JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

MINISTRY OF WATER RESOURCES
HIS MAJESTY'S GOVERNMENT OF NEPAL

MASTER PLAN STUDY FOR
WATER RESOURCES DEVELOPMENT OF
THE UPPER KARNALI RIVER AND MAHAKALI RIVER BASINS

FINAL REPORT

VOLUME VI

SUPPORTING REPORT

APPENDIX VII IRRIGATION
APPENDIX VIII FLOOD MITIGATION

OCTOBER 1993

NIPPON KOEI CO., LTD., TOKYO JAPAN
CHUO KAIHATSU CORPORATION, TOKYO JAPAN

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This Report consists of

Volume I	Executive Summary	
Volume II	Main Report of Part I (General Study of the Master Plan)	
Volume III	Main Report of Part II (Detailed Analysis of Priority Schemes)	
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The cost estimate was based on the March 1993 price level and expressed in US Dollar according to the exchange rate of US$ 1.00 = Nepal Rupees 46.65 = Japanese Yen 116.30 as of March 31, 1993.

VOLUME VI

SUPPORTING REPORT

IEE	:	Initial Environmental Examination
IRDP	:	Integrated Rural Development Project
IUCNNR	:	International Union for Conservation of Nature and Natural Resources
JICA	:	Japan International Cooperation Agency
KMTNC	:	King Mahendra Trust for Nature Conservation
LRMP	:	Land Resource Mapping Project
MFE	:	Ministry of Forests and Environment
MHDB	:	Marsyandi Hydropower Development Board
MPID2	:	Master Plan for Irrigation Development in Nepal Cycle 2
MWDR	:	Mid-Western Development Region
MWR	:	Ministry of Water Resources
NARSC	:	National Agricultural Research Service Centre
NCCNCR	:	National Council for the Conservation of National and Cultural Resources
NEA	:	Nepal Electricity Authority
NEC	:	Nepal Electricity Corporation
NPC	:	National Planning Commission
NPWC	:	National Parks and Wildlife Conservation
NWSC	:	Nepal Water Supply Corporation
RNA	:	Royal Nepal Army
Rs.	:	Nepalese Rupee
SHDB	:	Small Hydro Development Board
SHIP	:	Second Hill Irrigation Projects
S/W	:	Scope of Work
UMN	:	United Mission to Nepal
UN	:	United Nations
UNDP	:	United Nations Development Programme
U.S.A.	:	United States of America
US$	:	Dollars in United States of America
VDC	:	Village Development Committee
WDR	:	Western Development Region
WEC	:	Water and Energy Commission
WECS	:	Water and Energy Commission Secretariat
WSSB	:	Water Supply and Sewerage Board

LIST OF UNIT OF MEASUREMENT

°C	:	degree centigrade or Celsius
cusec	:	cubic foot per second = 0.02832 m^3/s
El.	:	Elevation
GWh	:	Giga Watt hour
ha	:	hectare
km	:	kilometer
km^2	:	square kilometer
kW	:	kilo Watt
kV	:	kilo Volt
m	:	meter
m^3/s	:	cubic meter per second
m^3/sec	:	cubic meter per second
m^3/day	:	cubic meter per day
MW	:	Mega Watt
%	:	percent

APPENDIX VI

IRRIGATION

APPENDIX VI
IRRIGATION

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1. INTRODUCTION

1.1 Institutional Background for Irrigation Development

The Department of Irrigation (DOI) under the Ministry of Water Resources (MWR), established in 1951, is responsible for the planning, design, construction and management of all public sector irrigation systems in Nepal. The DOI's main functions include the sustained operation and maintenance of the completed systems. DOI is headed by Director General and is structured with central divisions for Planning and Design, Construction, Administration and various centrally controlled Projects and Boards (refer to Figure 1.1.1).

Other government institutions associated with irrigation development include: the Department of Agriculture (DOA) which is responsible for providing agricultural extension services; the Ministry of Local Development which is providing financial and technical support for small scale hill irrigation schemes (served areas of less than 50 ha); the National Agricultural Research Service Centre (NARSC) which is responsible for all agricultural research activities; the Agricultural Development Bank of Nepal (ADBN) which is responsible for providing agricultural credit for farmers; the Agricultural Inputs Corporation (AIC) which is responsible for importing and distributing agricultural inputs; and the Food Corporation of Nepal (FCN) which is responsible for conducting the food grain policy through sale and purchasing of food grains (Ref. VI-1).

1.2 Irrigation Development Area

The Study Area encompasses a total cultivated area of 655,000 ha including land in the Terai Ecological Belt, of which 594,000 ha are considered irrigable. Of the irrigable cultivated area 193,000 ha have been under some kind of irrigation and the remaining 401,000 ha can be taken as potential area for future irrigation development (refer to Table 1.2.1). Except for land in the Terai Ecological Belt, most of the irrigable lands are in river valleys and small patches on mountain slopes. Therefore, irrigation schemes can command only small areas and numerous schemes are consequently needed for irrigation development. Table 1.2.2 shows district-wise breakdown of irrigated area on the basis of classification by scheme (DOI, Farmer), whilst Table 1.2.3 shows district-wise breakdown of total cultivated area on the basis of classification by monsoon season and year round irrigation types.

Table 1.2.4 shows district-wise breakdown of potential area on the basis of classification by land type and land use. Table 1.2.5 shows 19 districts ranking of Hill Valley Potential Irrigation Area. The other five Terai districts lying in the Terai are excluded.

1.3 Development Demand of Irrigation

Consumption of five main food grains, i.e. paddy, maize, millet, wheat and barley, was at first estimated to grasp the development demand of irrigation in the Study Area and the country. According to Agricultural Statistics of Nepal, 1990 (Ref. VI-2), the total production of five main food grains in the nation reached a level of 5,394,980 ton in year 1988/89 as given in Table 1.3.1.

On the other hand, the population in year 1988 was estimated at 17,351,722 persons in the country using the annual growth rate of respective Development Regions, which was computed based on 1981 and 1991 population censuses, as shown in Table 1.3.2. If the supply of five main food grains, even though the self-sufficiency ratio at present stays at a level of 80 to 90%, is assumed to be filled with 100%, the requirement per head is estimated at 311 kg a year from the production of 5,394,980 ton in year 1988/89 and the population of 17,351,722 persons in year 1988.

Table 1.3.3 gives the balance of five main food grains in year 1988 by Development Region, showing food deficits in the Mid Western and Far Western Development Regions of the Study Area as well as the Central Development Region. The food deficit per person in a year is highest in the Far Western Development Region with a value of 39.7 kg, followed by 9.4 kg of the Mid Western Development Region and 2.8 kg of the Central Development Region. This result will tell the necessity of the increase of food production in the Study Area as an urgent task.

Table 1.3.3 further computed the food balance in year 2000 and 2013, giving the deficit of 445,577 ton in year 2000 and 964,126 ton in year 2013 as a sum of the Mid Western and Far Western Development Regions. If the food deficit in the Study Area is fulfilled with the development of new irrigation schemes with the production of 5 ton per hectare, the Study Area will require to develop an irrigation area of 89,115 hectare by year 2000 and 192,825 hectare by year 2013. Even if actual fulfillment of food deficit will of course be achieved with the combination of the improvement of seeds and the rehabilitation of existing irrigation schemes besides the new development of irrigation schemes, a stress is required to place on agricultural development to secure self-sufficiency of staple foods in the Study Area.

1.4 Objective of This Study

The objective of the subject Study is to identify irrigation potential schemes in the Study Area, and from among these select priority schemes.

2. PRESENT SITUATION OF IRRIGATION DEVELOPMENT IN THE STUDY AREA

2.1 Present Situation of Irrigation Projects in Mid Western Development Region

2.1.1 Hill Ecological Belt

The Hill Ecological Belt comprises five districts; that is, Surkhet, Dailekh, Jajarkot, Rukum and Salyan in the Mid Western Development Region. The area is characterized by river valleys and plateaus of the Siwaliks and Churia range of mountains. The Bheri River is the main river in this area except for Dailekh district. The cultivated lands are mainly distributed on the banks of the Bheri River (refer to Table 2.1.1 and Ref. VI-3). A brief description of each district is given below.

(1) Surkhet

In Surkhet district, four schemes have been identified by the MPID2, of which three schemes; that is, Salkot, Kaprichaur and Khorke Khola Irrigation projects have been completed. The DIO has identified three schemes, of which two schemes have been commenced, and of which one scheme, i.e. Surkhet Valley, has not been commenced. A large number of FMIS and AMIS schemes exist in Surkhet district. The command areas for such schemes range from 5 ha to 304 ha. At present, the DIO does not have any new schemes in this district.

(2) Dailekh

In Dailekh district lying north of Surkhet, MPID2 identified one scheme, which is under construction with upper reach canal completed. The DIO has completed one scheme at Lohartar with an area of 30 ha in 1989 and has proposed one new scheme. In addition, about 230 FMIS and AMIS schemes exist in this district.

(3) Jajarkot

The MPID2 has identified four schemes in this district, out of which two schemes are on-going. The DIO has four more on-going schemes started three to four years ago. In addition, DIO has studied 14 schemes of which five have been found to be feasible. There are more than a hundred FMIS and AMIS schemes in the district.

(4) Rukum

The MPID2 has identified five schemes in this district, of which only one scheme has been completed. The DIO has five completed schemes and four on-going schemes. About 100 FMIS and AMIS schemes are in the district. During the visit of the Study Team, detailed information on some of projects could not be obtained.

(5) Salyan

In Salyan district, the MPID2 has identified only one scheme which is on-going with less than 5 % of construction completed. The DIO has two nearly completed schemes and nine completed schemes. The DIO also has two schemes under investigation. About 300 FMIS and AMIS schemes exist in the district.

2.1.2 Mountain Ecological Belt

The Mountain Ecological Belt comprises five districts; that is, Jumla, Kalikot, Mugu, Dolpa and Humla in the Mid Western Development Region. The area is mountainous so irrigation is difficult. Moreover, the area is devoid of any roads, so irrigation projects are costly. At present, 12 projects have been completed irrigating less than 650 ha in total (refer to Table 2.1.2). A brief description of irrigation shemes in each district is presented below.

(1) Jumla

In Jumla district, MPID2 has identified two schemes, of which one on Dhupijyula is completed. A total of 19 schemes has been identified by DIO besides MPID2 schemes. About 100 ha of land has been irrigated by four completed schemes and two schemes are under construction. Information could not be collected from DIO for the remaining 13 schemes.

(2) Kalikot

Of 11 schemes on record at DIO, two schemes, of which Ukhadi Khola scheme is cancelled, were identified by MPID2. The remaining nine schemes are also in the preliminary stage, so for this district irrigation development is nil. There are promising command areas on the banks of the Karnali River, but lack of budget and high cost make the irrigation schemes prohibitive.

(3) Mugu

There are five schemes under DIO in this district, of which only one MPID2 scheme named Khanayagau Irrigation Project with 20 ha command area is completed and two other schemes are on-going with little progress. The other two schemes are under the planned stage.

(4) Humla

Out of six schemes with DIO, two schemes were identified by MPID2. One MPID2 scheme named Yanchu Irrigation Project with 35 ha command area is completed and the other scheme has been cancelled. The District Irrigation Office has identified three new schemes, but detailed information is not available.

(5) Dolpa

In Dolpa district, MPID2 has identified two schemes and the names of ten schemes were obtained from the Regional Directorate office in Surkhet. As the Study Team could not visit the district, detailed information was not obtained.

2.2 Present Situation of Irrigation Projects in Far Western Development Region

2.2.1 Hill Ecological Belt

The Hill Ecological Belt comprises three districts; that is, Doti, Achham and Dadeldhura in the Far Western Development Region. This area lies in the Siwaliks and Churia range of mountains. In Doti and Achham districts, the Seti River and its tributaries are a main water source, whereas the Mahakali River flows along the western boundary of Dadeldhura and Baitadi districts. A pre-feasibility level study of a re-regulating dam at Rupalgad in Dadeldhura for the Pancheshwar high dam is being conducted. The possibility of irrigation by using the proposed reservoir at Pancheshwar to the downstream area is also proposed for a detailed study. District-wise description of irrigation schemes is given below (refer to Table 2.2.1 and Ref. VI-3):

(1) Doti

MPID2 has identified nine schemes by counting Kaflebari I and II as one, of which two schemes have been completed, four schemes are on-going and three schemes are cancelled due to various reasons. DIO has completed 14 schemes and three more schemes are on-going. Two schemes of the DIO have been postponed due to lack of funds. The DIO also looks after 12 schemes completed by Farm Irrigation Office before the DIO was established. There are about 200 FMIS and AMIS schemes in the district.

(2) Achham

The SHIP has studied seven schemes; two schemes are on-going and the remaining five schemes have not commenced. However, MPID2 identified only one scheme. In addition, the DIO has four on-going and existing schemes started in 1991. More than 200 FMIS and AMIS schemes exist in the district.

(3) Dadeldhura

The MPID2 has identified four schemes in the district, of which three schemes are on-going and one scheme has not been commenced. The DIO is constructing one more irrigation scheme in Ugratara Village in the district. There are no major irrigation schemes completed but 157 FMIS and AMIS schemes exist in the district mainly in Raigoon Khola Valley.

2.2.2 Mountain Ecological Belt

The Mountain Ecological Belt comprises four districts; that is, Baitadi, Darchula, Bajura and Bajhang in Far Western Development Region. The area is in the southern slopes of the Himalayan range. Only Baitadi district is linked by black top road with Terai. There are markets for agriculture products from Baitadi and Darchula districts in nearby Indian towns. Bajura and Bajhang are more remote without any road links. A brief description of each district is given below (refer to Table 2.2.2).

(1) Baitadi

The MPID2 has identified five schemes in the district, of which one scheme was completed in 1991 and three schemes are on-going. The DIO has no information on the

remaining one scheme. In addition, the DIO has completed five schemes with three on-going schemes.

(2) Darchula

The MPID2 has identified four schemes in the district, none of which has been completed. The DIO has completed one scheme covering only 40 ha of land. Five schemes are on-going and two schemes are ready to start.

(3) Bajura

The SHIP has studied five schemes, of which three schemes were identified in the MPID2 report. One SHIP scheme is already completed and two schemes are under construction. In addition, the DIO has started construction of three schemes in the district.

(4) Bajhang

The SHIP has studied 17 schemes, of which 16 schemes were identified in the MPID2 report. Six SHIP schemes are already completed and work is in progress for five schemes. One scheme has been cancelled after some works. In addition, the DIO has completed one scheme and three schemes are on-going The DIO also has seven schemes proposed for future implementation.

