site Condition

In Chisapani area, water is very limited throughout the year. Water is not recognised at the river bed of Chisapani Khola, however, subsurface water which flows on hard rock below the weathered rock is available at upstream of the proposed upper checkdam site because a few water pipes (mainly for domestic use) cross the valley are observed.

Several water sources are available in the upper part of the main footpath. Under such circumstances, water storage tanks (concrete) should be prepared near the construction site.

2.4.3 Availability of Construction Materials

Gravel and sand are not available at each proposed site. Aggregate for concrete should be transported from Phedigaon by using man-power. Other major construction materials, such as cement, steel bars, timber, gabion wire, concrete pipes, fuel, and oil are transported from Hetauda.

2.4.4 Construction plan

i) Work Volume

Major work item is as follows:

- -Gravel, soil-excavation / 400 cu m
- -Weathered Rock-excavation / 1,700 cu m
- -Rock-excavation / 30 cu m
- -Plain Concrete / 70 cu m
- -Rubble Concrete / 545 cu m
- -Wet Masonry / 170 cu m
- -Boulder Riprap / 50 cu m
- -Gabion / 100 cu m

ii) Construction plan

The same procedure as that of Checkdam Dh-1 may be taken.

2.5 Mahadev Besi IDPP

2.5.1 Accessibility

Mahadev Besi Bridge is located on Prithivi Highway, about 35 km away from Kathmandu. The bridge is now under erection of its girders. The boulders on the riverbed are crushed into pieces by a group of labour forces (mainly from India) and sold as aggregates. The riverbed is also utilised as a temporary road for aggregate transportation beyond the upper checkdam site.

2.5.2 Site Condition

Water flow is identified on the downstream section of Agra Khola even at the end of the dry season. Each site condition is given below:

Groundsill No.1 site

The site is located at about 0.6 km upstream from Mahadev Besi Bridge. A water canal is aligned on the right bank (about 3.3m higher from the riverbed) and a temporary intake is located at about 250 m upstream.

Groundsill No.2 site

The site is located about 60 m upstream from Mahadev Besi Bridge.

2.5.3 Availability of Construction Materials

Boulders, gravel and sand are available on the riverbed of Agra Khola. Other major construction materials, such as cement, steel bars, timber, gabion wire, concrete pipes, fuel and oil are to be transported from either Hetauda or Kathmandu.

2.5.4 Construction Plan

(1) Groundsill No.1

i) Work Volume

Major work item is as follows:

-Gravel, soil-excavation / 5,500 cu m
-Weathered Rock-excavation / 3,700 cu m
-Rock-excavation / 100 cu m
-Plain Concrete / 525 cu m
-Rubble Concrete / 1,390 cu m
-Wet Masonry / 955 cu m
-Boulder Riprap / 215 cu m
-Gabion / 460 cu m

ii) Construction plan

The same procedure as that of Checkdam Na-1 may be taken.

(2) Groundsill No.2

i) Work Volume

Major work item is as follows:

-Gravel, soil-excavation / 5,200 cu m
-Weathered Rock-excavation / 3,300 cu m
-Rock-excavation / 70 cu m
-Plain Concrete / 300 cu m
-Rubble Concrete / 1,230 cu m
-Wet Masonry / 325 cu m
-Boulder Riprap / 1,285 cu m
-Gabion / 675 cu m

ii) Construction plan

The same procedure as that of Checkdam Na-1 may be taken.

(3) Spur dike and Riverside Park

i) Work Volume

Major work item is as follows:

-Gravel, soil-excavation / 1,010 cu m
-Rubble Concrete / 355 cu m
-Dry Masonry / 250 cu m
-Boulder Riprap / 640 cu m
-Fascine Mat / 280 sq. m

ii) Construction plan
Manpower and backhoes are to be used for the excavation of spur dikes, while the planting for the riverside park is mainly manpower.

2.6 Kulekhani IDPP

2.6.1 Accessibility

For the sand excavation from Kulekhani reservoir of upper part, access road for about 1 km from the existing Kunchaal - Kulekhani road will be required. The proposed route is from the Taukhel through the Kulekhani Demonstration Centre of the DOSC on the left bank of Bisingkhel Khola and access to the reservoir in the upper part. Since the most part of the route exist, only approach road from the bank to the reservoir will be required.

2.6.2 Site Condition

The proposed sand excavation site will be submerged from July to November due to water impounding the reservoir during the rainy season. Therefore, only six months from December to May would be possible to activate the sand excavation works.

3. COST ESTIMATE

3.1 Basic Conditions

3.1.1 Mode of Construction

It is assumed that the construction of the CDPP and IDPP projects will be performed on the basis of contract and the contractors will be procured through both the local competitive bid (LCB) and the international competitive bid (ICB). It is, therefore, proposed to divide the works into LCB and ICB contract works in due consideration of the natures of the works involved, the project implementation schedule and the amount of the construction cost.

The proposed mode of construction is as follows:

Project Title	Mode of Construction
Phedigaon / Phatbazar CDPP (Gully Control)	LCB
Phedigaon / Phatbazar CDPP (Main Checkdam)	ICB
Phedigaon / Phatbazar CDPP (Coffering Dike)	ICB
Phedigaon / Phatbazar CDPP (Channel Work)	LCB
Namtar / Tilar CDPP	ICB
Chisapani CDPP	LCB
Mahadev Besi IDPP(Groundsill No.1 & No.2)	ICB
Mahadev Besi IDPP(Spur Dike & Riverside Park)	LCB
Kulekhani IDPP	LCB

The local contractors are classified into four categories depending on the contract limit as follows:

Category	Contract Limit
A	> 6,000,000 Rp
B	4,000,000-10,000,000 Rp
C	500,000- 5,000,000 Rp
D	< 1,000,000 Rp

3.2 Unit Price Assessment

The unit prices of materials and labour wages are estimated at 1996 / 97's price level with reference to the Garrigaon Irrigation Project in Phedigaon. Information was also obtained from the Makwanpur District Office, the Ministry of Local Development, District Irrigation Office of Makwanpur District. The official unit price of major construction material is shown in Table 3.2.1.

3.3 Unit Price Estimate

3.3.1 Material Price and Labour Cost

The construction costs were estimated at the 1996 price level for the CDPP and IDPP projects respectively. The ICB comprise foreign and local currency components, whereas the LCB has only local component. They are divided into the direct and indirect construction costs. The indirect construction costs includes the government administration cost and engineering services. The direct construction cost is based on the work quantity and unit price of the corresponding work item.

3.3.2 Equipment Cost

The unit prices of equipment cost are estimated based on the Kulekhani Disaster Prevention Project as of 1992, of which the project site is located in Makwanpur district and the site conditions as well as the type of construction works are almost similar to the ICB basis of the CDPPs and the IDPPs. For estimating the equipment cost as of 1996 / 97, 3% of annual price escalation is taken into account.

3.3.3 Unit Price Estimate

The basis and condition of the cost estimate are as follows:

i) Unit price by work item
This covers the direct costs of labours, materials and equipment and the indirect costs such as contractors overhead, profit and expenses.

ii) Exchange rate
The foreign exchange rate is 1us$= 109.1 Yen =55.75 Rp. as of June 1996.

iii) Unit Prices for ICB Basis
The unit prices for major work items in the ICB basis are shown in Table for respective sites. The work to be carried out under the ICB basis are categorised rather big scale. The unit prices of ICB basis are composed of the local labours, local and foreign materials and foreign equipment cost as the basic unit rate. In addition to the basic unit rate, the overhead of the contractors with 30% are taken into account, which are included in the administration and supervision fee but not included the insurance.

iv) Unit Prices for LCB Basis
The unit prices for the LCB basis are shown in Table 9.3.1. Unit prices for LCB basis are estimated based on those of PPP basis. 15% of the basic unit rate is added as contractor's profit and another 5% is added as the government tax portion.

v) Direct Construction Cost
The cost estimate was made for each work based on the unit prices and work quantities obtained through each feasibility level design. The miscellaneous item is added with 20% of the basic direct cost only for ICB basis. In due consideration that the ICB basis works are to be commenced prior to those of LCB, 10% of the basic direct cost and miscellaneous items is to be allocated for the preparatory work of ICB basis. This includes the arrangement of site office, water supply, electricity, temporary access road and other relevant works. Thus the direct construction cost is defined as the total amount of basic direct cost, miscellaneous items and preparatory work for ICB basis, while miscellaneous items and preparatory work are omitted from LCB basis.

vi) Indirect Cost

Administration cost : The disaster prevention works are expected to be carried out under the leadership of the central government. For estimation of this, 5% of direct construction cost are to be allocated only for local cost.

Engineering costs : Engineering costs include detailed topographic survey, detailed design and a further technical support. For the ICB basis works, 20% of direct cost is considered, whereas LCB works are accounted for 10% of direct construction cost.

Physical contingency : Physical contingency covers the fluctuation of direct construction costs, administration costs and engineering costs. For the ICB basis works, 30% of direct construction costs, administration costs and engineering costs is assumed, whereas LCB works are accounted for 20% of direct construction cost. ICB basis works require further survey works, design and technical supports as the works are rather big scale, therefore, higher rate is taken

3.4 Cost Estimate

Based on the above procedures, project costs of the respective CDPP and IDPP are estimated. The detailed cost breakdown is shown in the tables of 3.4.1-3.4.26.