3. IRRIGATION POTENTIAL SCHEMES IN THE STUDY AREA

3.1 Site Visits During Phase I and II

During Phase I and II of the Study the irrigation group of the study team visited Regional and District Irrigation Offices and flew over potential irrigation areas to grasp the present situation of irrigation development in the Study Area. Discussions were held with concerned officials and relevant information was collected. The group visited Doti, Achham, Bajura, Bajhang, Dadeldhura, Baitadi, Darchula, Surkhet, Dailekh, Jajarkot, Rukum and Salyan district headquarters. Humla, Mugu and Dolpa could not be visited during the group's site visit due to absence of the irrigation engineer. However, information was obtained from Humla, Mugu and Dolpa districts under site visit by another study team member.

The group also visited Mahakali Irrigation Project Stage II and Babai Irrigation Project offices. A summary of the site visit schedule is given as follows:

Duration		Sites Visited
<Phase I>		
First	Dec. 8 to 11, '91	
		1) Reconnaissance of overall the Study Area by helicopter
		2) Chisapani and Pancheshwar project site
		3) Babai Irrigation Project Area
Second	Dec. 22 to 24, '91	
		1) Surkhet Regional Irrigation Office - Korhke Khola I/P
		2) Surkhet - Babai - Nepalganj
<Phase II>		
First	March 16 to 20, '92	
		1) Mahakali Irrigation office ~ Sarda and Tanakpur barrages
		2) Dhangadhi Regional Irrigation office ~ Mahakali Stage II site
		3) Darchula, Baitadi, Dadeldhura and Doti DIO
		4) Surkhet Regional Irrigation Office ~ Surkhet Hill Valley
		5) Tikapur Site ~ Kathmandu.
Second	April 5 to 8, '92	
		1) Surkhet (met Kalikot I/O engineer) ~ Dailekh and Jajarkot DIO.
		2) Rukum, Rolpa and Salyan DIO. Babai Irrigation Project office.
		3) Bajura, Bajhang, Doti and Achham DIO.
		4) Chisapani ~ Nepalganj ~ KTM.

As the results of visits to the district office of DOI, the irrigation potential schemes, Large scale, Small scale and Valley cultivation, were identified in the Study Area (refer to Figure 3.1.1).

3.2 Large Scale Irrigation Potential Schemes

A number of large and medium irrigation schemes have been studied for the development of command area in the Terai Ecological Belt. The Karnali (Chisapani) Multipurpose Project, Mahakali Irrigation Project Stage I and II, Babai Irrigation Project, and Sikta Irrigation Project along with medium sized schemes cover irrigable land in the Terai Ecological Belt.

A short description of these large schemes is given below:

Sikta Irrigation Project (West Rapti Multipurpose Project)

The project was first studied in 1967 by Lahmeyer International Ltd., extending the command area of 76,070 ha from Kapilvastu in the east to Banke in the west. MPID2 reexamined the project and proposed that the Sikta Irrigation Project area be considered under the Bheri-Babai Diversion scheme.

Babai Irrigation Project

The project develops a net command area of 13,500 ha stage I on the eastern part of the Babai River using its natural flow. The construction of a 270 m long weir, head regulator and desilting basin completed in July 1992.

The construction of main and branch canals will start from fiscal year of 1993. These structures were designed with the anticipation of the diversion flow from Bheri - Babai Diversion scheme.

Khutiya II Irrigation Project

This project was envisaged as a refinement of the original project developed in the early 1980s. The project will serve an area of 1,500 ha located within the existing project area. The project will be implemented by DOI under the United Nations Capital Development Fund (UNCDF).

Mahakali Irrigation Project Stage II

Stage II of the Mahakali Irrigation Project is planned to provide irrigation infrastructure and related facilities for 6,800 ha of land in the eastern part of the stage I command area. The construction of main canal is on-going with finance provided under IDA credit.

Karnali (Chisapani) Multipurpose Project

The detailed feasibility study of the Karnali (Chisapani) Multipurpose Project was completed in 1989 by Himalayan Power Consultants (HPC). As part of the project, the consultants proposed an irrigation development of the area between the Rapti River in the east and the Mohana River in the west. The net area of 191,000 ha overlaps Babai, Sikta, and Khutiya Irrigation Project areas. Since this project is big, alternative irrigation development projects have been considered for immediate implementation.

Bheri-Babai Diversion Project

A total of 40,000 ha of irrigable land including Babai Irrigation project stage I command Area of 13,5000 ha, has been identified on the left and right banks of the Babai River. Since dry season flow in the Babai River is not sufficient to supply all of irrigable area, it was proposed to divert 35 m^3/s of flow from the Bheri River to the upstream reaches of Babai Irrigation weir. In addition the project will generate 24 MW of power. The Babai headworks and desilting basin have been designed with the anticipation of the diversion flow. The command areas for this project are 5,500 ha in the eastern part and 21,000 ha in the western part of the Babai River. Possibility of extending irrigation facilities to the command area of the Sikta Irrigation Project would make the diversion project more attractive (refer to Figure 3.2.1).

The project as reformulated during the MPID2 studies would entail diversion of $60m^3/s$ from the Bheri River basin to the Babai River basin. MPID2 water balance studies indicated that development of a total net command area of 53,500 ha would be possible; this area is large enough to incorporate the Babai and Sikta irrigation project area. A summary of large scale irrigation potential schemes is referred to in Table 3.2.1.

3.3 Small Scale Irrigation Potential Schemes

MPID2 identified small potential irrigation projects (2,000 ha and less)in the Study Area. So far as the Study Area is concerned, there were 82 potential projects with a total area of 11,732 ha, including 11 projects of 5,384 ha in the Terai Ecological Belt, 38 projects of 4,178 ha in the Hill Ecological Belt and 33 projects of 2,170 ha in the Mountain Ecological Belt (refer to Table 3.3.1). Feasibility study reports were collected for 46 of the projects as listed in Table 3.3.2(1/17 -17/17).

During Phase II, the following 15 projects were excluded from examination because of lying outside the Study Area :

- eleven projects of the Terai Ecological Belt in the Mid and Far Western Development Regions.
- four projects of the Hill Ecological Belt in the Pyuthan and Rolpa districts.

Excluding the 15 projects, the remaining 67 projects are in the Study Area, of which 44 projects (66%) are completed or on-going and 23 projects are yet to start. A list of the projects identified by MPID2 is given in Table 3.3.3.

Under the Asian Development Bank (ADB) loan, DOI has established the Second Hill Irrigation Project (SHIP) for planning, design and construction of irrigation schemes in four districts, i.e. Doti, Achham, Bajura and Bajhang. There are 31 schemes, in the above 67 remaining projects, covering 3,069 ha of land under SHIP of which 10 schemes covering 781 ha have been completed, 13 schemes covering 1,608 ha are under various stages of construction and the remaining eight schemes covering 680 ha are yet to start (refer to Table 3.3.4).

DOI established the District Irrigation Offices (DIO) in 1985 for planning, design and implementation of potential irrigation schemes at the district level. Before that, irrigation schemes were studied and implemented by DOI through the regional director's office and small irrigation schemes were looked after by the Public Works Development under the Ministry of Local Development, and under the Ministry of Agriculture. In addition, the farmers themselves carried out irrigation works by digging small canals for irrigating a few hectares of land. Other agencies like FAO, Ministry of Agriculture, etc. also provide funds for such small irrigation schemes referred to as Agency Managed Irrigation Systems (AMIS). The Water and Energy Commission Secretariat (WECS) conducted Water Inventory Studies over most part of the country to assess water use for irrigation at the farm level. Alhough the scale of these schemes is very small in nature, the total area irrigated by such schemes is considerable. A list of such schemes called Farmer Managed Irrigation Systems (FMIS) and Agency Managed Irrigation Systems (AMIS) was made available from the Irrigation Sector Support Project (ISSP) as summarized in Table 3.3.5. But the current status of such schemes is not monitored by any agency at present. All FMIS and AMIS schemes listed are existing, however, information on future activities is not available.

After the District Irrigation Offices were established in 1985, district irrigation engineers were made responsible for planning and implementation of irrigation schemes. Every year, the engineer will request DOI for budget allocation to complete on-going schemes and to start new schemes. DOI with its limited resources could not fulfill these demands, and as a result reduced budget amounts resulting in postponement of some on-going schemes. During site visit by the Study Team, discussions with district engineers were held about performance of completed projects, conditions of on-going schemes and the possibility of starting or studying new schemes. A brief description of schemes in each of the districts in the Study Area is presented in Table 3.3.6.

3.4 Valley Cultivation Potential Schemes

During Phase I of the Study, the Study Team visited or conducted aerial inspection of sites with high irrigation potential. These areas were revisited or flown over during Phase II site visits. For most of the area, DIO is considering irrigation development. At present, these areas get some irrigation under FMIS and AMIS schemes (refer Table 3.4.1).

4. WATER BALANCE STUDY

4.1 Bheri-Babai Irrigation Scheme

4.1.1 Present Water Balance Study under MPID2

The Bheri-Babai diversion scheme has been under consideration since the early 1980's. The diverted flow of 35 m^3/s from the Bheri River was estimated to permit the development of net command area (NCA) of 40,000 ha in Bardiya district for year round irrigation.

Water balance calculations in the MPID1 indicate a minor shortfall of year round irrigation. In the foregoing, irrigable NCA for 10-year drought is estimated at 33,821 ha instead of 40,000 ha during March.

The project as reformulated during the MPID2 studies would entail diversion of 60 m^3/s from the Bheri River to the Babai River, with an envisioned possible development total of 53,533 ha in NCA.

Table 4.1.1 (2/6) to (3/6) and table 4.1.2 show available water discharge and the results of calculation for diverted flow over the range of 35 m^3/s to 60 m^3/s for increments of 5 m^3/s.

Figure 4.1 1 shows a schematic diagram of the Bheri-Babai potential scheme under the present work plan and MPID water balance study.

4.1.2 Water Balance Calculations Under This Study

A water balance study as dealt with in Appendix IV, Hydroelectric Power Generation, was carried out under the following conditions to roughly delineate the command area for the irrigation scheme.

(1) Calculation Conditions

(a) Water requirement is the same as for MPID2 (refer to Table 4.1.1 (1/6)).

(b) Flow of 48 m^3/s is assumed as the maintenance flow of the Bheri River (refer to Figure 4.1.1).

(c) The design intake discharge at the existing Bardiya diversion weir is the sum of the release discharge from the planned power station (58.2 m^3/s at maximum) and the inflow discharge from the Babai River (refer to Table 4.1.1 (4/6)).

(d) Water balance study is to be performed for the above design intake discharge over a period of 16 years of 1967 to 1986 (data lacking for 1968, 1975-76).

(e) Under the MPID2 water study, irrigable area was considered on the basis of the single case of design intake discharge based on computed discharge with a return period of 10 years. Under the subject Study, however, command area and irrigable area are computed on the basis of actual discharge observations for a past 16-year period.

(2) Priority in Determining Command Area

Priority in determining command area will be as follows:

Step 1:	Babai Irrigation Project, Stage I (13,500 ha) + Stage II-1 ~ 3 (5,500 ha)	= 19,000 ha
Step 2:	Babai Irrigation Project, Stage II	= 21,000 ha
Step 3:	Sikta Irrigation Project	= 34,270 ha
	Total:	= 74,270 ha

(3) Results of Computation

(a) Cropping pattern: monsoon season type (refer to Table 4.1.1 (5/6) and Figure 4.1.2)

Paddy command area falls below the design area (74,270 ha) only once (October 1979: 72,122 ha). Wheat command area falls below the design area (31,193 ha: cropping intensity of 42%) only once (March 1977: 18,184 ha).

(b) Cropping pattern: year round type (refer to Table 4.1.1 (6/6))

Paddy command area falls below the design area (74,270 ha) only once (October 1979: 73,561 ha).

Wheat and sugarcane command area falls below the design area (74,270 ha: cropping intensity of 100%) each year. During the cropping season (November to April) the smallest irrigable area occurs in March. The average smallest irrigable area during the 16-year period studied is 33,278 ha, which is equivalent to 45% of the command area (74,270 ha).

(4) Conclusion

A design command area for paddy cropping alone of 74,270 ha is possible under Bheri-Babai diversion with the failure of 1/16. However, in the winter season, upland cropping such as wheat and sugarcane of 33,270 ha will be possible.

4.2 Surkhet District Development Scheme

The Surkhet District Irrigation Development along the Bheri River is divided into 15 tributary sub-basins for its water source. Lifting difference between the Bheri River and the benefit areas is 40 to 260 m substantially making gravity irrigation impossible. Irrigation water for 15 sub-basins is thus sought in their upstream reaches. Of the 15 sub-basins, irrigation projects have been implemented for four sub-basins, and the remaining 11 sub-basins have untapped development potential (see Figure 4.2.1).

Of the undeveloped 11 sub-basins, it is reported that a surplus of discharge exists within seven sub-basins. However, helicopter reconnaissance under Phase II Study indicated that almost all of these tributaries were dry creek beds, and are thus considered inappropriate as water sources. The remaining four sub-basins are reported to exhibit a deficit water balance, and this is confirmed by the field survey by the Study Team.

Within the foregoing four sub-basins, the two schemes below are considered the most promising for development in the valley in terms of accessibility, cultivable area, and flatness of farm land. A water balance study is accordingly necessary in the future for the following schemes:

(a) Surkhet Valley Irrigation Scheme (Basin 12, NCA = 2,700 ha)

(b) Korelli Khola Basin Lift Irrigation Scheme (Basin 26, NCA = 316 ha).

(1) Surkhet Valley Irrigation Scheme

According to the feasibility study carried out by DOI, a primary water source for the scheme is the Chingar Khola, located outside the basin. However, since the scheme needs a long driving canal of 40 to 50 km, which requires intensive O/M of the canal, and also seems to have problems with water resources, it is recommended to carry out further study prior to developing the scheme.

The Study will include the following:

(i) Groundwater use in the Surkhet valley (well irrigation)

(ii) Surface water use in the Surkhet valley (farm pond construction)

(iii) Water conveyance to the benefit area by transbasin diversion from headworks sited on the Jupla River located upstream of the scheme area

(iv) Reduction of benefit area size, and measures including introduction of upland irrigation, and so on to maximize the effective exploitation of available water source.

(2) Korelli Khola Basin Lift Irrigation Scheme

Since the lifting difference between the Bheri River and the benefit area is around 40 m, the project (NCA = 316 ha) is considerd as a pumped irrigation scheme. Peak electric power required for lifting water to supply the entire benefit area is computed at 550 kW. A promising power source would be the Bheri-Babai power station proposed under this Study. A possible supplemental water source under the scheme would be the Chinchu Khola.