Table 2.1.1 Monthly Precipitation Summary (mm)

STATION : DAMAN
INDEX NO. : 0905
ESTD, DATE : MAY 1971
DISTRICT : MAKWANPUR

LAT : 27 36' N
LON : 35 05' E
ELEV : 2314 m
ZONE : NARAYANI

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1971	8	6	38	224	184	583	191	349	67	61	4	0	1715
1972	2	69	26	20	80	662	938	161	304	83	20	0	2365
1973	73	47	47	39	189	618	266	231	599	243	19	0	2371
1974	0	27	41	54	163	185	503	655	601	70	0	8	2307
1975	36	21	11	64	202	284	848	304	370	19	0	0	2159
1976	53	10	0	67	213	538	536	296	212	4	0	0	1929
1977	4	20	35	196	186	230	272	315	114	54	46	56	1528
1978	0	36	80	180	189	271	828	340	238	150	0	0	2312
1979	0	39	2	148	53	230	655	467	132	37	18	75	1856
1980	1	14	45	11	142	434	NA	NA	165	40	0	4	NA
1981	43	0	51	103	100	179	224	353	325	0	39	0	1417
1982	22	19	56	64	144	190	234	285	235	2	7	0	1258
1983	27	1	25	116	253	158	417	259	266	410	0	15	1947
1984	20	20	11	72	127	170	460	253	470	48	0	7	1658
1985	0	0	0	39	360	197	519	353	405	179	0	83	2135
1986	0	32	3	117	193	375	339	289	293	43	4	70	1758
1987	3	41	49	16	119	162	681	410	159	190	0	16	1846
1988	0	26	96	60	204	338	330	360	157	15	19	100	1705
1989	73	21	23	8	231	167	449	165	240	1	0	0	1378
1990	0	115	102	90	226	257	623	291	253	27	0	0	1984
1991	0	16	39	94	88	291	312	415	174	0	0	0	1429
1992	0	16	0	80	159	214	347	274	122	56	15	4	1287
1993	18	27	26	119	126	315	693	404	176	20	9	0	1933
1994	36	30	38	19	98	247	189	217	201	0	0	4	1079
MEAN	17	27	35	83	168	304	472	324	262	73	8	18	1978 *
MIN	0	0	0	8	53	158	191	161	67	0	0	0	
MAX	73	115	102	224	360	662	938	655	601	410	46	100	

*Note : Rainfall of 1995 is under preparation. * The figure is worked out from annual total.*

Table 2.1.2. List of Public Holidays

Date	Name	Type of Holidays	Accounted/(Remarks)
Apr. 13	New Year's Day		*
May 3	Buddha Jayanti	Buddha's Birth.	*
May 8	Law Day		(Courts only)
May 20	Bhoto Jatra	Hindu's Festival	(Kathmandu valley)
Aug. 28	Janai Purnima	Hindu's Festival	*
Aug. 29	Gai Jatra	Hindu's Festival	(Kathmandu valley)
Sept. 4	Krishnasthami	Hindu's God Birth.	*
Sept. 5	Gaura Parva	Hindu's Festival	(Far-western)
Sept. 16	Tij	Hindu's Festival	(Women only)
Sept.17	Rishi Panchami	Hindu's Festival	(Women only)
Sept. 26	Indra Jatra	Hindu's Festival	(Kathmandu valley)
Oct. 13	Ghatasthapana	Hindu's Festival	*
Oct.19-25	Dasain	Hindu's Festival	* (7 days)
Nov. 8	Constitutional Day		*
Nov. 10	Laxmi Puja	Hindu's Festival	*
Nov. 11	Gai Tihar	Hindu's Festival	*
Nov. 12	Tihar (Bhai-Tika)	Hindu's Festival	*
Nov. 16	Ghhath	Hindu's Festival	(Tarai district)
Dec. 25	Christmas Day		(Christain only)
Dec. 29	His Majesty's Birth.		*
Jan. 11	National Unity Day		*
Jan. 29	Martyrs Day		*
Feb. 8	Losar	Sherpa's Festival	*
Feb. 12	Bashanta Panchami	Hindu's Festival	*
Feb. 18	National Democracy Day		*
Mar. 7	Mahashivaratri	Hindu's Festival	*
Mar. 8	Women's Day		(Women only)
Mar. 9	Solar Eclipse		(Occasionaly)
Mar. 23	Fagu	Hindu's Festival	* (Hill district)
Mar. 24	Fagu	Hindu's Festival	(Tarai district)
Apr. 7	Ghode-Jatra	Hindu's Festival	(Kathmandu valley)

Note : Holidays are picked up from 1996-1997 Calender

Table 3.2.1 Price Investigation

Rate Unit : NRs

Item	Unit	Rate	Remarks
Labourer			
Foreman	m.d	95 (85)	
Skilled labour	m.d	105(140)	
Common labour	m.d	60 (80)	
Mason	m.d	105 (140)	
Carpenter	m.d	105 (140)	
Steel worker	m.d	105 (140)	
Welder	m.d	105 (140)	
Mechanic	m.d	105 (125)	
Driller	m.d	105 (125)	
Electrician	m.d	95 (140)	
Plumber	m.d	95 (140)	
Driver	m.d	85 (90)	Light Vehicle (80)
Operator (A)	m.d	95 (105)	Heavy equipment
Operator (B)	m.d	85 (90)	Light equipment
Material			
Sand	m3	140	
Gravel	m3	480, 500, 520	Three types
Boulder	m3	190	
Cement	50 kg	270	Hetauda (Ex factory)
Steel bar	t	27,500	Varies on sizes
Timber	m3	900	
Gabion wire	kg	40	Meduim coated
Concrete Pipe (Dia. mm)		NP-2/NP-3	Hetauda (Ex factory)
200	m	280/800	NP-2: Light duty
300	m	420/960	NP-3 : Heavy duty
400	m	540/1240	
500	m	700/1600	
600	m	890/1850	
700	m	1130/2400	
800	m	1375/2900	
900	m	1720/3460	
1000	m	2070/3900	
1100	m	N.A	
1200	m	2400/5200	
Fuel and Oil			
Petrol	liter	31.5	
Diesel	liter	13.5	
Lubricant (Engine) Oil	liter	123.75	(4 liter = 495 Rs)

Note:

(1) Rates are obtained from Makwanpur District Office and the figures in ( ) denote the rates in Kathmandu District (Department of Housing)

(2) Price Level : US$ = 109.1 Yen = 55.75 Rp (As of June 11, 1996)

Table 3.4.1 **Check Dams Dh-1D and Dh-2D on the Dhungakate Khola (ICB)**

Work Item	Quantity	Unit	Unit Cost F.C. (Rp.)	Unit Cost L.C. (Rp.)	Amount F.C. (Rp.)	Amount L.C. (Rp.)	Amount Total (Rp.)
I. Construction Base Cost					6,245,184	278,850	6,524,034
1. Preparatory Works (10% of Item 2)					567,744	25,350	593,094
2. Civil Works					5,677,440	253,500	5,930,940
2.1 Checkdams					5,677,440	253,500	5,930,940
a.Excavation					399,400	24,600	424,000
- Gravel / Soil	200	cu m	247	13	49,400	2,600	52,000
-Weathered Rock	700	cu m	400	20	280,000	14,000	294,000
-Rock	100	cu m	700	80	70,000	8,000	78,000
b.Concrete					4,331,800	186,650	4,518,450
- Plain Concrete	110	cu m	7,800	360	858,000	39,600	897,600
-Rubble Concrete	645	cu m	3,960	170	2,554,200	109,650	2,663,850
-Wet Masonry	220	cu m	4,180	170	919,600	37,400	957,000
c. Miscellaneous (20% of a to b)	1	l.s.		-	946,240	42,250	988,490
II. Administration Cost (5% of Total of Item I, exclusive to L.C.)					0	326,202	326,202
III. Engineering Cost (20% of Item I)					1,249,037	55,770	1,304,807
IV. Phisical Contingency (30% of I+II+III)					2,248,266	198,247	2,446,513
V. Total (I+II+III+IV)					9,742,487	859,068	10,601,555
Rounded Total					9,742,500	859,100	10,601,600

Note : *1 Price Level in June 1996
*2 Conversion Rate - 1.00 US$ =109.1Yen = 55.75 Rp.
*3 Costs do not include Price Contingency

Table 3.4.2 Series of Groundsills Dh-3D on the Dhungakate Khola (LCB)
H=3m, L=10m, n=9

Work Item	Quantity	Unit	Unit Cost F.C. (Rp.)	Unit Cost L.C. (Rp.)	Amount F.C. (Rp.)	Amount L.C. (Rp.)	Amount Total (Rp.)
I. Construction Base Cost						1,227,760	1,227,760
1. Civil Works (Gabion check dams)						1,227,760	1,227,760
a.Excavation						70,200	70,200
- Gravel / Soil	540	cu m		130		70,200	70,200
-Weathered Rock		cu m		370		0	0
-Rock		cu m		600		0	0
b.Concrete						448,740	448,740
- Plain Concrete		cu m		5,921		0	0
-Rubble Concrete	180	cu m		2,493		448,740	448,740
-Wet Masonry		cu m		2,698		0	0
c.Free Draining Backfill	110	cu m		360		39,600	39,600
d.Boulder Riprap	100	cu m		430		43,000	43,000
e.Gabion	630	cu m		994		626,220	626,220
2.Hillside Work						0	0
a.Simple terracing w.stones	0	m		200		0	0
b.Wicker-work	0	m		390		0	0
II. Administration Cost (5% of Total of Item I, exclusive to L.C.)						61,388	61,388
III. Engineering Cost (10% of Item I)						122,776	122,776
IV. Phisical Contingency (20% of Item I+II+III)						282,385	282,385
V. Total (I+II+III+IV)						1,694,309	1,694,309
Rounded Total						1,694,300	1,694,300

Note : *1 Price Level in June 1996
*2 Conversion Rate - 1.00 US$ =109.1Yen = 55.75 Rp.
*3 Costs do not include Price Contingency