5. CANDIDATES FOR PRIORITY SCHEMES

Seven large scale irrigation schemes were identified. Of these, the Khutia II Irrigation Project and the Mahakali Irrigation Project (stage II) were excluded from consideration since they are outside the scope of this Study. Accordingly, five schemes were evaluated.

5.1 Large Scale Irrigation Schemes

(1) Sikta Irrigation Project

This project (A = 34,270 ha) was originally formulated by NEA under the West Rapti Multipurpose Project. On the other hand, the MPID2 study concluded that it would be more economical to include the project under Bheri-Babai and/or Karnali project. Project EIRR is preliminarily computed at 18.4% (without diversion headworks cost). The project is accordingly recommended under this Study for inclusion as one part of the Bheri-Babai project.

(2) Babai Irrigation Project

This project (A = 13,500 ha) is currently under construction. Structures including intake, desilting basin, etc. have been completed by the Nepalese government in anticipation of their use to handle supplemental discharge under the Bheri-Babai diversion plan. Project EIRR is 10.4% to 18.4% assuming discharge augmentation from Bheri-Babai diversion.

(3) West Rapti Multipurpose Project

The Banke Development Area (Sikta Irrigation) originally under the project (A = 76,070 ha) is to be included under the Bheri Babai Irrigation Project. Also, the project basin is outside the delineated Study Area. As a result, the project is excluded from consideration as a priority scheme.

(4) Karnali (Chisapani) Multipurpose Project

Of the total project command area of 190,950 ha, the 100,320 ha of irrigated area on the left bank (A = 36,151 ha for Banke and A = 64,169 ha for Bardiya) overlaps with area under consideration for priority scheme selection. The previously mentioned Sikta and Babai schemes are included within this area. The feasibility study for this large

scale project was completed in 1989, and it is necessary in the future to assess its priority as an alternative plan to the Bheri-Babai Diversion Project.

(5) Bheri-Babai Diversion Project

Under the subject Study water balance analysis, cropping of principally 72,000 ha of paddy in the rainy season and 33,000 ha of wheat in the dry season was calculated as possible. In the case of projected yields of 3.0 t/ha of paddy and 2.2 t/ha of wheat, paddy and wheat production would total 216,000 t and 72,600 t, respectively. The economic impact of the project is thus extremely high, since the foregoing production figures achieve the total food production target for the year 2000 for both Bardiya and Banke districts (217,102 t of paddy and 40,835 t of wheat).

Project EIRR is evaluated at over 18%, considering that the Bheri-Babai diversion tunnel will comprise a power generation project, and that the headworks are already completed (MPID2, Volume 3, Table D3-15, Bheri-Babai Diversion Project NCA 53,500 ha, without headwork cost, EIRR = 18.4%).

5.2 Small Scale Irrigation Schemes

Out of the 78 planned projects (see Table 5.2.1) within the small scale scheme category of 1,835 projects, 14 projects were selected as the candidates for priority schemes (Table 5.2.2) according to the criteria and conditions set up in subsequent Section 6.1. Priority scheme components are shown in Table 5.2.3, and site locations are indicated in Figures 5.2.1 to 5.2.14. Project accessibility is described below:

No.	Scheme Name	District	NCA (ha)	Accessibility (from nearest town)	IRR (%)
(1)	Gatte Khola	Rukum	58	32 km from Dang Tulsipur	n.a.
(2)	Majoo Khola	Rukum	41.5	75 km from Dang Tulispur	n.a.
(3)	Rukumkot	Rukum	275	10 days walk from Chinchu or Tulispur	n.a.
(4)	Babiyachaur	Surkhet	325	2 days walk from Birendranagar	18.5
(5)	Surkhet Valley	Surkhet	2,700	in Surkhet municipality	8.7
(6)	Korelli Khola Basin Lift Irrigation	Surkhet	368	3.5 km from Chinchu	n.a.
(7)	Nalgad	Jajarkot	55	30 km from Chourjari	n.a.
(8)	Chaila	Jajarkot	110	n.a.	n.a.
(9)	Garjyangkot	Jumla	200	2 hours walk form Jumla airport	16.6
(10)	Natharpur	Mugu	60	2 days walk form Kalti airport	n.a.
(11)	Dhilamghatta	Mugu	141	2 days walk form Kalti airport	14.7
(12)	Doti Khola	Dadeldhura	170	8 hours walk from Dadeldhura	n.a.
(13)	Kakari-Melghat	Baitadi	65	40 km from airport	12.1
(14)	Dharigad	Darchula	300	60 km from Baitadi	12.8

Note: n.a. means "not available."

From the above, following three schemes are concluded to have good accessibility:

(5) Surkhet Valley Irrigation Project
(6) Korelli Khola Basin Lift Irrigation Project
(9) Garjyangkot Irrigation Project

6. SELECTION OF PRIORITY SCHEMES

6.1 Criteria and Conditions for the Selection of Priority Schemes

Following criteria and conditions are set up for the selection of priority schemes.

(1) Large Scale Irrigation Schemes

(i) Since these schemes are located in the Terai Ecological Belt, they should comprise long term water resources development projects aiming at self sufficiency of principal food crops in line with national food production targets.

(ii) IRR for economic evaluation is above 10%.

(iii) On-going projects under rehabilitation or other foreign agency fund are excluded.

(2) Small Scale Irrigation Schemes

(i) Accessibility from project site to nearest town is good, and nearby markets exist for farm products.

(ii) Study has been completed by DOI of scheme area, beneficiaries, target crops, design water source, etc. and project features and benefits are consequently clearly defined.

(iii) Top priority is given to gravity irrigation, with lift irrigation considered the next best option.

(iv) Upper ceiling for project site altitude is 2,500 to 2,600 m.

(v) Upper ceiling for headrace canal length to site is roughly 5 to 10 km in light of operation and maintenance issues.

6.2 Priority Schemes

Priority schemes as selected from among the large scale and small scale irrigation potential projects are as follows:

Scheme	District	Net command Area (NCA: ha)
Large scale irrigation priority scheme:		
Bheri-Bahai Division	Bardia and Banke	Monsoon season: A = 72,000 Winter season: A = 33,000
Small scale irrigation priority scheme		
Surkhet Valley	Surkhet	A = 2,700
Korelli Khola Basin Lift Irrigation	Surkhet	A = 368 (lift irrigation from river)
Garjyang Kot	Jumla	A = 200

7 INVESTIGATION FOR THE IRRIGATION PRIORITY SCHEMES

7.1 Bheri-Babai Irrigation Scheme

7.1.1 Project Description

A net command area of about 74,270 ha is available for the Bheri-Babai irrigation scheme as shown in Figures 7.1.1 and 7.1.2. Of this, about 40,000 ha lies in Bardiya district east of Karnali main stem as Babai irrigation project, of which Stage I extends in the left bank of the Babai River with a net command area of 13,500 ha. Stage II lies in the west (right) bank of the Babai River with small areas extending downstream and east of Stage I, commanding a net irrigation area of 26,500 ha. Meanwhile, an area of 34,270 ha lying in Banke district was previously planned to be developed with water from the Rapti River under Sikta irrigation project.

Natural flow of the Babai River can irrigate about 13,500 ha only, which coincides with Stage I of the Babai irrigation scheme. To fully develop 40,000 ha of Babai irrigation project, other water sources were sought, and transbasin from the Bheri River to the Babai River was found to be one of the promising ways.

The feasibility studies for the Babai irrigation scheme were carried out by Tahal Consulting Engineers in 1978 and its detailed designs were prepared by Sir M. MacDonald and Partners in 1981. According to their studies, the project has been planned to be developed in two stages : Stage I will include construction of a diversion weir in the Babai River, a canal intake and a settling basin with a capacity to serve 40,000 ha as well as construction of an irrigation and drainage system for 13,500 ha lying in the eastern bank of the Babai River.

Stage II will construct a diversion tunnel to transfer water of 35 m^3/sec from the Bheri River and extend an irrigation area of 5,500 ha situated in the eastern and southern flanks of Stage I area as well as an irrigation and drainage system for 21,000 ha extending in the western bank of the Babai River. In addition, diversion of 35 m^3/sec from the Bheri River will generate 24 MW of hydropower. Master Plan for Irrigation Development in Nepal Cycle 2 (MPID2) reformulated the project to entail a diversion of 60 m^3/sec from the Bheri River to the Babai River basin. The water balance studies indicated a possible development of about 53,500 ha of net command area, NCA, incorporating the Babai and Sikta irrigation project areas.

7.1.2 Present Condition

The works for Stage I of the Babai irrigation project started in 1988. A 270 m long diversion weir accommodating a road bridge of the East-West Highway has been completed, and the bridge opened its service for traffic since July 1992. A canal intake with a designed capacity of 53 m^3/s and a settling basin, about 1 km in length, lying downstream of the intake with a crump weir and flushing sluices were constructed.

The remaining works of Stage I will include the construction of 28 km long main canal and about 700 km long conveyance canals as well as the preparation of feeder roads and forest clearance of 1,150 ha in Khumber Cotton Project area. Due to budgeting constraints, these works could not be started yet, but budget was allocated to construct the first 5.5 km of the main canal in fiscal year 1992/93. This will enable to supply silt free water to local canal systems to irrigate about 4,000 ha in the project area. HMG/N now faces difficulties in finding financial sources to complete the Stage I works.

<Babai Irrigation Project (Remaining Works of Stage I)>

With the construction of the diversion structure completed at present, a five year implementation schedule starting from 1992 and ending in 1997 has been proposed for construction of the irrigation and drainage system (refer to Figure 7.1.3). The construction of main, secondary and branch canals, drains, and access and canal service roads is proposed to be implemented with the Government and donor agency funding, whereas the construction of tertiary canal system is proposed to be implemented with farmers' participation in line with Government policy. It is expected that the feeder channels will be constructed by the farmers, for which the project will provide technical assistance.

Main work items are as follows :

Main canal (lined)	7 km
Main canal (unlined)	21 km
Branch canal (lined)	5 km
Secondary canal	169 km
Tertiary canal	400 km
Main and Secondary drains	315 km.

<Babai Irrigation Project (Stage II)>

Only the intake site has been determined as of yet for the command area of 21,000 ha. The said intake site is located on the right bank as the starting point for the main canal under

Stage I, from where water is planned to convey by siphon under the Babai River for irrigating the design command area. Due to the priority placed by the Babai Irrigation Project Office on the Stage I of the project, the boundaries of the design benefit area of 21,000 ha under Stage II have not yet been determined, although canal design has not been formulated.

<Sikta Irrigation Scheme>

The prefeasibility study of the project was conducted from January 1975 to June 1978. Feasibility study was conducted by the German Consultant Lehmeyer International (Gmbh) from November 1978 to August 1980 and the feasibility of the project with run-of-river diversion alone was established. On the basis of these studies, the Department of Irrigation, Hydrology and Meteorology of HMG/N (DIHM) established its full fledged office in Nepalgunj in November 1981 for detailed investigation, planning, design and execution of the project.

Under the project, a diversion weir will be constructed on the Rapti River, and water is conveyed to the command area by a 36 km long main canal. The original implementation schedule called for construction over a 11-year period of 1982 to 1993 at a total cost of Rs.1.35 billion (1982 prices). However, the project remains unimplemented to date.

7.1.3 Water Sources

The Babai River, which originates from the Siwalik hills and has a catchment area of 300 km^2 near the intake site, flows east to west before emerging from hills to the Terai plain. Average annual flow at the site is 82 m^3/sec with a range of 10 to 241 m^3/sec.

The Bheri River, a major tributary of the Karnali River system, which originates in the Himalayan region, has a catchment area of about 12,000 km^2 at the diversion point. The recorded minimum and maximum monthly flows are about 80 m^3/sec and 1,470 m^3/sec respectively with a long term average annual flow of about 438 m^3/sec.

Since natural flow of the Babai River cannot meet the full development of the Babai irrigation scheme, it is necessary to divert water from the Bheri River to the upstream point of the diversion weir constructed in the Babai River with a 8.5 km long tunnel. Head of about 180 m is available for hydropower generation.

For the Sikta command area, the Rapti River has been thought as a water source. Although ample flow is available in the Rapti River, the construction of 36 km long main canal increases the project cost.

7.1.4 Land Use Plan

On the basis of the Karnali Multipurpose Project Study and the study by the irrigation engineer of this Study Team, the land use of the Bheri-Babai Irrigation Scheme is summarized as follows :

	Land Use Plan	%
Present Rainfed Arable Land (Suitable for Irrigation)	49,100 ha	52.7 %
Present Irrigation Land (Suitable for Irrigation)	25,200 ha	27.1 %
Total Potential Irrigation Area 1	74,300 ha	79.8 %
Present Forest and Grass Land (Suitable for Irrigation)	11,900 ha	12.8 %
Others (Unsuitable for Irrigation)	6,900 ha	7.4 %
Total	93,100 ha	100 %

The boundaries of the scheme are the Royal Bardiya National Park to the north, Dundawa Khola to the east, the Indian border to the south and Arahi Nalah to the west.

7.1.5 Proposed Cropping Pattern and Water Balance

The command area of the Bheri-Babai irrigation scheme is divided into three types in terms of cropping pattern as follows :

Type I : Babai Irrigation Project, Stage I (A= 13,500 ha)
Present cropping intensity : 123 %
Design cropping intensity : 175 %
(refer to Table 7.1.1 and Figure 7.1.4)

Type II : Babai Irrigation Project, Stage II (A= 26,500 ha)

Type III : Sikta Irrigation Scheme (A = 34,270 ha)
Proposed cropping intensity : 123 %
(refer to Table 7.1.2).

Main crops planted for the respective types are as follows :

Type I and II (Babai Stages I and II) : paddy, maize, cotton, groundnut and vegetables in the wet season ; wheat, pulses, oil seed and vegetables in the dry season

Type III : (Sikta) paddy, maize, mustard, pulses, potato and vegetable.

Of the above cropping types, the Type II (Babai Stage II ; A = 26,500 ha) has not been established either in actuality or at the planning stage. Furthermore, the Type III (Sikta ; A = 34,270) remains at the same stage as it was in 1981 and accordingly should be reviewed. On the basis of the foregoing, water balance calculation with the diversion flow from the Bheri River was carried out using hydrological data of 16 years between 1967 and 1986 (missing for three years) for the cropping pattern below as recommended at MPID2 under this Study:

Monsoon Season (MS) : cropping intensity 142 % (paddy and wheat)

Year round-current (YR/C) : cropping intensity 192 % (paddy, wheat and sugarcane).

Required irrigation discharge varies for each type of cropping pattern. Required discharges ($m^3/s/ha$) under the Study, the Babai Irrigation Project (Stage I) and the Sikta Irrigation Scheme are compared in Table 7.1.3. As can be seen from the Table, the required discharge under the Study somewhat exceeds that for the existing schemes.

In the future, it will be necessary to carry out a further cropping pattern study for Babai (stage II) and the Sikta irrigation scheme and on this basis to expand the irrigation area under the Project for winter season cropping.

7.1.6 Benefits

Benefit generated by the Bheri-Babai Irrigation Scheme was calculated by applying project crop data from the ongoing Babai Stage I (A = 13,500 ha) to the total command area under the Bheri-Babai scheme (A = 74,270 ha), since the cropping patterns have not been well determined for Type II and III.

Annual per hectare benefits on the basis of the project crops cultivated area and percentage of crop command area (CCA) are shown in Table 7.1.4 as average group budgets at economic prices. Individual crop budgets and input cost data are shown Tables 7.1.5, 7.1.6 and 7.1.7. Above crop budgets were calculated by applying World Bank and Babai Irrigation Project economic prices in 1992/1993 (refer to Table 7.1.8).

7.1.7 Proposed Implementation Schedule

The Project plans to develop all the command area of 74,270 ha in three steps by year 2010 as follows :

Step 1 : Babai Irrigation Project (Stage I and Stage II-1~3 areas to be completed by 1997 under the DOI plan. Total Project area is 19,000 ha)

Step 2 : Next, the Bheri ~ Babai diversion tunnel is to be completed.

Step 3 : Babai Irrigation Project, Stage II (A = 21,000 ha) and the Sikta Irrigation Project (A = 34,270 ha).

Timing for the above schedule is as follows :

Babai Stage I (A = 13,500 ha)	1993 ~1997
Babai Stage II-1~3(A = 5,500 ha)	1993 ~1997
Bheri ~ Babai diversion tunnel	1995 ~2000 (including 3 year study)
Babai Stage II (A = 21,000 ha)	2001 ~2007 (including 2 year study)
Sikta Irrigation (A = 34,270 ha)	2001 ~2010 (including 2 year study).

7.1.8 Project Cost

According to preliminary estimate by DOI in October 1992, the Babai Irrigation Project, Stage I (13,500 ha) scheduled for implementation during 1992 to 1997 would require a total project cost of Rs. 1.65 billion including physical contingency. On this basis, estimated costs for Babai Irrigation Project, Stage II - 1 ~ 3 and the Sikta Irrigation Project total Rs. 12.1 billion as shown in Table 7.1.9.

7.1.9 Project Evaluation

Project evaluation was carried out in economic viability. Following conditions were applied for the economic evaluation:

(1) Construction schedule and cost disbursement are assumed as follows (refer to Table 7.1.9)

Babai Stage I :	5 years (10 %, 25 %, 30 %, 25%, 10%)
Babai Stage II 1 ~ 3 :	4 years (10 %, 30 %, 50%, 10%)
Babai Stage II :	5 years (10 %, 25 %, 30 %, 25%, 10%)
Sikta :	8 years (5 %, 10 %, 15 %, 20 %, 20 %, 15 %, 10%, 5%).

(2) Economic cost is 85 % of total construction cost (refer to Table 7.1.10).

(3) O/M cost is 3 % of direct construction cost (refer to Table 7.1.10).

(4) Production benefit is assumed to be generated following the completion of construction as follows (refer to Table 7.1.10) :

Babai Stage I :	5 years (5 %, 15 %, 30 %, 50%, 100%)
Babai Stage II 1 ~ 3 :	4 years (10 %, 30 %, 60%, 100%)
Babai Stage II :	5 years (5 %, 15 %, 30 %, 50%, 100%)
Sikta :	8 years (5 %, 15 %, 30 %, 50 %, 70 %, 90%, 100%).

Based on the above costs and benefits, economic internal rate of return (EIRR) was gained to be 17.1 % for a project life of 50 years (refer to Table 7.1.11). Under this Study, it was assumed that benefit would be generated at a full constant level under the Project. However, it is necessary under future study to examine the possibility of benefit fluctuation due to adverse weather conditions, pest outbreak and so on.

It is furthermore noted that the costs necessary for the construction of Bheri-Babai diversion tunnel and diversion weir built in the Babai River with design discharge of 53 m^3/sec are not included. The former scheme is planned to be developed as an independent hydropower scheme, and the latter scheme is treated as a sunk cost due to its completion.

7.1.10 Future Development

The diversion weir and the head works for the Babai irrigation project are already constructed with a design diversion flow of 53 m^3/sec from the Bheri River. If the diversion flow is increased to 60 m^3/sec or so, additional works will be required for the headworks and the main canal. An alternative would be to construct a new intake and a main canal upstream of the existing diversion weir. This will enable irrigation of the areas lying upstream of the Babai irrigation command area, but will be a costly option. Another option is to line the main canal of the Babai irrigation project, most of which is unlined with a number of falls for increasing its flow capacity. Even if this option is adopted, the 6 km long main canal just downstream of the settling basin shall newly the constructed.

Another important consideration to be taken into account is an impact to the natural environment of the proposed diversion scheme. Some amount of flow must be secured to protect aquatic fauna as well as the use of local people lying in the downstream reaches of the diversion weir built in the Bheri River. There exist small scale irrigation projects to use groundwater in the downstream reaches of the existing Babai diversion weir. Since the diversion of water to the command area of the Babai irrigation project may cause the depression of groundwater level, countermeasures for those small irrigation projects will be required. The impacts to the natural and social environments will further be discussed in the Section 4.2 of Appendix III, which deals with the initial environmental examination for the Bheri-Babai irrigation scheme.

The diversion project could be viewed as the first step of irrigation development schemes planned in Karnali (Chisapani) Multipurpose Project. If the Chisapani high dam is constructed in future, the left bank canal extended from the Karnali reregulating dam can be connected to the Babai main canal near the head works. Nevertheless, this diversion project can proceed as a self-contained project irrigating a land of about 74,000 ha well in advance of the main Karnali development.

7.2 Surkhet Valley Irrigation Scheme

7.2.1 Existing Schemes

There are six small irrigation schemes with a total command area of 764 ha in the Surkhet Valley as shown in Figure 7.2.1, and those are managed by District Irrigation Office (DIO). The water sources for these schemes are such small rivers as the Khorke Khola, Itram Khola and Ghokreni Khola with the sub-surface flow in the middle reaches in dry seasons. Of six schemes, the Bulbule lift irrigation project utilizes springs as a water source for irrigating a cultivated land of 23 ha.

Some of these schemes were constructed by receiving the financial aid from a programme called Karnali-Bheri Integrated Rural Development (KBIRD), and then handed over to DIO. Rehabilitation and maintenance works are currently carried out by DIO. Due to low water availability, these schemes could not develop the command area fully.

Besides the irrigation areas, an area of about 2,000 ha is practiced under the rainfed condition in the valley; that is, cultivation is fully dependent on the onset of monsoon for paddy and timely winter rain for wheat. Small patches of lands are being irrigated by utilizing waters from springs, but the yields from these sources are very low.

7.2.2 Water Sources

There is a scarcity of water in the Surkhet Valley in dry seasons. The rivers flowing across the valley are of seasonal type with high flows in the monsoon season and very little flow in the dry season. Another potential source of water is farming ponds of springs or shallow wells. Lift irrigation from the Bheri River which is about 200 m down below the valley level, however, requires high cost for operation and maintenance. Groundwater potential was also investigated by the Study Team, however, promising sources were not so far detected. In this direction Study Team reviewed Chingar Khola diversion pre-feasibility study which was carried out by DOI in 1989, and sought a reliable water source for Surkhet Valley irrigation development (refer to Fig. 7.2.2).

During the field investigation of Phase III, surveys were conducted to search for and to assess the water sources for the irrigation schemes as discussed below.

(1) Surface Flow

A number of rivers, i.e. the Bharuli Khola, Banspani Khola, Khorke Khola, Itram Khola, Niware Khola and Gagse Khola (refer to Figure 7.2.1), drain water from the Surkhet Valley to the Bheri River. Flow of these rivers is high in the monsoon period, and then decreases rapidly after the monsoon. During dry seasons, very little flowing water can be seen in the upper reaches of the rivers, and the middle reaches are nearly dry exposing the boulder bed. Flowing water can again be seen in the lower reaches near the outlet of the valley, and is more ample than in the upper reaches. This situation makes it difficult to use surface water in the valley for the irrigation schemes extended in the upper or middle reaches without pumping. It is noted that the drinking water supply system has already sought a water source to the upper reaches of the Itram Khola and is planning to tap water from other rivers in the valley in future (refer to Figure 7.2.3).

A perennial river, the Jhupra Khola, flows north to east of the valley. A discharge measurement carried out on December 30, 1992 near its confluence with the Bheri River gave a flow of about 1 m^3/sec. In this case also, Department of Water Supply and Sewerage (DWSS) has proposed to build an intake to draw an amount of 88 l/sec for drinking water supply (refer to Figure 7.2.3). A small hydropower plant with an installed capacity of 345 kW is furthermore installed in this river. Hence, the possibility of utilizing this river as a source of irrigation is low.

(2) Springs

The fact that there exist a number of springs in the area shows appreciable groundwater potential in the valley. During the field investigation of Phase III, the Study Team observed nine springs lying in various parts of the valley as briefed below:

Barge Simal Village Well

This spring is situated in the Barge Simal Village Ward No. 1 near the Bharuli River. The well in the form of a square tank is used for drinking and washing by about 300 ~ 400 people. During rainy seasons, the well is over-flowing. The location of this spring is identified with alphabet "a" in Figure 7.2.1.

Bulbule in Barde Simal Village

This spring "b" is located near the Barge Simal spring and is similar to it in nature. A hollow tree trunk is driven inside the well to collect water. The yield as small as 0.3 l/sec is mainly used for drinking and washing.

Chisapani in Barge Simal Village

This spring "c" is located in the depressed land downstream of the Bulbule spring. A pond with bubbling water is formed in the middle of swampy land. A small channel is constructed to introduce water from the pond to the irrigation fields extended in the downstream area. The flow is about 1 to 2 l/sec.

Uttraganga

This spring "d" is located inside the temple premises lying in Uttraganga VDC. A rectangular pond with two taps was constructed to collect outflow, which is constant throughout the year and is about 1.2 l/sec.

Mulpani

This spring "e" is also located in Uttraganga VDC. A number of sources can be seen in a stretch of marshy land. According to local people, some of the sources may dry up in

April and May, but the main source supplies water all the year. Total flow of this spring is about 10 l/sec.

Lakshmipur

This spring "f" is located south of Uttraganga VDC and is submerged during the monsoon season by flood water of the Nikas Khola. Flow is estimated to be less than 1 l/sec.

Nanpur

This spring "g" is located near the road in Nanpur village and is used for drinking and washing purposes. Flow is estimated to be about 0.25 l/sec.

Patalganga

This spring "h" is located south of reserved forest. A rectangular tank with two taps was buried in it. Flow from the taps is estimated to be about 1 l/sec.

Bulbule

This famous spring "i" is located in the recreational centre south of the highway. A big tank with ten taps was buried to collect water. This spring with a capacity of about 20 l/sec is used for bathing and washing of local people. During night, water is pumped at a rate of 6 l/sec from the pond to the storage tank for supplying drinking water. The Bulbule lift irrigation project is a scheme to utilize water available at the downstream reaches of this spring.

(3) Deep Wells

In anticipation of finding an appreciable groundwater source, DWSS bored three deep wells with a depth of 200 m in July 1991 including the carrying-out of the electric resistivity tests in various parts of the valley as discussed below :

Boring site # 1

The site is located near the Bulbule spring as seen as No. 1 in Figure 7.2.1. An aquifer with a yield of about 1.5 l/sec was encountered at a depth of 7 to 8 m by the boring works carried out for a period of July 6 to July 19, 1991, but no other aquifer was found below that level. Water is now flowing out from the pipe installed in the borehole.

Boring site # 2

This site is located in the cultivated field of Piparia village. Boring works started on July 25, 1991, but struck no aquifer at this site, so the site is abandoned.

Boring site # 3

The site is located in the playground of the school in Latikoilli village. One aquifer with a yield of 3 l/sec was struck at a depth of 112 to 119 m by the boring works carried out in July 1991.

Boring works to drill up to a depth of 200 m at three sites do not show any considerable groundwater potential. In order to grasp a clear picture of groundwater potential in the valley, the Study Team also conducted a hydrogeological survey in the valley through the field investigation of Phase III as discussed in the Section 5.2 of Appendix I and briefed as below.

7.2.3 Hydrogeological Survey in Surkhet Valley

Hydrogeological investigation was carried out to search for groundwater in the Surkhet Valley by electric survey. The condition of site where the investigation was carried out is summarized as follows :

Location : Birendranagar and its suburbs, Surkhet district

Accessibility : Motorable road is connecting the area to Nepalganj, whilst access by air is available from Kathmandu and Nepalganj.

Electric surveys were carried out at three sites as depicted in Figure 7.2.4, whilst the survey results are given in a form of resistiviey profile as shown in Figure 7.2.5. Following deal with the results of electric survey :

(1) Geomorphology

The intermountain basin called "dun(doon)" is known to occur between the Siwalik mountain range and the Mahabharat mountain range. Surkhet Valley is one of the largest duns in Nepal with a flat land of more than 60 km^2 in the altitude ranging from 2,100 ft. to 2,300 ft. above mean sea level. Four major streams running down to south in the valley meet at the southern end of the flat land to form the Nikas Khola, a tributary of the Bheri River.

At the foot-hill of the Siwaliks extended in the northern part of Surkhet Valley, those four streams are forming the fans composed of loose and highly permeable boulder bed, resulting in scarcity of the surface water in the reaches during the dry season. In the southern half of the flat land, sub-surface soil is impervious massive dark gray silty mud, causing the ill-drained paddy field.

(2) Hydrogeology

The surface flow of the four rivers running across the valley is quite limited in the dry season, and most of the surface water in the upper reaches is used for drinking and/or for the small scale irrigation.

The middle reaches of the rivers are completely found dry during the field survey conducted in January 1993. At the central part of the valley, between the middle reaches and the lower reaches of the rivers, a number of springs are known to occur, and most of these springs are located at the "terminal fan". The Study Team investigated nine springs and gave brief descriptions for each spring as mentioned in the preceding 7.2.2, Water Sources.