Table 3.4.3 **Series of Groundsills Dh-4D on the Dhungakate Khola (LCB)**

H=3m, L=12m, n=14

Work Item	Quantity	Unit	Unit Cost F.C. (Rp.)	Unit Cost L.C. (Rp.)	Amount F.C. (Rp.)	Amount L.C. (Rp.)	Amount Total (Rp.)
I. Construction Base Cost						2,539,620	2,539,620
1. Civil Works (Gabion check dams)						2,539,620	2,539,620
a.Excavation						94,900	94,900
- Gravel / Soil	730	cu m		130		94,900	94,900
-Weathered Rock	0	cu m		370		0	0
-Rock	0	cu m		600		0	0
b.Concrete						797,760	797,760
- Plain Concrete	0	cu m		5,921		0	0
-Rubble Concrete	320	cu m		2,493		797,760	797,760
-Wet Masonry	0	cu m		2,698		0	0
c.Free Draining Backfill	210	cu m		360		75,600	75,600
d.Boulder Riprap	210	cu m		430		90,300	90,300
e.Gabion	1,490	cu m		994		1,481,060	1,481,060
2.Hillside Work						0	0
a.Simple terracing w.stones		m		200		0	0
b.Wicker-work		m		390		0	0
II. Administration Cost (5% of Total of Item I, exclusive to L.C.)						126,981	126,981
III. Engineering Cost (10% of Item I)						253,962	253,962
IV. Phisical Contingency (20% of I+II+III)						584,113	584,113
V. Total (I+II+III+IV)						3,504,676	3,504,676
Rounded Total						3,504,600	3,504,600

Note : *1 Price Level in June 1996
*2 Conversion Rate - 1.00 US$ =109.1Yen = 55.75 Rp.
*3 Costs do not include Price Contingency

Table 3.4.4 Series of Groundsills Dh-5D on the Dhungkate Khola (LCB)

H=3m, L=15m, n=7

Work Item	Quantity	Unit	Unit Cost F.C. (Rp.)	Unit Cost L.C. (Rp.)	Amount F.C. (Rp.)	Amount L.C. (Rp.)	Amount Total (Rp.)
I. Construction Base Cost						1,352,820	1,352,820
1. Civil Works (Gabion check dams)						1,352,820	1,352,820
a.Excavation						53,300	53,300
- Gravel / Soil	410	cu m		130		53,300	53,300
-Weathered Rock		cu m		370		0	0
-Rock		cu m		600		0	0
b.Concrete						398,880	398,880
- Plain Concrete		cu m		5,921		0	0
-Rubble Concrete	160	cu m		2,493		398,880	398,880
-Wet Masonry		cu m		2,698		0	0
c.Free Draining Backfill	110	cu m		360		39,600	39,600
d.Boulder Riprap	130	cu m		430		55,900	55,900
e.Gabion	810	cu m		994		805,140	805,140
2.Hillside Work						0	0
a.Simple terracing w.stones		m		200		0	0
b.Wicker-work		m		390		0	0
II. Administration Cost (5% of Total of Item I, exclusive to L.C.)						67,641	67,641
III. Engineering Cost (10% of Item I)						135,282	135,282
IV. Phisical Contingency (20% of I+II+III)						311,149	311,149
V. Total (I+II+III+IV)						1,866,892	1,866,892
Rounded Total						1,866,800	1,866,800

Note : *1 Price Level in June 1996
*2 Conversion Rate - 1.00 US$ =109.1Yen = 55.75 Rp.
*3 Costs do not include Price Contingency

Table 3.4.5 Series of Groundsills Dh-6D on the Dhungakate Khola (LCB)

H=3m, L=4m, n=12

Work Item	Quantity	Unit	Unit Cost		Amount		
			F.C. (Rp.)	L.C. (Rp.)	F.C. (Rp.)	L.C. (Rp.)	Total (Rp.)
I. Construction Base Cost						1,254,620	1,254,620
1. Civil Works (Gabion check dams)						1,254,620	1,254,620
a.Excavation						49,400	49,400
- Gravel / Soil	380	cu m		130		49,400	49,400
-Weathered Rock		cu m		370		0	0
-Rock		cu m		600		0	0
b.Concrete						448,740	448,740
- Plain Concrete		cu m		5,921		0	0
-Rubble Concrete	180	cu m		2,493		448,740	448,740
-Wet Masonry		cu m		2,698		0	0
c.Free Draining Backfill	120	cu m		360		43,200	43,200
d.Boulder Riprap	110	cu m		430		47,300	47,300
e.Gabion	670	cu m		994		665,980	665,980
2.Hillside Work						0	0
a.Simple terracing w.stones		m		200		0	0
b.Wicker-work		m		390		0	0
II. Administration Cost (5% of Total of Item I, exclusive to L.C.)						62,731	62,731
III. Engineering Cost (10% of Item I)						125,462	125,462
IV. Phisical Contingency (20% of I+II+III)						288,563	288,563
V. Total (I+II+III+IV)						1,731,376	1,731,376
Rounded Total						1,731,300	1,731,300