The largest one was measured at the famous Bulbule spring where groundwater of 20 l/sec is pouring out. Next to the Bulbule spring is Mulpani spring located in Uttraganga, which is pouring out about 10 l/sec. All of the other springs yield less than 2 l/sec. The fact that the lower reaches of the streams are draining much water than the upper reaches suggests that the maximum quantity of water could be obtained at the Nikas Khola, the only stream flowing out from the valley.

(3) Electric survey

To study the status of groundwater in the dried-up middle reaches of the stream, three lines of electric survey were conducted by Dipole-Dipole configuration along the Itram Khola (refer to Figure 7.2.4). As is clearly shown in the resistivity profile of Line-1 (refer to Figure 7.2.5), the iso-resistivity line is getting deeper towards the downstream reaches, whilst at the Line-2, which is located close to the terminal fan, the iso-resistivity line is getting shallower towards the downstream reaches. Since the iso-resistivity line is parallel to the groundwater table, the survey result could explain the mechanism of springs at the terminal fan.

The Line-3 was arranged perpendicular to the stream. The iso-resistivity line is shallow at the dried-up river bed, suggesting that the groundwater is being recharged with the

under flow water of the river bed. Another low-ressistivity was detected at the depth of 15 m of the Station No. 5, which might be buried in the ancient river channel.

(4) Conclusive remarks

It is concluded that the potential for development of groundwater as a source of irrigation water is not good for the Project area on the basis of electrical prospecting and data from three sites of test drilling carried out by the Department of Water Supply and Sewerage. The reasons for this are set out below.

According to the results of electrical prospecting, variation in resistivity values is small to a depth of 20 m below ground surface. Although a stable water bearing layer is anticipated to be present, pump-up per existing well is under 10 l/sec, which is not suitable for agricultural purposes. Furthermore, resistivity values show almost no change to 20 ~ 50 m depth below the surface. As a result, it is concluded that the possibility is high that this portion of ground is a clayey layer of lake sediment.

Test drilling data indicate distribution of clayey layer to 200 m depth, also suggesting that ground in flat areas as well most likely consists of clayey lake sediment. Also, electrical prospecting results yield resistivity values of 100 ~ 300 Ωm at 20 m depth, indicating the possibility of a sandy ~ clayey layer.

Furthermore, since the above geological composition implies the potential for ground subsidence as a results of goundwater pump up, groundwater exploitation, even in such case, should be limited to the fan area with careful consideration to possible impact on existing springs.

7.2.4 Proposed Cropping Pattern and Water Balance

(1) Cropping Patterns

<Present Cropping Pattern>

About 77 percent of the existing land is used for cultivation, whilst the rest is occupied by forests, settlements, streams and barren land. Paddy, wheat, mustard, potato and vegetables (onion, garlic and so on) are the important crops that can be grown in the area. The soil condition and the climate condition prevailing in the area favour cultivation of irrigated crops. Irrigation can bring substantial change in the area.

The farmers of the Project area also grow some wheat, millet and potato. The yield rate is low due to the absence of irrigation facilities. Total cropped area is 3,250 ha and present cropping intensity is 120 %. The overall present cropping pattern in the area is presented below:

NCA = 2700 ha, GCA = 3000 ha

Crops	Area under cropping (ha)	% of total cropped area
Paddy	2,300	85.18
Mustard	450	16.7
Vegetables (onion, garlic)	500	18.52

<Proposed Cropping Pattern>

Irrigation can bring substantial changes in the cropping pattern of any rainfed area. However the extent of changes depends on the availability of sufficient water throughout the year, on the economics of individual crops grown under irrigated condition and on the farmer's preference of crops for home consumption and market purposes. Future cropping pattern of the command area will depend upon the availability of water for irrigating winter and summer crops. The following cropping pattern has been planned in the command area to make maximum utilization of available water (refer to Figure 7.2.6):

NCA = 2700 ha, GCA = 3000 ha

Crop	Area planned (ha)	% of total cropped area	Growing season
Paddy	2,300	51.11	1 Aug ~ 21 Oct
Summer vegetable (onion)	1,000	22.22	15 Mar ~ 30 Jun
Wheat	700	15.56	15 Nov ~ 15 Mar
Potato	300	6.67	15 Nov ~ 31 Mar
Oil seed(mustard)	200	4.44	15 Dec ~ 15 Mar
Total	4,500	100	
Cropping intensity	(166.7 %)		

(2) Water Balance

There is no reliable water source in the Surkhet Valley. Therefore, the introduction of water from Chingar Khola, which is located outside of Surkhet Valley basin with a catchment area of 153 km^2, was sought (refer to Figure 7.2.2). A water balance study confirmed that the introduction of the Chingar Khola makes it possible to irrigate the NCA of 2,700 ha in the Surkhet valley (refer to Table 7.2.1).

7.2.5 Benefits

Incremental gross margin of without and with project at economic prices in 1993 was calculated. The project will result in the incremental gross margin of Rs. 58,672 million and gross production of 33.14 million tons per annum.

Individual incremental gross margin of corps per annum is shown Table 7.2.2 and 7.2.3.

7.2.6 Project Cost

The total project cost consists of initial investment cost and maintenance cost. The effective life of the project is estimated for 30 years after the completion of construction work. Cost as set out in the Surkhet Valley Irrigation Feasibility Study Report (DOI, 1991/92) is Rs. 313 million. Present cost is estimated at Rs.440 million based on the above feasibility study report including escalation factors of local cost recommended by Babai Irrigation Project office.

7.2.7 Project Evaluation

The project was evaluated in economic viability. Conditions given for the economic evaluation are as follows :

(1) Costs required for the construction are disbursed into five years as follows: 25 %, 25 %, 25 %, 15 %, 10 %.

(2) Production benefits increase following the completion of construction as follows :
6th year to 10th year : 15 %, 25 %,50 %,75 %, 100 % .

(3) Economic cost is 85 % of total construction cost.

(4) O/M cost is 3 % of direct construction cost.

Based on the above costs and benefits, economic internal rate of return (EIRR) was gained to be 6.0 % for a project life of 30 years (refer to Table 7.2.4).

7.3 Korelli Khola Basin Lift Irrigation Scheme

7.3.1 Project Description

The scheme is located in the eastern part of Surkhet district, on the left bank of the Bheri River as shown in Figure 7.3.1. The command area comprises wards 4,5,6,7,8 and 9 of Ram Ghat Village Development Committee. A survey carried out by VDC in 1988 showed a population of 3,750 and a command area of 368 ha in the project area.

There is no such Khola which can supply perennial irrigation water to Korelli Khola basin by gravity. Water balance calculation in MPID2 indicates that this basin has insufficient water to serve the existing irrigation lands, even at the monsoon season when ample water is available. The only means available to improve the situation will be a scheme to lift water from the Bheri River with relay pumps to a head tank for distribution to an irrigation command area of 368 ha.

7.3.2 Water Sources

There are a number of small streams in the area draining monsoon water into the Bheri River. Since these streams are seasonal, they have not been used for irrigation. At present, a command area of 166 ha is cultivated under the rainfed condition. The Bheri River flows about 30 to 40m below the lowest command area. In order to irrigate the whole of the command area, water should be pumped to the tank lying at the highest point in the area. Head required for such pumping is more than 100m.

7.3.3 Cropping Pattern

Paddy is the major crop in the area, covering about 70% of the cropped area in the monsoon season. Maize is grown in the remaining 30% of land. The time and period of cultivation are largely dependent on the onset of monsoon. The crop production is governed by the amount of rain. In winter, wheat, barley and millet are sown in the field. If winter rains occur in time, some yield may be harvested, otherwise no yield is to be obtained.

A proposed cropping pattern is shown in Figure 7.3.2.

7.3.4 Benefits

Incremental gross margin of without and with project at economic price in 1993 was calculated. The project will result in the incremental gross margin of Rs. 10,995 million and gross production of 995 tons per annum. Individual incremental gross margin of crops per annum is shown in Table 7.3.1.

7.3.5 Project Cost

Under the project, water is to be lifted from the Bheri River by main and relay pumps to the head tank for distribution to an irrigation command area of 368 ha.

Salient pump features are as follows :

Type :	horizontal double suction multi-stage turbine pump
Main pump :	Q = 9.0 m^3/min x 3 units, H = 60 m, P = 450 kW
Relay pump :	Q = 9.0 m^3/min x 3 units, H = 40 m, P = 330 kW.

Initial cost includes diversion facilities, pump equipment, electrical equipment, transmission line (L = 20 km from Birendranagar) and irrigation facilities. Running cost assumes electric power charge of Rs. 2.6/kW-hr for the pump operating period of 12 months and the beneficiary population of 3,750 (estimated 750 households).

The total project cost consists of construction cost, replacement cost of pump facilities, O/M cost and electric charges for pump operation. The O/M cost is estimated at three percent of direct construction cost. The electric charges of pump operation per annum are Rs. 3,723 thousand. The breakdown of construction cost is given as follows :

Work item	Cost (unit : thousand Rs)
Diversion facilities	4,000
Pump and mechanical equipment	19,000
Electrical equipment	4,000
Transmission line	11,000
Irrigation facilities	6,000
Total	44,000

7.3.6 Project Evaluation

The project was evaluated in economic viability. Conditions given for the economic evaluation are follows:

(1) Construction costs are disbursed into three years:
20 %, 10 %,70 %.
Pumping equipment is assumed to be installed in the third year.

(2) Production benefits increase following the completion of construction as follows:
4th year to 7th year : 50 %,70 %, 90 %, 100 %.

(3) Economic cost is 85 % of total construction cost.

(4) O/M cost is 3 % of direct construction cost.

(5) Electric power charge is Rs. 3,723 thousand per annum.

Based on the foregoing costs and the benefits, economic internal rate of return (EIRR) was gained to be 7.3 % for the project life of 30 years (refer to Table 7.3.2).

7.4 Garjyangkot Irrigation Scheme

7.4.1 Project Description

The project area is located in Garjyangkot village of Jumla district, Mid Western Development Region as shown in Figure 7.4.1. The command area extends on the northern slope of hills lying on the right bank of the Tila River. A feasibility study of the scheme carried out in 1986 by Feasibility Study Project, DOI, shows its feature with a 5.8 km long canal and a net command area of 200 ha. The project area is connected to Jumla Khalanga, the district and zonal headquater, by trails, but Jumla itself is not connected by roads yet. Thus transportation is one of main shackles to develop the scheme. The climate in the area is temperate and sub-tropical.

7.4.2 Water Sources

The water source for the scheme is the Talpunerd Khola or called Dudeli Khola. The stream originating from the hills with snowfall has a catchment area of about 16 km^2 at the intake site about 500 m upstream of the confluence with the Tila River. The minimum flow recorded in winter, which is about 800 l/sec, increases with snowmelt starting in March and reaches the peak in monsoon. Water available in the stream meets the irrigation demand.

7.4.3 Present Condition

District Irrigation Office of Jumla has already started the construction of canal. A 3.8 km long canal has been excavated, of which about 350 m near the intake is lined. Due to budgetary constraints, the works do not proceed further. However, the local people made a temporary intake at the new site 200 m downstream of the original site. People place a half hollowed tree trunk in the stream to introduce water into the canal in May and June. About 100 m from the intake, the canal runs through landslide-prone hill. The canal has to be cleared every year and there is a lot of leakage. So, the water available at the user's end is little and can irrigate about 30 ha of paddy field only. At the onset of the monsoon, the canal will be closed to protect it from flooding. Hence, irrigation is available only for two to three months for a small area.

7.4.4 Cropping Pattern

Single cropping is applied at present due to unavailability of water and climatic conditions. Paddy is grown in about 40 ha of land with limited irrigation. Seeds are sown in nursery beds in early June and saplings are planted after one month. The harvesting of paddy is done in November/December. Wheat is another major crop grown in the area. The seeds are sown during December/January. After the snow melts, the wheat stalks come up and harvest is in May/June. The case is similar for barley and millet. A stretch of land near the intake site cited in the feasibility report as command area is used now as grazing land. Apples and apricots are planted in a small orchard. A proposed cropping pattern is shown in Figure 7.4.2.

7.4.5 Benefits

Incremental gross margin of without and with project at economic price in 1993 was calculated. The project will result in the incremental gross margin of Rs. 6.0 million and gross production of 932 tons per annum. Individual incremental gross margin of crops per annum is shown in Table 7.4.1 at economic prices.

7.4.6 Project Cost

The scheme consists of a weir type structurd at Talpunerd Khola. The total length of the canal is 5.8 km, of which 400m is the idle length. At present the first 3.8 km long portion of the canal has been excavated. The cost estimate is as follows:

Work items	Cost (unit : thousand Rs)
Intake	7,400
Drop structures	3,000
Cross draining works	400
Outlets	650
Escape	100
Canal works (L =5.8 km)	8,400
Irrigation Facility	3,000
Land acquisition	400
Miscellaneous cost of 5 %	1,000
Contingency of 10 %	2,100
Total	26,450

7.4.7 Project Evaluation

The project evaluated in economic viability. Conditions given for the economic evaluation are as follows :

(1) Construction costs are disbursed into three years ;
30 %, 40 %,30 %.

(2) Production benefits increase following the completion of construction as follows ;

4th year to 7th year : 50 %,70 %, 90 %, 100 %.

(3) Economic cost is 85 % of total construction cost.

(4) O/M cost is 3 % of direct construction cost.

Based on the foregoing costs and the benefits, economic internal rate of return (EIRR) was gained at 14.7 % for the project life of 30 years (refer to Table 7.4.2). It is noted that the construction cost for the existing 3.8 km long canal is treated as sunk cost in the economic evaluation.

7.4.8 Future Development

The project is already under construction, postponed for lack of funds. The water availability from the source is adequate and installation of a micro hydropower plant is an available option. The canal running along the hill contours needs lining at most places due to seepage problems. The command area can be increased by extending the canal to west. The area is suitable for paddy cultivation and horticulture.

8. IRRIGATION DEVELOPMENT FOR THE STRATEGIC AREAS

8.1 Jumla Strategic Area

Temperatures in the area never exceed 24°C, and drop to a minimum -5°C in November to February. Mean annual rainfall is 1,000 mm. Elevation of cultivated land is 2,400 to 2,600 m with topographical tilt ranging from 5% to 20%.

Under the above conditions, wheat is cultivated as the main crop along with barley, millet and paddy. However, amounts of grain production are insufficient.