Note : *1 Price Level in June 1996
*2 Conversion Rate - 1.00 US$ =109.1Yen = 55.75 Rp.
*3 Costs do not include Price Contingency

Table 3.4.6 Series of Groundsills Dh-7D on the Dhungakate Khola (LCB)
H=3m, L=12m, n=13

Work Item	Quantity	Unit	Unit Cost F.C. (Rp.)	Unit Cost L.C. (Rp.)	Amount F.C. (Rp.)	Amount L.C. (Rp.)	Amount Total (Rp.)
I. Construction Base Cost						2,361,720	2,361,720
1. Civil Works (Gabion check dams)						2,361,720	2,361,720
a.Excavation						88,400	88,400
- Gravel / Soil	680	cu m		130		88,400	88,400
-Weathered Rock		cu m		370		0	0
-Rock		cu m		600		0	0
b.Concrete						747,900	747,900
- Plain Concrete		cu m		5,921		0	0
-Rubble Concrete	300	cu m		2,493		747,900	747,900
-Wet Masonry		cu m		2,698		0	0
c.Free Draining Backfill	200	cu m		360		72,000	72,000
d.Boulder Riprap	190	cu m		430		81,700	81,700
e.Gabion	1,380	cu m		994		1,371,720	1,371,720
2.Hillside Work						0	0
a.Simple terracing w.stones		m		200		0	0
b.Wicker-work		m		390		0	0
II. Administration Cost (5% of Total of Item I, exclusive to L.C.)						118,086	118,086
III. Engineering Cost (10% of Item I)						236,172	236,172
IV. Phisical Contingency (20% of I+II+III)						543,196	543,196
V. Total (I+II+III+IV)						3,259,174	3,259,174
Rounded Total						3,259,100	3,259,100

Note : *1 Price Level in June 1996
*2 Conversion Rate - 1.00 US$ =109.1Yen = 55.75 Rp.
*3 Costs do not include Price Contingency

Table 3.4.7 Hillside works Dh-8D, Dh-9D, Dh-10D on the Dhungakate Khola Basin (LCB)

Work Item	Quantity	Unit	Unit Cost F.C. (Rp.)	Unit Cost L.C. (Rp.)	Amount F.C. (Rp.)	Amount L.C. (Rp.)	Amount Total (Rp.)
I. Construction Base Cost						3,171,000	3,171,000
1. Civil Works (Gabion check dams)						0	0
a.Excavation						0	0
- Gravel / Soil		cu m		130		0	0
-Weathered Rock		cu m		370		0	0
-Rock		cu m		600		0	0
b.Concrete						0	0
- Plain Concrete		cu m		5,921		0	0
-Rubble Concrete		cu m		2,493		0	0
-Wet Masonry		cu m		2,698		0	0
c.Free Draining Backfill		cu m		360		0	0
d.Boulder Riprap		cu m		430		0	0
e.Gabion		cu m		994		0	0
2.Hillside Work						3,171,000	3,171,000
a.Simple terracing w.stones	2,400	m		200		480,000	480,000
b.Wicker-work	6,900	m		390		2,691,000	2,691,000
II. Administration Cost (5% of Total of Item I, exclusive to L.C.)						158,550	158,550
III. Engineering Cost (10% of Item I)						317,100	317,100
IV. Phisical Contingency (20% of I+II+III)						729,330	729,330
V. Total (I+II+III+IV)						4,375,980	4,375,980
Rounded Total						4,375,900	4,375,900

Note : *1 Price Level in June 1996
*2 Conversion Rate - 1.00 US$ =109.1Yen = 55.75 Rp.
*3 Costs do not include Price Contingency
*4 cost of nursary tree, and cost for planting are not included
*5 cost for slope treatment and mixture of fertiliser are included
*6 reinforcement bar arrangement is done by manpower
*7 Additives against corrosion are included

Table 3.4.8 Series of Groundsills Gh-1D on the Ghatte Khola (LCB)
H=4m, L=15m, n=21

Work Item	Quantity	Unit	Unit Cost F.C. (Rp.)	Unit Cost L.C. (Rp.)	Amount F.C. (Rp.)	Amount L.C. (Rp.)	Amount Total (Rp.)
I. Construction Base Cost						5,767,615	5,767,615
1. Civil Works (Gabion check dams)						5,767,615	5,767,615
a.Excavation						341,250	341,250
- Gravel / Soil	2,625	cu m		130		341,250	341,250
-Weathered Rock		cu m		370		0	0
-Rock		cu m		600		0	0
b.Concrete						1,333,755	1,333,755
- Plain Concrete		cu m		5,921		0	0
-Rubble Concrete	535	cu m		2,493		1,333,755	1,333,755
-Wet Masonry		cu m		2,698		0	0
c.Free Draining Backfill	355	cu m		360		127,800	127,800
d.Boulder Riprap	575	cu m		430		247,250	247,250
e.Gabion	3,740	cu m		994		3,717,560	3,717,560
2.Hillside Work						0	0
a.Simple terracing w.stones		m		200		0	0
b.Wicker-work		m		390		0	0
II. Administration Cost (5% of Total of Item I, exclusive to L.C.)						288,381	288,381
III. Engineering Cost (10% of Item I)						576,762	576,762
IV. Phisical Contingency (20% of I+II+III)						1,326,551	1,326,551
V. Total (I+II+III+IV)						7,959,309	7,959,309
Rounded Total						7,959,300	7,959,300

Note : *1 Price Level in June 1996
*2 Conversion Rate - 1.00 US$ =109.1Yen = 55.75 Rp.
*3 Costs do not include Price Contingency

Table 3.4.9 Series of Groundsills Gh-2D on the Ghatte Khola (LCB)
H=4m, L=15m, n=12

Work Item	Quantity	Unit	Unit Cost F.C. (Rp.)	Unit Cost L.C. (Rp.)	Amount F.C. (Rp.)	Amount L.C. (Rp.)	Amount Total (Rp.)
I. Construction Base Cost						3,296,425	3,296,425
1. Civil Works (Gabion check dams)						3,296,425	3,296,425
a.Excavation						195,000	195,000
- Gravel / Soil	1,500	cu m		130		195,000	195,000
-Weathered Rock		cu m		370		0	0
-Rock		cu m		600		0	0
b.Concrete						760,365	760,365
- Plain Concrete		cu m		5,921		0	0
-Rubble Concrete	305	cu m		2,493		760,365	760,365
-Wet Masonry		cu m		2,698		0	0
c.Free Draining Backfill	200	cu m		360		72,000	72,000
d.Boulder Riprap	330	cu m		430		141,900	141,900
e.Gabion	2,140	cu m		994		2,127,160	2,127,160
2.Hillside Work						0	0
a.Simple terracing w.stones		m		200		0	0
b.Wicker-work		m		390		0	0
II. Administration Cost (5% of Total of Item I, exclusive to L.C.)						164,821	164,821
III. Engineering Cost (10% of Item I)						329,643	329,643
IV. Phisical Contingency (20% of I+II+III)						758,178	758,178
V. Total (I+II+III+IV)						4,549,067	4,549,067
Rounded Total						4,549,000	4,549,000

Note : *1 Price Level in June 1996
*2 Conversion Rate - 1.00 US$ =109.1Yen = 55.75 Rp.
*3 Costs do not include Price Contingency

Table 3.4.10 **Series of Groundsills Gh-3D on the Ghatte Khola (LCB)**
H=4m, L=15m, n=13

Work Item	Quantity	Unit	Unit Cost F.C. (Rp.)	Unit Cost L.C. (Rp.)	Amount F.C. (Rp.)	Amount L.C. (Rp.)	Amount Total (Rp.)
I. Construction Base Cost						3,569,050	3,569,050
1. Civil Works (Gabion check dams)						3,569,050	3,569,050
a.Excavation						211,250	211,250
- Gravel / Soil	1,625	cu m		130		211,250	211,250
-Weathered Rock		cu m		370		0	0
-Rock		cu m		600		0	0
b.Concrete						822,690	822,690
- Plain Concrete		cu m		5,921		0	0
-Rubble Concrete	330	cu m		2,493		822,690	822,690
-Wet Masonry		cu m		2,698		0	0
c.Free Draining Backfill	220	cu m		360		79,200	79,200
d.Boulder Riprap	360	cu m		430		154,800	154,800
e.Gabion	2,315	cu m		994		2,301,110	2,301,110
2.Hillside Work						0	0
a.Simple terracing w.stones		m		200		0	0
b.Wicker-work		m		390		0	0
II. Administration Cost (5% of Total of Item I, exclusive to L.C.)						178,453	178,453
III. Engineering Cost (10% of Item I)						356,905	356,905
IV. Phisical Contingency (20% of I+II+III)						820,882	820,882
V. Total (I+II+III+IV)						4,925,289	4,925,289
Rounded Total						4,925,200	4,925,200

Note : *1 Price Level in June 1996
*2 Conversion Rate - 1.00 US$ =109.1Yen = 55.75 Rp.
*3 Costs do not include Price Contingency

Table 3.4.11 Hillside works Gh-4D, Gh-5D on the Ghatte Khola Basin (LCB)

Work Item	Quantity	Unit	Unit Cost		Amount		
			F.C. (Rp.)	L.C. (Rp.)	F.C. (Rp.)	L.C. (Rp.)	Total (Rp.)
I. Construction Base Cost						1,360,500	1,360,500
1. Civil Works (Gabion check dams)						0	0
a.Excavation						0	0
- Gravel / Soil		cu m		130		0	0
-Weathered Rock		cu m		370		0	0
-Rock		cu m		600		0	0
b.Concrete						0	0
- Plain Concrete		cu m		5,921		0	0
-Rubble Concrete		cu m		2,493		0	0
-Wet Masonry		cu m		2,698		0	0
c.Free Draining Backfill		cu m		360		0	0
d.Boulder Riprap		cu m		430		0	0
e.Gabion		cu m		994		0	0
2.Hillside Work						1,360,500	1,360,500
a.Simple terracing w.stones	1,050	m		200		210,000	210,000
b.Wicker-work	2,950	m		390		1,150,500	1,150,500
II. Administration Cost (5% of Total of Item I, exclusive to L.C.)						68,025	68,025
III. Engineering Cost (10% of Item I)						136,050	136,050
IV. Phisical Contingency (20% of I+II+III)						312,915	312,915
V. Total (I+II+III+IV)						1,877,490	1,877,490
Rounded Total						1,877,400	1,877,400