In addition, major fruit crops including apple, peach, apricot and so on are produced. Nevertheless, farms are not well for systematic cropping, and instead fruit trees grow in random and scattered locations around the farm house. Cultivation of vegetables such as pumpkin, gourds, radish, potatoes and so forth is extremely limited due to lack of irrigation facilities and low amounts of sunshine.

Crops are produced primarily for local consumption in the area with surplus marketed in nearby villages. The Garjyangkot Irrigation Project (A = 200 ha) proposed for the area targets the production of staples (paddy, wheat, barley and potato) to the exclusion of fruit crops. In the future, however, it is proposed that an irrigated nursery bed for fruit crops be established to introduce cash crops into the area.

8.2 Surkhet Strategic Area

Development of the Surkhet valley (NCA = 2,700 ha) is considered to be the highest priority. At present, paddy, summer vegetables, wheat, potato and mustard are cultivated in the area. Incremental benefit under irrigation development of the area as described in Section 4.2 is crop production increase of 12,275 t and net production margin of Rs 56,541,000 per annum. In combination with the above development, it is proposed that a domestic water supply plan also be implemented.

8.3 Dipayal-Silgakhi-Rajpur Strategic Area

The total area of Dipayal-Silgadhi municipality is 3,134 ha. Cropped area is 1,029 ha, of which only 200 ha is irrigated. The Dware Khola, Dipayal Khola, Mallo Amalakhet Khola and Kher Khola on the left bank of the Seti River comprise the main water sources of the area.

Irrigation facilities under the Dipayal West and East Irrigation Project (A = 100 ha) completed in 1987, FMIS, etc. exist in the vicinity, and no new irrigation project is planned. In the future, it will be necessary to utilize these existing irrigation facilities to expand agricultural production in the area.

8.4 Baitadi Strategic Area

Small scale irrigation projects comprising Dananigad Irrigation Project (A = 24 ha), Udaya Irrigation Project (A = 10 ha) and Simile Irrigation Project (A = 8 ha) are currently under construction in the vicinity of Baitadi town.

In addition, the Surnayagad Irrigation Project (A = 120 ha) was constructed near Patan airport in 1988. Major crops cultivated under the above projects are paddy, wheat, barley, maize, millets and potato. Horticulture crops include pear, peach, apricot, apple and so on. Irrigation is primarily targeted at lowland paddy to the exclusion of upland maize.

Since there is no large scale irrigation project planned for the area, increased farm production must be accomplished through (i) effective use of existing irrigation facilities, (ii) pest control measures and (iii) fertilizer use.

List of References

Ref. VI-1 DOI. (1990). MPID2 Report.

Ref. VI-2 Ministry of Agrigulture. (1990). Agricultural Statistics of Nepal 1990.

Ref. VI-3 WECS. (1992). Water Use Inventory Studies.

TABLES

Table 1.2.1 PRESENT AND POTENTIAL AREA

(1) Present cultivated area (Net ha)

Unit : ha

	Irrigated area	Potential for Irrigation	No potential for irrigation	Total	Total cultivated area
Mid Western Developmet Region					
Terai	74,000	87,000	6,000	93,000	167,000
Hills	26,000	25,000	134,000	159,000	185,000
Mountains	6,000	5,000	35,000	40,000	46,000
Far Western Development Region					
Terai	63,000	42,000	3,000	45,000	108,000
Hills	17,000	19,000	65,000	84,000	101,000
Mountains	7,000	9,000	32,000	41,000	48,000
Total	193,000	187,000	275,000	462,000	655,000

(2) Potential land use for irrigation (Net ha)

unit : ha

	Potential Irrigable Area		Total Irrigable area	Total remaining irrigable area
	Agricultural area	Non agricultural land		
Mid-Western Development Region				
Terai	161,000	85,000	246,000	172,000
Hills	51,000	0	51,000	25,000
Mountains	11,000	1,000	12,000	6,000
Far Western Development Region				
Terai	105,000	128,000	233,000	170,000
Hills	36,000	0	36,000	19,000
Mountains	16,000	0	16,000	9,000
Total	380,000	214,000	594,000	401,000

Table 1.2.2 PRESENT IRRIGATION DEVELOPMENT COMMAND AREAS (1/2)

<MID WESTERN DEVELOPMENT REGION>

Unit : ha

District	Developed Net Command Area (NCA) Irrigated Area			Unident Irrig	Overall Total
	DOI Scheme	Farmer Scheme	Total		
Dangdeukhuri	2,085	32,756	34,841	0	34,841
Banke	1,250	9,169	10,419	0	10,419
Bardiya	960	27,619	28,579	0	28,579
Total For	4,295	69,544	73,839	0	73,839
TERAI			(74,000)		
Pyuthan	340	3,444	3,784	506	4,290
Rolpa	0	1,934	1,934	795	2,729
Salyan	0	2,796	2,796	1,651	4,447
Rukum	600	1,426	2,026	194	2,221
Surkhet	0	9,862	9,862	0	9,862
Jajarkot	0	2,013	2,013	1,301	3,314
Dailekh	0	3,438	3,438	2,667	6,105
Total For	940	24,912	25,852	7,114	32,967
HILL			(26,000)		
Dolpa	0	264	264	0	264
Jumla	0	2,315	2,315	0	2,315
Kalikot	0	1,498	1,498	1,255	2,754
Mugu	0	987	987	800	1,787
Humla	0	471	471	88	558
Total For	0	5,535	5,535	2,143	7,678
MOUNTAIN			(6,000)		

Source: MPID2, Table A1-7

Table 1.2.2 PRESENT IRRIGATION DEVELOPMENT COMMAND AREAS (2/2)

<FAR WESTERN DEVELOPMENT REGION>

Unit : ha

District	Developed Net Command Area (NCA) Irrigated Area			Unident Irrig	Overall Total
	DOI Scheme	Farmer Scheme	Total		
Kailali	10,295	35,354	45,649	0	45,649
Kanchanpur	6,948	10,680	17,628	4,342	21,970
Total For	17,243	46,034	63,277	4,342	67,619
TERAI			(63,000)		
Achhan	0	5,331	5,331	5,022	10,353
Doti	0	5,086	5,086	3,613	8,699
Dadeldhura	120	3,410	3,530	2,548	6,078
Baitadi	395	3,225	3,620	2,901	6,521
Total For	515	17,052	17,567	14,084	31,651
HILL			(17,000)		
Bajura	0	1,742	1,742	642	2,384
Bajhang	0	3,668	3,668	3,044	6,712
Darchula	0	2,060	2,060	1,181	3,241
Total For	0	7,470	7,470	4,867	12,337
MOUNTAIN			(7,000)		

Source: MPID2, Table A1-7

Table 1.2.3 PRESENT AGRICULTURAL LAND USE (1/2)

<MID WESTERN DEVELOPMENT REGION>

Unit : Net ha

District	Agricultural Land use at Present				Total Cultivated Area	Total Irrigable
	Un Irrigated	Monsoon Season Irrigated	Year Round Irrigated	Total Irrigated	Area	
	1			2	3 = 1 + 2	4
Dangdeukhuri	40,536	18,719	5,267	23,986	64,522	59,505
Banke	39,529	7,487	2,509	9,995	49,524	48,550
Bardiya	40,945	9,627	2,264	11,891	52,836	52,660
Total For TERAI	121,010	35,832	10,040	45,872	166,882 (167,000)	160,715 (161,000)
Pyuthan	18,907	2,197	2,093	4,290	23,197	7,037
Rolpa	26,922	1,303	1,426	2,729	29,651	3,980
Salyan	23,586	2,308	2,139	4,447	28,032	5,282
Rukum	21,372	1,110	1,110	2,221	23,592	4,170
Surkhet	23,448	4,337	3,446	7,783	31,231	19,275
Jajarkot	17,800	1,663	1,651	3,314	21,114	4,143
Dairekh	22,268	3,631	2,474	6,105	28,373	7,075
Total For HILL	154,302	16,549	14,339	30,888	185,190 (185,000)	50,962 (51,000)
Dolpa	4,896	50	50	100	4,995	544
Jumla	10,532	1,115	995	2,110	12,642	4,765
Kalikot	10,372	1,547	1,207	2,754	13,125	3,084
Mugu	7,830	893	893	1,787	9,617	2,030
Humla	4,425	279	279	558	4,984	969
Total For MOUNTAIN	38,055	3,884	3,424	7,309	45,363 (46,000)	11,392 (11,000)

1, 2: From LRMP agricultural land use data base of cultivation types and cropping sequences (assumption)

4: Irrigable agricultural land areas from LRMP agricultural land use analysis

Source: MPID2, Table A1-6

Table 1.2.3 PRESENT AGRICULTURAL LAND USE (2/2)

<FAR WESTERN DEVELOPMENT REGION>

Unit : Net ha

District	Agricultural Land use at Present				Total Cultivated Area	Total Irrigable
	Un Irrigated	Monsoon Season Irrigated	Year Round Irrigated	Total Irrigated	Area	
	1			2	3 = 1 + 2	4
Kailali	36,458	20,873	9,392	30,265	66,722	64,112
Kanchanpur	19,000	13,783	8,167	21,970	40,971	40,891
Total For TERAI	55,458	34,656	17,579	52,235	107,693 (108,000)	105,003 (105,000)
Achhan	21,629	5,037	5,316	10,353	31,982	10,972
Doti	18,862	3,877	4,823	8,699	27,562	10,468
Dadeldhura	9,954	2,060	4,018	6,078	16,032	7,266
Baitadi	19,022	2,695	3,826	6,521	25,543	7,450
Total For HILL	69,467	13,668	17,983	31,651	101,118 (101,000)	36,155 (36,000)
Bajura	9,797	1,241	1,143	2,384	12,181	3,584
Bajhang	15,931	3,306	3,405	6,712	22,643	7,549
Darchula	9,960	1,276	1,965	3,241	13,201	4,239
Total For MOUNTAIN	35,687	5,823	6,514	12,337	48,024 (48,000)	15,373 (16,000)

1, 2: From LRMP agricultural land use data base of cultivation types and cropping sequences (assumption)

4: Irrigable agricultural land areas from LRMP agricultural land use analysis

Source: MPID2, Table A1-6

Table 1.2.4 IRRIGATION POTENTIAL BY LAND TYPE AND LAND USE (1/2)

<MID WESTERN DEVELOPMENT REGION>

Unit : ha

District	Net Irrigable Areas					
	Breakdown by Land Type			Breakdown by Land Use		
	TP&HV*	HS**	Total	Irrigable Agric.	Irrigable Non Agric.	Total Irrigable Area
Dangdeukhuri	66,767	22	66,789	59,505	7,284	66,789
Banke	84,540	45	84,585	48,550	36,035	84,585
Bardiya	94,264	41	94,305	52,660	41,645	94,305
Total For	245,571	108	245,679	160,715	84,964	245,679
TERAI			(246,000)	(161,000)	(85,000)	(246,000)
Pyuthan	6,374	664	7,037	7,037	0	7,037
Rolpa	2,192	1,788	3,980	3,980	0	3,980
Salyan	3,790	1,492	5,282	5,282	0	5,282
Rukum	3,491	678	4,170	4,170	0	4,170
Surkhet	18,165	1,110	19,275	19,275	0	19,275
Jajarkot	1,975	2,168	4,143	4,143	0	4,143
Dailekh	2,540	4,536	7,075	7,075	0	7,075
Total For	38,527	12,435	50,962	50,962	0	50,962
HILL			(51,000)	(51,000)	(0)	(51,000)
Dolpa	868	0	868	544	324	868
Jumla	4,526	239	4,765	4,765	0	4,765
Kalikot	661	2,423	3,084	3,084	0	3,084
Mugu	764	1,267	2,030	2,030	0	2,030
Humla	1,601	133	1,733	969	764	1,733
Total For	8,420	4,060	12,480	11,392	1,088	12,480
MOUNTAIN			(12,000)	(11,000)	(1,000)	(12,000)

* Terai plains and Hill valleys
** Hill slope
Source: MPID2, Table A2-3

Table 1.2.4 IRRIGATION POTENTIAL BY LAND TYPE AND LAND USE (2/2)

<FAR WESTERN DEVELOPMENT REGION>

Unit : ha

District	Net Irrigable Areas					
	Breakdown by Land Type			Breakdown by Land Use		
	TP&HV*	HS**	Total	Irrigable Agric.	Irrigable Non Agric.	Total Irrigable Area
Kailali	136,026	532	136,558	64,112	72,446	136,558
Kanchanpur	96,564	0	96,564	40,891	55,673	96,564
Total For	232,590	532	233,122	105,003	128,119	233,122
TERAI			(233,000)	(105,000)	(128,000)	(233,000)
Achham	3,725	7,246	10,972	10,972	0	10,972
Doti	5,710	4,757	10,468	10,468	0	10,468
Dadeldhura	4,983	2,283	7,266	7,266	0	7,266
Baitadi	2,796	4,653	7,450	7,450	0	7,450
Total For	17,215	18,940	36,155	36,155	0	36,155
HILL			(36,000)	(36000)	(0)	(36,000)
Bajura	2,229	1,355	3,584	3,584	0	3,584
Bajhang	5,026	2,523	7,549	7,549	0	7,549
Darchula	1,943	2,296	4,239	4,239	0	4,239
Total For	9,198	6,175	15,373	15,373	0	15,373
MOUNTAIN			(16,000)	(16000)	(0)	(16,000)

* Terai plains and Hill valleys

** Hill slope

Source: MPID2, Table A2-3

Table 1.2.5 RANKING OF HILL VALLEY POTENTIAL IRRIGABLE AREA

Unit : Net ha

Ranking	District Name(Region)	Potential Irrigabe Area 1) Population (1991)	HV	HS	Identified 2) Scheme by MPID2 (Overall ha)	Remarks
1.	Surkhet(MID)	225,296	18,165	1,110	943	
2.	Pyuthan(MID)	173,893	6,374	664	1,000	out of study area
3.	Doti(FAR)	167,469	5,710	4,757	*1,102	*SHIP
4.	Bajhang(FAR)	139,178	5,026	2,523	*1,381	*SHIP
5.	Dadeldhura(FAR)	104,449	4,983	2,283	305	
6.	Jumla(MID)	76,305	4,526	239	250	
7.	Salyan((MID)	182,145	3,790	1,492	70	
8.	Achham(FAR)	197,888	3,725	7,246	142	
9.	Rukum(MID)	155,017	3,491	678	425	
10.	Baitadi(FAR)	220,229	2,796	4,653	227	
11.	Dailekh(MID)	187,820	2,540	4,536	477	
12.	Bajura(FAR)	92,083	2,229	1,355	295	
13.	Rolpa(MID)	179,904	2,192	1,788	100	
14.	Jajarkot(MID)	114,267	1,975	2,168	109	
15.	Darchula(FAR)	101,614	1,943	2,296	629	
16.	Humla(MID)	34,640	1,601	133	90	
17.	Dolpa(MID)	25,075	868		110	
18.	Mugu(MID)	36,445	764	1,267	201	
19.	Kalikot(MID)	88,781	661	2,423	315	
Total(Hill+Mount)		2,702,304	73,359	41,611	8,171	

1) Source:MPID2 Table A2-3
HV:Hill Valleys, HS:Hillslope

2) Source:MPID2 Tabie A3-3,Not Include Innitial Stage of Aerial Inspection Potential Irrigable Area By Study Team

Table 1.3.1 PRODUCTION OF FIVE MAIN FOOD GRAINS BY DEVELOPMENT REGION IN 1988/89

Unit : metric ton

Grains	Development Regions					Total
	Eastern	Central	Western	Mid Western	Far Western	
Paddy	971,630	1,138,710	614,410	312,620	245,840	3,283,210
Maize*	253,650	315,268	251,721	183,567	67,404	1,071,610
Millet	43,380	30,570	78,350	18,540	12,250	183,090
Wheat	133,970	287,510	158,730	155,750	94,090	830,050
Barley	2,180	4,340	4,520	11,330	4,650	27,020
Total	1,404,810	1,776,398	1,107,731	681,807	424,234	5,394,980

Note :

* Production of maize by Development Region is missing in Agricultural Statistics of Nepal, 1990, but its total production is available. Production of maize by Development Region in 1988/89 was estimated by multiplying the production rate of each Development Region to the total in 1987/88 by the 1988/89 total production.

Table 1.3.2 POPULATION PROJECTION OF THE FIVE DEVELOPMENT REGIONS

Development Region	Annul Growth Rate of Popu., %	Population				
		1981	1988	1991	2000	2013
Eastern	1.83	3,708,923	4,210,930	4,448,374	5,237,005	6,629,300
Central	2.32	4,909,357	5,764,323	6,174,237	7,589,761	10,226,217
Western	1.83	3,128,859	3,552,354	3,751,922	4,417,082	5,591,395
Mid Western	2.09	1,955,611	2,260,294	2,406,095	2,898,422	3,792,654
Far Western	2.45	1,320,089	1,563,821	1,681,453	2,090,703	2,863,834
Total		15,022,839	17,351,722	18,462,081	22,232,973	29,103,400

Note :

Population of year 1988, 2000 and 2013 was projected by Development Region based on the annual growth rate obtained by using the 1981 and 1991 Population Cnsuses.

Table 1.3.3 BALANCE OF FIVE MAIN FOOD GRAINS BY DEVELOPMENT REGION

Unit : metric ton

Development Region	Production in YR. 1988/89	Year 1988			Year 2000			Year 2013		
		Population	Requirement	Balance	Population	Requirement	Balance	Population	Requirement	Balance
Eastern	1,404,810	4,210,930	1,309,599	95,211	5,237,005	1,628,709	-223,899	6,629,300	2,061,712	-656,902
Central	1,776,398	5,764,323	1,792,704	-16,306	7,589,761	2,360,416	-584,018	10,226,217	3,180,353	-1,403,955
Western	1,107,731	3,552,354	1,104,782	2,949	4,417,082	1,373,713	-265,982	5,591,395	1,738,924	-631,193
Mid Western	681,807	2,260,294	702,951	-21,144	2,898,422	901,409	-219,602	3,792,654	1,179,515	-497,708
Far Western	424,234	1,563,821	486,348	-62,114	2,090,703	650,209	-225,975	2,863,834	890,652	-466,418
Total	5,394,980	17,351,722	5,396,384	-1,404	22,232,973	6,914,456	-1,519,476	29,103,400	9,051,156	-3,656,176

Notes :

1) The balance of five main food grains was computed by using the estimated value of 311 kg required for each person in a year.
2) The balance of five main food grains in year 2000 and 2013 is sought relying on the production in year 1988/89.

Table 2.1.1 PRESENT SITUATION OF IRRIGATION PROJECT : SURKHET DISTRICT (1/5)

Type of Irrigation System	Implementing Agency	Existing Project		On-going Project		Planned Project		Cancelled Project		Remarks (MPID2. Project Number)
		Name or Nos.	NCA (ha)	Name or Nos.	NCA (ha)	Name or Nos.	NCA (ha)	Name or Nos.	NCA (ha)	
I. DOI	DIO (MPID2)	Khorke Khola	108			Babiyachaur	325			11501, 504
		Salkot	300							11502
		Kaprichaur	210							11503
	(OTHERS)			K-BIRD	1,318	Surkhet Valley	2,700			
				Chhinchu	354					
	Total I	3	618	2	1,672	2	3,025			
II. FMIS	Farmers	291	12,364							
III. AMIS	Farmers									
	Total for II+III	291	12,364							
	Total for I+II+III	294	12,982	2	1,672	2	3,025			

Note

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AMIS : Agency Managed Irrigation Systems (before sponsered by DOI, DIO, DDC, FAO etc.)
DIO : District Irrigation Office
SHIP : Second Hill Irrigation Project
MPID2 : Smaller Identified Potential Projects in Master Plan for Irrigation Development Cycle 2.
NCA : Net Command Area
n. a : Not Available.
K-BIRD : Karnali Bheri Integrated Rural Development

Table 2.1.1 PRESENT SITUATION OF IRRIGATION PROJECT : DAILEKH DISTRICT (2/5)

	Type of Irrigation System	Implementing Agency	Existing Project		On-going Project		Planned Project		Cancelled Project		Remarks (MPID2. Project Number)
			Name or Nos.	NCA (ha)	Name or Nos.	NCA (ha)	Name or Nos.	NCA (ha)	Name or Nos.	NCA (ha)	
I.	DOI	DIO (MPID2)			Rawatkot	477					110701
		(OTHERS)	Lohartar	30			Mafuwa	26			
		Total	1	30	1	477	1	26			
II.	FMIS	Farmers	206	2,413							
III.	AMIS	Farmers	25	708							
		Total for II+III	231	3,121							
		Tatol for I+II+III	232	3,151	1	477	1	26			

Note

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DIO : District Irrigation Office
SHIP : Second Hill Irrigation Project
MPID2 : Smaller Identified Potential Projects in Master Plan for Irrigation Development Cycle 2.
NCA : Net Command Area
n. a : Not Available.

Table 2.1.1 PRESENT SITUATION OF IRRIGATION PROJECT : JAJARKOT DISTRICT (3/5)

Type of Irrigation System	Implementing Agency	Existing Project		On-going Project		Planned Project		Cancelled Project		Remarks (MPID2. Project Number)
		Name or Nos.	NCA (ha)	Name or Nos.	NCA (ha)	Name or Nos.	NCA (ha)	Name or Nos.	NCA (ha)	
I. DIO	DIO (MPID2)			Holubhairabi	47	Nepgad	48			110601, 602
				Daha Khola	230	Jukot	n.a			110603, 604
	(OTHERS)			Bhutchaur	225	Punma	112			
				Ragadachaur	43	Paink Gintala	120			
				Thulo bagar	53	Paink Aaukiya	100			
				Rawat	20	Dhime	95			
						Pain Panikhet	90			
	Total of I			6	617	7	565			
II. FMIS	Farmers	121	2,131							
III. AMIS	Farmers	11	1,093							
	Total of II+III	132	3,224							
	Total of I+II+III	132	3,224	6	617	7	565			

Note

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SHIP : Second Hill Irrigation Project
MPID2 : Smaller Identified Potential Projects in Master Plan for Irrigation Development Cycle 2.
NCA : Net Command Area
n. a : Not Available.

Table 2.1.1 PRESENT SITUATION OF IRRIGATION PROJECT : RUKUM DISTRICT (4/5)

Type of Irrigation System	Implementing Agency	Existing Project		On-going Project		Planned Project		Cancelled Project		Remarks (MPID2. Project Number)
		Name or Nos.	NCA (ha)	Name or Nos.	NCA (ha)	Name or Nos.	NCA (ha)	Name or Nos.	NCA (ha)	
I. DOI	DIO (MPID2)	Natigad	50	Kotajahari	n.a	Ghatte Khola	58			110401, 404, 405
						Majoo Khola	42			110402
						Rukumkot	275			110403
	(OTHERS)	Bhanbhane Khola	n.a	Gatta Shentar	n.a					
		Garkhani Khola	n.a	Kamalpokhari	n.a					
		Chaurjahari	400	Pokhara	n.a					
		Jharabang Farm	n.a	Lagim	n.a					
		Sima farm	n.a							
	Total for I	6	450	4	n.a	3	375			
II. FMIS	Farmers	74	869							
III. AMIS	Farmers	29	1,595							
	Total for II+III	103	2,464							
	Total for I+II+III	109	2,914	4	n.a	3	375			

Note

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DIO : District Irrigation Office
SHIP : Second Hill Irrigation Project
MPID2 : Smaller Identified Potential Projects in Master Plan for Irrigation Development Cycle 2.
NCA : Net Command Area
n. a : Not Available.

Table 2.1.1 PRESENT SITUATION OF IRRIGATION PROJECT : SALYAN DISTRICT (5/5)

	Type of Irrigation System	Implementing Agency	Existing Project		On-going Project		Planned Project		Cancelled Project		Remarks (MPID2. Project Number)
			Name or Nos.	NCA (ha)	Name or Nos.	NCA (ha)	Name or Nos.	NCA (ha)	Name or Nos.	NCA (ha)	
I.	DOI	DIO (MPID2)			Banjhakanda	70					110301
		(OTHERS)	Falante Khola	40	Sitalpati	45					
			Med Khola	50	Lahaghat	50					
			Kharagar	40							
			Goth Khola	40							
			Farulachaur	50							
			Jimali Khola	50							
			Dendedade	30							
			Karagithi	60							
			Pipalneta	30							
		Total	9	390	3	165					
II.	FMIS	Farmers	289	4,256							
III.	AMIS	Farmers									
		Total for I+II	298	4,646	3	165					
		Total for I+II+III	298	4,646	3	165					

Note

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DIO : District Irrigation Office
SHIP : Second Hill Irrigation Project
MPID2 : Smaller Identified Potential Projects in Master Plan for Irrigation Development Cycle 2.
NCA : Net Command Area
n. a : Not Available.

Table 2.1.2 PRESENT SITUATION OF IRRIGATION PROJECT : JUMLA DISTRICT (1/5)

Type of Irrigation System	Implementing Agency	Existing Project Name or Nos.	Existing Project NCA (ha)	On-going Project Name or Nos.	On-going Project NCA (ha)	Planned Project Name or Nos.	Planned Project NCA (ha)	Cancelled Project Name or Nos.	Cancelled Project NCA (ha)	Remarks (MPID2. Project Number)
I. DOI	DIO (MPID2)	Dhupijyula	50			Garyangkot	200			120201
	(OTHERS)	Tatopani V. P.								120202
		Yakagau Tathandl	n.a	Ukhadi Irr Tank	25	Bhondariwadi	n.a			
		Bajaghat	20	Bumaramadi cha	15	Malakotor Malpa	n.a			
		Faste Gaon	30			Dhupijyula	n.a			
						Gajyangkot	15			
						Kashikakot Sime	n.a			
						Ghodemahadev T	20			
						Lohapi Gau	n.a			
						Tali V. P. Kanch	n.a			
						Mahatgau V.	n.a			
						Sani V.	n.a			
						Baskot V.	n.a			
						Malcpatal Khola				
						Khola Gau	n.a			
	Total	4	100	2	40	13	235			
II. FMIS	Farmers	n.a								
III. AMIS	Farmers	n.a								

Note

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DIO : District Irrigation Office
SHIP : Second Hill Irrigation Project
MPID2 : Smaller Identified Potential Projects in Master Plan for Irrigation Development Cycle 2.
NCA : Net Command Area

Table 2.1.2 PRESENT SITUATION OF IRRIGATION PROJECT : KALIKOT DISTRICT (2/5)

Type of Irrigation System	Implementing Agency	Existing Project		On-going Project		Planned Project		Cancelled Project		Remarks (MPID2. Project Number)
		Name or Nos.	NCA (ha)	Name or Nos.	NCA (ha)	Name or Nos.	NCA (ha)	Name or Nos.	NCA (ha)	
I. DOI	DIO (MPID2)					Khanlagad khola	100	Ukhadi Khola	215	120301, 120302
	(OTHERS)					Jhayangard	75			
						Kuni	70			
						Ukhadi	300			
						Bharta	156			
						Naulhan	140			
						Raku	8			
						Podecha	14			
						Sukatiya	30			
						Lalu	60			
	Total					10	953	1	215	
II. FMIS	Farmers	n.a								
III. AMIS	Farmers	n.a								

Note

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DIO : District Irrigation Office
SHIP : Second Hill Irrigation Project
MPID2 : Smaller Identified Potential Projects in Master Plan for Irrigation Development Cycle 2.
NCA : Net Command Area
n. a : Not Available.

Table 2.1.2 PRESENT SITUATION OF IRRIGATION PROJECT : MUGU DISTRICT (3/5)

Type of Irrigation System	Implementing Agency	Existing Project		On-going Project		Planned Project		Cancelled Project		Remarks (MPID2. Project Number)
		Name or Nos.	NCA (ha)	Name or Nos.	NCA (ha)	Name or Nos.	NCA (ha)	Name or Nos.	NCA (ha)	
I. DOI	DIO (MPID2)					Natharpur	60			120401
						Dhilamaghatta	141			120402
	(OTHERS)	Khanayagau	20	Gulmkulo	175					
				Lumsha	20					
	Total	1	20	2	195	2	201			
II. FMIS	Farmers	n.a								
III. AMIS	Farmers	n.a								

Note

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DIO : District Irrigation Office
SHIP : Second Hill Irrigation Project
MPID2 : Smaller Identified Potential Projects in Master Plan for Irrigation Development Cycle 2.
NCA : Net Command Area
n. a : Not Available.

Table 2.1.2 PRESENT SITUATION OF IRRIGATION PROJECT : HUMLA DISTRICT (4/5)

Type of Irrigation System	Implementing Agency	Existing Project		On-going Project		Planned Project		Cancelled Project		Remarks (MPID2. Project Number)
		Name or Nos.	NCA (ha)	Name or Nos.	NCA (ha)	Name or Nos.	NCA (ha)	Name or Nos.	NCA (ha)	
I. DOI	DIO (MPID2)	Yanchu Khola	35					Sanya Khola	70	120501, 502
	(OTHERS)	Melchham	31			Masspur	300			
						Shreenagar	65			
						Kharpu	20			
	Total	2	65			3	385	1	70	
II. FMIS	Farmers	n.a								
III. AMIS	Farmers	n.a								

Note

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DIO : District Irrigation Office
SHIP : Second Hill Irrigation Project
MPID2 : Smaller Identified Potential Projects in Master Plan for Irrigation Development Cycle 2.
NCA : Net Command Area
n. a : Not Available.