Note : *1 Price Level in June 1996
*2 Conversion Rate - 1.00 US$ =109.1Yen = 55.75 Rp.
*3 Costs do not include Price Contingency
*4 cost of nursary tree, and cost for planting are not included
*5 cost for slope treatment and mixture of fertiliser are included
*6 reinforcement bar arrangement is done by manpower
*7 Additives against corrosion are included

Table 3.4.12 **Check dams Gh-6D, Gh-7D, Gh-8D on the Ghatte Khola (ICB)**

Work Item	Quantity	Unit	Unit Cost		Amount		
			F.C. (Rp.)	L.C. (Rp.)	F.C. (Rp.)	L.C. (Rp.)	Total (Rp.)
I. Construction Base Cost					4,545,196	205,616	4,750,812
1. Preparatory Works (10% of Item 2)					413,200	18,692	431,892
2. Civil Works					4,131,996	186,924	4,318,920
a.Excavation					369,930	22,670	392,600
- Gravel / Soil	190	cu m	247	13	46,930	2,470	49,400
-Weathered Rock	650	cu m	400	20	260,000	13,000	273,000
-Rock	90	cu m	700	80	63,000	7,200	70,200
b.Concrete					3,073,400	133,100	3,206,500
- Plain Concrete	110	cu m	7,800	360	858,000	39,600	897,600
-Rubble Concrete	380	cu m	3,960	170	1,504,800	64,600	1,569,400
-Wet Masonry	170	cu m	4,180	170	710,600	28,900	739,500
c.Free Draining Backfill	0	cu m	380	20	0	0	0
d.Boulder Riprap	0	cu m	520	30	0	0	0
e.Gabion	0	cu m	1,200	300	0	0	0
f. Miscellaneous (20% of a to e)	1	l.s.		-	688,666	31,154	719,820
II. Administration Cost (5% of Total of Item I, exclusive to L.C.)					0	237,541	237,541
III. Engineering Cost (20% of Item I)					909,039	41,123	950,162
IV. Phisical Contingency (30% of I+II+III)					1,636,270	145,284	1,781,555
V. Total (I+II+III+IV)					7,090,505	629,564	7,720,070
Rounded Total					7,090,500	629,600	7,720,100

Note : *1 Price Level in June 1996
*2 Conversion Rate - 1.00 US$ =109.1Yen = 55.75 Rp.
*3 Costs do not include Price Contingency

Table 3.4.13 Coffering Dike Ph-2D on the Ghatte Khola (ICB)

Work Item	Quantity	Unit	Unit Cost F.C. (Rp.)	Unit Cost L.C. (Rp.)	Amount F.C. (Rp.)	Amount L.C. (Rp.)	Amount Total (Rp.)
I. Construction Base Cost					2,580,217	120,767	2,700,984
1. Preparatory Works (10% of Item 2)					234,565	10,979	245,544
2. Civil Works					2,345,652	109,788	2,455,440
a.Excavation					261,110	16,290	277,400
- Gravel / Soil	130	cu m	247	13	32,110	1,690	33,800
-Weathered Rock	450	cu m	400	20	180,000	9,000	189,000
-Rock	70	cu m	700	80	49,000	5,600	54,600
b.Concrete					1,524,600	65,450	1,590,050
- Plain Concrete	0	cu m	7,800	360	0	0	0
-Rubble Concrete	385	cu m	3,960	170	1,524,600	65,450	1,590,050
-Wet Masonry	0	cu m	4,180	170	0	0	0
c.Free Draining Backfill	0	cu m	380	20	0	0	0
d.Boulder Riprap	325	cu m	520	30	169,000	9,750	178,750
e.Gabion	0	cu m	1,200	300	0	0	0
f. Miscellaneous (20% of a to e)	1	l s.		-	390,942	18,298	409,240
II. Administration Cost (5% of Total of Item I, exclusive to L.C.)					0	135,049	135,049
III. Engineering Cost (20% of Item I)					516,043	24,153	540,197
IV. Phisical Contingency (30% of I+II+III)					928,878	83,991	1,012,869
V. Total (I+II+III+IV)					4,025,139	363,960	4,389,099
Rounded Total					4,025,100	364,000	4,389,100

Note : *1 Price Level in June 1996
*2 Conversion Rate - 1.00 US$ =109.1Yen = 55.75 Rp.
*3 Costs do not include Price Contingency