Table 2.1.2 PRESENT SITUATION OF IRRIGATION PROJECT : DOLPA DISTRICT (5/5)

Type of Irrigation System	Implementing Agency	Existing Project		On-going Project		Planned Project		Cancelled Project		Remarks (MPID2. Project Number)
		Name or Nos.	NCA (ha)	Name or Nos.	NCA (ha)	Name or Nos.	NCA (ha)	Name or Nos.	NCA (ha)	
I. DOI	DIO (MPID2)	Jupal	175			Chaila	110			120101, 102
	(OTHERS)	Raligaun	20							
		Likhu	200			Mukut.	n.a			
		Patihalnarini	50			Mijer.	n.a			
		Dottakup	15			Simushaldang	n.a			
						Komashagaun	25			
						Guphatar	n.a			
						Hulhara	n.a			
	Total I	5	460			7	135			
II. FMIS	Farmers	n.a								
III. AMIS	Farmers	n.a								

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DIO : District Irrigation Office
SHIP : Second Hill Irrigation Project
MPID2 : Smaller Identified Potential Projects in Master Plan for Irrigation Development Cycle 2.
NCA : Net Command Area
n. a : Not Available.

Table 2.2.1 PRESENT SITUATION OF IRRIGATION PROJECT : DOTI DISTRICT (1/3)

Type of Irrigation System	Implementing Agency	Existing Project Name or Nos.	Existing Project NCA (ha)	On-going Project Name or Nos.	On-going Project NCA (ha)	Planned Project Name or Nos.	Planned Project NCA (ha)	Cancelled Project Name or Nos.	Cancelled Project NCA (ha)	Remarks (MPID2. Project Number)
I. DOI	DIO (MPID2)									
	(OTHERS)	Doud	20	Kalagad	50	Dang	n.a			
		Sau Khola	40	Banlekh	55	Girichoura	40			
		Baglekh	n.a	Rithegad	50	Lana Kedareswor	55			
		Tijali	30			Toleri	50			
		Basudevi	60			Lamikhel	25			
		Dipayal	45			Kalikasthan	9			
		Ranagaon	30							
		Pachnali	15							
		Barchhen	20							
		Gadsera	40							
		Tijdli	20							
		Bhanwar Dada	6							
		Mudegaon	20							
		Pokhri	10							
	Total	14	356	3	155	6	179			
	SHIP (MPID2)	Dipayal East	45	Dipayal West	55			Bhumitdjmandu	100	140201, 202
		Kaflebari II	60	Kadamandu	140			Mastamandu	102	140203, 205, 206
		Kaflebari I	28	Bandungrasain	155			Mudegaon	60	140204, 208, 209
				Latamandu	120					140207
	(OTHERS)									
	Total	3	133	4	470	6	179	3	262	
	Total for I	17	489	7	625	6	179	3	262	
II. FMIS	Farmers	203	3,121							
III. AMIS	Farmers									
	Total for II+III	203	3,121							
	Total for I+II+III	220	3,610	7	625	6	179	3	262	

Note

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DIO : District Irrigation Office
SHIP : Second Hill Irrigation Project
MPID2 : Smaller Identified Potential Projects in Master Plan for Irrigation Development Cycle 2.
NCA : Net Command Area
n. a : Not Avaiable.

Table 2.2.1 PRESENT SITUATION OF IRRIGATION PROJECT : ACHHAM DISTRICT (2/3)

Type of Irrigation System	Implementing Agency	Existing Project		On-going Project		Planned Project		Cancelled Project		Remarks (MPID2. Project Number)
		Name or Nos.	NCA (ha)	Name or Nos.	NCA (ha)	Name or Nos.	NCA (ha)	Name or Nos.	NCA (ha)	
I. DOI	DIO (MPID2)									
	(OTHERS)	Pujgaon	15	Daigepani	35					
				Kotekhet	20					
				Deotada	16					
	Total	1	15	3	71					
	SHIP (MPID2)			Lungreli Parbal	141					140101
	(OTHERS)			Babla	30	Chandika	75			
						Khaptad	140			
						Vardadevi	65			
						Sutar	140			
						Mujagaon	60			
	Total			2	171		480			
	Total for I	1	15	5	242	5	480			
II. FMIS	Farmers	204	2,518							
III. AMIS	Farmers	14	113							
	Total for I+II	218	2,631							
	Total for I+II+III	219	2,646	5	242	5	480			

Note

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AMIS : Agency Managed Irrigation Systems (before sponsered by DOI, DIO, DDC, FAO etc.)
DIO : District Irrigation Office
SHIP : Second Hill Irrigation Project
MPID2 : Smaller Identified Potential Projects in Master Plan for Irrigation Development Cycle 2.
NCA : Net Command Area
n. a : Not Available.

Table 2.2.1 PRESENT SITUATION OF IRRIGATION PROJECT : DADELDHURA DISTRICT (3/3)

Type of Irrigation System	Implementing Agency	Existing Project		On-going Project		Planned Project		Cancelled Project		Remarks (MPID2. Project Number)
		Name or Nos.	NCA (ha)	Name or Nos.	NCA (ha)	Name or Nos.	NCA (ha)	Name or Nos.	NCA (ha)	
I. DOI	DIO (MPID2)			Gilla	80					140301, 302
				Sakayal	60					140303, 304
				Sirse Khola	208	Dotikhola	208			
	(OTHERS)			Ugra Tara	50					
	Total for I			4	398	1	208			
II. FMIS	Farmers	157	943							
III. AMIS	Farmers									
	Total for II+III	157	943	4	398	1	208			

Note

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DIO : District Irrigation Office
SHIP : Second Hill Irrigation Project
MPID2 : Smaller Identified Potential Projects in Master Plan for Irrigation Development Cycle 2.
NCA : Net Command Area
n. a : Not Available.

Table 2.2.2 PRESENT SITUATION OF IRRIGATION PROJECT : BAITADI DISTRICT (1/4)

Type of Irrigation System	Implementing Agency	Existing Project		On-going Project		Planned Project		Cancelled Project		Remarks (MPID2.
		Name or Nos.	NCA (ha)	Name or Nos.	NCA (ha)	Name or Nos.	NCA (ha)	Name or Nos.	NCA (ha)	Project Number)
I. DOI	DIO (MPID2)	Surnayagad	120	Satgad	65	Kakari-Melghat	65			140401, 402, 405
				Dilleswari	90					140403
				Dumanigad	24					140404
	(OTHERS)	Sehari	58	Udaya	10					
		Thala Kanda	25	Kohila	80					
		Salena	65	Simile	8					
		Agreghat	12							
		Dhungeli	6							
	Total I	6	286	6	277	1	65			
II. FMIS	Farmers	n. a								
III. AMIS	Farmers	n. a								
	Total for I+II+III	6	286	6	277	1	65			

Note

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DIO : District Irrigation Office
SHIP : Second Hill Irrigation Project
MPID2 : Smaller Identified Potential Projects in Master Plan for Irrigation Development Cycle 2.
NCA : Net Command Area
n. a : Not Available.

Table 2.2.2 PRESENT SITUATION OF IRRIGATION PROJECT : DARCHULA DISTRICT (2/4)

Type of Irrigation System	Implementing Agency	Existing Project		On-going Project		Planned Project		Cancelled Project		Remarks (MPID2. Project Number)
		Name or Nos.	NCA (ha)	Name or Nos.	NCA (ha)	Name or Nos.	NCA (ha)	Name or Nos.	NCA (ha)	
I. DOI	DIO (MPID2)			Kukuregad	114	Dharigad	300			150301, 303
				Umara Raskot	95					150302
				Dhap	120					150304
	(OTHERS)	Lithu Pattu	40	Dinasi	50	Sipti	95			
				Barab luita	60	Lasku	40			
				Baskot	40					
				Selpe	40					
				Baseri	40					
	Total	1	40	8	559	3	435			
II. FMIS	Farmers	n.a								
III. AMIS	Farmers	n.a								

Note

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DIO : District Irrigation Office
SHIP : Second Hill Irrigation Project
MPID2 : Smaller Identified Potential Projects in Master Plan for Irrigation Development Cycle 2.
NCA : Net Command Area
n. a : Not Available.

Table 2.2.2 PRESENT SITUATION OF IRRIGATION PROJECT : BAJURA DISTRICT (3/4)

Type of Irrigation System	Implementing Agency	Existing Project		On-going Project		Planned Project		Cancelled Project		Remarks (MPID2. Project Number)
		Name or Nos.	NCA (ha)	Name or Nos.	NCA (ha)	Name or Nos.	NCA (ha)	Name or Nos.	NCA (ha)	
I. DOI	DIO (MPID2)									
	(OTHERS)			Jera	80					
				Pudabawla	30					
				Lamgaon	42					
				3	152					
	SHIP			Kolti	150					150101
				Gothi (Pandusen)	80					150102
						Martadi	65			150103
	(OTHERS)	Bandhu	50			Barbise	150			
	Total	1	50	2	230	2	215			
	Total for I	1	50	5	382	2	215			
II. FMIS	Farmers	n.a								
III. AMIS	Farmers	n.a								

Note

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DIO : District Irrigation Office
SHIP : Second Hill Irrigation Project
MPID2 : Smaller Identified Potential Projects in Master Plan for Irrigation Development Cycle 2.
NCA : Net Command Area
n. a : Not Available.

Table 2.2.2 PRESENT SITUATION OF IRRIGATION PROJECT : BAJHANG DISTRICT (4/4)

Type of Irrigation System	Implementing Agency	Existing Project Name or Nos.	Existing Project NCA (ha)	On-going Project Name or Nos.	On-going Project NCA (ha)	Planned Project Name or Nos.	Planned Project NCA (ha)	Cancelled Project Name or Nos.	Cancelled Project NCA (ha)	Remarks (MPID2. Project Number)
I. DOI	DIO (MPID2)									
	(OTHERS)	Majesin	60	Barbelka	70	Baweli	100			
				Tamil	30	Jimkot	25			
				Regum	30	Panalt	40			
						Bhatgaon chaur	80			
						Dafru	60			
						Rilu	25			
						Dipil	50			
	Total	1	60	3	130	7	380			
	SHIP (MPID2)	Juili	172	Thapagaon	155	Pujarikot	41	Tontali	60	150201, 202, 206, 216
		Ritapata	125	Majhigaon	170	Biskhet	89			150203, 204, 208
		Deuraphant	34	Talkot-Dantoli	172	Khaira	70			150205, 210, 209
		Gairasela	44	Bhandar-Panesh	86	Paringal	100			150207, 211, 214
		Kuchha	68			Regan	50			150212, 215,
		Pikhet	155							150213
	(OTHERS)			Ruinabagar	34					
	Total	6	598	5	617	5	350	1	60	
	Total for I	7	658	8	747	12	730	1	60	
II. FMIS	Farmers	n.a								
III. AMIS	Farmers	n.a								

Note

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DIO : District Irrigation Office
SHIP : Second Hill Irrigation Project
MPID2 : Smaller Identified Potential Projects in Master Plan for Irrigation Development Cycle 2.
NCA : Net Command Area
n. a : Not Available.

Table 3.2.1 LARGE SCALE POTENTIAL IRRIGATION PROJECTS

Unit: Net ha

Name	District	Existing		New Scheme	Total
		DOI	FMIS		
Run-of-River Project					
Sikta	Banke	1,250	2,890	31,930	36,070
Babai	Bardiya		5,308	8,192	13,500
Khutiya II	Kailai		1,000	2,500	3,500
Mahakali II	Kanchanpur		703	6,099	9,800
Multipurpose Project					
West Rapti	Kapilbastu	800	4,996	24,704	30,500
	Dangdeukhuri	435	7,396	1,669	9,500
	Banke	1,250	2,890	31,930	36,070
	Total	2,485	15,282	58,303	76,070
Karnali	Banke	1,250	2,430	32,471	36,151
	Bardiya	960	23,527	39,682	64,169
	Kailali	3,633	28,653	58,344	90,630
	Total	5,843	54,610	130,497	190,950
Bheri-Babai	Bardiya	960	11,312	27,728	40,000
					636,910

Remarks: DOI: Irrigation system managed by DOI
FMIS: Farmer managed irrigation system

Source: MPID2 Annexes-Volume 1

Table 3.3.1 SUMMARY OF THE SMALLER IDENTIFIED POTENTIAL IRRIGATION PROJECTS (1/2)

<MID WESTERN DEVELOPMENT REGION>

Unit : ha

District	Number of Projects	Net Command Areas		
		Overall Scheme	Existing Scheme	New Scheme
Dangdeukhuri	8	3,125	480	2,645
Banke				
Bardiya	1	290		290
Total For TERAI	9	3,415	480	2,935
Pyuthan	3	1,000		1,000
Rolpa	1	100		100
Salyan	1	70		70
Rukum	5	425		425
Surkhet	4	943	200	743
Jajarkot	3	109	67	42
Dailekh	1	477		477
Total For HILL	18	3,124	267	2,857
Dolpa	2	110		110
Jumla	2	250		250
Kalikot	2	315		315
Mugu	2	201		201
Humla	2	90		90
Total For MOUNTAIN	10	966		965
Total For MID WEST	37	7,505	747	6,757

Source: MPID2, Table A3-3

Table 3.3.1 SUMMARY OF THE SMALLER IDENTIFIED POTENTIAL IRRIGATION PROJECTS (2/2)

<FAR WESTERN DEVELOPMENT REGION>

Unit : ha

District	Number of Projects	Net Command Areas (ha)		
		Overall Scheme	Existing Scheme	New Scheme
Kailai	1	649		649
Kanchanpur	2	1,800		1,800
Total For TERAI	3	2,449		2,449
Achhan	1	142		142
Doti	9	1,102	313	789
Dadeldhura	4	305		305
Baitadi	5	227		227
Total For HILL	19	1,776	455	1,321
Bajura	3	295	45	250
Bajhang	16	1,381	965	416
Darchurla	4	629	90	539
Total For MOUNTAIN	23	2,305	1,100	1,205
Total For FAR WEST	45	6,530	1,555	4,975
Total For MID+FAR	82	14,035	2,302	11,732

Source: MPID2, Table A3-3